A New South Wales Government Initiative

Herons Creek to Stills Road

Upgrading the Pacific Highway

REVIEW OF ENVIRONMENTAL FACTORS
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Review of environmental factors
Pacific Highway Upgrade Herons Creek to Stills Road

23 April 2007

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Pacific Highway Upgrade Herons Creek to Stills Road
23 April 2007

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1 EXECUTIVE SUMMARY

1.1 Introduction

This review of environmental factors (REF) has been prepared by HLA-Envirosciences Pty Limited (HLA) on behalf of the NSW Roads and Traffic Authority (RTA) to take into account all matters affecting, or likely to affect, the environment as a result of the upgrade of the northbound carriageway of the Pacific Highway from Herons Creek to Stills Road, 53.5 km to 57.0 km north of the Taree interchange. This also includes the provision of a two way service road and a grade separated interchange south of Bago Road (the Proposal).

1.2 The Proposal

The Proposal forms part of the RTA's Pacific Highway Upgrading Program. The scope of the Proposal was determined to ensure the standard of this section of the highway would be consistent with current Pacific Highway standards. The Proposal considered by this REF includes the provision of a new northbound carriageway, intersection upgrades, an interchange near Bago Road, service roads and culvert crossings for local drainage lines.

For the purpose of the Proposal, the RTA is both the proponent and determining authority under Part 5 of the *Environmental Planning and Assessment Act,* 1979 (EP&A Act).

The section of the highway between Herons Creek and Stills Road is currently dual carriageway. The current northbound carriageway was previously a two-way two-lane section of the highway and the horizontal and vertical alignment is below current standard. It became the northbound carriageway when the southbound carriageway was constructed in the late 1980s. The existing speed limit on this section of the Pacific Highway is 100 km/hour in both directions, increasing to 110 km/hour to the north of the Herons Creek and Stills Road section.

The Proposal includes of the construction of a new northbound carriageway within the existing median area, parallel to the existing southbound carriageway. Much of the existing northbound carriageway would become a two-way local service road, linking Bago Road, Burrawan Forest Drive, Herons Creek Public School and local properties to the grade separated interchange south of Bago Road.

All of the proposal could be constructed in the first stage, or some elements, such as part or all of the interchange, could be deferred until later stages. The decision on staging will not be made until construction funding is available. For this REF two possible stages have been considered, with stage 1 representing the likely minimum to be constructed if the Proposal were staged, and stage 2 representing the full Proposal.

1.2.1 Stage 1

It is considered that, as a minimum, stage 1 would include construction of the new northbound carriageway from Herons Creek to Stills Road and the two-way service road from Herons Creek Public School to Bago Road.

Access to Herons Creek Public School and properties adjoining the existing highway would be via the two-way service road (the current northbound carriageway). If the proposed grade separated interchange south of Bago road were not constructed in the first stage, at-grade seagull intersections would be constructed at Bago Road and Bobs Creek Road.

1.2.2 Stage 2

If not constructed as part of stage one work, a grade-separated interchange would be constructed south of the existing intersection of the Pacific Highway at Bago Road. The interchange would provide a two-lane bridge over the highway, which would allow for all turning movements to and from the highway.

Access to Herons Creek township, Herons Creek timber mill and Herons Creek Public School would be via a new extension of the two-way service road crossing Herons Creek upstream of the existing bridges.

1.3 Costs

The total estimated cost of the upgraded highway to the ultimate (stage 1 plus stage 2) motorway class proposal is $43 million.

1.4 Zoning of the proposed activity

The Proposal passes through land zoned 1(a1) Rural, 1(a3) Rural – Agricultural Protection and 1(f) State Forests by *Hastings Local Environmental Plan 2001* (LEP 2001).

In Zones 1(a1) Rural and 1(a3) Rural Agricultural, development for the purpose of roads is permissible with development consent. In Zone 1(f) State Forests, development for the purpose of roads is permitted without development consent. SEPP 4 applies to development for the purposes of a classified road and allows development to be carried out without development consent in the zones where development consent would otherwise be required.

1.5 Community consultation

The community consultation program for the Proposal began in February 2005 with the distribution of a community update. A community information session was advertised in the local press and held on 16 February 2005.

A community liaison group was formed and an initial meeting held on 13 April 2005. Further meetings were held in June 05 (which included a design workshop) and March 06.

Individual meetings were held in July and August 2005 with Port Macquarie - Hastings Council, Boral Timber, Herons Creek Public School, Bunyah Local Aboriginal Land Council, Volcanic Resources, NSW State Forests and the two landowners who are adjacent to the Proposal.

The concept design for the Proposal was put on display from 10 February 2006 to 17 March 2006.

Following the concept design display 13 submissions were received. Submissions were received from Department of Natural Resources, Forests NSW, Department of Planning, Department of Primary Industries, Department of Environment and Conservation, Port Macquarie-Hastings Council, Boral Country Concrete and Quarries, Boral Timber, Bago Wines and four individuals.

The issues raised in submissions covered the areas of planning and land use, concept design issues, safety, property impacts, noise, tourism issues, bushfire, non-Indigenous heritage and flora and fauna, particularly aquatic ecology. The *Concept Design Submission Report* is attached as **Appendix I**.

1.6 Planning focus meeting

A planning focus meeting, with representatives from government agencies and other stakeholders was held on 17 February 2005.

The meeting was attended by representatives from Port Macquarie-Hastings Council, Great Lakes Council, Greater Taree City Council, DIPNR (now the Department of Planning and the Department of Natural Resources), NSW Forests, Country Energy and Rural Fire Service.

Representatives from Department of Environment and Conservation and NSW Fisheries did not attend but submitted comments. The Department of Education was invited but did not attend. Notes from the planning focus meeting are included as **Appendix J**.

1.7 Need for the Proposal

The Proposal is needed as part of the RTA's broader plans and strategy to upgrade the section of the Pacific Highway between Hexham to the Queensland border to a high standard dual carriageway.

The need to upgrade the section of the Pacific Highway between Herons Creek and Stills Road is based on a number of factors which include regional and coastal population growth, road safety and economic issues.

1.8 Landforms geology and soils

The Proposal would result in changes to the landforms as a result of the earthworks required in the construction of the new northbound carriageway. Likely impacts on soils include the potential for soil erosion to occur during construction works.

1.8.1 Contamination assessment

The Proposal area includes an area of land where materials from a former chemical spill on the highway were buried. A study was undertaken in August 2005 to identify the presence and extent of soil contamination and to confirm disposal or re-use options for the burial material. The findings of the contamination assessment were that the material encountered was 'Inert Waste' with respect to NSW Environment Protection Authority (EPA) guidelines, and suitable for direct disposal to a licenced landfill. The report is attached as **Appendix B**.

Safeguard measures to be adopted for the Proposal would include the development of a soil and water management plan and a construction environmental management plan for the Proposal.

1.9 Air quality

The Proposal has the potential to affect ambient air quality during both the construction and operational phases, with the primary air quality impacts caused by vehicle exhaust emissions during the operational phase. The proposal would not increase vehicle numbers and would move northbound highway traffic further away from Herons Creek Public School (the only premises fronting the northbound carriageway in the project length).

The removal of approximately 20 ha of vegetation as part of the Proposal would reduce the capacity of the existing environment to remove carbon dioxide from the atmosphere. Extensive

revegetation would reduce the impact of this activity on ambient air quality and it is considered to be negligible.

In order to minimise the potential impacts of dust and emissions during construction, an air quality management plan would be developed for the Proposal.

1.10 Water quality and hydrology

During construction there is potential for sediment runoff occurring as a result of soil erosion from disturbed areas that may affect the quality of water and biota in drainage lines that cross the Proposal area.

There is also potential for leaks and spills of fuel or oil to affect surface or ground water quality. Effluent from facilities such as a temporary batching plant could flow into drainage lines if not appropriately managed.

The operation of the highway could result in the build up of contaminants that could be transported via runoff into local drainage lines. Although the Proposal would increase the total area of road surfaces, the amount of traffic using the highway and service roads is not expected to increase as a result of the Proposal. Therefore the potential contaminant load would not increase over that of the existing highway.

Safeguard measures to capture pollutants would be incorporated in the detailed design. The stormwater management plan developed for the site would provide detailed management measures to prevent impacts on water quality as a result of the Proposal.

Hydraulic Investigation

A hydraulic investigation of transverse drainage structures was undertaken by the RTA Bridge Section in July 2006. The proposed extensions of the existing transverse drainage structures and the installation of the new structures will have no significant impact on the existing flood flow distribution. A change in outlet velocity is marginally observed. The report is attached as **Appendix C**.

1.11 Noise and vibration effects

A noise and vibration assessment was prepared for the Proposal. Future noise levels were predicted by undertaking detailed modelling of the existing and proposed road configuration using RTA Technologies' *Environmental Noise Model* version 3.1.

Herons Creek Public School is within 100 m of the Proposal. There is a residence to the east near Herons Creek that is 130 m away, with Herons Creek village and three rural residences more than 250 m away. Traffic noise levels at all residential receivers would comply with the criteria.

An acoustic barrier at Herons Creek Public School is proposed as part of the Moorland to Herons Creek project (which would precede construction of this project). This would provide the assessed traffic noise reduction of about 5dB (A) required to achieve compliance with the noise criterion.

A noise and vibration management plan would be developed for the Proposal.

The *Noise and vibration impact assessment* report is attached as **Appendix D**.

1.12 Biodiversity

An ecological assessment investigated the potential affect the Proposal would have on terrestrial flora and fauna. The assessment included a field survey undertaken between 5 and 7 October 2005.

Potential impacts from the proposed road upgrade include the clearing of approximately 20 ha of woodland or forest. Clearing of remnant vegetation would result in the loss of roosting and foraging opportunities for birds and arboreal mammals. It is unlikely there would be a significant reduction in the availability of medium to large tree hollows, as the majority of trees within the footprint of the proposed development are relatively young and lack hollow development.

The assessment did not record any threatened species or endangered ecological communities in the study area. In addition, no endangered populations listed under Schedule 1, Part 2 of the *Threatened Species Conservation Act, 1995* are present within the study area or would be affected by the Proposal. There was also no Critical Habitat, declared under the provisions of the Threatened Species Conservation Act, within the study area.

An assessment of the Proposal under the provisions of *State Environmental Planning Policy No. 44 – Koala Habitat Protection* (SEPP 44) was also undertaken. This found that it was possible koalas would pass through the site occasionally, but it was considered unlikely that there is a resident koala population due to the proximity of the highway. The study area was therefore not considered to be core koala habitat under SEPP 44.

The assessment concluded that there would not be a significant impact to threatened species potentially occurring within the study area. However, the Proposal has the potential to affect the local biodiversity by impeding species movement, increasing the risk of collision with vehicles and weed invasion. Safeguard measures would be employed to reduce these impacts.

1.13 Visual and landscape

The Proposal is considered to have a moderate impact on the visual environment. The highway is the existing dominant visual feature and mitigation measures would include a landscaping strategy to:

- Re-establish vegetation cleared during construction works.
- Supplement the vegetation maintained.
- Reduce the visual impact of the new sections of road upon adjacent properties.

1.14 Indigenous heritage

An Aboriginal heritage study investigated the nature of any Indigenous archaeological resources within the development area and identified the potential for impact on these resources. An archaeological survey was conducted on 30 to 31 November 2005 by HLA archaeologists and representatives from Bunyah Local Aboriginal Land Council to identify the archaeological potential of the study area.

Three recorded Aboriginal sites are located in the study area, all previously identified by Navin Officer (2001) during a 2001 survey of Herons Creek. The three sites were an isolated find, a scarred tree and a potential archaeological deposit. None are directly impacted by the Proposal.

1.15 Non-Indigenous heritage

An assessment of Non-Indigenous heritage was undertaken to assess the nature of any European archaeological resources within the development area and to identify the potential for impact on these resources. A field survey was conducted on 30 to 31 November 2005. The study was undertaken to the standards outlined in the Heritage Office *Heritage Manual* (1996).

Two historic sites were identified during the course of the survey, consisting of:

- The remains of an eucalypt with switchboard/axe grooves to one side located on the south side of Herons Creek Road.
- Herons Creek Bridge.

Neither site is directly impacted by the proposal.

1.16 Socio- economic consideration

The construction of the Proposal would potentially have impacts on land use, amenity, properties, access and employment opportunities.

In the short term during construction the amenity of the area would be affected by increases in construction traffic, dust and noise. Measures such as the implementation of a traffic management plan, noise and vibration management plan and an air quality management plan would be undertaken to minimise these short-term impacts.

The Proposal would require the acquisition of approximately 20 ha of land. All property acquisition would be negotiated in accordance with the RTA's *Land Acquisition Policy* and compensation would be in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*.

The construction of the Proposal would provide positive economic benefits by providing employment opportunities and business for suppliers in the local region.

The operation of the new road would provide a number of positive social and economic impacts for the local area, region and State. A reduction in the number of accidents and in travel time along the highway is expected. The two way service road and the new northbound carriageway would provide greater capacity for cyclist use than the existing northbound carriageway.

Measures would be implemented to minimise the potential social and economic impacts as a result of the Proposal. These would include the development of a traffic management plan and traffic control plans.

1.17 Waste minimisation and management

Buried fill material was identified in a contamination assessment. This would be sent to landfill at a licensed facility prior to works being undertaken.

Where possible, waste generated during the construction works would be sorted for recycling, reuse or disposal and transported off site to licensed facilities.

Trees required to be removed would be milled or chipped and used as mulch for revegetation works.

Portable toilets would be provided on site for the use of contractors and staff. These would be pumped out by a licensed waste contractor on a regular basis.

Safeguards to manage waste would be implemented and would include the development of a waste management plan.

1.18 Hazards and risks

The potential risks and hazards involved in the construction of the Proposal relate to spillage of dangerous or hazardous materials or wastes; traffic accidents; contact with underground utilities; workplace accidents and bushfire.

Spillage of dangerous or hazardous materials during construction would be managed by the implementation of appropriate management procedures and controls.

Traffic management measures would be implemented in accordance with an approved traffic management plan and traffic control plans.

Measures to mitigate the spillage of dangerous goods and contaminants associated with runoff have been incorporated into the design of the Proposal. The incidence of vehicle accidents is expected to reduce as a result of the Proposal and, therefore, the risk to human health and safety would be reduced.

1.19 Cumulative environmental effects

The Proposal is not being undertaken in isolation as it is part of the Pacific Highway Upgrading Program and would link with the northern extent of the Moorland to Herons Creek project. The Pacific Highway Upgrading Program will ultimately result in benefits for the local area, region and State. These benefits include improved road safety and reduced travel times. Economic benefits would include increased tourist access to many areas along the coast and economic flow-on effects. The Proposal would also assist in improving the traffic flow on the highway. This would, in turn, help to increase the fuel efficiency for vehicles using the highway.

1.20 Principles of ecologically sustainable development

The Principles of ecologically sustainable development have been considered throughout the development of the Proposal in the concept design and the development of safeguards. Ecologically sustainable development will continue to be considered in the detailed design and management of the Proposal. These principles, and how they have been considered, are outlined below.

The precautionary principle
The precautionary principle has been applied throughout the development of this route alignment option. The Proposal, together with the implementation of appropriate safeguard measures, does not present a significant risk of serious or irreversible environmental damage.

Intergenerational equity
The Proposal would benefit future generations by improving access to areas on the NSW coast and improving road safety. The Proposal is consistent with long-term planning aims and would help to benefit the productivity of the region in the future. The decision on the proposed alignment was made with the consideration of the local community and other stakeholders in order to ensure a satisfactory outcome was made for both the present and future generations.

Conservation of biological diversity and ecological integrity

Biological diversity and ecological integrity have been considered in the flora and fauna impact assessment. This assessment found that the Proposal could be undertaken without significant impact on the ecological environment. The reduction of impacts on biological areas has been a consideration in the development of the proposal. A number of safeguards are described that relate to conservation of biological diversity and ecological integrity.

Improved valuation and pricing of environmental resources

It is difficult to assign a monetary value to the environment in this locality. However, by managing environmental impacts by identifying site safeguard measures to mitigate adverse environmental effects and including the cost of these measures in the overall cost of the Proposal, the value of environmental resources has been considered as part of the Proposal.

The Proposed alignment for the upgrade was not chosen on cost alone, but also on a consideration of environmental and biological factors as well as engineering, social and economic aspects. This resulted in the proposed upgrade route, which is seen to be the most suitable alignment by the community and stakeholders and the RTA.

2 INTRODUCTION

This review of environmental factors (REF) has been prepared by HLA-Envirosciences Pty Limited (HLA) on behalf of the NSW Roads and Traffic Authority (RTA) to take into account all matters affecting, or likely to affect, the environment as a result of the upgrade of the northbound carriageway of the Pacific Highway from Herons Creek to Stills Road, 53.5 km R[0000010,2150,A2,5.710] to 57.0 km R[0000010,2171, B1, 3.310] north of Taree (the Proposal).

This REF has been prepared to satisfy the requirements of Section 111 of the *Environmental Planning and Assessment Act,* 1979 (EP&A Act). This REF describes the proposal and the associated environmental impacts in the context of Clause 228 of the *Environmental Planning and Assessment Regulations,* 2000. The factors identified in Clause 228 have been addressed in **Section 12** of this document.

2.1 Proposal identification

The Proposal is to upgrade the northbound carriageway of the Pacific Highway between Herons Creek and Stills Road, 53.5 km to 57.0 km north of Taree.

The Proposal is part of the Pacific Highway upgrading and is within the Port Macquarie-Hastings local government area.

2.2 Background

The Proposal forms part of the RTA's Pacific Highway Upgrading Program. The scope of the Proposal was determined to ensure the standard of this section of the highway would be consistent with current Pacific Highway standards The Proposal considered by this REF includes the provision of a new northbound carriageway, intersection upgrades, an interchange near Bago Road, associated service roads and culvert crossings for local drainage lines.

A *Preliminary Environmental Envestigation* was prepared in April 2005 by the RTA to identify environmental constraints and issues to be considered in the development of the Proposal. The preliminary environmental investigation identified the environmental constraints and determined the scope of the subsequent environmental assessment of the construction and operation of the Proposal. It also made a number of recommendations for the development of the preferred option in order to minimise potential impacts associated with identified constraints. The preparation of this REF has included a review of the preliminary environmental investigation and, where relevant, has included the recommendations made in that document (refer to **Appendix A**).

The preferred option was developed by the RTA based on consultation with the local community, council, Bunyah Local Aboriginal Land Council and relevant government agencies and a preliminary assessment of alternative route options. A number of other reports have been prepared, including the *State Highway No. 10 – Pacific Highway Herons Creek to Stills Road Project Development Proposal* (RTA 2004), the *Pacific Highway – Herons Creek to Stills Road Desktop Study Preliminary Feasibility of Route Options* (RTA, 2005a) and the *Herons Creek to Stills Road Concept Design Report* (RTA, 2005b). This review is based on the concept design provided in the *Herons Creek to Stills Road Concept Design Report* (RTA, 2005b). Alternative route options are addressed in **Section 7.2** of this REF.

2.3 The proponent

For the purpose of the Proposal, the RTA is both the proponent and determining authority under Part 5 of the EP&A Act.

3 PROPOSAL DESCRIPTION

3.1 Location

The Proposal is located on the mid north coast of NSW and lies within the Port Macquarie-Hastings local government area. It extends for 3.5 km along Higway 10 Pacific Highway between Herons Creek and Stills Road. This section of the highway is located 53.5 km north of Taree and approximately 19 km south of Port Macquarie.

Figure 1 shows the location of the Proposal.

For the purpose of this report, the study area is defined as the area of land that extends the length of the route (approximately 3.5 km) and 100 m west and east of the existing northbound and southbound carriageways of the Pacific Highway, including the area between the carriageways.

3.2 General features

3.2.1 General description

The section of the highway between Herons Creek and Stills Road is currently dual carriageway. The northbound carriageway was previously a section of the Pacific Highway a two-way two-lane section of the highway and is on a poor horizontal and vertical alignment. It became the northbound carriageway when the southbound carriageway was constructed in the 1980s. The existing speed limit on this section of the Pacific Highway is 100 km/hour in both directions, increasing to 110 km/hour to the north of the section (Roadnet, 2006).

The Proposal consists of the construction of a new northbound carriageway within the existing variable width median area, parallel to the existing southbound carriageway. Much of the existing northbound carriageway would become a two-way local service road, linking Bago Road, Burrawan Forest Drive (west), Herons Creek Public School and local properties to the proposed grade separated interchange south of Bago Road.

The upgrade of the Pacific Highway for this section could be undertaken in stages as detailed below. The proposed development would be designed for 110 km/h travel speed and would provide a high standard four-lane dual carriageway. The carriageways would be separated by a 12 m median that would allow the future addition of an extra two lanes on each carriageway if required. **Figure 2** provides an aerial photograph overlain with the proposed upgrade alignment.

The concept design was prepared for the ultimate motorway standard proposal, and it is this Proposal that has been assessed in this REF.

Construction could be staged, with some sections initially constructed to arterial class. An arterial class road is designed as a controlled access road and is developed with a strategy for conversion to motorway class in the future. Arterial roads are generally signposted at 100 km/hr. A motorway is designed to a 110 km/hr freeway standard, and requires an alternative route to be available for local traffic through the provision of service roads or local arterial road networks. A freeway is a special form of Controlled Access Road defined in the *Roads Act* 1993. The road is generally divided with no access for traffic between interchanges and with grade separation at all intersections.

All elements of the proposal could be constructed in the first stage, or some elements, such as part or all of the interchange, could be deferred until later stages. This decision will not be made until

HLA

Regional Site Location
NSW Roads and Traffic Authority
Review of Environmental Factors
Pacific Highway Upgrade
Herons Creek to Stills Road
Herons Creek NSW

NPWS Estate
State Forest
Highway
Railway
Road

FIGURE 1

PROJECT-FILE NAME	N6033105	DATE	23 October 2006	DRAWN	TO	APPROVED

Proposed Stockpile Locations
NSW Roads and Traffic Authority
Review of Environmental Factors
Pacific Highway Upgrade
Herons Creek to Stills Road
Herons Creek NSW

FIGURE 2

construction funding is available. For this REF two possible stages have been considered, with stage 1 representing the likely minimum to be constructed if the Proposal were staged, and stage 2 representing the full Proposal.

3.2.2 Stage 1

It is considered that, as a minimum, stage 1 would include construction of the new northbound carriageway from Herons Creek to Stills Road and the two-way service road from Herons Creek Public School to Burrawan Forest Drive.

Access to Herons Creek Public School and properties adjoining the existing highway would be via a two-way service road (the current northbound carriageway). If the proposed grade separated interchange south of Bago road were not constructed in the first stage, at-grade seagull intersections would be constructed at Bago Road and Bobs Creek Road.

3.2.3 Stage 2

If not constructed in the first stage a grade-separated interchange would be constructed near Boyds Road south of the existing intersection of the Pacific Highway at Bago Road. The interchange would provide a two-lane bridge over the highway, which would allow for all turning movements from Stills Road and Bobs Creek Road, to and from the highway.

Access to the highway would only be provided at the grade-separated interchange. Upon completion of the grade-separated interchange at Bago Road, the existing Herons Creek Road intersection would close.

Access to Herons Creek township, Herons Creek timber mill and Herons Creek Public School would be via a new two-way service road crossing Herons Creek upstream of the existing bridges. Highway intersections at Bobs Creek Road would close and access would be via the interchange south of Bago Road.

3.3 Costs

The total estimated cost of the upgraded highway to the ultimate motorway class proposal is $43 million.

3.4 Timing

The timing for commencement of construction of the Proposal has not been determined, but preliminary works are expected to commence within the next three to four years. The construction of the Proposal would be expected to take approximately 80 weeks.

4 STATUTORY POSITION

4.1 Zoning of the proposed activity

The Proposal passes through land zoned 1(a1) Rural, 1(a3) Rural – Agricultural Protection and 1(f) State Forests by *Hastings Local Environmental Plan 2001* (LEP 2001).

In Zones 1(a1) Rural and 1(a3) Rural Agricultural, development for the purpose of roads is permissible with development consent. In Zone 1(f) State Forests, development for the purpose of roads is permitted without development consent.

