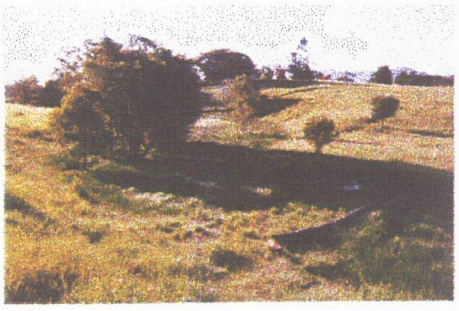
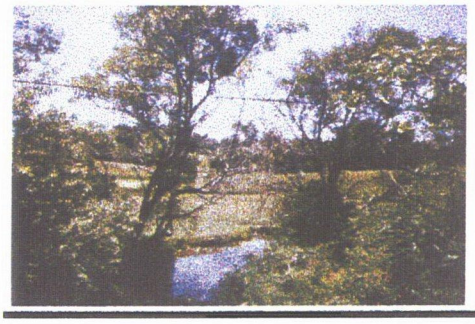
Roads and Traffic Authority

Representations Report





The Bonville Project
Volume III

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July 1999

APPENDIX 3 – Species Impact Statement Supplementary Information Report

BIOSIS

RESEARCH

Bonville Project
Species Impact Statement –
Supplementary Information Report

May 1999

Prepared for

PPK Environment & Infrastructure

By

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INTRODUCTION

Biosis Research prepared the *Species Impact Statement – Bonville Project in July 1998.* The Species Impact Statement (SIS) was exhibited for a five-week period during which time members of the public and relevant government agencies were invited to tender their submissions on various aspects of the project. A number of submissions raised issues in relation to the SIS. Responses to these issues are presented in Part A of this Species Impact Statement Supplementary Information Report (hereafter referred to as SIS SIR).

The aims of Part A are:

- To summarise how the SIS complied with the requirements of the *Threatened Species Conservation (TSC) Act 1995*;
- To summarise how the SIS complied with the Director-General (D-G) Requirements of NSW National Parks & Wildlife Service (NPWS) dated 12 August 1997;
- To address comments included in the NSW NPWS submission dated 8 September 1998;
- To address issues raised by a review of the 8-part test (Biosis Research 1997) undertaken by P. & J. Smith (1998);
- To clarify any further outstanding issues with respect to the SIS.

In addressing matters raised in relation to the EIS and SIS, the Roads & Traffic Authority (RTA) undertook additional desktop studies on flora and fauna issues, as well as specialist studies into aquatic species and wetlands. As a result of those studies and in response to representations received, the RTA decided to modify the proposal exhibited in the EIS to minimise identified impacts on terrestrial and aquatic fauna and on wetlands. The modifications are described in the *Supplementary Route Selection and Design Report* (PPK 1999a). Of particular relevance to this report were the widening of the median and the provision of additional mitigation measures in the Pine Creek State Forest segment of the route.

The environmental impacts of the proposed modifications in relation to flora and fauna are assessed in Part B of this document. Part B outlines how the proposed modifications would minimise impacts on flora and fauna identified in the EIS.

How to Read this Report

Part A of this report considers only outstanding environmental issues arising from the Species Impact Statement (Biosis Research 1998). The SIS described and assessed a proposal that is hereafter referred to as the "original proposal". Major tables in this part of the report are denoted by the prefix "A".

Part B of this report assesses what is hereafter referred to as the "modified proposal". It comprises a stand-alone report that addresses all changes that may have occurred in response to submissions and to changes in conservation significance or to threatened species considered as a result of additional studies. The proposal was modified mainly within Pine Creek State Forest (PCSF) and at creek and wetland crossings. Changes are associated with:

- Redesign of the proposal, including mitigation measures;
- Consideration of seven additional Vulnerable or Endangered species;
- Any changes in conservation significance status based on new information;

- Results of additional studies undertaken.

Major headings, tables and figures in this part of the report are denoted by the prefix "B". Attachments contain relevant submissions, reports prepared as part of this study and Curricula Vitae for relevant personnel.

Part A – Compliance with SIS Requirements and Responses to NPWS Submissions

Part A of this report is comprised of tables and associated Attachments. The three major tables summarise the Species Impact Statement requirements, D-G Requirements and points raised in the NPWS submission (some of these are covered in the other two tables). Attachments comprise supporting tables and maps.

Tables and Attachments are summarised below:

Table A1 Compliance of SIS with requirements of the *Threatened Species Conservation Act 1995*.

Table A2 Compliance with requirements of the Director-General of the NSW NPWS.

Table A3 Responses to NPWS comments on Species Impact Statement – Bonville Project (Biosis Research 1998).

Table A4 Responses to comments on Bonville 8-part test (Biosis Research 1997) by P. & J. Smith Ecological Consultants dated November 1998.

Table A5 Further clarification of the SIS based on comments provided by Chris Moon dated 19/10/98.

A1.0 Attachments

A1.1 Figures

Figure 1 (a-c) Vegetation Communities Within the Study Corridor.

Figure 2 Flora Sample Sites.

Figure 3 Vegetation Community Mapping (reproduced from Fisher *et al.* (1996)).

Figure 4 Koala Habitat Mapping (reproduced from SFNSW (1997)).

Figure 5 Fauna Sample Sites.

A1.2 Tables

Table 1 Survey effort for the proposed route.

Table 2 Probability levels of occurrence in the study area for all threatened species.

Table 3 Areas of vegetation communities removed as a result of the proposal.

Table 4 Weather conditions during the survey periods, as extracted from the Bureau of Meteorology, Coffs Harbour Meteorological Office (1997).

Table 5 Comparison of communities mapped by Fisher *et al.* (1996) and by Biosis Research.

TABLE A1: Compliance of the SIS with requirements of the *Threatened Species Conservation Act 1995*. Any issues associated with the modified proposal are found in Part B of this report.

SECTION	ISSUES	SIS REFERENCE	RESPONSE
109(1)	A Species Impact Statement must be in writing	Complies	
109(2)	A Species Impact Statement must be signed by the principal author of the Statement and by the applicant	Declaration in front of SIS	
110(1)	A Species Impact Statement must include full description of the action proposed, including its nature, extent, location, timing and layout and, to the fullest extent reasonably practicable, the information referred to in this section	Section 1.1	
110(2)	A Species Impact Statement must include:		
110(2)(a)	a general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action;	Appendix E	
110(2)(b)	an assessment of which threatened species or populations known or likely to be present in the area are likely to be affected by the action;	Appendix E	
110(2)(c)	for each species or population to be affected, details of its local, regional and State-wide conservation status, the key threatening processes generally affecting it, its habitat requirements and any recovery plan or threat abatement plan applying to it;	Appendix E	No recovery or threat abatement plans have been prepared for the species listed in Appendix 2 of the D-G Requirements.
110(2)(d)	an estimate of local and regional abundance of those species or populations;	Appendix E	Quantitative surveys are generally not undertaken for impact assessments which are primarily concerned with recording the presence or absence of species, particularly

SECTION	ISSUES	SIS REFERENCE	RESPONSE
			threatened species. Apart from Koalas, most of the relevant species have never or only rarely been recorded in the local area (i.e. 10-km radius). Abundance estimates cannot be calculated using these data. SFNSW (1997) reported that there were approximately 400 Koalas in PCSF. Local Koala expert Chris Moon (*pers. comm.*) notes that there are no large concentrations of Koalas to the east of the existing highway between PCSF and Lyons Road. There are unlikely to be 100 animals scattered throughout this area and he cautions that there may be considerably less than this number.
110(2)(e)	a general description of the threatened species or populations known or likely to be present in the area that is likely to be affected by the action;	Appendix E	This has been repealed.
110(2)(f)	a full description of the type, location, size and condition of the habitat (including critical habitat) of those species and populations and details of the distribution and condition of similar habitats in the region;	Appendix E	
110(2)(g)	a full assessment of the likely effect of the action on those species and populations, including, if possible, the quantitative effect of local populations in the cumulative effect in the region;	Appendix E	
110(2)(h)	a full description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic and	Section 6.1	Alternative routes for the highway proposal were summarised in Sections 4.1, 4.2 and 4.8 of the EIS and in PPK (1999). Alternative routes were assessed from an

SECTION	ISSUES	SIS REFERENCE	RESPONSE
	social considerations and the principles of ecologically sustainable development;		environmental viewpoint in Biosis Research (1997). This study found the existing Pacific Highway corridor to be the best option because it was already subject to disturbance and barrier effects. Environmentally, the best option through PCSF is determined to be as close as possible to the existing highway. This minimises further disturbance and barrier effects in an area considered to be of State conservation significance. An alternative route located approximately 200 m to the east of the existing Pacific Highway was proposed by the Bellingen Environment Centre (BEC) in their submission. The flora and fauna values of this route were investigated in January 1999 by PPK Environment & Infrastructure and Chris Moon (PPK 1999b). The study found that there were only minor differences between the BEC proposal and the modified proposal. Overall, the BEC route had marginally less ecological value than the modified proposal; however, the former route would cause greater fragmentation of the forest and would probably result in a greater overall impact to the regional Koala population.

SECTION	ISSUES	SIS REFERENCE	RESPONSE
			Amongst all the options considered between Pine Creek and Lyons Road, the upgrade of the existing highway was assessed as having the least environmental effects. The proposed route transects areas of remnant vegetation and plantation varying from regional to high local significance and creates new creek crossings. Impacts on sensitive areas were reduced through minor adjustments in alignment but the final route was constrained by noise and other community issues. The proposed route minimised environmental impacts north of Williams Road. Bongil Bongil NP, an area of high regional significance, is found in this area. Habitat lost in this area would be compensated as part of a larger habitat compensation package to be negotiated between the RTA and NPWS.
110(2)(i)	a full description and justification of the measures proposed to mitigate any adverse effect of the action on the species and populations, including a compilation (in a single section of the statement) of those measures;	Tables 3 & 4, Section 6.1	
110(2)(j)	A list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the species or	Section 3	The RTA is the proponent and nominated determining authority for the proposal. The Chief Executive of the RTA will seek the concurrence of the Director-General of the

SECTION	ISSUES	SIS REFERENCE	RESPONSE
	population.		National Parks and Wildlife Service if it is decided that the proposal is to proceed. In the event that the Director-General of the NPWS does not concur the proposal will not proceed. If the Director-General of the NPWS concurs, the approval of the Minister for Urban Affairs and Planning will be sought. If the approval is given, the Chief Executive of the RTA will determine if the project will proceed. If mangroves are to be trimmed or removed as part of the project, then a permit is required in accordance with the *NSW Fisheries Act 1994*. Development consent may be required to clear native vegetation in accordance with the *Native Vegetation Conservation Act 1997* unless an exemption applies because of the provisions of section 88 of the *Roads Act 1993*. Biosis Research has the approval of the Director-General of NSW Agriculture Animal Care and Ethics Committee to conduct surveys for Environmental Impact Statements and Species Impact Statements. The RTA does not require further approval if the project proceeds.

SECTION	ISSUES	SIS REFERENCE	RESPONSE
110(3)	A Species Impact Statement must include information as to "ecological communities".		None of the ecological communities listed in Schedule 1 of the *TSC Act 1995* are present within the study corridor.
110(4)	A Species Impact Statement must include details of the qualifications and experience in threatened species conservation if the person preparing the statement and of any other person who has conducted research or investigation relies on in preparing the statement.	Appendix K	
110(5)	The requirements of subsection (2) and (3) in relation to information concerning the State-wide conservation status of any species or population, or any ecological community, are taken to be satisfied by the information in that regard supplied to the principal author of the Species Impact Statement by the NP&WS, which information that Service is by this subsection authorised and required to provide.		Noted
111	Director-General's Requirements	Appendix A	

TABLE A2: Compliance with requirements of the Director-General of the NSW NP&WS.

SECTION	ISSUES	SIS REFERENCE	RESPONSE
	The SIS must include the information requested below:		
1	*Study area.* The type of action proposed must be detailed, including the timetable for the carrying out the proposed development and the number of hectares affected. This must include details of the location of any auxiliary infrastructure and all components of the proposed development.	Section 1.1	
	A plan of the study area will be provided. This plan will show the location and type of vegetation communities present within the study area and the scale of the plan.	Appendix J	
	An aerial photograph (preferably colour) of the locality (or reproduction of such a photograph) must be provided. This aerial photograph should clearly show the study area and the scale of the photograph	Appendix J	
	A topographic map of the locality at a scale of 1:25 000 must be provided. This map will detail the location of the proposal, major land tenure unit such as parks, reserves, and State Forests, and areas of high activity such as townships, regional centres and major roads.		Given the linear nature of the development and the difficulty of presenting a map at this scale, NPWS accepted that the scales of the existing maps were adequate.
	Threatened species habitat The location of the subject species recorded during the SIS survey must be represented on a map of the study area. Where available, the information provided must include species name, date recorded, name of person who made the record, type of record	Figure 4, Table 2	

SECTION	ISSUES	SIS REFERENCE	RESPONSE
	(e.g. scat identification, trapped, sighted), use of habitat (e.g. nesting, roosting, foraging), and number of individuals recorded.		
	A description of suitable habitat characteristics for subject species within the study area can be clearly delineated, this habitat must be represented on a map of the study area.	Appendix E	See Figure 1(Attachments)
	A list of subject species must be provided. In determining these species, consideration shall be given to the habitat types present within the study area, records of threatened species in the locality and the known distribution of threatened species. The subject species must include, but need not be limited to the following species:	Appendix D	
	Amphibia: Green and Golden Bell Frog *Litoria aurea* Green-thighed Frog *Litoria brevipalmata* Wallum Froglet *Crinia tinnula* **Reptiles:** White-crowned Snake *Cacophis harrietae* Pale-headed Snake *Hoplocehalues bitoqualus* Stephen's Banded Snake *Hoplocehalues stephensii*	 Appendix D Appendix D Appendix D Appendix D Appendix D Appendix D	
	Birds:		

SECTION	ISSUES		SIS REFERENCE	RESPONSE
	Black Bittern	*Dupetor flavicollis*	Appendix D	
	Black-necked Stork	*Xenorhynchus asiatucus*	Appendix D	
	Bush Thick Knee	*Burhinus magnirostris*	Appendix D	
	Glossy Black Cockatoo	*Calyptorhynchus lathami*	Appendix D	
	Masked Owl	*Tyto novaehollandiae*	Appendix D	
	Osprey	*Pandion haliaetus*	Appendix D	
	Powerful Owl	*Ninox strenua*	Appendix D	
	Red Goshawk	*Erythrotriorchis radiatus*	Appendix D	
	Rose-crowned Fruit Dove	*Ptilinopus regina*	Appendix D	
	Sooty Owl	*Tyto tenebricosa*	Appendix D	
	Square-tailed Kite	*Lophoiciinia isura*	Appendix D	
	Swift Parrot	*Lathamus discolor*	Appendix D	
	White-eared Monarch	*Monarcha leucotis*	Appendix D	
	Wompoo Fruit Dove	*Ptilinopus* magnificus	Appendix D	
	Yellow-eyed Cuckoo Shrike	*Coracina lineata*	Appendix D	
	Mammals:			
	Brush-tailed Phascogale	*Phascogale tapoatafa*	Appendix D	
	Common Planigale	*Planigale maculata*	Appendix D	
	Koala	*Phascolarctos cinereus*	Appendix D	
	Long-nosed Potoroo	*Potorous tridactylus*	Appendix D	
	Parma Wallaby	*Macropus parma*	Appendix D	
	Squirrel Glider	*Petaurus norfolcensis*	Appendix D	
	Tiger Quoll	*Dasyurus australis*	Appendix D	
	Yellow-bellied Glider	*Petaurus australis*	Appendix D	
	Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	Appendix D	
	Greater Broad-nosed Bat	*Scoteanax rueppellii*	Appendix D	
	Eastern Little Mastiff Bat	*Mormopterus norfolkensis*	Appendix D	
	Hoary Bat	*Chalinolobus nigrogriseus*	Appendix D	

SECTION	ISSUES		SIS REFERENCE	RESPONSE
	Great Pipistrelle	*Falsistrellus tasmaniensis*	Appendix D	
	Golden-tipped Bat	*Kerivoula papuensis*	Appendix D	
	Large-footed Mouse-eared Bat	*Myotis Adversus*	Appendix D	
	Little Bent-wing Bat	*Miniopterus australis*	Appendix D	
	Common Bent-wing Bat	*Miniopterus schreibersii*	Appendix D	
	Queensland Blossom Bat	*Syconycteris australis*	Appendix D	
	Plants:			
	Amorphospermum whitei		Appendix G	
	Acronychia littoralis		Appendix G	
	Hicksbeachia pinnatifolia		Appendix G	
	Marsdenia longiloba		Appendix G	
	Parsonsia dorrigoensis (sp. B)		Appendix G	
	Petsicairia elatior		Appendix G	
	Phaius australis		Appendix G	
	Tinospora tinosporoides		Appendix G	
	In describing the study area, consideration must be given to the previous land uses and the effect of these land uses on the study area. Relevant historic events may include sand mining, fire history, clearing, logging, recreational use and agriculture activities		Section 2	
	A description of fauna habitat components such as the frequency of tree hollows, density of understorey vegetation and presence of rock outcrops must be given. The condition of the habitat within the study area must be discussed, including the prevalence of introduced species. A description of the habitat requirements of threatened species likely to occur in the study area must be provided.		Section 4.4.2.2, Appendix E	

SECTION	ISSUES	SIS REFERENCE	RESPONSE
	Fauna habitat for subject species must be described with particular reference to which area are used in the study area, and for what purposes these areas are required (e.g. roosting, feeding, nesting or breeding, etc.)	Appendix E	
	Survey methods A fauna and flora survey is to be conducted in the study area. Targeted surveys must be conducted for all subject species. Species of taxonomic uncertainty must be confirmed by a recognised authority such as the Australian Museum or NSW National Herbarium	Section 4.3.2.2	
	A full description of the methodologies used in the fauna and flora surveys and habitat assessment must be provided, including survey techniques employed, number and location of traps, size of survey sites, dates of survey, the time spent surveying and prevailing weather conditions. Where appropriate this information must be provided in map format. Where possible, surveys should be undertaken during seasons and climatic conditions during which the subject species are most likely to be detected.	Section 4.3.2.2	See Figure 2 (Attachments) See Table 1 (Attachments)
	In addition to survey records, where NPWS predicted distribution maps are available for fauna listed in Section 1.7, these must be consulted to identify areas of potential habitat for threatened species within the study area. These maps are available under licence from NPWS.		The threatened species predictive distribution maps (RACAC 1996) provide probability levels for the occurrence of threatened species in the study area. All species that have predicted distribution maps available are presented with their probability levels of occurrence in Table 2 (Attachments).
	Any areas which may act as corridors between the study area and adjacent areas of likely habitat for subject species must be	Section 4.4.3	

SECTION	ISSUES	SIS REFERENCE	RESPONSE
	identified and described.		
	A full list of the protected fauna and native plants (as defined by the *National Parks and Wildlife Act 1974*) found during the course of surveys must be included. Such information is indicative of the habitat quality of the site.	SIS Appendix H, SIS Appendix G	SISSIR Section B5.0
	The effect of the season, prevailing weather conditions, and survey techniques employed must be considered with respect to the results of the survey.	Section 4.3.2.3	
2	**Assessment of likely impacts** The assessment matters listed below must be addressed: For all subject species, the SIS shall state the following:		
	• the location, nature and extent of habitat removal or modification which may result from the proposed action;	Section 5.6.1 to Section 5.6.6	See Table 3 (Attachments)
	• the potential impact of the removal or modification of habitat: and	Section 5.6.1 to Section 5.6.6	
	• The likely contribution of the proposed action to threatening processes acting on population of those species in the locality.	Section 5.6.1 to Section 5.6.6	
	• A discussion of other populations of threatened species in the locality must be provided. The long-term security of the other	Section 4.6.1 to 4.6.6	

SECTION	ISSUES	SIS REFERENCE	RESPONSE
	habitats must be examined. The relative significance of the subject site for subject species in the local context must be provided. • If movement corridors for subject species are present within the subject site, the impact of the proposal on these areas must be discussed • Consideration must be given to possible indirect effects of the action on the area surrounding the subject site, for example altered hydrological regimes, soil erosion or pollution	Section 5.3.2 Section 5	See Part B SISSIR
3	**Amelioration** The following issues must be addressed: While no recovery plans or threat abatement plans have been approved in accordance with the *TSC Act* as yet, draft recovery plans have been prepared for the species listed in Appendix 2. Where a draft recovery plan is relevant to any subject species, consideration must be given to the information contained in these plans and whether any draft recovery plan recommendation is applicable to the proposal.	Not Applicable (Draft Recovery Plans were not available for the species listed in Appendix 2)	
	In discussing alternatives to the proposal, and the measures proposed to mitigate the effect of the proposal, consideration must be given to developing long-term management strategies to protect areas within the study area which are of particular importance for the subject species. This may include proposals to restore or improve habitat, and/or to provide compensatory habitat. The strategies should identify the long-term objectives for the subject	Section 5.5, Section 6, Section 5.6.2.2, Table 4	

SECTION	ISSUES	SIS REFERENCE	RESPONSE
	site. Measures for minimising the number of road kills of threatened fauna, particularly the Koala, should be identified. These may include fauna over or underpasses, exclusion fencing, and appropriate revegetation and habitat restoration in adjacent areas. The techniques used must employ current best known practice. As such, an appropriate directed literature review should be conducted.		
	Any proposed monitoring of the effectiveness of the proposed mitigation measures, and of the impact of the proposal on subject species, must be provided. Details of the methodology of such monitoring must be provided. A discussion of possible options for changes to mitigation measures in the light of monitoring results must be included.	SIS Section 7, SISSIR Section B9.1	
	Details of any habitat restoration programmes proposed for the study area must be provided, including the expected timeframe for habitat restoration, any proposals or opportunities to improve habitat, and the likely impact on flora and fauna, particularly during the time between the impact on the habitat and any habitat restoration.		There are no plans for habitat restoration included in the proposal. However, opportunities for revegetation works have been identified in forested areas adjacent to Bongil Bongil NP and PCSF and at Pine Creek. All disturbed areas would be restored as soon as possible after clearing. An EMP would be prepared in consultation with NPWS.
4	**Additional Information** • Any consent required under Part IV of the *Environmental Planning and Assessment Act 1979* including the name of the consent authority and when it is proposed to make the development application; or • Any approvals required under Part V of the *Environmental*		The RTA is the proponent and nominated determining authority for the proposal. The Chief Executive of the RTA will seek the concurrence of the Director-General of the National Parks and Wildlife Service if it is decided that the proposal is to proceed. In the event that the Director-General of the NPWS does not concur the proposal will not

SECTION	ISSUES	SIS REFERENCE	RESPONSE
	Planning and Assessment Act 1979 including the name of the determining authority(ies), the basis for the approval and when these approvals are proposed to be obtained. • Animal Care and Ethics Committee approval under the *NSW Animal Research Act 1985*		proceed. If the Director-General of the NPWS concurs, the approval of the Minister for Urban Affairs and Planning will be sought. If the approval is given, the Chief Executive of the RTA will determine if the project will proceed. If mangroves are to be trimmed or removed as part of the project, then a permit is required in accordance with *the Fisheries Management Act 1994*. If the proposal is not considered to be a designated development, then a permit to clear native vegetation may be required in accordance with the *Native Vegetation Conservation Act 1997*. Biosis Research has the approval of the Director-General of NSW Agriculture Animal Care and Ethics Committee to conduct surveys for Environmental Impact Statements and Species Impact Statements. The RTA does not require further approval if the project proceeds.
Appendix 3 1.2	Refer to Koala survey maps (Lunney *et al.* 1997).	SIS Section 4.5.8	Koala habitat maps included in SISSIR.
1.6	Dry pitfall trapping required to target Common Planigale	SIS Section 4.3.2.2	Species presumed to be present.
1.9	Mist netting required to target Queensland Blossom Bat.	SIS Section 4.3.2.2	Species presumed to be present.
1.10	Diurnal bird species listed to be targeted during survey.	SIS Section 4.3.2.2,	Species presumed to be present.

SECTION	ISSUES	SIS REFERENCE	RESPONSE
		Appendix E	
1.11	Reptile species listed to be targeted during survey.	SIS Section 4.3.2.2, Appendix E	Species presumed to be present.
1.12	Threatened fauna features to be targeted during surveys.	SIS Section 4.3.2.2, Appendix E	Additional information provided in SISSIR.
3	Data provided to NPWS for inclusion into Atlas of NSW Wildlife.		Data has been provided to NPWS.
3.1(iii)	AMG locations for fauna and flora surveys to be provided.	Section 4.6, Figure 4	Additional data has been provided in SISSIR.
3.1(vii)	AMG locations for Rusty Plum to be provided.	SIS Figure 4	SISSIR Part A Table A3, page 4-15
3.2	Call playbacks for Squirrel Glider and Bush Thick-knee required.	SIS Nocturnal Call Playbacks	SISSIR Part A Table A3, p. 4-6

Table A3: Response to NPWS comments (9/9/98) on Species Impact Statement (Biosis Research 1998). Amendments to the text are listed below. Some amendments are included in Part B of this report.

Page #	Section	SIS Reference	Amendments
2-1	2 Study Area	Para 2, sentence 5	Replace with: This species was previously listed as Presumed Extinct in Schedule 1, Part 4 of the *Threatened Species Conservation (TSC) Act 1995*. It is now provisionally listed as Endangered in Schedule 1 of the *TSC Act 1995*. The provisional listing has been determined by the NSW Scientific Committee (1998) on an emergency basis as the species is likely to become extinct if the circumstances and factors threatening its survival continue.
3-1	3. Legislative Context	Para 1, end of sentence 1	Add: "...habitat, populations and ecological communities."
		End of para 2	Add: This Species Impact Statement has been prepared according to the Director General's requirements of the New South Wales National Parks and Wildlife Service, in accordance with Section 111 of the *Threatened Species Conservation (TSC) Act 1995*.
		End of para 4	Add: SEPP 44 does not apply to land dedicated or reserved under *the National Parks and Wildlife Act 1974* or land dedicated under the *Forestry Act 1916* as a State Forest or Flora Reserve. SEPP 44 therefore does not apply to that part of the study area within Pine Creek State Forest or to land owned by NPWS.
4-3	4.3.1.1 Survey Effort	Survey effort table	See Table 1 (Attachments)
4-4	4.3.1.3 Data Collection	Map of vegetation communities	See Figure 1 (Attachments)
		Para 2, sentence 1	Replace with: Records of threatened flora (flora listed as Endangered or Vulnerable in the *TSC Act 1995*) .....
		Para 2 "significant"	Replace with: "threatened"
		Para 3, sentence 1	Replace with: Searches for threatened flora species, rare flora species (Briggs and Leigh 1995) and significant species (Sheringham and Westaway 1997) .....
4-5	4.3.1.6 Classification of vegetation	Fisher et al. (1996) map; PCSF Koala habitat mapping	See Figures 3 and 4 (Attachments)

Page #	Section	SIS Reference	Amendments
	communities		
	4.3.2.1 Survey Effort, Nocturnal call playback	Figure 4 "frog call playback" symbol	Replace with "nocturnal call playback" symbol. See amended Figure 5 (Attachments).
	Hair tube	Para 1, before last sentence	Insert: Each of these transects was 200 metres long.
	Koala surveys by Chris Moon	Para 1, sentence 3	Replace with: The proposed truck stop was briefly assessed for vegetation diversity and complexity, habitat values, topographical features and amenity on 4 May 1998 (Moon 1998a).
4-6	4.3.2.2 Survey technique, Habitat Models and Dip net surveys	Para 1	Replace with: Several different survey techniques were used in order to target threatened fauna species. These techniques are outlined in the D-G Requirements; the exceptions are pit-fall trapping, mist-netting, dip-netting and call playback for Squirrel Gliders. The latter two techniques are relatively time-consuming and were aimed at capturing only two species, the Common Planigale and Queensland Blossom Bat. Therefore, it was agreed with NPWS that we would assume these species were present due to suitable habitat occurring in the study site. This suitable habitat was determined using the threatened species predictive distribution models provided by the NPWS (RACAC 1996). The dip net surveys were not considered essential by NPWS with the frog call playback and active searching following rain considered appropriate for the frog species targeted. In addition to this, specialist frog surveys were undertaken by a recognised authority, Francis Lemckert. The Squirrel Glider call playbacks were not conducted since this species is not generally highly vocal and recordings of this uncommon call were therefore not available.
	Frog surveys	Para 1, end of sentence 3	Add: ...by nocturnal and diurnal call playback.
		Para 1, sentence 4	Replace with: Some calls were recorded for subsequent analysis by Ray Williams (Ecotone Ecological Consultants).
		Para 1, sentence 5	Remove: "and tadpole searches"

Page #	Section	SIS Reference	Amendments
	Reptile surveys	Para 1, sentence 2	Replace with: As stated in the D-G Requirements bark, ground debris, fallen hollow logs and senescent trees which provided potential snake shelter were examined diurnally and nocturnally.
	Nocturnal call playback	Bush Stone Curlew	No change. See Section *Nocturnal Call Playback*.
	Bat surveys	Survey dates	No change. Details in Section 4.3.2.1 Survey Effort.
	Survey dates	Survey dates	No change. Details in Section 4.3.2.1 Survey Effort.
	Weather conditions	Table showing weather conditions	See Table 4 (Attachments)
4-8	4.3.2.3 Limitations	Para 1, last sentence	Replace with: The threatened species predictive distribution maps (RACAC 1996) were available for all threatened bat species listed in the D-G Requirements, except for the Yellow-bellied Sheath-tailed Bat *Saccolaimus falviventris* and the Eastern Little Mastiff Bat *Mormopterus norfolkensis*. The latter species are therefore assumed to occur within the study site where suitable habitat occurs. All other bat species are considered to have the potential to occur within the study site due to the presence of suitable habitat (RACAC 1996). The call playback technique may have a reduced effectiveness when conducted in close proximity to major roads due to traffic noise. This limitation would be most applicable to the nocturnal call play back site at Sid Burke Rest Area (Site 1) and the frog call playback site at Pine Creek (Site 1). However, these surveys were conducted at night outside peak traffic periods. The nocturnal call playback at Mailmans Track Road, Pine Creek State Forest was conducted away from the highway with minimal interference by traffic noise.
4-9	4.4.1.1 Species	Para 2, sentence 1 "(1995)"	Replace with: "(1996)"
		End of para 2	Insert: National significance is also assessed using the *Endangered Species Protection (ESP) Act 1992*.
4-10	4.4.1.2 Communities	End para 4	Add: Fisher *et al.* (1996), Griffith (1993) and RACAC (1996) were also used in the assessment of regional significance.

Page #	Section	SIS Reference	Amendments
4-13	4.4.3 Flora and Fauna Corridors	End of para 1	Add: In addition to these two regional corridors, locally significant corridors occur along Bonville Creek, Pine Creek and other minor creeks.
	4.5.2 Vegetation Communities	Map showing vegetation communities.	See Figure 1 (Attachments)
4-13		First sentence and dot-points	Replace with: Seven broad native vegetation communities occur within the study area. These are listed in (new table to be inserted) below. The equivalent community description from Fisher *et al.* (1996) is provided. Insert Table 5 (Attachments).
4-14	4.5.2 Vegetation Communities, *Tall Open Forest (Tallowwood)*	Add to dot-points	• *Tallowwood/Sydney Blue Gum Tall Open Forest* Dominant tree species in this community include Tallowwood *Eucalyptus microcorys* and Sydney Blue Gum *E. saligna*. Other canopy species present include Blackbutt *E. pilularis*, Narrow-leaved White Mahogany *E. acmenoides*, Turpentine *Syncarpia glomulifera* and Flooded Gum *E. grandis*. *Condition:* Good • *Mixed Hardwood* As the description for this community suggests, the canopy is a mix of hardwood species, including Narrow-leaved White Mahogany *E. acmenoides*, Grey Ironbark *E. siderophloia* and the Grey Gum *E. propinqua*. No Red Mahogany *E. resinifera* was recorded from the study area. Other species such as Tallowwood, Blackbutt, Pink Bloodwood *Corymbia intermedia* and Brush Box *Lophostemon confertus* are also present. *Condition:* Moderate-Good
		First sentence "...occurs in Site 6"	Replace with: "...occurs in Site 1 (near Pine Creek) and Site 6."
	Tall Open Forest *(Flooded Gum dominant)*	First sentence	Add: "Site 6" to list.

Page #	Section	SIS Reference	Amendments
4-15	4.5.3 Significant flora species	First 2 paras	Replace with: Rusty Plum *Amorphospermum whitei* was the only threatened flora species identified in the study area. This species is listed as Vulnerable on Schedule 2 of the *TSC Act 1995*. An individual plant was located in the Tall Open Forest in Pine Creek State Forest adjacent to the existing Truck Stop (Biosis Research 1997) within the area to be directly disturbed by the proposal. The specimen could not be relocated for survey undertaken for this report despite intensive searching by Biosis Research and a representative of the NPWS. However, two other specimens were located outside the area to be disturbed, but within the study area, in the vicinity of the original record (these are located at E302362, N1634751 and at E302650, N1634739. It is considered that the specimen located in the survey conducted for Biosis Research (1997) is the closer of the two specimens located for this study and will therefore not be affected by the proposal. The Rusty Plums surveyed were not flowering or fruiting. One plant species, Climbing Fern *Lygodium microphylla* is considered to be at or very close to its southern limit in the forest at Site 10 (Biosis Research 1997). This species is not listed on the *TSC Act 1995*; however it is considered to be regionally significant (Sheringham and Westaway 1997). A single specimen of *Epigomium roseum* was located at the site for the proposed Rest Area opposite Mailmans Track. This species is considered to be regionally significant (Sheringham and Westaway 1997). The flowering stem of the *Epigomium roseum* was submitted to the Herbarium and its identity has been confirmed. Four other species listed as significant (Sheringham and Westaway 1997) were recorded in the study area. These are *Arytera distylis*, *Digitaria divaricatissima*, *Exocarpus latifolius* and *Hybanthus vernonii* ssp *scaber*. *Eleocharis tetraquetra*, a species thought to be extinct in NSW until recently, was targeted as a result of a number of populations being located to the north of the study area. The species is now provisionally listed as Endangered in the *TSC Act 1995*. No specimens of *Eleocharis tetraquetra* were located along the proposed route.
4-16	4.5.4 Significant Vegetation	End of para 2	Add: Griffith (1993) cites Bonville (exact area not defined) as providing opportunities for further reservation of the Flooded Gum and Tallowwood associations. More specifically,

Page #	Section	SIS Reference	Amendments
	Communities		the conservation targets for vegetation communities developed by the Resource and Conservation Assessment Council (1996) for the Draft Interim Forestry Assessment Report have not been met for the Tallowwood, Flooded Gum, Moist Blackbutt or Swamp Forest communities present in the study area.
	4.5.5 Fauna species	Para 1, sentence 1	Replace with: A total of four amphibian species, four reptile species, 54 native bird species, 19 mammal species (18 native, one introduced) and one native invertebrate species were recorded during the present study.
		Sentence 2	Remove
	4.5.6 Fauna habitats	Paras describing each habitat type	Add: *Tall Open Forest (Blackbutt dominated)* Threatened species that have the potential to occur in this habitat type include the Powerful Owl, Stephen's Banded Snake, Common Planigale, Koala, Yellow-bellied Glider and Common Bent-wing Bat. *Tall Open Forest comprising Flooded Gum and rainforest species* Threatened species that have the potential to occur in this habitat type include the Powerful Owl, Wompoo Fruit-dove, Rose-crowned Fruit-dove, Barred Cuckoo-shrike, White-crowned snake, Giant-barred Frog, Long-nosed Potoroo, Koala, Yellow-bellied Glider and Queensland Blossom Bat. *Tall Open Forest dominated by Flooded Gum Plantation* Threatened species that have the potential to occur in this habitat type include the Masked Owl, Little Bent-wing Bat and Koala. The latter species was recorded in this habitat type. *Riparian vegetation (Blackbutt)* Threatened species that have the potential to occur in this habitat type include the Osprey, Square-tailed Kite, White-eared Monarch, Tiger Quoll, Koala and Large-footed Mouse-eared Bat. *Swamp Forest*

Page #	Section	SIS Reference	Amendments
			Threatened species that have the potential to occur in this habitat type include the Osprey, Regent Honeyeater, Black Bittern, Green and Golden Bell Frog, Wallum Froglet, Koala and Large-footed Mouse-eared Bat. *Sedgeland* Threatened species that have the potential to occur in this habitat type include the Black Bittern, Black-necked Stork, Green and Golden Bell Frog, Wallum Froglet and Large-footed Mouse-eared Bat.
4-19	4.5.7 Significant fauna species	After para 1 followed by new table	Insert: The threatened species predictive distribution maps (RACAC 1996) provide probability levels for the occurrence of threatened species in the study area. All species that have predicted distribution maps available are presented with their probability levels of occurrence in Table 2 (Attachments).
4-19	4.5.8 Significant fauna habitats	Para 1, sentence 2	Replace with: Although these fauna species are not likely to be solely dependent on habitat patches in the study site, vegetated remnants may provide important habitat features for threatened and other fauna (e.g. Koala food trees, hollow-bearing trees, roosts or nests).
		PCSF Koala Habitat mapping.	See Figure 4 (Attachments)
		Para 2	The predicted distribution maps (RACAC 1996) are at a much smaller scale than any of the study area maps and do not provide enough detail to accurately locate the habitat boundaries on appropriate maps. Pine Creek State Forest is the only area that is readily identifiable.
4-20	4.6.1 Site 1. Pine Creek State Forest (PSCF)	Heading "(PSCF)"	Replace with: "(PCSF)"
5.2	5.3.1 Vegetation Clearance/Habitat Loss	Table quantifying vegetation loss	See Table 3 (Attachments)

Page #	Section	SIS Reference	Amendments
5-3	5.3.2 Fragmentation/ Isolation of Habitats	Para 3, sentence 1	Replace with: The greatest potential for the cleared development area to act as a barrier is where it intersects wildlife corridors. There are two regional corridors and numerous locally significant corridors, which occur along Bonville Creek, Pine Creek and other minor creeks in the proposal area.
5-4	5.3.6 Feral Animals	End of para 1	Add: The European Red Fox is listed as a Threatening Process on Schedule 3 of the *Threatened Species Conservation Act 1995*. Fauna at particular risk are non-flying mammals between 35 g and 5 500g and ground nesting birds. Prey also includes reptiles, amphibians and invertebrates. It has been implicated in the severe decline and extinctions of fauna within this "Critical Weight Range".
		Last para, end of sentence 1	Add: ...and habitats with high edge to area ratios. That is, where new alignments and service roads are created there may be increased feral animal invasion, however the highway development is unlikely to significantly alter the current situation.
		Last sentence	Remove.
5-6	5.5 Mitigation measures into proposal	Part B SISSIR Sections B4.1, B4.2, B7.0	Mitigation measures for gliders are incorporated as part of the modified proposal. Compensatory habitat is discussed in detail in the report *Discussion Paper –Compensatory Habitat Assessment for the Bonville Deviation* (Bali and Anderson 1998) and summarised in the SISSIR.
5-7	5.5.2 Medium structures	Second dot-point	Remove.
5-8	5.6.1.1 Flora	Table 3, Site 10, Proposal column	Add: This land is currently owned by NPWS.
		Site 1, Proposal column, last sentence	Remove.

Page #	Section	SIS Reference	Amendments
		Site 1, Amelioration column, after "Rusty Plum..."	Insert: "...specimens adjacent to the proposal."
		Site 1, Amelioration column, delete "if transplantation not possible"	Replace with: The specimens should be protected from all works to be undertaken in the vicinity through the use of protective fencing and maintenance of existing runoff patterns during construction.
5-9	5.6.1.2 Fauna, *Pine Creek State Forest*	Para 2, before "(Austeco 1997)"	Insert: The potential for the Koala proof fencing to prevent fauna movement that currently occurs across the highway is high.
		Para 3, sentence 1, SISSIR	Remove.
5-11	5.6.2.2 Fauna	Table 4, "Proposal" heading	Replace with: "Mitigation Incorporated as Part of Proposal"
		Table 4, "Amelioration" heading	Replace with: "Amelioration Adequate?"
		Table 4, Amelioration column "none"	Replace with: "yes"
		Table 4, Amelioration column, Titans Close, last sentence	Add: Investigate potential for revegetation west of current highway to strengthen vegetation corridor.
	5.6.4 Aquatic impacts	Part B SISSIR Section B4.5	This was undertaken as part of an additional wetland assessment.
5-13	5.6.6 Cumulative impacts	Para 3	Replace with: Fencing undertaken along the route is likely to reduce fauna roadkills as the currently available habitat beside the highway will be made more secure. There will be a net loss of habitat and a modification of fauna movement across the highway as a result of

Page #	Section	SIS Reference	Amendments
			the development. In general, the loss of habitat associated with the development is not considered to be of a scale which would reduce biodiversity in the region.
6-1	6.1.1.3 Landscape plantings	Para 1, end of sentence 3	Add: ", especially along the roadside areas adjacent to Bongil Bongil National Park and Pine Creek State Forest."
6-6	6.1.2.1 Habitat loss	Part B SISSIR Sections 8.1.1	It should be noted that the clearing guidelines developed for the Bulahdelah to Cooloongoolook section of the Pacific Highway are part of an Environmental Management Plan and are therefore too detailed for an SIS. Broad guidelines for Rusty Plum have been developed. Broad pre-clearing guidelines are presented in Section B8.2.4.
	Appendix C Flora Profiles for Target Species	*Eleocharis tetraquetra*, Conservation Status, sentence 3 "form"	Replace with: "from"
2	Appendix E Fauna Profiles for Target Species	Giant Barred Frog, Amelioration Measures, last sentence	Add: Targeted surveys should be conducted at Pine Creek prior to construction and any individuals found should be relocated to nearby suitable habitat. Construction should be undertaken to avoid winter months if possible when this species is less active. Habitat restoration work should be undertaken adjacent to bridge work to maintain water quality and habitat for this species.
13		Osprey, Amelioration Measures, last sentence	Add: Clearance activities near the Osprey nest should be minimised or avoided during their nesting period (June to October).
31		Koala, Effects of Proposed Activities, end of para 1	Add: It is recognised however that this fencing may alter the movement patterns of Koalas.
8-1	8. Overall Impact Assessment	Dot-point 2	Replace with: Significant mitigation measures have been incorporated into the proposal in order to minimise barrier effects and to reduce or eliminate Koala road kills. These are

Page #	Section	SIS Reference	Amendments
			likely to reduce the impact of the existing Pacific Highway.
9-1	9. References	Additional references	Add: Briggs J.D. and Leigh J.H. (1996). *Rare or Threatened Australian Plants*. CSIRO Publishing Australia. Forestry Commission of New South Wales (1989). Research Note No. 17. *Forestry Types in New South Wales*. Forestry Commission of New South Wales, Sydney. Griffith S. (1993). *Conservation status of coastal plant communities in northern New South Wales – a review*. NSW National Parks and Wildlife Service. NSW Scientific Committee (1998). *Determination for listing of an endangered species on an emergency basis*. Sheringham P. and Westaway J. (1997). Significant Vascular Plants of Upper North East New South Wales. A Report by the New South Wales National Parks and Wildlife Service for the Natural Resources Audit Council. NSW National Parks and Wildlife Service.

Table A4: Responses to comments on Bonville 8-part test (Biosis Research 1997) by P. & J. Smith Ecological Consultants dated November 1998. Although it was beyond the scope of the authors to assess the SIS, their comments are also addressed below.

Comment	Response	Reference
Predictive lists are incomplete	The predictive lists are based on locality searches on the NPWS database.	
Four threatened fauna species were not considered in the SIS (Comb-crested Jacana, Regent Honeyeater, Eastern Chestnut Mouse, Eastern Cave Bat)	None of these species is listed under the D-G Requirements although suitable habitat occurs in the study corridor. For the sake of completeness, it has been assumed that all four species occur within the study area.	SISSIR Sections B5.2.1, B7.1.1, B7.1.2
Two threatened fauna species are not listed in the *TSC Act* and are not considered in the SIS (Grassland Melomys, Eastern Broad-nosed Bat)	As these species are not listed on Schedules 1 or 2 of the *TSC Act 1995*, they did not have to be considered in the SIS.	These species are not considered further in the SISSIR.
Consideration should be given to the following species: *Thesium australe*, Grass Owl, Barking Owl	Records for *Thesium australe* are very old. There is no suitable habitat for this species in the study corridor. The Grass Owl (*Tyto longimembris*) was formerly listed on the *TSC Act 1995* as the Eastern Grass *Owl (Tyto capensis*). It was not listed on the D-G Requirements. Because this species could occur in the study corridor, it has been considered in the SISSIR. The Barking Owl was listed on the *TSC Act* relatively recently (after 12 June 1998). As the 8-part test was completed in April 1997, these species were not targeted. Furthermore, this species was not listed on the D-G Requirements. Because this species could occur in the study corridor, it has been considered in the SISSIR.	SISSIR Sections B5.1, B5.2.1, B7.1.1, B7.1.2
No details given for time and date of flora survey		SIS Section 4.3.1.1, SISSIR Part A (Attachments)

Comment	Response	Reference
No details on timing or effort for fauna survey		SIS Section 4.3.2.1, Table 1
Threatened fauna not satisfactorily targeted	It should be noted that the survey methodology was discussed in detail with representatives from NPWS and with the Environment Officer from the RTA. Note also that as per the NPWS Information Circular 2 (NPWS 1996), habitat assessments are encouraged rather than detailed surveys for 8-part tests. Habitat for most species added to the D-G Requirements would have been recorded during the preliminary study (Biosis Research 1997). It is not a NPWS requirement to target each species by a specific survey procedure. It was also agreed with NPWS that, if we could not undertake specific survey methods such as pitfalling for dunnarts, then we would assume these species were present if their habitat was present.	
No mention of *Eleocharis tetraquetra* in the 8-part test	Prior to late 1997, E. *tetraquetra* was only known in NSW from the Grafton district. There were no recent records for this species during our 1997 locality search nor was it listed on the D-G Requirements. Once advised of its presence to the north of the study corridor, we undertook targeted searches.	SIS Section 4.5.3, SISSIR Part A (Table A3)
The SIS did not eliminate any threatened species from further consideration	No specific species were eliminated from further consideration. However, species that may be significantly impacted by the proposal are highlighted.	Appendix 10 in Biosis Research (1997)
Eight-part test does not address the problem of barriers being created for gliders; the SIS does not recommend mitigation for gliders		SISSIR Sections B4.2, B7.1.2
No mention of compensatory habitat	Compensatory habitat is mentioned in the SIS and in the SISSIR.	SIS Section 5.6.1.2, SISSIR Section B8.2.1

Comment	Response	Reference
No detailed mapping of vegetation communities and fauna habitat		SISSIR Part A (Attachments)
No quantification of native vegetation to be cleared		SISSIR Part A (Attachments)
No systematic attempt to identify and map sites of greatest conservation significance	A letter from NPWS (26 May 1997) specified those remnants that were to be surveyed as part of the SIS. These areas were mapped and their conservation significance assessed as part of the SIS.	SIS Figure 3, SIS Section 4.6
No consultation with predicted distribution maps of threatened fauna habitat	The predicted distribution maps (RACAC 1996) are at a much smaller scale than any of the study area maps and do not provide enough detail to accurately locate the habitat boundaries on appropriate maps. Pine Creek State Forest is the only area that is readily identifiable.	SISSIR Part A (Attachments)
Rainforest gullies have not been mapped	No rainforest was found within the study corridor. Gullies containing rainforest elements were actually Tallowwood – Sydney Blue Gum.	These gullies are not mapped separately but as part of the larger vegetation community (see Attachments).
No mapping of wetlands presented		SISSIR Figure B2, Appendix 4
No mapping of high quality Koala habitat presented		SISSIR Part A (Attachments)
Results of 8-part test at odds with Section 4.10 of the EIS		SISSIR Part A (Table A3)
Detailed assessment of the proposal left to the SIS	The detailed assessment of the proposal should be undertaken in the SIS rather than in the 8-part test.	

TABLE A5: Further clarification of the SIS based on comments provided by Chris Moon dated 19/10/98.

Page #	Section	SIS Reference	Amendments
23	SIS Appendix I, Section 4.5 Fauna Crossings and EIS Appendix J Section 4.5	After para 2	Add: The movement patterns of nomadic and dispersing young Koalas are unpredictable. However, in their ranging Koalas remain generally attracted to areas with trees. For example, Hume (1996) tracked a young male koala some kilometres along a treed creekside corridor, although Prevett (1996) identified a koala "black spot" near Ballarat, Victoria, which lacked trees and was 10 kms from the nearest koala population. Despite this apparent anomaly, placement of underpasses should relate to availability of habitat and/or evidence of above-average koala mortality. Available evidence (e.g. Appendix 1) indicates that underpasses could be placed anywhere in Pine Creek State Forest and have a high likelihood of being found by ranging koalas.
30	Koala (*Phascolarctos cinereus*)	**Habitat requirements**, Last para.	Remove.
		Conservation reserves, sentence 2	Remove.

1.0 ATTACHMENTS

Table 1: Survey effort for the proposed route.

Site*	Survey Effort
Site 1. Pine Creek State Forest	56 hours
Site 2. Pacific Highway (South of East Bonville Road)	3 hours
Site 5. South of East Bonville Road	5 hours
Site 6. North of East Bonville Road (Grandis Road)	3 hours
Site 7. Bonville Station Road	4 hours
Site 10. South of Lyons Road to Williams Road.	16 hours
Eleocharis tetraquetra	9 hours

* Note: random meander flora survey at each site incorporated all topography and vegetation communities present.

Table 2: Probability levels of occurrence in the study area for all threatened species which could occur.

Probability level	Common Name	Scientific Name
0 – 0.25	Wallum Froglet	*Crinia tinnula*
	Hoary Wattled Bat	*Chalinolobus nigrogriseus*
	Great Pipistrelle	*Falsistrellus tasmaniensis*
	Golden-tipped Bat	*Kervioula papuensis*
	Common Bent-wing Bat	*Miniopterus schreibersii*
	Large-footed Mouse-eared Bat	*Myotis adversus*
	Greater Broad-nosed Bat	*Scoteanax rueppellii*
	Masked Owl	*Tyto novaehollandiae*
	Powerful Owl	*Ninox strenua*
	Rose-crowned Fruit Dove	*Ptilinopus regina*
	Sooty Owl	*Tyto tenebricosa*
	White-eared Monarch	*Monarcha leucotis*
	Parma Wallaby	*Macropus parma*
0.26 – 0.50	Wompoo Fruit Dove	*Ptilinopus magnificus*
	Tiger Quoll	*Dasyurus maculatus*
0.51 – 0.75	Black Bittern	*Dupetor flavicollis*
	Common Planigale	*Planigale maculata*
	Long-nosed Potoroo	*Potorous tridactylus*
	Yellow-bellied Glider	*Petaurus australis*
0.76 – 1.00	Little Bent-wing Bat	*Miniopterus australis*
	Queensland Blossom Bat	*Syconycteris australis*
	Brush-tailed Phascogale	*Phascogale tapoatafa*
	Bush Stone-curlew	*Burhinus magnirostris*
	Square-tailed Kite	*Lophoictinia isura*
	Yellow-eyed Cuckoo-shrike	*Coracina lineata*
	Swift Parrot	*Lathamus discolor*
	Squirrel Glider	*Petaurus norfolcensis*

Table 3: Area to be cleared in each community type along the proposed corridor. "R" denotes regional significance according to Fisher *et al.* (1996). Community names are as per Fisher *et al.* (1996).

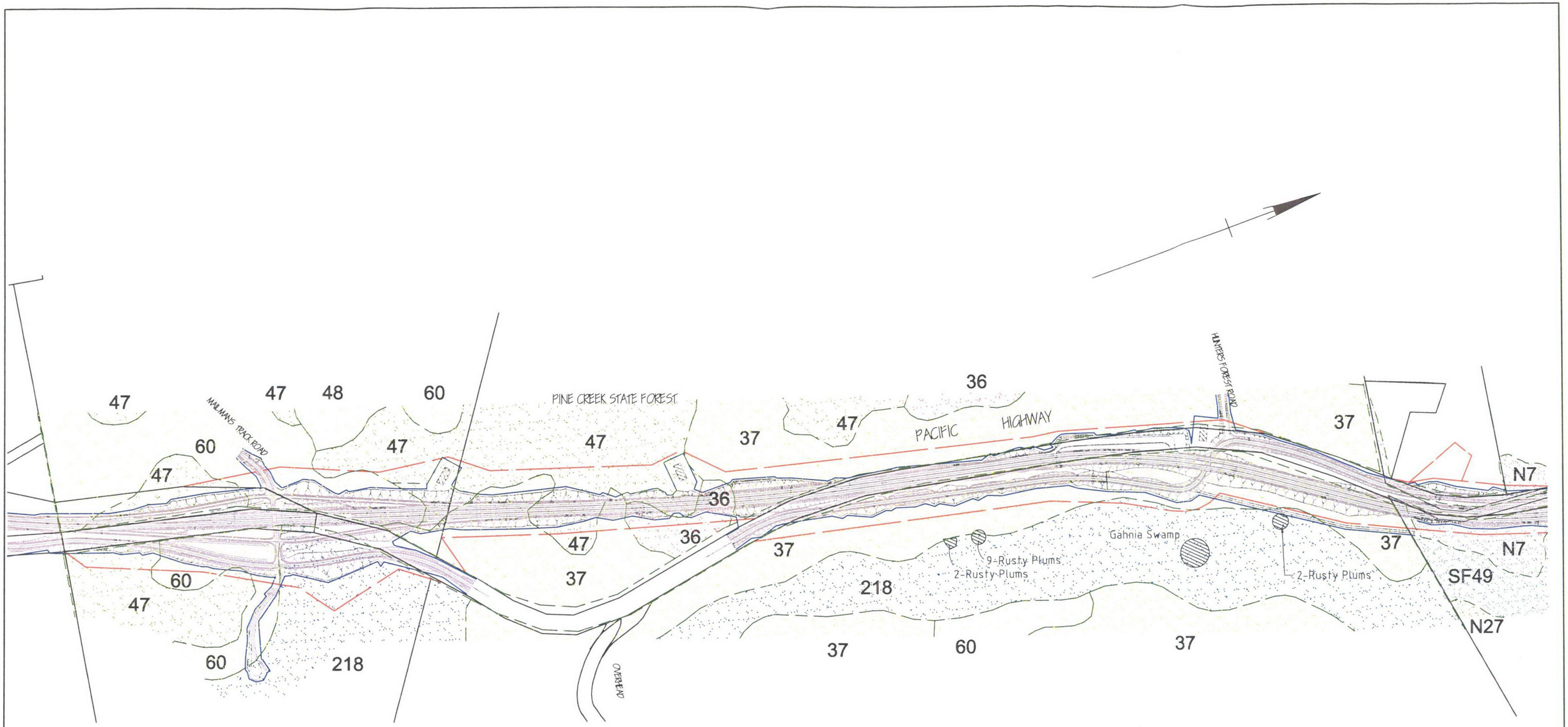
Vegetation Community	Area to be cleared (ha)
Tallowwood/Sydney Blue Gum	6.3
Moist Grey Ironbark/Grey Gum/ Tallowwood/White Mahogany (R)	3.1
Dry Blackbutt (R)	11.5
Moist Blackbutt	3.1
Paperbark	0.3
Flooded Gum (R)	8.0
Swamp Mahogany	0.9
Tallowwood (R)	2.5
Scattered Trees	1.6
Eucalypt Plantation	13.8
Regrowth	0.7
TOTAL	51.8

Table 4: Weather conditions during the survey periods, as extracted from the Bureau of Meteorology, Coffs Harbour Meteorological Office (1997).

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Wind (ms^{-1}, direction)	Rainfall (mm)
Week prior to first survey	10.4	26.3	2.6 W - 8.2 N	31.4
Week 1 surveys				
22/9/97	14.9	20.2	6.7 S	4.2
23/9/97	12.3	20.0	8.7 S	0.4
24/9/97	12.7	18.3	3.1 SW	14.8
25/9/97	10.2	26.0	6.2 S	0.0
Week prior to second survey	10.5	14.9	4.1 SSE - 8.2 NE	80.0
Week 2 surveys				
13/10/97	14.5	22.6	4.6 SSE	0.0
14/10/97	11.7	25.2	9.8 NE	0.0
15/10/97	13.6	27.7	5.7 NE	0.0
16/10/97	9.3	26.9	7.7 NE	0.0
17/10/97	10.2	28.0	6.2 NNE	0.0

Table 5: Comparison of vegetation communities described by Biosis Research and those mapped by Fisher *et al.* (1996) and reproduced in Map 3 (See Attachments).

Vegetation Community	Fisher *et. al.* (1996) Equivalent
Tall Open Forest (Dry/Moist Blackbutt)	Dry N2a; Moist N7
Tall Open Forest (Flooded Gum dominant)	N27; N52a
Tall Open Forest (Tallowwood)	N7a
Tall Open Forest (Plantation)	EP
Swamp Forest	N52; N20
Riparian vegetation (Dry Blackbutt)	N44a
Sedgeland/Rushland	SG6502



Note
The vegetation areas shown were derived from the Vegetation of the Coffs Harbour City Council LGA (Fisher *etal.* 1996) and the Pine Creek State Forest Draft Koala Management Plan (State Forests NSW 1997)

LEGEND
- Proposed Road Boundaries
- Vegetation Areas
- Property Boundaries
- Extent of Clearing

SCALE A 0 50 100 150 200 1:4000 UNREDUCED

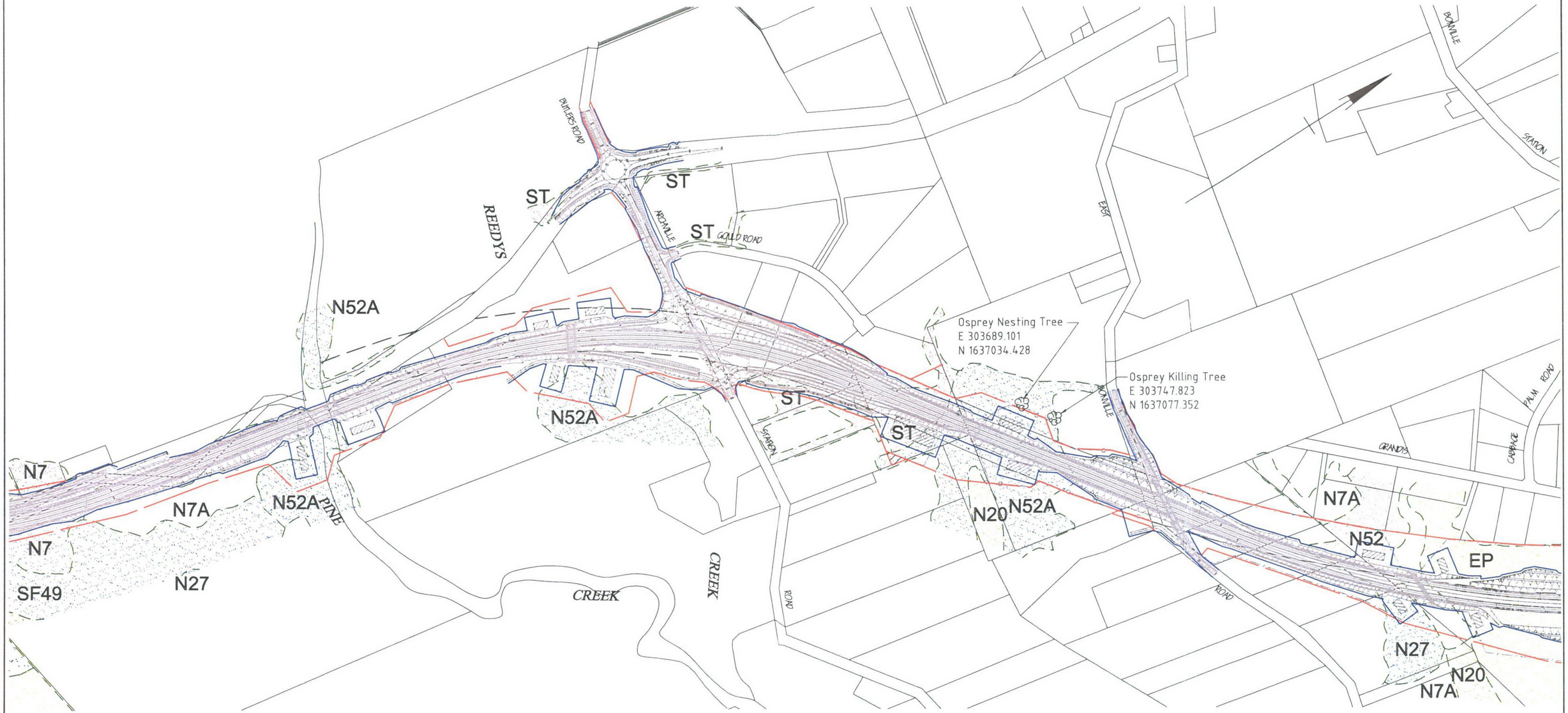
Vegetation Communities

(Pine Creek State Forest Draft Koala Management Plan, State Forests NSW 1997)
36 Moist Blackbutt
37 Dry Blackbutt
47 Tallowwood - Sydney Blue Gum
48 Flooded Gum
60 Narrow Leaved White Mahogany - Red Mahogany
218 Forestry Plantation

(Vegetation of the Coffs Harbour City Council LGA, Fisher *etal.* 1996)
EP Eucalyptus Plantation
N7 Moist Blackbutt
N7A Tallowwood
N20 Paperbark
N27/EP Flooded Gum/Eucalyptus Plantation
N27 Flooded Gum
N52 Swamp Mahogany
N52A Flooded Gum
R Regrowth
SF49 Turpentine
SG6502 Sedgeland/Rushland
ST Scattered Trees

VEGETATION COMMUNITIES WITHIN THE STUDY CORRIDOR

FIGURE 1a.



Note
The vegetation areas shown were derived from the Vegetation of the Coffs Harbour City Council LGA (Fisher *etal.* 1996) and the Pine Creek State Forest Draft Koala Management Plan (State Forests NSW 1997)

LEGEND
- Proposed Road Boundaries
- Vegetation Areas
- Property Boundaries
- Extent of Clearing

SCALE A 0 50 100 150 200 1:4000 UNREDUCED

Vegetation Communities

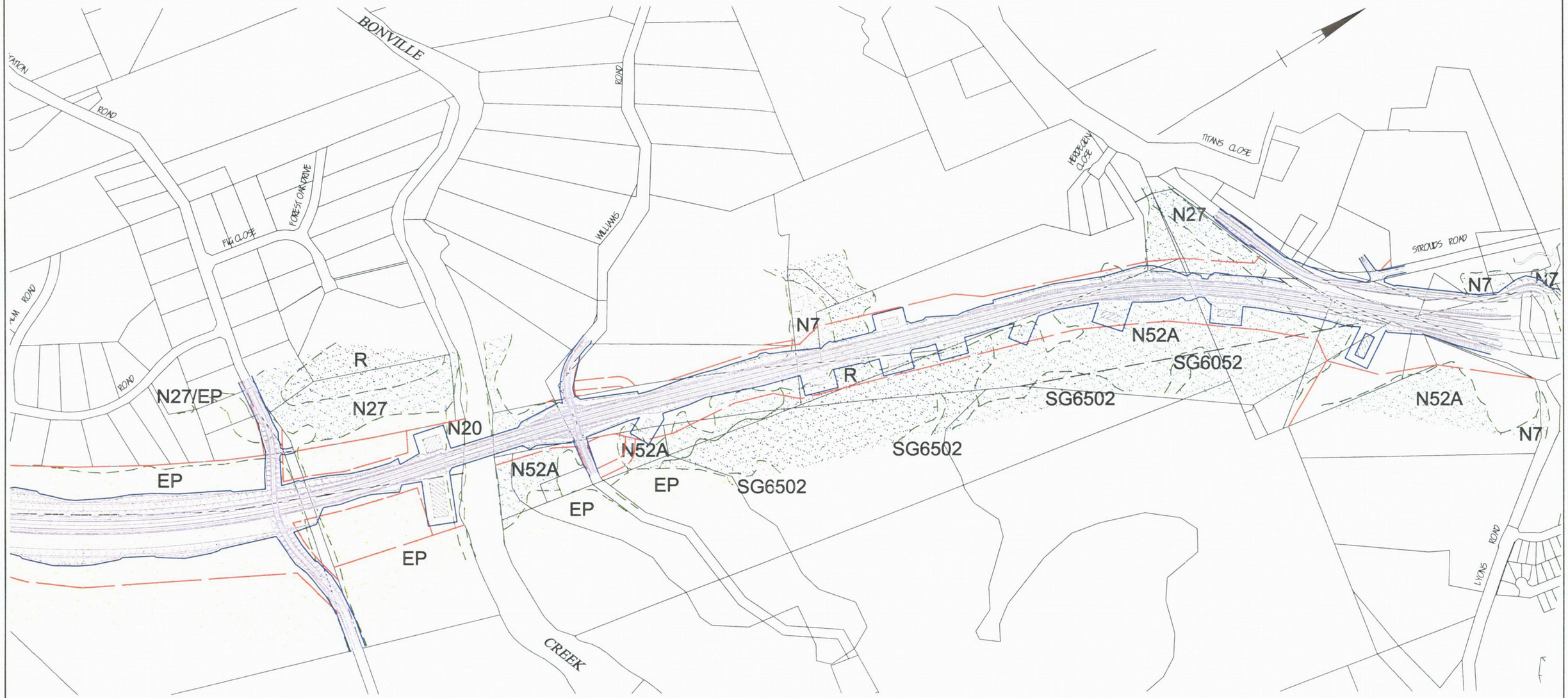
(Pine Creek State Forest Draft Koala Management Plan, State Forests NSW 1997)
36 Moist Blackbutt
37 Dry Blackbutt
47 Tallowwood - Sydney Blue Gum
48 Flooded Gum
60 Narrow Leaved White Mahogany - Red Mahogany
218 Forestry Plantation

(Vegetation of the Coffs Harbour City Council LGA, Fisher *etal.* 1996)
EP Eucalyptus Plantation
N7 Moist Blackbutt
N7A Tallowwood
N20 Paperbark
N27/EP Flooded Gum/Eucalyptus Plantation
N27 Flooded Gum
N52 Swamp Mahogany
N52A Flooded Gum
R Regrowth
SF49 Turpentine
SG6502 Sedgeland/Rushland
ST Scattered Trees

VEGETATION COMMUNITIES WITHIN THE STUDY CORRIDOR

FIGURE 1b.