4.2 Other statutory matters

4.2.1 State Environmental Planning Policy No 4

Under Clause 11C of State Environmental Planning Policy (SEPP) 4 - "Development without consent and miscellaneous exempt and complying development", development for the purposes of a classified road may be undertaken without obtaining development consent if the development is not prohibited. Since the proposed work does not require development consent, the proposed work must be assessed as an activity under Part 5 of EP&A Act. The RTA is the proponent and nominated determining authority for the activity. **Section 6.1** considers matters described in Clause 228 of the Environmental Planning and Assessment Regulation 2000. This REF will assist the RTA to satisfy its obligations under Part 5 of the EP&A Act.

The Pacific Highway is considered to be a classified road under the definitions provided in the *Roads Act* 1993. Therefore the provisions of SEPP 4 apply to the Proposal and the works within Zone 1 (a1) and Zone 1(a3) which would otherwise require development consent can be undertaken without development consent.

4.2.2 Tree Preservation Order

Clause 20 of Hastings Local Environment Plan 2001 relates to tree preservation and the objective of the clause is *"to protect vegetation and provide for the assessment of the impact of clearing for the reasons of preserving amenity and the ecology of the area of Hastings"*. A tree preservation order is to identify a tree or class of trees that must not be ringbarked, cut down, topped, lopped, removed or wilfully destroyed without development consent or the permission of the council. The clause does not apply to trees in a state forest or within a reserve under the *Forestry Act 1916*, or to trees in Zone 8(a). Therefore this clause does not apply to trees affected by the Proposal within Burrawan State Forest, but would apply to trees within Zones 1 (a1) Rural and 1 (a3) Rural Agricultural.

However, as clause 11C of SEPP 4 applies to the Proposal, the removal of trees outside of Burrawan State Forest would also be permissible without development consent or the permission of the Port Macquarie-Hastings Council.

4.3 Confirmation of Part 5 position

Land subject to the Proposal is zoned 1(a1) Rural, 1(a3) Rural Agricultural Protection and 1(f) State Forests by Hastings Local Environment Plan 2001. Development for the purpose of roads is permitted without development consent in Zone1(f); within Zones 1(a1) and 1(a3) road development is permissible with consent. SEPP 4 applies to development for the purposes of a classified road and

allows development to be carried out without development consent in the zones where development consent would otherwise be required. SEPP 4 also negates the requirement for the consent of council to remove trees where Clause 20 of Hastings Local Environment Plan 2001 applies. Therefore Part 5 of the EP&A Act applies and the RTA is the determining authority for the Proposal.

5 SPECIALIST STUDIES AND COMMUNITY INVOLVEMENT

5.1 Specialist studies

The following specialist studies were undertaken as part of this REF:

- *Report on contamination assessment of the former burial area Pacific Highway between Herons Creek and Stills Road Herons Creek* (Douglas Partners Pty Ltd, 2005).
- *Hydraulic investigation of transverse drainage structures* (RTA Bridge Section, 2006).
- *Noise and vibration impact assessment* (Spectrum Acoustics, 2006).
- *Traffic study* (RoadNet Pty Ltd, 2006).
- *Review of flora and fauna* (HLA, 2006a).
- *Aboriginal and historic heritage assessment* (HLA, 2006b).
- *Urban and landscape concept design report* (KIAH Infranet 2006)

5.1.1 Contamination assessment

The Proposal area includes an area of land where burial of materials from a former chemical spill occurred on the Pacific Highway. A study was commissioned to identify the presence and extent of soil contamination and to confirm disposal or re-use options for the burial material.

The contamination assessment of the former burial area prepared by Douglas Partners involved:

- Review of the site history including discussions with the RTA and Department of Environment and Conservation.
- A site inspection.
- Soil sampling at five locations.
- Laboratory testing of selected soil samples for a range of potential organic and inorganic contaminants.
- Preparation of a report discussing the findings of the assessment.
- The findings of the contamination assessment are summarised in **Section 9.1.2** of this REF and the report is found in full in **Appendix B**.

5.1.2 Hydraulic investigation

The hydraulic investigation of transverse drainage structures by the RTA Bridge Section involved:

- Concept checking and analysis of the seven existing transverse drainage structures to be extended and seven new drainage structures.
- Analysis of the performance of the existing and proposed structures in 1 in 50 year average recurrence interval and 1 in 100 year average recurrence interval flood events.
- The hydraulic investigation of transverse drainage structures is found in full in **Appendix C**.

5.1.3 Noise and vibration

A noise and vibration impact assessment was undertaken by Spectrum Acoustics as part of the preparation of the REF. This involved:

- Determination of the current background noise levels on the site, having due regard for the location of the nearest noise sensitive locations.
- Identification of the relevant noise and vibration criteria.
- Prediction of expected noise and vibration levels from the Proposal.
- Assessment of noise and vibration impacts during construction and operation in accordance with the Enviornment Protection Agency's "Environmental Criteria for Road Traffic Noise" and the Environment Protection Agency's "Environmental Noise Control Manual".
- Making of recommendations on the requirements for mitigation measures and further assessment.
- The findings of this assessment are summarised in **Section 9.4** of this REF and the assessment report is found in full in **Appendix D.**

5.1.4 Traffic study

The traffic study undertaken by RoadNet Pty Ltd involved:

- An assessment of traffic data, traffic modelling and economic analysis in order to justify the Proposal and to assist in the design of the road and intersections.
- Reviews and projections of traffic volumes.
- Assessment of road and intersection capacity.
- Analysis of accident data.
- Provisions for cyclists, pedestrians and buses.
- Assessment of the cumulative impacts of the Proposal on the road network.
- The traffic study is found in full in **Appendix E**.

5.1.5 Flora and fauna

The flora and fauna assessment of the Proposal undertaken by HLA involved the following:

- A review of information currently available, including searches of the Department of Environment and Conservation Wildlife Atlas, Royal Botanic Gardens database and an on-line search for matters of national environmental significance to identify significant plants and communities that occur within the study area.
- Field assessment of plants, animals, and ecological communities present within the study area, undertaken during spring.
- Preparation of a list of species found in the area, and those potentially occurring in the area.
- A review of the significant species and ecological communities listed under the *Threatened Species Conservation* (TSC) *Act* and an impact assessment in accordance with Section 5A of the EP&A Act.

- An assessment of the impact on species protected by the provisions of the *Environmental Protection Biodiversity Conservation* (EPBC) *Act.*
- Preparation of a list of suggested measures to mitigate potential effects on vegetation and fauna habitat.
- The findings of this assessment are detailed in **Section 9.5** of this REF and the assessment report is found in full in **Appendix F**.

5.1.6 Indigenous and non-Indigenous

The indigenous and non-indigenous heritage assessment undertaken by HLA involved:

- Background research, including a search of the aboriginal heritage information management databases and background archaeological information, a search of a wide variety of historic databases including the NSW Heritage Office State Heritage listing and register, the Register of National Estate, and relevant local environment plans.

5.1.7 Aboriginal community consultation

- A detailed field survey of the Proposal area, involving representatives of the Aboriginal community groups.
- Definition of the archaeological potential of the subject areas based on information collated during this research and taking previous landscape use and disturbance into account.
- Reporting of the archaeological survey documenting the methodology and results of the survey and assessment, incorporating previous results undertaken in the study area.
- Assessment on the potential impact on both Aboriginal and historic heritage.
- Identification of heritage issues, including appropriate mitigation strategies.
- The findings of this assessment are detailed in **Sections 9.7** and **9.8** of this REF and the assessment report is found in full in **Appendix G**.

5.2 Community and stakeholder involvement

5.2.1 Community involvement

The RTA commenced a community consultation program for the Proposal in February 2005. This involved the distribution of a community update flyer that contained a description of the project, contact information and a dedicated 1800 phone number for any questions.

Advertisements were placed in local papers inviting members of the community to a community information session to discuss the project. The community information session was held on 16 February 2005 and a community liaison group was subsequently formed. The community liaison group was made aware that the aims for developing the group were to:

- Create a forum for discussion and exchange of information on topics related to the development phase of the project.

- Assist the project team to identify local issues related to the project that will be addressed into the development phase of the project.
- Act as a two-way communication link between the project team and the community and stakeholders.

The role of the community liaison group was to:

- Represent the broad range of local community and stakeholder interests.
- Identify and communicate community and stakeholder concerns about the project.
- Disseminate information on the project to the local community.
- Consider the range of community views, interests and issues related to the detailed design and construction of the project.

The initial community liaison group meeting was held on 13 April 2005 where the project objectives were outlined and the project team's preliminary findings presented. After discussion, the group consensus was that route option 2 (refer **Section 7.2.1**) appeared to be the best option. The main issues raised were the access arrangements to the highway from the side roads, the access to Herons Creek School and the school bus stop location. Two more meetings were held (June 2005 which included a design workshop and March 2006) and further community liaison group meetings will also be held in the future as the detailed design stages of the Proposal progress.

In addition, individual meetings were held in July 2005 with Port Macquarie - Hastings Council, Boral Timber, Herons Creek Public School, Bunyah Local Aboriginal Lands Council, Volcanic Resources, NSW State Forests and the two landowners who are adjacent to the Proposal (on the eastern side). A record of these meetings is listed in **Appendix H**. Comments from these meetings were an input to the development and refinement of the design and were a key input to the decision to adopt the central alignment.

Throughout the process of selecting a preferred option and developing a preliminary concept design, the project team consulted with potentially affected landholders and other stakeholders with an interest in the Proposal. The comments, requests, ideas and information gained from this consultation had significant influence on the preliminary concept design of the Proposal.

Interviews with landholders were carried out in July 2005 and August 2005. The majority of these interviews involved a site visit by members of the project team and discussions with the landholder at their property. The project team also met with any additional stakeholders as required when requests were received.

Issues raised at these landholder interviews were:

- Highway access from properties.
- Concerns about maintenance of the service road.
- Redistribution of heavy vehicles and traffic.
- Pedestrian safety concerns.
- Concern about property acquisition.

Interchange and overbridge locations and configurations were revised a number of times in response to issues raised by the community in landholder interviews. The final preferred configuration of

interchanges and overbridges addresses all major issues identified through the landholder interviews and the other community consultation methods employed by the project team.

The exhibition of the concept design was publicised in the following ways:

- Advertisements in the *Camden Haven Courier* on 15 and 22 February 2006.
- Advertisements in the *Port Macquarie Express* on 15 and 17 February 2006.
- Advertisements in the *Port Macquarie News* on 15 and 23 February 2006.
- Advertisements in the *Hastings Gazette* on 16 and 23 February 2006.
- A letterbox drop of the Community Update Number 1 on 10 February 2006.

The concept design for the Proposal was put on display between 10 February 2006 and 17 March 2006 at the following locations:

- Laurieton Library;
- Greater Taree Council;
- Port Macquarie-Hastings Council;
- Port Macquarie RTA Motor Registry;
- Wauchope RTA Motor Registry;
- RTA Hunter Regional Office; and
- RTA Pacific Highway Office.

It was also made available on the RTA web site from 10 February 2006.

13 submissions were received in response to the concept design display. Submissions were received from:

- Department of Natural Resources;
- Forests NSW;
- Department of Planning;
- Department of Primary Industries;
- Department of Environment and Conservation;
- Port Macquarie-Hastings Council;
- Boral Country Concrete and Quarries;
- Boral Timber;
- Bago Wines; and
- Four individuals.

The issues raised in submissions covered the areas of:

- Planning and land use;
- Concept design issues;
- Safety;
- Property impacts;
- Noise;
- Tourism issues;

- Bushfire;
- Non-Indigenous Heritage; and
- Flora and Fauna, particularly aquatic ecology.

The *Concept Design Submission Report* is attached as **Appendix I.**

Additional consultation and landholder interviews were held during and following the concept design display held in February and March 2006. The feedback from these interviews was an important input into further development of the concept design.

5.2.2 Planning focus meeting

A planning focus meeting, involving representatives from government agencies and other stakeholders, was held on 17 February 2005 to inform these stakeholders on the Proposal and to provide an opportunity for the representatives to advise on the requirements of each agency.

Nineteen people attended the planning focus meeting, including representatives from the RTA. Eleven representatives sent their apologies, with some sending alternative representatives in their place. Others had provided preliminary issues for inclusion in the planning process. All those who declined the invitation were offered the opportunity to be kept informed through minutes of the meeting and further information as it became available. Representatives from the following organisations attended the planning focus meeting:

- Port Macquarie-Hastings Council.
- Great Lakes Council.
- Greater Taree City Council.
- Department of Infrastructure, Planning and Natural Resouces (now two separate agencies: the Department of Planning and the Department of Natural Resources).
- NSW Forests.
- Country Energy.
- Rural Fire Service.

Representatives from Department of Environment and Conservation and NSW Fisheries did not attend but submitted comments. Notes from the planning focus meeting are included as **Appendix J**. The Department of Education was invited but did not attend.

Feedback from the members of the community, stakeholders and government agencies was used to develop route options and finalise the preferred route for the Proposal and to select the option which was considered to satisfy the objectives of the Proposal best and the needs of the stakeholders and the RTA.

6 STRATEGIC STAGE

6.1 Planning and environment background

6.1.1 State Environmental Planning Policies

State Environmental Planning Policy 14 – Coastal Wetlands aims to ensure coastal wetlands are preserved and protected for environmental and economic reasons. This SEPP applies to the Port Macquarie-Hastings local government area (LGA). The SEPP identifies over 1300 wetlands of high natural value within the State and requires that land clearing, levee construction, drainage work or filling may only be carried out within these wetlands with the consent of the local council and the agreement of the Director-General of the Department of Planning. Such development also requires an environmental impact statement to be lodged with a development application.

There are no SEPP 14 Coastal Wetlands located within 5km of the site and therefore the provisions of SEPP 14 do not apply to the Proposal.

State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44) encourages the conservation and management of natural vegetation areas that provide habitat for koalas to ensure that permanent populations will be maintained over their present range. The Port Macquarie-Hastings LGA is listed in Schedule 1 of SEPP 44 as an LGA in which koalas are known to occur. While the requirements of the SEPP do not technically apply to this Proposal, as it is not subject to Council consent, it is the RTA's practice to consider potential impacts on koalas in its environmental impact assessment process. Therefore an investigation of core koala habitat has been undertaken as part of the flora and fauna assessment for this REF and the findings are detailed in **Section 9.6.6**.

6.1.2 North Coast Regional Environmental Plan

The *North Coast Regional Environmental Plan* applies to land within the Port Macquarie-Hastings LGA and provides guidelines for the preparation of local environmental plans and for certain types of development. The *Regional Environment Plan* sets the basis for new urban and rural development along the coast with an emphasis on careful management. The *Regional Environment Plan* specifies other matters for consideration in development application assessment and imposes consent and concurrence provisions for listed heritage items.

There are no items of state or regional heritage significance listed in Schedule 2 or 3 of the *Regional Environment Plan* that would be affected by the Proposal. The Proposal area is also not within a conservation area listed in schedule 1 of the *Regional Environment Plan*.

Clause 28 provides the following objectives of the *Regional Environment Plan* in relation to the natural environment:

a) to protect areas of natural vegetation and wildlife from destruction and to provide corridors between significant areas,

b) to protect the scenic quality of the region, including natural areas, attractive rural areas and areas adjacent to water bodies, headlands, skylines and escarpments, and

c) to protect water quality, particularly within water catchment areas.

The Proposal objectives are compatible with these objectives. **Section 9** of this REF provides consideration of the impacts of the proposal on the environment. Safeguards would be implemented during construction and operation of the Proposal to prevent impacts to the environment (**Section 10.2**), specifically safeguards covering biodiversity, visual landscape, landform, ecology and soil and water quality.

Clause 52 of the *Regional Environment Plan* includes the following objectives in relation to transport:

a) To safeguard the role and efficiency of the main road system of the region, particularly by recognising the importance of primary arterial roads.

b) To facilitate maintenance and improvement of transport in the region.

The Proposal would facilitate these objectives by improving the safety and efficiency of this section of the Pacific Highway.

6.1.3 Pacific Highway Safety Review, May 2004

In October 2003, following an increase in fatal crashes, the Minister for Roads instigated a review of road safety on the Pacific Highway between Hexham and the Queensland border to be undertaken by the Roads and Traffic Authority.

The *Pacific Highway Safety Review* (RTA, 2004) examined the circumstances surrounding the fatal crashes that had occurred on the highway and identified some of the key safety issues.

The main issues identified were heavy vehicles travelling too fast, and inconsistent and inappropriate changes in speed zonings on the highway. The review identified a road safety strategy for the highway. The vision for this strategy is:

'A significant reduction in trauma, both injury and death, caused by road crashes on the Pacific Highway'

The vision is underpinned by six goals for the highway:

- Continue the upgrading of the highway to high standard dual carriageway from Hexham to the Queensland border.
- Facilitate safer operation of two-way single carriageway sections.
- Manage and enforce speed limits.
- Address long distance driver fatigue in both heavy and light vehicles.
- Respond to the road safety impacts of increased usage by heavy vehicles.
- Minimise the adverse impacts of traffic incidents.

Underpinning these goals are the following programs:

- **The Pacific Highway Upgrading Program.** The Pacific Highway Upgrading Program is part of the plan to meet the vision of the strategy. The proposal for the upgrade between Herons Creek and Stills Road is part of the program to upgrade the highway to high standard dual carriageway, and is therefore part of the RTA's strategic plan to improve safety on the Pacific Highway by continuing the upgrading of the highway to high standard dual carriageway from Hexham to the Queensland border in accordance with the recommendations made in the *Pacific Highway Safety Review* (RTA, 2004).

- **An Enhanced Road Safety Engineering Works Program** to address issues such as poor alignment; potential for head-on crashes; poor shoulders and roadside hazards; intersections and rest facilities.
- **A Behavioural Program** to address issues such as speeding and fatigued driving.
- **An Enforcement Program** to address speeding and compliance with transport regulations by both heavy and light vehicle drivers.
- **A Technology Program** including development of point to point speed camera technology using fixed digital speed cameras as well as the Safe-T-Cam system; and installation of variable message signs.

6.1.4 AusLink white paper

In June 2004, the federal government released the AusLink white paper as its new national transport plan. AusLink outlines the federal government's long-term approach to address the transport challenges facing Australia. The White Paper provides a strategic approach to Australia's future to ensure that the nation's land transport network will meet future challenges. The aim is that AusLink will translate better planning into better solutions by targeting transport funding to priority needs and allowing certainty for future investment.

The federal government is backing the AusLink initiative with an increase in land transport investment. It is allocating a total of $11.8 billion for road and rail transport over the five years to 2008–09. Components of this funding include:

- $7.7 billion for the AusLink National Network.
- $1.5 billion for Roads to Recovery.
- $2.6 billion for Financial Assistance Grants identified for roads.
- $90 million for the National Black Spot program.

The Pacific Highway between Newcastle and Brisbane forms part of the Australian Government's AusLink National Network. The AusLink National Network is based on national, regional and urban transport corridors, links to ports and airports, and intermodal connections between road and rail. Through AusLink, the federal government has committed to continued joint funding for the Pacific Highway that involves an increased contribution of $160 million per year for three additional years following the completion of the original ten-year upgrade program, in June 2006. .

It is anticipated that the Pacific Highway Upgrading Program, and therefore the Proposal, would receive funding through the AusLink program.

6.2 Need for the Proposal

The Proposal is needed as part of the RTA's broader plans and strategy to upgrade the section of the Pacific Highway between Hexham to the Queensland border to a high standard dual carriageway.

The need to upgrade the section of the Pacific Highway between Herons Creek and Stills Road is based on a number of factors which include regional and coastal population growth, road safety and economic issues. These are discussed in the sections below.

6.2.1 Population growth

The Pacific Highway links the two state capital cities of Sydney and Brisbane and passes through regions which continue to have the highest population growth rate in NSW.

In relation to the Proposal, Port Macquarie is the focal point of the local region and is an important holiday destination. The total population of the Port Macquarie - Hastings local government area exceeds 60,000 with over half living in the Port Macquarie precinct. Wauchope (population 5000) is also an important local centre and Bago Road is an important link to Wauchope from the south. Camden Haven, located just to the south of the project, is a rapidly growing area (population over 6000) and includes the towns of Kendall, Kew, North Haven, West Haven and Laurieton. Taree is the next major centre to the south and has a population of approximately 45,000 residents.

Sustained growth in the mid north coast region and the coastal areas of NSW on the whole, and forecasts for continued growth in the region, has resulted in an increased pressure on the road transport system. Improvements in road infrastructure are required for safe and efficient transport up and down the coast in order to accommodate growth trends.

The Proposal is also needed to ensure that the expected traffic growth on the highway would not increasingly expose the deficiencies of the existing road. In the long term, the Proposal would result in increased safety and improved traffic conditions on this section of the Pacific Highway.

6.2.2 Road safety issues

The existing northbound carriageway of this section includes a number of small horizontal and vertical curves which require a lower travel speed and have a higher potential for accidents. Accident data on the section of Pacific Highway from Stills Road to Bobs Creek Road, Herons Creek was analysed for the 4.75-year period from 19 July 1999 to 7 April 2004. In this period there were 36 accidents reported with 2 fatalities and 23 injuries.

The upgrade of this section of the highway would provide a connection between existing and proposed high quality dual carriageways. The Herons Creek to Stills Road upgrade is needed to ensure that the standard of carriageway in this section of the Pacific Highway will be consistent with the standard of adjoining sections of the highway. This consistency would reduce the rate of road accidents and injuries associated with this section of the Pacific Highway. Continuity of high quality road conditions is known to correlate with lower levels of accidents, especially fatalities (Arup, 2005). Uniform road conditions also reduce driver fatigue and frustration, both of which can contribute to accidents (Arup, 2005).

6.2.3 Economic issues

A high standard, reliable road network which links large regional and metropolitan centres and small towns is necessary to provide access to markets and sources of goods and services. Transport cost is often a major component of production cost; therefore road improvements would have a direct and positive affect on economic efficiency (Arup, 2005).

6.2.4 Consequences of no action

The consequences of the Proposal not being undertaken would include adverse impacts for the overall efficiency and safety of the Pacific Highway on a regional and local scale.

In particular, the following aspects would be specifically affected if no action were undertaken:

- The existing accident rate is likely to increase with increasing traffic volumes.
- Increasing traffic congestion and an increase in travel time for the route over the forecast period, particularly in holiday periods.

- Worsening road and traffic conditions with greater potential for intersection delays and a consequent deterioration in road safety and property accessibility.
- A general decline in the highway's level of service (refer to Section **7.2.3**).
- As upgrading of the Pacific Highway proceeds (for example Karuah to Bulahdelah Sections 2 and 3, Bulahdelah Bypass, Coopernook to Herons Creek), this section from Herons Creek to Stills Road will become increasingly inconsistent with the general standard of the Pacific Highway between Hexham to Port Macquarie

7 CONCEPT STAGE

7.1 Objectives

The Proposal would comprise part of the Pacific Highway Upgrade Program and would be undertaken in order to achieve the objectives of this program, which are:

- Significantly reduced road accidents and injuries.
- Reduced travel times.
- Reduced freight transport costs.
- Develop a route that involves the community and considers their interests.
- Provide a route that supports economic development.
- Manage the upgrading of the route in accordance with ecologically sustainable development principles.
- Provide the best value for money.

The specific objectives for the undertaking of the Proposal are to:

- Develop a dual carriageway road with potential to reduce crash rates to 15 crashes per 100 million vehicle kilometres over the Proposal length.
- Develop a concept design that meets or exceeds B-Double requirements, including at intersections, where required.
- Maximise the use of the existing road reserve, where possible.
- Satisfy the technical and procedural requirements of the RTA with respect to design of the Project.
- Allow for all connections and improvements necessary to upgrade the existing highway where it is retained as part of the project.
- Consider delay management strategies to minimise disruption to local and through traffic and maintain access to affected properties and land during construction.
- Provide flood immunity on at least one carriageway for a 1:100 year flood event with a minimum of at least a 1:20 year flood event.
- Provide intersections designed to provide at least level of service C[1] twenty years after opening for the 100 highest hourly volume.
- Develop solutions that address community expectations for the access to the new highway.
- Retain or replace existing rest areas within the study area.
- Develop a concept design generally meeting the criteria for a 100 km/h design speed for the vertical alignment and a 110 km/h design speed for the horizontal alignment.
- Ensure the Proposal outcomes achieve value for money.
- Provide a strategy for future upgrades to be easily integrated into the Proposal from both engineering and environmental perspectives.

[1] Level of service C means a stable flow with drivers restricted to select desired speed and ability to manoeuvre (RoadNet, 2005).

- Minimise direct access to the highway in the motorway condition by the provision of service roads.
- Maximise the use of the existing road pavement.

7.2 Options

The development of the route for this Proposal involved two levels of investigation. The first investigation was to determine where the upgrade would be located in relation to the existing southbound carriageway and considered the arterial option as well as developing an motorway class road. The second level of investigation was to determine the appropriate interchange configuration and final connectivity for non-through highway use. The *Concept Design Report* (RTA, 2005b) provides further details on the different options and their development.

7.2.1 Alternative route options

Three alternative route options were considered for the Proposal. All options developed were based on the assumption that Herons Creek Public School remains and requires access from the north via a service road (the existing northbound carriageway). The school's other access, immediately south of the existing Herons Creek Bridge, will be closed as a part of the Moorland to Herons Creek upgrade.

Option 1 (western option)
Option 1 would involve upgrading the existing northbound carriageway to comply with the design standards for Pacific Highway Upgrade Program. This option would seek to maximise the utilisation of the existing northbound carriageway. The advantages of this option were:

- It provides improved safety for road users when compared to the "Do nothing" option.
- It provides improved travel conditions when compared to the "Do nothing" option.

The disadvantages of this option were considered to be:

- That 76 per cent of the existing northbound carriageway would require reconstruction.
- Properties on the western side of the carriageway would still have an undesirable access to the highway.
- Provision of a future service road to the western properties would require a strip of land to be excised from all properties to the west of the highway.
- The realignment of the northbound carriageway would increase the fragmentation of the forestry land in the median area.
- The construction phase would require the reduction of the southbound carriageway to one lane in each direction.
- Bago Road would require 400 m of regrading.
- There would still be a large separation between the north and southbound carriageways at the intersection with Bago Road which would impact upon the future upgrade to a six lane road.
- This option may be more expensive than building a completely new carriageway.

Option 2 (central option)
Option 2 would involve the construction of a new northbound carriageway with central median parallel to the existing southbound carriageway. The new northbound carriageway would comply with the

design standards for the Pacific Highway Upgrade Program. The advantages of this option were considered to be:

- That 90 per cent of the existing northbound carriageway could be retained for use as a local service road. A section of new service road pavement would be required in front of the school, which is common to all options.
- Elimination of direct access to the highway from properties on the west side of the carriageway.
- Future third lanes could be easily constructed in the median area in already disturbed land.
- The new carriageway would be constructed adjacent to the existing southbound carriage and clear of the existing northbound carriageway and therefore would not substantially disrupt the existing traffic flow.
- Utilises much of the existing road corridor.
- It provides improved safety for road users when compared to the "Do nothing" option.
- It provides improved travel conditions when compared to the "Do nothing" option.

There were no identified disadvantages of this option. Attendees at both the project focus meeting and the community information session recommended this option as the preferred route for the new carriageway.

Option 3 (eastern option)
Option 3 involves the construction of a new southbound carriageway with central median to the east of and parallel to the existing southbound carriageway. The existing southbound carriageway would then become the northbound carriageway. The advantages of this option were considered to be:

- That 90 per cent of the existing northbound carriageway could be retained for use as a local service road. A section of new service road pavement would be required in front of the school, which is common to all options.
- Elimination of direct access to the highway from properties on the west side of the carriageway.
- The new carriageway would be constructed adjacent to the existing traffic flow.
- It provides improved safety for road users when compared to the "Do nothing" option.
- It provides improved travel conditions when compared to the "Do nothing" option.

The disadvantages of this option were considered to be:

- It would require acquisition of a strip of forestry land on the eastern side.
- It does not use the existing highway road reserve.
- There are increased staging issues as crossovers would need to be constructed at either end of the new carriageway.

7.2.2 Alternative access options

Interchange options to suit both stage 1 and stage 2 were investigated for each of the three alternative route options described above as part of their assessment.

Once route option 2 was seleced as the preferred option for the through alignment, a number of interchange and intersection senarios were developed and assessed.

All the access options developed included a service road between the Herons Creek and Burrawan Forest Drive and all required some lane acquisition.

The different access options proposed were:

- Option A: which would involve a diamond interchange at the existing intersection of Bago Road and the southbound carriageway, and twin roundabouts either side of the highway with a bridge over the highway linking the roundabouts.
- Option B: would involve a diamond interchange approximately 250 m north of the existing intersection of Bago Road and the southbound carriageway, involving twin roundabouts either side of the highway with a bridge over the highway linking the roundabouts. Bago Road would be deviated to the north.
- Option C: involves a half diamond interchange approximately 530 m south of the existing intersection of Bago Road and the southbound carriageway, and twin roundabouts either side of the highway with a bridge over the highway linking the roundabouts. There are southbound highway ramps only at this location. Northbound highway ramps are at Bago road and the existing northbound carriageway.
- Option D: involving a three-quarter diamond interchange approximately 530 m south of the existing intersection of Bago Road and the southbound carriageway, with twin roundabouts either side of the highway with a bridge over the highway linking the roundabouts. The northbound loading ramp is located on the existing northbound carriageway.
- Option E: involves a three-quarter diamond interchange approximately 530 m south of the existing intersection of Bago Road and the southbound carriageway, involving twin roundabouts either side of the highway with a bridge over the highway linking the roundabouts. The northbound loading ramp uses the existing Bago Road alignment with a sweeping left hand curve onto the highway.
- Option F: involves a diamond interchange 530 m south of the existing intersection of Bago Road and the southbound carriageway, and twin roundabouts either side of the highway with a bridge over the highway linking the roundabouts.

7.2.3 The “Do nothing” option

The “Do nothing” option would maintain the existing situation and would not involve any upgrading works. This section of highway would be inconsistent with the high standard dual carriageway that adjoins to the north and is soon to be constructed to the south. If the Proposal is not undertaken it would result in deteriorating traffic and safety conditions on the existing carriageway of this section of the Pacific Highway. In particular the following aspects would be specifically affected:

- Increase in the current accident rate as a result of increasing traffic volumes.
- Increasing traffic volumes would result in the gradual increase in travel time for the route over the forecast period, particularly in holiday periods.
- Likely to generate worsening road and traffic conditions with greater potential for intersection delays and a consequent deterioration in road safety and property accessibility.
- A general decline in the highway’s level of service.

7.2.4 The preferred option

Option 2 (central) for the through highway, coupled with option F for access was considered the preferred option to meet the project objectives and address community expectations. The end points for the Proposal were selected to connect with an existing high quality section of dual carriageway to the north and with a proposed high quality dual carriageway to the south.

This option was considered to have a number of advantages over the other options. It should result in a lower accident rate than option 1 (western option) for the highway as there would be fewer curves to negotiate. It would also maximise the use of the existing road carriageway asset as it would leave 90 per cent of the existing northbound carriage pavement unaffected and able to be used as an alternative route service road. option1 (western option) would require up to 95 per cent of the existing carriageway to be reconstructed and this would mean that as well as reconstructing the northbound carriageway, the service road would need to be reconstructed for the length of the route.

Option 3 (eastern option) provided many of the benefits of option 2 (including 90 per cent of the existing northbound carriageway pavement retained for use as a service road), but option 3 had no advantages over option 2, required more acquisition and had increased staging issues (with crossovers required at each end).

The preferred option locates the interchange in a position which would allow it to easily service Bago Road, the Herons Creek community and the Bobs Creek Road community. This option requires the second lowest area of vegetation to be removed of the alternative options. It would also require the second lowest amount of land to be acquired and the land to be acquired is generally not developed.

The preferred option would have the least effect on traffic during the construction phase as the majority of the northbound carriageway can be built, whilst maintaining traffic flows. The existing northbound carriageway would not be interrupted until after the new northbound carriageway is built. Roadworks that can be undertaken clear of traffic are generally cheaper and faster than construction undertaken “under traffic”, providing better value for money, faster completion and less disruption.

The preferred option would also be easily adaptable to a 6-lane road if required in the future as additional lanes could be accommodated in the median area. The proposed grading and cross section would also be designed to suit a future 6-lane upgrade.

By providing an interchange and overpass in an area where the existing highway is in a cutting the amount of imported fill required would be reduced, therefore this option requires fewer earthworks than other options. Although sections of State Forest will be acquired for the Proposal, the proposed site for the interchange is where there is the narrowest distance between the existing carriageways, thereby minimising the area of forest required. Also, by containing the interchange in one area, the amount of forest isolated into pockets is reduced.

The area of forest between the existing highway carriageways is not currently logged due to access and safety problems (proximity of the highway carriageways to the felling operation). The preferred option would allow Forest NSW to log the residual area of the existing median, providing access to a resource that is not currently available.

The provision of a service road from Herons Creek to Burrawan Forest Drive and the access provisions to the interchange from Bobs Creek Road and Boyd’s Road would mean a greater level of safety for access of forestry logging, transport and management vehicles, fire fighting operations and all users of the area of forest. The proposed interchange would give the public one location to refer to for navigation and reference.

8 DESIGN CONSIDERATIONS

If the Proposal is approved, detailed design would be completed further developing all aspects of the concept design as outlined in this REF. This final design would take into account concept design and general issues raised within the REF, during the display period as well as the results of further investigations. Consequently, it is possible that the details of the final Proposal may vary from the description provided in this section. The concept design and construction methods proposed in this and the following section as a solution to the project objectives and constraints may also be varied within the limits of any conditions imposed and the design constraints, principles and standards detailed in this section.

Provided below is a description of how the project may be constructed in stages. The advantage of constructing in stages is that it will limit the level of disruption to the service along the Pacific Highway, and ensure road safety is maintained.

8.1 Stage 1

The new northbound carriageway and the two-way service road from Herons Creek Public School to Burrawan Forest Drive and intersection improvements at Bago Road and Bobs Creek Road would be constructed in stage 1.

Access to Herons Creek Public School and properties adjoining the existing highway would be via the two-way service road. New at-grade seagull intersections would provide improved access to the highway at Bago Road and Bobs Creek Road.

8.2 Stage 2

A grade-separated interchange near Boyds Road is proposed south of the existing intersection of the Pacific Highway at Bago Road in stage 2. The interchange would provide a two-lane bridge over the highway, which would allow for all turning movements from Stills Road and Bobs Creek Road, to and from the highway.

Access to the highway would only be provided at the grade-separated interchange south of Bago Road. Upon completion of the grade-separated interchange at Bago Road, the existing Herons Creek Road intersection would close.

Access to Herons Creek township, Herons Creek timber mill and Herons Creek Public School would be via a new two-way service road crossing Herons Creek upstream of the existing bridges. Highway intersections at Bobs Creek Road would close and access would be via the interchange south of Bago Road.

Table 1 provides a summary comparing the main differences between the two stages.

Table 1: Comparison of Stage 1 and Stage 2

Intersection	Stage 1	Stage 2
Bago Road	At-grade seagull intersection.	New grade separated interchange.
Bobs Creek Road	At-grade seagull intersection.	Intersection to close.
Boyd's Road	Intersection to close	Connection to grade separated interchange.

Intersection	Stage 1	Stage 2
Burrawan Forest Drive	Intersection to close.	Access to highway via the northbound carriageway service road.

8.3 Existing road

The section of the highway between Herons Creek and Stills Road is currently dual carriageway. The northbound carriageway was previously a two-way two-lane section of the highway and is on a winding and hilly alignment. It became the northbound carriageway when the southbound carriageway was constructed in the 1980s. The existing speed limit on this section of the Pacific Highway is 100 km/hour in both directions, increasing to 110 km/hour to the north of the section (Roadnet, 2006).

To the south of this section is a bi-directional single carriageway road which is proposed to be upgraded in the Coopernook to Herons Creek Project. This would involve the construction of two new carriageways with two lanes in either direction with a landscaped central median and a design speed of at least 100 km/h.

The characteristics of the existing section of the Pacific Highway are detailed in **Table 2**.

Table 2: Existing highway characteristics

Item	Details
Number of lanes	2 northbound, 2 southbound
Lane width	3.5 m
Median details	Variable to 70 m
Width of shoulder	Variable: left 2-3 m, right 0.5-1.2 m
Drainage	8 transverse drainage lines
Bridges	None
Pavement condition	Both carriageways good

8.4 Existing and forecast traffic

8.4.1 Traffic study

A Traffic Study was undertaken by RoadNet Pty Ltd (2005/2006) and involved:

- An assessment of traffic data, traffic modelling and economic analysis in order to justify the Proposal and to assist in the design of the road and intersections.
- Reviews and projections of traffic volumes.
- Assessment of road and intersection capacity.
- Analysis of accident data.
- Provisions for cyclists, pedestrians and buses.
- Assessment of the cumulative impacts of the Proposal on the road network.

A traffic study for the Proposal was undertaken by RoadNet Pty Ltd and is provided in **Appendix E**.

8.4.2 Existing traffic

Recent average annual daily traffic and historical counts on the Pacific Highway as provided by the RTA are provided in **Table 3**.

Table 3: AADT Pacific Highway

Station	Location	1978	1982	1986	1990	1995	1998	2001
09.123	10 km north of MR600, Laurieton Road	5070	6110	6242	8086	9720	11,570	11,898

Source: RTA Traffic Volume Data for Hunter Region, 2001 in RTA (2004).

The traffic study found that the corrected average annual daily traffic for the section of the highway in 2005, based on traffic counts undertaken in February 2005, to be 12,946 at 200 m south of Herons Creek and 7740 at 50 m north of Stills Road (Roadnet, 2006).

8.4.3 Traffic peaks

Traffic flows on the highway peak during the major public holiday periods such as Easter, Christmas and school holiday times, with peak travel 50 per cent to 100 per cent greater than average weekday level (Moorland to Herons Creek Environmental Impact Statement, Working Paper No.1, Arup 2004)

The section of the highway between Herons Creek and Stills Road experiences peak daily traffic volumes southbound and northbound at approximately 12 noon and 3 pm. North bound volumes tend to be higher Wednesday to Saturday and southbound volumes are heavier Sunday to Tuesday (Roadnet, 2006).

8.4.4 Vehicle types

Heavy vehicles comprise approximately 20 per cent of the traffic on this section of the highway, with heavy trucks making up about 10 per cent (Roadnet, 2006).

8.4.5 Forecast traffic volumes

Projected average annual daily traffic volumes were extrapolated from traffic counting stations at 50 m north of Stills Road and 200 m south of Herons Creek. **Table 4** details the projected average annual daily traffic's calculated by Roadnet 2006.

Table 4: Projected AADTs south of Herons Creek

Year	AADT
2005	12,946
2010	15,897
2020	21,800
2030	27,702

8.4.6 Truck traffic growth

It is assumed that the percentage of heavy vehicles on the highway would remain constant and grow in accordance with the traffic growth. Of the calculated 12,946 vehicles for the 2005 average annual daily traffic south of Herons Creek, 19.2 per cent are heavy vehicles (RoadNet, 2006).

8.4.7 Forecast daily volumes

The calculated 2005 average annual daily traffic of 12,946 was used and extrapolated with the growth rate to give a design volume of 2928 vehicles per hour (100 highest hour) for the year 2030 (RoadNet, 2006).

8.4.8 Traffic accidents

From 19 July 1999 to 7 April 2004, 36 accidents were reported between Bobs Creek Road and Stills Road. These accidents resulted in two deaths and 23 injuries. The accidents were spread throughout the 24 hour period, but approximately half of the accidents occurred between 10am to 12pm and 2pm to 4pm (RoadNet, 2006).

8.4.9 Level of service

The ability of a road to accommodate traffic flows is measured by a level of service. For a through route the level of service can be described as one of the following:

A Free flow whereby drivers are virtually unaffected by others in the traffic stream and can choose their own travel speeds.

B Stable flow with slight inconvenience from others in the traffic stream. Drivers have reasonable freedom to choose their own travel speeds.

C Stable flow with drivers restricted to select desired speed and ability to manoeuvre.

D Approaching unstable flow with drivers being severely restricted in travel speeds and freedom to manoeuvre.

E Unstable flow close to capacity. Minor disturbances in the traffic stream cause breakdown.

F Forced flow with more vehicles approaching than can fit. Queuing and delays result.

The existing highway currently operates at level of service A, with Bago Road intersection operating at level of service C with Boyds and Stills Road operating at level of service B (Roadnet, 2006).

The Proposal aims to have a level of service no worse than 'C' for the 100 highest hourly volume in 20 years after opening. The detailed analysis undertaken by Roadnet found that this level of service would be achieved by the Proposal.

8.5 Urban and regional design

The design principles adopted for the proposed highway upgrade are:

- To include a detailed and rigorous engineering analysis to predict the effects of the highway on existing ground conditions and infrastructure;
- To provide a cost effective design.
- To cater for the required traffic volumes.
- To be safe to travel at the proposed design speed.
- To minimise adverse environmental effect.
- To consider community needs.

These design principles were used to develop a design that is integrated with the surrounding environment and that attempts to maintain or enhance the existing environmental, visual, and

aesthetic value of the landscape and community through which the road passes. The design principles adopted for the Pacific Highway are described in RTA's *Pacific Highway Urban Design Framework* (March 2005).

Landscaping and urban design principles have been used to assist in the concept design. The urban design objectives and road users' expectations should be satisfied by:

- A geometric alignment which would fit into the surrounding landform; achieved by adopting large flowing curves which complement the existing carriageway and existing landforms.
- A co-ordinated alignment which is predictable; achieved by using large vertical and horizontal curves which allow for good forward sight of the road resulting in no sudden alignment changes.
- A road that complements the adjoining sections of highway.
- Clear and concise road signs and pavement delineation; achieved by having minimal intersections; therefore the only direction signs required are for the next interchange.
- The use of safety barriers to best practice; achieved by using the appropriate barrier and only where the hazard cannot be designed out.
- Providing a visually pleasing overbridge at the Bago Road interchange, achieved by engaging qualified urban designers to work closely with the bridge designers from the beginning.

8.6 Road design parameters

The design standards to be adopted for the Proposal are based on the *Pacific Highway Design Guidelines* (March 2006), *RTA Road Design Guide,* 2005 and Austroads publications.

Incorporation of a rest area or truck stop facility is not proposed within this project, although the need for a truck-stopping bay in each direction has been considered.

Three cuttings would be required and details are provided in **Table 5**.

Table 5: Proposed cutting details

No.	Location	Length of cutting (m)	Approximate maximum height (m)
C1	40 m north of Herons Creek Bridge	550	3
C2	1290 m north of Herons Creek Bridge	310	6.5
C3	2050 m north of Herons Creek Bridge	440	7.4

8.6.1 Alignment

Detailed design would be undertaken if the the proposal is approved, further developing all aspects of the concept design as outlined in this REF. This final design would take into account the concept design on which this REF is based and general issues raised within the REF during the display period, as well as the results of further investigations. Consequently, it is possible that the details of the final

proposal may vary from the description provided in this chapter. The concept design and construction methods proposed in this and the following section as a solution to the project objectives and constraints, may also be varied by the construction contractor. These would be within the limits of any conditions imposed, the location of the corridor boundary, threatened species impacts and the design constraints, principles and standards detailed in this section.

The Proposal would provide a high standard alignment suitable for 110 km/hr travel, with horizontal curves with radii between 1550 m and 5500 m. The vertical alignment would be gentle with the majority of grades between 1 per cent and 2 per cent, although gradients of around 5 per cent are required near Herons Creek. The grading proposed would provide for flood-free travel during a 1-in-100-year flood in the area and ensure that heavy vehicles would be able to maintain their speed. The vertical alignment adopted for the new northbound carriageway concept design is generally parallel to the existing southbound carriageway, but slightly higher to allow for future pavement strengthening of the southbound carriageway.

8.6.2 Cross section – highway

Divided dual carriageways are proposed with two lanes in each direction. The proposed northbound carriageway would be constructed immediately to the west and parallel to the existing southbound carriageway. A typical cross section is provided in **Figure 3**.

The carriageways proposed would be 10 m wide and would comprise a 2.5 m wide outer shoulder, two 3.5 m wide travel lanes and a 0.5 m wide inner shoulder. Portions of the shoulder would have additional widening to accommodate areas containing safety barriers, verges, shoulder rounding and open drains.

The proposed median between carriageways would be a constant width of 12 m. The designed median cross section would take into account the current and future drainage requirements and has allowed for a median safety barrier when the highway is updated to six lanes. The median would have gentle slopes and would be landscaped.

The outer batter slopes would vary depending on stability of cut and fill materials. A slope of 2.5 to 1 (horizontal to vertical) in embankment and 2 to 1 (horizontal to vertical) in cutting has been adopted for design purposes, but may need to be varied.

8.6.3 Cross section – service road

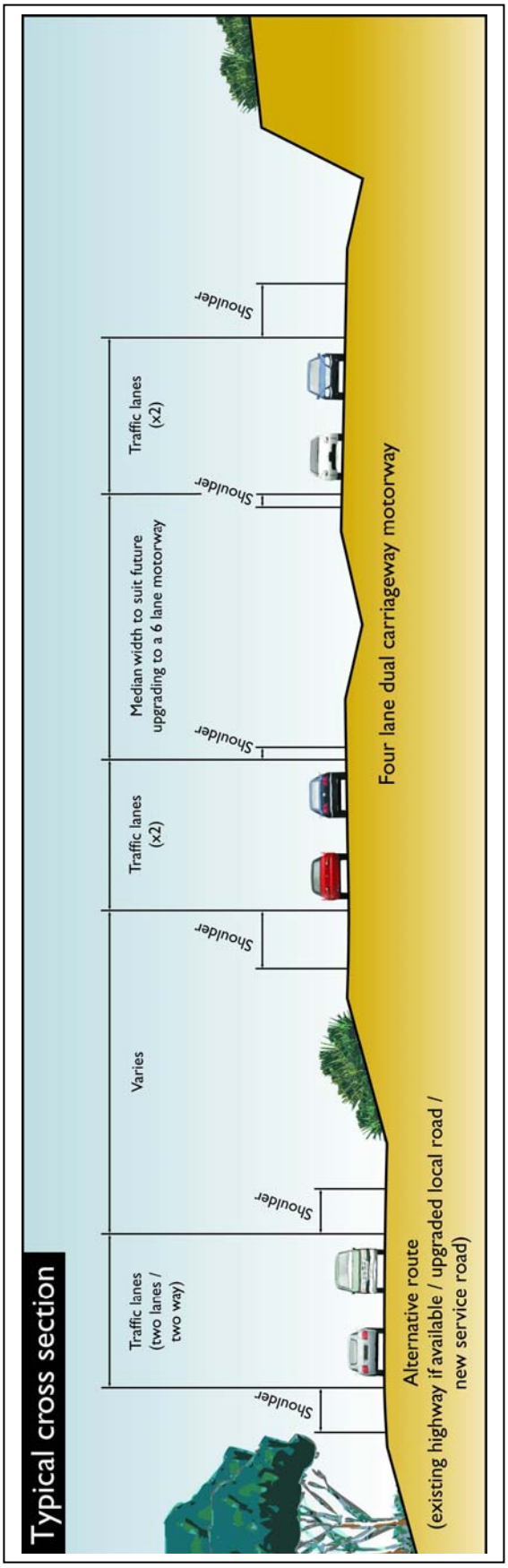
The proposed service road would be a dual lane, bi-directional road comprising 2.5 m shoulders and two 3.5 m lanes. Additional bays may be provided adjacent to property access points to allow safe access for property owners, school buses to stop and garbage services to operate in a safe manner. The outer batter slopes would vary depending on stability of cut and fill materials. A slope of 2 to 1 (horizontal to vertical) has been adopted for design purposes, but may need to be varied.

8.6.4 Interchanges and intersections

Bago Road

In stage 1 an at-grade seagull intersection would be constructed at the existing Bago Road junction with the southbound carriageway. Appropriate length acceleration and deceleration lanes would be incorporated in the design.

A grade separated interchange is proposed 500 m south of the existing Bago Rd intersection in stage 2. This would consist of a bridge over the highway with roundabouts on either side to provide traffic distribution control.


Typical cross section
Alternative route
(existing highway if available / upgraded local road / new service road)
Shoulder
Traffic lanes (two lanes / two way)
Shoulder
Varies
Shoulder
Traffic lanes (x2)
Shoulder
Median width to suit future upgrading to a 6 lane motorway
Shoulder
Traffic lanes (x2)
Shoulder
Four lane dual carriageway motorway

Bobs Creek Road
In stage 1 Bobs Creek Road would be connected to the highway with an at-grade seagull intersection.