Date of last edit: 13/05/1999-08.49 Cad File: L:\58H300A\DRF\ACAD\DESIGN\Final_Concept_Drawings\Figure1B.dwg



Note
The vegetation areas shown were derived from the Vegetation of the Coffs Harbour City Council LGA (Fisher *etal.* 1996) and the Pine Creek State Forest Draft Koala Management Plan (State Forests NSW 1997)

LEGEND
- Proposed Road Boundaries
- Vegetation Areas
- Property Boundaries
- Extent of Clearing

SCALE A 0 50 100 150 200 1:4000 UNREDUCED

Vegetation Communities

(Pine Creek State Forest Draft Koala Management Plan, State Forests NSW 1997)
36 Moist Blackbutt
37 Dry Blackbutt
47 Tallowwood - Sydney Blue Gum
48 Flooded Gum
60 Narrow Leaved White Mahogany - Red Mahogany
218 Forestry Plantation

(Vegetation of the Coffs Harbour City Council LGA, Fisher *etal.* 1996)
EP Eucalyptus Plantation
N7 Moist Blackbutt
N7A Tallowwood
N20 Paperbark
N27/EP Flooded Gum/Eucalyptus Plantation
N27 Flooded Gum
N52 Swamp Mahogany
N52A Flooded Gum
R Regrowth
SF49 Turpentine
SG6502 Sedgeland/Rushland
ST Scattered Trees

VEGETATION COMMUNITIES WITHIN THE STUDY CORRIDOR

FIGURE 1c.

Date of last edit: 13/05/1999-08:51 Cad File: L:\58H300A\DRF\ACAD\DESIGN\Final_Concept_Drawings\Figure1C.dwg

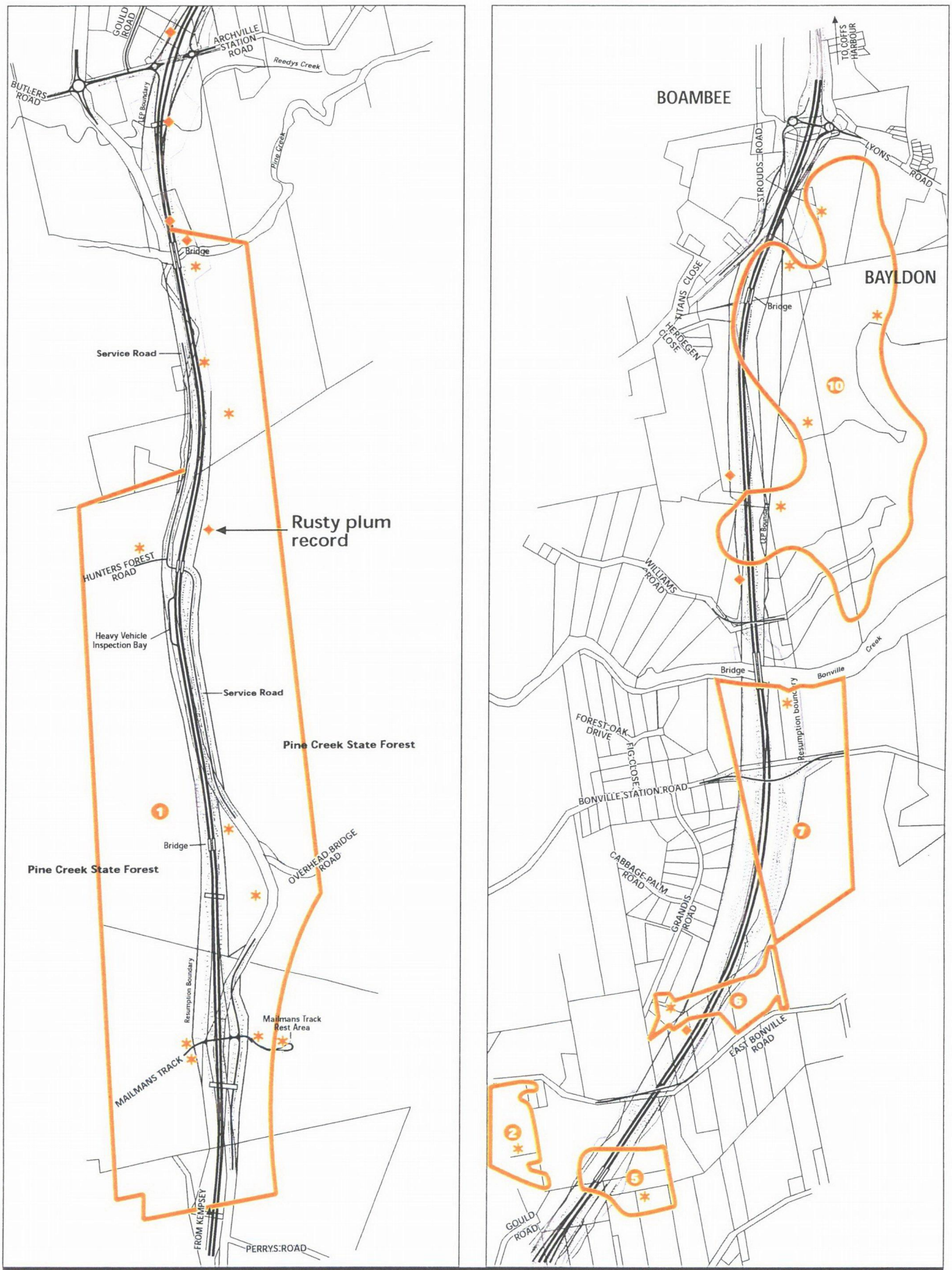
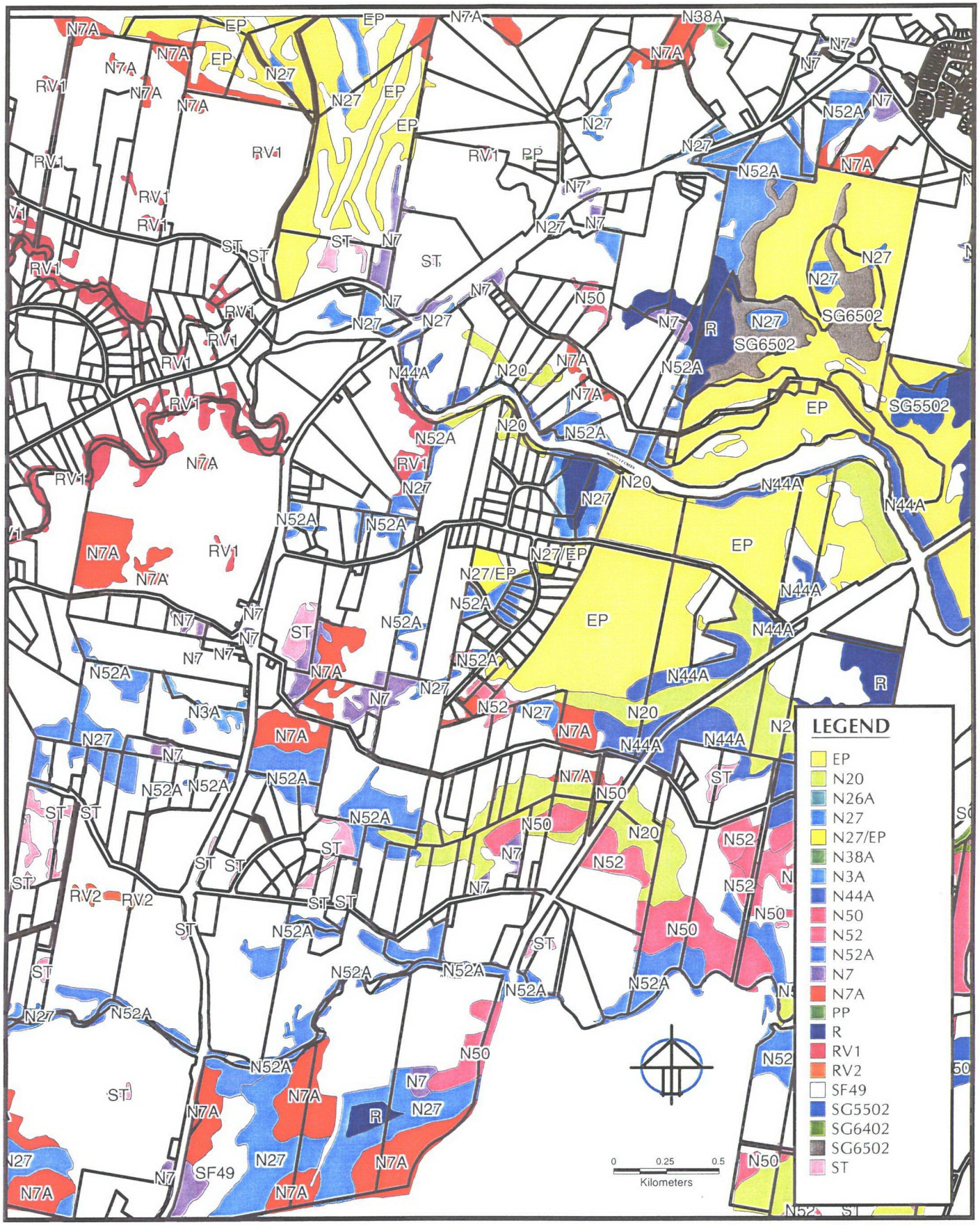


Figure 2
Flora Sample Sites

- Site boundaries
- Indicative locations of random meanders
- Indicative locations of intensive survey for *(Eleocharis tetraquetra)*
- Additional flora and fauna rapid survey site

Source: Biosis Research 1998

58H200A/DWG/FIG 2/R1



Vegetation designations refer to map units classified in the report "The Vegetation of Coffs Harbour City Council LGA" (Fisher et al., 1996) held by Coffs Harbour City Council.

Vegetation Community Mapping (reproduced from Fisher et al. (1996)) Figure 3

Fig 6-2

Pine Creek
Koala Project

Zones and Koala Records

- 1 Km AMG Grid
- Koala Records @ 25/8/97
- State Forest Boundary
- Creek Exclusions
- Types in Interm koala reserve
- Excluded Types
- Excluded PMP Zones
- Pine Creek Roads
- National Park

Zones

- Exclude
- Not State Forest
- Typed not Zoned
- Unknown
- Zone 1
- Zone 2
- Zone 3
- Zone 4
- Zone 5 - Interim Koala Reserve

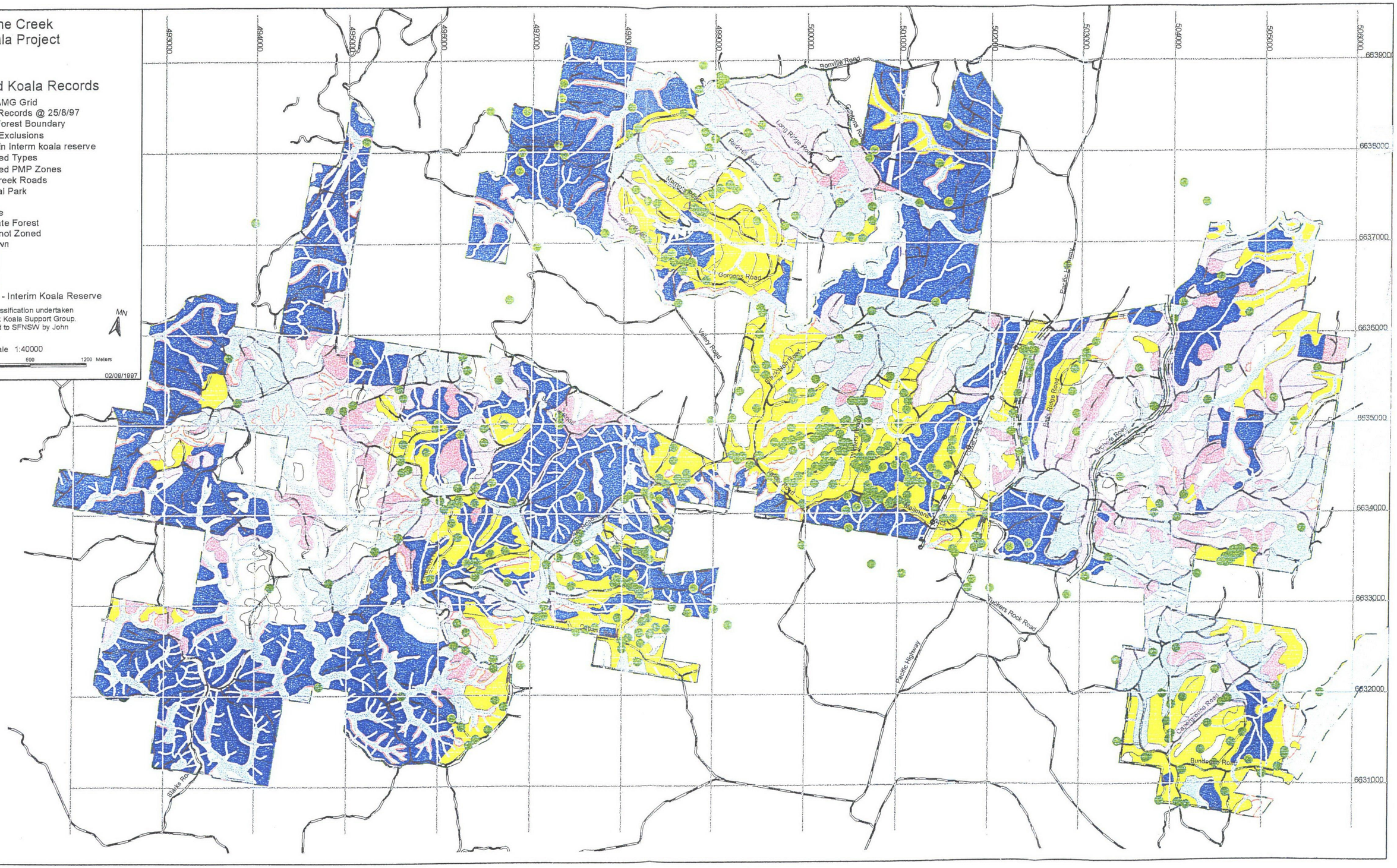
Fieldwork and classification undertaken by the Pine Creek Koala Support Group. Linework supplied to SFNSW by John Murray on 3/7/97.

MN

Scale 1:40000

600 0 600 1200 Meters

02/09/1997



Zone 4 – Koala emphasis
Zone 5 – Interim Koala Reserve
Koala Management Zones are defined in "Pine Creek State Forest Draft Koala Management Plan" (SFNSW 1997).

Koala Habitat Mapping (reproduced from SFNSW (1997)) Figure 4

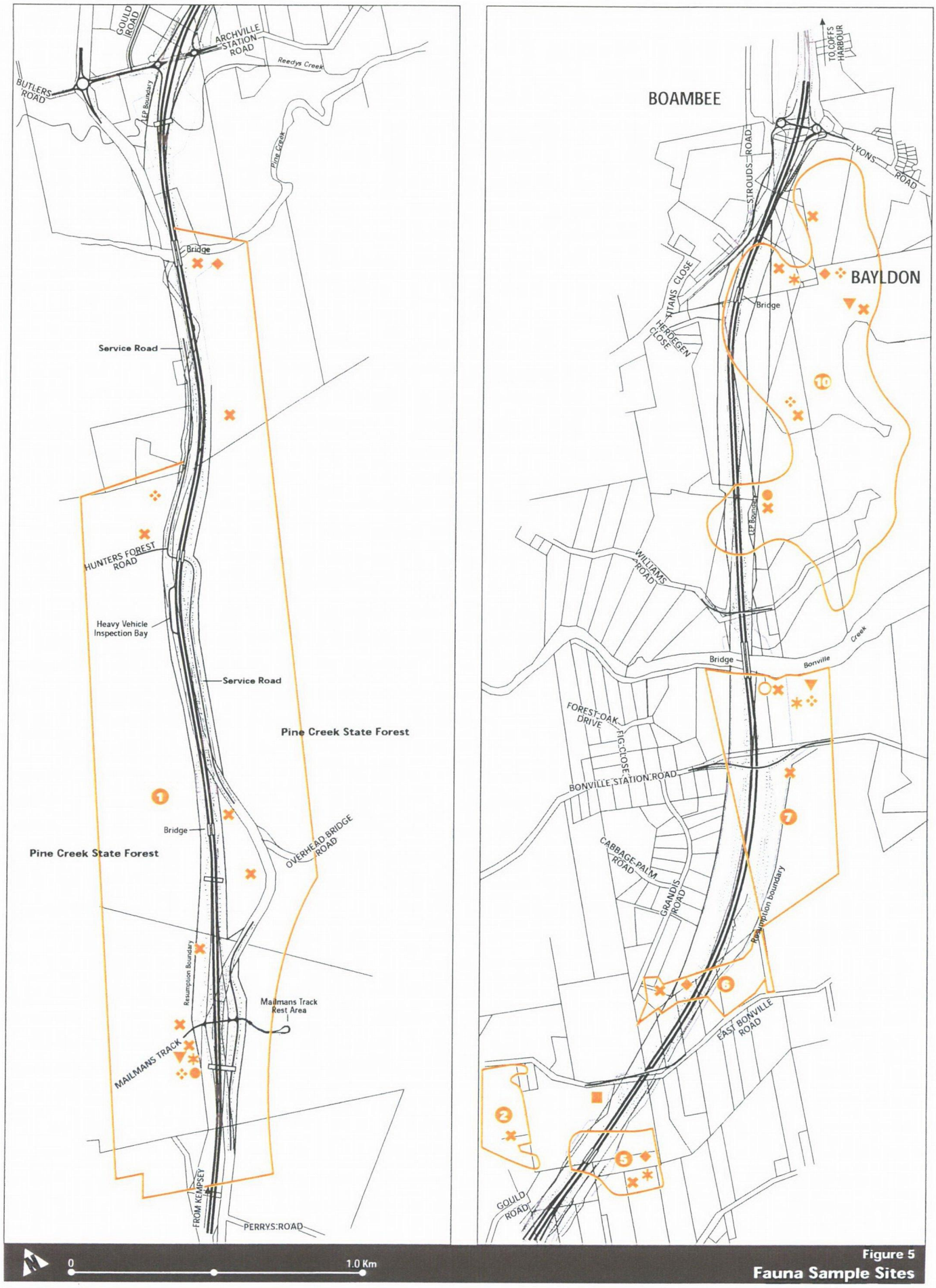


Figure 5
Fauna Sample Sites

Source: Biosis Research (1998)

58H200A/DWG/FIG 5/R1

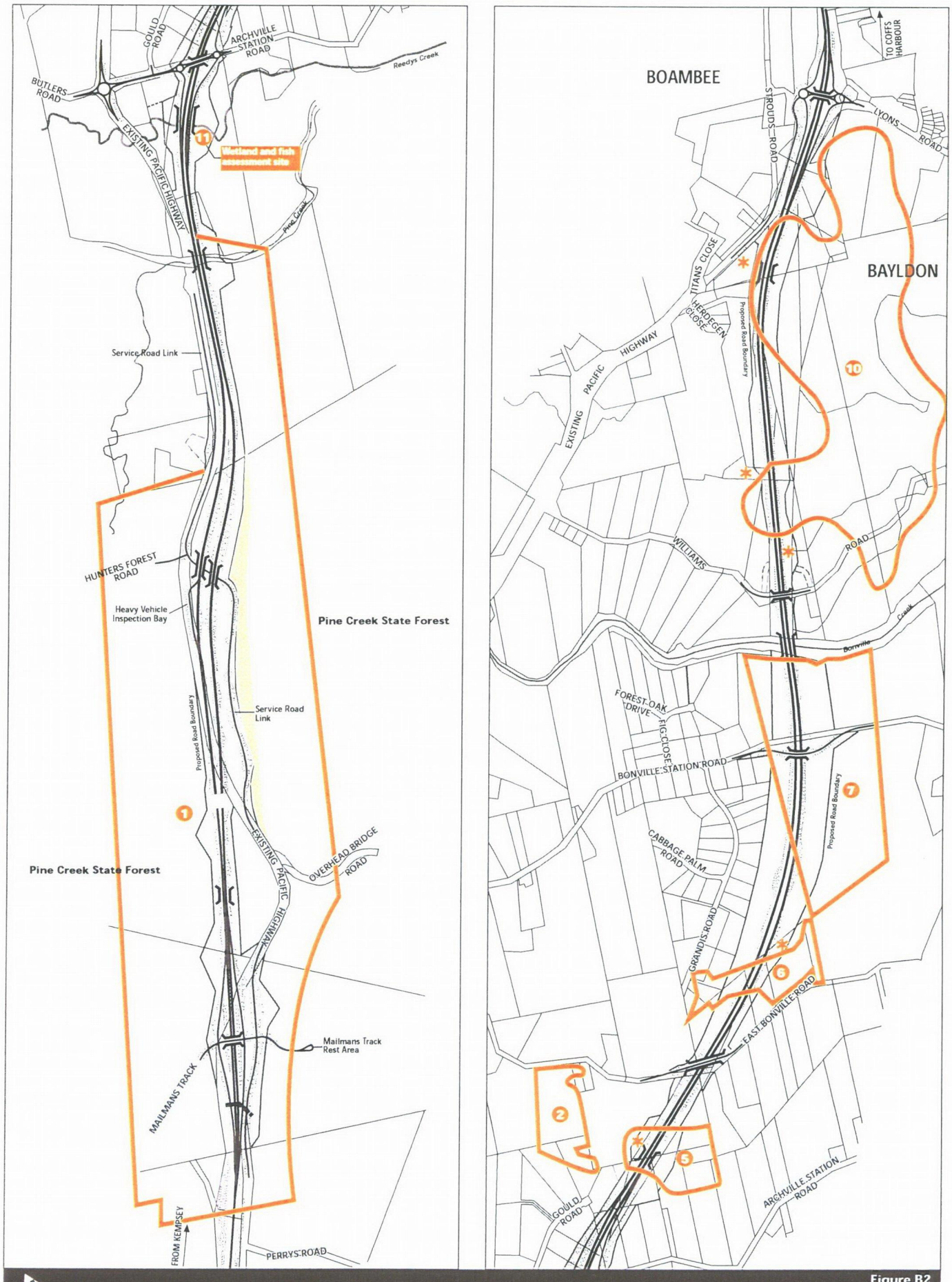


Figure B2
Additional Survey Sites

58H200A/FIG B2/R4

Part B – Table of Contents

LIST OF FIGURES

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Part B – Impact Assessment of the Modified Proposal

B1.0 INTRODUCTION

An overview of the modified proposal route is shown in Figure B1 and described in detail in the *Supplementary Route Selection and Design Report* (PPK 1999a). This impact assessment considers mainly proposal changes in Pine Creek State Forest and at creek crossings. Where the proposal has not been changed, the SIS still applies together with supplementary information provided in Part A of this report.

B1.2 Summary of Submissions

Major submissions were received from the following organizations:

- NSW National Parks and Wildlife Service;
- NSW Fisheries;
- Australian Heritage Commission;
- Ulitarra Conservation Society;
- Bellingen Environment Center Inc.;
- North Coast Environment Council;
- Pine Creek Koala Support Group; and,
- Bundagen Co-operative Limited.

Although many individuals also submitted their comments, all relevant issues were covered in the organizational submissions. Complete responses to the various issues raised in all submissions are included within the *RTA Representations Report - The Bonville Project* (RTA in prep.).

The main environmental issues can be summarised as follows:

Table B1: Main environmental issues raised in submissions.

Issue	Response	SISSIR Reference
Inadequate number of underpasses for fauna in PCSF.	The modified proposal incorporates one major fauna underpass, one major fauna overpass, one shared underpass and one large culvert in PCSF.	Section B6.2, B7.1.2
Lack of evidence that Koalas will utilise underpasses and culverts.	The modified proposal incorporates a major fauna overpass for the central section of Pine Creek Forest.	Section B6.2, B7.1.2
Inadequate passage for gliders in PCSF.	The modified proposal incorporates a major fauna overpass and a vegetated median with tree retention possible over approximately 60% of the proposal length in PCSF.	Sections B6.2, B7.1.2
Barrier impacts for all fauna between tablelands and coast.	The modified proposal incorporates adequate crossing structures for both terrestrial and aquatic fauna species including: a major overpass, major underpasses, a shared underpass, major bridges and large and small culverts.	Section B6.2, B7.1.2
Destruction of rainforest gullies.	The modified proposal has reduced impacts to the forest gullies by easing the northbound carriageway to the east, adjusting its vertical alignment and reducing the width of the median.	Sections B6.2, B7.1.1

Issue	Response	SISSIR Reference
The proposed highway should be constructed further to the east.	The straightening of the highway is largely due to constraints set by the alignment of the Raleigh section of the Pacific Highway and to safety and engineering issues.	See Part A Table A1
Increased edge impacts on the interim-listed Bongil Bongil Area	This area of Bongil Bongil NP nearest the modified proposal is already highly disturbed and construction is unlikely to significantly increase edge effects.	Section B7.1.2, B7.1.3
Loss of regionally significant Koala habitat in the area of rest stop and truck-checking station	The northbound and southbound carriageways have been moved eastwards. The proposed truck inspection station falls within the footprint for the existing Pacific Highway. A compensatory habitat package which takes into account all key habitat lost as a result of development is being developed by the RTA and NPWS.	Section B6.1 *Discussion Paper – Compensatory Habitat Assessment for the Bonville Deviation* (Bali and Anderson 1998); See Section B8.2.1; (copy supplied to NPWS previously)
Impacts to Osprey nest.	Mitigation measures to protect the existing Osprey nest are described. Avoid clearing during nesting season (June-October).	SIS Appendix E
Impacts on aquatic organisms, not considered, in particular those found in Bonville, Pine and Reedys Creeks.	Impacts on aquatic macroinvertebrates were considered by Robyn Tuft & Associates in the EIS for the Bonville Project (PPK 1998). An aquatic ecological assessment has been undertaken by Bill Rooney (W.S. Rooney & Associates).	Appendix 3 ; summarised in Section B4.4
Lack of fish sampling.	It was agreed between NSW Fisheries and the RTA that the study site was not likely to support endangered fish species and that fish sampling was therefore not required.	No change.
Impact to wetlands not considered, specifically changes to drainage and wetland integrity.	Impact of the development on wetlands in the study site was the subject of a supplementary report undertaken by Adam King (Team Leader Ecology, Biosis Research).	Appendix 4; summarised in Section B4.5
Fisheries Management Amendment Act 1997 not considered.	Fish species listed in the Act have been subjected to an 8-part test.	Appendix 3; Section B4.3

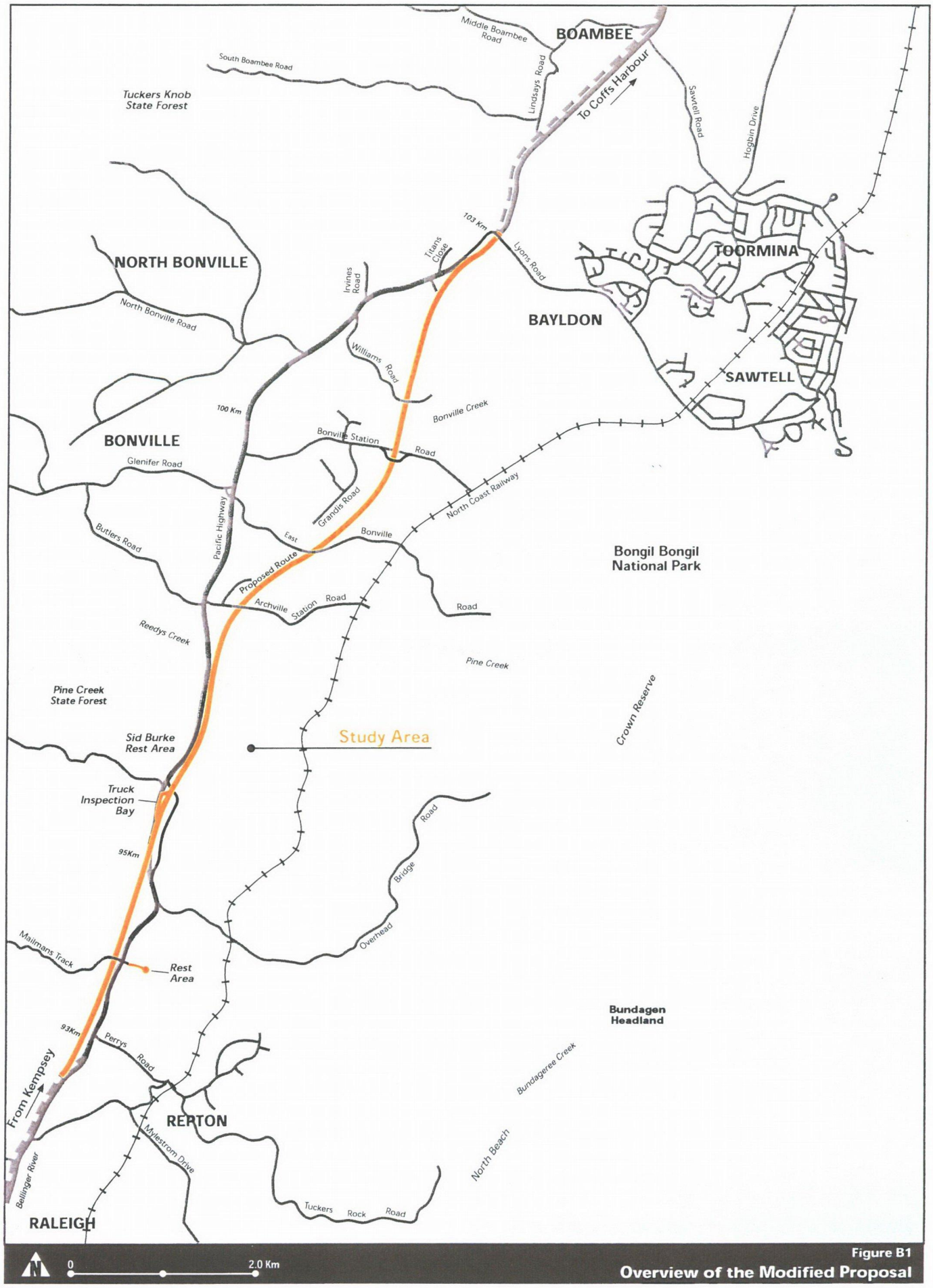


Figure B1
Overview of the Modified Proposal

58H200A/DWG 1.1/R2

B2.0 STUDY AREA

Areas investigated as part of this report are within the original 250 m corridor which was surveyed during the original SIS. Additional survey work was undertaken in order to assess flora and fauna values, fish habitat and wetland significance. Areas where these surveys were conducted are shown in Figure B2.

B3.0 LEGISLATIVE CONTEXT

Biosis Research prepared the *Species Impact Statement - Bonville Project in July 1998.* The Environmental Impact Statement (EIS) and Species Impact Statement (SIS) were exhibited for a five-week period during which time members of the public and relevant government agencies were invited to tender their submissions on various aspects of the project.

3.1 Environmental Planning and Assessment (EP&A) Act 1979

The SIS has been prepared in accordance with all statutory requirements including Section 112(1B) of the *EP&A Act 1979*. The latter requires that an SIS be prepared where an activity is likely to significantly affect threatened species, populations or ecological communities or their habitats in accordance with Division 2 of Part 6 of the *TSC Act 1995*.

In response to environmental concerns raised in some representations, five additional studies were undertaken and a subsequent assessment of the modified proposal was undertaken to minimise environmental impacts. The studies included:

- A fauna overpass desktop assessment;
- A median strip desktop assessment;
- A rapid field survey of areas to be cleared as a result of the proposal for median strip retention;
- A wetland assessment; and,
- An aquatic 8-part test.

Recommendations from these studies were incorporated into design changes to ensure that impacts identified in the original proposal were minimised (PPK 1999a; SISSIR Sections B4.1.5, B4.2.5, B4.3.5, B4.4.5, B4.5.5, B6.0) and to ensure that:

- any environmental impacts caused by the modified alignment were identified (Section B7.0); and,
- any impacts associated with the new alignment were not significantly greater at any point and were reduced along most of the alignment (*Conclusions* Sections B7.1.1, B7.1.2, B7.1.3, B7.1.4, B10.0).

An aquatic 8-part test was undertaken in accordance with Section 5A of the *EP&A Act* (SISSIR Section B4.4). It concluded that there would be no significant effect on any endangered fish species or its habitat and that an SIS would not be required.

3.2 Threatened Species Conservation Act 1995

The additional studies have been summarised in this report in the following Sections: B4.1, B4.2, B4.3, B4.4 and B4.5. In undertaking these studies:

- All terrestrial realigned carriageways and associated service roads in Pine Creek State Forest fall within the original 250 m study corridor considered in the SIS (see Figures

B3a-c);

- All terrestrial realigned carriageways along the remaining route remain unchanged (see Figure B4);
- All additional threatened flora and fauna species identified in a review of the 8-part test undertaken by Smith and Smith (1998) have been considered (SISSIR Sections B5.1, B5.2). The modified proposal is not considered to have a significant impact on these species (SISSIR Sections B7.1.1, B7.1.2, B7.1.3, B7.1.4);
- For aquatic and wetlands crossings associated with the modified proposal, no threatened species, populations or ecological communities or their habitat would be significantly impacted (SISSIR Sections B4.4, B7.1.1, B7.1.2, B7.1.3, B7.1.4);
- Barrier impacts have been reduced in PCSF through incorporation of a major fauna overpass, a major fauna underpass, a shared underpass, a culvert and a wide vegetated median into the road design (see Section B7.1.2);
- Aquatic impacts have been minimised in wetlands within the study corridor as well as in SEPP 14 wetlands downstream (see Section B7.1.1);
- Although the median strip would result in the removal of an additional 2 ha (approx.) of habitat, this is offset on the basis that gliding distances would be reduced, thereby maintaining gene flow of glider populations across the highway (SISSIR Sections B4.2, B7.1.2).

For reasons listed above, it is considered that for any comparisons between the SIS and SISSAR, it can be demonstrated that no additional species, populations, ecological communities or their habitat/s would be significantly affected and that no further significant impacts would occur. Overall, the modified proposal is considered to minimise/reduce impacts identified. In addition, no new significant impacts would be created by changes to the alignment.

Where responses to the requirements of the *TSC Act* have altered as a result of the modified proposal, these have been addressed in relevant sections of the SISSIR:

- The modified proposal is detailed in PPK (1999a), SISSIR Figures B1 and B4 and in Section B6.0;
- A plan of the study area showing location and type of vegetation communities present within the study corridor was prepared (see Figure B3a-c, SISSIR Section B7.1.1);
- The location of threatened species (i.e. Rusty Plum) recorded during the additional surveys is shown in SISSIR Figure B3a; methodology is described in SISSIR Section 4.3.2 and locational data are given in Section B4.3.3;
- Suitable habitat characteristics for a Vulnerable species listed within the D-G requirements, the Wallum Froglet, are located in SISSIR Figure B3a and described in Section B4.3.3. A service road associated with the modified proposal was realigned to avoid this habitat (Section B4.3.5);
- Assessment of the likely effects of the modified proposal on threatened terrestrial and aquatic species, populations and ecological communities is assessed in SISSIR Section B7.0;
- Justification of mitigation measures is provided in PPK (1999a) and summarised in SISSIR Table B8. Relevant information regarding the design changes is provided in a summary of environmental issues raised in submissions (SISSIR Table B1) and in additional studies summarised in SISSIR Sections B4.1 to B4.5. The effectiveness of mitigation measures is assessed in SISSIR Section B7.0. As a result of submissions, additional studies and the impact assessment, further amelioration measures are proposed in SISSIR Section B8.0 for both terrestrial (Sections B8.1 and B8.2) and aquatic (Section B8.3) habitats;

- No further approvals or licencing requirements are required in relation to the modified proposal. Relevant approvals and/or licences are listed in Part A of this report (Table A1).

In addition to the above, the requirements of the Director-General for National Parks and Wildlife Service are provided in Table A2 in Part A of this report.

3.3 Fisheries Management Amendment Act 1997

This legislation came into effect on 1 July 1998 (NSW Fisheries 1998) while the Bonville study was underway. The *Fisheries Management Amendment Act 1997* incorporates Part 7A of the *Fisheries Management Act 1994*. Part 7A provides for the listing of threatened species, populations or ecological communities and the listing of key threatening processes in schedules contained in the *Fisheries Management Act 1994*. Of the four fish species currently listed:

- Habitat for only one of them, the Oxleyan Pygmy Perch, may occur within the study site or downstream of it. However, the site is outside the known range of this species (SISSIR Section B4.4, Appendix 3);
- Even if the Oxleyan Pygmy Perch occurred within the study site, mitigation measures at Reedys Creek and at other wetlands in the study corridor would ensure that the species and/or its habitat were not significantly affected by the modified proposal (SISSIR Sections B7.1.1, B7.1.2, B7.1.3).

Aquatic impacts have been reduced for the modified proposal as a direct result of two additional aquatic studies which recommended the upgrading of the culvert at Reedys Creek crossing to a major bridge in order to minimise loss of aquatic habitat and to maintain wetland function downstream (SISSIR Sections B4.4, B4.5). Other wetland crossings (PPK 1999a, SISSIR Table B8) have been modified in order to ensure the maintenance of surface and sub-surface flows through the enlargement of culverts and/or the provision of permeable base layers. Provided that additional amelioration measures are undertaken (SISSIR Section B8.3), the modified proposal is likely to reduce potential aquatic impacts to an insignificant level (SISSIR Sections B7.1.1, B7.1.2) and to improve the current situation (i.e. the existing Pacific Highway) in terms of long-term wetland conservation (SISSIR Section B4.5).

Therefore, in considering the overall environmental impacts of the modified proposal (SISSIR Section B10.0), all threatened species, populations or ecological communities and their habitats have been taken into account. This supplementary report demonstrates that the design changes have aimed to mitigate all identifiable environmental impacts. Where it was not possible to mitigate fully for environmental impacts (i.e. the loss of key terrestrial habitat), then consideration has been given to a compensatory habitat package (SISSIR Section B8.2.1).

B4.0 METHODOLOGY

Additional studies were undertaken in order to provide input into the redesign of the proposal. These are summarised in the table below:

Table B2: Additional studies undertaken for the modified proposal.

Study (aim)	Methodology	Consultant
Assessment of fauna overpass (input into design)	Literature review and consultation	Biosis Research, October-November 1998
Assessment of wide vegetated median (input into design)	Literature review and consultation	Biosis Research, November 1998
Survey of areas to be cleared as a result of vegetated median retention (input into design and impact assessment)	Rapid field survey	Biosis Research, November 1998
Aquatic ecological assessment (input into design, impact assessment and mitigation)	Literature review, consultation and rapid field assessment	W.S. Rooney & Associates (Appendix 3)
Wetland assessment (input into design, impact assessment and mitigation)	Literature review, consultation and rapid field assessment	Biosis Research (Appendix 4)

B4.1 Desktop Fauna Overpass Assessment

Submissions indicated that the original proposal did not adequately address the issue of glider movement over the highway. It was suggested by several submissions that a fauna overpass should be considered as a mitigation measure. Biosis Research was asked to assess the benefits of an overpass for gliders and Koalas in particular, and to recommend an appropriate width. Fauna overpasses have not previously been used in Australia and no information is presently available on the usage of these structures by fauna. However, two fauna overpasses are proposed for the Yelgun to Chinderah Pacific Highway upgrade (Sinclair Knight Merz 1998).

B4.1.1 Background

The aim of a fauna overpass would be to maintain gene flow in arboreal mammal populations, particularly those of gliders and Koalas. As these species may not all utilise underpasses and culverts, mitigation measures such as overpasses and vegetated medians are more likely to act as suitable movement corridors (i.e. by providing intermediate habitat).

B4.1.2 Literature review

In order to compile information about corridor widths, a brief literature review was undertaken. In addition, the following experts were consulted regarding suitable widths for fauna corridors: Chris Moon (Koala Survey and Management Services); Brad McDonald (AGC Woodward-Clyde); and Steven Priday (Australian Museum Business Services (AMBS)).

B4.1.3 Results

Flora

Discussions held with Chris Moon, a consultant and local Koala expert, revealed that fauna species were likely to use the overpass because vegetation and substrate in surrounding forest would be similar (i.e. no apparent boundaries between the two). However, he had some concerns that the overpass could become weed-infested without careful planning and ongoing management. He was aware of research that had shown that a light penetration distance of approximately 30 m was considered acceptable for controlling weeds and considered that a minimum corridor width of 60 m was adequate to minimise weed invasion. Chris Moon felt that the overpass would be colonised by local plant species, especially eucalypts, wattles and grasses. One option to control weed invasion at the outset would be to ensure that soils on the overpass are nutrient-poor.

Fauna

In effect, a fauna overpass would act as a wildlife corridor across the highway. Wildlife corridors may vary considerably in width depending on the species concerned and the vegetation present (see Wilson and Lindenmeyer 1995). For example, a vegetated corridor of 10 m planted appropriately may be adequate for small mammals living in urban habitats (e.g. bandicoots). However, a width of 200 m or more is more appropriately located between logging coupes; these can be used as home ranges for some of the more wide-ranging species (e.g. Yellow-bellied Gliders). As 60 m was considered to be adequate for weed control, this width was assessed for use by gliders and Koalas.

Consultation and literature review suggest that arboreal mammals are highly mobile and would be able to cross the overpass provided that it was planted appropriately. Home range sizes for the targeted species are considerably larger than the overpass although some individuals may incorporate it into their larger home ranges. However, it would not be expected that the overpass would form the core area of individual home ranges for any of the species considered.

The home range of the Yellow Bellied Glider is in the order of 35 hectares (Strahan 1995), however this can vary from between 30 to 60 hectares (Henry and Craig 1984; Goldingay 1987). On average, individuals can glide for a distance of 35 metres (range = 7-91 m) and may travel up to 2 km during a single night (Henry 1985, Goldingay 1991).

The gliding distance of the Squirrel Glider is up to 60 metres (Murray, 1996). This species has been found in some habitats in densities of up to 3 per hectare (Strahan 1995). Home ranges of 3.82 hectares have been found by Quin (1995), in the productive coastal forests of New South Wales although these home ranges get much larger in less productive forests. They can travel in the order of 1 km per night from their foraging area to a preferred hollow (Strahan 1995).

Sugar Gliders regularly move over 50-55 m to cross the Princes Highway (S. Priday, *pers. comm.*). According to preliminary results of an arboreal marsupial monitoring study currently being undertaken by AMBS, individual gliders have been radio-collared and followed. Many Sugar Gliders have been found to have home ranges which span both sides of the road.

The home range size of Koalas varies widely according to the density of the population and abundance of mature food trees in an area. It can vary from less than one hectare to greater than 80 hectares for males (Table 2.10; CSIRO 1997). Although males are not territorial, there is a dominance hierarchy and dominant males chase and attack subordinates if they are

encountered. Koalas often cross open paddocks, backyards with isolated trees and have even been known to swim creeks. Moon (1990, in CSIRO 1997) found that a mature tree density of 2/ha could be utilized as a corridor by Koalas.

B4.1.4 Conclusions

A 60 m overpass appears to be appropriate for mitigating impacts at Bonville. In the long-term, habitat provided by the overpass would act to facilitate movement for fauna species though it is unlikely to provide sufficient resources to support individuals on a permanent basis (i.e. home ranges). In the shorter term, retained trees together with launching poles may provide a functional corridor. The aim of the overpass is to maintain gene flow for a diversity of fauna groups, including gliders and Koalas. As a general rule of thumb, only one effective migrant (i.e. breeding individual) per generation needs to disperse in order to maintain gene flow (Hartl and Clark 1989). An overpass of 60 m placed centrally within PCSF is likely to provide at least this level of gene flow.

Brad McDonald (AGC Woodward-Clyde, pers. comm.) argued that a 40-m width was adequate for two similar overpass structures proposed for the Yelgun to Chinderah Pacific Highway upgrade. The aim of those corridors is to minimise barrier effects across two fragmented but significant vegetation corridors, primarily for Koalas. In the case of the Bonville deviation, there are strong reasons to make the overpass wider than 40 m, including:

- its location within a corridor of state significance;
- its importance as one of two major mitigation structures proposed along the 3-km length of Pine Creek State Forest.

B4.1.5 Recommendations

A number of recommendations were made, namely:

- To provide appropriate soil and drainage conditions for tall eucalypts for use as gliding platforms and/or forage trees;
- To prevent weeds such as Lantana forming a dense impenetrable understorey;
- To plant dense hardy species along the edges of the overpass in order to provide canopy and shelter from wind and light at ground level;
- To provide appropriate planting on either side of the overpass.

B4.2 Desktop Assessment of Vegetated Median

The modified proposal for the Bonville deviation at Pine Creek State Forest (PCSF) includes a vegetated median to facilitate movement of gliders across the highway. This may also facilitate movement of small passerine birds but would not be available to Koalas and medium to large ground-dwelling fauna species due to fauna exclusion fencing. Biosis Research undertook a desktop study to compare the original proposal (i.e.with ground cover only) with the current proposal, taking into account the gliding abilities of the two threatened *Petaurus* species (e.g. Squirrel Glider and Yellow-bellied Glider) likely to occur in PCSF.

B4.2.1 Background

The original proposal comprised a median up to 10 m wide with ground vegetation and provided several locations where the width of the impact (footprint) could be kept to 55 m or less. The modified proposal contains several opportunities to create a vegetated median increasing in width from 6-50 m in selected sections of the route. Locations for a wide median are based on topographical features and the consequent ability to retain some of the

existing vegetation.

B4.2.2 Literature review

Little is known about the effectiveness of vegetated medians as a mitigation measure for gliders. However, there is some information available regarding gliding distances and angles for gliders in the Genus *Petaurus* and regarding the movements of Sugar Gliders across the Princes Highway (Section B4.1). The following glider experts were consulted regarding this topic: Ross Goldingay (Southern Cross University), Steve Jackson (Healesville Sanctuary) and Steve Priday (AMBS). Although the experts did not view the final proposal, they were asked to provide opinions about the ability of gliders to cross varying easement widths and to comment on the potential use of vegetated medians by gliders.

B4.2.3 Results

Within the Genus *Petaurus*, glide angles and ratios are relatively similar for the Yellow-bellied Glider, the Mahogany Glider (*Petaurus gracilis*) and the Sugar Glider even though these species vary considerably in size (see Jackson, in press). However, when the same author compared the latter two species, he found that there were considerable differences in the height of launch, height of landing, diameter of landing tree and glide distance. For comparative purposes, the Yellow-bellied Glider is relatively large at 450-700 g, the Mahogany and Squirrel Gliders are intermediate (350-450 g and 190-300 g, respectively) and the Sugar Glider is smallest at 69-150 g.

Gliding abilities of the Yellow-bellied Glider have been summarised in Goldingay (1991). Mean glide distance recorded during that study was 34.9 m (SD=17.0 m; n=67). Glides ranged between 7 and 90.8 m. In another study, the author noted Yellow-bellied Gliders regularly gliding 100 m across an electricity easement.

Less is known about the gliding abilities of the Squirrel Glider although Murray (1996) reported that this species could glide up to 60 m. However, a recent study undertaken by Jackson (in press) reviewed gliding abilities of the Genus *Petaurus* with particular emphasis on the Mahogany Glider and the Sugar Glider. As the Squirrel Glider is slightly smaller than the Mahogany Glider, we would expect their gliding abilities to be similar. Mean glide distance recorded for Mahogany Gliders in north Queensland was 29.7 m (SD=2.4). Glides ranged from 8 to 60 m.

Although the Sugar Glider is not a focus of the current study, the species is of interest because it represents the "lowest common denominator" in terms of the vegetated median usage. Jackson (in press) recorded a mean glide distance of 20.4 m (SD=1.3; n=33) for this species in northern Queensland. Glides ranged between 8 and 42 m. However, according to preliminary results of a study being conducted by AMBS, it appears that Sugar Gliders are regularly gliding over distances of 50-55 m to cross the Princes Highway, south of Nowra (S. Priday AMBS, *pers. comm.*). Most collared Sugar Gliders appear to have home ranges spanning both sides of the highway.

We have estimated a range of tree heights required in order for gliders in the Genus *Petaurus* to cross easements measuring 30-40 m and 50-60 m using glide angles of 28 to 31 degrees (Goldingay 1991; Jackson in press). We assumed a landing height of 5 m above ground. The results are summarised below:

Table B3: Association between glide angle and distance and tree height required.

Glide Angle (degrees)	Glide Distance (m)	Height of launching trees (m)
31	30-40	23- 29
28	30-40	21-26
31	50-60	35-41
28	50-60	32-37

Jackson (in press) also found that there appeared to be a lower limit in the DBH (diameter at breast height) of landing trees for Mahogany and Sugar Gliders. The most narrow landing tree for the former species was 19.1 cm DBH and the corresponding measurement for the Sugar Glider was 11.5 cm. These factors may also have to be taken into account when tree species are selected for planting. An initial investigation into the selection of suitable tree species for planting was undertaken by Ross McKinnon (Horticulturalist) in association with Woods Bagot (Landscape Architects).

B4.2.4 Conclusions

It is considered that the inclusion of a vegetated median of varying width containing a mixture of retained vegetation and plantings will maintain gene flow within glider populations in the short to long-term. Experts consulted considered that it was preferable that gliders cross the highway in two relatively short glides of 30-40 m as compared to one long glide of 50-60 m. There was general support for the creation of a wide vegetated median as a mitigation measure to facilitate movement of gliders over the proposal. It is likely that the shortened glide distances created by the vegetated median would substantially reduce the risk of road kills associated with crossing wider easements.

B4.2.5 Recommendations

The vegetated median would be continuous, with tree retention and planting occurring over approximately 60% of the length of PCSF. Even if it does not contain mature trees, retained vegetation is considered preferable to plantings because it is already established and is likely to have progressed beyond the seedling stage. The width of the vegetated median varies between 6-50 m according to topographical features. A wide vegetated median is less likely to be significantly affected by edge effects including windthrow, weed invasion and desiccation. This is therefore more likely to be viable in the long-term. Nevertheless, it is expected that some form of regular maintenance would be required within the vegetated median.

The following recommendations were made:

- Retained and planted canopy trees should attain a minimum height of 20-25 m and a diameter of 10-20 cm;
- It is essential that tall trees be available as gliding platforms at least in the longer term;
- In the short-term, it may be possible to utilise tall poles with cross-bars in those areas dominated by plantings.

B4.3 Field Survey of Areas to be Cleared to Retain Vegetated Median

Because retention of vegetation along parts of the median would require that the southbound carriageway and proposed service road (i.e. existing Pacific Highway) be moved further to the east, Biosis Research was commissioned to undertake a rapid field assessment of native vegetation as part of the modified proposal. However, this area was previously assessed as part of a broader 250 m study corridor considered in the Species Impact Statement. The wide vegetated median option would result in the removal of approximately two hectares more native vegetation than the original proposal.

B4.3.1 Background

The section of proposal examined is within Pine Creek State Forest and private land directly to the north of the forest (i.e. Woods' property). This assessment was undertaken to target the area affected by the change in alignment to the east of the original proposal. The aim of this study was to ground-truth the accuracy of previous vegetation community mapping by SFNSW (1997) and Fisher *et. al.* (1996), to identify habitat for threatened flora species and to undertake opportunistic observations of threatened fauna species.

B4.3.2 Field survey

A rapid field assessment was undertaken on 30 November and 1 December 1998. The study was conducted by Suzanne Dray (Senior Botanist, Biosis Reseach) and Jason Anderson (Senior Zoologist, Biosis Research). During the assessment the weather varied from sunny to overcast with showers.

Flora Communities

Flora communities identified along the route included Dry Blackbutt (Forest Type 37) and Forestry Plantation (Forest Type 218). These were ground-truthed by field survey and reference to available mapping.

Flora Species

The traverse pegged by the surveyors (i.e. approximately 40 m west of the boundary of the hatched area shown in Figure B2) was used as a basis for flora and fauna assessment, together with the "Telstra track" that lies adjacent and to the east of the existing Pacific Highway. These pegged lines were traversed with random meanders undertaken to target threatened flora species (particularly the Rusty Plum *Amorphospermum whitei*) and to identify potential habitat for significant fauna species. The area surveyed on the traverse of the lines encompassed a "belt transect" of approximately 10 metres in width. Thirteen random meanders were undertaken around surveyor's pegs on the lines. These were undertaken mostly in a circular fashion around the peg with the radius varying between 10 and 50 metres. These random meanders were undertaken to give a good geographical spread of the area evaluated and to target the habitat of the Rusty Plum.

The location of the random meanders is as follows:

- Within a 10 m corridor along the surveyed traverse for the length of the hatched area (Figure B2) and within the Wood's property.
- Peg no. Northbound (N) 95329 R37, Southbound (S) 95320 R37; RM 20 m east.
- 100 m approx north from (N) 95329 R37, (S) 95320 R37; RM 30 m west.
- 200 m approx north from (N) 95329 R37, (S) 95320 R37; RM 50 m east.
- 270 m approx north from (N) 95329 R37, (S) 95320 R37; RM 20 m east.
- 320 m approx north from (N) 95329 R37, (S) 95320 R37; RM 50 m east.
- (N) 95001 R97, (S) 94989 R40; RM approx 20 m radius to west of peg.
- (N) 94888 R148, (S) 94882 R92; RM approx 30 m radius.
- (N) 94693 R142, (S) 94696 R88; RM approx 20 m radius to west of peg.
- (N) 94516 R135, (S) 94526 R86; RM approx 20 m radius.
- (N) 94414 R136, (S) 94424 R90; RM approx 15 m radius.
- (N) 94355 R133, (S) 94365 R89; RM approx 20 m radius to east of peg.
- (N) 94090 R138, (S) 94103 R104; RM approx 20 m radius.
- (N) 93965 R136, (S) 93977 R110; RM approx 20 m radius to west of peg.

Fauna Habitat

Fauna habitat was examined along the pegged lines as well as at the points where the random meanders for flora were undertaken. Assessment of vegetation structure, vegetation

type, ground litter, tree hollows and any microhabitat features was undertaken.

Fauna Species
The fauna assessment was conducted along the pegged lines as well as at the points where the random meanders for flora were undertaken. Assessment involved undertaking incidental observations of scats, tracks and other signs of fauna activity such as diggings. Good quality habitat was also noted. During the site visit the weather was overcast with occasional showers, making survey conditions sub-optimal.

B4.3.3 Results
Vegetation Communities
The vegetation communities previously mapped by State Forests of NSW (1997) and Fisher *et. al.* (1996) were found to be accurate. The area mapped as plantation (Forest Type 218) provides suitable habitat for the Rusty Plum.

The rainforest gullies identified and mapped may not fit the strict definition of rainforest; rather they have rainforest elements such as palms and other mesic species in the canopy and understorey layers.

Flora Species
A total of 11 Rusty Plums were located. None of these were flowering or fruiting. These were located at the following positions and are shown in Figure B3a.

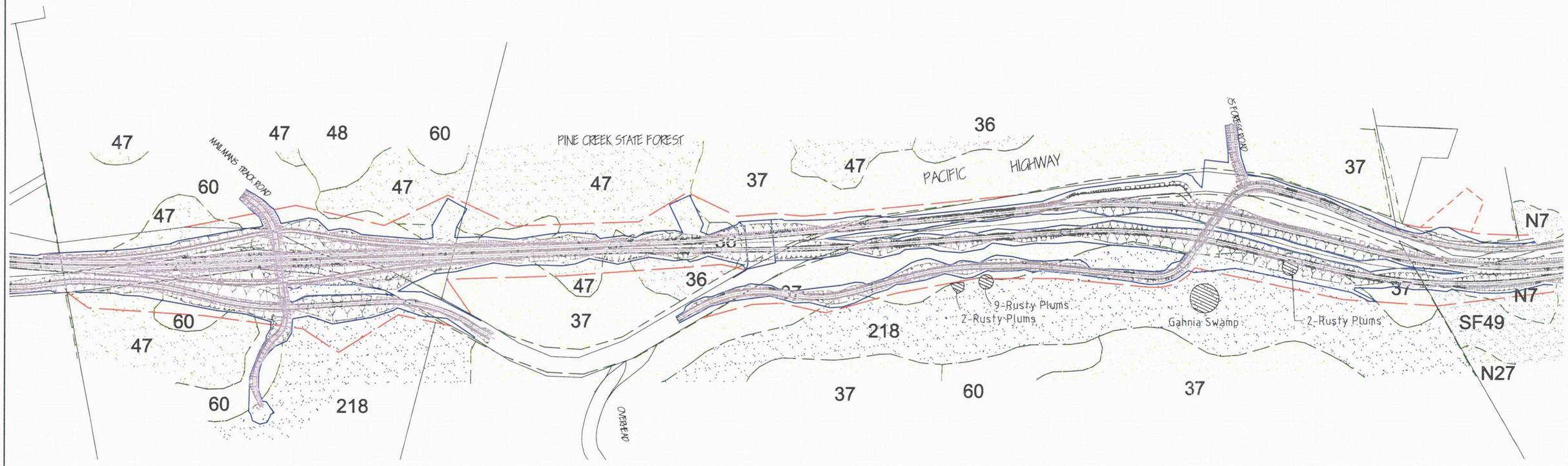
- 9 plants ranging from < 2 m to c. 8 m at E302465, N1634145 (approx 15 m radius).
- 2 plants of c. 8 m and 10 m at E302455, N1634085 (approx 20 m radius to east of peg).

No other potential habitat for threatened flora species was identified during the survey.

Fauna Habitat
The *Gahnia* swamp that occurs on the eastern side of the service road (i.e. to the east of the southbound lane) represents good quality habitat for a wide range of ground fauna. It provides potential habitat for the threatened Wallum Froglet. The area between the Telstra track and the existing highway represents poor quality habitat for fauna as it has been cleared in the past and is not structurally mature. There is also a high prevalence of exotic flora species present in this area.

The quality of the habitat between the Plantation (Forest Type 218) and Dry Blackbutt (Forest Type 37) is very similar. The plantation has some patchy areas infested with Lantana whilst the Dry Blackbutt is lacking these. The overstorey height and Diameter over Bark at Breast Height (DBH) in both of these areas are largely the same. The DBH is generally up to 60 cm with no obvious hollows evident. There is a reasonable level of fallen timber to provide shelter for ground fauna.

The forested area examined has low quality potential habitat for the following species: White-crowned Snake, Pale-headed Snake, Stephen's Banded Snake, Square-tailed Kite, Wompoo Fruit-Dove, Rose-crowned Fruit Dove, Powerful Owl, Masked Owl, White-eared Monarch, Barred Cuckoo-shrike, Tiger Quoll, Brush-tailed Phascogale, Common Planigale, Koala, Parma Wallaby, Red-legged Pademelon, Greater Broad-nosed Bat, and Golden-tipped Bat. These fauna species do not have specific habitat requirements or are mobile and are not likely to be dependent on the habitat along the proposed route. Similar habitat is found elsewhere in Pine Creek State Forest. The forest is likely to be used by a range of forest dwelling and/or mobile threatened fauna.



Note
The vegetation areas shown were derived from the Vegetation of the Coffs Harbour City Council LGA (Fisher *etal.* 1996) and the Pine Creek State Forest Draft Koala Management Plan (State Forests NSW 1997)

LEGEND
- Proposed Road Boundaries
- Vegetation Areas
- Property Boundaries
- Extent of Clearing

SCALE A 0 50 100 150 200 1:4000 UNREDUCED

Vegetation Communities

(Pine Creek State Forest Draft Koala Management Plan, State Forests NSW 1997)
36 Moist Blackbutt
37 Dry Blackbutt
47 Tallowwood - Sydney Blue Gum
48 Flooded Gum
60 Narrow Leaved White Mahogany - Red Mahogany
218 Forestry Plantation

(Vegetation of the Coffs Harbour City Council LGA, Fisher *etal.* 1996)
EP Eucalyptus Plantation
N7 Moist Blackbutt
N7A Tallowwood
N20 Paperbark
N27/EP Flooded Gum/Eucalyptus Plantation
N27 Flooded Gum
N52 Swamp Mahogany
N52A Flooded Gum
R Regrowth
SF49 Turpentine
SG6502 Sedgeland/Rushland
ST Scattered Trees

VEGETATION COMMUNITIES ALONG THE MODIFIED PROPOSAL

FIGURE B3a.

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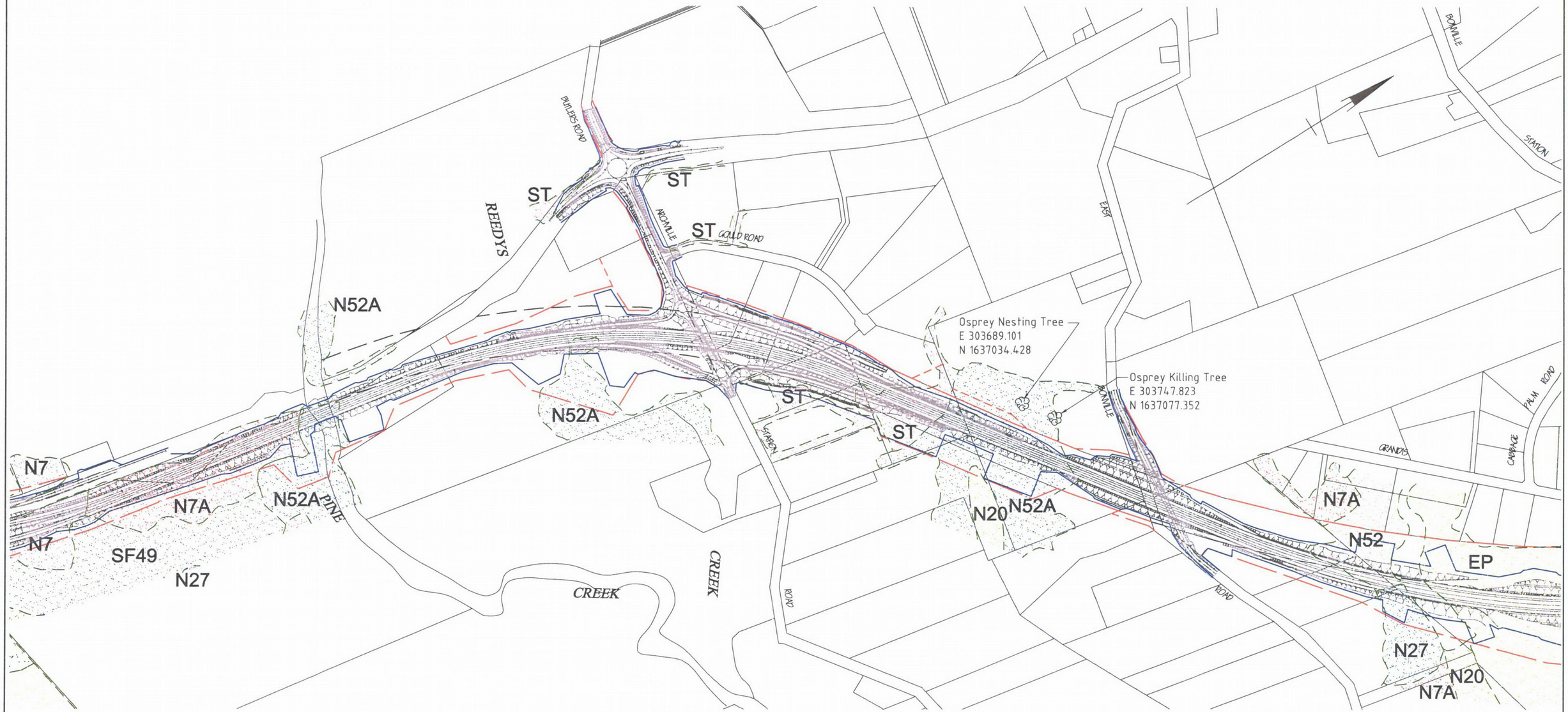

Note
The vegetation areas shown were derived from the Vegetation of the Coffs Harbour City Council LGA (Fisher *etal.* 1996) and the Pine Creek State Forest Draft Koala Management Plan (State Forests NSW 1997)

LEGEND
- Proposed Road Boundaries
- Vegetation Areas
- Property Boundaries
- Extent of Clearing

SCALE A 0 50 100 150 200 1:4000 UNREDUCED

Vegetation Communities

(Pine Creek State Forest Draft Koala Management Plan, State Forests NSW 1997)
36 Moist Blackbutt
37 Dry Blackbutt
47 Tallowwood - Sydney Blue Gum
48 Flooded Gum
60 Narrow Leaved White Mahogany - Red Mahogany
218 Forestry Plantation

(Vegetation of the Coffs Harbour City Council LGA, Fisher *etal.* 1996)
EP Eucalyptus Plantation
N7 Moist Blackbutt
N7A Tallowwood
N20 Paperbark
N27/EP Flooded Gum/Eucalyptus Plantation
N27 Flooded Gum
N52 Swamp Mahogany
N52A Flooded Gum
R Regrowth
SF49 Turpentine
SG6502 Sedgeland/Rushland
ST Scattered Trees

VEGETATION COMMUNITIES ALONG THE MODIFIED PROPOSAL

FIGURE B3b.