In stage 2 Bobs Creek Rd would be extended 850 m to the north and connected to the eastern roundabout of the grade separated interchange.

Boyds Rd
Boyds Road is a gravel access road in NSW Forest's property.

In stage 1 Boyds Road would no longer have direct access to the highway. Consultation will be undertaken with Forests NSW during final design and provision will be made to allow access from Boyds Road to the local road network. Should staged construction require the provision of any connecting roadways, these would follow the alignment of the motorway roadworks, that is, no clearing outside the motorway footprint would be required.

In stage 2 Boyds Road would be connected to the extension of Bobs Creek Rd, providing access to the eastern roundabout of the interchange.

Burrawan Forest Drive
In stages 1 and 2, access to Burrawan Forest Rd would only be via the existing northbound carriageway service road. In stage 1 access to the highway would be via the Bago Rd seagull intersection and in stage 2 access to the highway would be via the interchange.

Stills Road (east of highway)
Stills Road to the east of the highway is used primarily for forestry management. No design changes have been included within the Proposal for this intersection at this time. Appropriate access will be maintained with access arrangements to be developed in consultation with Forest NSW.

8.6.5 Local access

The highway upgrade would have controlled access boundaries for the full length of the route with proclaimed access points at interchanges. Local road connections would be maintained by the provision of the Herons Creek to Burrawan Forest Drive service road and the Bobs Creek Road extension to the interchange. The connectivity of access across the highway would be improved with the interchange overpass near Bago Road.

Access to all properties would be provided, although adjustments to the existing accesses within the adjoining property may be required. These property adjustments would be negotiated during the detailed concept design phase. The majority of existing accesses along the existing northbound carriageway would be retained.

8.6.6 Bridges and structures

The major creek crossing in the area is over Cutty Creek, which is currently crossed via a pipe culvert. The culvert would require extension within the existing median area. Other crossings are of small drainage lines, which would be crossed via box culverts or pipe culverts. Consideration of culvert design to provide crossing points for fauna would be undertaken during detailed design.

The proposal includes one bridge, which would be the road overpass bridge for the Bago Rd interchange. The proposed bridge would have abutments sitting on the top of the existing cutting and a centre pier.

8.6.7 Drainage and flooding

Longitudinal drainage would be provided to drain the median and outer carriageway open drains. This drainage system would be designed to accommodate a 1 in 10 year storm event with a review of the outcome of a 1 in 100 year event. Longitudinal drainage would generally be in the form of open concrete drains with a pit and pipe network to evacuate the water.

8.6.8 Earthworks

The Proposal would require the importation of some fill material. The earthworks requirements are as detailed in **Table 6**.

Table 6: Earthworks Requirements

Requirement	Total project - m^3 of material
Excavation from site to fill	137,000
Excavation from site to unsuitable (assumed)	10,000
Imported material to fill	78,000

Source: RTA (2006)

Excavated material that is not suitable for on-site reuse or recycling would be disposed of at a licensed landfill facility.

Earthwork requirements were calculated by the RTA based on the concept design and previous history of the road. A geological investigation has been conducted in conjunction with the bridge foundation investigation.

8.6.9 Pavements

A total pavement thickness of 700 mm has been allowed for above the earthworks layers. The base level of the pavement has been allowed as 300 mm minimum thick select subgrade which acts as support for the structural pavement above it. The select subgade would be a natural granular earthwork material with specified properties superior to general earthworks material. The select material would be won from the cuttings on site or imported from nearby quarries. The select layer may require additives to stabilise the material and bring it up to specification. This would either occur in place or be pre-mixed in a pug mill adjoining the site.

The top levels of the pavement would comprise either a rigid or flexible pavement. A rigid pavement consists of a sub-base and a base of concrete (either reinforced or not reinforced) and a flexible pavement has a sub-base of either cemented gravels or lean mix concrete with a base of deep lift asphalt. If appropriate and feasible, other pavement solutions may be considered in order to minimise potential noise impacts on adjacent noise receivers. These alternative pavement surfaces may include open-grade asphalt and exposed aggregate or porous concrete pavements. The type and design of the structural pavement to be used for the Proposal would be determined during the detailed design phase. For the pavements off the highway, such as interchange ramps, service roads and connecting local roads, conventional flexible pavements would be used. These pavements would consist of gravel pavements with a surface of stone-mastic asphalt, dense-grade asphalt or bitumen seal.

8.7 Construction activities

The construction of the Proposal is expected to take approximately 2.5 years. Construction activities would be undertaken during the following times:

- Monday to Friday – 7am – 6pm.
- Saturday – 8am – 1pm.

No construction work will take place on Sundays or public holidays. Should work be required to be undertaken outside of the hours described above, the procedure contained in the RTA's *Environmental Noise Management Manual 2001, "Practice Note vii – Roadworks Outside of Normal Working Hours"* would be followed. Extended hours would be addressed in the noise and vibration management plan. There is potential that hours may be extended, in consultation with the community.

The Proposal would generally be undertaken using standard road building techniques. These techniques change slightly for individual projects, but would include:

- Site establishment works would include the establishment of construction compounds, batch plants, machinery access roads and material storage areas.
- Clearing would be undertaken by machinery, with approximately 20 ha of vegetation to be cleared.
- Ripping would be undertaken with bulldozers and material haulage, spreading and compaction would be undertaken by scrapers or trucks. The need for rock blasting would be avoided as much as possible due to the proximity of houses.
- Bridge construction would be undertaken with precast piles and deck units.
- Drainage construction using precast pipe culverts, reinforced concrete box sections and cast in situ concrete drains.
- Select subgrade placement and compaction using graders and rollers. The upper material layers could be improved with stabilising materials if required.
- Pavement type will be consistent with the RTA's approved heavy pavement types (typically concrete subbase with concrete or asphalt base). Low noise pavement types may be used. On-site batching with haulage to the paver is the expected method.
- The majority of the works would be undertaken clear of traffic. Construction staging would be necessary at the crossover from the existing northbound carriageway at either end of the project to the new northbound carriageway Proposal.
- Construction of roadside furniture including guideposts and safety barriers.
- Installation of lighting at interchange ramp entries, exits and intersections.
- Installation of signs and linemarking throughout the project.
- Refurbishment of the service road (existing highway) to a level suitable for use as a two-way local access road.

8.8 Construction traffic management

A traffic management plan would be prepared for the Proposal by the contractor. The traffic management plan would be developed in accordance with the RTA's *Traffic Control at Work Sites*

Manual (2003) and would outline the construction vehicle movement plan(s) to minimise obstruction to road users for the full duration of the construction works.

Total construction time for the Proposal is estimated at 80 weeks, with the bulk of earthworks to take place over a 20 week period. In order to assess the "worst case" for volume of truck movements, a peak activity period for earthworks of twelve weeks has been adopted.

Note that the earthwork construction could take place over a longer period with fewer track movements per day, but based on the worst case highest volume truck movements, the requirement for fill material on the site is expected to generate approximately 164 laden truck movements per day (or 328 two-way truck movements). This number of truck movements would require a positive traffic control at the access points to the section.

Table 7: Haulage Movements

Time in weeks	Operating days per week	Laden trips per day	Total trucks per day (2 way)	Hours per day	Trucks per hour (2 way)
12	5.5	164	328	8	41

The truck movements in and out of the construction site would be in the vicinity of 41 per hour during the earthworks phase of stage 2, as shown in **Table 7**. The peak hour traffic on the highway would be over 1000 vehicles in either direction. Traffic controls would be required at the site access points in order to ensure safety.

The traffic management plan would also include appropriate traffic controls such as temporary traffic signals or other forms of controls such as manual traffic control, warning signs or speed reduction. Temporary sidetracks and crossovers may also be utilised in the traffic management plan to ensure safe working conditions are maintained adjacent to traffic. The traffic management plan would also detail arrangements for access to neighbouring properties affected by the construction works.

8.9 Property acquisition

Property acquisition would be required to accommodate the new road infrastructure. The acquisition and adjustment to boundaries would be approved by the General Manager Pacific Highway. Property acquisition and the terms of agreement would be negotiated between the RTA and the individual landowners. **Figure 4** identifies land that would be acquired to undertake the Proposal.

Property access adjustment would be required to two properties to reconnect access to the service road. Property access adjustment plans would be instigated in the detailed concept design stage. The detailed concept design would be shown to the relevant landowner for comment, alteration and agreement in principle, before the final design stage. **Table 8** details the property location and access adjustment details.

Table 8: Property access adjustments

Location	Property	Proposed adjustment details
5494 Pacific Highway	DP754403 Lot 47	Construct access approximately 300m long, close to ground level, to the north along the western boundary connecting to Bobs Creek Road
5499 Pacific Highway	DP754403 Lot 36	Construct access approximately 240m long, close to ground level, to connect to the existing school's access.

MOORLAND TO HERONS CREEK PROJECT

HERONS CREEK PUBLIC SCHOOL

HERONS CREEK

NORTH COAST RAILWAY

To Wauchope

BAGO ROAD

BURRAWAN FOREST DRIVE

CUTTY CREEK

To Kempsey

From Taree

BOBS CREEK ROAD

BOYDS ROAD

CUTTY CREEK

STILLS ROAD

HERONS CREEK

OrthoView aerial photography (1997) under licence to RTA by Department of Lands

PROJECT-FILE NAME	N6033105
DATE	23 October 2006
DRAWN	TO
APPROVED	

Property to be acquired by the RTA

Property already owned by the RTA

Property Acquistions - Herons Creek to Stills Road

NSW Roads and Traffic Authority

Review of Environmental Factors

Pacific Highway Upgrade

Herons Creek to Stills Road

Herons Creek NSW

HLA

Not to Scale

FIGURE

4

8.10 Utilities

A water main currently exists at Herons Creek on the western side of the existing highway. This supplies water to Herons Creek Public School. A Telstra main is also located on the western side of the existing northbound carriageway and on the northern side of Bago Road. The Telstra line should not be affected by the Proposal.

Domestic supply power lines would need to be relocated. Some or all utility adjustment may be undertaken prior to the commencement of construction works and in consultation with the appropriate utility provider. Details of this would be included within contract documentation.

8.11 Material sources

As described in **Section 8.6.8**, additional fill material would be required for the Proposal. There is one quarry 10 km away, along Bago Road, which produces sub-base pavement material and select material. There are also four quarries located within 25 km at Wauchope, John's River, Sancrox and Bonny Hills. These produce aggregates, road base and select fill material.

Based on the current estimates, the total Proposal would require approximately 78,000 m^3 (solid volume) of imported fill material to be transported to the site. Material would be transported on a regular basis during earthworks and not all the material would be stockpiled on site at one time.

8.12 Stockpile and compound sites

If concrete or asphalt pavement is to be provided, a temporary batching plant would be required during construction. This would be located in a suitably cleared area, the location of which would be identified in detailed design plans and the construction environmental management plan. An appropriate environmental impact assesment would be undertaken to confirm the site before work on the batching plant commenced.

While the final location of stockpile site will be determined during final design and construction, locations that may be used as stockpile sites are shown in **Figure 5**. The RTA's *Stockpile Site Management Procedures,* 2001 have been referred to in determining the location of the potential stockpile sites.

It is anticipated that these sites would be located in suitably heavily cleared areas at least more than 2 m from existing vegetation, concentrated water flows, roads and hazard areas where possible. Final locations of stockpiles would be detailed in the construction environmental management plan and soil and water management plan to be prepared for the Proposal, but are likely to be in cleared areas to the south of Herons Creek.

Once sites for stockpiles and compounds are finalised, these would be subject to their own environmental impact assessment through consultation with the RTA. All stockpiles would be managed according to the RTA's *Stockpile Site Management Procedures* (RTA, 2001).

MOORLAND TO HERONS CREEK PROJECT

HERONS CREEK PUBLIC SCHOOL

NORTH COAST RAILWAY

HERONS CREEK

POSSIBLE STOCK PILE SITE 10,400m²

To Wauchope

BAGO ROAD

BURRAWAN FOREST DRIVE

CUTTY CREEK

To Kempsey

From Taree

BOBS CREEK ROAD

BOYDS ROAD

CUTTY CREEK

POSSIBLE STOCK PILE SITE 7,400m²

STILLS ROAD

HERONS CREEK

OrthoView aerial photography (1997) under licence to RTA by Department of Lands

PROJECT-FILE NAME	N6033105
DATE	23 October 2006
DRAWN	TO
APPROVED	

Proposed Stockpile Locations
NSW Roads and Traffic Authority
Review of Environmental Factors
Pacific Highway Upgrade
Herons Creek to Stills Road
Herons Creek NSW

HLA

Not to Scale

FIGURE 5

9 ENVIRONMENTAL IMPACT ASSESSMENT

9.1 Landforms geology and soils

9.1.1 Existing environment

Landforms
The site is within an area of natural moderate to gentle undulating slopes, with the major landform unit being the deep depression associated with Cutty Creek. The landform of the Proposal site is a common feature of the Herons Creek floodplain and surrounding land. Broken Bago Range is situated approximately 12 km west of the site and separates the Camden Haven and Hastings catchments (RTA ETB, 2005).

Geology
The 1:250,000 scale geological map for Hastings indicates the area is within the Lorne Basin and is underlain by Early Triassic age sedimentary rocks which overlie folded, stratified Carboniferous and early Permian rocks of the Hastings block (DPI, 2006). NSW Geological Survey data indicates that the geology of the area comprises three units, namely:

- Unconsolidated alluvium of Quaternary age occurring along Herons Creek.
- The Grants Head Formation of Early Triassic age, this comprises quartz and quartz-lithic sandstone plus carbonaceous and micaceous siltstone. This forms the upper part of the Lorne Basin in the area and occurs north of Herons Creek.
- The Mingaletta Formation of Late Carboniferous age. This is comprised of sandstone, with minor siltstone, conglomerate and coal. It forms part of the Hastings Block which underlies the Lorne Basin (DPI, 2006).

Soils
The natural soils of the area would generally consist of a fine sandy clay loam to approximately 0.2 m, followed by a layer of medium heavy silty clay to approximately 0.5 m in depth. The soils types in the area are likely to be Yellow Podsolic or similar and be moderately permeable and moderately well drained with no free water. The soils are also likely to be moderately erodible when exposed, and could suffer from sheet erosion (RTA ETB, 2005).

Acid sulfate soils
There are no potential acid sulfate soils (as mapped on acid sulfate soil risk maps by the former Department of Land and Water Conservation) in the area to be disturbed by the Proposal.

9.1.2 Contamination assessment

The Proposal area includes an area of land where burial of materials from a former chemical spill occurred on the Pacific Highway. A study was undertaken in August 2005 to identify the presence and extent of soil contamination and to confirm disposal or re-use options for the burial material.

The contamination assessment of the area prepared by Douglas Partners involved:

- Review of the site history including discussions with the RTA and Department of Environment and Conservation.
- A site inspection.
- Soil sampling at five locations.

- Laboratory testing of selected soil samples for a range of potential organic and inorganic contaminants.
- Preparation of a report discussing the findings of the assessment.

The assessment found that there were minor levels of pesticides within the buried waste; these levels were found to be within conservative health based guidelines. Materials tested outside the burial area also had results within health based guidelines for sensitive land use.

The findings of the contamination assessment were that the material encountered was 'Inert Waste' with respect to NSW Environment Protection Agency guidelines, and are suitable for direct disposal to a licenced landfill. The report is found in full in **Appendix B**.

9.1.3 Potential impacts

The Proposal would result in changes to the landforms as a result of the earthworks required in the construction of the new northbound carriageway. Three cuttings are proposed for the new carriageway (as detailed in **Section 8.6**), up to a maximum height of 7.4 m and varying in length from 310 m to 550 m. Geological investigation during detailed design of the Proposal will provide more accurate details on the requirements for earthworks and construction.

There is potential for soil erosion to occur during construction works as approximately 20 ha of vegetation, comprising approximately 60 per cent native forest and woodland communities and 40 per cent landscaping or modified shrublands, may be cleared; substantial earthworks are also required for the construction of the new carriageway. The majority of disturbance would be associated with the interchange for the Boyds Road and Bobs Creek Road access. Impacts of erosion are most likely to occur as a result of runoff from exposed surfaces and stockpiles, which could result in pollution of downstream waterways.

It has been estimated that up to 78,000 m^3 of fill would be required to be imported on to the site. It is anticipated that material would be transported on a regular basis during earthworks and not all the material would be stockpiled on site at any one time. Stockpiles would be located in cleared areas as nominated in the construction environmental management plan. Safeguards outlined in **Section 10.2** would be implemented to minimise and manage the potential for erosion from the site.

As the proposed works would impact upon an area of buried materials identified in the contamination assessment, it is recommended that these materials be excavated and disposed of to a licensed landfill (Douglas Partners, 2005).

There is potential for soil contamination associated with the storage, handling and use of fuels and oil on site during construction works. Fuel and oil would be stored and secured in a bunded area within the site compound, and measures outlined in **Section 9.1.4** would be put in place to minimise potential risks.

9.1.4 Safeguards

The following safeguards are proposed to minimise the potential for impacts to landforms, geology and soils.

- Develop a soil and water management plan as part of the construction environmental management plan for the Proposal. The surfacewater management plan will include:
  - Appropriate erosion and sediment control measures to be implemented prior to and during earthworks. The control measures should include erosion and

sediment controls, sediment basins, exclusion zones, diversion bunds, catch drains, energy dissipaters, sediment traps etc.

- Use of revegetation measures such as hydromulching to minimise potential for erosion of exposed surfaces and batters.
- Undertaking revegetation as soon as practicable after the disturbance.
- Requirements for routine inspection and testing to ensure that controls and procedures are effective.
- Minimising the extent of clearing where possible to minimise erosion potential.
- Staging of clearing where possible.
- Maintaining vegetation in drainage lines until the latest possible time to reduce erosion risk and retain filtering capacity.

- Maintain plant and equipment used on site in good order to ensure potential for leaks and spills are minimised.
- Maintain spill kits on site to manage spills of fuel or oils.
- Store fuel or oil in accordance with Department of Environment and Conservation EPA *Bunding and Spill Management Guidelines* (2004) and Workcover *Storage and Handling of Dangerous Goods* (2005), in roofed and bunded areas able to contain 120 per cent of the maximum capacity of the largest storage tank or container. The bunded areas should be located at least 20 m away from drainage lines.
- If contaminated or potentially contaminated material is exposed during earthworks then work in the area should cease and a qualified consultant be engaged to investigate the extent of contamination and recommend measures to dispose of contaminated material.

9.2 Water quality and hydrology

9.2.1 Existing environment

Surface water

Cutty Creek is the main watercourse within the Proposal area. This creek is crossed by the existing carriageways of the Pacific Highway approximately 710 m north of the Bago Road intersection. However, there are also unnamed natural and artificial drainage lines and ponds within the study area. The Cutty Creek catchment is moderate in size and consists of a number of smaller tributaries. Upstream of the site the creek drains an area of Burrawan State Forest east of Bago Road and south of Internal Break Road,downstream the catchment consists of a number of rural properties before the confluence with Herons Creek (RTA ETB, 2005).

The water quality in Cutty Creek would generally be influenced by runoff from the highway and rural activities occurring in the surrounding area. No water quality data is available for review for Cutty Creek or the Proposal area.

On a broader scale the site is located within Herons Creek catchment, which is a sub-catchment of Queens Lake. Queens Lake forms part of the Camden Haven Estuary, which has a catchment of approximately 720 km^2. There are no SEPP 14 Coastal Wetlands located within 5 km of the site.

A hydraulic investigation of transverse drainage structures was undertaken by the RTA Bridge Section in July 2006. This document is located in **Appendix C**.

Groundwater
Douglas Partners, based on August 2005 site observations for their contamination assessment between Herons Creek and Stills Road, assessed the regional groundwater flow regime to be towards Cutty Creek, which flows towards Herons Creek. Based on these site observations the depth to the water table was assessed to be greater than 5 m (Douglas Partners, 2005).

Flooding
The potential for flooding within the study area is considered low to moderate. The Herons Creek floodplain is located south and west of the Proposal area and flooding of the southern end of the study area is only expected during major high flow conditions within Herons Creek. There is the potential for localised flooding associated with high flow conditions of Cutty Creek.

9.2.2 Hydraulic investigation

A hydraulic investigation of transverse drainage structures was undertaken by the RTA Bridge Section in July 2006 and involved:

- Concept checking and analysis of the five existing transverse drainage structures to be extended and seven new drainage structures.
- Analysis of the performance of the existing and proposed structures in 1 in 50 yr Average Recurrence Interval and 1 in 100 yr Average Recurrence Interval flood events.
- The hydraulic investigation of transverse drainage structures is found in full in **Appendix C**.

9.2.3 Potential impacts

Construction
There is potential for sediment run off as a result of soil erosion from disturbed areas to affect the quality of water and biota in drainage lines downstream of the Proposal. Sediment can affect water quality by increasing turbidity, reducing light penetration and visibility, which in turn can limit plant growth and movement of aquatic biota. Fine sediments also entrain other pollutants such as metals.

During construction there is greater potential for erosion during late summer and autumn due to higher rainfall and the potential for extreme weather events. There is also the potential for afternoon winds in late winter and early spring to cause movement of soils on disturbed areas and stockpiles.

Based on the preliminary calculations for the earthworks (refer to **Section 8.6.8**) large amounts of material would be required to be excavated and filled on the site. Further calculations on the extent of the earthworks would be undertaken during detailed design. Calculations for potential soil loss would be undertaken as part of the surfacewater management plan. Initial locations and sizings for the sediment basins required for the works are found in **Figure 6**.

There is also potential for leaks and spills of fuel or oil to affect surface or ground water quality or effluent from facilities such as a temporary batching plant to run off into drainage lines if not appropriately managed. Safeguards detailed in **Section 9.2.4** would be established to minimise the potential for construction activities to affect surface or ground waters.

The Proposal would be designed so as the level of the service of the highway is trafficable up to the 1 in 100 yr Average Recurrence Interval of flood events (RTA Bridge Section, July 2006).

Operation

The operation of the Highway would result in the build up of contaminants on the road surface, in the median area and in the roadside corridors. During rain events contaminants may be transported via run-off into local drainage lines. Although the Proposal would increase the total area of road surfaces, the amount of traffic using the Highway and service roads is not expected to increase as a result of the Proposal and, therefore, the potential contaminant load would not increase over that of the existing Highway.

In order to minimise the impacts of contaminants, safeguard measures would be incorporated in the detailed design to capture pollutants, thereby reducing the potential for downstream pollution.
The operation of the highway could result in the build up of contaminants on the road surface, in the median area and in the roadside corridors. During rain events contaminants may be transported via run-off into local drainage lines. Although the Proposal would increase the total area of road surfaces, the amount of traffic using the highway and service roads is not expected to increase as a result of the Proposal and, therefore, the potential contaminant load would not increase over that of the existing highway.

In order to minimise the impacts of contaminants, safeguard measures would be incorporated in the detailed design to capture pollutants, thereby reducing the potential for downstream pollution. **Figure 6** shows the sedimentation control basins proposed in the concept design.

The proposed extensions of the existing transverse drainage structures and the installation of the new structures will have no significant impact on the existing flood flow distribution. A change in outlet velocity is marginally observed (RTA Bridge Section, July 2006).

9.2.4 Safeguards

The following safeguards are proposed to minimise the potential impacts of the project relating to water quality and hydrology:

- Develop a surfacewater management plan as part of the construction environmental management plan for the Proposal. The surfacewater management plan should include:
  - Design specifications outlined in the “Managing Urban Stromwater – Soils and Construction" (the “Blue Book”) (Landcom 2004).
  - Employ a soil conservationalist to assist with soil conservation management.
  - Development of effective erosion and sediment control measures.
  - Development of a drainage strategy for the Proposal, incorporating water sensitive road design techniques such as grass swales, sediment basins and anti-pollution ponds where required.
  - Provision of a bunded area for washing plant and equipment with appropriate collection and treatment systems.
  - Calculations for potential soil loss and finalisation of sizing and locations of sediment basins.
  - Inspection of erosion and sediment control measures on a weekly basis.
  - Conduct of wash down and refuelling activities and activities involving and other potentially hazardous materials in areas isolated from stormwater and/or drainage lines and in accordance with best management practices.
- Implement a water quality monitoring program for Herons Creek during construction.

9.3 Air quality

The Proposal has the potential to affect ambient air quality during both the construction and operational phases, with the primary air quality impacts caused by vehicle exhaust emissions during the operational phase. Pollutants of concern in vehicle exhaust are carbon monoxide, nitrogen oxides and particulates.

9.3.1 Existing environment

Climate

The area has a warm temperate climate with a strong sub-tropical marine influence. The closest Bureau of Meteorology Station is located at Laurieton, approximately 9.5 km southeast, and data from this station is considered indicative of the site. Summer has cool to warm days with average minimum and maximum temperatures for January of 16.2°C and 25.8°C respectively. Winters are cool to cold with average minimum and maximum temperatures for July of 5.3°C and 16.6°C respectively. Annual rainfall at Laurieton is approximately 1549 mm and is generally higher in late summer and autumn, with March having the highest monthly average of 186 mm. Rainfall is lowest in late winter and early spring (RTA ETB, 2005).

Severe weather events have been documented for the Bureau of Meteorology mid north coast region and include storms involving wind gusts of up to 93 km/hour (January 2000), heavy rain and hail of two to three centimetres (December 2001 and August 2003) and power blackouts resulting from severe weather events (January 2004) (RTA ETB, 2005).

Winds

The closest Bureau of Meteorology station with available wind data is Port Macquarie, which is approximately 18.4 km northeast of the site. Southwesterly winds are predominant in the morning during summer at Port Macquarie, with northeasterly winds in the afternoon. In winter, winds are predominantly from the west and southwest. Higher wind speeds generally occur in the afternoon (RTA ETB, 2005).

Air Quality

The air quality within the area is considered to be good as it is primarily a rural area. Existing sources which currently contribute to air pollution include:

- Emissions from motor vehicles travelling on the highway and local road network.
- Forestry activities, such as burning or cleared vegetation.
- Bushfires and backyard burning.
- Dust in dryer and windier conitions.

9.3.2 Potential impacts

Construction works associated with the project may temporarily increase particulate levels in the air. The use of the upgraded roadway by vehicles would be the only source of pollution following construction.

Construction

The following equipment and activities are potential sources of dust during the construction period:

- Earthmoving equipment (such as bulldozers, trucks and compactors).
- Vehicle movements on unsealed road surfaces.
- Unloading fill material.

- Wind erosion from stockpiles and exposed surfaces.
- Batching plant.

Vehicle emissions, which include greenhouse gases such as carbon dioxide, would be emitted from diesel powered construction machinery and equipment and vehicles travelling to and from the site. However, the number of pieces of construction equipment would be relatively low when compared to the vehicles using the highway both during and following construction of the new carriageway. Exhaust emissions emitted by equipment would be managed by ensuring equipment is well maintained.

The removal of approximately 20 has of vegetation as part of the Proposal would also reduce the capacity of the existing environment to remove carbon dioxide from the atmosphere. Extensive revegetation would reduce the impact of this activity on ambient air quality and it is, considered to be negligible.

Operation

Once the Proposal is completed and operational, emissions from vehicles using the highway would result in impacts to the local air quality. Vehicle emissions from the existing traffic on the Pacific Highway already affect the air environment. The Proposal itself is not expected to increase the volume of traffic using the highway, but a general growth in population and coastal development would increase the number of vehicles using the highway in the future.

A detailed air quality study was conducted by Arup (2005) for the adjoining Moorland to Herons Creek section of highway. The study included monitoring carbon monoxide levels at five locations for a seven day peak traffic period in 2000 and the installation of a meteorological station to measure wind direction and temperature during this time. Dispersion modelling using the CALINE4 program was also conducted.

The nearest sensitive receptor to the road is the Herons Creek Public School, which is located along the northbound lane immediately north of Herons Creek. The school buildings are located between 25 m and 80 m from the existing pavement edge of the northbound carriageway. To provide a conservative estimate of emissions, the peak emissions estimated in the Arup Moorland to Herons Creek air quality study for each year for each pollutant were compared to the Department of Environment and Conservation air quality criteria specified in *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (2005), as detailed in **Table 9.**

Table 9: Highest Estimated Peak Hour Traffic Emissions for the Moorland to Herons Creek Proposal

Year	CO (ppm)	NO_2 (ppm)	Fine particulate matter ($\mu g/m^3$)
2002	1.1	0.12	8.4
2011	0.4	0.09	3.2
2021	0.3	0.09	2.5
Air Quality Goals	25	0.12	50

It can be seen from **Table 9** that the predicted worst case emissions of carbon monoxide and fine particulate matter are well below the air quality goals. The predicted nitrogen dioxide levels equal the air quality goal in 2002, but decrease in subsequent years. As the figures in **Table 9** represent a conservative, worst case estimate, the air quality impacts associated with the Project are not considered to be significant.

9.3.3 Safeguards

The following safeguards are proposed to minimise the potential impacts of the project relating to climate and air quality:

- Undertake regular monitoring of the Bureau of Meteorology weather and warnings information and works should be programmed to avoid increasing the risk of erosion and sedimentation.
- Develop an air quality management plan as part of the construction environmental management plan for the Proposal. Mitigation measures would include:
  - Watering of unsealed roads, stockpiles and exposed areas particularly during dry and windy conditions.
  - Revegetate and stabilise disturbed areas as soon as practicable following completion of earthworks, progressively where possible.
  - Managing vehicle speeds on unsealed roads where near houses/receivers with the aim to reducing the occurrence and amount of dust.
  - Ensure all equipment and machinery is well maintained and doesn't emit excessive exhaust emissions.
  - Stabilising disturbed areas with vegetation as soon as practicable to prevent or minimise wind blown dust.
  - Ensure adequate dust suppression control measures are in place for construction activities during periods of high wind, and cover/water of stockpiles and exposed areas at these times.
  - Specific control measures will be developed for work in the vicinity of Herons Creek Public School.
  - Planned revegetation would reduce greenhouse impacts.

9.4 Noise and vibration effects

A noise and vibration impact assessment was undertaken by Spectrum Acoustics as part of the preparation of the REF. This involved:

- Determination of the current background noise levels on the site, having due regard for the location of the nearest noise sensitive locations.
- Identification of the relevant noise and vibration criteria.
- Prediction of expected noise and vibration levels from the Proposal.
- Assessment of noise and vibration impacts during construction and operation in accordance with the Enviornment Protection Authority's "Environmental Criteria for Road Traffic Noise" and the RTA's "Environmental Noise Management Manual".
- Making of recommendations on the requirements for mitigation measures and further assessment.
- The findings of this assessment report are found in full in **Appendix D.**

9.4.1 Existing environment

The existing ambient noise levels are low to moderate; dominant noise sources include noise from road traffic on the Pacific Highway, forestry activities within the Burrawan State Forest and rail traffic

on the north coast railway. Existing vibration levels in the area are associated with passing heavy vehicles on the highway and are intermittent.

The nearest noise sensitive receiver is the Herons Creek Public School located along the northbound lane immediately north of Herons Creek. School buildings are located between 25 m and 80 m from the existing pavement edge of the northbound carriageway. A residence is located on the Paramount property situated along the southbound lane approximately 200 m from the highway, immediately north of Herons Creek (RTA ETB, 2005).

Several residences are located along Bobs Creek Road and off Boyds Road; these are located greater than 500 m from the highway.

Monitoring was undertaken in the free field adjacent to the tennis court near the access road into the school. The location was approximately 80 m from the highway. The results are summarised in **Table 10** below.

Table 10: Ambient noise levels

Location	$L_{Aeq(15\ hour)}$ dB(A)	$L_{Aeq(9\ hour)}$ dB(A)
Herons Creek Public School	57	57

The data from the logger showed a relatively uniform L_{eq} noise level over each 24-hour period of the monitoring. This is considered typical of locations near the Pacific Highway where the traffic mix alters between night and day. That is, during the night traffic volumes decrease but relative and actual numbers of heavy vehicles increase, resulting in a similar overall L_{eq} noise level.

Construction noise criteria are calculated based on background (L_{90}) noise levels. The measured background noise level is shown below in **Table 11**. As construction activities will be limited to day time hours, only this period is shown.

Table 11: Background noise levels

Location	L_{90} (Day)* dB(A) L_{90}
Herons Creek Public School	46

* 7.00 a.m. to 6.00 p.m. Monday to Saturday – 8.00 a.m. to 6.00 p.m. Sunday and Public Holidays.

9.4.2 Noise and vibration criteria

Construction Noise

Noise emanating from construction sites in NSW is subject to conditions detailed in the EPA (DEC) *Environmental Noise Control Manual* and RTA's *Environmental Noise Management Manual*. Section 171 of the *Environmental Noise Control Manual* specifies construction noise limits at the worst affected receivers as follows:

Level restrictions

i) Construction period of 4 weeks and under.

ii) The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).

iii) Construction period greater than 4 weeks and not exceeding 26 weeks.

iv) The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).

Where construction activity extends beyond 26 weeks it is typical that the noise level should not exceed the project specific noise goals for a site, as determined by the procedures detailed in the NSW *Industrial Noise Policy*. For the Proposal this would equate to the background level plus 5 dB(A).

Operational noise

Noise emissions from vehicles travelling on public roads in NSW are assessed according to conditions outlined in the EPA's "*Environmental Criteria for Road Traffic Noise*". Under the definitions in the ECRTN, the Pacific Highway is classed as an arterial road. The criterion applicable to the Proposal is for "*redevelopment of existing freeway/arterial road*". The recommended criteria for such works are set at 60 dB(A) $L_{Aeq(15\ hour)}$ (i.e. day) and 55 $L_{Aeq(9\ hour)}$ (night). The *Environmental* Criteria for road traffic noise also contains the proviso that, where noise criteria are already exceeded, in all cases the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB.

Vibration

Vibration associated with passing heavy vehicles, or construction machinery, is considered to be intermittent in nature. The Department of Environment Conservation sets out limits for vibration in buildings in its *Environmental Noise Control Manual*. These limits are directed at personal comfort for continuous and intermittent vibrations. Spectrum Acoustics evaluated various vibration criteria and decided that the most stringent was 2.8 mm/s. This criterion was adopted for the assessment of potential impacts from the Proposal.

9.4.3 Potential impacts

Spectrum Acoustics undertook noise modelling of various scenarios using the *United Kingdom Department of Environment's Calculation of Road Traffic Noise* to predict L_{eq} (15hr) and L_{eq} (9hr) noise indices. These models are accepted by Department of Environment and Conservation and the RTA.

Construction noise

The earthworks and drainage phase of construction works is expected to have the longest duration and generate the highest construction noise levels. Noise is associated with plant and equipment such as concrete trucks, pumps, pneumatic and hydraulic hammers and mobile cranes.

For modelling purposes, Spectrum Acoustics assumed that up to four plant items (e.g. a roller, dozer, grader and water cart) would be working in close proximity during the initial earthworks phase of construction. Such a configuration of machinery would result in sound pressure levels of about 93 dB(A) at 7 m (i.e. a combined sound power level of 118 dB(A)). Due to the relatively short distance between the noise sources and receivers, the influence of variable meteorological conditions was not considered in the modelling. The calculations also did not take into account the variable screening effects of topography or intervening structures (e.g. sheds etc) between the noise sources and the receiver. The results of calculations of noise from earthworks are shown in **Table 12**.

Table 12: Predicted noise levels from earthworks during the construction phase

Distance from centre of works (m)	Predicted noise dB(A) L_{10}
100	70
250	62
500	56
1000	50

Noise from paving activities will generally be significantly lower than those for general earthworks. In addition, the paving works move along the route at a faster rate and typically will have an impact on individual receivers for up to two weeks only. The predicted paving noise levels are shown in **Table 13**.

Table 13: Predicted noise levels - paving phase

Distance from centre of works (m)	Predicted noise dB(A) L_{10}
100	62
250	54
500	48
1000	42

Herons Creek Public School is approximately 1100 m from the site of the overpass construction and the residence closest to the construction of the overpass is approximately 1200 m away near Herons Creek. A conservative sound power level of 117 dB(A) (or 92 dB(A) at 7 m) was adopted for the modelling scenario. The results of calculations are shown below in **Table 14**.

Table 14: Predicted noise levels from overpass construction

Distance from centre of works (m)	Predicted noise dB(A) L_{10}
1100	48
1200	47

The main source of noise from a batching plant comes from agitator trucks operating at high revolutions whilst being loaded and preparing to depart. Noise from the batching plant itself is relatively insignificant. A scenario of three trucks using the batching plant at the one time was assessed by Spectrum Acoustics.

This scenario does not take into account any screening effects of the batching plant or buildings associated with it. Predicted noise levels are shown in **Table 15**.

Table 15: Predicted noise levels from batching plant operation

Distance from centre of works (m)	Predicted noise dB(A) L_{10}
200	68
500	60
1000	54

Noise levels from earthworks and paving activities during construction were assessed against the 4–26 week construction noise criterion at a distance of less than about 500 m from the modelled earthworks scenario and less than 200 m from paving activities.

The construction of the overpass would not have any adverse noise impacts at the nearest residence, approximately 1200 m away. Noise from the batching plant would exceed the noise criterion at distances up to about 1500 m under the assessed conditions.

Due to the nature of construction work, noise exceedances will likely be sporadic in nature. That is, received noise levels will be dependant upon factors such as:

- The location and proximity to each other of various plant items.

- What work is being undertaken at any given time and whether it involves all machinery operating at the maximum sound power levels modelled.

In addition, any impacts on individual residences are likely to be short term only as the construction works are carried out along the northern sections of the road corridor.

Construction Vibration

As there are no residences within 10 m of the construction area, the only potential vibration impacts will arise from piling activities. It can be assumed that the vibration level is inversely proportional to distance. That is, at double the distance from the source the vibration level will be halved.

This indicates that, even at the maximum vibration level for piling of 30 mm/sec at 10 m, received vibration levels will likely be below the criterion at all distances greater than 35 m from the piling activity.

Operational traffic noise

A comparison of noise levels before and after the proposed road works at Herons Creek Public School is found in **Table 16**.

Table 16: Predicted increase in noise levels from road traffic

Location	$L_{Aeq(15\ hr)}$ Future existing (2010)	$L_{Aeq(1\ hr)}$ Future existing (2010)	$L_{Aeq(15\ hr)}$ Predicted (2020)	$L_{Aeq(1\ hr)}$ Predicted (2020)
Herons Creek Public School	57.9	57.9	60.1	60.1

The analysis of traffic noise for the year 2020 (with road works completed) and 2010 (future existing) indicated that the project would increase traffic noise by slightly more than 2dB(A) at the outside façade of Herons Creek Public School.

The façade of the school would need to attenuate at least 15 dB(A) to achieve compliance. Typically the façade of a light framed building would achieve an internal traffic noise reduction of 10 dB(A) with the windows open sufficient to attain adequate air flow. The same façade would typically achieve a 20 dB(A) noise reduction with windows closed.

The noise level would also be 60 dB(A) $L_{Aeq\ (1hr)}$ outside of the school. This is 5 dB(A) over the applicable criterion for such an area.

An acoustic barrier is planned at Herons Creek Public School as part of the Moorland to Herons Creek upgrade project. This barrier would be positioned to be compatible with, and meet the requirements of, this Herons Creek to Stills Road Proposal.

Section 9.4.4 below outlines measures that may be required to be employed to minimise traffic noise impacts at Herons Creek Public School.

Traffic vibration

Vibration resulting from vehicular movements along road corridors can be divided into the following two broad sources:

- The roughness of the road surface; and
- Potholes, bumps or other surface discontinuities.

Conservative calculations to determine the vibration arising from a continuous stream of heavy vehicles to residential receivers (10 m from the traffic stream) result in mid-span levels of less than 0.1 mm/s, readily complying with the criterion for residential receivers.

The presence of potholes can result in vibration levels that approach or possibly exceed the criterion, depending upon local parameters. A regular maintenance schedule program readily solves this potential aspect of vibration impact.

9.4.4 Safeguards

The following safeguards are proposed to minimise noise and vibration impacts:

- Development of a noise and vibration management plan adopting best management practices consistent with the RTA's Environmental Noise Management Manual. Measures would include:
  - Provide an acoustic barrier at Herons Creek Public School, as per the *Statement of Commitments* for the Moorland to Herons Creek Upgrade
  - Establish close liaison with potentially affected receivers as soon as possible and provide a contact name and phone number for a project representative to which any questions or complaints can be directed.
  - Undertake compliance monitoring of noise or vibration levels in areas where piling may occur within 50 m of any residence.
  - Undertake pre-construction surveys of heritage buildings or vibration sensitive structures occurring within 200 m of proposed piling works.
  - Monitor vibration from construction machinery that is to be operated within 50 m of an existing building.
  - Undertake a building condition survey where construction machinery is to be operated within 50 m of an existing building.
  - Inform all personnel of their obligations and responsibilities with regard to minimising noise emissions.
  - Familiarise construction personnel with methods of controlling noisy machines and alternative construction procedures.
  - Schedule excessively noisy activities, such as rock hammering, to occur at times to cause least annoyance to the community.
  - Conduct regular maintenance on all equipment.
  - Shut down or throttle down to a minimum machines that are used intermittently.
  - Where possible incorporate noise controls in any portable equipment used and employ noise suppression devices for all mechanical plant.
  - Employ contractors and equipment that are best suited to the task.
  - Locate batching plants as far from any residences as is practicable.
  - Orientate the engines of agitator trucks away from residences.
- Locate portable equipment in locations where topography or site sheds etc. provide barriers between the equipment and nearest potentially affected residences.
- Undertaken effective noise impact assessment of the final location and design of batching plants.

9.5 Biodiversity

An assessment was undertaken by HLA to investigate the potential affect the Proposal would have on terrestrial flora and fauna. The assessment included a field survey undertaken between 5 and 7 October 2005. The assessment in full can be found in **Appendix F**, and a summary of the key elements is found in this section.

Review of previous studies and databases
A number of previous ecological investigations for the locality were reviewed as part of background to the assessment. These were:

- broad-scale vegetation mapping for the local area which was undertaken for the Comprehensive Regional Assessment Aerial Photograph Interpretation project; and
- a report by Biosis (2004) as part of Moorland to Herons Creek highway upgrade EIS, which investigated ecology to the south of Herons Creek.

The NSW Scientific Committee's final determinations were reviewed to identify endangered ecological communities and endangered populations, protected by the Threatened Species Conservation Act, that occur in the North Coast. Reviewing online databases maintained by the Department of Environment and Conservation identified the critical habitat within in the local area. Nine threatened vascular plant species and five non-threatened ROTAP species are recorded within 10 km of the Proposal area. The review of the on-line final determinations by the NSW Scientific Committee identified 11 endangered ecological communities that occur within the North Coast Bioregion. Based on these final determinations and review of Atlas of NSW Wildlife records, there are no endangered populations likely to occur within 10 km of the Proposal area. A review of the on-line critical habitat register and recovery plans did not identify the presence of critical habitat for any flora species or community within 10 km of the Proposal area.

Department of Environment and Conservation records of terrestrial fauna species held within the Atlas of NSW Wildlife were extracted for a 10 km buffer area around the Proposal area. Within the search area, there were records for 270 vertebrate species; thirty-two of which are threatened in NSW.

The review of the on-line final determinations by the NSW Scientific Committee found one endangered population that potentially occurs within the region (but not within 10 km of the Proposal area), namely the Emu, *Dromaius novaehollandiae*, population in the NSW North Coast Bioregion.
A review of the on-line critical habitat register and recovery plans did not identify the presence of critical habitat for any fauna species within 10 km of the Proposal area. The BioNet on-line databases were reviewed for fauna records for Burrawan State Forest held by Forests NSW. Sixty-four species of vertebrates, including nine amphibians, 48 birds and seven mammals, were found to have been recorded within the State Forest. These included three threatened species, the Glossy Black-cockatoo, Sooty Owl and Yellow-bellied Glider.

9.5.1 Flora and fauna

The flora and fauna assessment of the Proposal undertaken by HLA involved the following:

- A review of information currently available, including searches of the DEC Wildlife Atlas, Royal Botanic Gardens database and an on-line search for matters of national environmental significance to identify significant plants and communities that occur within the study area.
- Field assessment of plants, animals, and ecological communities present within the study area, undertaken during spring.

- Preparation of a list of species found in the area, and those potentially occurring in the area.
- A review of the significant species and ecological communities listed under the TSC Act and an impact assessment in accordance with Section 5A of the EP&A Act.
- An assessment of the impact on species protected by the provisions of the EPBC Act.
- Preparation of a list of suggested amelioration measures to mitigate potential effects on plant vegetation and fauna habitat.
- The Assessment report is found in full in **Appendix F**.

9.5.2 Flora

The flora of the study area was investigated by HLA staff undertaking a field survey in October 2005 involving walked transects to verify existing vegetation community mapping with the aid of recent aerial photography. The study area was extensively walked over up to 50 m away from the proposed footprint of the Proposal. The majority of the study area is managed by Forests NSW. A special uses permit is required to undertake plant collection within Forests NSW estate areas. The vegetation and fauna surveys were limited to observation only as a permit could not be obtained in time for the field survey. The survey effort focused on potential habitat for threatened species. Significant weed species were recorded when observed and species used in garden landscaping were not recorded, except where these had established within the road reserve.

No threatened species or endangered ecological community or communities were observed within the study area. Three noxious species were recorded within the study area. These were *Lantana camara*, Crofton Weed and Small-leaved Privet. Several environmental weeds also occur in the area; these included Camphor Laurel and Japanese Honeysuckle.

The vegetation in principal sections of the study area is described below.

Herons Creek
The canopy of the riparian vegetation associated with Herons Creek is a mixture of native and exotic species. Native species' diversity is greatest to the east of the existing bridges. The canopy is dominated by White Mahogany (*E. acmenoides*) and Sydney Blue Gum (*E. saligna*), with Kanuka (*Tristaniopsis laurina*) forming a relatively dense understorey. The groundcover was sparse under the dense shrub cover. The vegetation along the aquatic habitat was dominated by *Juncus* sp., *Cyperus eragrostis* and *Schoenoplectus* sp. and herbs including *Viola* sp.

To the west of the bridges the riparian vegetation is dominated by Small-leaved Privet (*Ligustrum sinense*) and Camphor Laurel (*Cinnamomum camphora*). The shrub understorey is dense and highly modified, containing Narrow-leaved Wattle (*Acacia longissima*), Blackwood (*Acacia melanoxylon*) and Tobacco Bush (*Solanum mauritianum*). The ground cover is dominated by exotic species. These include Kikuyu (*Pennisetum clandestinum*), Lamb's Tongues (*Plantago lanceolata*), *Verbena bonariensis*, Flax-leaved Fleabane (*Conyza bonariensis*), Japanese Honeysuckle (*Lonicera japoni*ca), *Watsonia* sp. and *Biddens pilosa*.

Herons Creek School to Bobs Creek Road (west)
Young Tallowwood (*E. microcorys*) dominates the canopy of the vegetation community to the west of the Pacific Highway. Other trees include Blackbutt and White Mahogany. The understorey is approximately 2 m in height and dominated by fabaceous species such as Dogwood (*Jacksonia scoparia*), White Dogwood (*Ozothamnus diosmifolius*), Hopbush (*Dodonaea triquetra*), *Pultenaea villosa* and Bracken (*Pteridium esculentum*). The ground cover is dominated by Kangaroo Grass

(*Themeda australis*), *Lomandra longifolia* and Blady Grass (*Imperata cylindrica var. major*). The hardstand and earthworks to the west of the Bobs Creek Road intersection are dominated by exotic vegetation.

Herons Creek to Bobs Creek Road (east)
The vegetation between Bobs Creek Road and the Pacific Highway is typically a tall shrub and eucalypt regeneration community that has grown since the construction of the highway. It is dominated by White Dogwood, Hopbush and *Pultenaea villosa*, with emergent young Blackbutt and Tallowwood. The groundcover is dominated by grasses and *Lomandra longifolia*. The vegetation south from where Bob Creeks Road turns to the east becomes moister and young Turpentine (*Syncarpia glomulifera subsp. glomulifera*) is present. Blackbutt dominates the canopy toward Herons Creek, with some mature specimens present. A tall shrub understorey that is associated with moister habitats gradually increases toward Herons Creek, particularly in minor drainage lines. Species in the moister areas included Lilly Pilly (*Acmena smithii*) and Cheese Tree (*Glochidion ferdinandi var. ferdinand*). The native understorey is gradually dominated by exotic species closer to the private property adjacent to Herons Creek. Species include Small-leaved Privet, Camphor Laurel, *Cotoneaster* sp. and Japanese Honeysuckle.
Bago Road Intersection
The canopy of the vegetation community in the vicinity of the proposed intersection of Bago Road with the existing northbound carriageway is dominated by Blackbutt (*E. pilularis*), with Tallowwood forming a lesser canopy cover. The trees were tallest nearer to the road, as logging activity has reduced the tree height and canopy cover further west of the Pacific Highway. The taller understorey is dominated by *Acacia longifolia*, *Allocasuarina littoralis* and eucalypt regeneration. The lower shrub understorey is dominated by Hopbush and Bracken. Bracken increased in density as the canopy was reduced by logging activity. The area likely to be affected by the proposed intersection is presently a hardstand, with one large Blackbutt potentially within the intersection footprint. The majority of the unsealed surface is highly modified through earthworks associated with road construction and much of the cleared area to the west of the present Pacific Highway is hardstand. The vegetation is typically low and dominated by grasses, such as the exotic Kikuyu and native species including Kangaroo Grass, *Lomandra longifolia* and Blady Grass.