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Note
The vegetation areas shown were derived from the Vegetation of the Coffs Harbour City Council LGA (Fisher *etal.* 1996) and the Pine Creek State Forest Draft Koala Management Plan (State Forests NSW 1997)

LEGEND
- Proposed Road Boundaries
- Vegetation Areas
- Property Boundaries
- Extent of Clearing

SCALE A 0 50 100 150 200 1:4000 UNREDUCED

Vegetation Communities

(Pine Creek State Forest Draft Koala Management Plan, State Forests NSW 1997)
36 Moist Blackbutt
37 Dry Blackbutt
47 Tallowwood - Sydney Blue Gum
48 Flooded Gum
60 Narrow Leaved White Mahogany - Red Mahogany
218 Forestry Plantation

(Vegetation of the Coffs Harbour City Council LGA, Fisher *etal.* 1996)
EP Eucalyptus Plantation
N7 Moist Blackbutt
N7A Tallowwood
N20 Paperbark
N27/EP Flooded Gum/Eucalyptus Plantation
N27 Flooded Gum
N52 Swamp Mahogany
N52A Flooded Gum
R Regrowth
SF49 Turpentine
SG6502 Sedgeland/Rushland
ST Scattered Trees

VEGETATION COMMUNITIES ALONG THE MODIFIED PROPOSAL

FIGURE B3c.

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Fauna Species
No threatened fauna or signs of threatened fauna were observed.

B4.3.4 Conclusions
As a result of this survey, several more Rusty Plum individuals were located in the study area (in addition to those found in the original SIS). It is apparent that the plantation comprises suitable habitat for this species and that more individuals may potentially be removed by clearing. The quality of the habitat in both the plantation and the Dry Blackbutt is largely consistent with little discernable difference between these communities. The Gahnia Swamp is not of particular significance to any threatened species other than the Wallum Froglet.

Although the retention and enhancement of a vegetated median would result in the clearing of approximately two additional hectares of native vegetation, the benefits of providing movement corridors for gliders is considered to outweigh any disadvantages. Together with the fauna overpass, the vegetated median is considered adequate to maintain gene flow in glider populations. The additional key habitat removed would be taken into account in the compensatory habitat package (see Section B8.2.1).

B4.3.5 Recommendations
The service road to the east of the proposal has been aligned so as to avoid surveyed Rusty Plum individuals and a Gahnia swamp. As there is the possibility of further Rusty Plum individuals being located within the corridor, a protocol has been developed for any other Rusty Plums or other threatened species located pre-construction (see Section B8.1.1). Potential Wallum Froglet habitat would not be impacted by construction of the modified proposal.

B4.4 Aquatic Ecological Assessment

The aquatic ecological assessment was undertaken by Bill Rooney (Principal, W.S. Rooney & Associates) in November 1998 and included both field and desktop components. A Curriculum Vitae for Bill Rooney is contained in Appendix 5. The complete report is found in Appendix 3 and is summarised below.

B4.4.1 Background
The purpose of the report was to address concerns expressed in a submission prepared by NSW Fisheries (see Appendix 2) and to assess the modified proposal for the Bonville Deviation of the Pacific Highway. A meeting was held in the Ballina offices of NSW Fisheries on 2 November 1998 between the RTA, their consultants, and the NSW Fisheries Conservation Manager to discuss the Fisheries concerns and the work needed to satisfy those concerns.

W.S. Rooney & Associates Pty Ltd were commissioned to undertake the following tasks:

- Undertake additional aquatic habitat assessment without quantitative sampling;
- Apply an '8 part test' for threatened fish species within all aquatic habitats traversed by the proposed route. Although earlier advice from NSW Fisheries indicated that no threatened fish species were present in the study area, the determining authority is still required to have regard to the '8 part test' in order to satisfy the legislative requirements of section 111(4) of the *EP&A Act*.
- Assess the modified proposal in relation to three major creek crossings in the study corridor;
- Determine whether mangroves and/or seagrass occur within or near the proposed road

alignment in Bonville Creek. If either is present, determine the species, distribution, and likely loss or impact during construction of the proposed bridge over Bonville Creek.

- If either seagrass or mangroves could be lost as a result of construction or subsequent shading by the bridge, determine the areas to be affected and locate suitable area/s as close to the site as possible for compensatory planting. The need for a permit from NSW Fisheries to prune mangroves that may grow under the bridge is to be investigated.
- Prepare a report summarising the above findings and incorporating the aquatic ecological information (notably that on insects) included in the water quality working paper prepared by Robyn Tuft & Associates Pty Ltd.

B4.4.2 Literature review

In addition to the EIS (PPK 1998) and SIS (Biosis Research 1998) prepared for the Bonville deviation, a search was made for other existing reports or information on the fauna of these creeks. Standard reference works were consulted for information on fish species likely to occur in these waters and the distribution of threatened species. Contact was made with local officers from NSW Fisheries and other specialist consultants who may have worked in the area. The most recent SEPP 14 wetland maps were obtained from the Department of Urban Affairs and Planning, and other relevant environment protection legislation was reviewed. In particular, the NPWS Information Circular No. 2 (1996) was obtained from the NSW Threatened Species Unit at Port Stephens.

B4.4.3 Field survey

The aquatic habitats that were the subject of this study consisted of three creeks:

- Bonville Creek;
- Pine Creek;
- Reedys Creek.

The three creeks were closely examined in the field between 12-14 November, 1998. Bonville Creek was traversed from the existing Pacific Highway to Sawtell by small boat using snorkel and mask for underwater inspection where appropriate; the banks of Bonville Creek under the road alignment were traversed on foot. Pine and Reedys Creeks were examined on foot at the location of the road alignment and for a short distance upstream and a longer distance downstream. Three visits were made to Pine Creek at various times of the day to observe for fish and Platypus.

Other wetlands occur along the proposed road alignment between Archville Station Road and East Bonville Road, between East Bonville Road and Bonville Station Road, and in Bongil Bongil National Park between Lyons Road and Williams Road. These were the subject of further investigation by Adam King from Biosis Research (see Section B4.5, Appendix 4).

B4.4.4 Results

Habitat assessment

Bonville Creek aquatic habitat is characterised by the following:

- Deep tidal waters providing habitat for freshwater, diadromous and occasionally marine fishes and for freshwater and estuarine invertebrate species;

- No seagrasses;
- Scattered mangroves, particularly on the south bank.

Pine Creek aquatic habitat is characterised by the following:

- Deep freshwater providing habitat for small to medium sized native fish species, pollution-sensitive macroinvertebrates and Platypus;
- No seagrasses or mangroves.

Reedys Creek aquatic habitat is characterised by the following:

- Shallow swamp/wetland grading from open rushland to paperbark swamp providing habitat for small freshwater native fish species and a possible drought refuge for native animals;
- Mild pollution.

Aquatic 8-part test

Of the four fish species currently listed in Schedules 4 and 5 of the *Fisheries Management Act 1994*, only habitat for the Oxleyan Pygmy Perch was considered as possibly occurring within the study area. The Trout Cod and Eastern Cod were considered not likely to occur in the study area whereas the Honey blue-eye was considered highly unlikely to occur there.

The Oxleyan Pygmy Perch is known from only 18 localities in Queensland and New South Wales. It appears that the species' range has contracted considerably. Although the southern limit of the known distribution is 90 kms north of the study site near Grafton, Rooney (Appendix 3) considers that habitat within the study area, most notably Reedys Creek and Bongil Bongil NP, may be suitable for this species.

A further five species that may occur in the study area are 'potentially threatened' while another five may be at or near the southern limit of their distribution. Suitable habitat for most of these species occurs within Bonville and Pine Creeks. As the modified proposal comprises major bridges over these two creeks, there is unlikely to be significant long-term impacts on the habitat for these species.

B4.4.5 Conclusions

It is possible that listed fish species have not been recorded in the study area due to inadequate survey. The 8-part test assessment was based on the likelihood of a species occurring in wetlands within the study area, the presence of suitable habitat and on the potential impacts of the modified proposal incorporating mitigation measures. Consideration of the eight factors did not reveal that a significant impact was likely on the four declared threatened species in NSW or their habitat based on available information.

Habitat which may be suitable for some species near the edge of their distribution (e.g. Mouth almighty, Olive perchlet) or restricted in their distribution (i.e Purple-spotted gudgeon) occurs in Reedys Creek. As part of the modified proposal, a 60-m bridge would be constructed over at this crossing. Although a small proportion of habitat would be removed and short-term construction impacts may occur, these are unlikely to have significant long-term impacts on fish species or their habitat.

It was concluded that the major bridge structures to be constructed over Bonville, Pine and Reedys Creeks as part of the modified proposal would not result in a significant impact to wetland habitat. Furthermore, the modified proposal appears to meet both the broad intent and the specific principles of the NSW Wetlands Management Policy (DLWC 1996).

B4.4.6 Recommendations

The following specific recommendations were made for Bonville Creek:

- Prohibit use of small embayment immediately downstream of the south bank of Bonville Creek to construction crews to prevent clearing of river mangroves.
- Access water within the cleared road alignment without damaging any mangroves;
- Avoid damaging or removing small mangrove shrubs along the south bank;
- Minimise sedimentation and maintain water quality.

The following specific recommendations were made for Pine Creek:

- Prevent damage to the aquatic habitat in Pine Creek, in particular the high quality pool about 100 m downstream of the proposed crossing.
- Minimise sedimentation and maintain water quality.

The following specific recommendations were made for Reedys Creek:

- Remove Paperbark trees carefully in order to prevent disturbance to remaining understorey and submerged or floating vegetation. Trees should be cut and removed in sections using a small crane.
- If the existing backwater of the creek is used as a sedimentation basin, then a bund should be constructed at its downstream end to contain runoff from the earthworks on the northern abutment and approach to the bridge (see Section B4.5 also).

If the existing backwater at Reedys Creek is used as a sedimentation basin, the following guidelines apply:

- A bund wall with spillway could be constructed at the downstream end of the backwater to contain runoff from the earthworks on the northern abutment and approach to the bridge;
- The spillway would need to be above an acceptable flood level to prevent floodwaters from inundating the basin and mixing with its contents.

B4.5 Wetland Assessment

The wetland assessment was undertaken by Adam King (Team Leader Ecology, Biosis Research) in November 1998 and included both field and desktop components. A Curriculum Vitae for Adam King is contained in Appendix 5. The complete report is found in Appendix 4 and is summarised below.

B4.5.1 Background

This study was undertaken in order to assess the wetlands present within the study corridor and the potential impacts of the modified proposal on those values identified. In particular, the nature and degree of impact of the modified proposal on Reedys Creek and other wetlands along the proposal (i.e. between Archville Station Road and East Bonville Road, between East Bonville Road and Bonville Station Road and within Bongil Bongil NP) were assessed. Four main wetland areas were found adjacent to the proposal corridor; these are shown in Figure B2.

The investigation was undertaken to achieve the following objectives:

- To verify the quality and significance of wetland habitat in the study area;
- To verify the impact of the modified proposal on the wetland resource; and,

- To investigate and provide recommendations on any measures necessary to mitigate any potential impacts upon the wetlands.

B4.5.2 Field Survey

Wetland issues were identified by a rapid assessment of wetland conservation status and ecological significance. The four wetland areas were identified from aerial photography, topographic maps and through consultation with Bill Rooney. Two days of field work were undertaken to investigate each wetland area in some detail. Photographs, site data sheets and supplementary notes were taken while in the field. This enabled the status and value of each wetland to be evaluated within both catchment and site-specific contexts.

Assessment Methodology

The method used to assess the wetlands along the proposed Bonville bypass route was developed by the Department of Land and Water Conservation to rapidly evaluate extensive areas of wetland habitat in the western regions of NSW (King 1998). The method involves visiting each wetland and observing parameters that relate to basic wetland functions, human impacts and potential for restoration. NSW NPWS has endorsed the method for use in the central west region of NSW, although it can be applied in all areas of the State.

Consequently the wetlands were assessed with respect to the following considerations:

- Is there wetland vegetation within the wetland or in adjacent areas?
  If yes = good,
  If no = degraded.
- What is the primary source of water?
  If natural runoff / inundation from river or creek = good,
  If a mix of natural and agricultural = moderate
  If intensive agriculture tailings = degraded.
- Is the wetland presently or potentially used by waterbirds or is the wetland connected morphologically to other wetland areas.
  If close or connected = good
  If some distance away = moderate
  If isolated = degraded
- Is the wetland situated hydrologically above or below intensive agriculture or urban development?
  If above = good,
  If in same location = moderate,
  If below = degraded.
- Is the wetland connected or adjacent to a floodway, catchment or watercourse?
  If yes = good,
  If partially = moderate
  If isolated by development = degraded.
- Is there a visually definable depression?
  If yes = good
  If partially obscured by development = moderate
  If obscured by development = degraded.
- Has the wetland perimeter been altered?
  If no = good,
  If perimeter extended = moderate
  If perimeter reduced = degraded
- Has any construction occurred in the wetland?
  If no = good,

If destruction less than 50% = moderate,
If more than 50% = degraded

- What landuses occur in the catchment or immediately adjacent to the wetland?
  If a natural area = good
  If catchment is predominantly grazing = moderate
  If catchment predominantly intensive agriculture or urban = degraded.
- Where does the wetland source its water supply?
  If from natural surfaces (ie National Park) = good
  If from 50% natural and urban / agricultural = moderate
  If from urban or agricultural surfaces = degraded
- What is the quality of water in and around the wetland?
  If natural and unpolluted = good
  If pollution intermittent and light = moderate
  If there is high potential and/or pollution observed = degraded.

The assessment of each wetland was based upon an overall evaluation of the above considerations with a strong emphasis on defining natural wetland morphology and vegetation in good condition. An overall condition level of "Degraded", "Moderate" or "Good" was then assigned to each wetland. Wetland features were identified by means of:

- The air photo mosaic supplied by the RTA;
- Past experience within the region and New South Wales; and
- Background information and history provided by local landholders.

Specific wetland features assessed included wetland morphology, hydrology, land use, vegetation and the presence of threatened species.

Where wetland condition was found to be "good", it was normally due to:

- well-defined wetland morphology;
- the maintenance of a natural source of water;
- the presence of a significant amount of natural wetland vegetation.

Where wetland condition was found to be "degraded", it was commonly:

- subjected to significant grazing pressure;
- surrounded by or contain agricultural landuses;
- subjected to some type of water regulation or intensive agricultural runoff.

B4.5.3 Results

As a result of the wetland assessment described above, wetlands adjacent to the modified proposal were described and the issues relating to the maintenance of their functionality outlined.

Wetland Type and Condition

Each wetland was assessed in the field and classified after Winning (1992). The four wetland environments have been described and issues related to the construction of the proposal have been outlined below. A number of recommendations for mitigation are discussed in Section B4.5.5.

Table B4: Wetland condition.

WETLAND STUDY NO.	WETLAND NAME	WETLAND TYPE	CONDITION
1	Reedys Creek Locality	Floodplain Lagoon	Degraded
2	Reedys Creek (downstream)	Floodplain Lagoons	Good
3	Upstream SEPP 14 No. 344	Floodplain Creek Swamp	Good
4	SEPP 14 Wetland No. 344	Estuarine (Brackish) Swamp (western end)	Degraded
5	SEPP 14 Wetland No. 335	Estuarine (Brackish) Swamp (western end)	Degraded
6	The Pond	Dam	Good
7	Bongil Bongil Swamp	Estuarine (Brackish) Swamp	Good
8	Bongil Bongil Swamp (Buffer Habitat)	Upland Phreatic Swamp	Good

Wetland Issues

The main issues for each wetland assessed are summarised below:

Table B5: Wetland issues.

Wetland	Issues
Reedys Creek (Wetlands Nos. 1 & 2)	• depth and management of Acid Sulfate Soils (ASS)
Upstream of SEPP 14 Wetland No. 344 (Wetland No. 3)	• maintenance of water quality • ASS management • maintaining the present status of the SEPP wetland.
The Pond (Wetland No. 6)	• maintaining the protective buffer effects for the SEPP 14 Wetland No. 335
Bongil Bongil Swamp (Wetland Nos. 7 & 8)	• maintenance of the supply and quality of ground water flow to the southern arm of the wetland • the maintenance of the two creeks flowing into the swamp to the west and north-west

B4.5.4 Conclusions

The potential impacts of the modified proposal on each of the wetlands identified in the study area is assessed below.

Reedys Creek

The 60-metre bridge at the Reedys Creek crossing is expected to have only limited impact at the crossing locality and an insignificant impact on downstream wetland habitats. Habitat loss is not expected to be significant because the area is small (i.e. 0.1 ha), it is physically isolated from the core of Wetland No. 2 and it provides only limited habitat for wetland fauna.

The construction of the northern approach to the bridge would involve filling most of the degraded oxbow lagoon at the site. The lagoon exhibits limited value as wetland habitat and does not contribute significantly to the overall health of Wetland No. 2, the SEPP 14 wetland downstream or to the catchment as a whole.

The modified proposal has ensured the hydrologic functions of the locality are maintained through the planned construction of a 60-metre bridge and the placement of a permeable rock layer underneath the northern part of the carriage way contained within the oxbow lagoon.

ASS contamination is expected to be low if pylons are encased with metal sleeves and the ASS is closely monitored and managed according to the management plan outlined in Appendix H of the EIS.

Wetland No. 3
The modified proposal would not have a significant impact on this wetland because it would maintain an existing wildlife corridor and wetland functionality. The wildlife corridor underneath the modified proposal is considered adequate for the passage of water and aquatic species. The southern approach of the road would be lined with a permeable base in order to maintain water flow.

Wetland No. 6
The modified proposal transects this wetland. In order to preserve its buffering function for Wetland No. 335 and to mitigate the threat of stagnation in either part of the wetland, the modified proposal incorporates four sets of pipes and a permeable rock layer underneath the proposed road crossing. This would ensure the flow of water and the passage of aquatic species between each half of the wetland.

Wetland Nos. 7 & 8
The modified proposal does not directly impact Wetlands Nos. 7 and 8 where it approaches Bongil Bongil NP. It includes a culvert where it crosses a creek flowing into the western edge of Bongil Bongil Swamp in order to maintain the base surface flow entering the wetland. It should also ensure the passage of groundwater past the locality with the use of permeable rock layers under the entire culvert construction.

Despite some vegetation removal and temporary water quality issues, the modified proposal has incorporated mitigation measures to reduce the impact of construction and of long-term environmental effects of traffic passing through the area. Furthermore, there would be no significant net loss of natural wetlands as a result of the modified proposal. If additional mitigation measures outlined below are stringently followed, it is considered that there is no need for compensatory habitat to replace natural wetlands located along the modified proposal.

B4.5.5 Recommendations
The following additional mitigation measures should be considered during construction of the modified proposal:

Table B6: Summary of mitigation measures for relevant wetlands.

Construction Activity	*Mitigation*
Vegetation removal at Reedys Creek	• The removal of riparian and instream vegetation should not include tree roots which are needed to stabilise creek sediments until other aquatic plants colonise the site. • Extraction methods should require the trees to be cut off at the stump and lifted out by a crane.
Bridge and culvert construction	• Metal sleeves should be used to encase the construction of the pylons to reduce the risk of ASS contamination. • Machinery used in the construction of the pylons should not disturb instream sediments. • All damage arising from construction activities in the riparian zone should be repaired as soon as practicable.
Water quality management (during construction)	• Water flowing into the SEPP 14 wetlands should be subject to permanent and effective water quality measures. • During construction, the ecosystem of Wetland No. 6 should be preserved as far as practicable by isolating the construction site with sheet piling to prevent the contamination of the remaining area of habitat.
Water quality management (post-construction)	• A treatment facility (sedimentation basin or oil and sediment separator) should be constructed at Reedys Creek. • All road runoff should be treated in sedimentation basins or sediment and oil separators before discharge into adjacent creeks or wetlands • Water quality structures should be placed as far away as possible from creeks and wetlands to prevent accidental overflow into natural wetland habitats. • Noise screens and trash traps could be used in Wetland No. 6 to prevent foreign matter from being washed or blown into the wetland from the new road.
Re-establishment of wetland connectivity	• Once culvert construction is complete at Wetland No. 6, the two disjunct sections of the wetland should be brought back on line to resume their buffering role for Wetland No. 335.
Sedimentation basin construction	• The construction of all sedimentation basins should ensure that there is a minimum of vegetation removal when positioned in close proximity to wetlands especially Wetland Nos. 7 and 8.

Construction Activity	*Mitigation*
Constructed wetland design	Any constructed wetland used in the modified proposal (particularly at Reedys Creek) should: 1. Use appropriate constructed wetland technology to enable the wetland to capture and treat the first 12 mm of runoff from its catchment; 2. Have the capacity to contain the volume of pollutant expected from a large tanker spill within its catchment; 3. Ensure that the catchments supplying constructed wetlands can produce sufficient base flow to maintain a viable wetland ecosystem; 4. Be protected from at least a one in two year magnitude flood; 5. Isolate the wetland from subsurface hydrology to prevent seepage downstream; and, 6. Be subjected to regular maintenance to prevent toxic levels of pollutants from building up and to enable the continuing functionality of the basin's ecosystem.

B5.0 SIGNIFICANCE ASSESSMENT

Following a review of submissions, further literature review and additional targeted rapid survey work, the significance of the study site was reassessed according to the methodology outlined in Section 4.4 of the SIS.

B5.1 Terrestrial Flora

One further vegetation community is present in the Pine Creek State Forest that was not described in the SIS; this community type was not affected by the original proposal. Turpentine *Syncarpia glomulifera* is the dominant canopy species in this community. Other common canopy species include Tallowwood *Eucalyptus microcorys*, Sydney Blue Gum *E. saligna*, Flooded Gum *E. grandis*, Narrow-leaved White Mahogany *E. acmenoides*, Grey Ironbark *E. siderophloia*, Pink Bloodwood *Corymbia intermedia* and Brush Box *Lophostemon confertus*. The condition of this community is considered to be good.

As part of their review of the 8-part test for the Bonville area (Biosis Research 1997), Smith and Smith (1998) considered that the species *Thesium australe* may be potentially impacted by the proposal. They note that Cooper (1986, in Smith and Smith 1998) referred to specimens located in the NSW Herbarium that were collected at Muttonbird Island in 1909 and McCauleys Head in 1957.

Thesium australe is semi-parasitic herbaceous shrub (Ridgeway 1995). The following is summarised from Griffiths (1992). Its preferred habitat is grassland or grassy *Eucalyptus* woodland in which *Themeda australis* is a dominant species with occasional records of association with *Poa* species. The species has also been recorded from grassy open heathland in the southern tablelands of NSW and similar areas in Victoria. The key habitat type of *Thesium australe* on the North Coast is coastal headland. Griffiths (1992) mapped potential sites for the species in the Coffs Harbour Shire and none of these are located within the study area.

There is no suitable habitat within the study area for this species. It is unlikely to be present and therefore is not likely to be affected by the original or modified proposals.

B5.2 Terrestrial Fauna

The number and type of fauna habitats has not changed from the SIS. The Turpentine community fits into the Tall Open Forest habitat type.

In a review of the 8-part test for the Bonville area undertaken by Smith and Smith (1998), it was noted that several fauna species included in that study were not considered further in the SIS. These are:

Table B7: Threatened fauna species which may occur within the study area.

Species	Significance
Comb-crested Jacana;	Vulnerable
Regent Honeyeater;	Endangered
Eastern Chestnut Mouse;	Vulnerable
Eastern Cave Bat;	Vulnerable
Grass Owl;	Vulnerable
Barking Owl	Vulnerable

It should be noted that the first four species listed were considered in the 8-part test and

were targeted using those survey methods specified by NPWS. However, none of these species were included in the D-G Requirements which formed the basis of the SIS survey. Suitable habitat for these species occurs in the study area. Furthermore, survey techniques used as part of the SIS (i.e. active searching, hair-tubing, harp-trapping and Anabat detection) would have targeted these species if they had been present.

It should also be noted that the Grass Owl and Barking Owl are known from very recent records (Debus *et al.* 1998 and Debus 1997; in Smith and Smith 1998). The Grass Owl was not targeted and although it is known to use rank pasture, this habitat type does not appear to be in short supply within the study area. The Barking Owl was not specifically targeted through call playback although it could have been detected through spotlighting. Although these species were not listed in the D-G Requirements, most of them are fairly mobile and could occur on the study site. We therefore consider them further in short profiles below.

B5.2.1 Threatened Fauna Species Profiles

The information contained in the following profiles has been summarised from: SFNSW (1995), Strahan (1995), Menkhorst (1995), Marchant and Higgins (1990), and Blakers *et al.* (1984) unless stated otherwise.

Comb-crested Jacana Irediparra gallinacea

Comb-crested Jacanas forage along the edges of pools and among floating leaves, probing and pecking amongst the vegetation. The exceptionally long hind toe of this species enables the bird to walk on waterweeds. They are thought to eat mainly aquatic plants and insects. Nests comprise a platform of sedges, grasses and aquatic plants, and are usually constructed in the water and supported by aquatic vegetation. This species usually nests between September and January in eastern Australia.

The Comb-crested Jacana has the potential to utilise wetlands within the study corridor, particularly at Bongil Bongil National Park.

Regent Honeyeater Xanthonyza phrygia

The Regent Honeyeater is a highly specialised species that prefers box-ironbark forests. This species prefers or reaches its highest densities in old-growth forest. Preferred trees for feeding include: Red Ironbark *Eucalyptus sideroxylon*, White Box *E. albens*, Yellow Box *E. melliodora*, Yellow Gum *E. leucoxylon*, Red Gum *E. blakelyi* and River Red Gum *E. camaldulensis* (Robinson 1994). Webster and Menkhorst (1992) found that local habitat selection was determined by the presence of large flowering trees, high productivity and an understorey of saplings or shrubs. Honeyeaters are nomadic in their movements though they exhibit seasonal patterns of movement in relation to districts where there are flowering eucalypts and banksias.

This species has the potential to utilise the entire study corridor on a transitory or temporary basis.

Eastern Chestnut Mouse Pseudomys gracilicaudatus

In NSW, the Eastern Chestnut Mouse has been found in heathland and is most common in dense wet heath and swampy areas which is shares with the Swamp Rat. Optimum habitat is provided by young regenerating heath vegetation and the fire history of areas may influence whether or not it is present. Home ranges are generally less than 0.5 hectares. The species is largely nocturnal, with minimal daylight activity. Nests may be constructed of grass above ground or be part of a burrow complex. The Eastern Chestnut Mouse is a generalist granivore, predominantly consuming seeds, but also consuming plant stems, leaf

material, fungi and insects.

The Eastern Chestnut Mouse has the potential to utilise the study corridor, particularly Bongil Bongil NP and adjacent NPWS-owned land.

Eastern Cave Bat Vespadelus troughtoni
The Eastern Cave Bat is a cave dweller, known from drier forests and tropical woodlands from the coast and Dividing Range to the semi-arid zone. It has been found roosting in small groups under sandstone overhangs and in mine tunnels; occasionally it roosts in buildings. In all situations, the roost sites are reasonably well lit. This species is one of the least known members of its genus in eastern Australia.

The Eastern Cave Bat has the potential to utilise the study site for foraging purposes, as part of a much larger home range. No potential cave sites are known from the study corridor.

Grass Owl Tyto longimembris
The Grass Owl is a ground dweller that requires excellent ground cover and is consequently restricted to grassy plains, swampy areas with sedges, heaths and tussock grasses, floodplains with clumps of Canegrass or Lignum, or bore drains with sedges and dense stands of Cumbungi. It appears to prefer areas where good stands of Mitchell Grass are established. However, this species has also been recorded within dry sclerophyll forest. During the day, the Grass Owl rests on a trampled platform within a large tussock or other heavy growth. Diet consists mainly of small mammals supplemented with small birds and insects. It is a nomadic species that undergoes population explosions during rodent plagues (NSW NPWS 1996).

Grass Owls may utilise the study corridor as part of their larger home ranges.

Barking Owl Ninox connivens
The Barking Owl primarily lives in woodlands, but occurs in forest, partially cleared areas and occasionally near or in rural towns. It is nocturnal and nests in tree hollows. This species generally occur in pairs occupying large (greater than 100 hectares) territories (NSW Scientific Committee TSC Act Final Determination).

Barking Owls may utilise the study corridor as part of their larger home ranges.

B5.3 Aquatic Fauna

No significant fish species are likely to be found within the study area. The nearest record for a threatened species, the Oxleyan Pygmy Perch, is 90 kms to the north.

Although it is not a significant species, the Platypus may occur in Pine Creek. A pool providing deep water and suitable banks with good overhanging cover was located about 100 m downstream of the proposed crossing by Rooney (Appendix 3). The potential impacts of bridge construction on Platypus habitat in Pine Creek is considered further in Section B7.3.1.

B5.4 Significant sites

The Bongil Bongil Area containing Bongil Bongil National Park at its northern end and the Bundagen Flora Reserve at its southern end, has been Interim-listed on the Register of the National Estate. The following information has been summarised from the Australian Heritage Commission (AHC) website.

The Bongil Bongil Area contains a regionally rich bird fauna and is locally important as overwintering habitat for several bird species including honeyeaters, the Regent Bower Bird and the Pacific Baza. Local Koala expert Chris Moon disagrees (*pers. comm.*) with the statement that the place is a local stronghold for the Koala. It contains remnants of two plant communities which have been greatly reduced in extent in NSW, littoral rainforest and Melaleuca and Casuarina swamp forest. It also provides habitat for Koalas and for the Rusty Plum. The area has had severe but localised mining and forestry disturbances. It contains some Flooded Gum and Blackbutt plantations.

On the basis of this additional information, it is considered that the conservation significance of the Bongil Bongil Area adjacent to the proposal remains unchanged at high regional.

B5.4.1 Interim Deferred Forest Areas

Interim Deferred Forest Areas (IDFAs) were identified during the Comprehensive Regional Assessment (CRA) process as areas of high conservation value potentially required for a Comprehensive, Adequate and Representative (CAR) reserve system. There was an IDFA approximately 150-300 m east of the existing highway (Appendix 1). However, no deferred forest compartments in Pine Creek State Forest were included in the Regional Forest Agreement and no new national parks were created in the area (J. Turbill, NPWS Northern *Zone pers. comm.*).

B5.5 Overall Significance

The following additional vegetation communities, fauna species and significant areas have been considered with respect to the conservation significance of remnant vegetation within the study corridor:

- The vegetation community Turpentine has been added to the vegetation description of PCSF. As it is not considered to be a significant community, its presence does not alter the existing conservation significance rating. Furthermore, no deferred compartments were set aside for conservation purposes in PCSF as part of the CRA process. The conservation significance of PCSF therefore remains unchanged from the SIS (i.e. State).
- Six endangered and vulnerable fauna species were considered in addition to the 41 fauna species listed in the D-G Requirements. As none of these species are likely restricted to the study corridor, and most of them are highly mobile and likely to use the area as part of their larger home ranges, their potential occurrence does not alter existing conservation significance ratings of vegetation remnants in the study corridor (i.e. these vary from local to State).
- The aquatic 8-part test identified the possible presence of habitat for the Endangered Oxleyan Pygmy Perch, in Reedys Creek. It should be noted that the study site is outside the known distribution for this species. Given the existing information on the distribution of this species, the conservation significance of Reedys Creek is considered to be local. If the Oxleyan Pygmy Perch were found in the locality, this significance rating would have to be reviewed.
- Although the Interim-listed Bongil Bongil Area is recognised for its littoral rainforest values, this community is located well outside the study corridor. The area of Bongil Bongil adjacent to the modified proposal comprises predominantly plantation and has been subject to other disturbances. The conservation significance of the Bongil Bongil area therefore remains unchanged from the SIS (i.e. high regional).

On the basis of further information presented above, it is considered that the conservation significance of remnant vegetation within the study corridor should remain unchanged from the SIS (i.e. varying from site to site from local to state).

B6.0 SUMMARY OF DESIGN CHANGES

On the basis of submissions received, results of additional studies and specialised literature review, the following design changes have been implemented. These form an integral part of the modified proposal that is assessed in Section B7.0 below. Detailed design changes are outlined in PPK (1999a).

It is anticipated that construction would commence in January 2001 and continue over the next 2-3 years. An Indicative Construction Schedule is provided in PPK (1999a).

B6.1 Summary of Changes to Proposal

It should be noted that as a result of studies summarised in Sections B4.1, B4.2, B4.3 B4.4 and B4.5, design changes and mitigation measures have incorporated into the modified proposal. These are summarised below:

Table B8: Summary of changes to the proposal from south to north.

Type (location)	Alteration made	Environmental mitigation
Realignment northbound carriageway (PCSF)	Moved eastward. See Figure B4.	Minimises impact to gullies; truck inspection station/rest stop included in footprint of existing highway (Section B7.1.1)
Realignment southbound carriageway (PCSF)	Independently aligned. See Figure B4.	Allows a variable width vegetated median with retained vegetation (Section B7.1.1, B7.1.2)
Realignment service road	Moved eastward. See Figure B4.	Allows wide separator with retained mature trees; avoids Rusty Plum individuals and Gahnia community; designed for low speed environment to minimise clearing and Koala roadkills (Section B7.1.1, B7.1.2)
Vertical alignments of both carriageways (PCSF)	Lowering through Mailmans Track cutting and central forest gullies; lowering of service road opposite Mailmans Track.	Minimises forest clearing (Section B7.1.1)
Major fauna overpass (PCSF)	60-m wide fauna overpass to be constructed in central part of PCSF. See Figure B5.	Minimise barrier effects (Section B7.1.2)
Major fauna underpass	Deleted from northern forest gully	
Relocation major fauna underpass (PCSF)	Moved to southern forest gully replacing arch structure in EIS (medium). See Figure B4.	Minimise barrier effects (Section B7.1.2)
Safety barriers along vegetated median (PCSF)	Outer verges to include wire rope safety fence.	Permit tree retention/planting (Section B8.1.4)

Type (location)	Alteration made	Environmental mitigation
Major bridge (Reedys Creek locality)	Culvert converted to a 60 m (approx.) bridge to be constructed over each carriageway. A permeable base layer is to be provided beneath adjacent fill (north side).	Facilitate fish movement; minimise potential impacts of ASS on wetland; minimise impact on riparian vegetation; minimise loss of wetland habitat; minimise potential sedimentation during construction; maintain surface and sub-surface flows (Section B7.1.1, B7.1.2, Appendices 3 &4)
Fauna underpass structure (wetland south of East Bonville Road)	Permeable base layer to be provided.	Minimise effects on groundwater flow (Section B7.1.2, Appendix 4)
Additional culverts (wetland north of East Bonville Road)	Replace central culvert (5x1350 diam.) with four separate culverts (each 2x1200 diam.). Permeable base layer to be provided.	Maintain flow of surface and groundwater flow (Section B7.1.2, Appendix 4)
Creek to the west of Bongil Bongil Swamp	Permeable base layer to be provided.	Maintain flow of surface and groundwater flow (Section B7.1.2, Appendix 4)
Fauna underpass structure (wetland north of Herdegen Close)	Permeable base layer to be provided.	Maintain flow of groundwater (Section B7.1.2, Appendix 4).

B6.2 Mitigation Measures Incorporated into Proposal

Descriptions for mitigation measures incorporated as part of the modified proposal are as in Section 5.5 of the SIS. However, the medium-sized structure in the southern gully of PCSF and the culvert at Reedys Creek have been altered. Mitigation measures associated with the modified proposal are summarised below:

Table B9: Summary of mitigation measures associated with the modified proposal.

Size category	Type	Location
Major structures	Fauna overpass	Approx. 200 m north of northern forest gully, PCSF
	Fauna underpass	Southern forest gully, PCSF
	Fauna underpass with permeable base	North of Herdegen Close
	Bridges	Pine Creek, Bonville Creek, Reedys Creek
	Shared underpass	North of Sid Burke Rest Area
Culverts	Culvert with permeable base	Wetland south of East Bonville Road
	Four sets of twin pipe culverts on permeable base	Wetland north of East Bonville Road
	Extension of existing culvert	South of Mailmans Track
Other	Vegetated median	Along approximately 60% of PCSF

Size category	Type	Location
	Fauna exclusion fencing	Essentially unchanged from SIS; some minor alterations in area of fauna overpass

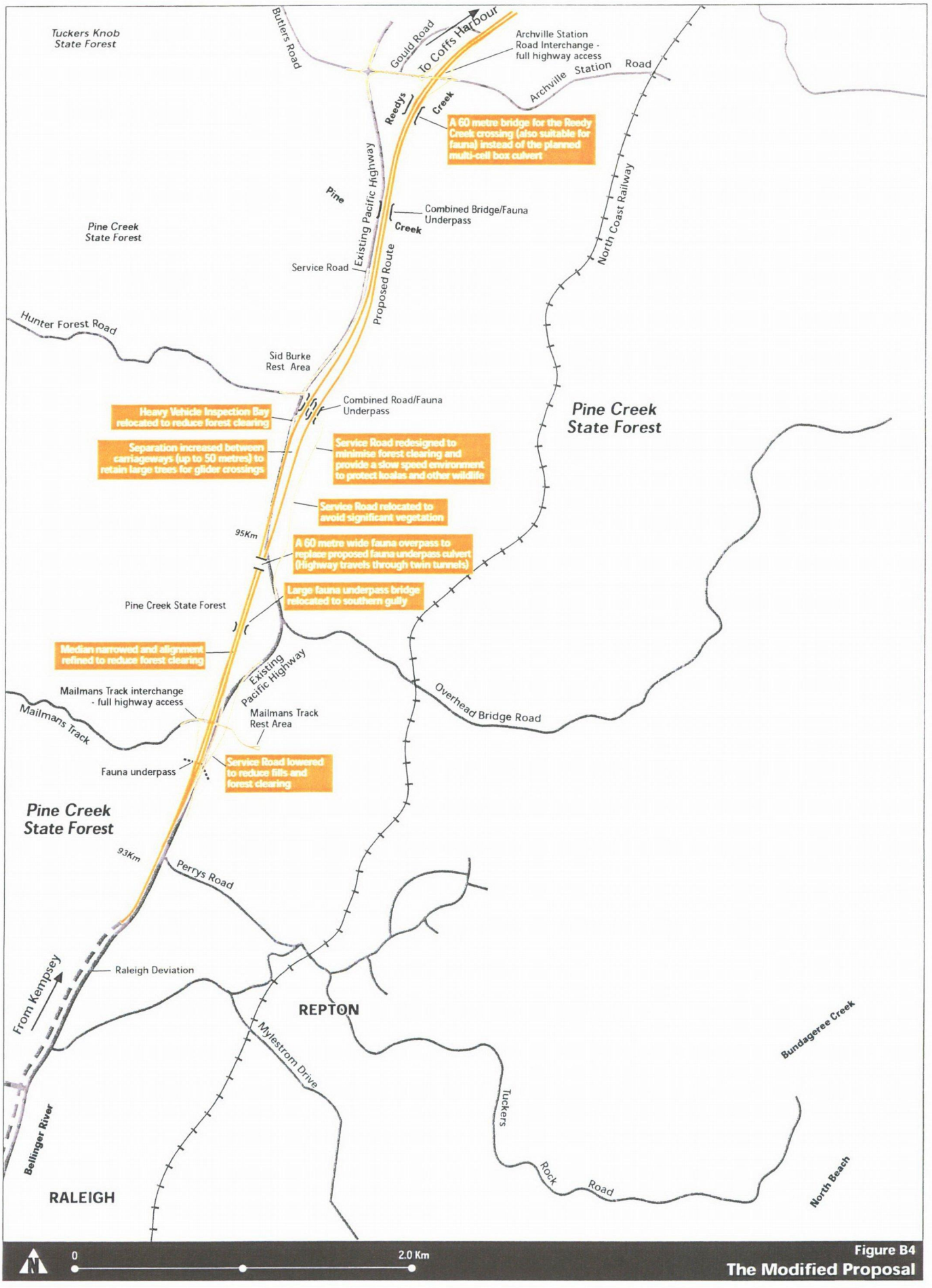

Figure B4
The Modified Proposal

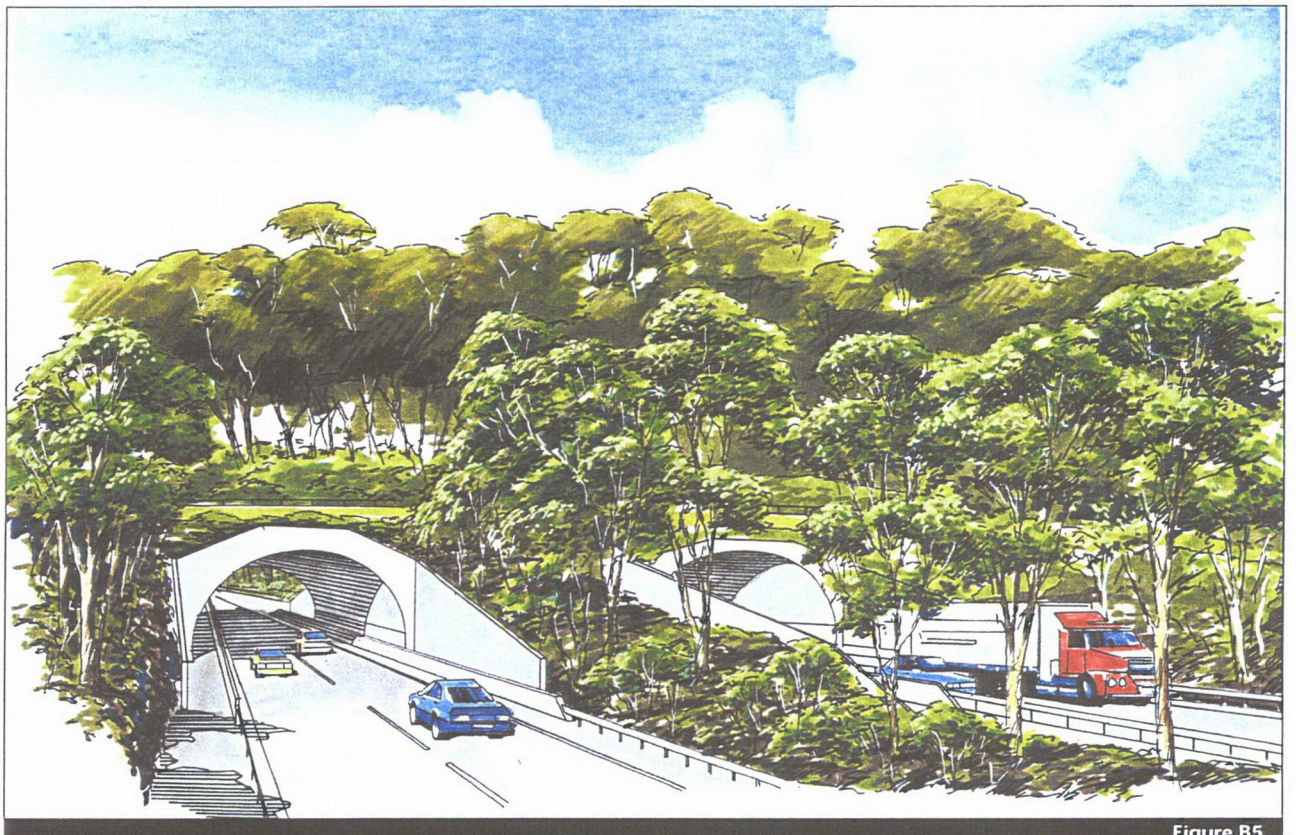

Figure B5
Artists Impression of Fauna Overpass

B7.0 IMPACT ASSESSMENT

This section is aimed specifically at assessing impacts associated with the modified proposal on terrestrial flora and fauna and on aquatic habitats and fauna occurring or likely to occur in the study corridor. For ease of comparison, the potential impacts of the modified proposal are compared with those of the original proposal at the end of each section.

B7.1 Potential Impacts of the Proposal

The area which has been most affected by changes to the proposal is Pine Creek State Forest. Other changes are associated with some creek or wetland crossings.

B7.1.1 Habitat Loss

Construction of the modified proposal would result in the loss of more native vegetation as the provision of a wide vegetated median increases the overall road footprint. However, this has been compensated for to some extent through the easing of the carriageways and associated service roads to the east and through the adjustments of vertical alignments.

Terrestrial Flora Communities

Potential habitat loss resulting from the modified proposal would be associated with PCSF. Vegetation communities affected by the modified proposal are shown in Figure B3 (a-c).

The modified proposal would result in the loss of more native vegetation than the original proposal (approximately 2 ha) in order to retain parts of a vegetated median. For each community, the following areas would be cleared as a result of the development:

Table B10: Area to be cleared in each community type along the proposed corridor. "R" denotes regional significance according to Fisher *et al.* (1996). Community names are as per Fisher *et al.* (1996).

Vegetation Community	Area to be cleared (ha)
Tallowwood/Sydney Blue Gum	3.0
Moist Grey Ironbark/Grey Gum/ Tallowwood/White Mahogany (R)	6.0
Dry Blackbutt (R)	10.8
Moist Blackbutt	4.0
Paperbark	0.2
Flooded Gum (R)	8.2
Swamp Mahogany	0.9
Tallowwood (R)	3.0
Turpentine (R)	0.2
Scattered Trees	1.7
Eucalypt Plantation	16.8
Regrowth	0.8
TOTAL	54.1

The vegetation communities to be disturbed are well represented elsewhere within Pine Creek State Forest and the local area. Only relatively small areas of each community would be lost from the locality as a result of the modified proposal. Scattered Trees, Eucalypt Plantation and Regrowth comprise 19.3 ha of the 54.1 ha to be removed (36%). The Tallowwood/Sydney Blue Gum, Moist Blackbutt, Paperbark, and Swamp Mahogany communities total 8.1 ha.

The communities considered to be regionally significant by Fisher *et al.* (1996) total 28.2 ha (52% of the total amount vegetation to be removed). Of the communities considered to be regionally significant, the Dry Blackbutt and Turpentine communities (11 ha) are in good condition in the study area, while the Moist Grey Ironbark/Grey Gum/ Tallowwood/White Mahogany community is in moderate to good condition (6 ha). The Flooded Gum community (8.2 ha) is in moderate condition and the Tallowwood community (3 ha) is in poor condition.

Terrestrial Flora Species
Two Rusty Plum individuals would be removed as a result of the modified proposal. Furthermore, suitable habitat for this species would be affected. As the flora survey was not comprehensive, there is a possibility of disturbance to, or removal of, unrecorded specimens of Rusty Plum within the area to be disturbed for the service road. Refer to Section B8.1.1 for protocol to be adopted if specimens are located in the area to be disturbed prior to construction.

The removal of two Rusty Plum individuals is not considered to constitute a significant impact to the population. The overall impact on flora species and communities remains unchanged from the SIS (i.e. high local).

Terrestrial Fauna Habitat
Potential habitat loss resulting from the modified proposal would be associated with PCSF.

Overall, a total of approximately 54 hectares would be removed as a result of the modified proposal. The habitat areas affected within PCSF and in NPWS owned land adjacent to Bongil Bongil NP are of high local significance because, although they form part of more extensive regional corridors, they are represented elsewhere in the local area. Plantation trees, regrowth and scattered trees provide only limited resources for fauna and are not secure from a conservation point of view and their removal is consequently considered to be of local importance only.

Although the northbound carriageway has been eased slightly to the east (i.e. south of the overpass), it still impacts on some high quality Koala habitat as defined by SFNSW (1997). This comprises mainly Sydney Blue Gum-Tallowwood and Dry Blackbutt communities. However, reduction of the width of the median in this area and adjustment of the vertical alignment has minimised the vegetation clearance required. However, the fauna overpass is expected to maintain gene flow between populations of several fauna groups, especially Koalas and gliders, across the highway. The overpass would be planted with Koala food trees and would contain trees of a sufficient height to be used as launch trees for gliders.

Terrestrial Fauna Species
Habitat for the Comb-crested Jacana would not be impacted by any alterations to the proposal occurring in PCSF. This species is considered further below under the Section entitled *Aquatic Fauna*.

Removal of habitat for the Regent Honeyeater, Eastern Cave Bat and two owl species is not likely to have a significant impact since these are highly mobile species; one or more individuals of any of these species may use the study area as part of more extensive home ranges. No caves suitable for roosting Eastern Cave Bats are known from within the proposal corridor. Potential habitat for the Eastern Chestnut Mouse may be found in swampy areas within Bongil Bongil National Park that are unlikely to be affected by the proposal. Careful road and culvert design (Section B4.5) together with additional

amelioration (Section B8.3) would act to minimise any impacts to existing hydrological regimes. Overall, the impact of the proposal on habitat loss for the above species is considered to be local.

Bongil Bongil Area

Although Bongil Bongil Area is Interim-listed on the Register of the National Estate, it is still considered to be part of an area of high regional significance. In the area adjacent to the modified proposal, it is considered to be important for its corridor values and as habitat for Rusty Plum. The potential impact of habitat removal in this area is unchanged from the SIS and is considered to be local.

Aquatic Habitat

Potential wetland habitat loss resulting from the modified proposal would be associated with Reedys Creek, wetlands to the south and north of East Bonville Road, the creek to the west of Bongil Bongil Swamp and the wetland north of Herdegen Close.

The Reedys Creek crossing has been upgraded from a culvert to a major bridge in order to minimise habitat loss and to maintain wetland function downstream. In addition, a permeable base layer would be used under the filled oxbow to maintain sub-surface flows. Other wetland crossings in the proposal corridor have been modified in order to ensure the maintenance of surface and sub-surface flows through the enlargement of culverts or the incorporation of permeable base layers.

The presence of Acid Sulfate Soils (ASS) is a potential problem at Reedys Creek but is also possible within other wetlands in the proposal corridor. This has been taken into consideration at Reedys Creek through the replacement of the culvert with a bridge. During construction, the presence of ASS would be monitored and, if detected, managed according to the *Acid Sulfate Soil Management Strategy* outlined in Appendix H of the EIS. If protocols for detecting and responding to ASS are followed rigorously, it is expected that potential impacts would be local and short-term. However, there is the potential for greater impacts if ASS is not carefully monitored.

The minimisation of sedimentation and erosion impacts has been taken into account in the design of stream crossings. These have been considered in detail in the *Water Quality Assessment* in Appendix K of the EIS. Impacts of sedimentation and erosion are expected to be further reduced during development of the modified proposal because:

- Reduced excavation is required, particularly at Reedys Creek;
- Buffer vegetation would be retained;
- Downstream effects on SEPP 14 wetlands have been taken into account in proposal design and mitigation measures.

Road design has taken into account the maintenance of surface and sub-surface flows and consequently the maintenance of long-term wetland functionality. These aquatic impacts are expected to be minimised through the use of permeable base layers beneath culverts and filled areas.

It is therefore expected that habitat loss arising as a result of a decrease in water quality or interference in hydrological regimes associated with the modified proposal would be local and short-term in nature.

Aquatic Flora

The aquatic ecological assessment (see Appendix 3) concluded that the removal of mangroves on Bonville could be avoided during highway development. The author considered that there was ample width between clumps of mangroves to launch any equipment or to gain access to the water; these comprised clumps of seedlings and juvenile plants. The mangroves are not likely to create a clearance problem under the proposed bridge although some individuals would be affected by reduced light penetration associated with bridge construction. If it was found that mangroves had to be removed as part of development, then a permit would be required (see Section B3.0).

Aquatic Fauna

The aquatic 8-part test concluded that there was not likely to be a significant impact of development on threatened fish species. The study found that, although habitat on the site, in particular the wetland downstream of Reedys Creek and Bongil Bongil Swamp, comprised potentially suitable habitat for one species of significance, the Oxylan Pygmy Perch, the study corridor is outside the known range of the species. Even if this species occurred at Reedys Creek, its habitat would not be significantly affected due to the construction of a major bridge at this locality.

The direct and indirect loss of aquatic habitat has been minimised through mitigation incorporated as part of the modified proposal. The Reedys Creek crossing has been upgraded from a culvert to a major bridge in order to minimise habitat loss and to maintain wetland function downstream. The maintenance of hydrological regimes and therefore wetland function in the Bongil Bongil Swamp has been maintained through the addition of permeable base layers. The impact on wetland habitat for threatened fish species (if they occur) is therefore considered to be local and short-term in nature.

Potential habitat for the Comb-crested Jacana is found in Bongil Bongil Swamp. Because of the design features detailed above, construction of the modified proposal is not likely to have a significant impact on these wetlands. Any impacts occurring would be likely to be local and short-term in nature.

Although not a significant species, the Platypus may occur within Pine Creek. Suitable habitat was found approximately 100 m downstream of the proposed bridge crossing during the aquatic ecological assessment. Design considerations would minimise downstream impacts during construction of a major bridge over Pine Creek. Should they occur, impacts are expected to be associated with construction only and to be local and short-term in nature. Operational impacts would only occur in the case of a road spill; the risk of this event taking place would be considerably less than is currently the case (i.e. existing Pacific Highway) due to mitigation measures incorporated into the modified proposal.

Conclusions

Overall, the modified proposal would result in the loss of approximately two hectares more terrestrial native vegetation in PCSF than the original proposal (i.e. 54 ha vs 52 ha). The cleared area would comprise about 28 ha of regionally significant vegetation communities compared to 25 ha for the original proposal. Within PCSF, the alignment has been eased eastwards slightly in order to reduce impacts to the two southern gullies. A small amount of Turpentine (i.e. 0.2 ha) would be cleared as a result of the modified proposal. Two Rusty Plum individuals would also be removed ; although this would not have a significant impact on the local population of this species, it is proposed that these individuals be relocated (Section B8.1.1). Suitable habitat for this species would be impacted by both proposals.

Although additional terrestrial fauna habitat would be removed in PCSF as part of the modified proposal, this is partially offset through the reduction of barrier effects for gliders and small birds. Furthermore, all key habitat removed (i.e. 43 ha) would be offset by means of a compensatory habitat package currently being negotiated between NPWS and the RTA. None of the additional Endangered or Vulnerable fauna species considered are likely to be significantly impacted by either proposal.

The potential impact of the modified proposal has not changed after taking into account the Interim-listing of the Bongil Bongil Area by the AHC. Key habitat removed would be offset by means of a compensatory habitat package currently being negotiated between NPWS and the RTA.

The aquatic 8-part test concluded that there was not likely to be a significant impact on the four threatened fish species listed. Furthermore, there was unlikely to be impacts on five 'potentially threatened' fish species. It any mangroves need to be removed or trimmed during bridge construction at Pine Creek, a permit would be required from NSW Fisheries.

Mitigation measures incorporated into the modified proposal would minimise the loss of aquatic habitat and maintain wetland functionality both within the study corridor and for SEPP 14 wetlands located downstream. The Reedys Creek crossing was upgraded from a culvert to a major bridge in order to achieve the above aims. Other wetland crossings in the modified proposal have been modified in order to ensure the maintenance of surface and sub-surface flows through the enlargement of culverts or the provision of permeable base layers. As there is no significant net loss of natural wetlands as a result of the modified proposal, compensatory habitat is not required. The modified proposal considerably reduces the potential aquatic impacts of the original proposal and improves the current situation (i.e. the existing Pacific Highway) in terms of the long-term conservation of wetlands.

B7.1.2 Barrier Effects and Habitat Fragmentation

A major consideration of the mitigation measures incorporated as part of the modified proposal has been the reduction of fragmentation and barrier effects. Of particular importance has been the incorporation of a fauna overpass and a vegetated median into the modified proposal. The NPWS supported the investigation of a vegetated median containing both retained and planted vegetation on the grounds that it would attempt to mitigate the impacts of fragmentation and a physical barrier for gliders (letter from NPWS to RTA dated 20/10/98). Upon the recommendation of NPWS, a survey was undertaken in order to assess the potential to retain particular trees. A flexible approach to determining the vegetated median width was taken in designing the modified proposal.

NPWS also supported in principle the major fauna overpass planned for PCSF on the grounds that it would substantially assist to maintain the integrity of the habitat corridor through which the modified proposal passes. This included the option to move the service road further to the east to enable additional habitat to be provided at approaches to the overpass.

Terrestrial Flora

The effect of the modified proposal with respect to barrier effects and habitat fragmentation would be unchanged from that described in the SIS (i.e. local).

Terrestrial Fauna

The modified proposal minimises barrier impacts in Pine Creek State Forest by incorporating a major fauna overpass, a major fauna underpass, a shared underpass and a culvert into the road design. The potential benefits of a fauna overpass in maintaining gene flow, particularly for fauna groups which may not use underpasses or culverts, was the subject of a specialised study (Section B4.1). As a general rule of thumb, only one effective migrant (i.e. breeding individual) per generation needs to disperse in order to maintain gene flow (Hartl and Clark 1989). The study concluded that an overpass of 60 m placed centrally within PCSF is likely to maintain this level of gene flow.

A major underpass has been relocated to the southern forest gully in PCSF (within approximately 400 m of the overpass). The underpass is likely to be utilised by most species because it would retain a natural soil substrate and experience good light penetration, allowing clear visibility of the habitat beyond. Furthermore, the relatively wide approaches to the underpass which can be vegetated through replanting or regeneration, would reduce the risk that these areas would become ambush points for introduced predators. The shared underpass is likely to be used by Koalas and other ground-dwelling fauna. The culvert may be used by those species which burrow or which can utilise dark sheltered habitats.

Of the additional threatened fauna species considered in Section B5.2, all except the Eastern Chestnut Mouse are considered to the highly mobile. They are therefore not likely to be significantly affected by barrier impacts and fragmentation associated with the proposal. Although potential habitat for the Eastern Chestnut Mouse and the Comb-crested Jacana occurs in Bongil Bongil NP, it would not be affected by the modified proposal as wetland functionality in this area has been maintained (Section B7.1.2, B4.5, Appendix 4).

In addition, a vegetated median consisting of retained vegetation and plantings is proposed through approximately 60% of PCSF (see Section B6.1). The provision of a wide vegetated median would result in the removal of an additional two hectares of native vegetation. However, this is considered to be justifiable on the basis that the median would reduce barrier effects for gliders by shortening gliding distances to 30-40 m from 50-60 m. As there is evidence to show that even small gliders (i.e. Sugar Glider) are capable of crossing highways measuring 50 m (see Section B4.1), creation of a vegetated median is likely to maintain gene flow between populations of gliders provided that launching trees are tall enough (i.e. greater than 20 m) and of an appropriate diameter (i.e. at least 20 cm for the large gliders). It is expected that habitat within the vegetated median would be used by highly mobile species and by small fauna dispersing from the overpass.

Fauna exclusion fencing would still form a barrier to fauna, especially medium- to large-sized ground-dwelling mammals. Within Pine Creek State Forest, fencing would also be used on either side of the fauna overpass to prevent individuals from gaining access to the vegetated median and becoming stranded there. On the other hand, fauna exclusion fencing is expected to significantly reduce the number of roadkills, especially for Koalas and other ground-dwelling mammals.

Although Reedys Creek was not considered to be a major fauna corridor, it has now been upgraded to a bridge in order to minimise the loss of aquatic habitat and to maintain natural wetland function as far as possible. The proposed bridge would allow terrestrial fauna unimpeded access to the riparian corridor. The corridor formed by the bridge would maintain a natural substrate and would have good light penetration.

The impacts of fragmentation and barriers are considered to be local for the modified proposal.

Table B11: Summary of fauna impacts and adequacy of mitigation incorporated into modified proposal.

Site	Mitigation Incroporated as Part of Proposal	Fauna Impacts	Amelioration Adequate?
Pine Creek State Forest (central)	Fauna Overpass	Local	Yes
PCSF (southern gully)	Fauna Underpass	Local	Yes
Reedys Creek	Major Bridge	Local	Yes

Bongil Bongil Area

Although the Bongil Bongil Area is already fragmented, the modified proposal creates another barrier at its northern edge. A major fauna underpass has been incorporated into the proposal in order to maintain the regional corridor values in this area. The potential impact of further fragmentation in this area is unchanged from the SIS and is considered to be local.

Aquatic Habitat

Major bridges spanning the riparian fringes proposed for Bonville, Pine and Reedys Creeks would mitigate any barrier effects for aquatic fauna. It is possible that Reedys Creek and the wetland north of East Bonville Road would have to be diverted during construction and their connectivity reestablished afterwards. This would temporarily fragment the habitat. Surface and sub-surface flows may also be temporarily halted during the construction process. It is expected that these corridors would be reestablished as soon as practicable and that potential impacts would be short-term only.

The aquatic 8-part test concluded that there was not likely to be any significant restriction to fish passage or to fish breeding/spawning cycles during bridge construction over Bonville Creek provided that sedimentation of the creek bed was minimised and existing water quality maintained. Similarly, no significant restrictions to fish passage or impact to breeding/spawning cycles are expected during construction of the Pine Creek bridge. Fish passage was not considered a significant issue for native fish inhabiting Reedys Creek as upstream habitat is degraded and likely to be used by introduced fish species only. Potential impacts are therefore considered to be local for aquatic habitats.

Table B12: Summary of wetland impacts and adequacy of mitigation incorporated into modified proposal.

Site	Mitigation Incroporated as Part of Proposal	Fauna Impacts	Amelioration Adequate?
Wetland north of East Bonville Road	Larger culverts	Local	Yes
Creek to west of Bongil Bongil Swamp	Permeable base layer	Local	Yes
Wetland north of Herdegen Close	Permeable base layer	Local	Yes

Conclusions

The potential effects of the modified proposal on terrestrial native vegetation in PCSF is not considered to be significantly different to the original proposal.

The modified proposal minimises barrier impacts to terrestrial fauna species in PCSF by incorporating a major fauna overpass, a major fauna underpass, a shared underpass and a culvert into the road design. In addition, a wide vegetated median strip has been included in order to reduce barrier impacts. Although the median strip would result in the removal of approximately two additional hectares of habitat, this is considered to be justifiable on the basis that the median would reduce gliding distances, thereby maintaining gene flow of glider populations across the highway. Fauna exclusion fencing would still form a barrier to fauna, especially medium- to large-sized ground-dwelling mammals. However, fencing is expected to significantly reduce the number of roadkills for these fauna groups as well as for Koalas. Additional Endangered and Vulnerable fauna species are not expected to be significantly affected by barrier or fragmentation impacts associated with either proposal.

The potential impact of the modified proposal has not changed after taking into account the Interim-listing of the Bongil Bongil Area by the AHC. A major fauna underpass has been incorporated into both proposals in order to maintain the regional corridor values in this area.

Although Reedys Creek was not considered to be a major terrestrial fauna corridor, it has been upgraded to a bridge in order to minimise disturbance to aquatic habitat and to maintain wetland function. The aquatic 8-part test concluded that there was not likely to be any significant restriction to fish passage or to breeding/spawning cycles during bridge construction at Bonville and Pine Creeks. Barriers are not an issue at Reedys Creek as habitat upstream of the proposed bridge is degraded. Reedys Creek and the wetland north of East Bonville Road would have to be diverted during construction and their connectivity reestablished afterwards.

B7.1.3 Edge Effects

Most of the study area has been subjected to considerable disturbance including clearing and fragmentation providing opportunities for edge effects to occur.

Terrestrial Flora and Fauna

The potential impact of edge effects on terrestrial flora and fauna is unchanged from the SIS and is considered to be local.

Bongil Bongil Area

The submission from the Australian Heritage Commission expressed some concern about the potential for increased edge effects including weed invasion and predators where the modified proposal transects the northern part of the Bongil Bongil Area. However, the area adjacent to the highway is already highly disturbed and it is not expected that the modified proposal will significantly increase edge effects in the Area.

Aquatic Habitat

Design of creek and wetland crossings has taken into account the minimisation of edge effects through retention of buffer vegetation, slight realignments and reduction of excavation works where possible. It is expected that residual edge impacts would be local.

Conclusions

It is not expected that edge effects associated with the modified proposal will be significantly different from those caused by the original proposal for terrestrial flora and

fauna species along the entire route, including PCSF and the Bongil Bongil Interim-listed area.

Design of creek and wetland crossings in the modified proposal has taken into account the minimisation of edge effects and represents a considerable improvement from the original proposal.

B7.1.4 Disturbance

Disturbance including noise and vibration, would most likely be associated with the fauna overpass and underpass in PCSF and with all other underpasses along the modified proposal including the Reedys Creek bridge.

The effects of noise and vibration on fauna using overpasses, underpasses or roadside habitats are unknown. A wide range of studies has shown that fauna species exhibit considerable behavioural effects as a result of continuous noise (see United States Department of Agriculture 1992) but it is difficult or impossible to demonstrate any loss of reproductive fitness as a result of disturbance alone. As evidenced by the number of roadkills on major highways including the Pacific Highway, fauna habituate readily to continuous noise. It is therefore expected that fauna groups will utilise these structures to cross the highway despite vehicle noise and vibration.

A number of submissions expressed concerns that the behaviour and home range movements of fauna, especially Koalas, would be significantly affected by the proposed highway given the presence of fauna exclusion fencing and limited crossing points. However, it should be emphasised that the existing Pacific Highway already forms a considerable barrier that significantly affects the mortality rates and behaviour of a range of fauna. In the case of Koalas, Chris Moon (1998a) points out that the turnover of individuals living near the highway, in particular males and dispersing juveniles, is likely to be high leading to a weak population structure and low fecundity.

As the behavioural response to fencing and mitigation structures is expected to be flexible, the potential impact of disturbance is likely to be local. Disturbance during the construction phase is also likely to be local though short-term. In order to determine the effect of disturbance on reproductive success, it is important to monitor populations within PCSF. This is discussed further in Section B9.0 below.

Conclusions

There is not expected to be any significant difference between the disturbance effects associated with the two proposals. Behavioural disturbances are associated with the existing highway. It is likely that all fauna groups will habituate to additional disturbances associated with use of the overpasses or underpasses; any short-term negative behavioural impacts are likely to be offset with the long-term benefits of maintaining gene flow across the highway.

B8.0 ADDITIONAL AMELIORATION REQUIRED

Mitigation measures have been incorporated into the modified proposal. Those recommendations arising from Sections B4.1.5, B4.2.5, B4.3.5, B4.4.5, B4.5.5 that have not already been incorporated into the road design, are discussed in this section. These additional recommendations are proposed to further reduce potential impacts of the modified proposal.

B8.1 Terrestrial Flora

The modified proposal is not likely to have a significant impact upon threatened flora species known or with the potential to occur, within the study area. Although two Rusty Plum individuals identified during the SIS would be removed, none of the 11 specimens recorded during subsequent supplementary surveys would be affected.

B8.1.1 Protocol for Rusty Plum and other significant flora species

The two Rusty Plum specimens to be removed as part clearing for the modified proposal, should be relocated to an appropriate habitat. NPWS should be consulted regarding suitable relocation sites.