The vegetation to the south of Bago Road is similar to the vegetation north of the road. It has a lower shrub understorey with a greater density of bracken. The area to be affected by the proposed intersection is also highly modified by road and hardstand construction.

Blackbutt dominates the vegetation between the present northbound and southbound carriageways of the Pacific Highway and the proposed Bago Road intersection. The trees are tall, but relatively immature with no hollow development. The understorey and groundcover is denser, with a well-developed litter layer, than the actively managed Forest NSW estate west of the northbound carriageway.

Proposed diamond intersection
The vegetation in the vicinity of the proposed diamond intersection within the island between the present northbound and southbound carriageways of the highway is dominated by Blackbutt and White Stringybark (*Eucalyptus globoidea*) regeneration. The understorey typically comprises young examples of the overstorey species, with scattered lower shrubs also occurring. Shrub species include Narrow-leaved Geebung (*Persoonia linearis*), Coffee Bush (*Breynia oblongifolia*) and Panax Elderberry (*Polyscias sambucifolia*).

Cutty Creek to Stills Road
The vegetation community between Cutty Creek and Stills Road is highly modified. The canopy is dominated by young Blackbutt regeneration, in association with tall shrubs and small trees such as Black Oak (*Allocasuarina littoralis*). There are many shrub species, including *Acacia* spp., *Leptospermum polygalifolium*, Hopbush and *Banksia spinulosa*. The groundcover is dominated by

exotic species, including *Erogrostis curviflora*, Purpletop and Whiskey Grass. The former alignment of the Pacific Highway passes through this section of the study area, and there is a large hardstand area that is used for the storage of gravel.

Boyds Road to Bobs Creek Road
The vegetation east of the southbound carriageway, between the present Boyds Road and Pacific Highway intersection, is similar to other vegetation on previously cleared areas adjacent to the Pacific Highway. It is dominated by *Acacia* spp. and young eucalypt regeneration. There is wet sclerophyll forest, dominated by Sydney Blue Gum and Bangalay (*Eucalyptus botryoides*), approximately 50 m east of Boyds Road. The understorey is a mixture of shrubs to 3 m and includes Tree Heath (*Trochocarpa laurina*) and Lilly Pilly. The ground cover was sparse and dominated by ferns and taller sedges such as *Gahnia* sp. A feature of the vegetation nearest Boyds Road was the abundance of vines and scrambling species such as *Hibbertia scandens* and Common Silkpod (*Parsonsia straminea*).

The vegetation community between Bobs Creek Road and the proposed intersection with Boyds Road is dominated by Blackbutt, with an understorey of White Dogwood, *Acacia* spp. and Hopbush. The ground cover is patchy, limited by deep leaf litter and woody debris. Two Blackbutt trees with hollow development are located within the visual screen corridor. The vegetation community behind the visual screen and within the proposed route to the existing Bobs Creek Road has been logged recently. The understorey is dominated by shrub species that occur in adjacent areas and eucalypt regeneration. The groundcover is limited by the shrubs and eucalypt regeneration, and is typified by *Panicum* sp. *Hibbertia* spp. and *Dampiera purpurea.*

9.5.3 Fauna

The fauna of the study area was investigated by HLA staff undertaking a field survey in October 2005. The investigations involved:

- Incidental observations of fauna during targeted flora survey.
- Aural survey for frogs along Cutty Creek.
- Identification of potentially significant habitats such as trees with hollow development.

The fauna survey focused on the identification of habitat features and indirect evidence of significant species.

Fauna description
Few species were observed within the forest remnants. Most species observed were small birds utilising the denser shrub understorey within logged coupes and roadside regeneration. Commonly observed species include the Superb Fairy-wren (*Malurus cyaneus*), Grey Fantail (*Rhipidura fuliginosa*) and White-plumed Honeyeater (*Lichenostomus penicillatus*). The shrub understorey is generally dense along areas that have been cleared for construction activities and recently logged coupes. Other species observed utilising the shrublands and logged coupes are common to fragmented rural communities, and included Butcherbirds (*Cracticus* spp.) and Australian Ravens (*Corvus coronoides*).

There are few mature trees with significant hollow development. This is likely to be a result of previous road construction activities (the area on the Proposal side of the existing southbound carriageway was extensively cleared durng construction of thet carriageway in the early 1990s) and on-going forestry operations. The relatively young age of the regeneration, and consequent limited hollow development, is unlikely to provide habitat for arboreal mammals. The forestry activities have thinned out the canopy

in many places, resulting in the likely reduction in foraging opportunities and increase in isolation for arboreal species.

Fallen timber and deeper leaf litter are well-developed within the remnant vegetation between the present northbound and southbound carriageways of the Pacific Highway. However there is unlikely to be a significant terrestrial mammal fauna community due to the relative isolation of these habitats by the highway. The reptile fauna diversity appeared limited, although the Grass Skink (*Lampropholis delicata*) is common within the leaf litter.

Aquatic habitat within the study area is limited to pools associated with Cutty Creek. The larger pools have resulted from the construction of the Pacific Highway. The benthic substrate for both creeks is sandy. The sand is finer and there is a higher silt component in Herons Creek compared to Cutty Creek. There are cobbles present at Cutty Creek, providing greater potential habitat for a diverse macro-invertebrate community.

The lower riparian vegetation of Cutty Creek between the northbound and southbound carriageways of the Pacific Highway is dominated by *Lomandra longifolia*. The riparian habitat of Cutty Creek to the west of the northbound carriageway is typically deep leaf litter that extended into the aquatic habitat.
No frogs were heard calling at Cutty Creek during the night survey (6 October 2005), and no tadpoles were observed despite the water clarity being better than Herons Creek. The Common Eastern Froglet (*Crinia signifera*) was heard in aquatic habitats associated with Herons Creek.

9.5.4 Existing impacts

Activities that have affected the biodiversity of the study area include road construction, forestry operations and vehicular movement. Most trees are relatively young and have not developed hollows. The construction of the existing Pacific Highway in the past has resulted in the clearing of taller vegetation from the roadside (with heavy clearing carried out in the area where the existing southbound carriageway was constructed in the early 1990s). The existing road is likely to reduce the ability for species to move through the local area due to the absence of vegetation cover increasing the likelihood of smaller species being killed by larger carnivores, the increased potential for collision with wildlife and alteration of animal behaviour adjacent to roads in the presence of noise, light and movement.

9.5.5 Potential impacts

Potential impacts from the proposed road upgrade include the clearing of approximately 20 ha of vegetation, located mostly east of the existing southbound carriageway between Boyds Road and Bobs Creek Road. Approximately 8.5 ha of this 20 ha is outside the road reserve and is forest which would be cleared for the construction of the proposed diamond interchange between the present northbound and southbound carriageways of the Pacific Highway. Approximately 5.5 ha of cleared or modified shrublands would be removed for the construction of the proposed northbound carriageway between Boyds Road and Stills Road.

Clearing of remnant vegetation would result in the loss of roosting and foraging opportunities for birds and arboreal mammals. It unlikely there would be a significant reduction in the availability of medium to large tree hollows, as the majority of trees within the footprint of the proposed development are relatively young and lack hollow development.

Indirect impacts that may result from the Proposal include noise during the construction phase and increased difficulty, particularly for arboreal mammals such as gliders, in traversing the highway after widening. The reduced denning opportunities for arboreal mammals from forestry activities is likely to limit the population size of arboreal mammals in the local area, with most arboreal mammal activities

concentrated in riparian habitats. There may be an increase in the potential for collision between wildlife and vehicles as a result of increased vehicle speeds.

There is an increased potential for the spread of weed species through the movement of soil containing seed, stem and root material if areas where weeds are present are not treated prior to earthmoving activities. There is also small potential for the spread of plant pathogens, for example *Phytophora* sp. Fungi, into the area on equipment used during the construction of the proposed road works. At present there is no evidence of dieback within the study area resulting from *Phytophora* sp. infection.

9.5.6 Threatened and endangered species, populations and communities

No threatened flora or fauna species were recorded within the study area. The following **Tables 17** and **18** summarise the threatened species identified as having potential to occur within 10 km of the Proposal, excluding species that utilise marine or estuarine habitats. No marine or estuarine habitat will be affected by the proposed development. Where appropriate, detailed assessments of impact have been prepared and are located in **Appendix F.**

Table 17: Threatened flora recorded within 10 km of the study area

Species	Status TSC Act
Allocasuarina defungens	Endangered
Acacia courtii	Vulnerable
Callistemon linearifolius	Vulnerable
Melaleuca biconvexa	Vulnerable
Melaleuca groveana	Vulnerable
Phaius tankervilliae	Endangered
Grevillea caleyi	Endangered
Hakea archaeoides	Vulnerable
Thesium australe	Vulnerable

Source: DEC Atlas of NSW Wildlife

Table 18: Threatened fauna recorded within 10 km of the study area

Species	Status TSC Act
Green and Golden Bell Frog (*Litoria aurea*)	Endangered
Green-thighed Frog (*Litoria brevipalmata*)	Vulnerable
Wallum Froglet (*Crinia tinnula*)	Vulnerable
Australasian Bittern (*Botaurus poiciloptilus*)	Vulnerable
Brown Treecreeper (*Calyptorhynchus lathami*)	Vulnerable
Glossy Black-Cockatoo (*Climacteris picumnus*)	Vulnerable
Black-necked Stork (*Ephippiorhynchus asiaticus*)	Endangered
Pied Oystercatcher (*Haematopus longirostris*)	Vulnerable
Swift Parrot (*Lathamus discolor*)	Endangered
Square-tailed Kite (*Lophoictinia isura*)	Vulnerable
Barking Owl (*Ninox connivens*)	Vulnerable

Species	Status TSC Act
Powerful Owl (*Ninox strenua*)	Vulnerable
Blue-billed Duck (*Oxyura australis*)	Vulnerable
Osprey (*Pandion haliaetus*)	Vulnerable
Wompoo Fruit-Dove (*Ptilinopus magnificus*)	Vulnerable
Masked Owl (*Tyto novaehollandiae*)	Vulnerable
Sooty Owl (*Tyto tenebricosa*)	Vulnerable
Australian Fur-seal (*Arctocephalus pusillus doriferus*)	Vulnerable
Spotted-tailed Quoll (*Dasyurus maculatus*)	Vulnerable
Dugong (*Dugong dugon*)	Endangered
Humpback Whale (*Megaptera novaeangliae*)	Vulnerable
Little Bentwing-bat (*Miniopterus australis*)	Vulnerable
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)	Vulnerable
Eastern Freetail-bat (*Mormopterus norfolkensis*)	Vulnerable
Yellow-bellied Glider (*Petaurus australis*)	Vulnerable
Squirrel Glider (*Petaurus norfolcensis*)	Vulnerable
Brush-tailed Phascogale (*Phascogale tapoatafa*)	Vulnerable
Common Planigale (*Planigale maculata*)	Vulnerable
Koala (*Phascolarctos cinereus*)	Vulnerable
Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*)	Vulnerable
Grey-headed Flying-fox (*Pteropus poliocephalus*)	Vulnerable
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	Vulnerable

Source: DEC Atlas of NSW Wildlife

No endangered ecological communities were recorded within the study area. No endangered populations listed under schedule 1, part 2 of the TSC Act are present within the study area or will be affected by the proposed highway upgrade.

There is no critical habitat declared under the provisions of the TSC Act within the study area.

State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44)

The study area is located within the Port Macquarie-Hastings Council area; this council is listed in schedule 1 of SEPP 44. The study area also contains Tallowwood (*E. microcorys*), which is listed in schedule 2 of SEPP 44 as a species that is a known food resource for koalas. As Tallowwood does not constitute more than 15 per cent of the canopy cover, it is considered that potential koala habitat, as defined in SEPP 44, is not present.

Core koala habitat is defined as an area with a resident koala population, including recent sightings, especially where females and young are present. No koalas or evidence of koalas were observed within the study area. There are many records within the NSW Department of Environment and Conservation Atlas of NSW Wildlife within a 20 km x 20 km grid centred on the study area, and Forests NSW has a record of the species from within the study area.

While it is possible that koalas will pass through the site, it is unlikely there is a resident population, partly due to the proximity of the existing highway. The study area is not considered to be core koala

habitat, and therefore the provisions for the protection of core koala habitat under SEPP No.44 do not require further consideration.

Commonwealth Environment Protection and Biodiversity Conservation Act, 1999 (EPBC Act)
A search of the EPBC database was also conducted for the area. A referral to the Department of Environment and Heritage under the EPBC Act was not prepared as, following field investigation and assessment, it is considered that there would be no significant affect on any migratory species, threatened species, endangered populations, threatened ecological communities or critical habitat protected by the provisions of the EPBC Act (refer to section 5.5 of **Appendix F**).

9.5.7 Key threatening processes

A key threatening process (KTP) is defined in the TSC Act as a process that:

- Adversely affects two or more threatened species, populations or ecological communities.
- Could cause species, populations or ecological communities that are not currently threatened to become threatened.

The proposed highway upgrade would involve the following three key threatening processes (KTP):

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.
- Removal of dead wood and dead trees.

In addition the scientific committee, established by the *Threatened Species Conservation Act*, has made a final determination to list the 'Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. lat)' as a KTP. While the Proposal would not involve the planting of Lantana, there is the potential for the spread of the species in disturbed areas through the movement of soil containing stem and seed material.

The scientific committee has also made a preliminary determination to support a proposal to list the loss of hollow-bearing trees as a key threatening process.
A summary of the impacts of the (KTP) on the Proposal are detailed below:

- While the proposed highway upgrade will not involve the planting of Lantana, there is the potential for the spread of the species in disturbed areas through the movement of soil containing stem and seed material and the competitive advantage Lantana within forest may gain from increased light penetration from clearing adjacent trees. Lantana will have to be controlled within the reserve to ensure that this species is not allowed to create infestations and be a source of invasion for adjacent lands.
- If perennial grass species are controlled prior to earth works that may assist in the spread of these species, and that invasive exotic perennial grass not be used in revegetation works it is unlikely that this (KTP) will result as of the proposed highway upgrade.
- The proposed highway widening will not result in the significant reduction of woody debris.
- The Proposal will not result in the significant reduction of hollow bearing trees. As discussed in section 8.5.2., the area covered by the Proposal is typically a tall shrub and eucalypt regeneration community that has grown since the construction of the eexisting southbound carriageway in the early 1990s. It is unlikely there

would be a significant reduction in the availability of medium to large tree hollows, as the majority of trees within the footprint of the proposed development are relatively young and lack hollow development.

9.5.8 Safeguards

While it is unlikely that there will be a significant impact to threatened species potentially occurring within the study area, the proposed highway upgrade has the potential for affecting the local biodiversity through weed invasion and siltation of riparian habitat. In order to mitigate these impacts, the following measures are recommended:

- Washing down all vehicles and equipment used in construction activities to avoid the importation of weeds and soil borne pathogens.
- Control of weeds prior to earth moving activities to minimise their spread.
- Procedures documented in the construction environment management plan in the event of any native animals being found or injured.
- Ensure there are no hollow bearing trees prior to removal.
- Use of seed sourced from local *Eucalyptus* sp. and shrubs in rehabilitation work.
- Protection of the riparian habitat associated with Herons and Cutty Creeks from sediment during construction.

9.6 Visual and landscape

9.6.1 Existing environment

The Proposal is located predominantly within the Burrawan State Forest and the dominant feature of the visual landscape is the existing northbound and southbound carriageways of the Pacific Highway. The visual amenity is dominated by the surrounding vegetated landscape; there are no cleared rural pastures adjacent to the highway, except for a turf farm that adjoins the existing highway, immediately north east of Herons Creek. During consultation, Forests NSW stated that the area is subject to logging and therefore it should not be assumed that the visual landscape would remain as it is now due to potential future logging.

Views of the Proposal site are limited to road users and to the Herons Creek Public School. All the way along this stretch of the highway views are limited by the topography and vegetation within the area.

9.6.2 Potential impacts

The assessment of visual impact involves two components:

- Visibility – which is the assessment of the extent to which the various components of the Proposal would be visible, the number of people who would see it, the distance from which it is visible and the context of the view.
- Visual prominence – which is an assessment of the degree of contrast (shape, colour, texture, size) between the Proposal and the surrounding landscape.

Visibility

The most visible elements of the Proposal during construction are likely to be the vehicles and machinery being used in the works and stockpiles. The construction of an overpass at the Boyds Road

intersection and the on and off ramps would be the most visible features of the Proposal once it is complete. The main viewers of the construction works and of the overpasses would be the motorists travelling along the section of the highway, who would have short-term views as they travel through the area.

The Herons Creek Public School, located along the northbound lane immediately north of Herons Creek, is reasonably well screened from the highway by vegetation and would therefore have limited views of the Proposal. The residence located on the Paramount Property, situated along the southbound lane approximately 200 m from the highway, immediately north of Herons Creek, is also well screened from the highway by vegetation. There would also be limited views of the Proposal from this location.

Visual prominence
The site is an existing road corridor and therefore the Proposal would not involve a significant change in the type of infrastructure in the area or its visual appearance. The introduction of an overpass and on and off ramps is likely to increase the visual prominence of the highway. The proposed location for the overpass, on top of an existing highway cutting, would minimise the visibility of the abutments and reduce the amount of embankment required for its construction. The bridge would have abutments sitting on the top of the existing cutting and a central pier. The bridge would be of a "clean and simple form" in appearance in order to minimise its visual prominence.
The Proposal would include a landscaping strategy to re-establish vegetation cleared during construction works and supplement the vegetation maintained. The Proposal is considered to have a moderate impact on the visual environment and would be limited predominantly to the construction period and immediately after. However, given that the highway is the dominant existing visual feature at present and that measures would be incorporated to reduce impacts and maintain the existing rural characteristics of the area, the impacts are not considered to be significant.

9.6.3 Safeguards

The following safeguards are proposed to minimise the visibility of the Proposal:

- Develop the project in ccordance with Pacific Highway urban design principles.
  - Shape ends of cut batters to suit topography.
  - Incorporate effective urban design into the interchange overbridge design.
- Develop a landscape strategy for the Proposal to include the following measures:
  - Landscape disturbed areas with endemic plants.
  - Landscape the median and verges with frangible plants and native grasses.

9.7 Indigenous heritage

9.7.1 Indigenous and non-Indigenous

An assessment of Indigenous heritage was undertaken by HLA to assess the nature of any Indigenous archaeological resources within the development area and identify the potential for impact on these resources. The Indigenous and Non-Indigenous heritage assessment undertaken by HLA involved:

- Background research, including a search of the Aboriginal heritage information management databases and background archaeological information, a search of a wide variety of historic databases including the NSW Heritage Office State

Heritage listing and register, the Register of National Estate, and relevant local environment plans.

- Aboriginal community consultation in accordance with Department of Environment and Conservation's new consultation guidelines, including communication with a number of State Government Agencies and advertising in the local newspaper, to allow registrations of interest from relevant Aboriginal stakeholders in the area.
- A detailed field survey of the Proposal area, involving representatives of the Aboriginal community groups.
- Definition of the archaeological potential of the subject areas based on information collated during this research and taking previous landscape use and disturbance into account.
- Reporting of the archaeological survey documenting the methodology and results of the survey and assessment, incorporating previous results undertaken in the study area.
- Assessment on the potential impact on both Indigenous and Non-Indigenous heritage.
- Identification of heritage issues, including appropriate mitigation strategies.

The assessment is found in **Appendix G** of this REF. The study was undertaken to the standards outlined in the following documents:

- The NSW Department of Environment (formerly National Parks and Wildlife Service) *Aboriginal Cultural Heritage Standards and Guidelines* Kit (1997).
- The Department of Environment and Conservation *Aboriginal Cultural Heritage and the Integrated Development Assessment Guidelines* (2000).
- The Department of Environment and Conservation *Interim Community Consultation Requirements for Applicants* (2005).

9.7.2 Aboriginal community consultation

HLA undertook the following steps with regard to Aboriginal community consultation for this project:

- Contacted the Northeast Environment Protection and Regulations Division of Department of Enviornment and Conservation (Northeast EPRD) for advice on the relevant Aboriginal stakeholders.
- Contacted the Bunyah Local Aboriginal Land Council to identify their interest in the project and any relevant Aboriginal groups.
- Contacted Port Macquarie-Hastings Council.
- Searched the databases of the Native Title Tribunal to identify possible Native Title holders.
- Searched the databases of the Office of Registrar of Aboriginal Corporations.
- Through the RTA, advertised in the Port Macquarie News, Camden Haven Courier, Port Macquarie Express, Hastings Gazette, National Indigenous Times, and Koori Mail newspapers between the end of September and early November 2005, allowing 10 days for registrations of interest. There were a number of registrations, specifically from Ananawan Gundungarra Elders and the Bunyah Local Aboriginal Land Council. Only the Local Aboriginal Land Council participated in the fieldwork.

At the completion of the survey, discussions between HLA and the Bunyah Local Aboriginal Land Council did not identify any major issues in regards to Aboriginal sites or places, although discussions with Bunyah Local Aboriginal Land Council did reveal concerns in regards to potential Aboriginal heritage over the southern parts of Herons Creek (which falls within the Moorland to Herons Creek project and has been addressed in that projects environmental assessment).

9.7.3 Field survey

Following the compilation of background archaeological, environmental and historical information on the area, an archaeological survey was conducted by HLA personnel on 30 to 31 November 2005 between Herons Creek and Stills Road to identify the archaeological sensitivity of the study area. Trevor Roberts of the Bunyah Local Aboriginal Land Council accompanied HLA during the field survey.

Overall the survey covered 58 ha (actually 584,175 m^2), which represents some 59 per cent of the section of proposed development area. Herons Creek to Stills Road was split into ten transects. Each transect was individually described for potential surface and subsurface archaeology. The start, end and any other relevant features were located with global positioning system, while multiple photographs were taken of each transect. Survey results, summaries of the transects and the survey coverage is detailed in ***Appendix G***.

Three recorded Aboriginal sites were found within the study area and all these sites were previously identified by Navin Officer (2001) during an initial survey of Herons Creek. The three sites were #36-6-0149, an isolated find; #36-9-0149, a scarred tree; and a potential archaeological deposit at Herons Creek southern alluvial flat. The isolated find was located just off Clulies Road, south of Herons Creek, in a ploughed field and could not be located by HLA personnel due to the ongoing disturbance of the area. In relation to the scarred tree, HLA tried to locate the site and identified two trees with scars in the interpreted site's vicinity. Neither HLA personnel nor the Bunyah Local Aboriginal Land Council representative considered that either scar was man-made as both lacked the appropriate diagnostic features, such as overgrown callus growth or the typical elliptical shape of an artificial scar (Long 2003). Navin Officer (2001) suggested that #36-9-0149 could have been the result of fire.

Navin Officer (2001) identified the southern alluvial flat of Heron Creek as a potential archaeological deposit (PAD). Given the regional information on the settlement and movement of Aboriginal people in this region, it seems likely that this large flat area adjacent to Herons Creek would have been used by Aboriginal people. HLA agrees that this area is a PAD and, in addition, HLA personnel located an additional alluvial flat, clearly older due to its height and distance from the creek, which retained an *in situ* podsol. RTA has given the undertaking to investigate the PAD identified by Navin Officer in accordance with Department of Envirionment and Conservation's current requirements as part of the Moorland to Herons Creek project. The area required for the Herons Creek to Stills Road proposal is contained within the PAD area identified by Navin Officer.