Prior to construction of the service road, a survey of the alignment should be conducted to target the Rusty Plum and other significant species targeted in the SIS. The feasibility of relocating any further Rusty Plum specimens in the vicinity of the service road should be examined, and may depend on the number and size of the specimens located and the proximity to other specimens. If the relocation of plants was not considered a feasible option, cuttings should be taken from the plants and propagated for use in landscaping and/or planting in suitable adjoining habitat. If fruit is present on plants to be disturbed, the seed should also be collected and treated, then used in the same locations as cuttings.

The Rusty Plum is a species that is considered to enhance landscaping due to the nature of the foliage and fruit. The species is characterised by brightly rusty coloured leaf tips and has a large blue-black edible fruit that appears in spring and summer (and is therefore likely to attract birds). Plants grow to 5-6 m. The Rusty Plum is however, a slow grower and prone to scale insect attack while below 2 m (Nicholson 1992). It would be suitable for sheltered areas away from roadsides.

B8.1.2 Minimising the removal/disturbance of native vegetation

Removal of vegetation in conjunction with the proposal should be restricted to the area essential to the construction of the proposal. Additional clearing for works compounds and other ancillary uses should where possible be located in areas that are currently cleared (i.e. outside Pine Creek State Forest). Where this is not feasible, areas that are relatively more disturbed than the adjoining vegetation should be utilised. Site selection should favour relatively flat areas that do not adjoin gullies or other sensitive areas. Areas with particular features such as habitat trees should be avoided where possible. Where an area to be cleared contains one or more habitat trees, these should be marked for retention.

Where an area of native vegetation is required to be cleared for ancillary uses that will cease after construction, the following method of clearing should be employed:

- mark the boundary of the area to be cleared in such a way that the boundary will not be extended during clearing works (may require temporary fencing);
- collect seed and/or propagative material from native species present (i.e. within a radius of 1-5 kms);

- construct soil erosion and sedimentation control measures in stages throughout the clearing to minimise the area of unstable or unprotected soil surface;
- where cleared vegetation is windrowed, so not allow windrows to push into or abut, the vegetation to be retained;
- stockpile topsoil in long, low piles to ensure viability of seed stock in the soil is maximised.

In riparian areas the following additional measures should be implemented:

- ancillary areas should be located the maximum practicable distance from the stream;
- construction of sedimentation collection structures should be completed prior to works commencing;
- sedimentation collection structures should comprise best practice measures and be maintained regularly;
- disturbance to streambanks and streambeds should be minimised during preparation of the site and construction of control measures, as well as during construction of the proposal.

After construction, the substrate should be "ripped" or similarly treated and the topsoil replaced. Branches from the cleared vegetation may be used as brushmatting on the bare soil in conjunction with other methods of soil stabilisation. Tube stock propagated from the material collected prior to clearing should be planted and maintained for an initial period.

B8.1.3 Weed management

A Weed Management Strategy should be developed as part of the Environmental Management Plan (EMP) to be prepared in consultation with NPWS. The strategy should include prioritisation of weed species known in the study area and methods and timing for removal.

B8.1.4 Landscape plantings

Plantings in landscaped areas should comprise native species only. Plantings should reflect the nature of the closest natural vegetation and take into account the landform and aspect. Seed and vegetative material should be collected from the adjoining vegetation and propagated for use in landscaping. Collection of the propagative material should commence well in advance of the construction works to ensure stock will be ready for planting when required. The use of local provenance in landscaping works is important in the retention of the local gene pool for species, plant viability and suitability to the local conditions (i.e. 1-5 kms). There is the potential for non-endemic (but still native) stock to invade the surrounding bushland and become environmental weeds. The possibility of using Rusty Plum in landscape plantings should be further investigated.

The structural nature of the substrate for landscaping (pH, fertility and physical characteristics) should try to reflect the natural substrate in adjoining areas. This will provide suitable conditions for the native species to establish and potentially reduce the incidence of weeds.

B8.2 Terrestrial Fauna

The modified proposal is not likely to have a significant impact upon threatened fauna species known or with the potential to occur, within the study area.

B8.2.1 Compensating for habitat loss

There would be a net habitat loss as a result of the proposal. As there is no mitigation for

habitat loss available, it has been accepted that a compensatory habitat package is appropriate. The RTA and the NPWS are currently developing a package based on the guidelines outlined in the following documents:

- *Road Development and Impacts on Habitat Amelioration Measures – Compensatory Habitat* (RTA Policy Draft 6, 12/11/98); and
- *Discussion Paper – Compensatory Habitat Assessment for the Bonville Deviation* (Bali and Anderson 1998)

The RTA policy has determined that the acquisition or conservation management of compensatory habitat is an appropriate mitigation where key habitat is lost. Key habitat is habitat that is likely to support flora and fauna species, populations or ecological communities considered to be significant at a national, state, regional or high local level. In the case of Bonville, the modified proposal is likely to result in the loss of approximately 43 hectares of key habitat. Opportunities for acquiring or managing areas of compensatory habitat will be the subject of detailed investigation if the project is approved.

B8.2.2 Reducing Barrier Effects

Overpasses, underpasses and other bridging structures are mitigation measures aimed at reducing barrier impacts. Although these can be expected to be more attractive to a wider range of fauna groups than tunnels, appropriate planning and management will ensure that they are more likely to be used by target species.

Overall, it is important that design of the fauna overpass includes:

- Appropriate soil and drainage conditions for tall eucalypts for use as gliding platforms and/or forage trees;
- Appropriate planting on either side of the overpass.

As further recommended by Chris Moon (1998b), environmental conditions on the overpass should be manipulated in order to target particular species of native flora and fauna. He favours relatively poor nutrient and soil conditions to actively discourage the proliferation of weeds. Other recommendations (Moon 1998a, b) include:

- Control of light to prevent weeds such as Lantana from proliferation especially on the northern side, through landscape planting regimes;
- Inclusion of open and densely grassed areas suitable for different species available in the ground layer;
- Planting of dense hardy species along the edges of the overpass in order to provide canopy and shelter from wind and light at ground level.
- Use of local stock;
- Use Koala food trees such as Tallowwood and Grey Gum, Flooded Gum and Blackbutt towards the centre and Forest Oak among the mid-storey species;
- Habitat regeneration work on proposed overpass;
- Provision of poles with cross-bars near accesses to highway (in the short-term);
- Use of calming structures on service roads adjacent to overpass.

In the case of fauna underpass approaches, it is important that these do not funnel fauna into areas where they will be exposed to ambushes by introduced predators. It is therefore recommended that habitat regeneration using local stock be undertaken at the approaches to underpasses. Wherever vegetation cannot be established due to shading or other unsuitable conditions, consideration should be given to "internal" design features such as the provision

of vertical and horizontal logs to provide Koalas and other fauna with an escape mechanism. Expert advice should be sought on this matter to avoid inappropriate configurations of logs as is currently the case within the culvert at the southernmost end of PCSF.

Most of the recommendations outlined for planting and management of the fauna overpass apply in the case of the vegetated median. Although the median would have some retained vegetation, other sections would have to be planted. The focus of the canopy plantings should be to provide launching trees of appropriate height and diameter for the larger gliders. At a minimum, retained and planted canopy trees should attain a height of 20-25 m and a diameter of at least 10-20 cm (see Section 4.2.5) to facilitate movement by these species. Plant species appropriate for planting on the overpass and vegetated median has been the subject of a specialised investigation by Woods Bagot (1998). The list of appropriate species is constrained somewhat by safety issues.

Landscaped areas should be self-sustaining after a period of 5-10 years. In the meantime, it is likely that they will require active management. Management details would be outlined in the EMP prepared for the area.

B8.2.4 Pre-clearing Guidelines

Pre-clearing surveys would need to be conducted by a qualified zoologist and/or botanist. It may also be necessary to involve a member of WIRES, NPWS or a veterinarian in the case of stranded or injured fauna. Detailed clearing protocol would be prepared prior to construction as part of an EMP. However, some broad guidelines summarised from the SIS and SISSIR are presented below:

Table B13: Summary of pre-clearing guidelines.

Guidelines	Reference
Follow protocol for Koalas	SIS Section 4.5
Follow protocol for Giant Barred Frog. Individuals that are directly affected should be relocated to nearby suitable habitat. Avoid clearing/construction during winter months.	SISSIR Part A, Table A3
Follow protocol for Rusty Plum and other significant flora species.	SISSIR Section B8.1.1
Consider nesting period for Osprey (June-October)	SIS Appendix E, SISSIR Part A, Table A3
Implement erosion and sedimentation controls and vegetation protection.	Section B8.1.2
Prepare and EMP containing a weed control strategy and detailed revegetation plans in consultation with NPWS.	See broad guidelines in Sections B8.1.3, B8.1.4.

B8.3 Aquatic Flora and Fauna

Recommendations for amelioration measures provided as part of the aquatic 8-part test and wetland assessment are given below. They are summarised below for each wetland for easy reference.

B8.3.1 Bonville Creek

- Prohibit use of small embayment immediately downstream of the south bank of Bonville Creek to construction crews which would require clearing of river mangroves;
- Small mangrove shrubs along the south bank should not be damaged or removed;

- Minimise sedimentation and maintain water quality.
- All damage arising from construction activities in the riparian zone should be repaired as soon as practicable.

B8.3.2 Pine Creek

- Particular care should be taken to prevent damage to the aquatic habitat in Pine Creek, in particular the high quality pool about 100 m downstream of the proposed crossing.
- Minimise sedimentation and maintain water quality.
- All damage arising from construction activities in the riparian zone should be repaired as soon as practicable.

B8.3.3 Reedys Creek (Wetland Nos. 1 & 2)

- The removal of riparian and instream vegetation should not include tree roots which are needed to stabilise creek sediments until other aquatic plants colonise the site.
- Extraction methods should require the trees to be cut off at the stump and lifted out by a crane.
- Metal sleeves should be used to encase the construction of the pylons to reduce the risk of ASS contamination.
- Machinery used in the construction of the pylons should not disturb instream sediments.
- All damage arising from construction activities in the riparian zone should be repaired as soon as practicable.
- Prevent any digression in the quality of the water flowing into the SEPP 14 wetlands, which should include permanent and effective water quality measures.
- A treatment facility (sedimentation basin or oil and sediment separator) should be constructed at Reedys Creek.
- Details for construction of a sedimentation at this locality are given in Sections B4.5.5 and B4.4.6.

B8.3.4 Wetland No. 3 (wetland south of East Bonville Road)

- Mitigation should aim to maintain the natural hydrology and water quality and to avoid edge effects.
- Prevent any digression in the quality of the water flowing into the SEPP 14 wetlands, which should include permanent and effective water quality measures.

B8.3.5 Wetland No. 6 (wetland north of East Bonville Road)

- Use to treat from a tertiary level the flow produced by proposed water quality ponds;
- Noise and trash traps should be used.
- Prevent any digression in the quality of the water flowing into the SEPP 14 wetlands, which should include permanent and effective water quality measures.
- During construction, the ecosystem of Wetland No. 6 should be preserved as far as practicable by isolating the construction site with sheet piling to prevent the contamination of the remaining area of habitat.
- Noise screens and trash traps should be used in Wetland No. 6 to prevent foreign matter from being washed or blown into the wetland from the new road.
- Once culvert construction is complete at Wetland No. 6, the two disjunct sections of the wetland should be brought back on line to resume their buffering role for Wetland No. 335.

B8.3.6 Wetland No. 7 (creeklines north and south of Herdegen Close)

- Water quality in creek located to the north of Herdegen Close should be maintained or improved.
- Use constructed wetland technology in the triangle formed by the old and new Pacific

Highways north of Herdegen Close to mitigate water quality problems downstream of construction.

- The construction of all sedimentation basins should ensure that there is a minimum of vegetation removal when positioned in close proximity to Bongil Bongil Swamp.
- At the creek south of Herdegen Close entering the western edge of Bongil Bongil Swamp, construction of proposed water quality ponds should aim to minimise the amount of vegetation removed on the downslope side and maintain water quality.

B8.3.7 Wetland No. 8 (buffer habitat for Bongil Bongil Swamp)

- Heavy machinery should not be used within 10 m of the tree line including moist areas;
- Quality of surface water entering the habitat should be free of silt, debris and water-borne pollutants.
- The construction of all sedimentation basins should ensure that there is a minimum of vegetation removal when positioned in close proximity to any wetlands especially Wetland Nos. 7 and 8.

B8.3.8 All Wetlands

- All road runoff should be treated in sedimentation basins or sediment and oil separators before discharge into adjacent creeks or wetlands
- Water quality structures should be placed as far away as possible from creeks and wetlands to prevent accidental overflow into natural wetland habitats.

B9.0 MONITORING.

In developing roads, the RTA seeks to avoid, minimise and/or compensate for the negative impacts on fauna through the use of various mitigative measures (RTA 1998). However, the effectiveness of these measures is largely unknown. The ultimate aim of monitoring is to halt any degradation due to development in the short to medium term and to improve mitigation measures in the longer term. The results of pre-construction monitoring would be incorporated into the final design and additional amelioration measures. This section provides some monitoring guidelines for flora and aquatic systems and describes the proposed Koala monitoring program recently put out to tender by the RTA.

B9.1 Terrestrial

In general, aquatic systems tend to be monitored more than terrestrial ones. There is therefore less information available regarding terrestrial ecosystems and how they respond to various impacts.

B9.1.1 Flora

Monitoring of any relocated or propagated specimens of Rusty Plum should be conducted in order to gauge the success rate of these activities. Monitoring should be undertaken at regular intervals over at least a five-year period. A suitable monitoring program may include documentation of the following:

- whether the plant has been relocated, or propagated from seed or cutting;
- substrate condition;
- shelter percentage of canopy;
- species in canopy and understorey;
- amount of growth;
- health of plant.

In particular, the vegetation on the overpass and median should be the focus of monitoring programs. The condition of other local provenance used in the landscaping should also be monitored on a regular basis for at least five years.

The Weed Control Strategy prepared for the site should identify key sites for control and monitoring of weeds. It should also provide detailed information on the implementation of weed eradication programs, including identification of weed problems and the appropriate timing and method of control.

B9.2.2 Fauna

A long-term Koala monitoring program is planned for the Bonville and Yelgun to Chinderah Pacific Highway deviations. Although the focus of the study is primarily on Koalas, the study would also provide opportunities to collect information on other species.

Koala monitoring study

A contract for this study is soon to be awarded. The monitoring study would run for a total of six years, including 2 years pre-construction, 2 years during construction and 2 years post-construction. As such, Koala behaviour and movement patterns would be monitored during baseline conditions (i.e. existing Pacific Highways at Bonville and Yelgun-Chinderah) as well as during periods subject to construction and operational impacts.

Briefly, the researchers selected for the study will:

- Review existing information;
- Determine appropriate sites for research and monitoring;
- Determine Koala behaviour and habitat requirements in the study areas;
- Determine the relative effectiveness of selected mitigation structures;
- Provide a final report.

The Consultant is expected to undertake original research and to use a variety of assessment techniques including sand beds, automatic photographic equipment, visual inspections, radio-tracking and/or eartagging. Several of these methods are non-selective and would allow collection of data on species other than Koalas (see *Gliders* and *Other species* below).

With respect to the Bonville area, it is recommended that particular emphasis be placed on monitoring the following for Koalas:

- Use of the fauna overpass.
- Use of the underpass located approximately 400 m from the overpass. Of particular interest is the differential use of the two corridor structures over the same monitoring period.
- Use of the shared underpass in PCSF.
- Use of the extended culvert in PCSF near the Raleigh deviation.
- Use of the major fauna underpass north of Herdegen Close.
- The effectiveness of fauna-exclusion fencing in reducing or eliminating road kills.

It is noted that the Brief issued by the RTA may allow for the manipulation and testing of structures throughout the study period. It may be of interest to monitor underpasses or culverts with and without internal structures aimed at providing Koala escape routes.

Gliders

Two major mitigation measures, the fauna overpass and the median strip, are aimed at providing a movement corridor for gliders. This group should therefore be targeted as part of a separate study to monitor the effectiveness of these measures in facilitating gene flow across the highway.

Data on glider movements could be obtained by several different means. Firstly, because survey methods used in the Koala monitoring study are largely non-selective (except for collaring), it would be possible to collect information for gliders on an *ad hoc* basis. This data could then be analysed as a separate study. Secondly, a radio-tracking study similar to that being undertaken by AMBS south of Nowra could be initiated. Particular emphasis should be placed on monitoring the following for gliders:

- Use of the major fauna overpass in the short- and long-term;
- Use of vegetated median in the short- and long-term;
- Use of poles as temporary launching platforms;
- Incidence of road kills pre-construction, during construction and post-construction;

Other species

Data for other mammal species could also be recorded as part of the Koala monitoring program. These could be easily identified and recorded during spotlight and sand bed surveys. If automatic photography is used, then this method also incidentally records other species. As for gliders, the RTA could consider commissioning a researcher to analyse additional data.

It is also recommended that the use of approaches to culverts and underpasses by introduced predators be monitored. These species rapidly learn to take advantage of opportunities to ambush prey and may require that structural modifications be implemented in some areas.

B9.2 Aquatic

Recommendations summarised in Section B8.3 primarily advocate the maintenance of water quality and existing hydrological regimes. Monitoring should therefore aim to achieve these aims, particularly during the construction period. An appropriate monitoring program for fin-fish would be designed in consultation with NWS Fisheries. In addition, monitoring programs for water quality (Appendix K of the EIS) and for ASS (Appendix H of the EIS) should be intiated.

B10.0 OVERALL IMPACT ASSESSMENT

Route selection and design of the Bonville deviation has minimised potential impacts of highway development through the incorporation of mitigation measures. Additional amelioration together with recommendations for management and monitoring would further reduce potential impacts. A comparison of the potential effects of the two proposals is presented below:

Table B14: Comparison of potential impacts between original and modified proposals.

Impact Type	Original proposal	Modified proposal
Habitat Loss		
Terrestrial flora	High local	High local
Terrestrial fauna	Local	Local
Aquatic fauna	NA*	Local
Wetlands	NA*	Local
Barriers/Fragmentation		
Terrestrial flora	Local	Local
Terrestrial fauna	High local	Local
Aquatic fauna	NA*	Local
Wetlands	NA*	Local
Edge Effects		
Terrestrial flora	Local	Local
Terrestrial fauna	Local	Local
Aquatic fauna	NA*	Local
Wetlands	NA*	Local
Disturbance (behavioural)		
Terrestrial fauna	Local	Local
Overall Impact	***High local***	***High local***

* No assessment undertaken as part of SIS.

The overall impact is determined by the highest potential impact level identified (i.e. high local for terrestrial flora). However, the impacts associated with the modified proposal are considered to be less than those for the original proposal for the following reasons:

- The potential impact of barriers/fragmentation for terrestrial fauna have been reduced from high local to local (Section B7.1.2, Table B14);

- Aquatic impacts were not assessed as part of the SIS, thereby making direct comparisons between the two proposals impossible. However, impacts resulting from the loss of habitat have been reduced considerably as part of the modified proposal (Section B7.1.1). This is particularly the case at Reedys Creek where a proposed culvert was replaced by a major bridge.
- Potential impacts to wetland function have been minimised through the enlargement of culverts and the provision of permeable base layers to all relevant stream and wetland crossings within the study corridor (Section B7.1.2). These would act to maintain surface and sub-surface flows not only for these wetlands but also for SEPP 14 wetlands located downstream.
- Additional amelioration measures have been recommended to further reduce impacts (Section B8.0).
- Loss of any additional key habitat (i.e. approx. 2 ha) would be compensated for in addition to the 43 ha presently being negotiated between the RTA and NPWS.

The overall impact of the modified proposal is therefore considered to be less than that associated with the original proposal and to be acceptable from an environmental perspective.

B11.0 REFERENCES

Bali R. & Anderson J. (1998). Discussion Paper – Compensatory Habitat Assessment for the Bonville Deviation. Report prepared for the RTA.

Biosis Research (1997). Preliminary flora and fauna assessment of the Pacific Highway Upgrade from Mailmans Track to Lyons Road, Bonville. Report prepared for PPK Environment & Infrastructure.

Biosis Research (1998). Bonville Project Pacific Highway Coffs Harbour Species Impact Statement. Report prepared for PPK Environment & Infrastructure.

Blakers M., Davies S.J.J.F. and Reilly P.N. (1984). *The Atlas of Australian Birds*. RAOU and Melbourne University Press, Carlton.

CSIRO (1997). Koala Literature Review. Report prepared for State Forests of New South Wales. CSIRO Division of Wildlife and Ecology, Canberra.

DLWC (1996). *The NSW Wetlands Management Policy*. Department of Land & Water Conservation.

Fisher, M. Body, M. and Gill, J. (1996). The Vegetation of the Coffs Harbour City Council LGA - Executive Summary. Coffs Harbour City Council.

Goldingay, R.L (1991) Tully-Millstream Hydro-electric Scheme – Yellow-Bellied Glider Baseline Study (Volume 1). Report prepared for the Queensland Electricity Commission.

Goldingay R.L. (1987). Sap Feeding by the Marsupial, *Petaurus australis*: An enigmatic behaviour? Oecologia (Berl.) 73: 154-158.

Griffiths S. J. (1992). *Species Recovery Plan. Thesium australe*. Australian National Parks and Wildlife Service Endangered Species Program Project No. 196. NSW National Parks and Wildlife Service.

Hartl and Clark (1989). *Principles of Population Genetics*. Second Edition. Sinauer Publications.

Henry, S.R (1985) The diet and socioecology of gliding possums in southern Victoria. Ph.D. Thesis, Monash University, Clayton, Victoria.

Henry, S.R and Craig, S.A (1984) Diet, ranging behaviour and social organisation of the Yellow-bellied Glider (*Petaurus australis* Shaw) in Victoria. Pp. 331-341 in Possums and Gliders. Eds. A.P Smith and I.D Hume. Surrey Beatty and Sons, Chipping Norton, New South Wales.

Jackson S. (in press). Glide Angle in the Genus Petaurus and a Review of Gliding in Mammals. Mammal Review.

Marchant S. and Higgins P.J. (1990). *Handbook of Australian, New Zealand and Antarctic birds. Volume I:Part B*. Oxford University Press, Melbourne.

Menkhorst P. (1995). *Mammals of Victoria. Distribution, ecology and conservation.* Oxford University Press, Melbourne.

Moon, C. (1998a). Letter to RTA dated 19 October 1998.

Moon C. (1998b). Letter to PPK Environment & Infrastructure dated 7 November 1998.

Murray, M (1996) Eleebana Local Squirrel Glider Study. Report to Lake Macquarie City Council by SWC Wetland and Ecological Management Consultancy.

Nicholson N and H (1992). *Australian Rainforest Plants. In the forest and in the garden.* H. and N. Nicholson, the Channon.

NPWS (1996). Information Circular 2: Threatened Species Assessment under the EP&A Act: The '8 Part Test' of Significance. NPWS Hurstville.

NSW Fisheries (1998). Conservation of threatened aquatic species. Fishnote DF/71. August 1998.

NSW NPWS (1996). *Threatened Species of Western New South Wales.* New South Wales National Parks and Wildlife Service, Hurstville.

PPK Environment & Infrastructure (1998). Bonville Project Pacific Highway Coffs Harbour Environmental Impact Statement. Volumes 1 and 2. Report prepared by PPK Environment and Infrastructure for the Roads & Traffic Authority, Grafton.

PPK Environment & Infrastructure (1999a). Supplementary Route Selection and Design Report. Report prepared for the Roads & Traffic Authority, Grafton.

PPK Environment & Infrastructure (1999b). Bonville Project, Pacific Highway, Coffs Harbour. Ecological Assessment of the Route Proposed by the Bellingen Environment Centre. Report prepared for the Roads & Traffic Authority, Grafton.

Quin, D.G. (1995) Population ecology of the Squirrel Glider (*Petaurus norfolkensis*) and the Sugar Glider (*P.breviceps*) (Marsupialia: Petauridae) at Limeburners Creek, on the central north coast of New South Wales. Wildlife Research 22, 471-505.

RACAC (1996). Draft Interim Forest Assessment Report. Resource & Conservation Assessment Council, Sydney.

Ridgeway A.(1995). *The occurrence of Thesium australe (Austral Toadflax) within Yuaygir National Park at three selected sites.* Report prepared for NSW National Parks and Wildlife Service.

Robinson, D. (1994). *Research Plan for Threatened Woodland Birds of Southeastern Australia.* Technical Report Series NO. 133. Department of Conservation and Natural Resources.

RTA (1998). Road Development and Impacts on Habitat Amelioration Measures - Compensatory Habitat. RTA Policy Draft 6, 12/11/98.

RTA (in prep). RTA Representations Report – The Bonville Project. Roads & Traffic Authority, Rosebery.

Sinclair Knight Merz (1998). Pacific Highway Upgrade Yelgun to Chinderah Environmental Impact Statement. Prepared by Sinclair Knight Merz for the Roads & Traffic Authority and the Commonwealth Department of Transport and Regional Development.

Smith P. & Smith J. (1998). Proposed Pacific Highway Upgrade at Bonville – Review of Flora and Fauna Assessment. Report prepared for DUAP, November 1998.

State Forests of NSW (1997). *Pine Creek State Forest Draft Koala Management Plan*. State Forests of NSW.

Strahan, R. (ed.) (1995) *The Mammals of Australia*. Reed Books, Chatswood.

United States Department of Agriculture (1992). Potential Impacts of Aircraft Overflights of National Forest System Wildernesses. Report to Congress. U.S. Department of Agriculture Forest Service.

Webster R. & Menkhorst P. (1992). The Regent Honeyeater (*Xanthomyza phrygia*):population status and ecology in Victoria and New South Wales. *Arthur Rylah Institute for Environmental Research Technical report Series* No. 126, Department of Conservation and Environment, Victoria.

Wilson A-M & Lindenmeyer D.B. (1995). *Wildlife Corridors. Conservation of Biodiversity – A Review*. Centre for Resource and Environmental Studies, ANU, Canberra.

Winning, G. (1992). North Coast Wetland Survey, A Survey of the floodplain wetlands of the Richmond, upper Clarence and Hastings Rivers undertaken for NSW Department of Water Resources.

Woods Bagot (1998). Letter and accompanying species lists addressed to PPK Environment and Infrastructure dated 2 November 1998.

APPENDIX 1 – NPWS SUBMISSION

8 September 1998

NSW NATIONAL PARKS AND WILDLIFE SERVICE

Pacific Highway Development Office
PO Box 546
GRAFTON
NSW 2460

Confirmation of facsimile recd 9/9

Our reference: DB:db3048-4;98/1097
Your reference:

EIS SUBMISSION
PROJECT: BONVILLE
DATE RECEIVED: 11/9/98
REGISTERED NO: 20

ATTENTION: Ken Oldfield

Dear Ken

Re: Species Impact Statement and Environmental Impact Statement for the Proposed Bonville Deviation of the Pacific Highway Upgrade.

Thank you for your letter which was received in this office on 5 August 1998 inviting National Parks and Wildlife Service (NPWS) to examine and comment on the Species Impact Statement (SIS), Environmental Impact Statement (EIS) and Working Papers for the Bonville Deviation.

The document provides considerable detail regarding the nature and impacts of the proposal, however, NPWS considers that the Director-General's Requirements have not been adequately addressed. In addition, NPWS does not agree with some of the conclusions that have been reached regarding the overall impact assessment. The following provides details on these comments for your consideration.

The numbering in this document follows that contained within the SIS or EIS, unless otherwise stated. Tables are provided to indicate compliance with the Director General's Requirements for the SIS.

NPWS comments on the cultural heritage components of the project will be sent separately.

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Tel: (02) 9585 6444
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Species Impact Statement:

2. Study Area:

- *Eleocharis tetraquetra* is now provisionally listed as endangered.

3. Legislative Context:

- No mention is made of the Director-General's Requirements (DGRs) for a Species Impact Statement, which is required by Section 111 of the *Threatened Species Conservation Act* 1995 (TSC Act) .

4.3.1.3. Data Collection:

- A map is not provided of the vegetation communities which were identified using aerial photography. Presentation of such a map is considered essential to identify habitats throughout the study area, and to assess the adequacy of surveys.
- The terminology used in the SIS confuses "threatened" flora with "significant" and "rare" flora. NPWS considers "threatened" flora to be those listed on Schedules 1 or 2 of the TSC Act, "rare" flora to be species identified by Briggs and Leigh (1996) as rare and "significant" flora to include "threatened" and "rare" species plus additional species of conservation significance as per criteria described in Sheringham and Westaway (1995).

4.3.1.6 Classification of Vegetation Communities

- It would be very useful to provide the vegetation mapping undertaken by Fisher *et al.* (1996) referred to in the SIS. In addition to this vegetation mapping, this section would benefit by some reference to the Pine Creek State Forest Koala Habitat Mapping, and provision of such mapping, undertaken by State Forests of NSW. This mapping has classified areas according to its habitat suitability for Koalas.

4.3.2.1 Survey Effort

- Specific issues regarding fauna survey effort is dealt with in comments relating to compliance with the DGRs provided in the tables below. General comments follow:

  Nocturnal call playback: It is stated that survey was conducted over four nights, however, only three sites are indicated on Figure 4. Was one site visited twice, or is the figure incorrect?

  Hair tube: What is the length of the transects on which hair tubes were laid out?

- The survey undertaken by Chris Moon of the proposed rest area was targeting Koalas and assessing Koala habitat suitability, and did not survey for other values. This is not stated in the SIS.

4.3.2.2 Survey Technique

- The SIS does not state how suitable habitat for the Common Planigale and Queensland Blossom Bat was determined. Suitable habitat should be

determined by referring to NPWS potential habitat models, which identify areas of suitable habitat along the sections of the route.

- The SIS does not state whether dip net surveys for frogs were conducted.
- The SIS does not state who conducted the identification of recorded frog calls.
- Additional detail should be provided with regard to fauna survey techniques, specifically:
    - The dates on which each fauna group was surveyed should be specified.
    - Weather conditions for each day or night of survey should be detailed. Were any surveys conducted in cold, windy conditions?
    - Which habitats were searched for which species?
    - Was *Litoria aurea* survey done both day and night?
    - Were arboreal epiphytes on fallen trees searched for the Pale-headed Snake?
    - Were buttressed trees and strangler figs targeted for Stephen's Banded Snake?
    - Was call playback conducted for the Bush Thick-knee or Squirrel Glider?
    - When were microchiropteran bat surveys conducted?
    - As only one Anabat site is marked on Figure 4, was Anabat conducted at the same site for three nights?

4.3.2.3 Limitations

- Some discussion as to the limitation of call playback techniques would be considered useful. For example, as the two call playback sites conducted in Pine Creek State Forest were conducted close to the existing highway, it would be useful to include some discussion as to the limitations traffic noise may have had on this technique.
- Given the limitations discussed with regard to microchiropteran bat survey, NPWS commends the approach to assume that all threatened bat species occur on the site if suitable habitat is present. NPWS potential habitat models should be consulted to identify suitable habitat.

4.4 Significance Assessment

4.4.1.1 Species

- The reference for Briggs and Leigh should be 1996, not 1995 as stated in the SIS.
- National significance should also be assessed using the Commonwealth *Endangered Species Protection Act* 1992.

4.4.1.2 Communities

- Regional significance for vegetation should be assessed using Griffith (1993) and Resource and Conservation Assessment Council (1996) conservation targets, in addition to Hager and Benson (1994).

4.4.3 Flora and Fauna Corridors

- Locally significant corridors should be mentioned in addition to "regional" corridors, e.g. those along waterways of the study areas such as Bonville Creek and Pine Creek.

4.5.2 Vegetation Communities

- Without a vegetation map, it is not possible to determine the location and extent of the vegetation communities described in this section of the SIS.
- The "riparian vegetation" community which includes Bonville Creek should include some discussion of the large, hollow-bearing trees that occur along this creek. Ospreys are known to occur along Bonville Creek.

4.5.3 Significant Flora Species

- There appears to be some confusion in the SIS as to the location and potential impact of the proposal on the threatened plant *Amorphospermum whitei* identified in Pine Creek State Forest during the preliminary surveys of the route options. Subsequent surveys have not relocated the plant. NPWS considers that the plant should be relocated and, if it will be impacted by the proposal, propagation material (seed or cuttings) should be taken from the plant for use in appropriate revegetation or landscaping areas (this has been identified in the SIS in Table 3).
- In addition to TSC-listed flora, the significance of flora species should be assessed using Sheringham and Westaway (1995). Using this reference, a further five significant species were recorded in the SIS surveys; *Arytera distylis, Digitaria divaricatissima, Epigomium roseum, Exocarpus latifolius* and *Hybanthus vernonii* ssp. *scaber.*

4.5.6 Fauna habitats

- This section would be improved with some examples of the species of threatened fauna that are likely to utilise each habitat type, e.g. whether there is the presence of hollow logs for threatened reptiles, fruiting rainforest trees that may provide a food resource for threatened rainforest pigeons, etc.

4.5.7 Significant Fauna Species

- NPWS potential habitat models should be used to identify suitable habitat for the Common Planigale and the Queensland Blossom Bat. Both these species have potential habitat predicted along parts of the proposed route.

4.5.8 Significant Fauna Habitats

- NPWS potential habitat models can be used to more accurately define habitat boundaries as requested in the DGRs S.1.1.2.
- It would be most useful to present maps which indicate the location of high quality Koala habitat within Pine Creek State Forest (Zones 4 and 5) in order to assess the relevance of these areas to the current proposal.

5.3.1 Vegetation Clearance/Habitat Loss

- No quantification of the vegetation clearance and habitat loss is presented in the SIS. This is considered to be a major inadequacy with the document as, without these figures, it is very difficult to assess the potential impact of the proposal, and its relevance to threatened species habitat. This comment is also directed at Section 5.6.1 of the SIS.

5.3.2 Fragmentation/Isolation of Habitats

- The SIS states that there are two wildlife corridors within the study area that will be intersected by the proposal (refer to Section 4.4.3 for further comment).

5.3.6 Feral Animals

- There appears to be some contradictory statements in the SIS with regards to feral animals. Section 4.4.5 states that "the development is likely to assist with the colonisation of new areas [by feral animals], particularly given the new alignment adjacent to forest in the north". However, in Section 5.3.6, it is stated that the highway development is "unlikely to significantly alter the current situation" as the site already supports feral animals. Further, in Section 4.5.5, the SIS states that the "study site did not appear to be utilised by a high diversity or large numbers of introduced bird and mammal species". NPWS considers that the proposal may result in increased invasion by feral animals due to the creation of sections of new alignment and service roads as many feral animals are known to use roadways for movement.
- NPWS considers that some discussion be provided on predation by the European Red Fox as this has been added to Schedule 3 of the TSC Act as a Key Threatening Process.

5.5 Mitigation Measures Incorporated into Proposal

- The proposal does not appear to include any mitigation measures for gliders, including the threatened Yellow-bellied Glider and Squirrel Glider. Although NPWS recognises that there are safety and design constraints, there is a need to investigate any opportunities to retain forest vegetation in the median within Pine Creek State Forest to mitigate the impacts to arboreal mammals such as Gliders. This may be possible by providing small sections of split carriageway with retained vegetation in the median, potentially east of Hunters Forest Road, where it may be possible to move the proposed northbound carriageway slightly to the west to locate this carriageway on currently cleared land opposite Sid Burke Rest Area, and retain the proposed southbound carriageway in its current location.
- The proposal does not appear to include any mitigation measures for habitat loss, particularly threatened species habitat, apart from that associated with NPWS-owned land in the north of the study area. Mitigation measures for habitat loss may include compensatory habitat, or revegetation/regeneration of degraded habitat areas.

5.5.1 Major Structures and 5.5.2 Medium Structures

- The structure north of Herdegen Close has been listed as both a major and a medium structure. Is this referring to two separate structures, or is this an error?

5.6.1 Habitat Loss

5.6.1.1 Flora

- Table 3 of the SIS does not note that Site Number 10 to the north of the proposal involves the loss of an area of land owned by NPWS.

5.6.1.2 Fauna

- NPWS does not consider that loss of habitat is compensated for by "facilitating movement of and increasing the local survivorship of fauna living near the highway". This is also stated in Section 8 of the SIS. Facilitation of movement and increasing local survival through fencing attempts to mitigate barrier effects, not loss of habitat.
- It is not possible to assess whether NPWS agrees with the statement that "small amounts" of habitat will be lost, as no quantification of habitat loss is provided in the SIS.
- Some comment should be provided regarding the potential for fauna fencing to prevent movement that currently occurs across the highway.
- NPWS considers that acquisition of compensatory habitat must be considered for the loss of habitat along the entire route, not only for the loss of habitat on land owned by NPWS.

5.6.2. Barrier Effects and Habitat Fragmentation

5.6.2.2 Fauna

- Table 4 of the SIS is confusing. The "Proposal" column seems to be indicating amelioration measures proposed for the development, and thus comments in the "Amelioration" column state "None required".
- NPWS suggests an additional amelioration measure for the Titans Close area to include investigation of the potential for revegetation west of the current highway to strengthen the vegetation corridor.

5.6.3 Edge Effects

- NPWS recommends the investigation of the potential for habitat regeneration (e.g. weeding and replanting with appropriate species) work to be undertaken in appropriate roadside areas, for example, adjacent to Bongil Bongil National Park. This comment also relates to Section 6.1.1.3 of the SIS.

5.6.5 Aquatic Impacts

- Disturbance of acid sulphate soils has not been mentioned as a potential downstream impact to aquatic systems.

5.6.6 Cumulative Impacts

- The SIS states that "Loss of Koala and other fauna habitat is likely to be supplemented by additional habitat which may become available as a result of fencing to be undertaken along the route". This is misleading as no "additional"

habitat will be provided, but currently available habitat will be made more secure. It should be stated clearly that there will be a net loss of habitat. It is incorrect to suggest that roadside habitat is not currently utilised as a wide range of fauna and flora species would occupy this habitat, albeit that there is a loss of fauna from roadkills. In addition, no account is made of the current movement that takes place across the highway, which is likely to be modified by fencing and underpasses.

6.1. Amelioration Measures

6.1.2.1 Habitat loss

- The SIS states that a protocol for circumstances where Koalas may be injured or killed during clearing or construction works is outlined in Moon (1998). NPWS recommends that this approach be extended to all fauna. The pre-clearing guidelines that were developed for the Bulahdelah to Coolongoolook section of the Pacific Highway Upgrade provide an example of such guidelines.

Appendix E. Fauna Profiles for Target Species

- NPWS suggests that consideration be given to conducting preconstruction surveys for Giant Barred Frog *Mixophyes iteratus* at the Pine Creek locality. If individuals are found in an area which will be directly impacted by the proposal, these individuals should be relocated to nearby suitable habitat. Timing of construction activities to avoid winter months when Giant Barred Frogs are less active should be attempted. In addition, NPWS recommends that some habitat restoration work be conducted adjacent to bridge work in this locality to improve the quality of the habitat for this species, e.g. weed control and replanting with suitable native species.
- It is recommended that construction activities, particularly clearing, should be minimised or avoided during the nesting period of the Osprey located adjacent to the proposed works.
- Effects of proposed activities on Koalas should include reference to the fact that movement patterns are likely to be altered by fencing along the route.

The following comments relate to how the SIS has complied with the DGRs. The headings used below are the same as those provided in the DGRs.

Table 1.

Matters to be addressed:

Number	Complied?	Comments
1.1	partly	The timetable for the carrying out of the proposal has not been provided. The number of hectares affected by the proposal has not been provided.
1.2	no	A plan showing the location and type of vegetation communities has not been provided.
1.3	yes	
1.4	partly	A map has been provided which details the location of the proposal, land tenure units and areas of high activity, however, this is not at 1:25,000 scale as

Number	Complied?	Comments
		requested by the DGRs. However, given the linear nature of this development, and the difficulty that presenting a map of this scale would present, NPWS considers that the map supplied is adequate for the purposes of this study.
1.5	partly	The Giant Barred Frog records are not indicated on the map. It is recognised that this species was the subject of a separate, targeted survey after the main SIS surveys, however, the localities of these species should be provided on a map.
1.6	yes	
1.7	yes	
1.8	yes	
1.9	yes	
1.10	yes	
1.11	yes	See Table 3 for further comment
1.12	partly	See Table 3 for further comment. Predictive distribution maps have not been consulted.
1.13	yes	
1.14	yes	
1.15	yes	See Table 3 for further comment.
2.1	partly	The extent of habitat removal is not quantified. The nature of habitat to be removed is discussed only in very general terms.
2.2	yes	
2.3	yes	
2.4	yes	
3.1	no	Draft recovery plans have not been referred to.
3.2	yes	
3.3	partly	Possible options for changes to mitigation measures in the light of monitoring results has not been included.
3.4	partly	The expected timeframe for habitat restoration has not been specified, apart from a recommendation for weed management to continue for 2 years. No opportunities for improving habitat have been provided.
4.1	partly	The name of the determining authority or when approvals are proposed to be obtained has not been provided. Animal Care and Ethics Committee approval has not been listed.

Table 2.

Compliance with Sections 109 and 110 of the Threatened Species Conservation Act 1995:

Section	Complied?	Comments
109 (1)	yes	
109 (2a)	yes	
109 (2b)	yes	
110 (1)	partly	See S.1.1 of DGRs comments above
110 (2a)	yes	
110 (2b)	yes	
110 (2c)	yes	Draft recovery plans should be referred to as specified in S.3.1 of the DGRs.
110 (2d)	yes	
110 (2e)	yes	
110 (2f)	partly	See comments above (S.2.1 of DGRs).
110 (2g)	yes	
110 (2h)	no	No alternatives to the proposal are described.
110 (2i)	yes	
110 (2j)	partly	See comments above (S.4.1 of DGRs)
110 (3a-g)	NA	
110 (4)	yes	
110 (5)		See comments 110 (2a-j)

Table 3.

Appendix 3 of DGRs - Survey techniques:

Survey technique	Complied?	Comments
1. Fauna:		
1.1 Spotlight survey	yes	
1.2 Koala survey	partly	Koala habitat maps have not been referred to or presented.
1.3 Call playback	yes	
1.4 Hairtubes	yes	
1.5 Scat and tracks	yes	
1.6 Common Planigale	yes	No survey conducted, but species presumed to be present where there is suitable habitat.
1.7 Frog survey	yes	
1.8 Microchiropteran bats	yes	
1.9 Queensland Blossom Bat	yes	No survey conducted, but species presumed to be present where there is suitable habitat.
1.10 Diurnal birds:	not determined	Inadequate information is provided to determine whether adequate survey was conducted for diurnal birds. Refer to survey requirements for individual diurnal bird species.

Survey technique	Complied?	Comments
1.11 Reptiles:	not determined	Inadequate information is provided to determine whether adequate survey was conducted for reptiles. Refer to survey requirements for individual reptile species.
1.12 Threatened Fauna Features:	not determined	Inadequate information is provided to determine whether adequate survey was conducted of threatened fauna features.
2. Flora		
2.1 General requirements	yes	
2.2 Field methodology	yes	
3. Data recording requirements		No mention is made of whether data has been provided to NPWS for inclusion on the NSW Wildlife Atlas.
3.1 Fauna and flora surveys:		
3.1(i) Survey technique	yes	
3.1(ii) Date of survey	yes	
3.1(iii) Survey location AMG	partly	No location details are provided for flora survey.
3.1(iv) Locality description	no	
3.1(v) Survey point or transect mapped	no	
3.1(vi) Survey start time & finish time	no	
3.1(vii) Threatened species recorded	yes	No AMG is provided to indicate the location of the Rusty Plum.
3.2 Fauna survey:		
3.2(i) Observation type	yes	
3.2(ii) Call playback	yes	Calls of the Squirrel Glider and the Bush Thick-knee do not appear to have been played.
3.2(iii) Baits used	yes	
3.2(iv) Climate	no	Inadequate detail is provided.
3.3 Flora survey:		
3.3(i) Name of person conducting ID	no	
3.3(ii) Number of individuals of threatened taxa	yes	
3.3(iii) Size of population (ha)	yes	
3.3(iv) Whether flowering or fruiting	no	

Environmental Impact Statement

NPWS is pleased to see that some comments from review the of the draft EIS have been incorporated into the current document. However, the following comments are directed towards issues considered not adequately addressed in the EIS.

Section 1.6 The Decision Making Process

- Paragraph four summarises the requirements of the TSC Act, namely that a SIS is required when it is concluded that there is likely to be a significant impact on threatened species. In addition to threatened species, the TSC Act includes assessment of whether there is a significant impact on threatened species habitat, populations and ecological communities.

Section 4.8 The Southern Section of the Route

- The EIS discusses factors considered in the assessment of the route options, including the presence of "stump hollows". Presumably this is intended to mean hollow-bearing trees. This should be clarified.

5.3 Highway Alignment and Major Features

- NPWS considers that it is misleading to state that it is proposed that there will be "major fauna crossings at nine locations over the length of the project". Many of these proposed crossings are bridge crossings, which have been modified to be more suitable for use by fauna. This should be more clearly stated.

5.3.6 Fauna Underpasses

- Some inconsistency is apparent in the EIS which states in Section 5.3.6 that eight areas suitable for fauna underpasses were determined. However, page 5-3 states that there will be nine fauna underpasses incorporated into the proposal.

- NPWS does not recommend that skylights be used in the median areas above fauna underpasses as a result of advice received from Chris Moon (Koala Survey and Management Services). This is due to the amount of noise that may be generated into the underpasses which may deter fauna use, and that nocturnal animals do not require light.

5.3.8 Highway Rest Areas and Driver Reviver Sites

- NPWS recommends that trees and understorey shrubs be maintained in these areas wherever possible to provide a more complex habitat for fauna and flora.

5.3.10 Highway Fencing

- NPWS recommends that poles be erected on the highway side of the fauna exclusion fencing at regular intervals (e.g. every 200m) to provide Koalas that may find a way on to the highway with a means to climb back to safety. This is necessary as it has been noted by local residents in the vicinity of the Korora

Koala fencing that Koalas have been unable to climb up the chain mesh fencing after straying on to the highway.

- It is necessary to ensure that fauna exclusion fencing be constructed at a distance from standing trees to prevent Koalas using the trees as a way to access the highway. The ends of fencing should curve back into the forest where appropriate to prevent fauna from accessing the highway at these points. This is appropriate at the southern end of Pine Creek State Forest.

5.3.13 Signs and Road Lighting

- It is not clear which locality is referred to in the EIS which states that Koala warning signs will be erected "along the service road link". NPWS considers that Koala warning signs should be erected along all service roads where fauna fencing is erected.

5.7.1 Landscape Strategic Plan

- Clear zones should be minimised wherever possible. NPWS recommends that investigation be conducted into the use of guard rails within Pine Creek State Forest in order to minimise clear zones and maximise the retention of forest vegetation.

- Table 5.3 does not list *Amorphospermum whitei* as an appropriate plant species for landscaping. NPWS recommends the use of this plant where appropriate, given that it was the only threatened plant species recorded during the flora surveys.

5.7.2 Detailed Design Phase

- The EIS states that the detailed design phase would be undertaken in close consultation with the local community and Coffs Harbour City Council. NPWS requests to be involved in this stage of the project, particularly given the concurrence role in relation to the SIS.

5.7.3 Landscape Components and Management

- NPWS recommends that plant species used in landscaping include those that will provide a food resource for fauna. In particular, nectar-producing species such as *Banksia* spp, *Callistemon* spp and *Melaleuca* spp. would provide a food resource for the Queensland Blossom Bat, which has been recorded in the area and is presumed to be present where suitable habitat exists.

- Consideration should be given to retention of vegetation between access roads and proposed new highway wherever possible through Pine Creek State Forest. This appears to be indicated on the landscape figures for the area around Mailman's Track Interchange.

Section 6.3 Flora and Fauna

- As this section of the EIS is essentially a summary of information provided in the SIS, reference to those comments provided above should be made.

6.3.5 Significant Vegetation Communities - Impacts and Mitigation

- See comments for section 5.3.1 of SIS regarding the extent of habitat clearing. This should be quantified for the entire route, and specify the amount of land owned by NPWS proposed for removal.

- No discussion is presented regarding Interim Deferred Forest Areas (IDFAs) in Pine Creek State Forest. These areas have been identified as high conservation value and potentially required for a comprehensive, adequate and representative reserve system as an outcome of the Comprehensive Regional Assessment process. The closest IDFA is approximately 150-300m east of the existing highway.

6.3.6 Fauna

- The EIS states that fauna species are not likely to be solely dependent on habitat patches in the proposal area. However, it is important to note that patches may contain important habitat features for threatened and other fauna, for example Koala food trees, hollow-bearing trees, roost or nests, etc.

6.3.8 Fauna Species

Osprey

- NPWS considers that it is not acceptable that construction of the road would cause the pair of Ospreys to leave their current roosting and nesting tree. NPWS does not agree that the Ospreys could simply move to another suitable site as these are likely to be used by other species. Refer to comments on Appendix E of the SIS regarding this species.

Giant Barred Frog

- Refer to comments on Appendix E of the SIS regarding this species.

6.3.9 Fauna Habitats - Impacts and Mitigation

Pine Creek State Forest

- NPWS does not agree with the statement in the EIS that exclusion fencing would be equivalent to the breeding output of an additional 500 hectares of Koala habitat. Refer to comments on Section 5.6.6 of the SIS.

Cumulative Impacts

- Cumulative impacts should address the following issues: loss of poorly conserved vegetation/forest types; increase of barrier effects between the coastal plain and the hinterland escarpment; and loss of habitat in an area of high biodiversity.

6.4.3 Impact Assessment and Mitigation Measures

Fauna Underpasses

- Consideration should be given to internal design features of fauna underpasses such as provision of vertical and horizontal logs to provide Koalas with an escape mechanism if predators enter the underpasses.

Improvement measures for the existing highway

- NPWS recommends that reduced speed limits and traffic calming measures (e.g. rumble strips, raised crossing area) be implemented in the area of Titans Close on the existing highway.

8.3 Content and Structure of the Environmental Management Plan

- NPWS would like to be involved in the development and review of the Environmental Management Plan (EMP).

8.5 Summary of Mitigating Measures
Flora and Fauna

- The first dot point of this section states that areas to be cleared would first be inspected for Koalas. This should include inspection for other fauna as well as Koalas.

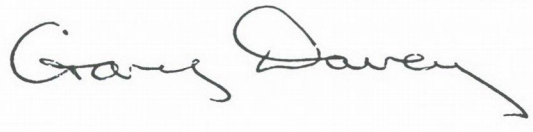
- Maintenance of fauna fencing and underpasses should be included in this section.

9.3 Bio-physical Impacts

- This section of the EIS states that the proposal would have no significant impact on any threatened plants known, or with the potential to occur within the route corridor. This statement is incorrect, as there are several threatened species which have the potential to occur within the corridor, but have not been detected in the surveys.

If you wish to discuss these comments further please contact Dianne Brown on (02) 6659 8273.

Yours faithfully



GARY DAVEY
Manager, Threatened Species Unit
Northern Zone

for DIRECTOR-GENERAL

References:

Briggs, J. D. & Leigh, J. H. (1988) *Rare or Threatened Australian Plants.* Australian National Parks and Wildlife Service, Canberra.

Griffith, S. (1993) *Conservation status of coastal plant communities in northern New South Wales - a review.* Internal report to the NSW National Parks and Wildlife Service, Sydney.

Resource and Conservation Assessment Council (1996) *Draft Interim Forest Assessment Report.* Resource and Conservation Assessment Council, Sydney.

Sheringham, P. & Westaway, J. (1995) *Significant vascular plants of upper north-east New South Wales.* A report by the NSW NPWS for the Natural Resources Audit Council, NSW NPWS, Sydney

APPENDIX 2 – NSW FISHERIES SUBMISSION

NSW FISHERIES

SF:gh
8/9/98

Mr Les Wielinga
Pacific Highway Development Manager
Roads and Traffic Authority
Pacific Highway Development Office
PO Box 546
GRAFTON NSW 2460

Dear Mr Wielinga,

RE: PACIFIC HIGHWAY UPGRADE PROGRAM - PROPOSED BONVILLE DEVIATION - EIS AND SIS.

Thank you for your letter dated 5 August 1998 inviting comments on the above project.

NSW Fisheries wishes to raise the following issues and concerns regarding the EIS and the proposed project. These are listed as follows:

1. Impact on Aquatic Flora and Fauna - the EIS does not address the potential impacts (both positive and/or negative) on aquatic organisms, in particular in relation to the proposed crossings of Pine, Bonville and Reedy Creeks, and wetland areas. Only two broad statements are made on pp6-27 and 7-5. While it is agreed that bridges and box culverts are the preferred crossing options over waterways, impacts and mitigation measures associated with the construction of such structures should have been addressed in more detail (ie. potential restrictions on fish passage during construction, impacts on breeding/spawning cycles during waterway crossing construction, sedimentation and runoff, acid sulfate soil impacts etc.). Sampling of aquatic organisms was restricted to macroinvertebrates, and discussion on impacts of the project on aquatic organisms is limited to the Water Quality Assessment in Appendix H only. Other impacts associated with the crossing of the wetland areas at Bonville Creek south and west of Bayldon was also not discussed in detail, in particular potential changes to site drainage and wetland integrity.

2. Water Quality Monitoring - NSW Fisheries recommends that monitoring during construction, as outlined on p 6-39 of the EIS, be expanded to include dissolved oxygen, aluminium and iron to ensure that the release or mobilisation of any acid sulfate soils within sedimentation basins and receiving waters is detected. Fish kills associated with acid sulfate soils have been reported in the Coffs Harbour catchment in the past. Monitoring and control of such soils during the construction phase, particularly during bridge and culvert construction, is crucial to ensure significant impacts on aquatic organisms are minimised.

3. Licences and Approvals - section 8-1 outlines the required licences and approvals for this project. In correspondence from NSW Fisheries, dated 21 January 1997 (in Appendix B), the need for permits for any proposed dredging and reclamation works and damage or removal of marine vegetation (ie. mangroves, seagrass) was raised. These requirements have not been addressed in this section.

4. Threatened Species - NSW Fisheries has reviewed three EIS's for the Pacific Highway Upgrade during the same display period as this project (ie. Brunswick River - Yelgun, Yelgun - Chinderah). Two of the three EIS's have discussed and addressed the new threatened species provisions under the *Fisheries Management Amendment Act 1997*. This project has not discussed this requirement. While the saving provisions under the above Act apply in this instance, the approach adopted over the three projects has not been consistent.

NSW Fisheries suggests that the Project Manager for the Bonville Deviation project work in close consultation with the person employed under the Memorandum of Understanding between NSW Fisheries and the RTA to address the following issues during the design, construction and operational phases of the project:

- bridge and culvert design across all waterways to ensure that fish passage is unhindered, and site drainage, tidal inundation and wetland area integrity is not affected
- the development and/or review of aquatic flora and fauna and water quality monitoring programs during the construction and operational phases of the project
- minimisation of impacts on aquatic organisms and marine vegetation (mangroves, seagrass) during dredging and reclamation works and the construction of waterway crossings
- the design of the erosion and sedimentation control plan to ensure impacts on aquatic organisms are minimised

If you have any further queries regarding these comments, please contact me on (02) 6686 2018.

Yours sincerely

SARAH FAIRFULL
CONSERVATION MANAGER

NSW Fisheries, PO Box 154, Ballina NSW, 2478, Australia
Tel: (02) 8886 2018; Fax: (02) 6686 8907. Email: fairfuls@fisheries.nsw.gov.au

APPENDIX 3 – AQUATIC ECOLOGICAL ASSESSMENT

Prepared for the Roads and Traffic Authority
On Behalf of PPK Environment & Infrastructure

AQUATIC ECOLOGICAL ASSESSMENT:

BONVILLE DEVIATION OF THE

PACIFIC HIGHWAY

Job No. 9804-030
February, 1999

W.S. ROONEY & ASSOCIATES PTY LTD
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1.0 INTRODUCTION

This report was commissioned by Biosis Research Pty Ltd on behalf of the NSW Roads & Traffic Authority (RTA) and their principal consultants, PPK Environment and Infrastructure. It aims to address concerns expressed in a submission prepared by NSW Fisheries (see Appendix 1) and to assess the modified proposal for the Bonville Deviation of the Pacific Highway. A meeting was held in the Ballina offices of NSW Fisheries on 2 November, 1998 between the RTA, their consultants, and the NSW Fisheries Conservation Manager to discuss the NSW Fisheries concerns and the work needed to satisfy those concerns. The modified proposal is more fully described in the SISSIR (Biosis Research 1999).

The study area is the proposed deviation to the Pacific Highway at Bonville between Perrys Road and Lyons Road, a distance of 9.8km. There are three creeks that would be crossed by the proposed new highway (from north to south): Bonville Creek, Reedys Creek, and Pine Creek.

W.S. Rooney & Associates Pty Ltd were commissioned to undertake the following tasks:

- Undertake additional aquatic habitat assessment in the three creeks to be crossed by the modified proposal, without quantitative sampling;
- Apply an '8 part test' for threatened fish species within all aquatic habitats traversed by the proposed route. Although earlier advice from NSW Fisheries indicated that no threatened fish species were present in the study area, the determining authority is still required to have regard to the '8 part test' in order to satisfy the legislative requirements of section 111(4) of the EP&A Act.
- Assess the modified proposal in relation to three major creek crossings in the study corridor;
- Determine whether mangroves and/or seagrass occur within or near the proposed road alignment in Bonville Creek. If either is present, determine the species, distribution, and likely loss or impact during construction of the proposed bridge over Bonville Creek.
- If either seagrass or mangroves could be lost as a result of construction or subsequent shading by the bridge, determine the areas to be affected and locate suitable area/s as close to the site as possible for compensatory planting. The need for a permit from NSW Fisheries to prune mangroves that may grow under the bridge is to be investigated.
- Prepare a report summarising the above findings and incorporating the aquatic ecological information (notably that on insects) included in the water quality working paper prepared by Robyn Tuft & Associates Pty Ltd.

2.0 STUDY METHODS

The aquatic habitats that are the subject of this study consist of three creeks:

a. **Bonville Creek**

b. **Pine Creek**

c. **Reedys Creek**

The three creeks were closely examined in the field between 12-14 November, 1998. Bonville Creek was traversed from the existing Pacific Highway to Sawtell by small boat using snorkel and mask for underwater inspection where appropriate; the banks of Bonville Creek under the road alignment were traversed on foot. Pine and Reedys Creeks were examined on foot at the location of the road alignment and for a short distance upstream and a longer distance downstream. Three visits were made to Pine Creek at various times of the day to observe for fish and platypus.

Other wetlands occur along the proposed road alignment between Archville Station Road and East Bonville Road, between East Bonville Road and Bonville Station Road, and in Bongil Bongil National Park between Lyons Road and Williams Road. For further information on these wetlands, refer to King (1999).

In addition to the EIS and SIS prepared by PPK Environment and Infrastructure for the deviation, a search was made for other existing reports or information on the fauna of these creeks. Standard reference works were consulted for information on fish species likely to occur in these waters and the distribution of threatened species. Contact was made with local officers from NSW Fisheries and other specialist consultants who may have worked in the area. The most recent SEPP-14 wetland maps were obtained from the Department of Urban Affairs and Planning, and other relevant environment protection legislation was reviewed. In particular, the NPWS Information Circular No. 2 (1996) was obtained from the NSW Threatened Species Unit at Port Stephens. This circular provides useful information on the preparation of the '8 part test'.

3.0 RESULTS AND DISCUSSION

3.1 Habitat Assessment

3.1.1 Bonville Creek

Bonville Creek is one of two principal drainages into Bonville Creek Estuary at Sawtell. The aquatic habitat of Bonville Creek in the vicinity of the Pacific Highway deviation is reasonably wide (~ 60m), deep (~2.5m deep in the centre of the Creek), moderately turbid in dry weather (secchi disc visibility about 1m), and brackish. There are no conductivity data from the exact locality of the modified proposal, but at a site

about one kilometre upstream (120m downstream of the existing Pacific Highway) it varies from about half the salinity of seawater in dry weather to very fresh after significant rainfall in the catchment. Refer to the water quality working paper by Robyn Tuft & Associates Pty Ltd (Appendix K) in the EIS prepared by PPK Environment and Infrastructure (1998) for data.

Bonville Creek provides good habitat for a number of large to medium size fish, both freshwater and diadromous species, and also probably occasional marine species (see below).

Aquatic invertebrates near the existing Pacific Highway were a mix of estuarine and freshwater species (Robyn Tuft & Associates Pty Ltd, 1998), providing convincing evidence that the creek is certainly tidal in that area for a reasonable percentage of the time.

The benthic fauna in the area of the proposed new crossing of Bonville Creek appears to consist of estuarine organisms, rather than freshwater species, but no qualitative sampling was carried out.

3.1.1.1 Seagrass

Inspection of the substrate and banks of Bonville Creek revealed that no seagrasses occur at or near the proposed route alignment. The nearest seagrass occur as fringing beds of *Zostera capricorni* on both the north and south bank of lower Bonville Creek about 500m upstream of its confluence with Pine Creek (just upstream of the first major bend in Bonville Creek). West *et al.* (1985) mapped the seagrasses of Bonville Creek using 1:25000 aerial photographs. Their mapping indicated that, at that time, seagrasses only occurred as fringing vegetation in the lower reach of the Creek, below its confluence with Pine Creek. Seagrass distribution appears to have increased since the survey by West *et al.* (1985) but is unable to persist very far upstream in Bonville Creek because of reduced light penetration due to turbidity.

3.1.1.2 Mangroves

The north bank of Bonville Creek in the vicinity of the proposed highway crossing consists of a vertical incised channel 0.5-1.0m high, with an undercut bank that is held in place largely by tree roots. The topography rises sharply a few metres away from the bank, which is covered in terrestrial vegetation (trees and shrubs). There are no mangroves on the north bank of the Creek in the vicinity of the proposed road alignment.

The south bank of the Creek within the road alignment has a broader floodplain above a shallow (<0.5m) bank. The floodplain is covered in a stand of *Casuarina glauca* with a *Juncus sp.* understorey. The bank contains a few scattered river mangroves, *Aegiceras corniculatum*, which have colonised shallow intertidal sediments at the base of

the bank; there are nine mature to semi-mature plants and 49 seedlings. These plants occur in clumps with wide areas in between where no bank vegetation occurs.

A. corniculatum grows as a bushy shrub or slender tree up to 4m in height (Sainty and Jacobs, 1981). It occurs all along Bonville Creek wherever suitable substrate is found. Because the topography of the south bank is generally less steep and offers more frequent shallow sand/mud banks, the river mangrove is much more common on the south bank than the north bank. It occurs in all the small inlets and drainage lines along the Creek, provided there is some relatively flat substrate at the normal water line for seed settlement. It was observed to occur sporadically for another 500m upstream of the proposed highway crossing.

There are numerous localities for obtaining seedlings for compensatory planting along the Creek, should that be necessary. One particularly rich locality is on the south bank just downstream of the railway bridge. There are several other localities where the river mangrove is quite abundant: on the south bank immediately downstream (<30m) of the proposed highway crossing there is a small embayment (which may have been excavated out of the bank some time ago) which is lined with *A. corniculatum.* About 200m upstream of the proposed highway crossing on the south bank is a low sandy area where the mangroves are quite abundant. There are two or three small inlets on the north bank both up- and downstream of the proposed crossing which also contain good stands of *A. corniculatum.*

Transplanting mangrove seedlings is certainly possible and is done on occasions, but in this situation natural seed settlement and germination would probably be simpler and just as effective, if the correct substrate levels and slope are provided. Because of the existing wide distribution of river mangroves along the banks of Bonville Creek, self-seeding would occur quite rapidly.

The soffit (underside) of the road deck beams on the proposed highway bridge is 4.3m above normal water level (PPK drawing no. PD082. Because the creek bank shows signs of scour and appears to be eroding, the life span of mangroves or any vegetation immediately along the bank in the scour zone of floodwaters is limited. Low light under the bridge would further stunt the growth of the mangroves, so they are unlikely to reach their maximum height of 4m. Therefore, the mangroves that may establish under the bridge in future are unlikely to create a clearance problem under the bridge, and so shall not require any removal or trimming during operation of the highway.

Depending on how the bridges over Bonville Creek were constructed, there may be no need to remove or trim any of the mangroves during construction. There is ample width between clumps of mangrove to launch any equipment, or gain access to the water. There is a risk that construction crews requiring access to the water may attempt to use the small embayment immediately downstream on the south bank, because vehicle access to the shoreline is easier there (firmer ground). This would require the clearing of several of the river mangroves (a protected plant in NSW), and will require a permit from NSW fisheries.. There is ample opportunity for water access along the north bank, where there

are no mangroves near the proposed crossing, or within the road easement on the south bank without damaging any of the mangroves. The project EMP will need to ensure that workers are made aware of the small mangrove shrubs along the south bank and instructed not to damage or remove them during clearing of other vegetation.

Therefore, if the above simple mitigation actions are taken, no compensatory planting of mangroves should be required; furthermore, depending on the method of bridge construction, a permit should not be necessary to trim or remove any mangroves.

There is not considered to be any significant restriction to fish passage or impact on fish breeding/spawning cycles during construction of the bridge crossing over Bonville Creek provided sedimentation of the creek bed is minimised and water quality remains at the existing level.

3.1.2 Pine Creek

Pine Creek is the second of two principal drainages into Bonville Creek Estuary at Sawtell. At the proposed new highway crossing (immediately next to the existing Pacific Highway crossing) the Creek has the following characteristics: it varies between about 10-35m wide; it is about 2m deep in pools, much less in riffles; it is moderately turbid in dry weather (estimated secchi disc visibility about 1.5m); and it is freshwater.

There are no mangroves or seagrasses in this reach of Pine Creek. The aquatic habitat is reasonably good, with one particularly fine deep pool about 100m downstream of the proposed crossing. This pool and nearby banks appear to be good platypus habitat: steep mud banks with good overhanging bank cover immediately up- and downstream of the pool. There is good instream cover at and near the pool (*Nymphaea caerulea ssp. zanzibarensis, Ottelia ovalifolia, Vallisneria gigantea* and *Persicaria decipiens*). Adequate food supply is apparent, and water quality appears adequate (refer to Appendix K in the EIS).

Pre-dawn and sunset observations were made in this pool but no platypuses were detected. A local fisher met by chance on the Creek stated that platypus have indeed been seen in this vicinity of the creek within the past two years. Another person has told us that platypuses are occasionally sighted on upper Bonville Creek (upstream of the existing Pacific Highway).

The Creek also appears to be suitable habitat for a number of small to medium size native freshwater fish species (see below). Analysis of aquatic insects by Robyn Tuft & Associates Pty Ltd indicated that Pine Creek supports a diverse assemblage of aquatic fauna, including pollution-sensitive macroinvertebrates such as shrimp and certain mayflies and caddisflies. A macroinvertebrate index for water quality (SIGNAL score) indicated very good water quality (refer to Sections 5.2, 5.3 and Appendix 3 of this report for details).

The Pine Creek crossing of the new deviation is to be bridged, so there should be little or no interference with stream processes during operation of the road. During the construction of the bridge, particular care will need to be taken to prevent damage to the good aquatic habitat of the stream, particularly the high quality pool about 100m downstream. Excessive sedimentation would be particularly damaging to the stream and its flora and fauna because the existing clean sand and gravel substrate is preferred by many fish species for feeding and spawning. There should be no significant restrictions to fish passage or impacts on breeding/spawning cycles during construction of the Pine Creek bridge crossing provided sedimentation of the creek bed does not occur, and water quality (particularly turbidity, dissolved oxygen, and toxicant load) remains good.

3.1.3 Reedys Creek

Reedys Creek is a freshwater tributary of Pine Creek. It is shallow (<1m), full of native aquatic vegetation, and is more of a swamp/wetland than a flowing creek at the location of the proposed road crossing.

Open rushland grades into paperbark swamp at the location of the modified proposal crossing. The paperbark swamp has been fragmented and cleared over the years, but is surprisingly attractive, weed-free, and functional. It provides potential habitat for a number of small freshwater fish species (see below), and it also would act as a drought refuge for both native and stock animals.

Examination of the insect fauna by Robyn Tuft & Associates Pty Ltd (see Section 5.3.3) indicated that Reedys Creek was experiencing mild pollution. Inspection of the water quality data in their report indicates that the pollution was in the form of elevated nutrients, probably contributed by upstream land uses. The rushland and paperbark swamp probably act as a natural filter for the increased nutrients.

The modified Reedys Creek crossing comprises a cluster of bridges, each carrying a lane of carriageway or access ramp (Biosis Research 1999). The bridges would be at least 60m long, with a gap where the median would occur. This gap would allow some light to penetrate to the swamp. The modified proposal includes clusters of driven piles as the bridge supports, which would allow water to diffuse naturally between bridge supports.

This modified proposal would span across the majority of the open rushland and all of the paperbark swamp. However, the paperbark trees under the bridge will have to be cut since the bridge will only be on the order of 4m above water level. The aquatic plants, substrate surface, and water flows will remain.

There is some uncertainty whether the full range of aquatic vegetation will survive under the shaded conditions of the bridge. Possibly some mitigation measures, such as light reflecting panels to direct more light under the bridge, could be considered if deemed necessary once the bridge is constructed.

6.0 REFERENCES CITED

Arthington, A.H. (Editor)(1996). Recovery Plan for the Oxleyan pygmy perch (*Nannoperca oxleyana*). Final report to the Australian Nature Conservation Agency. Centre for Catchment and In-Stream Research, Griffith University.

Australian & New Zealand Environment & Conservation Council (ANZECC) (1992). Australian water quality guidelines for fresh and marine waters.

Biosis Research Pty Ltd (1998). Bonville Project: Pacific Highway Coffs Harbour. Wetland Evaluation. Prepared by Adam King, December, 1998 for the RTA.

Department of Land & Water Conservation (DLAWC) (1996). The NSW Wetlands Management Policy. NSW Government.

Faragher, R.A. and Harris, J.H. (1994). The historical and current status of freshwater fish in New South Wales. Proceedings from the Symposium: Animals of New South Wales and their History in the 20th Century. Royal Zoological Society of New South Wales. Australian Zoologist, Vol. 29(3-4): 166-176.

Harris, J.H. and Gehrke, P.C. (1997). Fish & Rivers in Stress: the NSW Rivers Survey. CRC for Freshwater Ecology, Canberra. 298p.

Jerry, D.R. and Woodland, D.J. (1997). Electrophoretic evidence for the presence of the undescribed 'Bellinger' catfish (*Tandanus* sp.) (Teleostei: Plotosidae) in four New South Wales mid-northern coastal rivers. Mar. Freshwater Res., Vol. 48: 235-40.

King, A. (1999). Bonville Project Pacific Highway Coffs Harbour: Wetland Evaluation. Prepared by Biosis Research Pty Ltd for the RTA.

McDowall, R.M. (1996). Freshwater Fishes of South-eastern Australia. Reed Books. Rev. ed.

NSW Fisheries (1998a). Conservation of threatened aquatic species. Fishnote DF/71. August, 1198.

NSW Fisheries (1998b). Policy and Guidelines: aquatic habitat management and fish conservation. (Eds. Smith, A.K. and Pollard, D.A.). Sydney, 76pp.

NSW Fisheries (undated). Conservation of threatened fish species & aquatic biodiversity. Brochure. 7pp.

NSW National Parks & Wildlife Service (1996). Information circular no. 2: threatened species assessment under the EP&A Act: the '8 part test' of significance. Threatened species management; 36pp.

Robyn Tuft & Associates Pty Ltd (1998). Water quality assessment for the proposed Pacific Highway upgrade from Mailmans Track to Lyons Road, Bonville. Appendix K, Vol. 2, Environmental Impact Statement. Prepared by PPK Environment & Infrastructure Pty Ltd for Roads and Traffic Authority of NSW.

Sainty, G.R. and Jacobs, S.W.L. (1981). Waterplants of New South Wales. Water Resources Commission of NSW.

West, R.J., Thorogood, C., Walford, T., Williams, R. J. (1985). Fisheries Bulletin 2: An estuarine inventory for New South Wales, Australia. Department of Agriculture, NSW. 140pp.

APPENDIX 1:

NSW FISHERIES RESPONSE TO THE BONVILLE DEVIATION EIS (Terms of Reference for This Study)

NSW FISHERIES

SF:gh
8/9/98

EIS SUBMISSION
PROJECT: BONVILLE
DATE RECEIVED: 10/9/98
REGISTERED NO: 36

Mr Les Wielinga
Pacific Highway Development Manager
Roads and Traffic Authority
Pacific Highway Development Office
PO Box 546
GRAFTON NSW 2460

Dear Mr Wielinga,

RE: PACIFIC HIGHWAY UPGRADE PROGRAM - PROPOSED BONVILLE DEVIATION - EIS AND SIS.

Thank you for your letter dated 5 August 1998 inviting comments on the above project.

NSW Fisheries wishes to raise the following issues and concerns regarding the EIS and the proposed project. These are listed as follows:

1. Impact on Aquatic Flora and Fauna - the EIS does not address the potential impacts (both positive and/or negative) on aquatic organisms, in particular in relation to the proposed crossings of Pine, Bonville and Reedy Creeks, and wetland areas. Only two broad statements are made on pp6-27 and 7-5. While it is agreed that bridges and box culverts are the preferred crossing options over waterways, impacts and mitigation measures associated with the construction of such structures should have been addressed in more detail (ie. potential restrictions on fish passage during construction, impacts on breeding/spawning cycles during waterway crossing construction, sedimentation and runoff, acid sulfate soil impacts etc.). Sampling of aquatic organisms was restricted to macroinvertebrates, and discussion on impacts of the project on aquatic organisms is limited to the Water Quality Assessment in Appendix H only. Other impacts associated with the crossing of the wetland areas at Bonville Creek south and west of Bayldon was also not discussed in detail, in particular potential changes to site drainage and wetland integrity.

2. Water Quality Monitoring - NSW Fisheries recommends that monitoring during construction, as outlined on p 6-39 of the EIS, be expanded to include dissolved oxygen, aluminium and iron to ensure that the release or mobilisation of any acid sulfate soils within sedimentation basins and receiving waters is detected. Fish kills associated with acid sulfate soils have been reported in the Coffs Harbour catchment in the past. Monitoring and control of such soils during the construction phase, particularly during bridge and culvert construction, is crucial to ensure significant impacts on aquatic organisms are minimised.

3. Licences and Approvals - section 8-1 outlines the required licences and approvals for this project. In correspondence from NSW Fisheries, dated 21 January 1997 (in Appendix B), the need for permits for any proposed dredging and reclamation works and damage or removal of marine vegetation (ie. mangroves, seagrass) was raised. These requirements have not been addressed in this section.

4. Threatened Species - NSW Fisheries has reviewed three EIS's for the Pacific Highway Upgrade during the same display period as this project (ie. Brunswick River - Yelgun, Yelgun - Chinderah). Two of the three EIS's have discussed and addressed the new threatened species provisions under the *Fisheries Management Amendment Act 1997*. This project has not discussed this requirement. While the saving provisions under the above Act apply in this instance, the approach adopted over the three projects has not been consistent.

NSW Fisheries suggests that the Project Manager for the Bonville Deviation project work in close consultation with the person employed under the Memorandum of Understanding between NSW Fisheries and the RTA to address the following issues during the design, construction and operational phases of the project:

- bridge and culvert design across all waterways to ensure that fish passage is unhindered, and site drainage, tidal inundation and wetland area integrity is not affected
- the development and/or review of aquatic flora and fauna and water quality monitoring programs during the construction and operational phases of the project
- minimisation of impacts on aquatic organisms and marine vegetation (mangroves, seagrass) during dredging and reclamation works and the construction of waterway crossings
- the design of the erosion and sedimentation control plan to ensure impacts on aquatic organisms are minimised

If you have any further queries regarding these comments, please contact me on (02) 6686 2018.

Yours sincerely

SARAH FAIRFULL
CONSERVATION MANAGER

NSW Fisheries, PO Box 154, Ballina NSW, 2478, Australia
Tel: (02) 6686 2018; Fax: (02) 6686 8907. Email: fairfuls@fisheries.nsw.gov.au

APPENDIX 2:

REPRESENTATION OF FRESHWATER FISHES IN NORTHERN NEW SOUTH WALES

APPENDIX 2: REPRESENTATION OF FRESHWATER FISHES IN NORTHERN NEW SOUTH WALES. After Faragher and Harris (1994).

FAMILY	SPECIES	COMMON NAME
Ambassidae	*Ambassis agassizii* [1]	Olive perchlet
	Ambassis marianus [2]	Estuary Perchlet
Anguillidae	*Anguilla australis* [3]	Shortfinned eel
	Anguilla reinhardtii [3]	Longfinned eel
Apogonidae	*Glossamia aprion*	Mouth almighty
Ariidae	*Arius graffei* [3]	Blue catfish
Atherinidae	*Atherinosoma microstoma*	Smallmouthed hardyhead
	Craterocephalus marjoriae [1]	Marjorie's hardyhead
	Craterocephalus stercusmuscarum [1]	Flyspecked hardyhead
Belonidae	*Strongylura krefftii* [1,3]	Freshwater long-tom
Chanidae	*Chanos chanos* [3]	Milkfish
Clupeidae	*Nematalosa erebi* [1]	Bony bream
	Potamalosa richmondia	Freshwater herring
Cyprinidae	*Carassius auratus* [4]	Goldfish
	Cyprinus carpio [4]	Common carp
Eleotridae	*Butis butis* [3]	Crimson-tipped gudgeon
	Gobiomorphus australis [3]	Striped gudgeon
	Gobiomorphus coxii	Cox's gudgeon
	Hypseleotris compressa	Empire gudgeon
	Hypseleotris klunzingeri	Western carp gudgeon
	Hypseleotris galii [2]	Firetailed gudgeon
	Hypseleotris sp. no.2	
	Mogurnda adspersa	Purple-spotted gudgeon
	Philypnodon grandiceps [3]	Flathead gudgeon
	Philypnodon sp. [3]	Dwarf flathead gudgeon
Gadopsidae	*Gadopsis marmoratus*	River blackfish
Galaxiidae	*Galaxias maculatus*	Common jollytail
	Galaxias olidus	Mountain jollytail
Gobiidae	*Arenigobius bifrenatus*	Bridled goby
	Pseudogobius sp.	Blue spot goby
	Redigobius macrostoma	Largemouth goby
	Afurcagobius tamarensis [2]	Tamar river goby
Hemirhamphidae	*Arramphus sclerolepis* [3]	Snub-nosed garfish
Kuhliidae	*Nannoperca oxleyana* [1]	Oxleyan pygmy perch
Lutjanidae	*Lutjanus argentimaculatus* [3]	Mangrove-jack
Magalopidae	*Megalops cyprinoides* [1,3]	Oxeye herring
Melanotaeniidae	*Melanotaenia duboulayi*	Duboulay's rainbowfish
	Rhadinocentrus ornatus	Softspined rainbowfish
Monodactylidae	*Monodactylus argenteus* [3]	Diamond fish
Mugilidae	*Liza argentea* [3]	Flat-tail mullet
	Mugil cephalus [3]	Sea mullet
	Myxus elongatus [3]	Sand mullet
	Myxus petardi [3]	Freshwater mullet

Mugilidae (cont.)	*Valalmugil georgii* [3]	Fantail mullet
Percichthyidae	*Maccullochella ikei* [1]	Eastern cod
	Macquaria ambigua [1,5]	Golden perch
	Macquaria colonorum [3]	Estuary perch
	Macquaria novemaculeata [3]	Australian bass
Percidae	*Perca fluviatilis* [4]	Redfin perch
Plotosidae	*Tandanus tandanus* [1]	Freshwater catfish
	Tandanus sp. [6]	Freshwater catfish
Poeciliidae	*Gambusia holbrooki* [4]	Eastern gambusia
Pseudomugilidae	*Pseudomugil signifer*	Southern blue-eye
Retropinnidae	*Retropinna semoni*	Australian smelt
Salmonidae	*Oncorhynchus mykiss* [1,4]	Rainbow trout
	Salmo trutta [1,4]	Brown trout
	Salvelinus fontinalis [1,4]	Brook char
Scorpaenidae	*Notesthes robusta* [3]	bullrout
Teraponidae	*Bidyanus bidyanus* [5]	Silver perch
	Leiopotherapon unicolor	Spangled perch

1 Although reported from northern NSW generally, they have not been recorded within or near this coastal study area (McDowall, 1996), and are therefore not likely to occur.

2 Species was not listed by Faragher & Harris, but was reported by McDowall (1996) to occur in the northern region of coastal NSW.

3 Migrates between fresh and salt water at a regular life-history phase, in either direction, but not necessarily to spawn, i.e. diadromous.

4 Indicates alien species.

5 Indicates species translocated from their normal range.

6 Possibly a different species to the western drainage species. Furthermore, those populations inhabiting coastal rivers from the Manning to the Bellinger may be a separate species to those inhabiting more northerly coastal rivers. Catfish that may occur in this study area are thought to more likely be the Manning-Bellinger species (Bishop, pers. com.).

APPENDIX 3:

BIOLOGICAL DATA FROM ROBYN TUFT & ASSOCIATES PTY LTD

ROBYN TUFT & ASSOCIATES

RT060

MACROINVERTEBRATE SAMPLING RESULTS

SUMMARY OF TAXA

Phylum	Class	Sub Class	Order	Family	Grade	Common Name
Annelida	Hirudinea				3	leech
Annelida	Oligochaeta				1	"earthworm"
Annelida	Polychaeta					Marine worm
Arthopoda	Crustacea			Cumacea		
Arthopoda	Crustacea		Decapoda			Crab
Arthopoda	Crustacea		Decapoda	Hymenosomatidae		Crab
Arthopoda	Insecta		Hemiptera	Belostomatidae	5	
Arthropoda	Arachnida		Acarina		5	mite
Arthropoda	Crustacea		Amphipoda		6	amphipod
Arthropoda	Crustacea		Amphipoda	Ceinidae	5	amphipod/scud
Arthropoda	Crustacea		Amphipoda	Gammaridae	6	amphipod
Arthropoda	Crustacea		Isopoda		5	isopod
Arthropoda	Crustacea		Isopoda	Sphaeromatidae	5	isopod
Arthropoda	Crustacea	Copepoda				copepod
Arthropoda	Crustacea	Malacostraca	Decapoda	Atyidae	7	shrimp
Arthropoda	Crustacea	Ostracoda				ostracod
Arthropoda	Insecta		Coleoptera	Curculionidae		"weevil"
Arthropoda	Insecta		Coleoptera	Dytiscidae	5	beetle
Arthropoda	Insecta		Coleoptera	Elmidae	7	beetle
Arthropoda	Insecta		Coleoptera	Gyrinidae	5	beetle
Arthropoda	Insecta		Coleoptera	Hydraenidae	7	beetle
Arthropoda	Insecta		Coleoptera	Hydrophilidae	5	beetle
Arthropoda	Insecta		Coleoptera	Hygrobiidae	5	beetle
Arthropoda	Insecta		Coleoptera	Psephenidae	5	beetle
Arthropoda	Insecta		Coleoptera	Ptilodactylidae	10	beetle
Arthropoda	Insecta		Coleoptera	Scirtidae	7	beetle
Arthropoda	Insecta		Coleoptera	Staphylinidae	5	beetle
Arthropoda	Insecta		Diptera	Athericidae	7	
Arthropoda	Insecta		Diptera	Chironomidae	1	gnat/midge larva
Arthropoda	Insecta		Diptera	Culicidae	2	mosquito larva
Arthropoda	Insecta		Ephemeroptera	Baetidae	5	mayfly nymph
Arthropoda	Insecta		Ephemeroptera	Caenidae	5	mayfly nymph
Arthropoda	Insecta		Ephemeroptera	Leptophlebiidae	10	mayfly nymph
Arthropoda	Insecta		Hemiptera	Corixidae	5	lesser water boatmen
Arthropoda	Insecta		Hemiptera	Gerridae	5	water strider
Arthropoda	Insecta		Hemiptera	Mesoveliidae	4	surface bugs
Arthropoda	Insecta		Hemiptera	Naucoridae	5	bug
Arthropoda	Insecta		Hemiptera	Notonectidae	4	water boatmen
Arthropoda	Insecta		Hemiptera	Veliidae	4	bug
Arthropoda	Insecta		Odonata	Aeschnidae	6	dragonfly nymph
Arthropoda	Insecta		Odonata	Coenagrionidae	7	damselfly nymph
Arthropoda	Insecta		Odonata	Corduliidae	7	dragonfly
Arthropoda	Insecta		Odonata	Gomphidae	7	dragonfly
Arthropoda	Insecta		Odonata	Isostictidae	7	damselfly nymph
Arthropoda	Insecta		Odonata	Libellulidae	8	dragonfly nymph
Arthropoda	Insecta		Trichoptera	Calamoceratidae	8	caddis fly nymph
Arthropoda	Insecta		Trichoptera	Leptoceridae	7	caddis fly nymph

SUMMARY OF TAXA

Phylum	Class	Sub Class	Order	Family	Grade	Common Name
Chordata				Melanotaeniidae		Rainbow fish
Chordata	Osteichthyes			Gobiidae		
Chordata	Osteichthyes			Poeciliidae		mosquito fish (Intro)
Mollusca	Gastropoda			Physidae	3	snail
Mollusca	Gastropoda	Pulmonata	Basommatophora	Planorbidae	3	snail

ROBYN TUFT & ASSOCIATES

MACROINVERTEBRATE SAMPLING RESULTS

Bonville Creek- Upstream — 3 Oct 1997

Total Number of Taxa 8

Taxon ID	Number of Taxa	Abundance	Score
Decapoda	2	3	0
Gammaridae	1	3	18
Sphaeromatidae	1	1	5
Atyidae	1	3	21
Curculionidae	1	1	0
Psephenidae	1	2	10
Gobiidae	1	1	0

Bonville Creek- Downstream — 22 Apr 1997

Total Number of Taxa 6

Taxon ID	Number of Taxa	Abundance	Score
Polychaeta	1	1	0
Hymenosomatidae	1	1	0
Isopoda	1	2	10
Sphaeromatidae	1	1	5
Atyidae	1	4	28
Athericidae	1	1	7

Bonville Creek- Downstream — 3 Oct 1997

Total Number of Taxa 15

Taxon ID	Number of Taxa	Abundance	Score
Polychaeta	1	1	0
Cumacea	1	3	0
Decapoda	1	2	0
Amphipoda	1	3	18
Isopoda	2	2	10
Copepoda	1	3	0
Atyidae	1	3	21
Ostracoda	1	3	0
Scirtidae	1	1	7
Chironomidae	3	2	2
Leptoceridae	1	1	7
Gobiidae	1	1	0

Pine Creek- Upstream — 23 Apr 1997

Total Number of Taxa 19

Taxon ID	Number of Taxa	Abundance	Score
Acarina	2	4	20
Atyidae	1	4	28
Dytiscidae	1	3	15
Elmidae	1	3	21
Gyrinidae	1	3	15
Hygrobiidae	1	3	15
Chironomidae	1	1	1
Baetidae	1	3	15
Leptophlebiidae	1	4	40
Atalophlebia	2	3	30
Gerridae	1	4	20
Veliidae	1	4	16
Libellulidae	1	2	16
Calamoceratidae	1	3	24

Leptoceridae	1	4	28
Melanotaeniidae	1	1	0
Poeciliidae	1	2	0

Pine Creek- Upstream — 3 Oct 1997

Total Number of Taxa 19

Taxon ID	Number of Taxa	Abundance	Score
Oligochaeta	1	2	2
Acarina	1	3	15
Atyidae	1	4	28
Dytiscidae	1	4	20
Elmidae	1	2	14
Hygrobiidae	1	3	15
Ptilodactylidae	1	1	10
Scirtidae	1	3	21
Chironomidae	2	3	3
Baetidae	1	3	15
Caenidae	1	1	5
Ulmerophlebia	1	3	30
Atalophlebia	2	3	30
Corduliidae	1	1	7
Gomphidae	1	1	7
Leptoceridae	1	4	28
Gobiidae	1	3	0

Pine Creek- Downstream — 22 Apr 1997

Total Number of Taxa 18

Taxon ID	Number of Taxa	Abundance	Score
Acarina	1	4	20
Ceinidae	1	1	5
Copepoda	1	4	0
Atyidae	1	4	28
Hydraenidae	1	2	14
Hydrophilidae	1	2	10

Hygrobiidae	1	4	20
Chironomidae	1	1	1
Culicidae	1	1	2
Leptophlebiidae	2	4	40
Corixidae	1	3	15
Mesoveliidae	1	2	8
Veliidae	1	3	12
Coenagrionidae	1	1	7
Leptoceridae	1	4	28
Melanotaeniidae	1	1	0
Gobiidae	1	2	0

Pine Creek- Downstream **2 Oct 1997**

Total Number of Taxa 14

Taxon ID	Number of Taxa	Abundance	Score
Acarina	1	3	15
Atyidae	1	4	28
Gyrinidae	1	3	15
Hydrophilidae	1	3	15
Chironomidae	1	3	3
Culicidae	1	1	2
Baetidae	2	3	15
Ulmerophlebia	1	3	30
Atalophlebia	2	3	30
Notonectidae	1	3	12
Veliidae	1	3	12
Isostictidae	1	1	7

Reedys Creek- Upstream **2 Oct 1997**

Total Number of Taxa 14

Taxon ID	Number of Taxa	Abundance	Score
Hirudinea	1	1	3
Belostomatidae	1	1	5
Acarina	1	4	20

Dytiscidae	1	4	20
Hydrophilidae	1	3	15
Staphylinidae	1	3	15
Chironomidae	1	3	3
Corixidae	1	2	10
Naucoridae	1	2	10
Coenagrionidae	1	3	21
Corduliidae	1	2	14
Libellulidae	1	2	16
Gobiidae	1	3	0
Poeciliidae	1	3	0

Reedys Creek- Downstream **3 Oct 1997**

Total Number of Taxa 22

Taxon ID	Number of Taxa	Abundance	Score
Hirudinea	1	2	6
Belostomatidae	1	2	10
Acarina	2	3	15
Copepoda	3	4	0
Dytiscidae	2	4	20
Chironomidae	2	3	3
Corixidae	2	2	10
Aeschnidae	1	3	18
Coenagrionidae	1	3	21
Corduliidae	2	4	28
Libellulidae	2	4	32
Poeciliidae	1	3	0
Physidae	1	3	9
Planorbidae	1	3	9

SIGNAL INDEX SUMMARY

		SIGNAL Index
Bonville Creek- Upstream	3 Oct 1997	6.0
Bonville Creek- Downstream	22 Apr 1997	6.3
Bonville Creek- Downstream	3 Oct 1997	5.4
Pine Creek- Upstream	23 Apr 1997	6.3
Pine Creek- Upstream	3 Oct 1997	6.1
Pine Creek- Downstream	22 Apr 1997	5.8
Pine Creek- Downstream	2 Oct 1997	5.6
Reedys Creek- Upstream	2 Oct 1997	5.1
Reedys Creek- Downstream	3 Oct 1997	5.0

APPENDIX 4 – WETLAND ASSESSMENT

BIOSIS

RESEARCH

BONVILLE PROJECT PACIFIC HIGHWAY COFFS HARBOUR - WETLAND EVALUATION

February 1999

Prepared for

PPK Environment & Infrastructure

By

Adam M. King

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CONTENTS

1. Introduction

This study was undertaken in order to address wetland issues associated with the Pacific Highway deviation at Bonville, south of Coffs Harbour. The original proposal for this section of the highway has been the subject of a previous EIS (PPK Environment & Infrastructure 1997) and an SIS (Biosis Research 1997). The modified proposal has taken into account wetland issues raised by submissions and by Bill Rooney (W.S. Rooney & Associates) and is described more fully in the *Bonville Project Species Impact Statement – Supplementary Information Report* (Biosis Research 1999). The purpose of this report is to assess the wetlands present within the study corridor and the potential impacts of the modified proposal on those values identified.

2. Objectives

The investigation was undertaken to achieve the following objectives:

1. To verify the quality and significance of wetland habitat present within the study area;
2. To evaluate the level of impact the modified proposal may have on the wetland resource; and,
3. To investigate and provide recommendations on measures necessary to mitigate potential impacts upon the wetlands.

3. Methods

Wetland issues were identified by a rapid assessment of wetland conservation status and ecological significance. Four wetland areas were located along the modified proposal. These were identified from aerial photography, topographic maps and from information obtained from Bill Rooney (W.S. Rooney & Associates, Newport) who conducted a habitat assessment for fish at the Reedys Creek wetland. Two days of field work were undertaken to investigate each wetland area in some detail. Photographs were taken and site data and supplementary notes were recorded while in the field. This enabled the status and value of each wetland to be evaluated within both catchment and site-specific contexts.

The method used to assess the wetlands along the modified proposal was developed by the Department of Land and Water Conservation to rapidly evaluate extensive areas of wetland habitat in the western regions of NSW (King 1998). The method involves visiting each wetland and recording parameters that relate to basic wetland functions, human impacts and potential for restoration. NSW National Parks & Wildlife Service (NPWS) has endorsed the method for use in the central west region of NSW, although it can be applied in all areas of the State.

Wetlands were assessed with respect to the broad categories of conservation value, morphology and hydrology. More specifically, the following questions were considered at each wetland:

Conservation Value:

1. The potential for the wetland to be restored or rehabilitated at a later date.

- Is there wetland vegetation within the wetland or in adjacent areas?

  If yes = good,

  If no = degraded.

- What is the primary source of water?

  If natural runoff / inundation from river or creek = good,

  If a mix of natural and agricultural = moderate

  If intensive agriculture tailings = degraded.

- Is the wetland presently or potentially used by waterbirds or is the wetland connected morphologically to other wetland areas.

  If close or connected = good

  If some distance away = moderate

  If isolated = degraded

2. The position of the wetland within the landscape.

- Is the wetland situated hydrologically above or below intensive agriculture or urban development?

  If above = good,

  If in same location = moderate,

  If below = degraded.

Morphology:

3. Whether the wetland was formed by natural fluvial processes.

- Is the wetland connected or adjacent to a floodway, catchment or watercourse?

  If yes = good,

  If partially = moderate

  If isolated by development = degraded.

4. Ability of the wetland to hold or carry water

- Is there a visually definable depression?

  If yes = good

  If partially obscured by development = moderate

  If obscured by development = degraded.

5. **The degree to which the wetland area was still contained within naturally formed morphology.**

- Has the wetland perimeter been altered?

  If no = good,

  If perimeter extended = moderate

  If perimeter reduced = degraded

6. **The amount of physical disturbance within the wetland (i.e. destruction of natural levees).**

- Has any construction occurred in the wetland?

  If no = good,

  If destruction less than 50% = moderate,

  If more than 50% = degraded

7. **What is the surrounding landuse**

- What landuses occur in the catchment or immediately adjacent to the wetland?

  If a natural area = good

  If catchment is predominantly grazing = moderate

  If catchment predominantly intensive agriculture or urban = degraded.

Hydrology:

8. **The primary source of waters influencing the wetland.**

- Where does the wetland source its water supply?

  If from natural surfaces (ie National Park) = good
  If from 50% natural and urban / agricultural = moderate
  If from urban or agricultural surfaces = degraded

9. **Water quality flowing to and from the wetland.**

- What is the quality of water in and around the wetland?

  If natural and unpolluted = good
  If pollution intermittent and light = moderate
  If there is high potential and/or pollution observed = degraded.

The assessment of each wetland was based upon an overall evaluation of the above considerations with a strong emphasis on defining natural wetland morphology and vegetation in good condition. An overall condition level of "Degraded", "Moderate" or "Good" was then assigned to each wetland. Wetland features were identified from the air photo mosaic supplied by the RTA, past experience of the author within the region and New South Wales, accompanied by background information and history provided by local landholders. Specific wetland features assessed included wetland morphology, hydrology, land use, vegetation and the presence of threatened species.

Where wetland condition was found to be "good" it was normally due to:

- well-defined wetland morphology;
- the maintenance of a natural source of water;
- the presence of a significant amount of natural wetland vegetation.

Where wetland condition was found to be "degraded", it was commonly:

- subjected to significant grazing pressure;
- surrounded by or contain agricultural landuses;
- subjected to some type of water regulation or intensive agricultural runoff.

4. Wetland Assessment

Each wetland was assessed in the field and classified after Winning (1992). The four wetland environments have been described and issues related to the construction of the modified proposal are summarised below and are shown in Figure 1:

Table 1: Wetland condition.

WETLAND STUDY NO.	WETLAND NAME	WETLAND TYPE	PLAN CHAINAGE	CONDITION
1	Reedys Creek Locality	Floodplain Lagoon	96700	Degraded
2	Reedys Creek (downstream)	Floodplain Lagoons	96700	Good
3	Upstream SEPP 14 No. 344	Floodplain Creek Swamp	97550	Good
4	SEPP 14 No. 344	Estuarine (Brackish) Swamp (western end)	97550	Degraded
5	SEPP 14 No. 335	Estuarine (Brackish) Swamp (western end)	98500	Degraded
6	The Pond	Dam	98500	Good
7	Bongil Bongil Swamp	Estuarine (Brackish) Swamp	100550	Good
8	Bongil Bongil Swamp (Buffer Habitat)	Upland Phreatic Swamp	100300	Good

The method of removing the paperbark trees also requires great care so as not to damage the remaining understory and submerged or floating vegetation. For example, large machinery should not be used to enter the wetland to cut or carry the trees. They will probably have to be cut and removed in sections using a small crane to prevent crushing the remaining vegetation.

Using the existing backwater of the Creek as a sedimentation basin could effectively control sedimentation and reduced water quality during the construction process. A bund wall with spillway could be constructed at the downstream end of the backwater to contain runoff from the earthworks on the northern abutment and approach to the bridge. However, the spillway would need to be above an acceptable flood level to prevent floodwaters from inundating the basin and mixing with its contents. If the sediment control basin were constructed so as to be above a reasonable flood level, and also contained a low flow outlet which could be capped in an emergency, it could function as a stormwater detention pond during operation of the road. It would also provide storage and treatment in the event of a chemical spill.

There is the possibility of several small fish species occurring in the shallow waters of the Reedys Creek wetland and other wetlands (see discussion below). Because a bridge is proposed for this crossing, fish passage will not be restricted during either construction or operation of the road.

3.1.4 Other Wetlands

It appears that the modified proposal will transect buffer vegetation adjacent to the high quality wetlands in Bongil Bongil National Park, between Lyons and Williams Roads. We have not examined the wetlands of Bongil Bongil National Park in sufficient detail to comment on potential impacts of the modified proposal. However, Robyn Tuft & Associates Pty Ltd, in Section 7.1 of their report in Appendix K to the EIS, describe these wetlands to be of excellent quality and note that these wetlands are regarded as significant by NPWS. Their brief description of these wetlands is reproduced here in Sections 5.3.3 and 5.3.4. King (1999) has reported in more detail on the wetlands crossed by the proposed highway deviation.

Such areas of pond and swamp with aquatic vegetation are potential habitat for the endangered Oxleyan pygmy perch (*N. oxleyana*), and also two species of rainbowfishes, the Southern blue-eye, the Olive perchlet, and possibly the Mouth almighty (see discussion below).

3.2 Threatened Species Legislation and Habitat Protection Policy

3.2.1 Recent NSW Fisheries Management Legislation

Legislation that provides for the protection of all threatened fish and marine plants native to NSW waters, was passed by both Houses of the NSW Parliament in December, 1997, and came into effect on 1 July, 1998 (NSW Fisheries, 1998a). This legislation, termed the *Fisheries Management Amendment Act 1997*, inserts Part 7A into the *Fisheries Management Act 1994*. Part 7A provides for the listing of threatened species, populations or ecological communities and the listing of key threatening processes in schedules contained in the *Fisheries Management Act 1994*. Once listed, detailed assessments will need to be made, under the current *Environmental Planning and Assessment Act 1979 (EP&A Act)*, of any likely impacts of proposed development before they can proceed (NSW Fisheries Circular, undated).

The schedules, current as of 1 July, 1998, are summarised in Table 1 (from NSW Fisheries Circular, undated). There are currently no listings for the categories of: endangered populations; endangered ecological communities; or key threatening processes. There are also no endangered aquatic plants listed on the schedules at this time, although mangroves and seagrasses are protected.

Table 1. **THREATENED (i.e. ENDANGERED OR VULNERABLE) FISH SPECIES IN NSW, AS LISTED IN SCHEDULES 4 & 5 OF THE FISHERIES MANAGEMENT ACT, 1994.**

Endangered Species	
Common name	***Species name***
Trout cod	*Maccullochella macquariensis*
Eastern cod	*Maccullochella ikei*
Oxleyan pygmy perch	*Nannoperca oxleyana*
Vulnerable Species	
Honey blue-eye	*Pseudomugil mellis*

The threatened species legislation administered by the NPWS under the *Threatened Species Conservation Act 1995* (TSC Act) and that administered by NSW Fisheries under amendments to the *Fisheries Management Act 1994* (FM Act), notably the addition of Part 7A, are essentially identical in application. NSW Fisheries deals with 'fish' and 'marine vegetation', and NPWS deals with all other flora and fauna (NPWS, 1996).

The TSC Act makes substantial changes to the *Environmental Planning and Assessment Act 1979* (EP&A Act). One major change is the introduction of a set of eight

factors which must be considered for informed decisions to be made regarding the effect of a proposed development or activity on threatened species, populations, or ecological communities, or their habitats. These factors form part of the threatened species assessment process under the EP&A Act, and are collectively referred to as the '8 part test'.

Part 2 (19) of the FM Act 1994 allows for the declaration of "protected species". Including the four endangered species listed above, there are currently 16 species of fish that are totally protected in NSW waters (see Section 3.4). They cannot be captured by any means and require special consideration in planning decisions.

3.2.2 The NSW Wetlands Management Policy

"It is the policy of the NSW Government to:

1. encourage the management of the wetlands of the State so as to halt and, where possible, reverse:
   - the loss of wetland vegetation;
   - declining water quality;
   - declining natural productivity;
   - loss of biological diversity; and
   - declining natural flood mitigation.
2. Encourage projects and activities which will restore the quality of the State's wetlands, such as:
   - Rehabilitating wetlands;
   - Re-establishing areas of buffer vegetation around wetlands; and
   - Ensuring adequate water to restore wetland habitats."

The NSW Wetlands Management Policy (DLAWC, 1996)

The NSW Wetland Management Policy is a whole of government policy. The goal of the NSW Wetland Management Policy is the ecologically sustainable use, management and conservation of wetlands in NSW for the benefit of present and future generations. To achieve this goal the Policy adopts nine principles for the sustainable management of wetlands. In terms of the three creek crossings, the modified proposal appears to meet both the broad intent and specific principles of the Policy.

3.3 Fish Species That May Occur in the Study Area

The two more southern creeks (Pine and Reedys Creeks) are freshwater habitat at the locations of the modified proposal crossings; however Bonville Creek is brackish at the crossing, and marine/estuarine animals and plants occur in this habitat.

The freshwater fish fauna of NSW includes 83 species in 33 families, including 12 alien species (Faragher and Harris, 1994). Of the total known freshwater fish fauna of NSW, 43 native species have been recorded from the coastal region of northern NSW. A

number of these species may occur within this study area, provided it is within the natural distributional range of those species and suitable habitat occurs. Appendix 2 lists all the known freshwater or diadromous fish species which have a possibility of occurring within the freshwater or brackish reaches of the tributaries to the Bonville Creek Estuary. It does not include the more marine fish species likely to be found in the lower, more saline reaches of the estuary and which may occasionally find their way upstream to the vicinity of the proposed road crossing.

3.4 Conservation Status of Fish That May Occur in the Study Area

The conservation status and habitat requirements of the four threatened species listed in the schedules to the FM Act 1994 are discussed in detail in Section 4.1.

Of the north coast records for freshwater fish, five species are included in the threatened species list published by the Australian Society for Fish Biology (ASFB) (Table 2).

Two of the five ASFB threatened species are classified as endangered (the Eastern cod and the Oxleyan pygmy perch), one is potentially threatened (Silver perch), one is restricted (Purple-spotted gudgeon), and the status of one species (the Freshwater catfish) is uncertain. Each of these species is discussed in more detail under the '8 part test' below.

Table 2. **CONSERVATION STATUS OF THREATENED FRESHWATER FISH SPECIES IN COASTAL NORTHERN NSW AS DETERMINED BY THE AUSTRALIAN SOCIETY FOR FISH BIOLOGY (after Faragher and Harris, 1994).**

Conservation status	Species	
	Scientific name	**Common name**
Endangered	*Maccullochella ikei*	Eastern cod
Endangered	*Nannoperca oxleyana*	Oxleyan pygmy perch
Potentially Threatened	*Bidyanus bidyanus*	Silver perch
Restricted	*Mogurnda adspersa*	Purple-spotted gudgeon
Uncertain	*Tandanus sp.*	Freshwater catfish

Two endangered species listed above by the ASFB are declared as endangered by the FM Act 1994 (Table 1): the Eastern cod and Oxleyan pygmy perch. The other two threatened species listed in the FM Act 1994 (Trout cod and Honey blue-eye) probably do not occur in coastal northern NSW.

3.4.1 Species at the Limit of Their Distribution

In addition to the five threatened species listed above from northern coastal NSW freshwaters, five other north coast species from Appendix 2 deserve special mention because they are at or near their known southern limit of distribution in the Bonville Creek catchment: two species of rainbowfishes (Softspined rainbowfish and Duboulay's rainbowfish), the Mouth almighty, the Olive perchlet and the Spangled perch. None of these five species is considered to be rare or threatened, although the rainbowfishes have a fairly restricted distribution in coastal drainages of southern Queensland and northern NSW. Suitable habitat at the limit of distribution of any species assumes greater significance for the conservation of that species.

We have confirmed that at least one of the rainbowfishes (the Softspined rainbowfish) occurs in Pine Creek. We have examined preserved specimens of suspected small rainbowfish collected by Robyn Tuft & Associates Pty Ltd in their sampling for aquatic insects, and can confirm that they are *Rhadinocentrus ornatus* (Softspined rainbowfish). The reported range of the Softspined rainbowfish is coastal areas east of the Great Dividing Range from Coffs Harbour to Byfield in southern Queensland (McDowall, 1996). Therefore, its presence in Pine Creek is at the very southern limit of its known distribution.

The larger Duboulay's rainbowfish (*Melanotaenia duboulayi*) also probably occurs in Pine Creek, because we observed what appeared to be this species during field inspections. However, we were not in a position to collect specimens and cannot confirm its presence at the present time.

The Mouth almighty (*Glossamia aprion*) is not known to occur south of about the Clarence River; it utilises habitat similar to that found in Pine and Reedys Creeks - dense vegetation in streams and ponds (McDowall, 1996). Bonville Creek catchment may well be too far south for this species, but because no one has ever really looked for small freshwater species in this area, it cannot be stated with certainty that it does not occur in the catchment. It is known to spawn in waters of about 22°, which is achieved in these creeks during spring-summer (Robyn Tuft & Associates Pty Ltd, *pers. comm.*).

The Olive perchlet (*Ambassis agassizii*) has not been recorded on the coast south of Lake Hiawatha, near Grafton. It utilises habitat similar to the Oxleyan pygmy perch (see below), but is also found in a much wider range of habitat types. Its distribution, unlike the Oxleyan pygmy perch, extends southwest into the Murray Darling system, and it is relatively common throughout most of its range (McDowall, 1996).

The Spangled perch (*Leiopotherapon unicolor*) is one of the most widespread of Australia's freshwater fishes, but is near its southern coastal limit within the study area (McDowall, 1996). If it occurs in this catchment, it is most likely to utilise the slow flowing pool habitat of upper Bonville Creek and Pine Creek.

3.4.2 Potentially Threatened Species

In addition to the above-declared (FM Act 1994) and listed (ASFB) threatened species, there are several marine and freshwater species that are potentially threatened. These fish have been fully protected in NSW, under the FM Act 1994, by prohibiting their capture by any means. However, it is significant to note that their habitat is not necessarily protected, as is the case for threatened species. The 'totally protected' species in NSW are shown in Table 3 (from NSW Fisheries, 1998b):

Table 3. **PROTECTED FISH IN NEW SOUTH WALES**

Protected Freshwater Fish Species	
Common name	***Species name***
Australian grayling	*Prototroctes maraena*
Macquarie perch	*Macquaria australasica*
Protected Marine or Estuarine Fish Species	
Common name	***Species name***
Ballina angelfish	*Chaetodontoplus ballinae*
Black rock cod	*Epinephelus daemelii*
Eastern blue devil fish	*Paraplesiops bleekeri*
Elegant wrasse	*Anampses elegans*
Estuary cod	*Epinephelus coioides*
Giant Queensland groper	*Epinephelus lanceolatus*
Grey nurse shark	*Carcharias taurus*
Herbsts nurse shark	*Odontaspis ferox*
Great white shark	*Carcharodon carcharias*
Weedy seadragon	*Phyllopteryx taeniolatus*

The two freshwater protected species (Australian grayling and Macquarie perch) can be readily dismissed from further discussion because they do not occur within or near the study area. The Australian grayling is not known to occur north of the Grose River near Sydney, and the Macquarie perch naturally occurs in western-flowing drainages from the Lachlan River southward into Victoria, and in upper reaches of the Hawkesbury and Shoalhaven Rivers.

The truly marine species are also not likely to occur in the upper reaches of the creeks because they are predominantly open ocean or rocky reef inhabitants. The Estuary cod is found on reefs and mainland estuaries, but its normal range is further north in Queensland, and only rare errant individuals are found in NSW waters.

3.4.3 Species Reduced in Numbers in NSW

The following three species of freshwater fish are not currently protected in NSW waters but their populations are considered to be reduced in numbers (NSW Fisheries, 1998b):

Non-parasitic lamprey	*Mordacia praecox*
Silver perch	*Bidyanus bidyanus*
Freshwater catfish	*Tandanus sp.*

The Non-parasitic lamprey does not occur in northern NSW, and has a very restricted range in southern NSW (Moruya and Tuross Rivers) and probably Victoria.

The Silver perch (*Bidyanus bidyanus*) has dramatically declined throughout most of its natural range, which is the Murray-Darling drainage system, but has been translocated to many eastern drainages and is now also subject to intensive fish farming for the restaurant trade (McDowall, 1996; NSW Fisheries, 1998b). Silver perch cannot be captured by either commercial or recreational anglers, other than in the backed-up waters of dams or reservoirs. Although reported to occur in north coast rivers, it was not recorded in the NSW Rivers Survey (Harris and Gehrke, 1997).

Silver perch occurs mainly in fast-flowing waters, especially where there are rapids and races (McDowall, 1996), but is known to also survive well in farm dams. Suitable habitat does not appear to be present on Bonville Creek near the proposed route (salinity too brackish), and Reedys Creek is too shallow, slow flowing and choked with macrophytes; however Pine Creek appears to provide suitable habitat in some of the deeper pools with associated riffles near the Pacific Highway. Anecdotal information from a local angler suggests that it may occur in Pine Creek.

The natural distribution of the Silver perch does not include the eastern drainages of northern NSW. However, it may occur in coastal rivers and streams because of translocations by man. Therefore, it could be argued that the occurrence of this species in the study area is not scientifically desirable because it is outside of its natural range. The real scientific concern is that the species recovers throughout its natural distributional range. Because it is a translocated species on the eastern seaboard, the occurrence of Silver perch in the study area can be discounted in terms of the preservation of suitable habitat or viable populations.

The north coast form of the Freshwater catfish (*Tandanus sp.*) has been given an 'uncertain' status by the ASFB. This is because recent electrophoretic studies of proteins of the north coast populations indicate that the north coast *Tandanus* populations appear to be a different species from the inland *T. tandanus* (Jerry and Woodland, 1997). Furthermore, populations from the Manning to Bellinger Rivers (termed the 'Bellinger' catfish) may be a different species from those northward of the Bellinger River (Jerry and Woodland, 1997).

Pine Creek and upper Bonville Creek (above the existing Pacific Highway) appear to contain suitable habitat for this species, which is likely to occur in this region. It is thought that the Freshwater catfish that may occur within this study area is probably the 'Bellinger' species (K. Bishop, *pers. comm.*). Usual habitat is the bottom of lakes and slow flowing rivers. They build a circular to oval nest from pebbles and gravel (the 'Bellinger' catfish builds a wavy oval nest). Movement of catfish in rivers is generally limited, and most remain in one locality (McDowall, 1996).

The Purple-spotted gudgeon (*Mogurnda adspersa*) is given a 'restricted' distribution status by ASFB. It was recorded from north coast rivers during the NSW Rivers Survey (Harris and Gehrke, 1997), but McDowall (1996) indicates that it only occurs in coastal drainages north of the study area from about the Clarence River northwards. It is also occurs patchily in the inland drainages of NSW. The suggested decline of this species is a result of high densities of Eastern gambusia (*Gambusia holbrooki*). Its natural habitat is slow flowing water among aquatic weeds, where suitable hard substrates are available for spawning. Pine Creek near the Pacific Highway, and possibly Reedys Creek, may satisfy these habitat requirements if it were to occur this far south along the coast. All indications are that it does not occur in this catchment.

3.4.4 Conclusion

Because the species considered above are not listed in relevant Schedules of the FM Act 1994, they are not subject to an 8 part test. Nonetheless, these fish are worthy of special consideration because they are either reduced in numbers or near the limit of their natural distribution. Suitable habitat for most of these species occurs within Bonville, Reedys and Pine Creeks. Since the modified proposal comprises major bridges over each of these creeks, there are unlikely to be significant long-term impacts on fish habitat or fish passage within those three creeks. However, short-term impacts associated with sedimentation and poor water quality resulting from soil erosion or spillages could occur during construction unless mitigation measures described in this and other environmental assessment reports are implemented.

4.0 THE '8 PART TEST'

Having regard to the above information, a rigorous '8 part test' was performed, as required, for the four threatened species declared in NSW under current legislation. However, a less rigorous and less formalised assessment was carried out for the protected species and also those with potentially threatened, restricted, or uncertain status, or are at the limit of their natural range in the study area, but which presently are unprotected. This would appear to be sound environmental management.

As noted by NPWS (1996), the ultimate aim of undertaking an assessment such as the '8 part test', is to improve the standard of consideration and protection afforded to

threatened species (including populations and ecological communities) and their habitats in the planning and assessment process. The consent or determining authority must take into account the '8 part test' in deciding whether there is likely to be a significant effect on threatened species, populations, ecological communities, or their habitats.

If the application of the '8 part test' reveals that a significant effect is likely, then:

- a species impact statement (SIS) must be prepared and the concurrence of the Director of Fisheries, or consultation with the Minister of Fisheries is required; and/or

- the proposal may be modified such that a significant effect on threatened species, populations, or ecological communities, or their habitats is unlikely. This may require the original application to be withdrawn and the modified proposal to be submitted for assessment.

For the 8 part test to have relevance there must be likelihood that one or more threatened species occur in an area which could be impacted by the proposal.

4.1 Likelihood of Occurrence of Threatened Species in The Study Area

The four declared (Schedules 4 & 5, FM Act, 1994) threatened species in NSW are: Trout cod (*Maccullochella macquariensis*), Eastern cod (*Maccullochella ikei*), Oxleyan pygmy perch (*Nannoperca oxleyana*) – endangered; and the Honey blue-eye (*Pseudomugil mellis*) – vulnerable.

4.1.1 Trout cod (*Maccullochella macquariensis*)

The Trout cod (*Maccullochella macquariensis*) is not reported by Faragher and Harris (1994) to occur on the north coast of NSW, but rather is reported to occur naturally in the Murray-Darling River system, and has been translocated to the south coast of NSW. Harris and Gehrke (1997) did not record this species from north coast freshwaters in the NSW Rivers Survey. Furthermore, McDowall (1996) describes the natural distribution of this species to be the southern tributaries of the Murray-Darling system and also to the north in the Macquarie River. He records two sites in the southeast of NSW where Trout cod had been translocated (Lake Sambell near Beechworth, and Cataract Dam near Sydney), but reports that the Lake Sambell population has been lost after a fish kill in the late 1970s. Recent (last 10 years) hatchery-reared fish releases have occurred at sites within the Trout cod's natural range, and there are signs that these populations are becoming self-sustaining (McDowall, 1996).

4.1.2 Eastern cod (*Maccullochella ikei*)

The Eastern cod (*Maccullochella ikei*) was reported by Faragher and Harris (1994) to occur in the northern coastal region of NSW, and was recorded from north coast freshwaters by Harris and Gehrke (1997) in the NSW Rivers Survey. McDowall (1996) reports its present distribution to be limited to the Clarence and Richmond Rivers. Fry of this species, artificially spawned and reared, were successfully stocked into the Richmond and Clarence Rivers, and their headwaters, in 1989, 1997, 1998, and 1999. This stocking over several years has provided a range of size classes which appear to be surviving and may become self-sustaining (S. Rowland, NSW Fisheries, pers. comm.).

The Eastern cod has not been recorded from Bonville Creek or any other waterway within the study area, but the capture of any species of *Maccullochella* is prohibited in eastern drainages north of the Macleay River to the Queensland border because of the Eastern cod's endangered status (McDowall, 1996).

According to McDowall (1996) little is known about its natural history or habitat requirements, but may resemble related species in some aspects. It is a relatively large, deep-bodied fish (typically to 5kg in weight and over 600mm in length) and, therefore, is unlikely to inhabit shallow creeks and swamps as an adult. Type habitat in the Nymboida River is typically clear flowing, with very rocky substratum and instream cover. This type of habitat does not occur within any likely impact zone from the present proposal, although it occurs in the vicinity of the existing Pacific Highway (and possibly further upstream) in Bonville Creek, and also in upper Pine Creek. Other flow regimes and substrate types may form part of its natural habitat. The salinity tolerance of the Eastern cod is not known to us but it is thought to be a strictly freshwater species (Harris, *pers. comm.*).

Available information indicates that the Eastern cod is unlikely to presently inhabit the stream reaches crossed by the modified proposal, and, therefore, is unlikely to be affected by it. But its assumed natural range is reasonably close to the study area, and it is remotely possible that this species could occur in Bonville Creek, since no one has ever looked in a scientific manner, and some suitable habitat for this species may occur near our study area (in upper Bonville and Pine Creeks). Therefore, in the absence of conclusive evidence, the precautionary principle should apply and care should be taken when designing and constructing creek crossings so as not to destroy the existing aquatic habitat. Because all modified proposed creek crossings will be bridged using either driven or encased bored piles, the risk of habitat damage is very minimal. It remains for the actual construction process to be equally sensitive, and the risk of habitat damage will be adequately minimised. The operational phase of the road should not impose any significant impacts on the waterways, provided any road spillages are collected off-stream and are removed or adequately treated before discharge.

4.1.3 Oxleyan pygmy perch (*Nannoperca oxleyana*)

The Oxleyan pygmy perch (*Nannoperca oxleyana*) is reported to occur in the north coast region of NSW by Faragher and Harris (1994), but was not recorded in the NSW Rivers Survey (Harris and Gehrke, 1997). McDowall (1996) describes its distribution as much more restricted than formerly and is now known from only 18 localities: in small coastal and swampy drainages on the mainland of southeast Queensland and on Fraser and Moreton Islands; in the Noosa River; and from North Range Lake in Bundjalung National Park, south of the Richmond River in northern NSW (Arthington, 1996).

N. oxleyana was recorded at only one locality (North Range Lake) out of 33 sites surveyed in the coastal heathland region of northern NSW in 1993 (Arthington, 1996). The southernmost study site in that survey was Wanderer Creek south of Grafton. According to Arthington (1996), Llewellyn (1980) had reported *N. oxleyana* from Lake Hiawatha, near Grafton, but it was not found at that location during the 1993 survey.

The Oxleyan pygmy perch is a small, shy fish found only in streams, swampy areas, and two lakes in coastal wallum (*Banksia*-dominated heathland), usually where there is dense aquatic vegetation. It prefers waters which are still to slow moving, are acidic (pH 5.4-5.7) and have very low conductivity, often darkly stained with humic acids, over substrates of siliceous sand and plant debris (from McDowall, 1996). This fish species was collected in shallow beds of submerged sedge (*Eleocharis sp.*) in North Range Lake (near Grafton) during 1993 (Arthington, 1996).

Although the southern limit of the current known distribution of this species is a reasonable distance (about 90km) to the north of the study area (around Grafton), McDowall (1996) considers the species to be much more geographically restricted than formerly. Its former regional distribution may have included some of the shallow, swampy wetlands within the study corridor, notably Reedys Creek and Bongil Bongil National Park (between Lyons Road and Bonville Creek). The paperbark swamp/wetlands at both these locations are considered to have moderately high environmental value at the present time (see Sections 3.1.3 and 3.1.4; Biosis Research (1999)), even though they have been fragmented and their hydrology altered in the past. Areas of permanent water within these wetlands could be suitable potential habitat for the Oxleyan pygmy perch and the Olive perchlet, if they ever had or could occur in this area.

4.1.4 Honey blue-eye (*Pseudomugil mellis*)

The Honey blue-eye (*Pseudomugil mellis*) is not reported to occur in north coast freshwaters (Faragher and Harris, 1994; McDowall, 1996), nor was it recorded in the NSW Rivers Survey (Harris and Gehrke, 1997). McDowall (1996) describes its natural range as very restricted, found only in wallum country in southeastern Queensland from about Brisbane north to Bundaberg, and also on Fraser Island. NSW Fisheries (1998b)

indicate that it once was found in far northern NSW, but we have no additional confirmation of any records from northern NSW.

From current literature, it seems highly unlikely that this species would occur as far south as this study area. Furthermore, there does not appear to be any specific wallum habitat within or near the proposed route of the highway deviation (although the coastal dune system east of the North Coast Railway Line was not examined).

4.2 Consideration of the Eight Factors

The eight factors to be considered are listed below in italics, followed by our assessment for each of the considered species in normal typeface. It should be noted that, even though the following species have not been recorded in the study area, this might be due to inadequate survey. The following assessment is based on the likelihood of a species occurring in wetlands within the study area, the presence of suitable habitat, and the potential impacts of the modified proposal in association with mitigation measures.

(a) In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

From Section 4.1 it can be seen that the Trout cod is highly unlikely to occur in the Bonville Creek catchment. The Eastern cod is unlikely to occur, and suitable habitat is not likely to be affected. The Honey blue-eye and the Oxleyan pygmy perch are unlikely to occur, but suitable habitat may occur in the freshwater swamp habitat within the catchment.

Trout cod (*Maccullochella macquariensis*)

The existing information on the distribution of the Trout cod indicates that it does not occur, either naturally or translocated, in or near this study area. Therefore, because there are no viable local populations of the species, the lifecycle of this threatened species will not be disrupted by any activity associated with the modified proposal.

Eastern cod (*Maccullochella ikei*)

Because this species probably does not occur in the study area, it is unlikely to be disrupted by any activity associated with the modified proposal.

Oxleyan pygmy perch (*Nannoperca oxleyana*)

Provided the method of construction (bridging) is sensitively implemented over the three creeks that are the subject of this report, there should be no significant risk to lifecycle components of this species such that any unforeseen population is at risk of extinction.

Despite the occurrence of other potentially suitable habitat upstream of SEPP-14 wetland No. 335 (refer to King, 1999), all available information suggests that this endangered species does not presently occur in the study area, nor is there any conclusive evidence that it ever occurred this far south.

Honey blue-eye (*Pseudomugil mellis*)

Because this species is very unlikely to occur, or to have the potential to occur within the study area, it is concluded that the lifecycle of this species is unlikely to be disrupted by the proposed activity.

(b) In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

There are no endangered populations listed on Schedules 4-5 of the amended Fisheries Management Act 1994. Furthermore, since it is unlikely that any of the declared threatened species would occur in the study area, there would probably be no unforeseen endangered populations of those species whose viability would be significantly compromised.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The Trout cod does not occur, either naturally or translocated, in or near the study area.

Available information indicates that the Eastern cod is unlikely to presently inhabit the stream reaches crossed by the modified proposal. Some potentially suitable habitat occurs upstream and outside of the potential impact zones of the creek crossings. However, there is no area of *known habitat* likely to be modified or removed by the proposed activity.

Available information also indicates that the Oxleyan pygmy perch and Honey blue-eye are unlikely to presently inhabit the stream/wetland habitats crossed by the proposed highway deviation. However, some potentially suitable habitat does occur along the route of the modified proposal (Reedys Creek and 'The Pond' upstream of SEPP-14 No. 335); a small proportion of that habitat at The Pond may be lost or modified (refer to wetland report by King, 1999). Due to the lack of fish survey work in the study area, the regional distribution of the habitat for these species is unknown. In any case, the amount of potentially suitable habitat that would be affected is not regarded as significant. At the present time none of this habitat is *known habitat* for these species, so it does not meet the criteria of this factor.

There are currently no threatened populations or ecological communities on the schedules of the Fisheries Management Act 1994.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

Because none of the threatened species have been recorded from the study area, there is no *known habitat* likely to become isolated from currently interconnecting or proximate areas. Where bridges are used to cross creeks and/or wetland, no long-term isolation or fragmentation will occur. Refer to the report by King (1999) for an assessment of impacts of road construction at 'The Pond' upstream of SEPP-14 wetland No. 335.

There are currently no threatened populations or ecological communities on the schedules of the Fisheries Management Act 1994.

(e) Whether critical habitat will be affected.

There is currently no 'critical habitat' listed in the Schedules of the amended Fisheries Management Act 1994 for any endangered species within the study area. Critical habitat is defined as the whole or any part or parts of land (or water) that is critical to the survival of a threatened species, population or ecological community (NPWS, 1996).

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

It is not known whether any threatened species is adequately represented in conservation reserves, but at least some of their habitat is protected. The only recent record of the Oxleyan pygmy perch is in Bundjalung National Park near Grafton; and Bongil Bongil National Park would contain many good quality swamp habitats potentially suitable for the Oxleyan pygmy perch and the Honey blue-eye, if they could occur this far south.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

There are no key threatening processes listed on the schedules of the FM Act 1994, as amended by the Fisheries Management Amendment Act 1997. Road construction can be a threatening process to aquatic systems and habitats if not carried out in a sensitive manner and using best practice techniques to manage environmental risks. However, the RTA prepares a detailed environmental management plan for all of its projects. This plan takes into account the mitigation approved in the determination of the EIS, and so should largely eliminate the risk of a road project becoming a threatening process.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

If any threatened species were to occur in this study area, they would be at their limit of known distribution. Given existing information, the study area is outside the known distribution of all of the declared threatened species (and several unthreatened species - see below). It is within 100 km of the nearest known occurrence for the Eastern cod and the Oxleyan pygmy perch. The Honey blue-eye is not presently known in NSW, but utilises similar habitat to the Oxleyan pygmy perch. Potential habitat for the Oxleyan pygmy perch, the Honey blue-eye, and the Eastern cod occurs within the study area. It is recommended that these species be targeted in any future surveys.

Conclusion

There is a lack of detailed and accurate information on the freshwater fish fauna within the study area, and suitable habitat does occur for up to three threatened species within the study area (although not likely to be significantly affected by the modified proposal). Therefore, until proper quantitative or even qualitative sampling is carried out, it cannot be confirmed that no threatened species occur.

In conclusion, consideration of the eight factors does not reveal that a significant impact is likely on the four declared threatened species in NSW, and therefore an SIS is not required. Bridges are proposed for all aquatic habitats that are the subject of this report, so long-term impacts on fish passage, isolation or habitat loss will be avoided.

4.3 Consideration of Other Potentially Threatened Species

There are five other fish species which are potentially threatened and which deserve consideration and protection under the broad aim of the threatened species legislation. These species were included in Tables 1 and 3 above and are:

Silver perch (*Bidyanus bidyanus*)
Purple-spotted gudgeon (*Mogurnda adspersa*)
Freshwater catfish (*Tandanus sp.*)
Australian grayling (*Prototroctes maraena*)
Macquarie perch (*Macquaria australasica*)

In addition to potentially threatened species, there are a further five species which are not threatened but at or near their southern limit of natural distribution within the study area. The maintenance of suitable habitat for these species is of particular concern for their continued survival near their biogeographic limit:

Duboulay's rainbowfish (*Melanotaenia duboulayi*)
Softspined rainbowfish (*Rhadinocentrus ornatus*)
Mouth almighty (*Glossamia aprion*)
Olive perchlet (*Ambassis agassizii*)
Spangled perch (*Leiopotherapon unicolor*)

The Silver perch, Australian grayling, and Macquarie perch are not discussed further because they do not naturally occur in the north coast region.

The potential habitat of the Purple-spotted gudgeon in Pine Creek should not be damaged provided care is taken in the bridging of Pine Creek.

The 'Bellinger' form of the Freshwater catfish (*Tandanus sp.*) may well occur in Bonville and Pine Creeks. Its habitat is not likely to be damaged by the proposed activity since both habitats will be bridged.

The five unthreatened species that would be at or near their southern limit of distribution, if they occur in this drainage system, are considered to have good habitat available in one or other of the three creeks under study.

The two rainbowfishes would utilise the vegetation-choked dark-stained pools of Reedys Creek swamps and the slow flowing pools of Pine Creek. They prefer vegetation in which to lay their eggs (McDowall, 1996).

If present, the Mouth almighty would utilise the dense vegetation in the Reedys Creek swamps near the study area, or possibly the upstream reaches of Pine Creek.

If present, the Olive perchlet would utilise much the same habitat as the Oxleyan pygmy perch, the Honey blue-eye and the Southern blue-eye; potential habitat is found in the vegetation choked swamps such as Reedys Creek and Bongil Bongil National Park.

The Spangled perch, one of the most widespread of our native freshwater fishes, is near its southeast coastal limit within the study area. If it occurs in this catchment, it is most likely to utilise the slow flowing pool habitat of upper Bonville Creek and Pine Creek.

In summary, there are seven potentially threatened or range-limited species that could utilise aquatic habitats found within or near the proposed route alignment:

1. Purple-spotted gudgeon (*Mogurnda adspersa*)
2. Freshwater catfish (*Tandanus sp.*)
3. Duboulay's rainbowfish (*Melanotaenia duboulayi*)
4. Softspined rainbowfish (*Rhadinocentrus ornatus*)
5. Mouth almighty (*Glossamia aprion*)
6. Olive perchlet (*Ambassis agassizii*)
7. Spangled perch (*Leiopotherapon unicolor*)

These species are not declared or listed in schedules under any legislation at the present time, and therefore, do not attract any special protection status under law. However, their occurrence in the study area has scientific and ecological value. There has been no investigation to determine whether any of these species occur in the catchment. Current proposed construction methods indicate that aquatic habitats in Bonville, Reedys and Pine Creeks will not be significantly impacted.

5.0 AQUATIC MACROINVERTEBRATES

5.1 Introduction

The following discussion and data are from the work by Robyn Tuft & Associates Pty Ltd, whose report is provided as Appendix K in the EIS. It has been included here so that all available aquatic ecological information is available in one report. Wording has been modified or added only for clarity because the text has been extracted from a broader document and would have been difficult to understand in its extracted form without the modifications/additions.

5.2 Methods

Ecological indicators of water quality measure the biological state of a water body. Water quality indicators include measures of types and abundance of algae, aquatic plants and aquatic fauna. The purpose of monitoring biological characteristics is firstly to have a direct measure of ecological impact and secondly to provide an indicator which can integrate water quality over a period of time to determine impacts which may not be detected by "snapshot" chemical sampling.

Aquatic fauna includes vertebrates such as fish, amphibians and reptiles as well as invertebrates. Although vertebrate fauna were recorded when observed, these organisms were not specifically targeted as they form part of the faunal assessment (see Flora and Fauna section). The water quality survey specifically collected macroinvertebrates, which are indicative of water quality. These include insect larvae, beetles, snails, worms, shrimps, mites and spiders.