9.7.4 Potential impacts

The majority of areas that would be disturbed by the Proposal are within 50 m of the existing Pacific Highway, which has had substantial effects on the surrounding area, most notably the modification of the surface drainage into singular channels. Other impacts include the levelling and grading of the road, forming substantial easements and slopes leading to and from the road. The study area reveals substantial clearing and farming, as well as over 80 years of logging by State Forests, which has promoted soil erosion and vegetation removal.

The archaeological survey and assessment divided the survey area into areas of low, moderate or high archaeological potential. The assessment was based on three criteria: the presence of known

surface archaeological materials, the probability of undetected surface archaeological materials, and the probability of subsurface archaeological materials. In short, the assessment was based on the results of the field survey within the broader framework of the archaeological understanding of site distribution within this region.

There is low to nil potential for *in situ* archaeological material to occur in the areas affected by previous development, i.e. roads, services, or buildings or areas where skeletal soils and/or etch surfaces dominate. These areas are considered to be the whole of the study area.

Two Aboriginal sites have been identified within the study area, namely #30-6-0149 and #30-9-0146. While HLA could not relocate the isolated find, nor agree with Navin Officer's (2001) determination of a scarred tree, both sites have been identified as of high potential. Site #30-6-0149 is within the area covered by the Moorland to Herons Creek project and has been addressed in that projects environmental assessment.

9.7.5 Safeguards

The following recommendations were made in the assessment with regard to Indigenous Heritage:

- Aboriginal objects are protected under the *NPW Act 1974* (as amended), regardless of location. Should any objects be identified during the course of site works, all works must cease and the Department of Environment and Conservation (North-eastern Branch, EPRD, Regional Archaeologist) contacted in regard to appropriate permit requirements before any further impact is undertaken.
- Should **suspected** skeletal material be uncovered during the course of site works, all works must cease in that area and the Department of Environment and Conservation, the NSW Police and the NSW Coroner's office contacted immediately, **regardless** of any existing Department of Environment and Conservation permits for the proposed development.
- Site #36-9-0146 is not directly impacted by the Proposal.
- All contractors who work within the confines of the study area should be made aware of the *NPW Act 1974* (as amended) and the fact that it is an offence to move, disturb or destroy Aboriginal objects without the written permission of the Director General of the Department of Environment and Conservatrion. Should Aboriginal objects be located outside of the area covered by the S90, or suspected skeletal material be found, all works in that area should cease and the Department of Environment and Conservation Regional archaeologist for North-eastern Branch, EPRD contacted immediately.

9.8 Non-Indigenous heritage

An assessment of non-Indigenous heritage was undertaken to assess the nature of any European archaeological resources within the development area and identify the potential for impact on these resources. The assessment is found in **Appendix G** of this REF. The study was undertaken to the standards outlined in the Heritage Office *Heritage Manual* (1996) Guidelines.

Heritage registers at State and Commonwealth level were searched to ascertain whether known historic sites or landscapes were listed within the study area. The following registers and databases were searched, and the results of the searches are provided:

- Register of the National Estate - A search of the register was conducted for the Port Macquarie-Hastings LGA. No heritage items are listed on the register within the proposed highway corridor from Herons Creek to Stills Road. The nearby

Middle Brother Mountain is listed on the register as an indicative place for its natural rather than cultural significance.

- State Heritage Inventory - There are no heritage items listed under the Heritage Act for the Herons Creek to Stills Road Proposal area.
- National Trust Register - No items within the proposed highway corridor are classified or listed on the Trust Register.
- Hastings Local Environmental Plan - No heritage items are listed on the Hastings Local Environmental Plan (2001) within the Herons Creek to Stills Road study area.

9.8.1 Field survey

Following the compilation of background archaeological, environmental and historical information on the area, an archaeological survey was conducted on 30 to 31 November 2005 between Herons Creek and Stills Road to identify the archaeological potential of the study area. The survey covered 58 ha and the area was split into transects as detailed in **Section 8.8.3** above.

Survey results, summaries of the transects and the survey coverage is detailed in **Appendix G**.

Two historic sites, H36 and H38, were identified during the survey. H36 consists of the remains of a Eucalypt with switchboard/axe grooves to one side and was previously identified by Navin Officer (2001). It is located on the corner of Herons Creek Road and Pacific Highway. The site was found to be in poor condition, with possible termite and fire damage.

H38, Herons Creek Bridge, was identified by Navin Officer (2001) and is a concrete beam bridge from pre-1948 which has undergone substantial alteration. This form of bridge is common in the northern region. Navin Officer (2001) identified over 150 similar examples of this type of bridge construction.

Both H36 and H38 are within the area covered by the Moorland to Herons Creek project and are addressed in that project's environmental assessment.

9.8.2 Potential impacts

This project involved the heritage investigation of a section of the existing Pacific Highway between Herons Creek and Stills Road, south of Port Macquarie. The survey investigated over 59 per cent of the study area, with effective coverage being acceptable but low due to substantial vegetation cover.

The majority of areas that would be affected by the Proposal are within 50 m of the existing Pacific Highway, which has had substantial effects on the surrounding area, most notably the modification of the surface drainage into singular channels. Other impacts include the levelling and grading of the road, forming substantial easements and slopes leading to and from the road. The study area reveals substantial clearing and farming, as well as over 80 years of logging by State Forests, which has promoted soil erosion and vegetation removal.

The historic tree stump identified as part of the archaeological assessment is within the area covered by the Moorland to Herons Creek project and are addressed in that project's environmental assessment. While these sites are of technological significance, they were found to reveal little about the activities and culture of the two areas.

Switchboard grooves identified in the tree stump, H36, reveal a particular logging technique common to the late 19th Century. These features are common across NSW and simply indicate that logging occurred in the study areas, information which was previously known. These items are not considered

to be able to provide additional information on the cultural heritage of the area, and as such are not considered of any great Local or State significance.

Herons Creek Bridge is a concrete beam bridge from pre-1948 which has undergone substantial alteration. This form of bridge is common in the northern region. Navin Officer (2001) identified over 150 similar examples of this type of bridge construction. Due to the technological aspects of the bridge and its association with the Pacific Highway, a highly significant State road, the bridge has been identified as of Local significance. Herons Creek Bridge is within the area covered by the Moorland to Herons Creek project and is addressed in that project's environmental assessment. This Proposal has no direct impact on Herons Creek Bridge.

Recommendations for further actions to be taken in relation to these historic sites are found in **Section 9.8.3** below.

9.8.3 Safeguards

The following recommendations were made in the assessment with regard to Indigenous heritage:

- Historical relics are protected under the Heritage Act 1977, regardless of location. Should any relics be identified during the course of site works, all works must cease and the NSW Heritage Office contacted in regard to appropriate permit requirements before any further impact is undertaken.
- Any management plan developed for H36 under the Moorland to Herons Creek Pacific Highway upgrade project should be referred to during the current project to ensure that any proposed work is consistent with this plan.

9.9 Socio-economic consideration

9.9.1 Existing environment

The nearest population centre to the Proposal is the village of Herons Creek, located approximately 950 m south of the Proposal. The population of Herons Creek is less than 500. Herons Creek is part of the rapidly growing Camden Haven area, which has Laurieton as the main service centre. Camden Haven has a population of approximately 7355 (ABS, 2001) and a median age of 56. The area is popular for retirees and tourism. The population of the area is also likely to increase with the release of 100-acre subdivisions along Bobs Creek Road.

A school bus operates in the area servicing school children travelling to schools in Port Macquarie, Laurieton and Wauchope. Some of the school bus pick-ups and drop offs occur within the existing highway median. The existing northbound carriageway on the highway is on a winding and undulating alignment with a narrow outside shoulder and is unsuitable for bicycle use.

The Pacific Highway is the major transport corridor connecting Sydney and Brisbane along the NSW coast. This section between Herons Creek and Stills Road provides for interstate traffic as well as a mix of local and regional traffic. In this section of the highway a number of unclassified local roads form intersections with the highway, including Bago Road, Stills Road, Boyds Road and Bobs Creek Road. Stills Road and Boyds Road are predominantly used as access roads to the Burrawan State Forest, while Bobs Creek Road and Bago Road provide for local and regional traffic. The intersection of Bobs Creek Road and the Pacific Highway provided for vehicle movements into and out of an access to Herons Creek Public School, where there are 11 students.

The dominant land use in the area is forestry associated with the Burrawan State Forest that surrounds the section of the highway and is within the median, and other State Forests in the region. Other land uses include grazing along Bobs Creek Road and the Pacific Highway. The primary landowners in the area are the Department of Education, State Forests NSW, Bunyah Local Aboriginal Land Council, the Department of Lands and the RTA.

9.9.2 Potential impacts

Construction

The construction of the Proposal would potentially affect the following social and economic aspects of the area:

- Land use;
- Amenity;
- Properties;
- Access; and
- Employment opportunities.

In the short term, during construction the amenity of the area would be affected by increases in construction traffic, dust and noise. These issues have been addressed in other sections of the REF and measures would be implemented to minimise these short-term impacts.

The Proposal would require the acquisition of approximately 20 ha of land as shown in **Figure 4**. All property acquisition would be negotiated in accordance with the RTA's *Land Acquisition Policy* and compensation would be in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*.

Access to some properties may be affected during construction. Access arrangements would be negotiated with land owners and a traffic management plan would be prepared and implemented to manage traffic during construction. Property access adjustment would also be required to some properties to reconnect access to the service road. Property access adjustment plans would be prepared in the detail concept design stage of the Proposal and finalised in the final design.

The construction of the Proposal would also provide positive economic benefits by providing employment opportunities and business for suppliers in the local region.

An economic analysis of the Proposal was carried out by RoadNet as part of the Traffic Study for the upgrade (RoadNet, 2006). The overall economic efficiency of the Project was examined and was reflected in the benefit cost ratio, which gives an indication of the economic viability of the work. Both stage 1 and stage 2 of the Proposal would provide a positive return on investment.

Operation

The operation of the new road would provide a number of positive social and economic impacts for the local area, region and state. By improving the quality of this section of the highway, there is expected to be a reduction in the number of accidents and a reduction in travel time along the highway. This will therefore benefit the thousands of motorists who use the Pacific Highway each year. Estimates by RoadNet indicate that the upgraded northbound carriageway would represent a travel time saving of 6 seconds per vehicle for southbound traffic and 19 seconds per vehicle for northbound traffic (RoadNet, 2006).

The new carriageway would provide greater capacity for cyclist use than the existing northbound carriageway. It would be designed to allow cyclists to travel safely along the road by way of a 2.5 m

wide sealed shoulder. The detailed design would avoid squeeze points (for example at drainage structures or bridges) unless suitable alternative arrangements can be made for cyclists.

The only crossing point on the highway would be at Boyds Road by way of the road overpass. The overpass would be designed to provide safe pedestrian and cycle access. The service roads would connect the surrounding areas to the overpass. The service roads and overpass would also enhance the ability for social interaction between residents in the area, as they would not need to travel on the highway to access other properties in the area. The interchange would also provide safer transport for local residents by car, bicycle or on foot. Service roads would carry little traffic and would be suitable for bicycle use. Pedestrian activity along the roads is currently low and is not expected to increase significantly. No special facilities would be provided for pedestrians. Equestrians are not expected to use this section of highway into the future and no special facilities are proposed for equestrians.

The detailed design of the Proposal would accommodate school buses.

9.9.3 Safeguards

The following safeguards are proposed to manage social and economic impacts:

- Develop traffic management and traffic control plans as part of the construction environment management plan for the Proposal in accordance with RTA Standard Procedures.
- All property acquisition would be negotiated in accordance with the RTA's Land Acquisition Policy and compensation would be in accordance with the *Land Acquisition (Just Terms Compensation) Act* 1991.
- Community consultation would be continued, via the community liaison group or other suitable means, throughout the development of the detailed design and construction to provide updated information on the Proposal and to consider any relevant issued raised.

9.10 Waste minimisation and management

9.10.1 Potential impacts

Material identified in the contamination assessment undertaken by Douglas Partners would be excavated and sent to a licensed facility prior to works being undertaken.

Waste generated during the construction works would include general construction waste such as concrete, rock, gravel, road base, waste oil, vegetation, general food and litter waste from construction workforce. Rubbish and recycling bins with lockable lids would be provided at site compounds. Where possible, waste materials would be sorted for recycling, reuse or disposal and transported off-site to licensed facilities.

Trees required to be removed would be assessed for their value as millable timber and provided to timber mills as appropriate. Other vegetation would be used for sediment filters (small winrows up to 1 m high away from watercourses) or chipped and used as mulch for revegetation works or made available as firewood. Weed species would not be used for mulch.

Portable toilets, pumped out by a licensed waste contractor on a regular basis, or licenced treatment systems would be provided on site for the use of construction personnel.

9.10.2 Safeguards

The following safeguards will be implemented to minimise and manage waste:

- Develop a waste management plan as part of the construction environment management plan for the Proposal in accordance with RTA's *Waste Minimisation and Management Guidelines* and the principles of the *Waste Avoidance and Resource Recovery Act,* 2001. The plan would include:
  - Consideration of the use of recycled products in the road construction during detailed design.
  - Provision of rubbish and recycling bins with lockable lids at site compounds.
  - Assess trees required to be removed for their value as millable timber and provide to timber mills as appropriate.
  - Chip or cut vegetation for use as mulch for revegetation works or for firewood, avoiding the use of weed species for mulch.
  - Cover waste materials when they are transported to landfills or waste management facilities.
  - No waste to be buried on site, unless approved and suitable for the site's future use.
  - No dumping of waste in or near waterways.
  - At source separation of waste for recycling.
  - Crush and reuse hard, inert construction or demolition waste on site where possible.
  - Re-use excavated soil on site where possible.

9.11 Demand on resources

Resources required for the construction works would include:

- Fill (see *imported fill* discussed below);
- Base and sub-base material (see section 7.6.9);
- Wearing surface;
- Fuel;
- Oil;
- Cement;
- Sand; and
- Workforce.

Imported fill

This proposal requires the importation of embankment fill material of approximately 78,000m^3. More material could have been obtained from within the Proposal by widening and flattening cut batters. This would have resulted in the acquisition of more land which Forest NSW use as a forestry resource. The ready availablility of general fill material from the three quaries close to the site is a cost effective solution and considered a more efficient use of resources.

Resources required for the Proposal are not considered to be in limited supply in the area. The three quarries located close to the site would be able to provide a local source of pavement material as well as general fill.

9.12 Associated infrastructure and activities

The type of infrastructure and activities that may be required in association with the Proposal are detailed in **Section 7** of this REF. Once sites for ancillary infrastructure and activities are finalised, these would be subject to their own environmental impact assessment and would be included in the project Construction Environment Management Plan. However, potential impacts from ancillary infrastructure and activities may include:

- Erosion;
- Impacts to surface water quality;
- Noise emissions;
- Dust; and
- Waste generation.

Safeguard measures such as those detailed in **Section 10.2** would be used to mitigate these impacts, and further measures would be detailed in impact assessments undertaken later in the design process.

9.13 Hazards and risks

This section identifies hazards that may arise from the construction and operation of the Proposal. Hazards and risks have the potential to impact upon human health and safety and the natural and built environment.

The Pacific Highway Upgrade Program, of which this Proposal is part, aims to provide an improved section by providing dual carriageway and thereby reduce accident rates.

A qualitative assessment has been undertaken to examine the risks associated with accidents involving hazardous goods during construction, and once the Proposal is operational, the risk of accidents affecting the public during construction and operation.

9.13.1 Construction

The potential risks and hazards involved in the construction of the Proposal relate to:

- Spillage of dangerous or hazardous materials or wastes, by way of leakages of stored materials or by vehicle or machinery accidents.
- Traffic accidents at construction access points.
- Contact with underground utilities.
- Workplace accidents.
- Bushfire.

Materials to be used during construction would be determined by the final design of the Proposal and by the construction contractor; however, dangerous or hazardous materials that are likely to be used may include those listed in **Table 19**.

Table 19: Dangerous and hazardous materials likely to be used during construction.

Dangerous goods	Hazardous materials
Distillate fuel	Cement
Petrol	Paints
Oils, grease and lubricants	Epoxies
Gases (such as oxygen and acetylene)	Solvents and thinners
Bitumen	Lime

These hazards and risks would be managed by the implementation of appropriate management procedures and controls. Construction work would be undertaken by a contractor and the potential for hazards and risks would be managed by the contractor in accordance with its environmental management system and construction environment management plan that would contain procedures for the management of risks and hazards.

The contractor would be required to have a quality system that contains mechanisms for handling and storage of hazardous materials and for monitoring procedures to ensure compliance. Measures would include those outlined in **Section 10.2**. There would be no significant potential for dangerous goods or wastes likely to be involved in construction to affect the public or workforce if handled in accordance with good practice and regulatory requirements.

Traffic management measures would be required to control traffic and minimise the risk of accidents both on site and with public road users. The contractor would be required to prepare and have approved traffic management plans and traffic control plans for specific parts of the sites. These plans would include appropriate traffic control measures at the main access points from the construction areas to the existing highway.

9.13.2 Operation

The potential risks and hazards involved in the operation of the Proposal relate to:

- Environmental risks such as:
  - Contaminants from normal operation of the highway carried by surface runoff.
  - Spills and leaks of dangerous of hazardous materials from vehicles.
- Risks to human health and safety such as:
  - Accidents affecting road users.
  - Accidents involving dangerous goods affecting road users and adjacent residents.

Environmental risks

A number of contaminants may be mobilised by surface runoff during normal operation of the highway.These may include litter or other waste and exhaust, discharges or wear products from vehicles. Measures to treat or mitigate these contaminants are discussed in **Section 9.14.3** of this REF.

Risks associated with dangerous goods or hazardous materials

The highway is the primary north-south route for trucks transporting dangerous goods. The most common dangerous goods that are transported on the highway are flammable and combustible liquids, liquefied petroleum gases, flammable gases, toxic materials and reactive materials. Heavy vehicles account for approximately 20 per cent of the total traffic on the highway (10 per cent light

commercial and 10 per cent heavy commercial) and only a small percentage of these would carry dangerous goods. Previous research has found that the percentage of all heavy vehicles carrying dangerous goods in NSW is 1.15 per cent (RoadNet, 2006). Therefore the likelihood of an incident involving dangerous goods is considered to be small. In addition, the resulting improvement in the quality of this section of the highway once the Proposal is operational would also further reduce the likelihood of an incident. Vehicles carrying dangerous goods are required to comply with the provisions of the *Dangerous Goods Act* 1997.

Should an incident occur on this section of the highway, a fire station is located at Laurieton. The NSW Fire Brigade is responsible for managing chemical and fuel spills and the Department of Environment and Conservation is responsible for offering advice on containment and cleanup. The RTA has existing procedures for assisting these authorities in the management and cleanup of such incidents.

In the event of an incident, traffic would be diverted and traffic flow maintained with only minor inconvenience to road users due to flexible traffic arrangements available with dual carriageways.

Risks to human health and safety
The Proposal would result in the construction of a new high standard dual carriageway that would provide a transport corridor safer than the existing, winding northbound carriageway. Therefore the incidence of vehicle accidents is expected to reduce as a result of the Proposal. Notwithstanding this, vehicle accidents may still occur and therefore the detailed design of the Proposal would include the provision of turning bays and widened shoulders to allow space for vehicles to stand clear of passing traffic (RoadNet, 2006).

Risks that could affect local residents are likely to be accidents involving dangerous goods or hazardous materials, which have been discussed above.

9.13.3 Safeguards

The following safeguards are proposed to minimise hazards and risks:

- Develop a traffic management plan and traffic control plan(s) for the Proposal to include procedures to manage vehicle accidents and emergencies.
- Maintain equipment used on site and regularly inspect for leaks.
- Where practical all construction traffic movements would be limited to the new carriageway to avoid conflicts with highway traffic.
- Engage appropriately licensed contractors to transport waste materials, and ensure transport in accordance with relevant guidelines and standards.
- Induct all site personnel and inform them of site environmental requirements, liabilities and responsibilities.

9.14 Cumulative environmental effects

Cumulative impacts can result from a number of different elements within a project as well as from a number of different projects with interacting impacts in the same locality.

9.14.1 Cumulative impacts with other projects

The Proposal is not being undertaken in isolation as it is part of the Pacific Highway Upgrading Program and would link with the northern extent of the Moorland to Herons Creek for which an environmental impact statement has recently been exhibited and planning approval obtained on the 14 December 2006. The combined effects of the upgrading program are considered to result

ultimately in benefits for the local area, region and State. These benefits include improved road safety and reduced travel times. Economic benefits would include increased tourist access to many areas along the coast and economic flow-on effects. Some of the negative impacts include increased clearing of vegetation and potential for increased vehicle usage.

As part of the Pacific Highway upgrading program, the Proposal would assist in improving the traffic flow on the highway. This would, in turn, help to increase the fuel efficiency for vehicles using the highway.

9.14.2 Cumulative impacts from the proposal

The principles of Ecologically Sustainable Development have been applied to the Proposal. This includes consideration of the cumulative impacts of the Proposal. The Proposal itself is not considered to result in substantial cumulative impacts. The impacts on the biophysical, social and economic environment have been assessed and addressed elsewhere in this REF, and safeguard measures have been proposed in **Section 10.2** to minimise these impacts.

10 IMPLEMENTATION STAGE

10.1 Environmental management

The environmental management of the Proposal would be a key element to ensure there are no significant impacts on the receiving environment as a result of the Proposal. The safeguards proposed in this REF would be included in the detailed design of the Proposal and in the construction environment management plan. The construction environment management plan would provide a guide and tool for the management of the construction activities and would be a dynamic document that would be regularly updated and reviewed and audited as the Proposal advances. The construction environment management plan would also include safeguards developed in the detailed design stage and any conditions issued in the determination of the Proposal.

The construction environment management plan would incorporate a number of sub-plans for the management of particular environmental issues. These would be:

- Soil and water management plan in accordance with the *RTA QA Specification G38 Soil and Water Management* and *Managing Urban Stormwater Soils and Construction Vol. 1 4th Ed* (March 2004), commonly called "The Blue Book".
- A flora and fauna management plan.
- Also a traffic management plan and traffic control plan would be prepared to manage traffic arrangements during the construction works.
- A landscape strategy which would detail requirements to revegetate areas of the road corridor following construction of the upgrade and would provide measures to manage weeds.
- An air quality, noise and vibration and waste management plan.

10.2 Summary of proposed safeguards

Environmental safeguards outlined in this document and listed in **Table 20** would be incorporated into the detailed design phase of the Proposal and during construction and operation of the Proposal. These safeguards would minimise any potential adverse impacts arising from the proposed works on the surrounding environment. All safeguards described in this REF and the decision report/conditions of approval would be incorporated into the construction environmental management plan. The construction environmental management plan would be developed in accordance with the specifications set out in the RTA's *QA Specification G36 – Environmental Protection (Management Plan)*. As with other Pacific Highway projects, a database of all proposed commitments would be prepared and monitored in construction and operation.