Macroinvertebrates were collected from sites upstream and downstream of the existing Pacific Highway on the three creeks (total of six sites). Bonville Creek was sampled once upstream of the existing highway (3 Oct. 1997) and twice downstream (22 Apr. and 3 Oct. 1997); Pine Creek was sampled twice (22 Apr. and 3 Oct. 1997) at both upstream and downstream locations. Reedys Creek was sampled once (2-3 Oct. 1997) at both upstream and downstream locations. Refer to Figure 1 for the location of their sampling sites. Note corrections to sample locations on Bonville

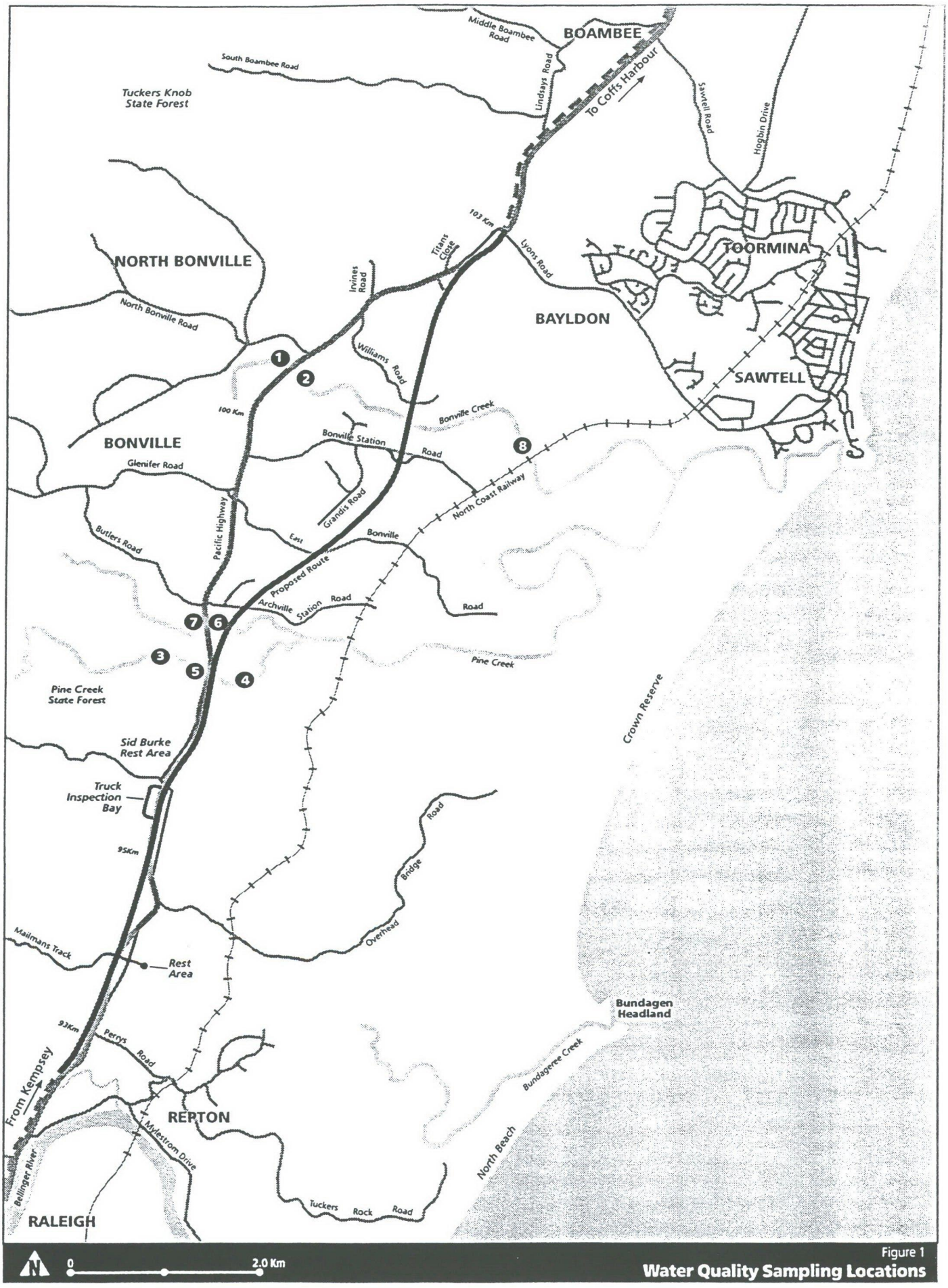

Figure 1
Water Quality Sampling Locations

58H300A/FIG 1

Creek, which were in error as shown in Figure 6.5 (Section 6.5 of Vol. 1) and Appendix K of the EIS.

At each site in-situ measurements were taken of water temperature, pH, dissolved oxygen and conductivity. Water samples for laboratory analysis of a range of parameters (see Appendix K of EIS) were collected 50 centimetres below the surface in specially prepared bottles, kept cool and transported to a NATA registered laboratory within 24 hours.

At each site aquatic plants were identified and distributions mapped. Periphyton and benthic algae coverage were recorded.

For macroinvertebrates, sweep samples using a 0.3 millimetre mesh net were collected from pool habitats over a 15-minute period. Samples were then sorted in the field and abundance of each family recorded on a four-point scale:

1 Rare (1 to 3 individuals)
2 Present (4 to 10 individuals)
3 Common (11 to 50 individuals)
4 Very Common (greater than 50 individuals)

A small number of each type were placed in ethanol for subsequent identification to family level classification using a dissecting microscope. The number of discrete taxa ("species") was also scored for each family.

Macroinvertebrate data was entered into a database that calculated the total number of taxa and a water quality index (SIGNAL index). The SIGNAL index (Chessman 1995) is a measure of water quality using the factors of indicator animals and abundance. It has been developed for Australian waters. Animals are identified to family level classification, with each family assigned a grade between 1 and 10 depending on the tolerance to common pollutants (higher values represent lower levels of tolerance). Each species is then assessed for abundance on a 4-point scale. Scores for each type are calculated from the product of grade and abundance. The Index is derived from the sum of scores divided by the sum of abundances. This provides a comprehensive ecological indicator that takes into account the number and abundance of pollutant sensitive animals.

SIGNAL indices are classified into 4 levels:

- less than 4 = probable severe pollution
- 4-5 = probable moderate pollution
- 5-6 = doubtful quality, possible mild pollution
- greater than 6 = clean water

Aquatic plants were identified to genus. This data, together with relative abundance and percentage cover at the sampling site were entered into a database. The data was then analysed for dominant types as well as for the presence or absence of specific indicator groups or genera. Descriptions and sampling schedules of macroinvertebrates, and SIGNAL scores are found in Appendix 3.

5.3 Results

5.3.1 Bonville Creek

Aquatic fauna at all sites in Bonville Creek consisted of an assemblage of freshwater and estuarine organisms. Crabs, shrimp, polychaetes (beachworms) and other small crustacea were the most abundant macroinvertebrates. The presence of shrimp, a sensitive organism suggests pollution levels are low. Native fish including Gudgeon, Flathead and Mullet were observed, as well as a Penny Turtle. Refer to Appendix 3 for a list of animals collected.

5.3.2 Pine Creek

Pine Creek supported a diverse assemblage of aquatic fauna including pollution sensitive macroinvertebrates such as shrimp and certain mayflies and caddis flies. Macroinvertebrate indices for water quality (SIGNAL scores) were calculated for the creek, and scores indicate very good water quality, with site 3 recording a slightly better value (refer to Appendix 3). Gudgeon, a native fish was observed in considerable numbers and the introduced mosquito fish, *Gambusia,* was also present. Frogs and tadpoles were apparent in the tributary.

5.3.3 Reedys Creek

Aquatic animals in Reedys Creek consisted of a variety of macroinvertebrates with some fish and frogs. The fish comprised of gudgeons, a native and numerous introduced mosquito fish (*Gambusia*), particularly at site 7. Pollution sensitive organisms were apparent at this upstream site, although present in low abundances and the majority of macroinvertebrates were more robust types such as Lesser Water Boatmen (Corixidae) and Beetles (Dytiscidae). Site 7 had a greater diversity of organisms with 22 different taxa recorded that included higher numbers of Corduliidae and Libellulidae, two genera of fairly sensitive dragonflies. SIGNAL scores were depressed indicating probable mild pollution (refer to Appendix 3).

5.3.4 Northern Tributary to Bonville Creek

This ephemeral tributary meanders through 5 kilometres of pasture, orchards and wetland before joining the main creek approximately 200 metres downstream of the North Coast Railway line. In the areas adjacent to the Pacific Highway, the stream is quite shallow, only 30 centimetres in average depth and there is no definite channel. Rather the creek trickles through thick beds of aquatic plants, particularly *Nymphaea sp.* (Waterlily) and *Scirpus sp.* (Clubrush). Numerous small fish belonging to the native Gudgeon family were recorded.

Extensive growth of green filamentous algae, with some brown flocculent organisms (probably diatoms) covered all instream plants and substrates. Despite this abundance of algae, dissolved oxygen levels were below the ANZECC (1992) guideline for the Protection of Aquatic Ecosystems. The presence of decaying organic matter such as plant material may have exerted a demand for oxygen. The water was acidic with low levels of dissolved salts and turbidity. A small patch of iron floc from iron and sulphur bacteria was observed on the right bank upstream of the Highway. Stream sediments were mainly sands and muds near the Highway, however thin patches, approximately 0.5 centimetres in depth, of white clay were observed approximately 200 metres downstream. These small patches extended over a distance of at least one kilometre and when disturbed caused the water column to turn a milky hue colour in the immediate area. The clays took at least several hours to settle.

5.3.5 Wetlands in Bongil Bongil National Park

The area to the north and east of the Bonville Creek northern tributary contains large area of wetlands, surrounded by regrowth tall forest. These were created in the late 1960s to early 1970s as a result of drainage changes and earthworks from forestry activities (pers. com. Smith, 1998). These wetlands supported extensive macrophyte beds of predominately Juncus sp. (rushes) and *Nymphaea sp.* (Waterlily). Algal growth was not evident, perhaps as macrophytes shaded the water. Dissolved oxygen levels were below the ANZECC (1992) guideline for the Protection of Aquatic Ecosystems, probably due to decomposing vegetative material. Nevertheless, Damselflies and fish were abundant and at least two species of frogs were heard. The concentration of dissolved salts was low at 99 microsiemens per centimetre, as was the turbidity. The pH was acidic, possibly due to the release of breakdown products from leaf litter.

LEGEND

Wetland Area

Proposed Road

6 Wetland Number

FIGURE 1

SEPP 14
Map 23
Current as of Amendment 2
26.6.87.

Map in force
as at 20 November 1998

4.1 Reedys Creek (Wetlands 1 and 2)

The wetlands potentially affected by the modified proposal at Reedys Creek are:

- Wetland No.1 (Plate 1) at the crossing site;
- Wetland No. 2 (Plate 2), 50 metres downstream and;
- Wetland No. 4 (SEPP 14 No. 344) two kilometers further down Pine Creek (Plate 3).

At the Reedys Creek crossing, there is the potential for Wetland No. 1 to be directly impacted by the modified proposal. It is degraded but still functional. This wetland is the result of an accluded prior stream channel, which often forms a semicircular shape. This wetland type is often found to be in good condition as its morphology enables it to retain water for longer periods of time. It is also less suitable for agricultural development as its ability to hold water can encourage its use as small farm water storages. Consequently, most billabongs retain a reasonable amount of perennial wetland vegetation.

Wetland No. 1 has been cleared of most of its bank vegetation (Plate 1). It was considered however to have been a part of Wetland No. 2 immediately downstream along the Reedys Creek channel (Plate 2). Past removal of vegetation has resulted in partial isolation of Wetland No.1, though it is in close proximity to perennial wetland vegetation associated with Wetland No. 2. Its past connectivity is indicated by the presence of a similar but degraded patch of Paperbark trees to the west.

The most outstanding feature of Wetland No. 1 is the amount of instream vegetation still present (Plate 1). Although partially degraded by the removal of bank vegetation and access by livestock in past years, the billabong provides a filtration value during low to medium flows. Its ability to slow the velocity of water through its meander and to catch suspended sediments within the aquatic plants growing in its substrate, is regarded as having some protective value for the remainder of Reedys Creek system and ultimately for SEPP 14 Wetland No. 344 located two kilometers downstream on Pine Creek. The oxbow does not contribute significantly to the protection of Wetland No. 2 because of its small size and degraded condition.

4.2 Upstream of SEPP 14 No. 344 (Wetland No. 3)

The modified proposal is likely to cross an unnamed tributary that supplies flow to SEPP 14 Wetland No. 344 two hundred metres (to the legal boundary) downstream. The crossing locality is not an extensive wetland but rather a narrow strip of riparian vegetation (Plate 4). Wetland No. 3, located approximately thirty metres upstream, is linear in shape and comprises a pooled reach or small basin contained within the creek channel. This wetland is maintained by local rainfall runoff between flood events. In some cases, this type of wetland is a surface expression of the water table.

4.3 SEPP 14 Wetland No. 344 (Wetland No. 4)

Approximately seventy metres downstream of the modified proposal crossing locality is the western extremity (the legal boundary) of SEPP 14 Wetland No. 344. This is a non-tidal basin, formed on estuarine sediments adjacent to tidal creeks or flats, in this case Pine Creek. Wetlands of this type are inundated by overbank flooding which may in part be from high tides. Wetland 344 has been divided into two parts by a railway levee further to the east (Plate 5). The rail levee is considered to have changed the water regime to an over-inundated state on its upstream side caused by the ponding effect of the railway levee. Consequently, the western section of the wetland is primarily a freshwater system drawing most of its water supply from groundwater seepage and runoff from the surrounding topography. The balance and mix of flora seems to be changing as a result.

4.4 SEPP 14 Wetland No. 335 (Wetland No. 5)

Wetland No. 335 is the same type as Wetland No. 344. The existing rail levee is considered to have changed the water regime to an over-inundated system (the extent of which is yet to be confirmed). Consequently, the western section of the wetland is primarily a freshwater system probably drawing most of its water supply from groundwater seepage and runoff from the surrounding topography.

4.5 The Pond (Wetland No. 6)

The modified proposal would transect this wetland which has potential to affect the ecological values of a locally modified wetland system located at the western extremity of SEPP 14 Wetland No. 335. At this location, the natural morphology has been levied for some years, creating a well-established wetland ecosystem (Plate 6). Native wetland flora species have adapted to the ponded water regime and have created a natural system suitable for native fauna. This wetland is considered essential to the protection of Wetland No. 335 from catchment pollutants (Plate 7).

4.4 Bongil Bongil Swamp (Wetlands Nos. 7 & 8)

Bongil Bongil Swamp (Plate 8) is the same wetland type as SEPP 14 Wetlands 335 and 344. Bongil Bongil Swamp is considered to be a non-tidal basin, formed on estuarine sediments adjacent to tidal creeks or flats, in this case Bonville Creek. It is understood that this wetland has been sand-mined in the past but has in fact restored itself to a level that has made it significant enough to be included as part of a National Park. The upstream extremity of the wetland forms a primarily freshwater system drawing most of its water supply from groundwater seepage and runoff from the surrounding topography. The presence of levees for vehicle tracks is considered to have contributed to the freshwater characteristic of the system, as the levees (although low) are probably capable of preventing small flood flows from Bonville Creek and retaining freshwater flowing from the west. This however would need to be confirmed. Certainly at the time of the field visit there was a constant flow of freshwater from the creeks entering the wetland on the western perimeter.

The area considered to be potentially most affected by the modified proposal is the southwestern to northern sectors of the swamp in the vicinity of grid square 5052mE 6640mN (between chainage 100550 to 100300) about twenty metres from the road proposal. The wetland in the southwest section (Wetland No. 8) is fringed with a moist transitional forest and what is considered to be an "Upland Phreatic Swamp" area (Plates 9 & 10 respectively). Both habitats contain *Gahnia sieberana* and *Restio tetraphyllus*, both of which favour prolonged marshy conditions. Where the Phreatic Swamp occurs, there is a distinct change in vegetation characterised by an absence of trees which indicates that the soil is at field capacity for prolonged periods of time. This indicates that it is very likely that the area is fed by a reliable source of groundwater seepage for most of the year.

Data from bore hole reports and discussions with Brett Hawkins (Principal Geotechnical Engineer, PPK Environment & Infrastructure) indicate that the source is not local. Bore hole data revealed that there was no free-flowing groundwater and that very stiff, dense silt clays occurred down to RL 0.42 meters (BH 27, PPK 1997). This result is not consistent with subsurface geology that normally produces groundwater flows. The source of groundwater for Wetland No. 8 is expected to be the same as that supporting the greater part of Bongil Bongil Swamp, even though the Phreatic Swamp was found to be uphill of the natural drainage line (at approximately RL 1 to 2 meters). The surface flow produced by the Phreatic Swamp area (Wetland No. 8) enters the southern arm of Bongil Bongil Swamp via the watercourse, which is viewed as essential to maintaining that part of the swamp during dry times.

It is considered that Wetland No. 8 in the vicinity of the natural drainage line is the primary water source for the southern end of the Bongil Bongil Swamp. This is in addition to two eastern flowing creeks that the wetland would rely upon for such water during dry periods.

5. Wetland Function

This section summarises the role of the wetlands in the proposal area. It is within this context that the Bonville wetlands should be viewed. It is important to review the significance and function of natural wetlands before construction commences, in order to predict impacts and recommend appropriate mitigations that include restoration and compensatory habitat.

In general, while long thought of as places to be avoided and destroyed, more recently, wetlands are looked upon as providing many useful services. Several of these are of direct benefit to people both ecologically and economically. This reasoning underpins the NSW State Wetland Management Policy (DLWC 1996). Wetlands benefit the environment by improving water quality, providing habitat for wildlife, mitigating floods and contributing to overall biodiversity and ecological health. A detailed discussion on the topic is found in Brady and Riding (1996).

5.1 Wetland Values

5.1.1 Water Quality Improvement

Wetlands assist in the maintenance and improvement of water quality by removing nutrients and sediment, synthesising chemicals and recycling organic matter. Wetlands thus provide an important filtering component to the landscape. They are however very susceptible to pollutants, and many deteriorate quickly when subject to large and prolonged volumes of polluted water. Wetlands are often referred to as the "kidneys" of a catchment, since they are often located in positions where they intercept and filter runoff from the land surface or from rivers and creeks upstream. If the cumulative health and distribution of wetlands within a catchment are degraded then it is likely that water quality problems further downstream in rivers and other water bodies will increase.

5.1.2 Aquatic Productivity

Wetlands are often identified as being amongst the most productive ecosystems on earth. Many nutrients found in wetlands represent the base of food chains, many of which not only start and finish within the wetland itself, but extend beyond the natural wetland system. The periodic "explosion" of productivity in ephemeral wetlands is perhaps the most notable example of this, where a seemingly unproductive area can fill with water and play host to many types of flora and fauna. The Bonville wetlands are a fairly permanent wetland type (i.e. a less fluctuating water level) but can exhibit a wetting and drying cycle on a seasonal basis. Any cycle exhibited would be more dependent upon seasonal weather conditions than on flooding events. During the drying periods, accumulated organic matter is exposed to the air leading to decomposition and mineralisation of organic matter and nutrients. These nutrients are released to the water when re-inundated thereby "kick starting" ecological processes.

5.1.3 Wildlife Values

Wetlands provide habitat for numerous plants, invertebrates, amphibians, mammals, reptiles, fish and waterbirds. It is perhaps these values for which wetlands are best known, especially in relation to waterbirds and fish.

The wetlands affected by the Bonville Project hold such values, especially as they are connected to estuarine systems that provide habitat for juvenile fish species assumed to be so critical for the local fishing industry. The overall values of the aforementioned wetlands all contribute to the status and health of their associated catchments, including habitats in downstream estuarine wetland systems.

6. Summary of Wetland Issues

This section summarises the issues associated with each of the wetlands assessed. The assessment of the modified proposal should be considered in relation to these.

6.1 Reedys Creek (Wetlands Nos. 1&2)

The main issues at Reedys Creek are the depth and management of Acid Sulfate Soils (ASS) during and after construction of the proposed road, which could impact native vegetation, fish, aquatic invertebrates and amphibian species.

Disturbance of ASS could result in generating acidic runoff into wetlands which could lead to:

- The exclusion of native fauna species from Wetland No. 2.
- The alteration of fish and amphibian habitat at the bridge locality.
- The exclusion and loss of vegetation at the bridge locality resulting in a cumulative loss of wetland habitat on a catchment scale.

6.2 Upstream of SEPP 14 No. 344 (Wetland No. 3)

The main issues at this location are:

- The maintenance of water quality;
- ASS management and;
- Maintaining the status of SEPP 14 Wetland No. 344.

Construction of the modified proposal should prevent any digression in the quality of the water flowing into the SEPP 14 wetland. Mitigative measures should include permanent and effective water quality measures to prevent impact to the core of Wetland No. 344. The prolonged effect of road runoff and siltation is likely to result in further pressure on an already degraded wetland system.

6.3 The Pond (Wetland No. 6)

The wetland function provides for and contributes to the protection of the SEPP 14 Wetland No. 335. This protective function should be maintained. In its present form, the Pond wetland is considered to be an effective buffer habitat for Wetland No. 335. Managing the pond during and after construction will need to be carefully planned to prevent natural wetland process from deteriorating.

6.4 Bongil Bongil Swamp (Wetlands Nos. 7&8)

The primary issues associated with Bongil Bongil Swamp are:

- The maintenance of the supply and quality of groundwater flow to the southern arm of the wetland. This is dependant upon the conservation of the fringing moist transitional forest and Phreatic Swamp (Wetland No. 8) on the southern perimeter.

- The maintenance of the natural hydrologies of two creeks flowing into Bongil Bongil Swamp at Grid Reference 505250mE 66404750mN (chainage 100550) to the west and at Grid Reference 505550mE 6641200mN (chainage 101300) to the northwest.

- The protection of the wetland from mechanical disturbance during road construction.

7. Impact Assessment

Most wetland issues at Bonville relate to the maintenance of the ecological sustainability of wetlands downstream of modified proposal crossing points and to the effective management of ASS and water quality. Therefore mitigation needs to be aimed at maintaining the natural hydrology (i.e. sources and flow of water) and the quality of water flowing into wetlands. This section aims to:

- Assess the potential impacts of the modified proposal on wetlands within the study area;
- Recommend additional mitigation to ensure that further wetland decline is prevented.

The final section of the report discusses the need compensatory habitat.

7.1 Wetland Nos. 1&2

The sixty-metre bridge at the Reedys Creek crossing is expected to have only limited impacts at the crossing locality and an insignificant impact on downstream wetland habitats. Impacts are considered below with respect to habitat, wetland function and water quality management.

Wetland Habitat

The vegetation at the crossing locality would be limited to the removal of the Paperbark trees at the bridges' immediate location. Habitat loss is not expected to be significant because the area is small (i.e. 0.1 ha), it is physically isolated from the core of Wetland No. 2 and it provides only limited habitat for wetland fauna.

Vegetation removal should not include tree roots, which are needed to stabilise creek sediments until other aquatic plants colonise the site. The preferred extraction method would be for trees to be cut off at the stump and lifted out by a crane.

Wetland Function

The construction of the northern approach to the bridge will involve the use of compacted fill that will envelop most of the degraded oxbow lagoon at the site. The lagoon exhibits limited value as wetland habitat and does not contribute significantly to the overall health of Wetland No. 2, the SEPP 14 wetland downstream or to the catchment as a whole.

It is important however that the hydrology of this locality is preserved. In the first instance, the modified proposal has ensured the hydrologic functions of the locality are maintained through the planned construction of a sixty-metre bridge and the placement of a permeable rock layer underneath the northern part of the carriageway contained within the oxbow lagoon. This is expected to maintain the current surface and subsurface water flows through the site to wetlands downstream.

Acid Sulfate Soils (ASS) and Water Quality Management

The central piers for the bridge will be constructed a few metres north of the instream centre of the creek using driven piles. The use of driven piles will eliminate ASS exposure to the atmosphere, thus preventing the acidification process.

The construction of the bridge abutments however, will require the excavation of a small amount of material on each side of the Reedys Creek crossing. The use of metal sleeves in this situation is expected to manage the ASS threat effectively enough so as not to threaten wetland habitat significantly. ASS contamination is expected to be low if:

- The central piers are driven;
- Metal sleeves are used to encase the construction of the abutments; and
- The ASS strategy outlined in the EIS (see Appendix H) is used at the site.

In addition, water quality mitigation techniques should include the post-construction management of "first flush" road pollutants and the containment of potentially large volume chemical spills caused by road accidents. The most appropriate method for the management of such threats to water quality at Reedys Creek is to locate a treatment facility (sedimentation basin or oil and sediment separator) as far as away as possible from the creek's riparian zone. This measure would limit the potential for raw pollutants to reach Reedys Creek and enable the discharge of tertiary-treated road runoff flow from the sedimentation ponds into the creek itself.

The current modified proposal includes a possible sedimentation basin located in the natural morphology of the oxbow lagoon at the bridge site. It is not considered best practice to situate such structures so close to a riparian zone that is still connected to the natural hydrology of the creek line and wetland systems downstream.

If the decision were taken to construct the basin in the oxbow lagoon the design would need to ensure that:

1. The sedimentation basin was constructed using appropriate constructed wetland technology that would enable it to capture and treat the first 12 mm of runoff from its catchment.

2. The sedimentation basin design could contain (i.e. prevent from entering Reedys Creek) the volume of pollutant expected from a large tanker spill within its catchment.

3. The sedimentation basin was prevented from becoming stagnant during dry periods by ensuring that the catchment could produce a sufficient appropriate amount of base water flow to maintain a viable wetland ecosystem.

4. The contents of the sedimentation basin are protected from at least a one in two year magnitude flood and that pollutants are isolated from subsurface hydrology to prevent seepage downstream.

5. The sedimentation basin is maintained on a regular basis to prevent toxic levels of pollutants from building up and to enable the continuing functionality of the basin's ecosystem.

7.2 Wetland No. 3

The modified proposal would not have a significant impact on this wetland because it would maintain the existing wildlife corridor and wetland functionality. The wildlife corridor underneath the modified proposal is considered adequate for the passage of water and aquatic species. The southern approach of the road would be underlined with a permeable base in order to maintain water flow.

Mitigation measures incorporated into the proposal are considered sufficient to protect the downstream water supply and wetland habitat present at the western end of Wetland Nos. 344 and 3. The area of riparian habitat affected by the modified proposal is considered to be small and localised, as the riparian zone at the proposed creek crossing is narrow.

7.3 Wetland No. 6

The modified proposal transects this wetland. In order to preserve its buffering function for Wetland No. 335, the even flow of water in the Pond must be ensured in order to prevent the stagnation of either half. The modified proposal allows for the passage of surface and subsurface water after construction.

To mitigate the stagnation threat, the modified proposal incorporates four sets of pipes and a permeable rock layer underneath the proposed road crossing. Two sets of pipes would be located on the northern and southern edges of the Pond and two

would be evenly spaced in the middle. This measure would ensure the flow of water and the passage of aquatic species between each half of the wetland. During construction, the Pond's ecosystem should be preserved as far as practicable by isolating the construction site with Geotextile fabric to prevent the contamination of the remaining area of habitat. This would entail running the Geotextile fabric out by hand and pushing the foundation rock on top. The edges of the Geotextile would be turned up at the edges to isolate the work area. Afterwards, the completed culvert construction could be integrated with the two halves of the Pond and brought back on line to protect Wetland No. 335 post-construction. Noise screens and trash traps could also be used to prevent foreign matter from being washed or blown into the wetland from the new road.

7.4 Wetland Nos. 7 & 8

The modified proposal includes a culvert where it crosses a creek flowing into the western edge of Bongil Bongil Swamp (Grid References 505250mE 66404750mN, chainage 100300); this will maintain the base surface flow entering the wetland. It should also ensure the passage of groundwater past the locality with the use of permeable rock layers under the entire culvert construction. The construction of the proposed water quality ponds at this locality should ensure that there is a minimum of vegetation removal on the down slope side, as the forest margins here contain high quality habitat that protects the core of Wetland Nos. 7 and 8.

The modified proposal does not directly impact Wetlands Nos. 7 and 8 where it approaches Bongil Bongil NP. To ensure that site disturbance is localised and that indirect impacts are minimised downstream, the following mitigation measures are recommended:

1. Avoid the upland habitat at Wetland No. 8 (Grid Reference 505200mE 6640110mN) (chainage 100300) and the western fringes of Wetland No. 7. This includes preventing the damage to trees and understorey and ensuring that runoff entering the habitat from the construction sites is free of silt, debris and waterborne pollutants. The movement of heavy machinery should not occur outside the footprint of the road development. Any stockpiling activities conducted outside the development footprint should be kept away from riparian zone and all wetland habitats. Water quality would be improved if runoff from construction were to be contained outside the boundary of both wetlands.

2. Improve the quality of road runoff from the existing Pacific Highway at Grid Reference 505550mE 6641200mN (chainage 101300). At the time of inspection, flow in this creek was visibly contaminated with silt, which was most evident near the existing Pacific Highway in a ponded area (Plate 13). The water from that pond flows into the northwestern sector of Bongil Bongil Swamp.

8. General Recommendations for Construction

Additional mitigation measures described in Section 7 are summarised in Table 2 for easy reference:

Table 2: Summary of additional mitigation measures.

Construction Activity	Mitigation
Vegetation removal at Reedys Creek	• The removal of riparian and instream vegetation should not include tree roots which are needed to stabilise creek sediments until other aquatic plants colonise the site. • Extraction methods should require the trees to be cut off at the stump and lifted out by a crane.
Bridge and culvert construction	• The construction of bridge abutments should use metal sleeves to prevent ASS contamination of receiving waters. • All bridge piers should be driven where there is high ASS risk to prevent contamination of receiving waters. • Machinery used in the placement of the piers should not disturb instream sediments. • All damage arising from construction activities in the riparian zone should be repaired as soon as practicable.
Water quality management (during construction)	• Prevent any reduction in the quality of the water flowing into the SEPP 14 wetlands, which should include permanent and effective water quality measures. • During construction, the ecosystem of Wetland No. 6 should be preserved as far as practicable by isolating the construction site with sheet piling to prevent the contamination of the remaining area of habitat.
Water quality management (post-construction)	• A treatment facility (sedimentation basin or oil and sediment separator) should be constructed at Reedys Creek. • All road runoff should be treated in sedimentation basins or sediment and oil separators before discharge into adjacent creeks or wetlands. • Water quality structures should be: 1. Protected from at least a one in two year magnitude flood outside the immediate riparian zone if practicable; 2. Cleaned regularly of polluted sediments; 3. Placed in locations that require the minimum disturbance to riparian and wetland vegetation; and 4. Sized to capture and hold the volume of pollutant expected from a large tanker spill. • Noise screens and trash traps could be used in Wetland No. 6 to prevent foreign matter from being washed or

Construction Activity	Mitigation
	blown into the wetland from the new road.
Re-establishment of wetland connectivity	• Once culvert construction is complete at Wetland No. 6, the two disjunct sections of the wetland should be brought back on line to resume their buffering role for Wetland No. 335.
Sedimentation basin construction	• The construction of all sedimentation basins should ensure that there is a minimum of vegetation removal when positioned in close proximity to wetlands especially Wetland Nos. 7 and 8.
Constructed wetland design	Any constructed wetland used in the modified proposal should (particularly at Reedys Creek): 1. Capture and treat the first 12 mm of runoff from its catchment; 2. Contain the volume of pollutant expected from a large tanker spill within its catchment; 3. Maintain an effective water treatment system through the effective design of the wetland; 4. Protect sediments from at least a one in two year magnitude flood; 5. Isolate the wetland's hydrology from subsurface flows to prevent seepage downstream; and 6. Prevent toxic residues contaminating wetland habitat through the flushing of contaminated sediments down stream during floods.

9. Compensatory Habitat

A commonly held point of view that the conservation of wetlands is intrinsically preferable to wetland creation. To this end, the modified proposal has acknowledged that natural wetlands fulfill an important catchment role that cannot be fully replaced by constructed copies. This is reiterated by the NSW Wetland Management Policy that states:

> *"Natural wetlands should not be destroyed, but when social or economic imperatives require it, the rehabilitation or construction of a wetland should be required"* to take its place.
>
> (NSW State Wetland Management Policy 1996).

In reality, the restoration of degraded wetlands may be hampered by previous development (i.e. major infrastructure like other roads, farming developments and in this case the railway levee) or advanced ecological decay. Consequently, the cost effort and risk of creating or restoring wetlands should be weighed up against the cost of mitigating impact at the outset.

9.1 Wetlands Nos. 1 & 2

The Reedys Creek Bridge will require minimal wetland habitat removal which is not expected to affect good quality habitat downstream (Wetland No. 2). The net loss of wetland vegetation at the Reedys creek crossing site is not considered to be significant and compensatory habitat is therefore not required.

9.2 Wetland No. 3

The riparian zone at the road crossing point downstream of Wetland No. 3 is narrow and does not constitute part of Wetland No. 3 or the SEPP 14 Wetland No. 344 downstream. As vegetation removal is limited to the road crossing point, it is unlikely that construction impacts would be transmitted outside the site. It is therefore considered that compensatory habitat will not be required.

9.3 Wetland No. 6

It is highly desirable that the Pond still function as an effective buffer for Wetland No. 335 against upstream impacts from road construction and use. The Pond is a modified wetland environment constructed by the use of a levee. As it is not natural and the construction of the road will be limited to the central area of the Pond, there is not expected to be any net loss of natural wetland habitat in Wetland No. 335. Consequently, compensatory habitat will not be required.

9.4 Wetland Nos. 7&8

The modified proposal will not encroach upon or affect any natural wetland environment associated with Wetland Nos. 7 or 8. Therefore no wetland habitat will be lost and consequently no compensatory habitat will be required.

If all the additional mitigation measures outlined in this report are stringently followed, thereby reducing off-site impacts downstream, then no natural wetland habitats would be adversely affected by the modified proposal, thus negating the need for compensatory habitat.

10. Overall Conclusions

The large volume of traffic using the existing Pacific Highway poses a significant existing threat to the Bonville wetland resource. This threat is significant because there are few mitigation measures in place along the existing route that are capable of capturing accumulated road pollutants and large chemical spills from road accidents. The modified proposal has addressed these issues as an integral part of its design. Despite some vegetation removal and temporary water quality issues, the modified proposal has incorporated mitigation measures to reduce the impact of construction and of long-term environmental effects of traffic passing through the area.

Overall the modified proposal is expected to have a good outcome for the Bonville wetlands provided that additional recommendations in this report (see Section 8) are implemented in conjunction with those strategies outlined in the Bonville EIS (Appendices H and K). Consequently, it is expected that the direct and indirect impacts would be limited to:

1. Local vegetation removal at the road crossing sites; and

2. A temporary reduction in local water quality during construction.

These impacts are not expected to accumulate over time.

Finally, the modified proposal has reduced the level of potential direct impacts on the Bonville wetland resource to a minimal level by avoiding the physical disturbance to identified natural wetland areas in good condition. Consequently, there will be no significant net loss of natural wetlands. For these reasons, it is considered that there is no need for compensatory habitat to replace natural wetlands located along the road route.

11. REFERENCES

Brady, A., & Riding, T., (1996) The Importance of Wetlands In Water Resources Management, A Literature Review. Technical Services Division, Dept. of Land and Water Conservation.

PPK Environment & Infrastructure (1997) Bonville Project, bore hole Geotechnical data.

King, A.M., (1998) Jemalong Land and Water Management Plan Area Wetland Evaluation. Ecological Services Unit, Centre For Natural Resources, Department of Land and Water Conservation.

NSW Government (1986), New South Wales, State Wetland Policy, The NSW Wetland Management Policy. Prepared by the Dept. of Land and Water Conservation.

Winning, G., (1992). North Coast Wetland Survey, A Survey of the floodplain wetlands of the Richmond, upper Clarence and Hastings Rivers undertaken for NSW Department of Water Resources.

PHOTOGRAPHIC RECORD

Plate 1 Photographed at GR 053070mE 6637470mN looking northeast at the upstream entrance of the wetland No.1. At this location the character and quality of instream aquatic vegetation can be seen. It is this type of habitat that is providing a filter function and flood mitigation role by slowing down and locally distributing water flow.

Plate 2 Photographed at GR 503180mE 6637390mN looking into wetland No. 2. This is an example of the high quality habitat found down stream of the Reedy Creek crossing locality. It is this habitat that must be assured a natural supply of surface and subsurface flows.

Plate 3 Photographed at GR 504895mE 6638140mN looking southeast into SEPP 14 wetland No. 344. The wetland habitat on this side of the wetland is connected to Pine Creek. Although burnt, the paperbark trees on this side of the rail levee are in better condition to those to the western side (upstream).

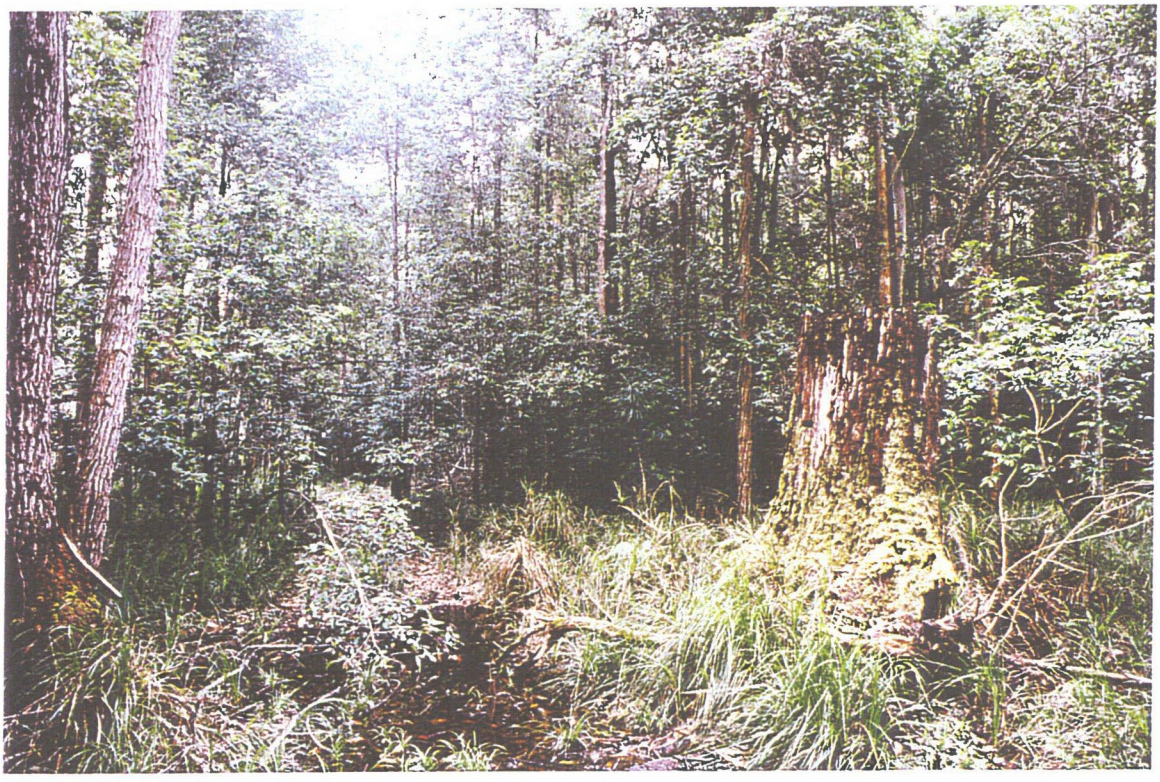

Plate 4 Photographed at GR 503700mE 6638000mN looking southwest. This is the approximate location of the road proposal where it is planned to pass through an area of riparian habitat.

Plate 5 Photographed at the same location as Plate 3. The upstream degradation of Paperbark trees is associated with the changing water regime of the wetland. This change is starting to exclude trees which is inappropriate.

Plate 6 Photographed at GR 504390mE 6638590mN looking northwest along "The Pond". The modified but high quality habitat found here is good protection for the habitat downstream (i.e. SEPP 14 wetland No. 335 in Plate 7).

Plate 7 Photographed at GR 504610mE 6638630mN looking north across the swamp. The conditions at this location are related to the ponding affect of the rail levee. This is to the detriment of mature wetland habitat downstream within the same wetland. Nonetheless this is still very high quality habitat.

Plate 8 Photographed at GR 505310mE 6640180mN looking north along the southern arm of Bongil Bongil Swamp. The watercourse supplied by wetland No. 8 enters the wetland to the left and rear of shot.

Plate 9 Photographed in the vicinity of GR 505245mE 6640120mN. Moist transition forest (wetland No. 8) down slope of the Phreatic Swamp in the same locality. Note the *Gahnia sieberana* shrub layer.

Plate 10 Photographed in the vicinity of GR 505245mE 6640120mN. Note the absence of trees due to water logging and the presence of the *Gahnia sieberana* and *Restio tetraphyllus* shrub layer.

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Plate 11 Photographed in the vicinity of GR 503130mE 6637430mN just upstream of Plate 2. This is the gap between wetlands No. 1 and 2 where previous disturbance has taken place. To the left is the vegetation remnant in the area of the road crossing. To the right of shot is the start of the high quality habitat so important to the status of wetland 2.

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Plate 12 taken in the same location as Plate 4 (but down stream) features the western most extremity of SEPP 14 wetland No. 344 at is current water level.

Plate 13 Photographed at GR 505475mE 6641220mN. This is a constructed water retention pond capturing flow from the Pacific Highway. The quality of water running from this pond was degraded.

APPENDIX 5 – RELEVANT CVs

CURRICULUM VITAE

Name: BILL ROONEY

Year of Birth: 1944

Nationality: America. Dual Citizenship: Australian and American

Qualifications: B.Sc. Geology, Boston College, USA 1966.

M.Sc. Biological/Geological Oceanography, Duke University, USA, 1971.

Commissioned as an officer in the US Army (Air Defence Artillery) 1966-68. Attained rank of 1st Lieutenant. Served in Vietnam.

Building Certificate, NSW Department of Technical & Further Education, 1982.

Professional: Member Australian Marine Sciences Association.

Member Coast and Wetlands Society of NSW.

Member Environment Institute of Australia.

Experience: **Director, W.S. Rooney & Associates Pty Ltd (1986-present).** Mr. Rooney formed his own company in July, 1986 specialising in applied marine science and environmental impact assessment.

Catherine Park Catchment Study, Scotland Island; road and drainage study and recommendations for Scotland Island Landcare Group and Pittwater Council (1998).

Long-term monitoring of mangrove-lined banks of the Parramatta River, as part of a wider monitoring program of the effects of marine traffic; in association with Patterson Britton & Ptnrs and Unisearch Water Research Laboratory, for the Waterways Authority (1997-98).

Assessment of heavy metal toxicity to aquatic life in Manly Lagoon for Johnstone Environmental Technology Pty Ltd as part of an EIS on the rehabilitation of the waste incinerator site on Addiscombe Road, Manly Vale (1997).

Camden Haven Estuary Processes Study: describe estuarine biological characteristics and processes; in association with Patterson Britton & Ptnrs Pty Ltd for Hastings Council (1997).

Marine ecological assessment of proposed maintenance dredging in the Lower Tweed River (Terranora Inlet) as part of a Review of Environmental Factors prepared by Patterson Britton & Partners P/L for DLAWC (1997).

Expert witness in the Land & Environment Court of NSW, offering opinion on the likely impact of a diesel spill from a petrol station into a tributary of the Yass River. Comment on the ecological condition of the tributary was also provided. On behalf of Environmental & Earth Sciences Pty Ltd (1997).

Design and supervision of the construction and long-term maintenance of an artificial wetland within a corporate park, stocking with native animals and plants, and preparation of a maintenance manual; in association with the Lingridge Partnership and Sainty and Associates, for Riverside Corporate Park (1996-98).

Preliminary environmental appraisal of a maintenance dredging proposal for the Sylvania Waters Canal Estate on the Georges River, in association with Patterson Britton & Partners Pty Ltd, for Sylvania Waterways Limited (1996).

Marine ecological assessment of the options for a permanent sand by-pass scheme from the Tweed River Estuary to the Gold Coast beaches, in association with WBM Pty Ltd, Patterson Britton & Ptnrs Pty Ltd and Hyder Consulting (Australia) Pty Ltd (1996).

Marine ecology and water quality inputs to Cobaki Broadwater Management Plan, Tweed River Estuary, in association with Patterson Britton & Partners Pty Ltd; for Tweed Shire Council (1996).

Preparation of Statement of Environmental Effects for proposal to dredge a yacht berth in McCarrs Creek, Pittwater; for Mr. Peter Muller (1996).

Assessment of aquatic ecological and water quality impacts of sewer overflows at West Camden and all Blue Mountains sewage treament plant systems as part of EIS's on sewer overflows, in association with Acer Wargon Chapman Pty Ltd; for Sydney Water (1995-96).

Marine ecological assessment of Yowie Bay, Port Hacking (Sydney, NSW) in association with Patterson Britton & Partners Pty Ltd as part of an Estuary Processes Study for Public Works Department and Sutherland Shire Council (1995).

Marine ecological input to Ukerebagh Passage Management Plan, Tweed River Estuary, in association with Patterson Britton & Partners Pty Ltd, for Tweed Shire Council (1995).

Marine ecological assessment of proposed development at Boat Harbour, near Port Stephens, NSW for McCloys Developments Pty Ltd (1995).

Aquatic fauna studies (fish, platypus, and riparian fauna) undertaken on behalf of Rust PPK for NSW Public Works Department as part of an EIS for a new Mittagong Regional Sewerage Scheme (1995-97).

Wallaga Lake Estuary Processess Study (flora and fauna) for Public Works Department and Bega Shire Council in association with Patterson Britton & Partners Pty Ltd (1995).

Environmental enhancements to the Terranora Broadwater Master Plan (Tweed River), for Tweed Shire Council on behalf of Patterson Britton & Partners Pty Ltd (1994).

Water quality and marine ecological impact assessment for Tweed River Entrance dredging and Gold Coast beach nourishment EIS, for NSW Public Works Dept. and Qld Dept. of Environment and Heritage, on behalf of Acer Wargon Chapman Pty Ltd (1994).

Expert testimony for court case in Land & Environment Court regarding the clean-up of contaminated sediments in Homebush Bay. Norton Smith & Co. (1994).

Environmental Liaison Officer for the North West Transport Link (M2) tollroad from North Ryde to Baulkham Hills. Roads & Traffic Authority (1993-95).

Aquatic ecological assessment of Homebush Bay for the purpose of an environmental risk investigation for ICI Australia Pty Ltd on behalf of AGC Woodward-Clyde Pty Ltd (1993).

Marine ecological review of Kogarah Bay dredging proposal for NSW Public Works Department, in association with Ecoservices Pty Ltd (1993).

Review of water quality protocol for NSW EPA on behalf of ICF/Kaiser Engineers Pty Ltd (1993).

Marine ecological resurvey of ocean effluent disposal site for Caltex Refining Co. Pty Ltd (1993).

Expert testimony in Land & Environment Court for Liverpool City Council: assessment of aquatic ecological effects of sand extraction on the bank of the Georges River at Moorebank (1993).

Darling Mills Creek sediment transport study; on behalf of Manidis Roberts Consultants, for Upper Parramatta River Catchment Trust (1992).

Assessment of aquatic habitat on creek adjacent to bore site at Picton; on behalf of Mackie Martin & Associates. Pty Ltd, for Bureau of Mineral Resources (1992).

Environmental maintenance and monitoring of F3 Freeway; for NPWS (1992).

Marine ecological impacts for Wollstonecraft Bay Marina EIS; for AGL (1992).

Independent review of REF for new access road to UTS, Ku-ring-gai campus; for NPWS (1992).

Monitoring of mangroves and foreshore of Upper Parramatta River during and after dredging for new ferry service. Department of Transport (1992-94).

Macroalgae as bioindicators of nutrient exposure and nutrient limitation in the Georges River/Botany Bay; Sydney Water Board (1992).

Expert witness testimony in Land & Environment Court regarding impacts of the discharge of heavy metals into wetland and watercourse at Hexam, NSW; for Genkem Pty Ltd (1991).

Investigation of contaminated landfill at Kelso Park, Panania; for Bankstown City Council (1991).

Bacteriological resurvey of Cowan Creek, Ku-ring-gai Chase National Park, NSW; for NPWS (1991).

Marine ecological assessment of proposal to dredge entrance to Wooloweyah Lagoon, Yamba, NSW; for the Public Works Department, on behalf of Patterson Britton & Partners P/L (1991).

Water quality aspects of stormwater catchment management plan for the Cooks River Catchment, NSW; in association with Binnie & Partners Pty. Ltd., for the Sydney Water Board (1990).

Marine ecological survey of Wollstonecraft Bay, Sydney Harbour, in conjunction with Johnstone Environmental Technology Pty. Ltd., for AGL (1990).

Environmental consultant to the Sydney Water Board, Pollution Abatement Branch, in association with Sinclair Knight & Partners as part of the Clean Waterways Programme (1990 -1993).

Water quality investigation of Kelso Creek for Bankstown City Council (1990).

Marine ecological assessment of dredging Terranora Inlet on the Tweed River for an EIS prepared by Public Works Department (1990).

Marine ecological survey and environmental impact assessment of dredging the Tweed River between Chinderah and Tweed Broadwater. For Neumann and Blundell Dredging Contractors (1990).

Marine ecological impacts of chemical spillages into Homebush Bay, Sydney Harbour, in association with Johnstone Environmental Technology Pty Ltd, for ICI Australia Ltd (1990).

Advice on fish and invertebrate stocking of a manmade lake at the Lakelands Housing Estate near Wyong, NSW. For Don Fox Planning Pty Ltd (1990).

Ecological assessment of wetland at Wyong and investigation of impacts from adjacent pesticide/herbicide formulation plant. On behalf of Epps Warren Pty. Ltd. for Bayer (Australia) Ltd (1990).

Marine ecological resurvey of Caltex Refinery ocean outfalls. Caltex Refining Co. Pty Ltd (1990).

Water quality aspects of stormwater catchment management plan for Raglan Street catchment at Manly,

Bacteriological survey of Cowan Waters, Broken Bay, NSW. National Parks and Wildlife Service (1988).

Marine ecological assessment of dredging Curalo Lagoon, Eden, NSW for EIS prepared by Sinclair Knight P/L for Bega Valley Shire Council (1988).

Marine ecological assessment of naval base deployment to Jervis Bay. Department of Defence (1987-1988).

Little Manly Point Boat Ramp: marine ecological assessment of boat ramp construction and increased use of aquatic reserve. Public Works Department (1987).

Monitoring of effects of chemical leachate on the intertidal zone of Homebush Bay for Union Carbide Australia Ltd (1987-1988).

Preparation of brief for marine studies to define environmental impacts of sewage sludge discharge at the Cronulla Ocean Outfall. MWS&DB (1987).

Marine ecological survey of Five Dock Bay in Sydney Harbour as part of a recreational boating options development study for Public Works Department (1986).

Bathymetric and subsurface profiling survey of Cape Flattery wharf area for Cape Flattery Silica Sand Mining Pty Ltd. Far North Queensland, for Land & Marine Pty Ltd (1986).

Marine ecological survey of Yena Gap, near Kurnell, NSW for Caltex Refining Co. Pty Ltd (1986).

Aquatic ecology impacts of the Fish River Water Augmentation Scheme from the Duckmaloi Weir to Oberon Dam, NSW via proposed pipeline; EIS prepared in assocation with Environmental Management Pty Ltd, for Public Works Department (1986).

Environmental Services Manager; Travers Morgan Pty Ltd (1982-1986). Responsible for establishing and managing an environmental studies arm of the practice.

Ecological Assessment of Sydney Harbour Foreshore and Subtidal Areas as part of a Sydney Harbour Regional Environmental Study and Plan; for Department of Environment and Planning and Maritime

Services Board, NSW in association with Mitchell McCotter & Associates Pty Ltd(1986).

Environmental Monitoring and Liaison Consultant for the F3 Freeway through Ku-ring-gai Chase National Park, for National Parks and Wildlife Service (1986-1989).

Marine Ecological Impacts of Potential Leachate from Contaminated Land Fill at the Union Carbide Chemicals Factory, Homebush Bay, Sydney (1986).

Marina Site Selection Study in Sydney Harbour for Public Works Department (1986).

Marine Ecological Impacts of Dredging a Shipping Channel in Halifax Bay, Qld, for Queensland Nickel Pty Ltd (1986).

Transport of Hazardous Cargo within the Ballarat Area for the Ballarat Area Planning Committee (1986).

Environmental Impact Statement of Alluvial Tin Mining at China Camp, Far North Qld. for Southern Ventures N.L. and Stannum Mines Pty Ltd (1985).

Newport Commercial Centre Traffic and Parking Study for Warringah Shire Council (1985).

Impact Assessment of Marine Reclamation and Boat Launching Facility in Gunnamatta Bay (Port Hacking Estuary, NSW) for Sutherland Shire Council (1985).

Plan of Management for Towra Point Nature Reserve for National Parks and Wildlife Service. Botany Bay, NSW (1984).

Singles Ridge Environmental Study for Blue Mountains City Council (1984).

Double Bay Marina Water Quality Study for Wellings, Smith & Byrnes (1983).

Environmental Impact Study of a Tourist Development in Malaysia for Kuttner, Collins International Pty Ltd (1983).

Marine Ecological Studies for Condor Oil Shale Project for the Joint Feasibility Study Management Group (1983).

Environmental Study and Draft Local Environmental Plan for Rural Lands Within 20 km of Taree. Greater Taree City Council (1983).

Marine Ecological Investigations Related to Ocean Discharge of Spent Caustic Wastes by Australian Oil Refining Pty Ltd, Kurnell, NSW (1983).

Environmental Study of West Menai Urban Release Area, Sutherland Shire (Sydney) (1982).

Project Manager/Senior Ecologist; Dames and Moore (1978-1982).

Marine Biological Studies for Redcliffe Petrochemical Plant, SA (1981).

Resort Marina at Wallis Lake, NSW: Examination of Aquatic Environment and Preliminary Marina Design (1980).

Marine Ecological Studies For The Rundle Oil Shale Project, Gladstone, Qld (1980).

Water Quality/Aquatic Biology Investigation of a Freshwater Impoundment on the Todd River, Alice Springs, NT (1980).

Expert Witness on Effects Of Shell Refinery Effluent, Corio Bay, Vic (1980).

EIS for Submarine Oil Pipelines in Botany Bay, Sydney (1979-1982).

Environmental Baseline Data Collection and Impact Assessment at Queensland Mines' Nabarlek Uranium Mine Project (1979-1980).

Environmental Investigations at Parklea Prison Site, Sydney (1979).

McArthur River, Qld Environmental Studies for Large Lead/Zinc Mining Project (1979).

EIS on Coal Washery and Rejects Disposal Area, Tahmoor, NSW (1978-79).

Project Manager and Aquatic Specialist for Environmental Studies, Noranda Koongarra Uranium Project (1978-81).

Senior Lecturer; Macquarie University, Centre for Environmental Studies (1977-1978).

Biological Study of Potential Impacts of Sand Dredging off the Sydney Coast (1978).

Consultancy to Australian National Parks & Wildlife Service to Develop a Policy for Marine Parks and Reserves in Australia (1977-78).

Senior Marine Scientist; Judell, Platt, Thomas and Associates Pty Ltd (1971-1976).

Environmental Studies Related to Ocean Discharge of High Ammonia Effluent from Nickel/Cobalt Treatment Plant, Queensland Nickel Pty Ltd, Townsville, Qld (1973-76).

Environmental Impact Study of Shoalhaven River for Wiggins Teape Pty Ltd (1971-72).

Seasonal Park Ranger with National Parks and Wildlife Service NSW (1975-76).

Appointed Field Supervisor of Interpretation Programme for National Parks and Wildlife Service Centenary Celebrations for Royal National Park (1979).

US National Science Foundation Grant for Study and Research on Carbonate Deposition and Diagenesis, Grand Cayman Island, B.W.I. (1971).

Research on Geological Significance of Microboring Organisms within Carbonate Sediments, Great Barrier Reef (1970-71).

US National Science Foundation Grant for Study and Research on Organism-Sediment Interrelationships, Bermuda Biological Station For Research (1969).

ADAM MURRAY KING — CURRICULUM VITAE

POSITION:

Team Leader Ecology, Biosis Research Pty. Ltd.

QUALIFICATIONS:

Postgraduate Diploma (Remote Sensing), University of New South Wales.

Bachelor Of Applied Science (Parks and Recreation), Charles Sturt University

Associate Diploma of Applied Science (Resource Management), Lismore College of Advanced Education.

EMPLOYMENT PROFILE:

1998 – Team Leader Ecology, Biosis Research Pty. Ltd.

1992 – 1998 Environmental Officer, Department of Land & Water Conservation, NSW.

1991 Soil Conservationist (Temporary), Soil Conservation Service, NSW.

1991 Technical Officer (Temporary), Geophysical Research Institute, University of New England.

1990 Hydrographic Assistant (Temporary), NSW Department of Water Resources.

1987 – 1989 Technical Officer, NSW National Parks & Wildlife Service.

FIELDS OF COMPETENCE:

- ✓ Geographical Information Systems (GIS).
- ✓ Remote Sensing.
- ✓ Air photo interpretation.
- ✓ Terrestrial and wetland ecology.
- ✓ Digital mapping.
- ✓ Habitat assessment.
- ✓ Flora and fauna survey.

PROFESSIONAL EXPERIENCE:

Adam has over 10 years experience in applied Natural Resource Management. A sample of key professional experience is presented below.

- GIS and Remote Sensing applications.
- Application of radar remote sensing for the monitoring of wetlands and vegetation mapping.
- Jemalong Wyldes Plains Irrigation Limited Land and Water Management Plan wetland evaluation.
- Progressive digital mapping of 2 million hectares of NSW wetlands.
- Wetland water requirements study in the Great Cumbung Swamp, NSW.

PUBLICATIONS:

Adam has published more than 14 government reports.

King, A.M. (inprep) Applications of Radar Remote Sensing For Mapping and Monitoring Wetlands.

King, A.M. (1998) Jemalong Wyldes Plains Wetland Evaluation. Department of Land and Water Conservation, Centre For Natural Resources.

King, A.M., (1997) Application of Radar Remote Sensing For the Mapping of Degraded Australian Ephemeral Wetlands. University of New South Wales, Graddip report.

Green, D.L., King, A.M. (1996) "South Coast Wetland Survey" Prepared by the Centre For Natural Resources Management, Department of Land and Water Conservation.

King, A.M. (1996) Euston Lakes Vegetation Assessment. Prepared by the Centre For Natural Resources Management, Department of Land and Water Conservation.

King, A.M. (1996) "Digital Mapping Methods". Environment Branch, Standard and Procedure Document.

King, A.M. (1995) Lake Victoria Vegetation Assessment. Prepared by the Centre For Natural Resources Management, Department of Land and Water Conservation

King, A.M. & Green D. ,(1995) "Wetlands of the Paroo River". Technical Services Division Dept. Of Water Resources (NSW)

King, A.M., Wettin P. (1995) "Status Overview of NSW Wetlands". Technical Services Division Dept. Of Water Resources (NSW). T.S. 92.086

King, A.M. & Green, D.L., (1995) "Wetlands of the Barwon-Darling River". Technical Services Division Dept. Of Water Resources (NSW).

Winning, G., King, A.M (1995). "Upper Northeast Rivers Region Survey Of Freshwater Wetlands". Technical Services Division Dept. Of Water Resources (NSW).

King, A.M. (1994) "Wetlands of Jemalong and Wilds Plains Irrigation District". T.S. 94.030. Technical Services Division.

Green, D.L., King, A.M. (1993) "Wetlands of The Warrego River System". Prepared by the NSW Dept. of Water Resources, Technical Services Division for the Warrego Water Users Association. T.S. 93.000

King, A.M. & Green, D., (1993) "Wetlands of the Lower Darling River and Great Darling Anabranch Technical Services Division Dept. Of Water Resources (NSW) T.S. 93.032

CONSULTANT REPORTS:

King, A.M., (1998) "Bonville Project, Pacific Highway Coffs Harbour: Wetland Evaluation". Biosis Research Pty. Ltd.

APPENDIX 4 – Compensatory Habitat

BIOSIS

RESEARCH

DISCUSSION PAPER
COMPENSATORY HABITAT ASSESSMENT FOR THE BONVILLE DEVIATION

December 1998

Report prepared by

R. Bali and J. Anderson

for

Roads and Traffic Authority

1. INTRODUCTION

Biosis Research was commissioned by the Roads and Traffic Authority (RTA) to undertake an overview study. The study was aimed at investigating the issues regarding the need for acquisition of compensatory habitat as a result of the Pacific Highway deviation at Bonville. As part of the study, the consultants were asked to:

- Undertake a literature review on the topic of compensatory habitat;
- Consider the opportunities for obtaining compensatory habitat.

2. SCOPE/PURPOSE

The **primary purposes** of this study are twofold. They are:

- To review the impact on vegetation remnants as a result of the deviation of the Pacific Highway at Bonville.
- To determine the appropriate type and quantity of compensatory habitat for areas where compensatory habitat is deemed to be required.

The **secondary purpose** of this study is to strategically overview opportunities for compensatory habitat for the purpose of initial prioritisation of areas where compensatory habitat is deemed to be required. This paper is not a detailed study of potential sites, nor a final package proposal. This is seen as the next stage of the compensatory habitat process.

3. BACKGROUND

National Parks and Wildlife Service (NPWS) have indicated to the RTA that a package of suitable measures to compensate for the loss of habitat, particularly threatened species habitat, as a result of the Pacific Highway at Bonville deviation should be prepared by the RTA (NPWS 1998b). This precipitated ongoing discussions between the RTA and NPWS and the preparation of the original version of this Draft Discussion Paper (May 1998). Comments in relation to the document were received from NPWS in correspondence dated 30 June 1998. The Draft Discussion Paper was based on the Bonville proposal, impact assessment and mitigation recommendations as described in the Species Impact Statement submitted in July 1998 (Biosis Research 1998).

The present report has undergone extensive review and has been modified to take into consideration the following:

- Substantial modifications to mitigation measures in response to submissions received after exhibition of the July 1998 EIS;
- Comments from NPWS dated 30 June 1998;
- An extensive literature review on the subject of compensatory habitat.

The current proposal and mitigation measures will be fully described in the revised SIS that is currently being prepared.

3.1 Literature Review

The concept of compensatory habitat is relatively new in Australia. However, it forms an integral part of government policies in Canada, the United States and Britain. As part of the current study, some 25 scientific papers and policy documents were reviewed in order to gain an understanding of issues underlying the acquisition or creation of compensatory habitat. In most of the papers reviewed, compensatory habitat relates to creation of wetlands wherever development has led to residual impacts

on natural wetlands (after mitigation). However, many of the principles applying to assessing the need for and the values of compensatory habitat are applicable in the case of the Pacific Highway.

A bibliography of reading material on the topic is included in Section 7 at the end of this report. Specific references are referred to below. Ecological principles underlying the need for and the suitability of compensatory habitat are fairly consistent amongst studies. In general, compensatory habitat is:

- Considered appropriate only where there is a residual impact after relocation, redesign and/or mitigation (Woltemade 1991; Scruton 1996; Dept. of Fisheries and Oceans 1998).

- Applicable in those cases where residual impacts occur on important habitat (i.e. regional or state significant); it is not applicable in relation to critical habitat (i.e. nationally significant) where only relocation is considered to be adequate (Bingham and Noon 1995;Dept. of Fisheries and Oceans 1998).

- Determined on a "like-for-like" basis with regards to size, habitat type and quality (Scruton 1966; Woltemade 1991). In cases where compensatory habitat is to be created, up to twice the area may be compensated for due to short-term loss of productivity and the risk of failure (McCuskey *et al.* 1994; Woltemade 1991; Scruton 1996). The size of the package is dependent on the vegetation/wetland type to be created and on the results of long-term monitoring. There is general agreement that monitoring programs have been inadequate or lacking (Race 1985; Kentula *et al.* 1992; Torok *et al.* 1996; Lee and Gosselink 1988; Brinson and Rheinhardt 1996; Race and Fonseca 1996; McCuskey *et al.* 1994; Simenstad and Thom 1996).

- Most preferred in the form of similar habitat located at or near to the development site and least preferred in the form of different habitat located off-site (Bourcher and Whatmore 1993; Woltemade 1991; Scruton 1996; Dept. of Fisheries and Oceans 1998).

- Determined on a project-by-project basis rather than on a regional/catchment/landscape approach (Lee and Gosselink 1988; Cowell 1997; Bedford and Preston 1988; Bedford 1996; Dept. of Fisheries and Oceans 1998);

- Based on physical (e.g. size) or biological (e.g. species) factors that are in turn considered to be indicators of function, productivity, wilderness, aesthetics and other intangible values (Simenstad and Thom 1996; Scruton 1996; Lee and Gosselink 1988; Cowell 1997; Woltemade 1991; Dept. of Fisheries and Oceans 1998).

Some authors stressed the importance of defining and achieving mitigation goals (Scruton 1996; Bingham and Noon 1995; McCuskey *et al.* 1994). Scruton (1995) cautioned that the creation of compensatory habitat for a particular species may be at the expense of another species.

3.2 RTA Policy

The RTA draft policy *Road Development and Impacts on Habitat Amelioration Measures - Compensatory Habitat (Draft 6, 12/11/98)* provides policy and guidelines to assist in determining the most appropriate measure(s) to ameliorate negative impacts on habitats. However, it should be noted that the policy is currently under review and should be considered an evolving document. It is also relevant to the following discussion that, although the RTA policy must consider economic and social values in addition to ecological ones, the present review considers only ecological values associated with compensatory habitat. The full policy is presented in Attachment 1.

The RTA draft policy is consistent with a number of papers reviewed in that it has a clear hierarchy of actions aimed at reducing environmental impacts. The draft policy states that during construction of roads the RTA should in order of consideration, endeavour to:

1. **avoid** impacts on habitat, through the planning process;
2. **minimise** impacts on habitat, through the planning process; and
3. **mitigate** for impacts on habitat, through the use of a range of amelioration measures.

A number of key points from the draft policy are discussed briefly below.

3.2.1 What is mitigation?

Mitigation is applied where there are residual impacts after the initial planning and route selection process. Mitigation is determined on a project-by-project basis and it may include a range of measures from the construction of major structures, through to site rehabilitation and compensatory habitat.

3.2.2 What is compensatory habitat?

The RTA draft policy defines compensatory habitat as "an area of land containing one or more key habitats which are acquired and/or committed by the RTA for the purposes of nature conservation, to make up for the loss of one or more key habitat(s)." Compensatory habitat is considered to be one of a range of mitigation measures. Consideration of compensatory habitat is only appropriate where there has been a loss of key habitat after route selection, road design and other mitigation measures have been employed.

3.2.3 What is key habitat?

Key habitat areas are those that support flora and fauna species, populations or ecological communities considered to be of significance due to the following:

- Inclusion on Schedule 1 of the *Threatened Species Conservation Act 1995* or the *Fisheries Management Amendment Act 1997* as an endangered species, population or community, or presumed extinct species;
- Inclusion on *Schedule 2 of the TSC Act 1995* as a vulnerable species;
- Inclusion in an area of habitat of an endangered species, population or ecological community declared critical habitat by the Minister of the Environment;
- Inclusion in a planning instrument under the *Environmental Planning and Assessment Act 1979* in a category of nature conservation significance;
- Inclusion in a National Estate listing;
- Inclusion within a conservation reserve gazetted under the *National Parks and Wildlife Act 1979* (e.g. National Park, Nature Reserve) or under the *Forestry Act 1916* (e.g. Flora Reserve);
- Recognised as an area of high nature conservation value in a property agreement or regional vegetation management plan under the *Native Vegetation Management Act 1997*;
- Inclusion in any other conservation agreement, state, national or international (e.g. JAMBA, CAMBA, RAMSAR, VCA);
- Being of particular significance to NPWS, NSW Fisheries, Department of Land & Water Conservation, State Forests of NSW, or other agency. (N.B. The relevant agency will be required to provide written justification for an areas being identified of "particular ecological significance".)

3.2.4 How much compensatory habitat is appropriate?

The RTA considers that where practicable, compensatory habitat should be at least equal in area to the key habitat lost. In cases where there is no existing habitat available, compensatory habitat may be established using part or full restoration. In the latter cases, the RTA may consider providing an area of compensatory habitat that is greater that the amount of key habitat to be lost.

Most of the literature on compensatory habitat reviewed concerns the creation of wetland habitat to replace impacted wetland. In general, this has involved a 2:1 (compensatory habitat:impacted habitat) ratio (Scruton 1996, Perry *et al.* 1996, McCuskey *et al.* 1994). Cowell (1997) refers to a case in Britain where a 15:1 ratio of gains to losses by area for wetland compensation was achieved. However, in this case, the compensation was "out-of-kind" (i.e. saltmarsh replacing shingle beach) which

underscores the uncertainty of exactly how much compensatory habitat is required. After reviewing some 75 projects where compensatory wetland was created, Allen and Feddema (1996) found that there was still a net loss of wetland habitat and recommended that a greater than 2:1 ratio be implemented.

In general, where there is some uncertainty about the successful establishment of compensatory habitat, it is advisable to provide extra area in order to counteract the following:

- Loss of productivity or functionality in the short- to medium-term (Simenstad and Thom 1996, Brinson and Rheinhardt 1996);
- Uncertainty of success in establishing wetlands (Race and Fonseca 1996, Allen and Feddema);
- Lack of guarantee that artificial wetlands will persist as permanent substitutes for impacted wetlands (Race 1985);
- The uncertainty of exactly how much out-of-kind habitat is required to replace impacted wetland; it is apparent from monitoring studies that certain wetland types are created more frequently and that others are very difficult or impossible to create (Cowell 1997, Kentula *et al.* 1992, Allen and Feddema 1996).

In fact, wetland creation is rarely if ever completely successful. Although this can be due to the fact that restoration goals are not clearly defined (and therefore cannot be adequately assessed), it is also related to physical characteristics such as: inadequate design, improper location, wrong contours, incorrect elevation, small size, poor sediment characteristics, lack of skill of constructors, weed invasion, exposure to storms and other environmental factors (Race and Fonseca 1996). In a case study, Perry *et al.* (1996) found that there was 88% survival of shrubs and trees in a wetland established in the previous year. Allen and Feddema (1996) found the establishment of small wetlands to be less successful than that of large ones.

Given that the 2:1 ratio is accepted as a means of accounting for the uncertainties of wetland habitat creation, it appears reasonable that a 1:1 ratio would be satisfactory for habitats that are already established. In most cases, areas of established habitat would only have to be acquired or otherwise conserved; these actions are not likely to result in any short-term loss of productivity or functionality of these areas but instead would increase their long-term sustainability.

3.2.5 Where should compensatory habitat be located?
The RTA considers that wherever possible, compensatory habitat should be located:

- Close to impacted key habitat;
- Adjacent to habitat which has some form of statutory conservation protection; and
- As part of a network of corridors.

Although the RTA draft policy recommends that the location of compensatory habitat be determined on a project-by-project basis, it recognises that because major road developments may have regional impacts, the establishment of compensatory habitat may involve the assessment of cumulative impacts.

3.2.6 What type and quality should compensatory habitat be?
The RTA considers that wherever possible, compensatory habitat should:

- Be similar to or better than impacted key habitat;
- Include a similar number of key species, populations or communities; and
- Be enhanced (i.e. revegetated, rehabilitated, restocked) in cases where quality is not the same.

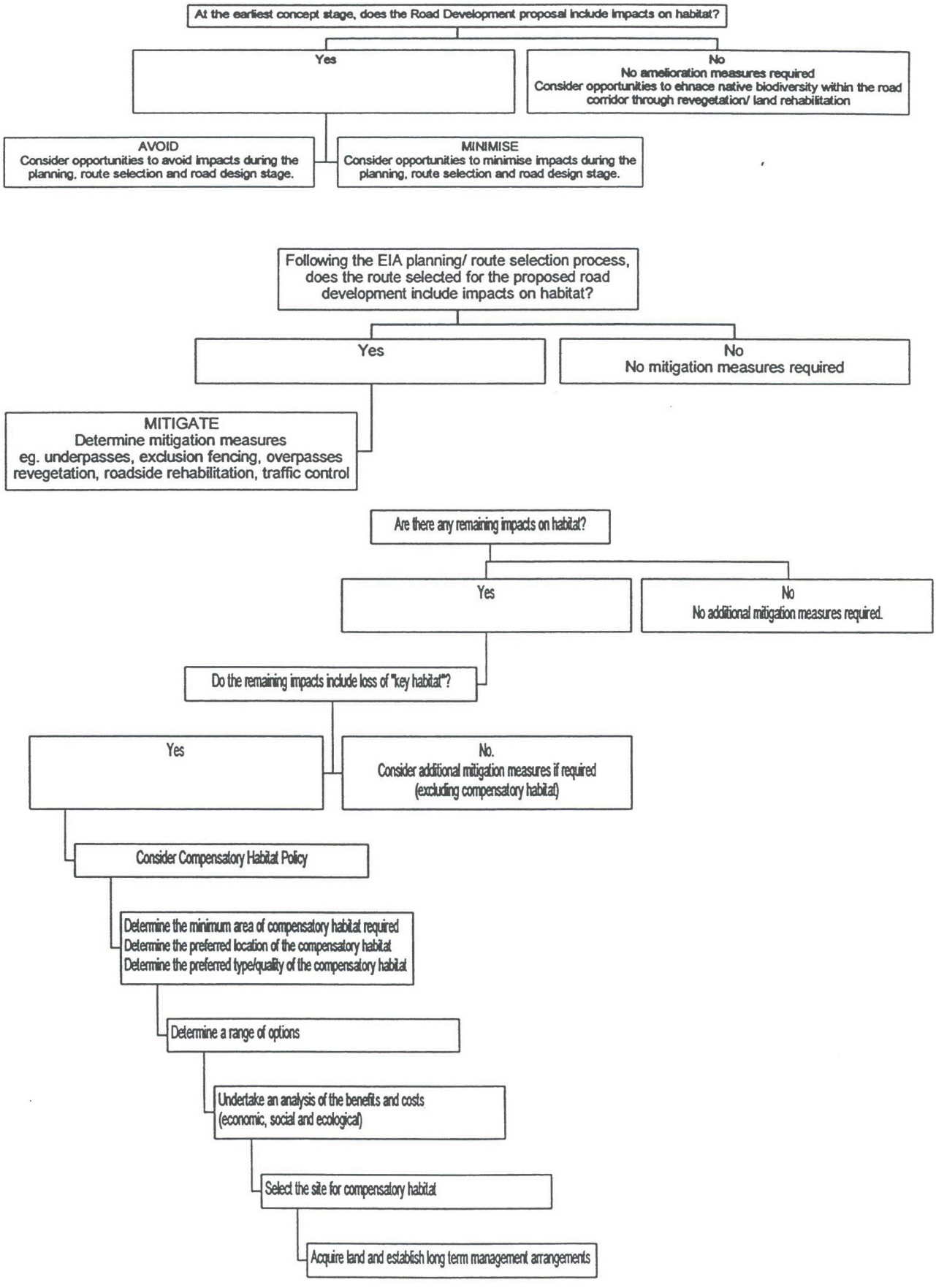
3.2.7 Assessment Matrix
An assessment matrix has been provided in the RTA draft policy in order to summarise the mitigation measures implemented for any road development. Justification as to the ability of mitigation measures to reduce impacts to an acceptable level should be included within the Species Impact Statement and

Environmental Impact Statement prepared for specific developments. The RTA draft policy requires that any agency disagreeing with these findings justify its response and provide guidance in writing.

3.2.8 Decision Framework for Compensatory Habitat

The RTA draft policy provides a Decision Support Flow Chart to determine if compensatory habitat is required. This is shown in Figure 1. It is used to analyse the need for compensatory habitat at Bonville later in this report.

Figure 1: Decision framework (reproduced from RTA Policy and Guidelines – Draft 6 12/11/98).



3.3 NPWS Draft Guidelines

The NPWS does not have an official policy regarding compensatory habitat. However, NPWS Northern Zone has made available the document *NPWS Draft Guidelines for Compensatory Habitat Assessment* (see Attachment 3). It contains a list of values that should be taken into consideration during compensatory habitat assessments. The NPWS also recommended that we review two recently completed compensatory habitat assessments (Ecopro 1997; Sinclair Knight Merz 1998). However, as stated above, the current report does not include a detailed assessment of compensatory habitat.

As a result of correspondence from NPWS comments on the Draft Discussion Report (May 1998) and RTA compensatory habitat policy, there appeared to be some ambiguity regarding the NPWS position on whether or not compensatory habitat should be determined on a regional scale in the case of Bonville. During a recent meeting between the RTA and NPWS (15 October 1998), it was agreed by both parties that compensatory habitat would be determined on a project-by-project basis. However, this is not to say that compensatory habitat will necessarily always be confined to the project area. This is dealt with further below.

The present report will provide a basis for further discussions between NPWS and the RTA concerning a suitable compensatory habitat package for the Bonville deviation.

4. REQUIREMENTS FOR COMPENSATORY HABITAT

The Bonville deviation route was subject to an extensive route selection process. Four options were considered in detail. The alignment of the southern section of the route was largely determined by the desire to remain close to the existing highway and by safety and engineering constraints whereas the northern section varied more widely. The final route was selected on the basis of social, economic, biological, heritage and community issues.

Sections of the final route were redesigned throughout the EIS process and in response to submissions largely in order to minimise flora, fauna and noise impacts. Options for redesign and mitigation relevant to ecological issues are detailed below. Details of the proposal, impact assessment and mitigation are found in the Bonville Project Environmental Impact Statement (PPK 1998) and Species Impact Statement (Biosis Research 1998).

For ease of discussion, the Bonville study area has been divided into three sections based on similarities in vegetation cover and consequent mitigation measures. These are: Pine Creek State Forest; creek and gully crossings along the route; and NPWS-owned land near Bongil Bongil National Park. Each section will be described briefly in terms of its biological values followed by a discussion of the potential impacts and proposed mitigation measures. Discussion of flora and fauna species is confined to those that are considered to be endangered or vulnerable at a statewide level.

4.1 Pine Creek State Forest (PCSF)

Approximately three kilometres of the Bonville deviation transects Pine Creek State Forest. This section was also defined to include an area of private land which is adjacent to the northern boundary of PCSF on the eastern side of the proposed highway as it is not distinguishable on ecological grounds.

4.1.1 Description

The area of Pine Creek State Forest included in the study area contains at least one species of State significance (Rusty Plum). Suitable habitat for *Parsonsia dorrigoensis* is present. *Hicksbeachia pinnatifolia*, *Marsdenia longiloba* and *Tinospora tinosporoides* have the potential to occur in parts of this site that provide sheltered conditions similar to rainforest.

A diverse range of fauna was found in PCSF during the SIS survey, including three species of state significance: the Koala, the Little Bent-wing Bat and the Giant Barred Frog. The Koala population in PCSF is considered to be of regional to state significance (Austeco 1997). Other species of state significance which may occur include: Wompoo Fruit-Dove, Rose-crowned Fruit-Dove, Glossy-Black

Cockatoo, Barred Cuckoo-shrike, Powerful Owl, Masked Owl, Sooty Owl; Brushtail Phascogale, Yellow-bellied Glider, Common Planigale, Queensland Blossom Bat, Common Bent-wing Bat and Eastern Cave Bat.

The NPWS has recognised PCSF as a major regional wildlife corridor between the tablelands escarpment and the coast, with special significance for Koalas. This extensive and continuous corridor provides a link to the coast via Dorrigo National Park, Tuckers Nob State Forest and then south-east through PCSF to Bongil Bongil National Park and the coast (NPWS Northern Zone unpubl. notes).

The Species Impact Statement found Pine Creek State Forest to be of State significance.

4.1.2 Impacts of Proposal on Fauna and Flora

The impacts on the flora and fauna of this area include:

- Fragmentation/Isolation of Habitats/Barrier Effects

  Fragmentation of this area would not have a significant effect on the more mobile faunal species such as birds and bats. However, less mobile species such as ground-dwelling mammals, small birds, reptiles and amphibians would be impacted by habitat fragmentation and barrier effects. Fragmentation and barrier effects would not be likely to affect the reproduction of flora species; however the fragmentation of this area makes it more open to exotic weed invasion. The proposed highway would create a barrier across a major regional wildlife corridor.

- Vegetation Clearance/Habitat Loss

  Approximately 33 ha of vegetation (i.e. includes 28.5 ha from PCSF) would be removed as part of highway construction within Pine Creek State Forest. This comprises mainly Dry and Moist Blackbutt and Tallowwood-Sydney Blue Gum vegetation communities. Vegetation clearance and habitat loss would affect fauna groups differently. Generally, the clearance of vegetation along a linear corridor is not expected to have a significant effect on the reproductive potential of flora species. The clearing of the vegetation along the proposed alignment does have the potential to remove rare flora species.

  Mobile fauna species including the Little Bent-wing Bat, Wompoo Fruit Dove, Rose-Crowned Fruit Dove, Glossy-Black Cockatoo, Barred Cuckoo-shrike, Powerful Owl, Masked Owl, Sooty Owl, Queensland Blossom Bat and Eastern Cave Bat, will be less affected by habitat loss because they are unlikely to be dependent solely on narrow linear habitats for all their resources. More sedentary species such as the Koala, Giant Barred Frog, Yellow Bellied Glider, Brushtail Phascogale and Common Planigale are more likely to be impacted through loss of habitat.

4.1.3 Mitigative Measures Proposed

Several route options were considered for the Bonville deviation within Pine Creek State Forest especially at its southern end. These were aimed at using the existing electricity easement and avoiding two gullies within PCSF. However, it was found that these alterations did not result in any obvious benefits from an ecological or an engineering perspective. Mitigation aimed at minimising barrier impacts to fauna through construction of overpasses and/or underpasses in different locations. The final result has been the result of an interactive process between the RTA, ecological consultants and the NPWS.

Several mitigation measures have been incorporated into the proposal in order to reduce barrier impacts to fauna groups. Two major structures (an overpass and an underpass) are proposed in a central position within the forest in order to facilitate movement of Koalas, gliders and other mammals species across the roadway. The underpass is likely to be utilised by most species because it would retain a natural soil substrate and allow clear visibility of the habitat beyond. Similarly, the proposed overpass

is likely to be used by all fauna groups including gliders provided that revegetation of the 50-m corridor includes appropriate species of tall trees.

Koala-proof fencing would be erected along the highway within PCSF. Although this would reduce or eliminate the incidence of Koala road kills, it is also likely to act as a barrier medium to large-sized ground-dwelling mammals (e.g. wallabies, possums, echidnas) and to other sedentary species that are unlikely to encounter or utilise overpasses or underpasses. Koala-proof fencing would also be used in order to prevent Koalas and medium- to large-sized ground-dwelling fauna species from entering the median strip from the vegetated overpass. In addition, a medium structure (shared with local traffic) near Sid Bourke Rest Area would provide a movement corridor for ground-dwelling fauna especially Koalas. The proposed vegetated median strip may provide a movement corridor for large and possibly small gliders provided that suitable species of tall trees are established. Small birds and reptiles would also be able to utilize habitat within the median strip.

Mitigation would also include measures to reduce the barrier effects of the old Pacific Highway in the area near the proposed overpass. These may include revegetation works close to the edge of the road, signage, rumble strips and lighting.

Mitigation measures for habitat disturbance include minimising areas to be cleared or disturbed during construction and protecting vegetation adjacent to earthworks. Revegetation or rehabilitation would apply to those areas:

- Disturbed through construction in the area of the Pine Creek crossing;
- Linking overpasses or underpasses to the old Pacific Highway and beyond;
- Along the old Pacific Highway;
- Overpass and median strip.

4.1.4 Assessment Matrix

An assessment matrix is provided below for Pine Creek State Forest:

	Impacts				
Mitigation measures	Barrier Effects	Road Kills	Fragmentation	Aquatic Impacts	Loss of Key Habitat
Fauna overpass	✔	✔	✔		
Major underpass	✔	✔	✔		
Koala-proof fencing		✔			
Vegetated median strip	✔		✔		
Bridge (Pine Creek)	✔	✔	✔	✔	
Sedimentation & erosion controls (Pine Creek)				✔	
Compensatory habitat					✔

✔ = adequately mitigated; ✕ = not mitigated

It is considered that mitigation measures employed at Pine Creek State Forest are adequate in reducing all impacts to an acceptable level with the exception of habitat loss (Biosis Research 1998).

4.1.5 Conclusions

Compensatory habitat is required for PCSF because, despite extensive effort to mitigate against ecological impacts, there is still a residual impact associated with overall net loss of key habitat (Figure 1). PCSF and privately-owned land to the north comprise key habitat for the following reasons:

- The Koala population in PCSF is considered to be of regional to state significance;
- The NPWS has recognised PCSF as a major regional wildlife corridor between the tableland escarpment and the coast, with special significance for Koalas;
- PCSF contains areas of high quality Koala habitat (SFNSW 1997);
- Pine Creek provides habitat for the Giant Barred Frog.
- PCSF provides habitat for at least five significant plant species and a further 13 significant fauna species;
- PCSF contains regionally significant Tall Open Forest (Blackbutt dominant);
- The Species Impact Statement (Biosis Research 1998) found Pine Creek State Forest to be of **State** significance.

4.2 Creek and Gully Crossings Along the Route

In general, the land transected by the deviation between Pine Creek and Bongil Bongil NP comprises cleared agricultural land with native vegetation remnants and creek crossings. Remnants of native vegetation are located to the south and north of East Bonville Road and along Bonville Creek; these are referred to by number as in the Species Impact Statement (Biosis Research 1998). The proposed highway crosses several major creeks and some minor gullies including Pine Creek, Reedy Creek and Bonville Creek. Sites are shown in Maps 1a and 1b. Note that even though Site 2 is included in the map, it would not be transected by the proposed Bonville deviation.

4.2.1 Description

Site 5 is located to the south of East Bonville Road. Although no significant plant species were located here, it may provide habitat for the five significant species listed above for Site 2 and for *Eleocharis tetraquetra, Persicaria elatior* and *Phaius australis*. It also provides habitat for the Koala, the Wompoo Fruit-Dove and a breeding pair of Ospreys. It is directly adjacent to SEPP 14 wetland 344. The Species Impact Statement found Site 5 to be of **Regional** significance.

Site 6 is located north of East Bonville Road. Although no significant plant species were located here, there is the potential for *Eleocharis tetraquetra, Persicaria elatior* and *Phaius australis* to occur. This site contains habitat for the Koala and the Great Egret. It is directly linked to SEPP 14 wetland 335. The Species Impact Statement found Site 6 to be of **Regional** significance.

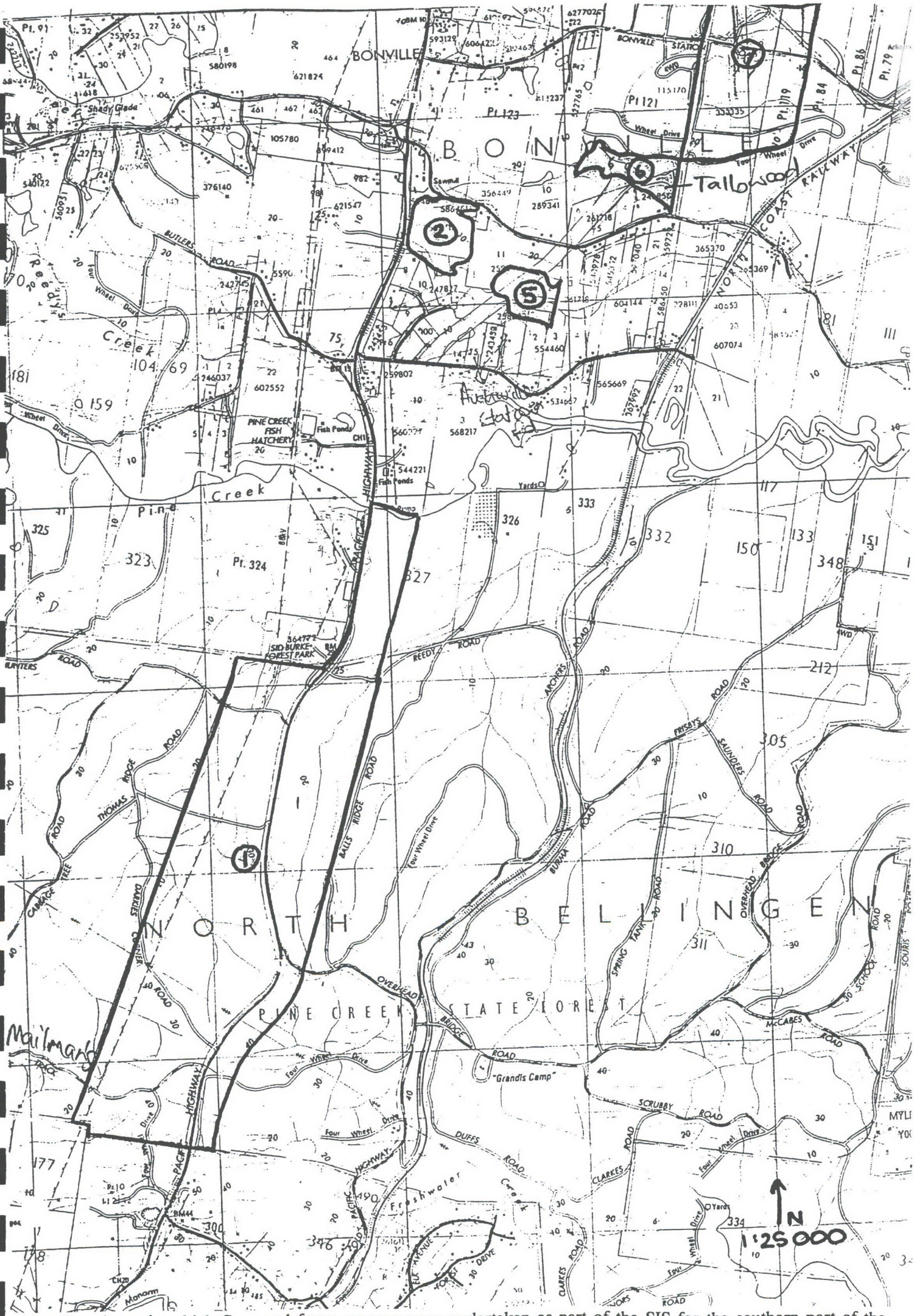
Site 7 is located at Bonville Station Road. Although no significant plant species were located here, there is the potential for *Eleocharis tetraquetra, Phaius australis Parsonsia dorrigoensis, Hicksbeachia pinnatifolia, Marsdenia longiloba, Tinospora tinosporoides* and *Amorphospermum whitei* to occur. At the time of the SIS survey, the site consisted mainly of *Eucalyptus* plantation that has since been cleared. A strip of riparian vegetation is associated with Bonville Creek. Habitat for the Koala and Grassland Melomys is present. Ospreys are sighted along Pine Creek. The Species Impact Statement found Site 7 to be of **High Local** significance.

4.2.2 Impacts of Proposal on Fauna and Flora

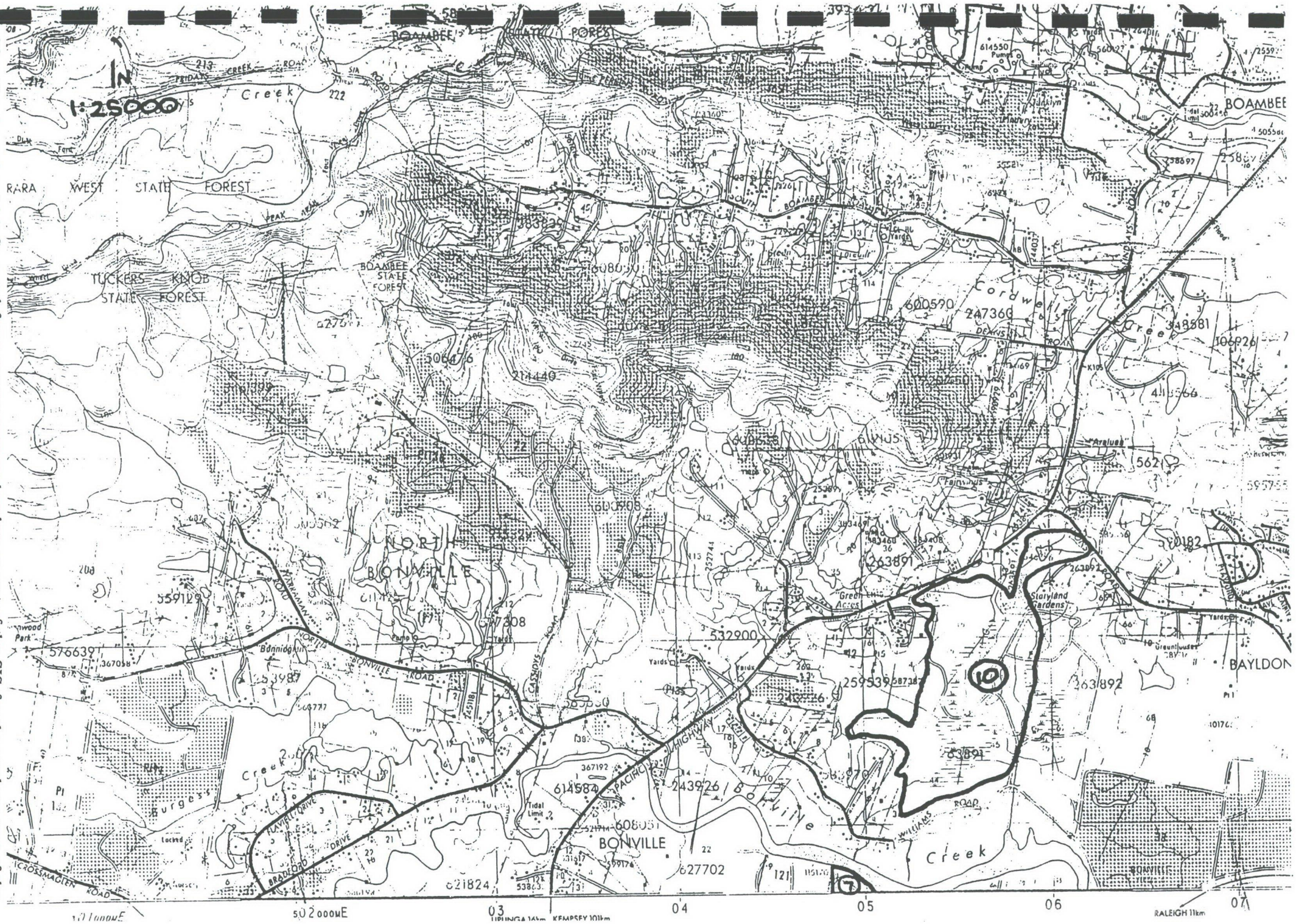
The impacts on the flora and fauna at creek crossings and vegetation remnants along the proposed highway include:

- Fragmentation/Isolation of Habitats/Barrier Effects

  Native vegetation along this section of the proposed highway is already fragmented. Although riparian vegetation is relatively continuous, the old Pacific Highway currently forms a barrier across all creeklines. The new alignment would create a new barrier, further fragmenting habitat.



Map 1a: Areas in which flora and fauna surveys were undertaken as part of the SIS for the southern part of the



Map 1b: Areas in which flora and fauna surveys were undertaken as part of the SIS for the northern part of the proposed Bonville deviation

Although often narrow and disturbed, riparian corridors provide movement corridors for mobile bird and bat species and habitat for birds, reptiles and amphibians. The culvert proposed for Reedy Creek allows for the passage of terrestrial as well as aquatic fauna.

- Water Quality

Earthworks associated with construction can lead to erosion of exposed soils and a consequent increase in the amount of suspended solids being carried into local water courses by surface water run-off. This would result in pollution of water courses with sediments, dissolved salts, organic solids and other material. Acid sulphate soils are also a potential problem.

- Vegetation Loss/Habitat Loss

Approximately 8 ha of native vegetation (not including plantation or regrowth) would be removed as a result of highway construction. This comprises the following communities: Paperbark, Flooded Gum, Swamp Mahogany, Moist Blackbutt, Tallowwood and Turpentine. Some *Eucalyptus* plantation and regrowth would also be removed as part of the development.

Mobile species such as the Osprey are not likely to be affected by loss of habitat unless this includes nest sites. However less mobile species such as the Koala and Grassland Melomys are more likely to be impacted through loss of habitat.

4.2.3 Mitigative Measures Proposed

Route options along this section of the Bonville deviation sought to minimise impacts on native vegetation remnants and stream crossings while taking into account agricultural and noise issues.

The type and size of mitigation measures to be incorporated as part of the proposal were decided in consultation with NPWS. Specifically, structures were selected according to the likely importance of each crossing to fauna movement. Large structures are proposed for Pine and Bonville Creeks as these provide important local movement corridors. These would allow the free passage of terrestrial as well as aquatic fauna. A minor structure is proposed for Reedy Creek as it is not likely to provide an important corridor for terrestrial or aquatic fauna. However, the culvert would allow movement of small species of terrestrial and aquatic species (e.g. reptiles, amphibians).

A number of measures would be implemented in order to control soil erosion and surface water run-off. These include: minimising the area disturbed; installing drainage works prior to disturbance; directing run-off to sediment control devices, reusing collected water for dust suppression; treating excessive water prior to discharge; emptying sedimentation basins after storm events; maintaining vegetation in and adjacent to drainage lines; stabilising drainage works; installing banks, bunds or drains across the contour; revegetating disturbed areas; and surrounding oil storage areas with bunds. In addition, an Acid Sulphate Soil management plan would be prepared.

Where vegetation is removed the areas will be rehabilitated as much as possible. Potential impacts from the removal of riparian vegetation are expected to be minimal as vegetated areas would be avoided where possible and rehabilitated in other cases. In particular, revegetation is proposed adjacent to bridge construction at Pine Creek, an area which provides habitat for the Giant Barred Frog.

4.2.4 Assessment Matrix

An assessment matrix is provided below for creek and gully crossings along the Bonville deviation:

	Impacts			
Mitigation measures	Barrier Effects	Fragmentation	Aquatic Impacts	Loss of Key Habitat
Bridges (Bonville Creek)	✔	✔	✔	
Sedimentation & erosion controls (Bonville, Reedy Ck)			✔	
ASS management plan			✔	
Compensatory habitat				✔

✔ = adequately mitigated; ✕ = not mitigated

It is considered that mitigation measures employed at creek and gully crossings are adequate in reducing all impacts to an acceptable level with the exception of habitat loss (Biosis Research 1998; Robyn Tuft & Associates 1998).

4.2.5 Conclusions

Compensatory habitat is required for Sites 5 and 6 and part of Site 7 (i.e. the riparian strip associated with Bonville Creek), despite extensive effort to mitigate against ecological impacts, there is still a residual impact associated with net loss of key habitat (Figure 1). These sites comprise key habitat for the following reasons:

- They comprise primary Koala habitat (Lunney *et al.* 1997);
- They provide potential habitat for 2-7 significant plant species and 1-3 significant fauna species;
- The Species Impact Statement found Sites 5 and 6 to be of **regional** significance and Site 7 to be of **high local** significance.

It is important to note that the Koala habitat mapping undertaken by Lunney *et al.* (1997) formed the basis for the LEP currently being prepared by the Coffs Harbour City Council. As the LEP has not yet been finalised, we cannot be certain that existing areas of primary and secondary Koala habitat will be incorporated into the final LEP (see key habitat – Section 3.2) nor that these areas would be guaranteed protection in the long-term.

SEPP 14 wetlands located adjacent to these remnants would not be directly affected by the highway; erosion and sedimentation mitigation measures would ensure that indirect impacts are also minimised. Compensatory habitat issues for the Giant Barred Frog have been considered in Section 4.1.

Compensatory habitat is required for Sites 5, 6 and part of Site 7 because they contain key habitat.

At the time of the SIS survey, Site 7 comprised mainly *Eucalyptus* plantation which has since been cleared. Plantations generally have substantially reduced habitat values (e.g. hollows, fruit and flowers, logs, leaf litter) and may therefore provide only marginal habitat. They are therefore not considered to provide key habitat although significant species such Koalas may utilise them. Presently, the former plantation has very few values for native fauna species.

Compensatory habitat is not required for the Eucalyptus plantation in Site 7 as it does not constitute key habitat.

4.3 NPWS Land Adjacent to Bongil Bongil National Park

The proposed highway transects a four-hectare area of native vegetation located between Williams Road and Lyons Road. The land was acquired by NPWS for inclusion into Bongil Bongil NP. It would be

acquired by the RTA for road construction; a linear section adjacent to the proposed highway would remain undisturbed.

4.3.1 Description

Six flora species of national significance are known to occur within Bongil Bongil National Park, including three which are of state significance (*Acianthus amplexicaulis*, *Acronychia littoralis*, *Alexfloydia repens*, *Amorphospermum whitei*, *Marsdenia hemiptera*, *Tinospora tinosporoides*). *Marsdenia hemiptera* is proposed for listing as Endangered at the state level. A further three species of national significance (*Eleocharis tetraquetra*, *Austrobuxus swainii* and *Backhousia anisata*) are considered likely to occur within the park. Of these species, only *Amorphospermum whitei* may occur in the area to be affected by the proposal.

The NPWS land contains more mature trees than adjacent areas within Bongil Bongil National Park. The Koala has been recorded at a number of sites in this area. A Tiger Quoll was recorded from just south of Lyons Road while Powerful Owl and Brushtail Phascogale records exist within an approximate one kilometre radius of the proposed highway alignment. The natural and artificial wetlands in this area are considered to be of high habitat value. Three species of state significance, the Black Bittern, Osprey and Comb-crested Jacana (three species listed on Schedule 2 of the TSC Act), occur in this area. The Black Bittern is known to have bred at one of these dams. There are unconfirmed records of the Black-necked Stork, which is of state significance, from the dams in this area.

The proximity and the connectivity of this site to more extensive forested areas, including Bongil Bongil National Park, together with the diversity of fauna habitats, indicate that this area is likely to support a wide variety of significant fauna.

The Species Impact Statement found this area to be of **High Regional** significance.

4.3.2 Impacts of Proposal on Fauna and Flora

The impacts on the flora and fauna of this area include:

- Fragmentation/Isolation of Habitats/Barrier Effects

  Fragmentation of this area would not have a significant effect on the more mobile faunal species such as birds and bats. However, less mobile species such as ground-dwelling mammals, small birds, reptiles and amphibians would be impacted by habitat fragmentation and barrier effects. Fragmentation and barrier effects would not be likely to affect the reproduction of flora species; however the fragmentation of this area makes it more open to exotic weed invasion. The proposed highway would increase barrier effects across a major regional wildlife corridor.

- Vegetation Clearance/Habitat Loss

  Approximately 2 ha of vegetation (not including regrowth) would be removed as part of highway construction adjacent to Bongil Bongil NP. This comprises mainly Flooded Gum and Moist Blackbutt communities. Vegetation clearance and habitat loss would affect fauna groups differently. Generally, the clearance of vegetation along a linear corridor is not expected to have a significant effect on the reproductive potential of flora species. The clearing of the vegetation does have the potential to remove rare flora species.

  Mobile fauna such as the Black Bittern, Osprey, Comb-crested Jacana and Black necked Stork would be less affected by habitat loss than other less mobile species such as the Koala, Tiger Quoll and Brushtail Phascogale.

4.3.3 Mitigative Measures in Proposal

The route alignment in the area of Bongil Bongil NP was moved to the west in order to minimise fragmentation impacts to the Park. The final route was selected in consultation with NPWS and ecological consultants but was subject to engineering constraints and local resident concerns.

One major fauna underpass has been proposed for this area in order to reduce barrier impacts for fauna groups. The underpass is likely to be utilised by most species because it would retain its natural substrate and allow clear visibility of the habitat beyond. The main purpose of the structure is to maintain the integrity of a regional wildlife corridor.

Koala-proof fencing would be erected along the highway adjacent to Bongil Bongil NP. Although this would reduce or eliminate the incidence of Koala road kills, it is also likely to act as a barrier to medium to large-sized ground-dwelling mammals and to other sedentary species that are unlikely to encounter or utilise underpasses. These may include wallabies, possums and echidnas.

Mitigation would also include measures to reduce the barrier effects of the old Pacific Highway near the proposed underpass. These may include revegetation works close to the edge of the road, signage, rumble strips and lighting.

Mitigation for habitat disturbance would include minimising areas to be cleared or disturbed during construction and protecting vegetation adjacent to earthworks.

4.3.4 Assessment Matrix

An assessment matrix is provided below for NPWS land adjacent to Bongil Bongil NP:

	Impacts				
Mitigation measures	Barrier Effects	Road Kills	Fragmentation	Aquatic Impacts	Loss of Key Habitat
Major underpass	✔	✔	✔		
Koala-proof fencing		✔			
Sedimentation & erosion controls (Pine Creek)				✔	
Compensatory habitat					✔

✔ = adequately mitigated; ✕ = not mitigated

It is considered that mitigation measures employed at NPWS land adjacent to Bongil Bongil NP are adequate in reducing all impacts to an acceptable level with the exception of habitat loss (Biosis Research 1998).

4.3.5 Conclusions

Compensatory habitat is required near Bongil Bongil National Park because, despite extensive effort to mitigate against ecological impacts, there is still a residual impact associated with loss of key habitat (Figure 1). NPWS land adjacent to Bongil Bongil NP comprises key habitat for the following reasons:

- The NPWS has recognised that this area forms part of the Tuckers Nob/Lyons Road Koala corridor which is considered to be of regional significance;
- It was proposed for addition to Bongil Bongil National Park;
- Bongil Bongil NP provides habitat for at least six significant plant species and nine significant fauna species;
- The subject area has been mapped as Preferred Habitat Type A in the Coffs Harbour Koala Habitat Mapping (Lunney *et al.* 1997, in NPWS 1998b).

- The Species Impact Statement found the area adjacent to Bongil Bongil National Park to be of **High Regional** significance.

5. DISCUSSION AND CONCLUSIONS REGARDING THE NEED FOR COMPENSATORY HABITAT

The need for compensatory habitat as a result of proposed highway construction at Bonville has been assessed using the decision framework shown in Figure 1. For ease of discussion, the highway deviation was divided into three sections and each of these was assessed separately according to the following criteria:

- The RTA study team has undertaken extensive route selection studies in order to best meet social, economic, biological, heritage and community concerns. From an ecological viewpoint, these studies have aimed to avoid areas of native vegetation and/or to minimise fragmentation.

- The RTA study team has investigated options for redesign of the highway at its southern and northern ends primarily as a result of flora and fauna concerns (generated by NPWS and the local community). From an ecological perspective, design options sought to minimise habitat loss, fragmentation and barrier effects.

- The EIS and SIS study teams have recommended mitigation measures to reduce the barrier impacts of the highway, to ensure that water quality both on- and off-site is maintained during construction and operational phases and to revegetate areas associated with the overpass, median strip and old Pacific Highway.

However, it was found that there was still a residual impact from loss of key habitat after relocation and redesign studies and mitigation. Key habitat loss is as follows:

Section of Bonville deviation	Key habitat loss
Pine Creek State Forest + Woods' property	Approximately 33 ha
Habitat Remnants and Creek Crossings	Approximately 8 ha
Bongil Bongil NP	Approximately 2 ha
TOTAL	**Approximately 43 ha**

Taking into account revegetation of the overpass and parts of the median strip and associated links along the old Pacific Highway, the provision of a compensatory habitat package comprising the equivalent of at least 40 ha would be considered adequate for the entire Bonville deviation. It should be noted that this estimate is based on ecological grounds only. Although we understand that economic factors will play an important part in the final negotiations for a compensatory package, these are not discussed further in this report.

5.1 Compensatory Habitat Guidelines

This section provides some general ecological guidelines for evaluating the type and amount of compensatory habitat required. Several of the papers reviewed during the course of this study stressed that it was important to identify the aim of mitigation/compensation. For instance, in the case of Bonville, much of the mitigation effort was aimed at reducing impacts on Koalas. However, mitigation measures such as fencing and underpasses have negative impacts on other fauna species, in particular ground-dwelling mammals and gliders. It is therefore important to take this into account when determining suitable compensatory habitat.

In general, compensatory habitat for PCSF should be of a similar type, quality and quantity as the habitat that is being removed. In particular:

- The size of the compensatory land package should if possible be the equivalent of at least 40 hectares in order to compensate for a similar amount of key habitat removed as part of the development.

- A compensatory package may comprise any or all of the following as agreed by the negotiating parties:

  - Land acquisition and transfer of tenure to NPWS or other land management authority (e.g. DLWC, SFNSW);
  - Privately-owned land protected under a Voluntary Conservation Agreement (VCA);
  - Revegetation of specific areas;
  - Rehabilitation of specific areas.

- It should comprise similar habitat to that removed although consideration and emphasis should be given to the habitat requirements of fauna species whose habitat is known to be impacted such as the Giant Barred Frog, Common Planigale and Koala as these are more likely to be impacted by the development.

- Wherever possible, compensatory habitat should be located close to the development site for the following ecological reasons:

  - To reinforce existing impacted corridors;
  - To maintain the viability of impacted areas;
  - To increase the probability of providing key habitat for species/populations/communities that have been impacted by the development;
  - To maximise the effectiveness of the mitigation measures put in place as part of the development;
  - To take into account the future managing authorities' requirements (i.e. practicality);
  - To reinforce direct association of compensatory habitat with project, thereby gaining community acceptance.

- All other things being equal, preference should be given to habitat areas that are adjacent to land with secure tenure.

6. OPPORTUNITIES FOR COMPENSATORY HABITAT

The RTA was given a list of proposed sites for compensatory habitat by NPWS. Several sites proposed as compensatory habitat were visited on 4 May including the Ruxton property, the Sawtell site and Lindsays Cutting (Boambee corridor). The sites was visited with Suzanne Dray (Senior Botanist, Biosis Research) and Chris Moon (Koala Survey and Management Services). A meeting to discuss compensatory habitat was held with staff of the NPWS Pacific Highway Upgrading Unit (Dianne Brown, John Turbill, Nick Sheppard, Lynn Baker) on 5 May. Subsequent to that meeting, Dianne Brown and Renata Bali visited three additional sites that the NPWS suggested should be considered in any discussions of compensatory habitat. Brief descriptions of these sites are included in Attachment 2.

Apart from size, it is important that habitat type and quality be considered as a first step in the determination of a compensatory habitat package. Towards this end, a summary of flora and fauna values for the areas of key habitat to be lost as a result of Bonville development is presented in Table 2. A similar list has been compiled for areas that are considered to provide opportunities for compensatory habitat near Bonville (Table 3).

6.1 Where do we go from here?

We propose the following process to advance the negotiations between NPWS and RTA for compensatory habitat:

1. Determine if the list of compensatory habitat opportunities is comprehensive enough given the information provided in Section 5 of this report.

2. Once the list comprises an adequate range of opportunities, short-list these on the basis of guidelines in section 5.1.

3. Assess sites included on the final short-list based on NPWS guidelines (Attachment 3);

4. Select a single site or a range of sites which best compensate for key habitat losses.

The process described above is based on ecological criteria only and is therefore necessarily simple. In reality, there are many planning and economic issues to be considered before a package can be finalised. In particular, availability of suitable habitat is paramount to the entire process. It is important that all these aspects of the assessment progress in parallel.

Table 2: Flora and fauna values for key habitat lost due to highway construction.

Key Habitat Areas Lost	Size	Communities Present	Habitat for Significant Spp	Condition	Corridor Values
PCSF & Woods' property	33 ha	Dry Blackbutt, Moist Blackbutt, Tallowwood – Sydney Blue Gum	Rusty Plum, *Parsonsia dorrigoensis, Hicksbeachia pinnatifolia, Marsdenia longiloba, Tinospora tinosporoides*, Koala, Little Bent-wing Bat, Giant Barred Frog, Wompoo Fruit-Dove, Rose-crowned Fruit-Dove, Glossy Black-Cockatoo, Barred Cuckoo-shrike, Powerful Owl, Masked Owl, Sooty Owl, Brushtail Phascogale, Yellow-bellied Glider, Common Planigale, Queensland Blossom Bat, Common Bent-wing Bat, Eastern Cave Bat	High quality koala habitat (SFNSW 1997)	Regional Corridor
Site 5	3.9 ha	Flooded Gum	*Eleocharis tetraquetra, Amorphospermum whitei, Parsonsia dorrigoensis, , Hicksbeachia pinnatifolia, Marsdenia longiloba, , Tinospora tinosporoides, Persicaria elatior, Phaius australis*, Koala, Wompoo Fruit-Dove, Osprey	Primary koala habitat (Lunney *et al.* 1997)	Local Corridor
Site 6	1.3 ha	Tallowwood, Swamp Forest	*Persicaria elatior, Phaius australis*, Koala, Great Egret	Primary koala habitat	Local Corridor
Site 7	1.2 ha	Plantation, Swamp Forest, Riparian	*Eleocharis tetraquetra, Phaius australis, Amorphospermum whitei*, Koala, Grassland Melomys	Primary and secondary koala habitat	Local Corridor
Land adjacent to Bongil Bongil NP	2 ha	Flooded Gum, Moist Blackbutt, Sedgeland/ Rushland	*Acianthus amplexicaulis, Acronychia littoralis, Alexfloydia repens, Amorphospermum whitei, Marsdenia hemiptera, Tinospora tinosporoides, Austrobuxus swainii, Backhousia anisata*, Koala, Tiger Quoll, Powerful Owl, Brushtail Phascogale, Black Bittern, Osprey, Comb-crested Jacana, Black-necked Stork	Primary koala habitat	Regional Corridor

Table 3: Identified opportunities for compensatory habitat.

Area Proposed	Size	Communities present	Habitat for Significant Spp.	Distance from Deviation	Condition	Future Mgmt/Proposed Tenure	Security of tenure	Corridor values	Rank
1. Ruxton/Elks' + NPWS land east of old Pacific Hwy	< 1 ha + road reserves	Tallowwood Flooded Gum	Koala food trees; possibly frogs; corridor important to migratory birds	Adjacent	Secondary Koala habitat	Weed eradication/ revegetation; RTA road reserve, VCA	VCA + revegetation (adjacent to privately – owned land)	Part of regional corridor,	
2. Sawtell site, Moller Drive	2.4 ha	Swamp Forest (Scribbly Gum)	Koala, Qld Blossom Bat, Brush-tailed Phascogale, Common Planigale, Masked Owl, Squirrel Glider, Swift Parrot, Wallum Froglet, mircrobats, overwintering area for honeyeaters, Scribbly Gum	4+kms	Primary Koala habitat	NP	Adjacent to Bongil Bongil NP and residential subdivision.	Extension to BBNP riparian corridor (local)	
3. Boambee corridor + revegetation (?)	Approx. 22 ha	Tallowwood, Moist Blackbutt, Swamp Forest	Koala, microbats, potential habitat for threatened flora	<4 kms	Primary Koala habitat	Nature Reserve NP	Adjacent to private land, adjacent land sympathetically managed.	Regional corridor	
4. Woods' land – north of PCSF to the east of the highway	Approx. 39 ha	Dry Blackbutt & Plantation Tallowwood Flooded Gum Moist Blackbutt. Turpentine	Giant Barred Frog, Common Bent-wing Bat, Little Bent-wing Bat, Powerful Owl, Sooty Owl, Yellow-bellied Glider, Rusty Plum	Adjacent	Primary & secondary koala habitat	VCA	Adjacent to PCSF, private land.	Pine Creek regional corridor	
5. North of E. Bonville Rd	Approx. 68 ha	Tallowwood Swamp Mahogany Flooded Gum Paperbark, Dry Blackbutt	Unknown	1.5 km	Primary Koala habitat	Addition to Bongil Bongil NP	Adjacent to Bongil Bongil, private land	Local corridor	
6. 'Storyland Gardens'	<4 ha	Tallowwood	Unknown	Adjacent	Primary Koala habitat	Addition to Bongil Bongil NP	Adjacent NP, SFNSW (status of IDFAs unknown)	Corridor between PCSF & BBNP - regional corridor	
7. PCSF between railway and coast*	Approx. 44 ha	Dry Blackbutt Tallowwood - Sydney Blue Gum Swamp Mahogany Plantation (mainly)	Unknown (Similar to Bongil Bongil NP)	<4 kms	Primary Koala habitat	Addition to Bongil Bongil NP	SFNSW or NPWS, dependant on status of IDFAs	Local corridor	

* This includes an area linking proposed IFDAs with the coast and is roughly bounded by "Bundagen" to the north, the Bundagen Flora Reserve to the south east and PCSF to the south west.

7. BIBLIOGRAPHY

Allen A.O. & Feddema J.J. (1996). Environmental auditing, Wetland Loss and Substitution by the Section 404 Permit Program in Southern California, USA. Env. Man. Vol. 20, No. 2: 263-274.

AUSTECO (1997). Koala Habitat, Abundance and Distribution in the Pine Creek Study Area. A Report to State Forests of NSW

Bedford B.L. & Preston E.M. (1988). Developing the scientific basis for assessing cumulative impacts of wetland loss and degradation on landscape functions: status, perspectives and prospects. Environmental Management 12: 751-771.

Bedford B.L. (1996). The need to define hydrologic equivalence at the landscape scale for freshwater wetland mitigation. Ecol. Appl. 6(1): 57-68.

Biosis Research (1998). Species Impact Statement for the Proposed Pacific Highway Upgrade from Mailmans Track to Lyons Road, Bonville. PPK Environment and Infrastructure, Concord West.

Bingham B.B. & Noon B.R. (1997). Mitigation of Habitat "Take": Application to Habitat Conservation Planning. Conserv. Biol. 11(1): 127-139.

Boucher S. & Whatmore S. (1993). Green Gains? Planning by agreement and nature conservation. J. Environmental Planning & Management 36(1): 33-49.

Brinson M.M. & Rheinhardt R. (1996). The role of reference wetlands in functional assessment and mitigation. Ecol. Appl. 6(1): 69-76.

Cowell R. (1997). Stretching the limits: environmental compensation, habitat creation and sustainable development. Trans. Inst. Br. Geogr. 22: 292-306.

Dept. of Fisheries and Oceans (1998). Habitat Conservation and Protection Guidelines (Developed from the Policy for the Management of Fish Habitat (1986)). Dept. of Fisheries and Oceans Canada. Second Edition.

Ecopro (1997). Bulahdelah to Coolongolook Deviation Compensatory Habitat Assessment. Acacia Environmental Planning.

Fisher M., Body M. and Gill J. (1996). The Vegetation of the Coffs Harbour City Council LGA. A report prepared for the Coffs Harbour City Council. NPWS, Northern Region.

Goldingay R. (1992). Fauna evaluation for development of land on Moller Drive, Bonville North. Report prepared for Gutteridge, Haskins & Davey, Coffs Harbour.

Kentula M. E., Sifneos J. C., Good J. W., Rylko M. & Kunz K. (1992). Trends and Patterns in Section 404 Permitting Requiring Compensatory Mitigation in Oregon and Washington, USA. Env. Man. Vol. 6, No. 1: 109-119

Kistritz R. (1996). Habitat Compensation, Restoration and Creation in the Fraser River Estuary: Are We Achieving a No-Net-Loss of Fish Habitat? Can. Tech. Rept. Fish.Aquat. Sci. 2349. 113 pp.

Lee C.L. & Gosselink J.G. (1988). Cumulative impacts on wetlands: linking scientific assessments and regulatory alternatives. Environmental Management 12:591-602.

Ludwig D. (1993). Environmental sustainability: magic, science and religion in natural resource management. Ecological Applications 3: 555-558.

McCuskey S.A., Conger A.W. & Hillestad H.O. (1994). Design and implementation of functional wetland mitigation: case studies in Ohio and South Carolina. Water, Air and Soil Pollution 77: 513-532.

Moon C. (1997). Lindsays Cutting Koala Monitoring Program – Stage 1 Final Report. Report prepared for the NSW Roads & Traffic Authority by Koala Survey and Management Services, Bellingen.

Moon C. (1998). Letter from C. Moon to Hugh Donaldson (PPK Environment & Infrastructure) regarding the northbound truck stop and fauna underpass site options in Pine Creek State Forest dated 7 April 1998.

NPWS (1998a). Koala Habitat Assessment – 12 Titans Close, Bonville. Unpubl. internal report dated 7/4/98. NPWS, Northern Region.

NPWS (1998b). Preliminary investigations by NPWS on potential compensatory habitat for the Bonville deviation. NPWS, Northern Region.

Perry M. C., Sibrel C. B. & Gough G. A. (1996). Wetland Mitigation: Partnership Between an Electric Power Company and a Federal Wildlife Refuge. Env. Man. Vol. 20, No. 6:933-939.

Preston E.M. & Bedford B.L. (1988). Evaluating cumulative effects on wetland functions: a conceptual overview and generic framework. Environmental Management 12: 565-583.

Quadra Planning Consultants Ltd. (1997). No Net Loss of Habitat: Assessing Achievement. Workshop Proceedings 26-27 February 1997, Kwantlen University College Richmond B.C. Fraser River Action Plan, Fisheries and Oceans Canada.

Race M.S. (1985). Critique of present wetlands mitigation policies in the United States based on an analysis of past restoration projects in the San Francisco Bay. Environmental Management 9:71-82.

Race M.S. & Fonseca M.S. (1996). Fixing Compensatory Mitigation: What will it take? Ecol. Appl. 6(1): 94-101.

Scruton D. (1996). Evaluation of the construction of artificial fluvial salmond habitat in a habitat compensation project, NEWFOUNDLAND, CANADA. Regulated Rivers: Res. & Man., Vol. 12: 171-183.

Simenstad C.A. & Thom R.M. (1996). Functional equivalency trajectories of the restored Gog-Le-Hi-Te estuarine wetland. Ecol. Appl. 6(1): 38-56.

Sinclair Knight Merz (1998). Proposed Upgrade of the Pacific Highway between the Brunswick River and Yelgun. Sinclair Knight Merz, St Leonards.

SFNSW (1997). Pine Creek State Forest Draft Koala Management Plan. State Forests of New South Wales, Northern Region.

Torok L. S., Lockwood S. & Fanz D. (1996). Environmental auditing, Review and Comparison of Wetland Impacts and Mitigation Requirements Between New Jersey, USA, Freshwater Wetlands Protection Act and Section 404 of the Clean Water Act. Env. Man. Vol. 20, No. 5: 741-752.

Whatmore S. & Boucher S. (1993). Bargaining with nature: the discourse and practice of environmental planning gain. Transactions of the Institute of British Geographers 18(2): 166-78.

Woltemade C. J. (1991). Environmental impact mitigation under the clean water act and the national environmental policy act: the case of two forks dam. Vol. 27. No.2.

ATTACHMENT 1

POLICY and GUIDELINES

Road Development and Impacts on Habitat Amelioration Measures

Compensatory Habitat

DRAFT 6

12/11/98

POLICY and GUIDELINES
Road Development and Impacts on Habitat
Amelioration Measures

NB. Policy and guidelines for compensatory habitat have been dealt with first. Policy and guidelines for other measures will be developed subsequently.

POLICY and GUIDELINES
Road Development and Impacts on Habitat
Amelioration Measures

PART 1

1. Purpose of the Document

The purpose of this document is to provide policy and direction for selecting the most appropriate measures to be employed to reduce impacts on habitat and biodiversity. Additionally, it provides guidelines for the implementation of mitigation measures (compensatory habitat).

2. Background to the Policy and Guidelines

The NSW Government, along with the Commonwealth and other State and Territory Governments, have endorsed the National Strategy for the Conservation of Australia's Biological Diversity. The goal of the strategy is to **protect biological diversity and maintain ecological processes and systems**. Following this commitment, the NSW Government has prepared the draft NSW Biodiversity Strategy, which reiterates the goal of the National Strategy. The core objectives of the draft NSW Biodiversity Strategy are to:

1. Ensure the survival and evolutionary development of species, populations and communities of plants, animals and micro-organisms native to NSW;
2. Strengthen management on a bioregional basis, including the integration of biodiversity conservation and natural resource management, consistent with the principles of ecologically sustainable development;
3. Identify, prevent and attack at source the threats to biodiversity through timely implementation of targeted actions;
4. Build on the success of existing initiatives to develop a coordinated and cost-effective biodiversity conservation program involving the community, industry and all levels of Government, and ensure that the rights, knowledge and values of local and Aboriginal communities are properly recognised and reflected;
5. Strengthen actions to inform, motivate, and achieve the support of the community, including local and Aboriginal communities, industry, State Government agencies and Local Government, in conserving biodiversity; and
6. Increase our understanding of the ecological systems and processes required to conserve biodiversity through scientific research, survey and monitoring, taking into account the knowledge and values of Aboriginal and local communities.

3. Key Policy Principle

Road development often involves the changing of land use or modifications to waterways. Areas of land and adjacent waterways prior to the construction of a road provide habitat for native species, populations and communities of plants, animals and micro-organisms.

In principle, the planning and construction of roads should, in order of consideration, endeavour to:

1. **avoid** impacts on habitat, through the planning process;
2. **minimise** impacts on habitat, through the planning process; and
3. **mitigate** impacts on habitat, through the use of a range of amelioration measures.

Avoiding impacts on habitat is the best way to maintain biodiversity, and can be achieved through the planning and route selection process. **Minimising** impacts will limit habitat loss where possible through the planning and route selection process. Where residual impacts on habitat exist after the initial planning and route selection process, measures can be employed that **mitigate** these impacts.

Road development can have a range of impacts on both terrestrial and aquatic flora and fauna. A reduction in area through loss of habitat, and the impact this has on its constituent biota is just one. Other impacts on flora and fauna result from fragmentation of contiguous areas of habitat and severance of fauna movement corridors. There are other issues related to impacts on habitat which need to be considered, namely:

- effects on threatened species, populations or ecological communities, or their habitats;
- impacts at a regional, sub-regional or catchment scale;
- the long term sustainability and maintenance of habitat.

The impacts on habitat need to be assessed during the project development process. This will usually occur by way of environmental impact assessment, as required under the *Environmental Planning and Assessment Act, 1979.*

The RTA employs several measures to mitigate impacts on habitat through road development. These measures are generally outlined in an Environmental Impact Statement (EIS), and a Species Impact Statement (SIS) where necessary, and become conditions for approval in a Clause 91 determination report for an EIS and Environmental Management Plan (EMP). They may also form part of the licence requirements under the *Threatened Species Conservation Act 1995* or the *Fisheries Management Amendment Act 1997.*

Determining the most appropriate and effective measures to be employed to mitigate impacts relies on a thorough assessment of the kind and extent of impacts and the measures available, on a project by project basis. Measures employed to mitigate impacts on habitat include:

- reducing construction zones;
- underpasses;
- overpasses;
- exclusion fencing;
- landscaping and revegetation;
- site rehabilitation;
- compensatory habitat;
- traffic control, such as advisory signs, reduction of speed limits and traffic calming measures; and
- driver education and awareness (signage, community involvement)

4. Process for Determining Mitigation Measures to be Employed

1. Determine the habitat issues or impacts which are being created through the development of a road (ie, removal of habitat of a particularly sensitive or important species, population or community, general habitat removal, barrier effects and severance of a wildlife movement corridor).

2. Explore amelioration options relevant to the impacts identified, using the principle of "avoid, minimise, mitigate". Impacts will be identified through the process of route selection, consultation with the community and the National Parks and Wildlife Service (NPWS) and through the process of developing a Review of Environmental Factors, an Environmental Impact Statement and a Species Impact Statement if required.

3. Discuss selected amelioration option(s) with the local community and relevant organisations and agencies, to determine the most favourable approach. For example, Catchment Management Committees, landcare groups, local naturalists groups, NPWS, NSW Fisheries, Department of Land and Water Conservation (DLWC), State Forests of NSW and Local Councils need to be consulted. Information should be presented on the relative economic cost of proposed avoidance, minimisation and mitigation measures, their effectiveness in providing for fauna and flora habitat and practical implications for their implementation, on-going management and maintenance.

At the conclusion of this process, the strategies to avoid and minimise impacts through planning and route selection, and mitigation measures to be included during road construction will have been determined. The complement of mitigation measures should reduce the impacts on habitat and its constituent flora and fauna to a level which is accepted as not significant. Guidance and justification on the significance or otherwise of impacts can be provided by NPWS.

Compensatory habitat is appropriate only where there is loss of *key habitat* after route selection, road design and mitigation measures have been employed. For definitions of *compensatory habitat* and *key habitat* see Part 2.

The mitigation measures used to address impacts on habitat may be recorded in an assessment matrix (see Table 1.) and will ensure that all impacts and mitigation measures are being considered. This matrix will also assist in assessing whether the complement of mitigation measures reduces the impacts on habitat to an adequate, acceptable level.

Table 1: Assessment matrix of mitigation measures

Mitigation Measure	Impact A	Impact B	Impact C	Impact D
A 1	▤			
A 2			▤	
A 3	▤	▤	▤	
A 4	▤	▤	▤	▤
A 5				▤

4. Determine the complement of amelioration option(s) to be adopted which avoid, minimise and mitigate the impacts of road development on habitat and its constituent flora and fauna.

PART 2

1. Compensatory Habitat -Policy and Definitions [#]

1.1 Policy

I. Compensatory habitat will be employed as a measure to mitigate impacts on *key habitat* areas, where it is assessed as the most ecologically sound, cost effective and practical measure available. (see 1.0 below)

II. Compensatory habitat will be provided only where the long-term management by an appropriate land manager is ensured and where the land tenure is secured for the purposes of conservation. (see 2.0)

III. Any additional ongoing property management requirements resulting from acquisition of compensatory habitat should be dealt with at the time of transfer to the future land manager by way of a present value lump sum payment and not by way of a continued Authority involvement (see 2.0).

1.2 Definitions

Compensatory Habitat
Compensatory Habitat is an area or areas of land containing one or more key habitats which are acquired and/or committed by the RTA for the purposes of nature conservation, to make up for the loss of one or more key habitat(s).

Key Habitat
For the purposes of this policy, *key habitat* refers to the natural environment inhabited by native flora and/or fauna species, populations or ecological communities which are deemed to be of significance. The significance of a species, population or ecological community may be determined as a result of:

- inclusion on Schedule 1 of the *Threatened Species Conservation Act 1995* or the *Fisheries Management Amendment Act 1997* as an endangered species, population or ecological community, or presumed extinct species;
- inclusion on Schedule 2 of the *Threatened Species Conservation Act 1995* as a vulnerable species;
- inclusion in an area of habitat of an endangered species, population or ecological community declared critical habitat by the Minister of Environment;
- inclusion in a planning instrument under the *Environmental Planning and Assessment Act 1979* in a category of nature conservation significance;
- inclusion on the National Estate listing;
- inclusion within a conservation reserve gazetted under the *National Parks and Wildlife Act 1979* (eg. National Park, Nature Reserve) or under the *Forestry Act 1916* (Flora Reserve);
- being recognised as an area of high nature conservation value in a property agreement or regional vegetation management plan under the *Native Vegetation Management Act.*
- inclusion in any other conservation agreement, state, national or international (eg. the Japan Australia Migratory Bird Agreement (JAMBA), the China Australia Migratory

[#] NB. Policy and guidelines for compensatory habitat have been dealt with first. Policy and guidelines for other measures will be developed subsequently.

Bird Agreement (CAMBA), the Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat, and Voluntary Conservation Agreements);

- being of particular ecological significance to NPWS, NSW Fisheries, the Department of Land and Water Conservation, State Forests of NSW or other agency. (NB. The relevant agency will be required to provide written justification for an area being identified of "particular ecological significance").

2. Designating Areas as Compensatory Habitat

Determining the area, location and type of compensatory habitat to be provided will be dependent on a number of factors.

2.1 Area of Habitat

Where compensatory habitat is assessed as an appropriate mitigation measure for impacts on habitat, the RTA will, where reasonably practicable provide an area of habitat at least equal to the area of *key habitat* which is being impacted by road construction.

Habitat must be of adequate size to provide for the sustained survival of key species, populations or communities. The total land area of habitat required for a given species, population or community will need to be assessed. This assessment will be made through consultation with conservation biologists including those from the National Parks and Wildlife Service and NSW Fisheries.

The area of compensatory habitat must also be a viable management unit in terms of its practical management. Potential land or waterway managers will need to be consulted so they may consider the practical and cost implications of any proposed area of compensatory habitat, prior to committing to its long term management.

In some cases there may not be an area of suitable habitat available to compensate for the loss of key habitat. In this case, an area of compensatory habitat may be established which requires full or part restoration or rehabilitation. Where habitat rehabilitation/restoration is required, an area greater than that lost through road construction may be considered. A greater area may be considered to offset risks associated with failure to establish an effective habitat area and the reduction in productivity that a rehabilitated/restored area may have.

2.2 Location of Habitat

Wherever possible the location of the compensatory habitat should be close to the impacted habitat, so that the local, regional or catchment biological diversity is maintained. However, it is important that the compensatory habitat remains viable in the long term, and that community concerns are met. There are also practical and cost implications in locating compensatory habitat.

Assigning compensatory habitat **close to the original impact** will improve the probability that the habitat being protected resembles the impacted habitat. Often there are opportunities to allocate an adjoining parcel of land as compensatory habitat, ensuring a close biological connection.

It is preferable for compensatory habitat to be located **adjacent to habitat which has some form of statutory conservation protection**. Failing this, unprotected habitat adjacent to compensatory habitat is also useful. An isolated area of habitat is the least suitable for conservation, as it increases the negative impacts from adjacent land use activities, increases the chances of destruction through inappropriate fire regimes, and decreases the opportunity for recruitment of flora and fauna into the habitat.

Corridors of native vegetation can be useful in providing for the movement of species across the landscape. They are particularly important in landscapes that have been largely modified through clearing for agriculture or urban development. Securing

compensatory habitat which is **part of a network of corridors** will contribute greatly to maintaining important local or regional biodiversity.

Major road projects may have impacts on key habitat at a large scale. This could be the result of a large individual road project or a road network redevelopment program. While compensatory habitat is generally considered on a project-by-project basis, the establishment of compensatory habitat may require an assessment of the **cumulative impacts** of the road development at a regional scale.

The location of compensatory habitat will also require **consultation with potential land managers**. Potential land managers will need to consider the practical and cost implications of any proposed location of compensatory habitat, prior to committing to its long term management.

2.3 Habitat type and quality

The type and quality of habitat to be allocated as compensation should be similar to or better than the habitat which is being impacted upon. Compensatory habitat should include as many as possible of the key species, populations or communities which have been assessed as being impacted through road construction.

Habitat quality is in part a measure of the condition of the habitat. It is dependent on the level of pest encroachment (weeds and feral animals), the adjacent landuse and its compatibility with nature conservation, the size, shape and security of its tenure. Other criteria for habitat quality include species richness, the number of threatened species and the presence of breeding, roosting and feeding sites for native fauna. Where the quality of available compensatory habitat is not equivalent to the impacted key habitat, the quality can be enhanced through works such as revegetation, rehabilitation, fish restocking or through changes to land tenure and management.

2.4 Assessment

An example of an assessment of the need for compensatory habitat is contained within the Discussion Paper *Compensatory Habitat Assessment for the Bonville Deviation (1998)*, prepared by Biosis Research Pty Ltd. This assessment is limited to ecological considerations, and is based on the process outlined within this policy and guidelines. This discussion paper also provides a brief literature review of relevant international references and an extensive bibliography.

Following ecological assessment, **economic considerations** are required to be made. Often the cost of acquiring land or water which may fulfil the ecological requirements for compensatory habitat is expensive. An assessment of the costs; ecological, social and economic, will be required before a final determination on the size and location of the compensatory habitat is made. Justification on these bases will require monetary and non-monetary evaluation.

A method for **assessment of the economic, social and ecological costs and benefits** when determining the size and location of compensatory habitat is provided below. It incorporates qualitative and quantitative assessment to assist the decision-making process, by organising costs and benefits in a simple matrix. Identifying all costs and benefits in this way can be assisted by consultation with specific stakeholders and the community, combined with economic analysis.

Costs and benefits of Site X as compensation for Y impact
(with examples of qualitative and quantitative costs and benefits)

	Economic	Social	Ecological
Costs	• acquisition of land ($150,000)	• loss of visual amenity • loss of public access	• loss of key habitat (10ha)
Benefits	• sale of surplus land ($45,000)	• addition to conservation reserves	• protection of key habitat (100ha)

3. Securing Land as Compensatory Habitat

3.1 Property Acquisition Procedure

The power to compulsorily acquire land is derived from statute and in the case of the RTA that statute is the **Roads Act 1993**. Land can be acquired for the purpose of the Act which broadly speaking is to accommodate roadworks. Acquired land must be used for the relevant public purpose or an acceptable collateral use and to compulsorily acquire land for the purposes of providing compensatory habitat would be considered to be too remote from the statutory purpose and in excess of the powers conferred by law.

The RTA can not compulsorily acquire land for the provision of compensatory habitat. However, there is nothing to stop the Authority purchasing land in the market place for that purpose, but in such cases the Authority can not compel an owner to sell land.

The Property Acquisition Manager is to be involved at the earliest stages of planning associated with the provision of compensatory habitat and in particular any discussions with land owners. RTA's property acquisition policies are to be observed and applied at all times. The Property Acquisition Manager is to manage the process of both acquiring the land for roads and acquiring the land to be made available for compensatory habitat.

In seeking to provide lands for compensatory habitat and before considering the purchase of privately owned lands, a search is to be made of suitable land within the Authority's portfolio of residue land, including any that may be available as a result of the road project. If no suitable property is identified, enquires are to be made of Local, State and Commonwealth government organisations and if suitable land is identified the cooperation of the relevant authority is to be sought in providing compensatory habitat.

Any increased management cost resulting from the provision of compensatory habitat by the Authority is to be compensated to the relevant land management agency by way of a lump sum payment sufficient to generate an annuity equivalent to the increased annual management cost. This additional management cost must be bone fide, reasonable and measurable.

3.2 Management

The RTA is not a land management agency and is therefore not equipped for managing lands, particularly for the purposes of nature conservation. There are other agencies and organisations better suited to undertake the long-term management of compensatory habitat. These include NPWS, State Forests, Department of Land and Water Conservation and Local Government. There are also other organisations which may be prepared to take on the management, including Trusts, landcare or other community groups. The long term management of compensatory habitat must be established through the appropriate provision of resources and security of tenure.

Securing the long term management of compensatory habitat will require consultation and negotiation with NPWS, State Forests or the Department of Land and Water Conservation, if they are the preferred management agency. There are provisions within the National Parks and Wildlife Act 1974, the Forestry Act 1916, the Crown Lands Act 1989, the Native Vegetation Conservation Act 1997, the Soil Conservation Act 1938 and the Fisheries Management Amendment Act 1997 which provide for the management of lands and/or waters for conservation. An agreement or memorandum of understanding, including a conservation plan, will be required to be negotiated, along with an up-front lump sum payment for the management of the land and/or waters in perpetuity.

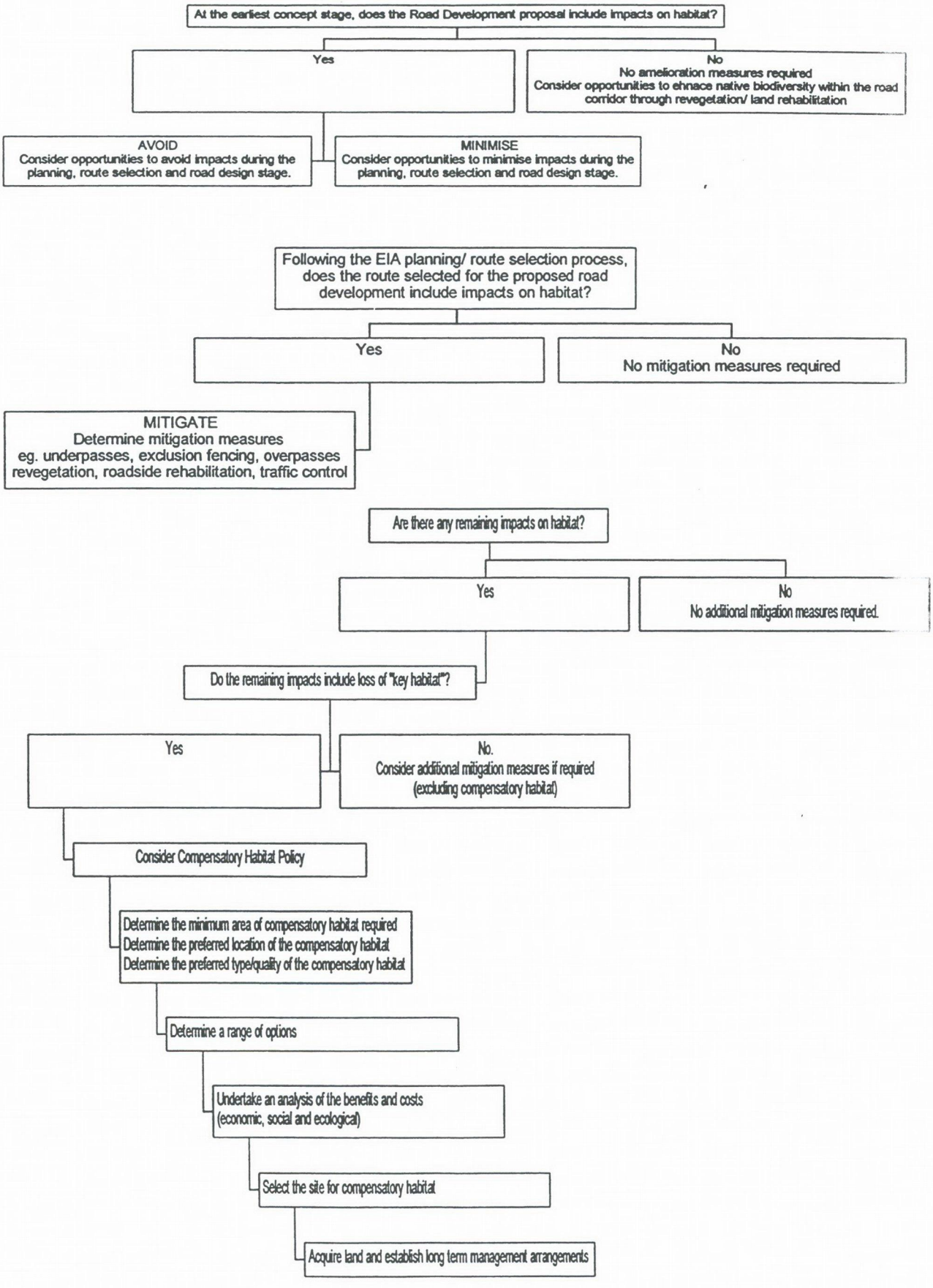
Vesting the management of land with Local Government will also require consultation and negotiation with the local authority. Land and/or waters can be brought under the control of Council through various means, such as a deed of agreement, the establishment of a trust or a lease arrangement with Council. While Local Governments are not equipped to provide specialist management of habitat for conservation, a management plan can be developed which applies to the habitat. The provision of resources to ensure the long term management of the habitat can be achieved through the establishment of a trust account. If the management of land is vested in Council, it is then classed as public land and is subject to the management provisions of the Local Government Act.

The RTA can, through consultation with NPWS, also be involved in securing management of compensatory habitat on private land and/or waters by private landholders. Voluntary Conservation Agreements (VCA), as described under Section 69 of the National Parks and Wildlife Act 1974, are a means for private landholders, as well as local council or a person leasing land and/or waters from the Government to improve the conservation status of natural environments. It is a joint agreement between a landholder and the Minister for the Environment. There are various incentives for landholders to undertake a VCA, such as a rating concession under the Local Government Act. The terms of the voluntary agreement are negotiated between the landholder and the NPWS, which acts on the Minister's behalf. The NPWS will only enter into a VCA if it considers that the proposed lands contain sufficient nature conservation values to warrant the making of a VCA. The securing of habitat for conservation by this means may not equate to compensation for impacts by the RTA, but may add value and legitimacy to amelioration measures undertaken by the RTA.

PART 3

1. Decision Support Flow Chart

The following flow chart summarises the process of avoiding, minimising and abating impacts on habitat and its constituent species, populations or ecological communities. This process is described in detail in Part 1. Once it has been determined that compensatory habitat is to be an mitigation measure, Part 2 outlines the considerations which need to be made to ensure that it is the most ecologically sound, cost effective and practical measure, and where the long term sustainability of habitat is secured.


At the earliest concept stage, does the Road Development proposal include impacts on habitat?
Yes
No
No amelioration measures required
Consider opportunities to ehnace native biodiversity within the road corridor through revegetation/ land rehabilitation
AVOID
Consider opportunities to avoid impacts during the planning, route selection and road design stage.
MINIMISE
Consider opportunities to minimise impacts during the planning, route selection and road design stage.
Following the EIA planning/ route selection process, does the route selected for the proposed road development include impacts on habitat?
Yes
No
No mitigation measures required
MITIGATE
Determine mitigation measures
eg. underpasses, exclusion fencing, overpasses
revegetation, roadside rehabilitation, traffic control
Are there any remaining impacts on habitat?
Yes
No
No additional mitigation measures required.
Do the remaining impacts include loss of "key habitat"?
Yes
No.
Consider additional mitigation measures if required (excluding compensatory habitat)
Consider Compensatory Habitat Policy
Determine the minimum area of compensatory habitat required
Determine the preferred location of the compensatory habitat
Determine the preferred type/quality of the compensatory habitat
Determine a range of options
Undertake an analysis of the benefits and costs (economic, social and ecological)
Select the site for compensatory habitat
Acquire land and establish long term management arrangements

ATTACHMENT 2

OPPORTUNITIES FOR COMPENSATORY HABITAT

This section systematically considers the areas proposed to date as compensatory habitat for the Pacific Highway Bonville deviation project. As far as possible, the points considered below take into account the NPWS Draft Guidelines (Attachment 3) and the RTA considerations outlined in the section above. Little information is available for some of the areas. Any additional areas recommended as a result of the Draft Discussion paper need to be investigated. The general locations of potential areas of compensatory habitat in relation to the proposed highway are shown in Map 2.

1. Ruxton Property, 12 Titans Close, Bonville

The Ruxton Property is the only site considered which forms an integral part of the Tuckers Nob/Lyons Road corridor. It measures approximately 3000 sq m and lies directly adjacent to the Old Pacific Highway. During a site visit to the property, we found it to contain some koala food trees but to have a dense understorey.

Proposal

The proposal is to purchase the land and to apply a Voluntary Conservation Agreement (VCA) to it. The land would then be resold with the VCA in place. The positive aspects of this proposal are that:

- It is located on the corridor which is most likely to be impacted by the proposed alignment of the Pacific Highway;
- It is located on a corridor considered by NPWS to be of regional significance to koalas.

Negative aspects of this option include:

- The Ruxton property together with adjacent RTA reserve forms a relatively small proportion of the already fragmented corridor.
- In terms of securing the corridor, it would be necessary to investigate options for protecting neighbouring bushland owned by Mr Elks.
- The corridor is quite fragmented at present. In particular, land directly to the west comprises open pasture.
- The continued existence of the corridor is under threat. The latter areas are likely to be rezoned as Rural Residential in the latest LEP. In that case, the Elks are likely to consider subdividing (G. Elks, *pers. comm.*)

Information available

The site has been inspected by staff from the NPWS on 7 and 16 April 1998 (NPWS 1998a). A koala habitat assessment was undertaken on the site.

Conservation significance

Although this site forms part of a larger corridor of regional significance (NPWS 1998b), it does not appear to provide koala habitat in its own right. The site itself is of no more than local significance.

- No evidence of koalas was found;
- Habitat assessment indicated that between 8%-18% of trees comprised primary browse trees for koalas (i.e. Tallowwood) with a thick understorey not preferred by koalas;
- Classified as "secondary" koala habitat by the Coffs Harbour City Council Koala Habitat Mapping;
- May contain suitable habitat for other species including frogs;

Map 2: General locations of potential areas of compensatory habitat in relation to the approximate route of the

- The corridor has been identified as being of importance to migratory birds (NPWS 1998b).
-

Likely LEP zoning

Is the Ruxton land likely to be zoned 7?

Tenure

The current owners Nell and Basil Ruxton are wishing to sell the property.

Value

Ballpark: $165 000

Recommendations

The Ruxton property forms a small part of the more extensive Tuckers Nob corridor which stretches from the tablelands of Dorrigo NP through Tuckers Nob and then to the west of Lyons Road (NPWS 1998b). The Tuckers Nob corridor is likely to provide an important link for fauna and has been recognised by the Interim Forest Assessment as an area likely to be required for a Comprehensive Adequate and Representative reserve system.

The property lies in a highly fragmented part of the corridor. The subject land should only be considered for purchase as part of a larger compensatory package which includes:

- Protection of adjoining Elks land (i.e. forested land directly to the north of Ruxton's property) through application of a VCA (negotiation or purchase);
- Undertake boundary adjustment and incorporate with Ruxton land before selling;
- Protection of forested land between the old and new highways as a road reserve;
- Amelioration measures on Old Pacific Highway to reduce risk of road kills through lighting, rumble strips, signage, speed limits, etc.;
- Weed eradication program for all VCA areas;
- Investigation of opportunities for strategic planting of koala food trees to the west of Ruxton's property.

The NPWS is of the opinion that, in isolation, the area probably does not function as koala habitat in its own right but may form part of a koala movement corridor. The NPWS considers that the area may be suitable for a VCA given its strategic position given that:

- The entire patch of remnant vegetation be protected through a VCA (i.e. Elks' property and Ruxton property);
- Existing vegetation within the corridor be protected and enhanced where possible;
- A weed eradication program be implemented on VCA land.

The Ruxton Property is located close to the area of impact and its acquisition and/or management is likely to promote the effectiveness of the major fauna underpass. Depending on zoning, this area may be protected without the implementation of a VCA. It should be noted that a VCA is costly in both time and effort to implement.

A separate assessment of the land between the old and new Pacific Highways should be undertaken.

2. Sawtell site, Lot 102 (DP839551) Moller Drive, Bonville Waters

The Sawtell site is located between Bonville Creek and the North Coast Railway and measures approximately 2.4 ha. It is surrounded by Crown land to the east and Bongil Bongil National Park on two sides (to the south and west). During the site visit, we found this site to provide habitat for fauna species, especially those requiring mature trees. However, the adjacent Crown land (between the existing subdivision and the subject land) appeared to be of better quality for koalas than the subject land. The site may provide habitat for a range of fauna species including the Koala, Blossom Bat, Brush-tailed Phascogale, Common Planigale, Masked Owl, Squirrel Glider, Swift Parrot, Wallum Froglet and may provide an overwintering area for honeyeaters. The site also provides the opportunity for an addition of a forest type (Scribbly gum) which is not currently represented in Bongil Bongil National Park.

Proposal
It is proposed to acquire this lot and add it to Bongil Bongil National Park. The positive aspects of this proposal are:

- It is recognised by NPWS as providing an opportunity to consolidate the boundaries of Bongil Bongil NP which is adjacent to the block;
- Amalgamation of the area into the NP would facilitate management of the area by NPWS.

The negative aspects of the proposal are:

- The land has an existing Development Approval with a time limit of the end of this year for development on it and as such may be very expensive to acquire;
- The NPWS view is that this site may be considered at $400,000 although this is dependent on the other options available and their quality (D. Brown, *pers. comm.*).

Information available
A fauna assessment has been undertaken for the site (Goldingay 1992).

Conservation significance
The subject land is considered to be of at least high local significance because it is relatively undisturbed and provides habitat for fauna in the form of mature trees.
- Comprises mature Swamp Forest with hollow-bearing trees;
- Strengthens corridor along Bonville Creek and Bongil Bongil NP;
- The site does not contain as many koala food trees as adjoining Crown land (C. Moon, pers. comm.);
- The site contains the only Scribbly Gum found within Bongil Bongil NP;

Likely LEP zoning

Not relevant.

Tenure

The subject land is owned by Integrated Developments Pty Ltd who would be interested in selling however they have a time limit as their Development Application expires this year.

Value

Asking price may be: $400 000
The RTA has valued the land at $200 000 to $250 000.

Recommendations
This area should only be considered for purchase if it is not too expensive. NPWS values this area from the perspective of consolidating the NP boundaries and management strategies. Although it is not directly affected by the road proposal, it would compensate for an area of National Park which would be removed. The long-term benefits of this purchase are not known.

3. Consolidation of Boambee Corridor
This area is recognized as being part of a corridor of regional significance for koalas (C. Moon pers. comm.; J. Turbill pers. comm.). Of particular relevance to the topic of compensatory habitat is the area between a planned koala tunnel to the west and remnant bushland to the east of Lindsay's Cutting.

Proposal
It is proposed that land to the east of the existing highway be purchased wholly or in part in order to consolidate the Boambee koala corridor. The positive aspects of this proposal are:

- The corridor has been well-studied (Moon 1997) and is recognized as being of regional significance to koalas;
- Considerable effort has already gone into constructing a koala tunnel and fencing in this area. Consolidation of corridor needed to ensure that these are used.
- Bushland remnants at Lindsays Cutting not only provide movement corridors but they also provide habitat for breeding koalas;
- Land in the vicinity including the tip site, university campus (for which a koala plan has been prepared), airstrip and proposed hospital contain native vegetation and can be managed as koala habitat.

The negative aspects of the proposal are:

- At least four landholders (Cunningham, Gardner, Synnot and Raye) are involved;
- One property is zoned "Residential" and the Master Plan for the area (i.e. Marshall Estate) is currently on display at Coffs Harbour City Council (the potential implications of this plan are not known).
- It is outside the project area.

Information available
The area has been the subject of intensive study on koalas over a 12-month period (Moon 1997).

Conservation significance
The Boambee corridor is recognised as being of at least regional significance for koalas (Moon C. *pers. comm.*; J. Turbill *pers. comm.*). The corridor is seen to be critical to the maintenance of the Coffs Harbour urban koala population (NPWS 1998b). The koala population has the potential to remain viable due to relatively large amounts of high quality koala habitat in the area.

- Remnant bushland to the east of the highway is of regional significance (Fisher *et al.* 1996);
- The Boambee corridor is a known hot spot for koala roadkills. The ¾ km stretch of highway between Englands Road and Sawtell Road has as many roadkills as the three km stretch in Pine Creek State Forest;
- Supports viable breeding populations of koalas.

Likely LEP zoning

Properties containing remnant bushland are likely to be zoned 7 (Environmental Protection) in the draft LEP. The zoning of cleared land is unknown although the Marshall Estate Master Plan is currently on display. Zone 7 will offer some protection to this area.

Tenure

The relevant area belongs to at least four landholders.

Value

Unknown. A section of land (32.2 ha) adjoining the highway is currently for sale (NPWS 1998b).

Recommendations

From a koala conservation perspective, this is probably one of the most valuable acquisitions that can be made. Because the corridor is strategically located, contains relatively large amounts of regionally significant vegetation and is adjacent to land which can be sympathetically managed, it is likely to provide a functional corridor for a diversity of fauna species. It is clearly seen to be important by the NPWS and is the favoured option of local koala expert Chris Moon.

This proposal is appropriate as it considers regional cumulative impacts of the Pacific Highway upgrade and the corridor would provide habitat for a range of fauna other than just Koalas. Since there are two regionally significant corridors in the area with one occurring in the study site, priority should perhaps be given to the Tuckers Nob/Lyons Road corridor as this is where the current disturbance is occurring. We recommend that whichever option is taken that one of these corridors should be adequately consolidated versus small parts of consolidation to each.

4. Addition to Pine Creek State Forest

This is a relatively large forested area continuous with the northern side of Pine Creek State Forest (PCSF) and adjacent to the highway. It forms part of the Pine Creek corridor from the tablelands to the coast via PCSF which is a recognised "hot spot" for threatened species, (NPWS 1998b). There is not much known about this area except that it comprises an area of regenerating mixed forest containing Tallowwood, Swamp Mahogany, Flooded Gum and Blue Gum. There are some mature trees associated with gullies.

Proposal

It is proposed that this area be acquired and managed as part of the Pine Creek corridor. The positive aspects of this proposal are:

- It is a relatively large area which is similar in structure to PCSF;
- From a strategic point of view, it forms a good link to deferred forestry areas and possibly to Bongil Bongil NP to the east;
- It adjoins Pine Creek bridge thereby forming an integral part of the corridor.
- Unlike the PCSF, it would provide secure tenure for nature conservation particularly given the recent proposals for increased forest harvesting intensity (D. *Brown pers. comm.*).

The negative aspects of the proposal are:

- No major connections to the west;

- Although this area does not provide the same level of fauna and flora conservation as a National Park it has a moderate level of protection under the Conservation Protocols for Timber Harvesting on State Forests and NPWS 120 Licences. There are also Interim Deferred Forest Areas in PCSF however these have not been considered in the planning process as the Comprehensive Regional Assessment process is still being undertaken and the final tenure of this land is presently undecided. It is uncertain who would be responsible for managing this area.

Information available
None. This area requires further assessment.
Conservation significance
The subject site is considered to be part of an existing corridor of regional significance. In isolation, it is considered to be of high local significance.

- The Giant Barred Frog (*Mixophyes iteratus*) was found in this area;
- The Pine Creek corridor is of particular importance to Koalas, Yellow-bellied Gliders and Brush-tailed Phascogale (NPWS 1998b). Other species such as the Common Bent-wing Bat Little Bent-wing Bat, Powerful Owl, Sooty Owl, and the Rusty Plum have been found in the area.
- The Pine Creek corridor represents an important gradient (i.e. tablelands to coast) for the maintenance of genetic exchange and ecological processes.

Likely LEP zoning

Unknown but likely to be zoned 7 (Environmental Protection).

Tenure

Steve Woods is the owner and he is not interested in selling. Possible reasons for this should be investigated.

Value

Unknown.

Recommendations
If this land were able to be obtained it may be quite suitable for compensatory habitat due to its position in relation to PCSF.

5. Remnant Bushland along East Bonville Road
This area adjoins an existing SEPP 14 (Coastal) wetland. It is unknown how much area is protected as a SEPP 14 wetland and how much falls outside this area. In addition, remnant vegetation to the north of East Bonville Road and along the railway track was considered by Dianne Brown of NPWS to have some habitat values. The latter area would need further investigation. These areas were viewed from the vehicle during the site visit.

Proposal
The proposal is to acquire and manage this area as a potential link to Bongil Bongil NP. The positive aspects of this proposal are:

- From a strategic viewpoint, it is linked to Bongil Bongil NP.

The negative aspects of the proposal are:

- Most of the area may already be partially protected under SEPP 14 legislation and therefore may not require further protection;
- The area may be carved up between many different landholders (C. Moon, *pers. comm.)*.
- Acquisition of this area may provide little additional habitat to that already protected by SEPP 14. Tenure and boundaries need further investigation.

Information available
None.

Conservation significance
The wetlands themselves are of state significance.
- Although Tallowwoods are present, no koalas have been found there recently (C. Moon, pers. comm.).

Likely LEP zoning

Unknown.

Tenure

Many be many landowners but need more information.

Value

Unknown. More information needed.

Recommendations
Some of this habitat is likely to be protected already under SEPP 14. Little additional habitat may actually be obtained through acquistion.

6. "Storyland Gardens"
This small area is contiguous with the northern side of Bongil Bongil NP and located to the south of "Storyland Gardens" (< 4 ha). From aerial photos, the trees contained in this area appear to be mature as compared to the majority of trees within the boundaries of the NP. We were unable to view or visit this area during our field visit as "Storyland Gardens" was closed.

Proposal
The proposal is to acquire this land and add it to Bongil Bongil National Park. The positive aspects of this proposal would be:

- It is adjacent to Bongil Bongil NP;
- It would act as a direct replacement for mature trees lost from the highway upgrade;
- It is located within the corridor which would be impacted by the upgrade.

The negative aspects of this proposal are:

- The subject land may already have an approved Development Application on it;
- It is small;
- Land adjacent to it is likely to be zoned urban residential in the draft LEP.

Information available
None.

Conservation significance
In isolation, this area would be of local significance. There is no information available regarding its flora and fauna values. Mature trees appear to be present in aerial photos.

Likely LEP zoning

Unknown.

Tenure

Unknown.

Value

Unknown.

Recommendations
This area does not appear to be viable in the long-term due to conflicting land uses such as urban development and the resulting edge effects in the surrounding area. However, if the price were reasonable, consideration of this area is recommended since it is located in the area of impact. Its addition to the park may compensate directly for the loss of NPWS land although more information is needed to assess its suitability for compensatory habitat.

7. Pine Creek State Forest – Railway to the Coast
This area comprises one end of the Pine Creek Corridor which is presently unsecured. This proposal is of importance to local conservation groups (J. Turbill pers. comm.).

Proposal
The proposal is to secure this area as an integral part of the Pine Creek corridor. The positive aspects of this proposal are:

- It would secure a major section of an existing corridor of regional significance. Although this area does not provide the same level of fauna and flora conservation as a National Park it has a moderate level of protection under the Conservation Protocols for Timber Harvesting on State Forests and NPWS 120 Licences. There are also Interim Deferred Forest Areas in PCSF however these have not been considered in the planning process as the Comprehensive Regional Assessment process is still being undertaken and the final tenure of this land is presently undecided. It is uncertain who would be responsible for managing this area.

The negative aspects of this proposal are:

- Much of this area may be secured as part of the Comprehensive Regional Assessment process presently underway;
- Unsure whether or not there is a need to secure more of this functioning corridor.

Information available
None.

Conservation significance
This area forms part of a corridor of regional significance.

- The Pine Creek corridor is of particular importance to Koalas, Yellow-bellied Gliders and Brush-tailed Phascogale (NPWS 1998b).

- The Pine Creek corridor represents an important gradient (i.e. tablelands to coast) for the maintenance of genetic exchange and ecological processes (NPWS 1998b).

Likely LEP zoning

State Forest.

Tenure

SFNSW

Value

Unknown. Possible trade-offs?

Recommendations

Some of this area may be secured through the CRA process. Further compensatory habitat may aim to strategically join up IDFAs.

ATTACHMENT 3

NPWS DRAFT GUIDELINES FOR COMPENSATORY HABITAT ASSESSMENT

Values to be addressed in compensatory habitat assessment

Draft

Compensatory habitat is being applied by the Roads and Traffic Authority (RTA) as mitigation measure for the impacts to natural heritage for the upgrade of the Pacific Highway. The RTA is currently developing a policy and guidelines to assist with the selection and extent of compensatory habitat.

Compensatory habitat assessments have been undertaken for RTA projects for the Pacific Highway upgrade. These include reports by Ecopro for the Bulahdelah to Coolongolook Deviation, and by Sinclair Knight Merz for the Brunswick Head to Yelgun upgrade. These documents contain issues to be addressed in a compensatory habitat assessment.

The points listed below summarise values that National Parks and Wildlife Service consider need to be addressed when undertaking a compensatory habitat assessment, designed to be used on a project by project basis, but should attempt to address regional issues where possible.

Much of the information listed below is held on NPWS database. It is available under licence from the Data Licensing Officer, at NPWS Head Office on 02 9585 6684. Other information is included in reports that are referenced at the end of this document.

Two major areas need to be considered when addressing the points listed below:

1. Assessment of the values of the area directly or indirectly impacted by the proposal.
2. A regional and local assessment of the values of the area being investigated as compensatory habitat.

<u>Points to be addressed:</u>

- description of habitats present (including the potential suitability of habitats for threatened species)
- assessment of the conservation significance of each habitat e.g. percentage of forest types conservation targets met (as per Resource and Conservation Assessment Council 1996) and/or vegetation communities (as per Hager & Benson 1994 or Griffith 1993) in the conservation reserve system
- percentage of threatened fauna and flora targets met (as per Resource and Conservation Assessment Council 1996)
- presence of significant flora as per Sheringham & Westaway (1995) (Sheringham & Westaway covers NSW north of Coffs Harbour. Outside this region, the categories used by Sheringham & Westaway may be applied to assess significance)
- presence of suitable habitat as per NPWS fauna habitat models where available
- threatened species records
- presence of Interim Deferred Forest Areas (IDFAs) (Resource and Conservation Assessment Council 1996)
- presence of any NPWS reserve proposals
- relationship to other current environmental assessment processes or legislation (e.g. Comprehensive Regional Assessment, NSW Coastal Policy, Vegetation Conservation Act)

- presence and function of vegetation corridors (local or regional), including an assessment of the importance of corridors for seasonal migratory and other mobile species and the potential to increase or enhance protection to other parts of corridors
- connectivity to other protected or potentially protected land in the landscape (e.g. other tenures that may be able to be reserved such as Crown Land)
- presence of any conservation zoning's), SEPP No 14 (Wetlands), SEPP No 26 (Littoral Rainforest), SEPP No 44 (Koala Habitat Protection), Native Vegetation Conservation Act
- assessment of threatening processes on surrounding land e.g. presence or future development of urban areas
- assessment of the strategic position within the overall reserve network
- assessment of fragmentation as a result of the upgrade in a regional perspective
- relationship to current government initiatives e.g. Comprehensive Adequate and Representative reserve system; Comprehensive Regional Assessment; coastal policy (inventory).
- Assessment of the relative practicality of compensatory habitat for conservation management
- Reference to any existing assessment studies that may have been undertaken

APPENDIX 5 – Preliminary Field Investigation for Indigenous Cultural Heritage Report

NORTHERN ZONE

NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

PRELIMINARY FIELD INVESTIGATION

FOR INDIGENOUS CULTURAL HERITAGE:

PROPOSED MODIFICATIONS TO THE

BONVILLE PROJECT, PACIFIC HIGHWAY,

MID-NORTH COAST, NSW.

REPORT PREPARED FOR THE ROADS AND TRAFFIC AUTHORITY

MARCH 1999

CONTENTS

1. INTRODUCTION

This report describes a preliminary field investigation on land to be affected by modifications to a proposed upgrade of the Pacific Highway at Bonville on the mid-north coast, NSW (**Figure 1**). The development proposal is hereafter referred to as the Bonville Project or the Proposal, which is currently being developed by the Roads and Traffic Authority (RTA) as part of the Pacific Highway Upgrading Program (PHUP).

A modification to the Bonville Project is currently being considered by the RTA, which could result in a widening of the median that separates the carriageways in one section of the Proposal. The aim of the preliminary field investigation was to determine whether this proposed modification would impact on Indigenous cultural heritage sites and to determine the need for a more detailed systematic assessment by a qualified consultant archaeologist.

The preliminary field assessment was undertaken on 18 February 1999 by Liam Dagg (Archaeologist, RTA Assessment Team), Brian Kelly (Coffs Harbour and District Local Aboriginal Land Council) and Robert Arnold (PPK Surveyor). No items of Indigenous cultural heritage were located by the survey. Constraints such as low ground surface visibility makes it impossible to state categorically that items of Indigenous cultural heritage are not present on land that may be affected by the proposed modifications to the Bonville Project. However, a range of other environmental characteristics (including previous landuse practices) makes it extremely unlikely that substantive evidence has gone undetected by the field survey.

The background to the investigation is described in **Chapter 2**. The methodology and results of the field assessment are presented in **Chapter 3**, and evaluated in **Chapter 4**. Management recommendations are proposed in **Chapter 5**. A draft of this report was provided to Coffs Harbour and District Local Aboriginal Land Council (LALC) for their comment and a copy of their response is attached as **Appendix 1**.

2. CONTEXT

This chapter details the context of the current study (**Section 2.1**), the location and characteristics of the area under investigation (**Section 2.2**), the Proposal (**Section 2.3**), and a predictive statement on the Indigenous site types that may be present on the land that may be impacted by the proposed median widening (**Section 2.4**).

2.1 Background to the Investigation

The RTA is proposing a major upgrade and realignment of the Pacific Highway around the village of Bonville. The Proposal is for the construction of a 9.8 km road comprising two carriageways separated by a median. An Environmental Impact Statement (EIS) and Species Impact Statement (SIS) have been prepared for the project, and were placed on public exhibition during August and September 1998. **Appendix N** of the EIS contained an assessment of Indigenous cultural heritage along the preferred route. This Working Paper was prepared by Navin Officer Heritage Consultants and is entitled "*Pacific Highway Bonville Deviation Environmental Impact Statement. Aboriginal Archaeology*

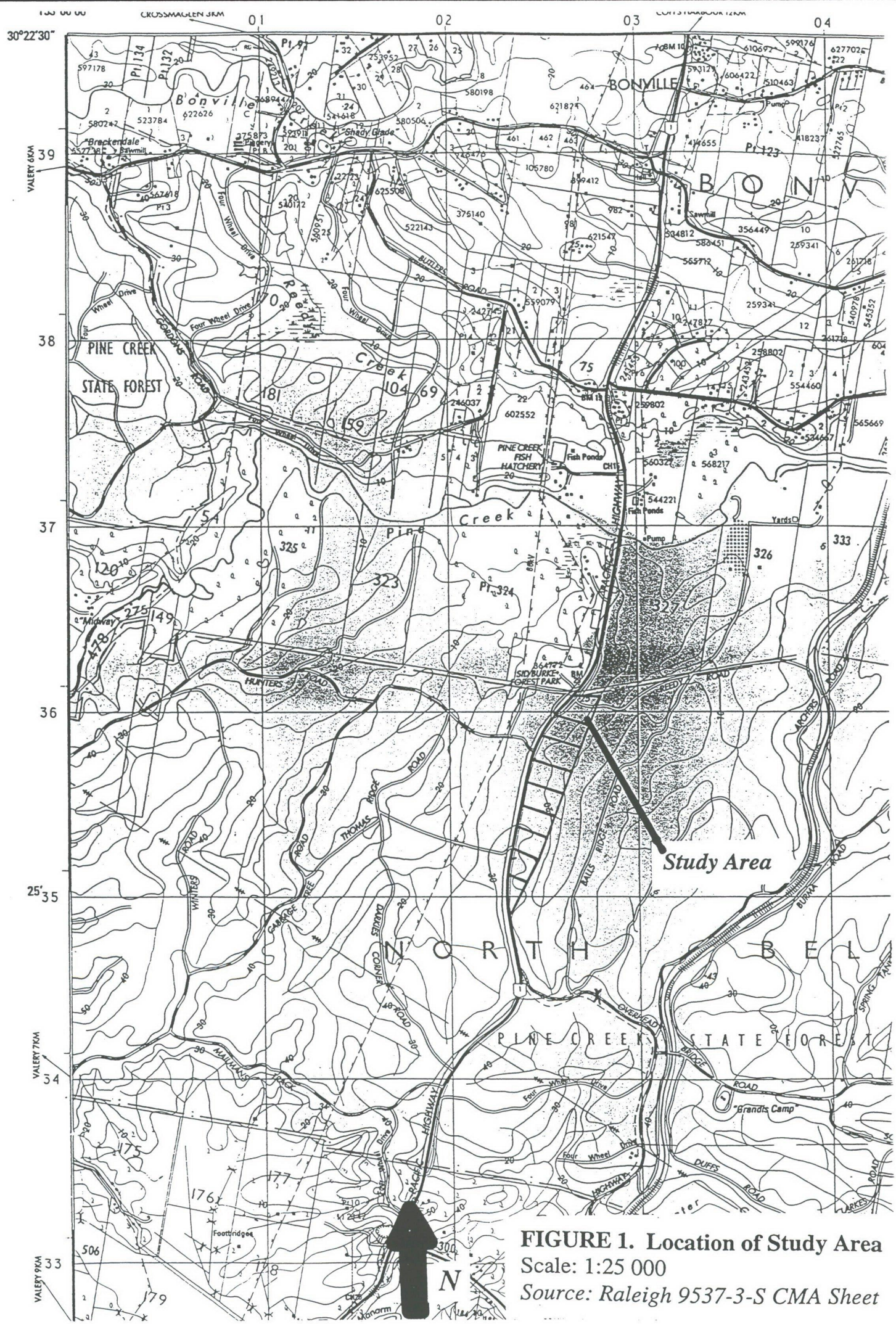


FIGURE 1. Location of Study Area
Scale: 1:25 000
Source: Raleigh 9537-3-S CMA Sheet

Component 1998". This Working Paper is hereafter referred to as Officer and Navin (1998).

Submissions to both the EIS and SIS are currently being considered by the RTA. As a consequence of comments made by the National Parks and Wildlife Service (NPWS) in relation to the SIS, the RTA is currently investigating the feasibility of widening the median between the carriageways on one section of the Proposal, to enable the preservation of upper storey vegetation within the median. Retention of this vegetation is designed to facilitate the movement of Gliders across the highway.

Widening of the median would require a lateral shift of the southbound carriageway to an area further to the east than what was originally proposed in the EIS. This shift would also require alterations to the location of a service road, which is proposed to run adjacent to and to the east of the highway in this section of the Proposal.

If the modification proceeds, it would impact an area that has not been assessed for the presence of Indigenous cultural heritage sites. To compensate for this, it was proposed by NPWS to undertake a preliminary assessment of this uninvestigated area. As stated above, one of the objectives of this preliminary assessment was to determine whether a more detailed and substantive investigation was required. Given the relatively small size of the unsurveyed section of land, a precursory examination was considered an appropriate first step in this process.

2.2 Location and characteristics

The Bonville Project crosses both the Bellingen and Coffs Harbour Local Government Areas (LGA), and is also within the designated boundaries of the Coffs Harbour and District LALC.

For the purpose of this investigation, the study area was arbitrarily defined as the land to the east of the Pacific Highway, and west of a line of surveyors pegs that generally denoted the outermost limits of the area to be impacted (**Figure 2**). The study area has an irregular shape and has an approximate area of 17.8 hectares.

The study area is located approximately 3 km to the south of the village of Bonville, within a section of Pine Creek State Forest (see **Figure 1**). Other relevant locality data is provided in **Table 2.1**.

Table 2.1 Locality Data

Relevant 1:25 000 CMA sheet	Raleigh 9537-3-S
General AMG reference	502550 E; 6636050 N
Parish	North Bellingen
County	Raleigh
Shire	Coffs Harbour

A general impression of the environmental characteristics of the study area was able to be formed through an evaluation of a range of data before the commencement of the field survey. The data included concept design plans, topographic maps and information

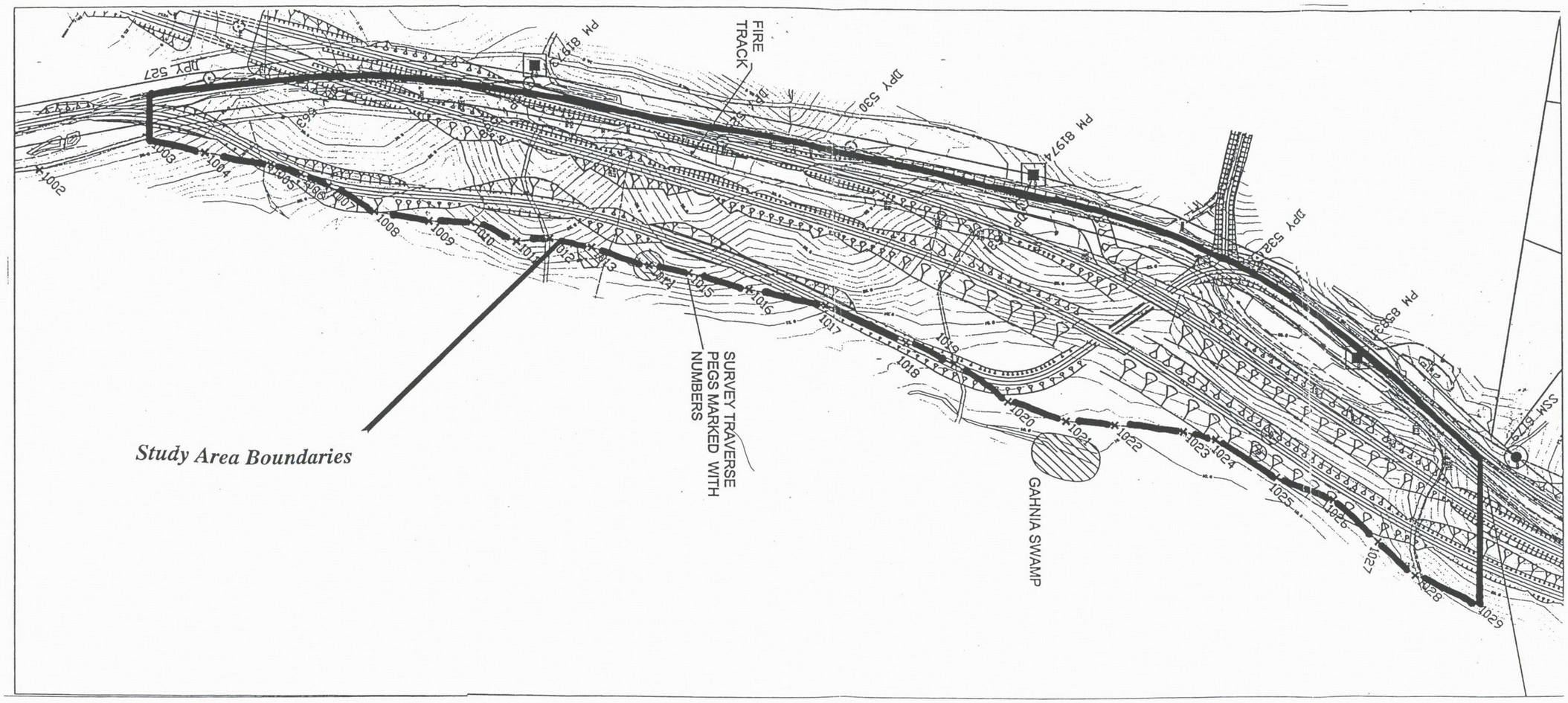


FIGURE 2. Development Proposal and Study Area Boundaries
Scale: 1:4500
Source: PPK Environment and Infrastructure

(including aerial photographs) contained within the EIS for the Bonville Project. The results of this evaluation are presented below in **Section 2.4.2**, and is used as a basis for the formulation of a predictive statement on the potential of the study area to contain Indigenous cultural heritage sites.

2.3 Development proposal

The nature of the Proposal within the study area was discussed in **Section 2.1**. A detailed description of the entire Bonville Project is presented within **Chapter 5**, **Volume 1** of the EIS.

To summarise from **Section 2.1**, modifications to the width of the median would result in a lateral shift to the east of both the southbound carriageway and the service road on the eastern side of that carriageway (see **Figure 2**). The carriageways and service road in this section would be constructed on fill embankments. Clearing for embankment construction would result in the removal of vegetation, and disturbance of the upper levels of the soil profile. From an Indigenous cultural heritage perspective, these activities have the potential to:

- destroy trees that have scars and/or carvings from Aboriginal activities; and/or
- disturb cultural heritage material that may be located on or beneath the existing ground surface.

The types of cultural material that have the most potential to be impacted by the Proposal, if present within the study area, is discussed further in **Section 2.4** below.

2.4 The Natural and Cultural Environment

It is generally accepted by archaeologists that:

> although the nature and distribution of archaeological sites in any landscape will have been ultimately underwritten by cultural choices, it is apparent that such choices were often strongly influenced by environmental factors such as climate, topography, bedrock geology, and associated soil and vegetational regimes (Collins 1997, 4).

Environmental factors may also influence the ability of the observer to detect cultural heritage sites. For example, vegetation cover may impede both visibility and accessibility. The major implication this has to the current investigation is that determining whether the study area contains cultural material cannot be determined solely on the basis of a visual inspection. Therefore, it is essential to consider the results of previous cultural heritage research, with emphasis on identifying the types of sites that have been previously located in similar contexts to those that comprise the study area.

2.4.1 Previous archaeological research

A detailed overview of previous archaeological research at both a local and regional level was provided in **Chapter 7** of Officer and Navin (1998). Based on this research the following points are considered most relevant:

- a range of site types have previously been recorded within the general Bonville/Coffs Harbour area. These include open campsites (stone artefact scatters), middens, scarred and/or carved trees, sites with associated natural/mythological significance, and ceremonial grounds (stone arrangements and/or bora rings);

- the predominant site context is elevated landforms adjacent to drainage lines or coastal margins (eg river/creek terraces, ridge/spur crests);

Prior to the field assessment by Officer and Navin (1998) no sites had been recorded on or within the immediate vicinity of land that may be impacted by the Bonville Project. However, some of the previously recorded carved trees were located in Pine Creek State Forest, of which the current study area is a component.

The field survey by Officer and Navin (1998) comprised a comprehensive inspection of an arbitrarily defined corridor approximately 100m wide. The corridor encompassed the preferred route of the highway that was proposed in the EIS. Systematic transects were attempted within this corridor, and an attempt was made to inspect all ground surface exposures and mature trees for archaeological evidence.

Effective survey coverage was reduced by vegetation cover in the majority of areas that were inspected. However, one site (coded BH 1) was located and comprised an isolated stone artefact. The artefact was located on a forestry track that crossed the toe slopes of a spur ridge, and is approximately 1250 m SSW of the current study area. Based on the results of the field assessment Officer and Navin (1998) concluded that the potential was low for additional cultural heritage material being located within the surveyed corridor. The low potential was argued to be the result of a combination of factors, with these being the impact of Non-Indigenous land use practices, and the low range of resources available within the surveyed area, relative to environmental zones closer to the coast and higher order drainage lines (eg the Bellinger River).

2.4.2 Predictive Model

It was stated above in **Section 2.4** that environmental factors will largely determine the nature and distribution of Indigenous cultural heritage sites within the study area. Based on the review of environmental data before the commencement of the field survey, it could be determined that the study area is located on the crest and eastern side slopes of a low, generally north-south oriented ridge. A number of east-west trending spurs emanate from the main ridge line. Drainage depressions occur between the spur ridges and drain to the east (see **Figure 2**). It is estimated that ridge/spur crests comprise 40 % of the study area, with the remaining 60 % being side slopes. In terms of topography the study area has a similar context to the isolated artefact (BH 1) recorded previously by Officer and Navin (1998).

The survey by Officer and Navin (1998) established that the bedrock geology (lower Permian slate, phyllite, schistose sandstone and schistose conglomerate) does not outcrop massively, either within or in the immediate vicinity of land that may be impacted by the Bonville Project. This negates the occurrence of site types such as rock shelters and axe grinding grooves within the current study area.

The study area occurs within a section of Pine Creek State Forest, and the aerial photographs indicate that the general area is heavily vegetated. Officer and Navin (1998) noted that mature vegetation was sparse, making the presence of scarred and/or carved trees unlikely. However, as noted above, there are records of carved trees occurring within other sections of Pine Creek State Forest. The possibility of these site types being present within the current study area cannot be entirely discounted without field inspection.

The impacts of previous land use practices were also observed by Officer and Navin (1998). The major impacts were located on level areas of land (eg ridge crests, flood plain), which are also the most likely contexts for a range of site types such as open campsites, burials and ceremonial grounds. If such site types occur within the study area, they are more likely to occur in contexts that have undergone some level of disturbance.

Based on the above considerations, the most likely site types to be encountered within the study area are isolated stone artefacts, open campsites, and scarred/carved trees. Less likely are site types such as burials and ceremonial grounds.

3. FIELD ASSESSMENT

The preliminary field inspection was undertaken on 18 February 1999 by Liam Dagg (NPWS), Brian Kelly (Coffs Harbour and District LALC) and Robert Arnold (PPK Surveyor).

3.1 Survey Strategy

The aim of the field assessment was to determine whether Indigenous cultural heritage sites were present, or likely to be present within the study area, and whether a more detailed investigation was required.

Prior to the fieldwork being undertaken, it was anticipated that comprehensive coverage of the study area would be achieved by walking systematic transects across each land unit. However, on arrival at the study area it became apparent that such an approach was not feasible, due primarily to the dense undergrowth. Subsequently, the survey strategy was modified to comprise an assessment of all available access tracks within the study area. Along each track (or transect), an attempt was made to make an inspection of:

- all ground surface exposures along the track, and either side of the track; and
- all mature upper storey vegetation either side of the track.

Details of each transect are detailed below.

3.2 Survey Description

A total of five transects were walked in the study area. The location of the transects are illustrated in **Figure 3**.

Transect 1 was walked along a track that was generally oriented east-west. The track crossed the side slope of the main north-south ridge and a spur ridge whose crest was

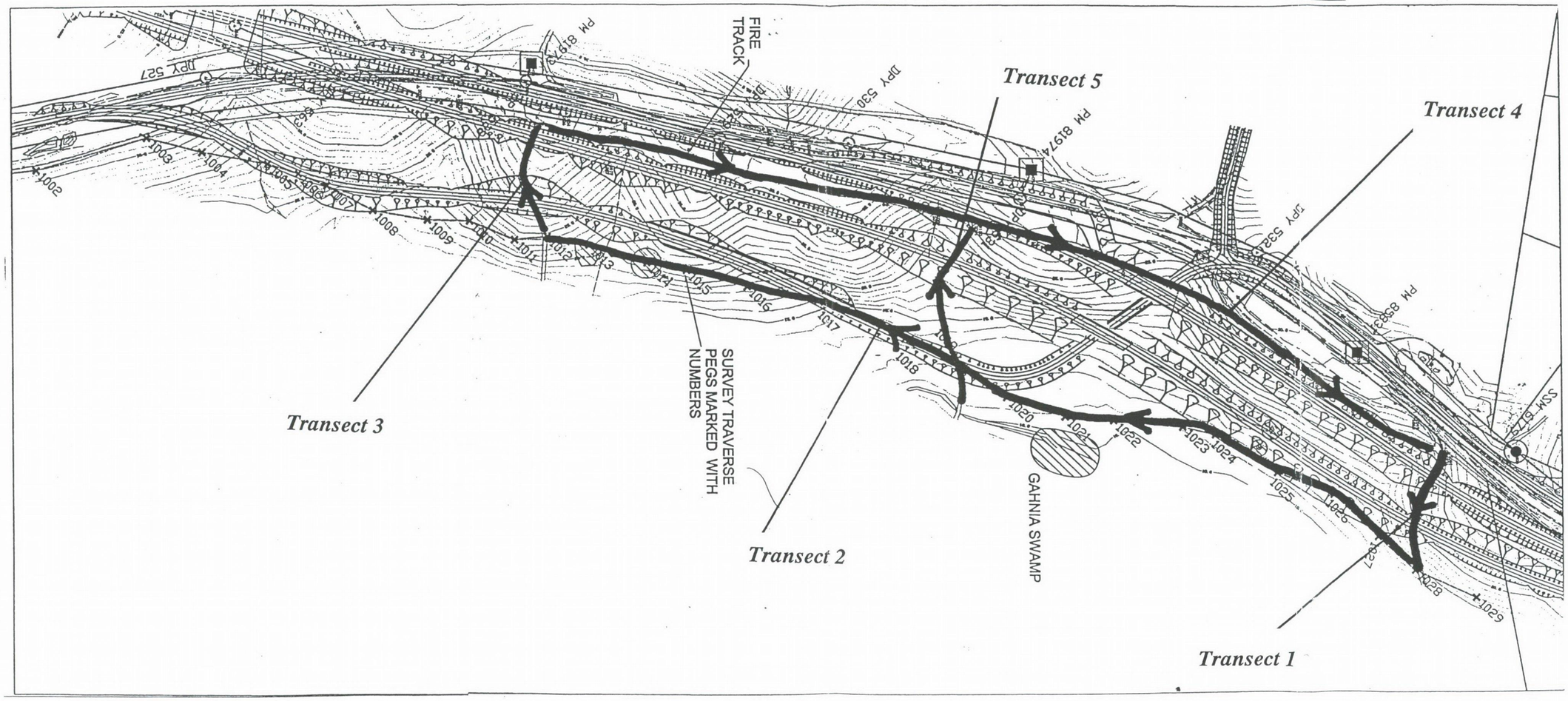


FIGURE 3. Location of Survey Transects
Scale: 1:4500
Source: PPK Environment and Infrastructure

further to the north. The slope was gently inclined (5-10 %). Visibility along the track was impeded by gravel and shadows resulting from overhanging trees. The approximate dimensions of the transect was 125 x 3 m (375 m ^{2}). Given the above constraints, average visibility along the track was considered extremely low (2 %). No rock outcrops were visible either side of the track. None of the mature trees that were observed had scars or carvings that could be attributable to Aboriginal activities.

Transect 2 followed the trail blazed by the surveyors when placing the marker pegs. The track was approximately 1 m wide, and enabled an assessment to be made of the ground surface for approximately 5 m either side of the trail. The trail was generally oriented north-south and predominantly crossed the side slopes of the main north-south trending ridge. One of the intermittent drainage lines was also crossed. This drainage line was categorised as a poorly defined drainage depression. Ground surface visibility was 0 % for the majority of the trail, with the exception of a single ground surface exposure approximately 1 m ^{2} in area. No exposures were visible off the trail. Visibility was impeded by a combination of lower storey vegetation, leaf litter and fallen tree limbs. The approximate dimensions of the transect was 850 x 10 m (8500 m ^{2}). No rock outcrops were visible either side of the trail. None of the mature trees that were observed had scars or carvings that could be attributable to Aboriginal activities.

Transect 3 inspected a track that was generally oriented east-west along a spur ridge crest. The track comprised two wheel ruts within a clearing that was approximately 4 m wide. The ground surface was visible within the wheel ruts to a total approximate width of 0.5 m. Average visibility within the wheel ruts was low (10 %). The approximate dimensions of the transect was 100 x 4 m (400 m ^{2}). No rock outcrops were visible either side of the track. None of the mature trees that were observed had scars or carvings that could be attributable to Aboriginal activities.

Transect 4 inspected a track that was oriented north-south along the crest of the north-south trending ridge. As with Transect 3, the track comprised two wheel ruts within a clearing that was approximately 4 m wide. The ground surface was visible within the wheel ruts to a total approximate width of 0.5 m. Average visibility within the wheel ruts was low (10 %). The approximate dimensions of the transect was 950 x 4 m (3800 m ^{2}). No rock outcrops were visible either side of the track. None of the mature trees that were observed had scars or carvings that could be attributable to Aboriginal activities.

Transect 5 was walked along an east-west oriented track that crossed the side slopes of the main north-south ridge. As with Transect 3, the track comprised two wheel ruts within a clearing that was approximately 4 m wide. The ground surface was visible within the wheel ruts to a total approximate width of 0.5 m. Average visibility within the wheel ruts was low (5 %). The approximate dimensions of the transect was 150 x 4 m (600 m ^{2}). No rock outcrops were visible either side of the track. None of the mature trees that were observed had scars or carvings that could be attributable to Aboriginal activities.

3.3 Survey results

No sites of Indigenous cultural heritage were recovered during the field assessment. The details of the survey are summarised in **Table 3.1**.

Table 3.1 Survey Summary

Transect	Land Unit	Transect Dimensions (m)	Transect Area (m^2)
1	ridge side slopes	125 x 3	375
2	ridge side slopes/ drainage depression	850 x 10	8500
3	spur crest	100 x 4	400
4	ridge crest	950 x 4	3800
5	ridge side slopes	150 x 4	600
Total			13 675

A total of 13 675 m^2 was traversed and/or inspected for the presence of Indigenous cultural heritage sites, which represents approximately 7.7 % of the study area. The low proportion of surveyed land is due directly to the density of vegetation, which impeded accessibility. In spite of the low proportion that was surveyed, at least an inspection was able to be made of a sample of each of the land units that comprise the study area.

The predominant feature of the study area is the upper storey vegetation, which covers all land units. The majority of trees observed were immature regrowth. The low proportion of trees that could be considered mature had no evidence that could be interpreted as scars or carvings from Aboriginal activities. Given the low proportion of land that was inspected, it cannot be categorically stated that such sites are absent from the study area. However, it is possible to mitigate for this during the early construction phase should the Proposal proceed, and this is discussed further in **Chapter 5** below.

The bedrock geology of the study area precludes the likelihood of rock outcrops that may have been used for a range of Aboriginal activities (eg. habitations sites, surfaces for the creation of rock engravings and/or axe grinding grooves). The only rocks observed during survey were small pebbles of quartz that were predominant along the track that crossed the main north-south ridge (Transect 4). None of these quartz pebbles bore fractures that could be interpreted as resulting from Aboriginal stone artefact manufacture.

Determining the presence of heritage sites that occur on or below the ground surface (eg stone artefact scatters) was impeded by the low proportion of ground surface exposures within the study area (**Table 3.2**).

Table 3.2 Ground Surface Exposures

Transect	Exposure Dimensions (m)	Exposure Area (m^2)	Visibility within Exposure (%)	Effective Visibility (m^2)
1	125 x 3	375	2	8
2	1 x 1	1	100	1
3	100 x 0.5	50	10	5
4	950 x 0.5	475	10	48
5	150 x 0.5	75	5	4
Total		976		65

From **Table 3.2** ground surface exposures totalled approximately 976 m^2, which represents 7.1 % of the area traversed/inspected, and even less when the low visibility within the exposures is taken into account. As with scarred or carved trees, the field survey is not considered adequate to provide categorical statements on whether cultural material such as stone artefacts is absent from the remainder of the study area. This will be discussed further below.

4. EVALUATION

It was concluded in **Section 2.4.2** that if any Indigenous cultural heritage sites were located in the study area, they were most likely to be:

- isolated stone artefacts;
- stone artefact scatters (open campsites);
- scarred or carved trees;
- burials; and/or
- ceremonial sites (stone arrangements, bora rings).

The presence of scarred or carved trees is considered unlikely, due primarily to the history of logging within the study area, and more generally within Pine Creek State Forest. Burials, stone arrangements and bora rings are also considered unlikely. The most likely context for these site types is along the crest of the ridges and spurs, but particularly the main ridge. A large proportion of this land unit has been disturbed by previous land use practices, including logging, the construction of the existing Pacific Highway, the fire trail (Transect 4) and a Telstra optic fibre cable that also runs parallel to the highway. If these site types were present, it is most likely that they have already been destroyed, or disturbed beyond recognition.

The two main site types that have possibly gone undetected by the field survey are isolated artefacts and/or stone artefact scatters (open campsites). Such material has the potential to be present anywhere across the landscape. Although the most likely context for this material is along the ridge/spur crests, they may also be present on the side slopes, as the slope gradient is not of a magnitude that would prevent habitation.

The environmental characteristics of the study area would suggest that, if stone artefacts are present, they are most likely to occur in low densities. The main basis for this argument is the fact that the study area does not contain resources that would facilitate long term, or intensive, occupation by Aboriginal groups. The drainage lines that occur within the study area are intermittent, and probably only flow following high rainfall events. If cultural material is present, it is probably not in densities that would warrant sub surface testing to locate it. Another factor that has to be considered is that the density of vegetation would make such an exercise extremely difficult. If material is present along the main ridge crest, the structure of the assemblage is most likely to have already been compromised by the previous land use practices described above (eg. highway construction).

It is more reasonable to speculate that the study area was traversed in order to access more viable resource zones further to the east (coastal strip) and/or north (Pine Creek), which is similar to the conclusions previously forwarded by Officer and Navin (1998) for the

broader Bonville Project. The management recommendations detailed below reflect these considerations.

5. MANAGEMENT RECOMMENDATIONS

The management recommendations are made following a consideration of:

- the legal requirements of Section 90 of the *National Parks and Wildlife Act* (1974), which states that it is illegal to deface, damage or destroy an Aboriginal relic without the prior written consent of the Director-General National Parks and Wildlife;
- the management recommendations that were proposed following the Indigenous cultural heritage assessment of other sections of the Bonville Project (Officer and Navin 1998);
- a predictive model of site location for the study area, based on an assessment of the environmental context and a review of previous archaeological research;
- field assessment of the study area;
- the potential for undetected cultural heritage material being present within the study area; and
- consultation with representatives of the Coffs Harbour and District LALC (refer **Appendix 1**).

Should the Proposal proceed, it is recommended that:

- no further investigation be undertaken of the study area for items of Indigenous cultural heritage, prior to the commencement of construction;
- on commencement of construction, a representative of the Coffs Harbour and District LALC be engaged to monitor the clearing of vegetation within the study area, and following this, undertake a further inspection of the ground surface within the study area. In the event that cultural material is recovered, work should cease immediately in this area, pending the implementation of mitigation measures that are considered approriate by the LALC and NPWS.

6. REFERENCES

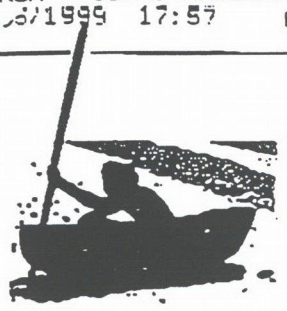
Collins, J. 1997. SH-10 Pacific Highway Proposed Coopernook Traffic Relief Route Aboriginal Archaeological Assessment. Report prepared for Connell Wagner Pty Ltd.

Officer, K. and K. Navin. 1998. Pacific Highway Bonville Deviation Environmental Impact Statement Aboriginal Archaeological Component. Report prepared for PPK Environment and Infrastructure.

PPK Environment and Infrastructure Pty Ltd. 1998. Bonville Project Pacific Highway Coffs Harbour Environmental Impact Statement (Vols. 1 and 2). Report prepared for the Roads and Traffic Authority.

APPENDIX 1

CORRESPONDENCE RECEIVED FROM COFFS HARBOUR AND DISTRICT LOCAL ABORIGINAL LAND COUNCIL



Coffs Harbour & District Local Aboriginal Land Council

PO Box 6150, Coffs Harbour Plaza NSW 2450
Phone (066) 52 8740 Fax (066) 52 5923

Chairperson Anita Craig Secretary Sue Hoskins Treasurer Judy Ferguson

Site Survey

Subject: Field investigation on proposed modifications to the Bonville Project, Pacific Highway, Mid North Coast, NSW.

Actions: Area specified was surveyed on 18th, February, 1999, accompanied by Liam Dagg (Archaeologist RTA Assessment team) and Robert Arnold (PPK Surveyor).

Findings: No visible signs of artefacts or culturally sensitive areas were found during this survey. Area is on slope leading to wetland with dense vegetation covering majority of slope.

Recommendations:

Area has been sufficiently surveyed for possible cultural factors. However, if during removal of topsoil any artefacts should be uncovered, proper authorities should be notified for analysis (ie; Coffs Harbour Local Aboriginal Land Council and relevant Bellinger River Community representatives, eg; Richard Kelly).

B Kelly

Brian Kelly
Sites Officer
Coffs Harbour Local Aboriginal Land Council

5.5.99