Table 20: Proposed Safeguards

Issue	Safeguard	Implementation phase
Landforms, geology and soils	Undertake a geological investigation in unison with the bridge foundation investigation, to provide a more accurate indication of earthworks and the method of construction required.	Pre-construction
Landforms, geology and soils	Develop a surface water management plan as part of the construction environmental management plan for the Proposal. The surface water management plan will include: • Appropriate erosion and sediment control measures to be implemented prior to and during earthworks. The control measures will include erosion and sediment controls, sediment basins, exclusion zones, diversion bunds, catch drains, energy dissipaters, sediment traps etc. • Use revegetation measures, such as hydromulching, to minimise potential for erosion of exposed surfaces and batters. • Undertaking revegetation as soon as practicable after the disturbance. • Requirements for routine inspection and testing to ensure that controls and procedures are effective. • Minimising the extent of clearing where possible to minimise erosion potential. • Staging of clearing where possible. • Maintaining vegetation in drainage lines until latest possible time to reduce erosion risk and retain filtering capacity.	Pre-construction Construction
Landforms, geology and soils	Maintain plant and equipment used on site in good order to ensure potential for leaks and spills are minimised.	Construction
Landforms, geology and soils	Maintain spill kits on site to manage spills of fuel or oils.	Construction
Landforms, geology and soils	Store fuel or oil in roofed and bunded areas able to contain 120 per cent of the maximum capacity of the largest storage tank or container. The bunded areas should be located at least 20 m away from drainage lines.	Construction
Landforms, geology and soils	If contaminated or potentially contaminated material is exposed during earthworks then work in the area will cease and a qualified consultant be engaged to investigate the extent of contamination and recommend measures to dispose of contaminated material.	Construction
Climate and air quality	Undertake regular monitoring of the Bureau of Meteorology weather and warnings information. Works should be programmed to avoid increasing the risk of erosion and sedimentation.	Construction

Issue	Safeguard	Implementation phase
Climate and air quality	Develop an air quality management plan as part of the construction environmental management plan for the Proposal. Measures to include the following: • Water of unsealed roads, stockpiles and exposed areas particularly during dry and windy conditions. • Revegetate and stabilise disturbed areas as soon as practicable following completion of earthworks or progressively where possible. • Manage vehicle speeds on unsealed roads with the aim to reducing the occurrence and amount of dust. • Ensure all equipment and machinery is well maintained and doesn't emit excessive exhaust emissions. • Stabilise disturbed areas with vegetation as soon as practicable to prevent or minimise wind blown dust. • Effective management of activities during periods of high wind and cover/water of stockpiles and exposed areas at these times.	Pre-Construction Construction
Water quality	Develop a stormwater management plan as part of the environmental management plan for the Proposal. The stormwater management plan should include: • Develop an effective erosion and sediment control plan. • Employ a soil conservationalist to assist in soil conservation management. • Development of a drainage strategy for the Proposal, incorporating water sensitive road design techniques such as grass swales, sediment basins and pollution ponds where required.	Pre-Construction Construction
Water quality	• Inspection of erosion and sediment control measures on a weekly basis. • Conducting wash down and refuelling activities and activities involving other potentially hazardous materials in areas isolated from stormwater and/or drainage lines and in accordance with best management practices.	
Water quality	Implement a water quality monitoring program for Herons Creek during construction.	Construction

Issue	Safeguard	Implementation phase
Noise and vibration	Develop a noise and vibration management plan as part of the construction environmental management plan for the Proposal adopting best management practices consistent with the RTA's *Environmental Noise Management Manual*. Measures would include the following: • Establish close liaison with potentially affected receivers as soon as possible and provide a contact name and phone number for a project representative to which any questions or complaints can be directed. • Undertake compliance monitoring of noise or vibration levels in areas where piling may occur within 50 m of any residence. • Undertake pre-construction surveys of heritage buildings or vibration sensitive structures occurring within 50 m of proposed driven piling works if required. • Monitor vibration from construction machinery that is to be operated within 50 m of an existing building. • Undertake a dilapidation survey where construction machinery is to be operated within 50 m of an existing building. • Inform all personnel of their obligations and responsibilities with regard to minimising noise emissions. • Familiarise contractors with methods of controlling noisy machines and alternative construction procedures. • Schedule excessively noisy activities such as blasting or rock hammering, to occur at times to cause least annoyance to the community. • Conduct regular maintenance on all equipment. • Shut down or throttle down to a minimum machines that are used intermittently. • Any portable equipment used should incorporate noise controls.	Pre-construction Construction Post-construction Operation

Issue	Safeguard	Implementation phase
Noise and vibration	- Employ noise suppression devices for all mechanical plant. - Employ contractors and equipment that are best suited to the task. - Use quieter alternatives to reverse alarms. - Locate batching plants as far from any residences as is practicable. • Orientate the engines of agitator trucks away from residences. • Locate portable equipment in locations where topography or site sheds etc. provide barriers between the equipment and nearest potentially affected residences. • Undertaken detailed noise impact assessment of final location and design of batching plants.	Pre-construction Construction Post-construction Operation
Noise and vibration	Construct an acoustic barrier along the edge of the road corridor near external play areas of Herons Creek Public School as part of the Coopernook to Herons Creek project.	Pre-Construction/early construction
Biodiversity	Washing down all vehicles and equipment used in construction activities to avoid the importation of weeds and soil borne pathogens.	Construction
Biodiversity	Control of weeds prior to earth moving activities to minimise their spread.	Construction
Biodiversity	Use of seed sourced from local *Eucalyptus* sp. and shrubs, in particular species that have abundant nectar and pollen, in rehabilitation work.	Post-Construction
Biodiversity	Protection of the riparian habitat associated with Herons and Cutty Creeks from sediment during construction.	Construction
Visual/Landscape	Develop a landscape strategy as part of the Construction Environment Management Plan for the Proposal to include the following measures: • landscape disturbed areas with endemic plants. • landscape the median and verges with frangible plants and native grasses.	Pre-Construction Post-Construction
Indigenous heritage	Aboriginal objects are protected under the *NPW Act 1974* (as amended), regardless of location. Should any objects be identified during the course of site works, all works must cease and the Department of Environment and Conservation (Northeastern Branch, EPRD, Regional Archaeologist) contacted in regard to appropriate permit requirements before any further impact is undertaken.	Construction

Issue	Safeguard	Implementation phase
Indigenous heritage	Should **suspected** skeletal material be uncovered during the course of site works, all works in that area must cease and the Department of Environment and Conservation, the NSW Police and the NSW Coroner's office contacted immediately, **regardless** of any existing Department of Environment and Conservation permits for the proposed development.	Construction
Indigenous heritage	Investigation of the Herons Creek Potential Arachological Deposit will be undertaken as part of the Coopernook to Herons Creek project.	Pre-Construction
Indigenous heritage	If further investigations of the Potential Archeological Deposit are required, a 'Care and Control' permit application should be applied for by the Aboriginal communities, allowing them to collect and care for any artefacts uncovered during the investigation.	Pre-Construction
Indigenous heritage	Site #36-9-0146 is not directly impacted by the Proposal. If #36-9-0146 was to be impacted by the works, then discussions should be held between the RTA and Department of Environment and Conservation in relation to their management.	Pre-Construction
Indigenous heritage	All personnel who work within the confines of the study area should be made aware of the *NPW Act 1974* (as amended) and the fact that it is an offence to move, disturb or destroy Aboriginal objects without the written permission of the Director General of the Department of Environment and Conservation. Should Aboriginal objects be located outside of the area covered by the S90, or suspected skeletal material be found, all works should cease and the Department of Environment and Conservation Regional archaeologist for Northeastern Branch, EPRD contacted immediately.	Pre-Construction Construction
Non-Indigenous heritage	Historical relics are protected under the *Heritage Act 1977*, regardless of location. Should any relics be identified during the course of site works, all works must cease and the NSW Heritage Office contacted in regard to appropriate permit requirements before any further impact is undertaken.	Construction
Non-Indigenous heritage	Any management plan developed for H36 under the Moorland to Herons Creek Pacific Highway upgrade project should be referred to during the current project to ensure that any proposed work is consistent with this plan.	Pre-construction
Socio-economic	Develop a traffic management plan and traffic control plans as part of the Construction Environmental Management Plan for the Proposal in accordance with RTA Standard Procedures.	Pre-Construction
Socio-economic	All property acquisition would be negotiated in accordance with the RTA's *Land Acquisition Policy* and compensation would be in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*.	Pre-Construction

Issue	Safeguard	Implementation phase
SocioeEconomic	Community consultation would be continued throughout the development of the detailed design and construction to provide updated information on the Proposal and to consider any relevant issued raised.	Detailed Design Pre-Construction Construction
Waste minimisation and management	Develop a waste management plan as part of the construction environmental management plan for the Proposal in accordance with RTA's *Waste Minimisation and Management Guidelines* and the principles of the *Waste Avoidance and Resource Recovery Act, 2001*. The plan would include: • Consideration of the use of recycled products in the road construction during detailed design. • Provision of rubbish and recycling bins with lockable lids at site compounds. • Assessment of trees required to be removed for their value as millable timber and provide to timber mills as appropriate. • Chip or cut vegetation for use as mulch for revegetation works or for firewood. Do not use weed species for mulch. • Cover waste materials when they are transported to landfills or waste management facilities. • No waste to be buried on site, unless approved and suitable for the site's future use. • No dumping of waste in or near waterways. • At source separation of waste for recycling. • Crush and reuse hard, inert construction or demolition waste on site where possible. • Re-use excavated soil on site where possible.	Detailed Design Pre-Construction Construction
Hazards and risk	Develop a traffic management plan and traffic control plan(s) as part of the construction environmental management plan for the Proposal to include procedures to manage vehicle accidents and emergencies.	Construction and Operation
Hazards and risk	Maintain equipment used on site and regularly inspect for leaks.	Construction
Hazards and risk	Where practical all construction traffic movements would be limited to the new carriageway to avoid conflicts with highway traffic.	Construction
Hazards and risk	Engage appropriately licensed contractors to transport waste materials, and ensure transport in accordance with relevant guidelines and standards.	Construction
Hazards and risk	Induct all site personnel and inform them of site environmental requirements, liabilities and responsibilities.	Construction

10.3 Licences and approvals

Works carried out as part of the construction and operation of the Proposal must comply with relevant provisions of legislation and regulations. Approvals that may be required are:

- Preliminary Research Permit (section 87) and a Consent to Destroy Permit (section 90) for potentially affected archaeological materials - *National Parks and Wildlife Act* 1974.
- Section 139 permit - *Heritage Act 1977*.
- Permit required under section 219 if fish passage would be blocked, notification under section 199 is required to be given to the Minister for dredging or reclamation works - *Fisheries Management Act* 1994*.*
- Licence to extract water and to divert water courses, construct sediment basins - *Water Management Act,* 2000.
- The RTA is exempt from the requirement for a Part 3A permit, but contractors may be required to obtain a permit for works within 40 m of protected waters -*Rivers and Foreshores Improvement Act,* 1948.
- Licence for the keeping of certain chemicals (as notified by the Department of Environment and Conservation) *Environmentally Hazardous Chemicals Act,* 1985.
- Licences required for generating or storing certain hazardous wastes - *Waste Avoidance and Resource Recovery Act* 2001.

11 OUTCOMES

A consideration of the main beneficial and adverse effects of the Proposal in relation to the biophysical, social and economic environments is made in this section.

11.1 Social/community

The Proposal may have the following adverse effects on the social environment:

- Short-term increase in noise during construction.
- Short-term increase in dust.
- Short-term decrease in visual amenity.
- Changes to property access during construction.

The Proposal is expected to have the following beneficial effects on the social environment:

- Improved road safety.
- Reduced travel time on the highway.
- Improved community access to the local area by the provision of the Boyds Road overpass for cars, cyclists and pedestrians.

11.2 Biophysical

Adverse residual effects on the biophysical environment, after implementation of the safeguards for the Proposal outlined in this REF, will be:

- Vegetation removal, including removal of habitat for fauna.

The adverse effects on the social environment will be somewhat mitigated by:

- Improved measures to manage weeds.
- Improved measures to protect flora and fauna.
- Improved pollution controls.
- Changes to property access during construction.

11.3 Economic

The Proposal could result in adverse economic effects due to acquisition of timber logging land from Forest NSW. However, some of the land to be acquired is not harvestable due to the proximity of the existing highway and the Proposal has the least amount of fragmentation of the options considered.

The Proposal is expected to have the following beneficial effects on the economic environment:

- Direct and indirect income benefits to the local and wider community as a result of the construction activities and improvements to the road infrastructure.
- Creation of employment opportunities during construction.
- The Proposal or a staged option has a positive benefit to cast ratio and would return to the community a positive investment.

Property acquisition would be negotiated in accordance with the RTA's *Land Acquisition Policy* and landowners would be compensated in accordance with the *Land Acquisition (Just Terms Compensation) Act* 1991.

11.4 Principles of ecologically sustainable development

The principles of ecologically sustainable development have been considered throughout the development of the Proposal in the concept design and development of safeguards, and will continue to be considered in the detailed design and management of the Proposal. These principles, and how they have been considered, are outlined below.

The Precautionary Principle – *that is to say, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*

The Precautionary Principle has been applied throughout the development of this route alignment option. The Proposal, together with the implementation of appropriate safeguard measures, does not present a significant risk of serious or irreversible environmental damage.

Intergenerational equity – *that is to say, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.*

The Proposal would benefit future generations by improving access to areas on the NSW coast and improving road safety. The Proposal is consistent with long-term planning aims and would help to benefit the productivity of the region in the future. The decision on the proposed alignment was made with the consideration of the local community and other stakeholders in order to ensure a satisfactory outcome was made for both the present and future generations. A large number of safeguards have been included in this REF.

Conservation of biological diversity and ecological integrity – *that is, that conservation of biological diversity and ecological integrity should be a fundamental consideration.*

Biological diversity and ecological integrity have been considered in this REF in the form of a detailed flora and fauna impact assessment (**Appendix F**). This assessment concluded that the Proposal could be undertaken without significant impacts upon the ecological environment. Reduction of impacts on biological areas has been a consideration in the development of the proposal. A number of safeguards are included that relate to conservation of biological diversity and ecological integrity.

Improved valuation and pricing of environmental resources – *that is to say, that environmental factors should be included in the valuation of assets and services, such as polluter pays, full life cycle costing, and utilising incentive structures/market mechanisms to meet environmental goals.*

It is difficult to assign a monetary value to the environment of the locality. However, by managing environmental impacts during both construction and operation by identifying site specific safeguard measures to mitigate against adverse environmental effects and including the cost of these measures in the overall cost of the Proposal, the value of environmental resources has been more accurately considered as part of the Proposal.

The Proposed alignment for the upgrade was not chosen on cost alone, but also on a consideration of environmental and biological factors as well as engineering, social and economic aspects. This resulted in the proposed upgrade route, which is seen to be the most suitable alignment by the community and stakeholders and the RTA.

11.5 Conclusion

The Proposal is part of the RTA's broader plans and strategy to upgrade the Pacific Highway to a high standard dual carriageway for the section from Hexham to the Queensland border. Hence, it is needed as part of the RTA and government's strategic plans for improvement for the highway.

The upgrade of this section of the highway would provide a connection between existing and proposed high quality dual carriageways and would result in increased safety and improved traffic conditions on the carriageway.

The Proposal that has been assessed in this REF is for the ultimate motorway standard including a grade separated interchange south of Bago Road. It allows for both motorway class and atrerial class as it is possible that construction will be staged, with some sections initially constructed to arterial standard.

The motorway option would have a greater impact upon the environment than the arterial class option, as it would require additional earthworks and construction elements, including an overpass at Boyds Road, and increased clearing of vegetation to facilitate this. Notwithstanding this, both the ultimate motorway class and the possible arterial class staging options are considered to be justifiable in that they would provide benefits to the local community and the broader region and state, and the adverse impacts would be able to be managed.

Additionally, with the safeguard measures put in place, the construction and operation of the upgrade to the Pacific Highway would not constitute a significant adverse environmental impact and will therefore not require an environmental impact statement to be prepared.

12 CLAUSE 228 CHECKLIST

Clause 228 of the EP&A Regulation states that for the purposes of Part 5 of the EP&A Act the following factors are required to be taken into account concerning the impact of an activity on the environment. These factors and the findings following environmental assessment are detailed in **Table 21** below.

Table 21: Clause 228 Checklist

Factor	Reference in REF	Positive/Negative Impact
Any environmental impact on a community. The Proposal would improve this section of the Pacific Highway, providing benefits to the local and wider community. The Proposal would result in the clearing of vegetation which would result in lost foraging opportunities for fauna. Minor short term impacts such as noise and dust and changes in access and traffic would be experienced during construction. Safeguards proposed would minimise these impacts.	Sections 6.2, 9.5, 9.9	Long- term positive Long-term negative, improved with revegetation Short-term negative
Any transformation of a locality. The Proposal would result in the expansion of the transport infrastructure in the area with the addition of a new interchange and overpass and therefore would affect the visual landscape in the long-term.	Sections 8.6, 9.6. Section 9.	Short term negative during construction. Positive long-term outcome from urban design and landscaping.
Any environmental impact on the ecosystems of the locality. The potential exists for short-term negative impacts during construction of the Proposal, but these should be effectively managed through the implementation of safeguards proposed and a Construction Environmental Management Plan.	Section 8.5, 8.12	Short term Negative
Any reduction of the aesthetic, recreational, scientific, or other environmental quality or value of a locality. During construction there may be a reduction in these values because of major earthworks, stockpiling and plant etc affecting the visual amenity. Additional landscaping provided as part of the Proposal would result in additional screening and amenity in the future.	Sections 9.1, 9.2, 9.3 9.4, 9.5, 9.6,9.7, 9.8, 9.9	Short term Negative Long-term positive

Factor	Reference in REF	Positive/Negative Impact
Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations. Two sites of moderate potential and four sites of high potential were identified, however none of these sites are impacted by this proposal (all fall within the Moorland to Herons Creek Project)	Sections 9.7 and 9.8	Minor
Any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act, 1974). The flora and fauna assessment undertaken for the REF (**Appendix F**) concluded that the Proposal would not significantly affect any such habitat. Revegetation will reduce any impact.	Section 9.5	Minor
Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air. The flora and fauna assessment undertaken for the REF (**Appendix F**) concluded that the Proposal would not result in endangering of species.	Section 9.5	Nil
Any long-term effects on the environment. The Proposal would have positive long-term effects on the socio-economic environment with improved safety and travel times on the highway.	Section 9.9	Long term Positive
Degradation of the quality of the environment. There is potential for minor short term environmental degradation due to noise, dust, impacts to traffic and water quality during construction. There would also be improvements to the water quality of surrounding waterways as a result of the installation of measures (such as sediment control structures) associated with the Proposal.	Section 9	Short term negative Long-term Positive

Factor	Reference in REF	Positive/Negative Impact
Any risk to the safety of the environment. The construction of the Proposal may result in short-term potential risks to the safety of the environment because of clearing, bare earth, accidents and spills, but these would be appropriately managed. In the long-term the Proposal would contribute to reducing the risk to the safety of the environment, by providing appropriate mitigation measures such as operational sediment control structures, .	Section 9.13	Short term negative Minor long-term positive.
Any reduction in the range of beneficial uses of the environment. The Proposal would result in a change in land use for small areas of loggable forest that need to be acquired. Construction of the improved highway could be considered to be a beneficial use for the relatively small areas to be acquired.	Sections 9.6, 9.9	Minor negative Positive
Any pollution of the environment. There is minor potential for short-term negative impacts during construction. However safeguards documented in the REF would minimise the potential for impacts. Improvements in road drainage and water management structures such as operational sediment basins would result in improved quality of runoff from the highway.	Sections 9.1, 9.2, 9.3, 9.4, 9.10, 9.13	Short term negative Long term positive
Any environmental problems associated with the disposal of waste. A waste management plan would be prepared as part of the construction environmental management plan which would detail measures to manage waste. There are not expected to be problems associated with the disposal of waste.	Section 9.10	Neutral
Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply. Resources required for the Proposal are not in limited supply in the area.	Section 9.11	Nil

Factor	Reference in REF	Positive/Negative Impact
Any cumulative environmental effect with other existing or likely future activities. The Proposal is not being undertaken in isolation as it is part of the Pacific Highway Upgrading Program and would link with the northern extent of the Moorland to Herons Creek project. The Proposal would result in a positive longterm impact in association with other sections of the Pacific Highway being upgraded, providing a safer, more efficient transport route.	Section 9.14	Long term Positive

13 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE (NES)

A search of the EPBC Act Database was conducted on 15 December 2006 for matters of National Environmental Significance and other matters protected by the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) within 5 km of the Proposal site.

The requirement for approval under the EPBC Act is triggered by a proposal which has the potential to have a significant impact on a matter of NES or a proposal which has the potential to have a significant impact on the environment on Commonwealth land. The EPBC Act also requires Commonwealth involvement in actions undertaken by, or on behalf of, a Commonwealth agency. The following sections provide an assessment of whether the Proposal may affect any of these matters. A more in depth assessment is provided in the *Review of Flora and Fauna* (HLA, 2006a) for the Proposal located in **Appendix F**.

13.1 World heritage properties

There are no world heritage properties located within 5 km of the proposed road upgrade, and none will be affected by the Proposal.

13.2 National heritage places

No national heritage places would be impacted by the Proposal.

13.3 Wetlands of international significance (Ramsar sites)

No wetlands of international importance protected under the provisions of the EPBC Act would be impacted by the Proposal.

13.4 Commonwealth listed threatened species and ecological c ommunities

Eleven threatened fauna species and five flora species, protected by the provisions of the EPBC Act, potentially occur within 5 km of the Proposal area. Targeted searches conducted for the Review of Flora and Fauna (refer to **Appendix F**) concluded that no threatened fauna or flora species will be significantly affected by the Proposal and a referral to the Commonwealth Environment Minister is not required.
There are no nationally threatened ecological communities located within 5 km of the proposed road upgrade, and none will be affected by the Proposal.

13.5 Commonwealth listed migratory species

The EPBC Database report listed ten migratory species or species habitat to potentially occur within 5 km of the Proposal area. No migratory species or species habitat protected by the provisions of the EPBC Act will be significantly affected by the proposed highway upgrade.

13.6 Nuclear actions

The Proposal is not a nuclear action.

13.7 Commonwealth marine areas

The Proposal would have no impact upon a Commonwealth Marine Area.

15 REFERENCES

Arup (2005). *Moorland to Herons Creek EIS*.

Australian Bureau of Statistics (2001). *Census of Population and Housing*

Biosis (2004). Working Paper No. 7 Flora and Fauna Assessment. In: Arup (2004). *Moorland to Herons Creek EIS*. Prepared for Ove Arup & Partners by Biosis Research Pty Limited.

Douglas Partners Pty Ltd (2005). *Report on Contamination Assessment Former Burial Area Pacific Highway Between Herons Creek and Stills Road Herons Creek.* Prepared for Roads and Traffic Authority of New South Wales, August 2005.

DPI (2006). Personal Communication from Jeff Brownlow, Geologist NSW Department of Primary Industries Mineral Resources Division, May 2006.

DSRD (2006). http://www.business.nsw.gov.au/regions.asp?cid=228. Department of State and Regional Development

HLA (2006a). *Review of Flora and Fauna, Pacific Highway Upgrade Herons Creek to Stills Road*. HLA Newcastle, NSW.

HLA (2006b). *Aboriginal and Historic Heritage Assessment – Proposed Upgrade of Pacific Highway, Herons Creek to Stills Road NSW*. HLA Sydney, NSW.

Navin Officer (2001). *Moorland to Herons Creek Pacific Highway Upgrade Route Selection Study. Cultural Heritage Assessment.* Report prepared by Navin Officer Heritage Consultants to Ove Arup and Partners.

Roadnet (2006). *Traffic Study Proposed Upgrading of Pacific Highway Herons Creek to Stills Road, Herons Creek.* Prepared for RTA Technology and Technical Services, Business Section, Hunter Region, February 2006.

Roads and Traffic Authority (2004) *Pacific Highway Safety Review*, May 2004.

Roads and Traffic Authority (2005a) *Pacific Highway – Herons Creek to Stills Road Desktop Study Preliminary Feasibility of Route Options.*

Roads and Traffic Authority (2005b) *Pacific Highway Upgrade Herons Creek to Stills Road Concept Design Report,* February 2006.

RTA Bridge Section (2006) *Hydraulic Investigation of Transverse Drainage Structures, Pacific Highway Upgrade from Herons Creek to Stills Road*. July 2006.

RTA Environmental Technology Branch (2005). *Pacific Highway Upgrade Herons Creek to Stills Road Preliminary Environmental Investigation*, April 2005.

RTA Pacific Highway Office (2004). *State Highway No. 10 – Pacific Highway Herons Creek to Stills Road Project Development Proposal*, May 2004.

Spectrum Acoustics (2006). *Noise and Vibration Impact Assessment, Pacific Highway Upgrade, Herons Creek to Stills Road Section*. New Lambton NSW.

Sinclair Night Mertz (2000) *Pacific Highway Upgrading Program – Strategic Assessment* (2000)

CERTIFICATION

This Review of Environmental Factors provides a true and fair review of the proposed activity in relation to its likely effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposed activity.

Name:

Signed:.....

Designation: Environmental Services Workgroup Manager

Date: 27th April 2007

I have examined this Review of Environmental Factors and the certification by Renae Gifford and accept the Review of Environmental Factors on behalf of the RTA.

Name (print): Greg Baird

Signed:.....

Designation: Project Development Manager

Date:. 19 April 2007

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Appendices

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Herons Creek to Stills Road

Review of environmental factors – Appendix A

Preliminary environmental assessment.

January 2007

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Pacific Highway Upgrade

Herons Creek to Stills Road

Preliminary environmental investigation

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1 Introduction and Methodology

1.1 Name of the Proposed Activity

Pacific Highway Upgrade, Herons Creek to Stills Road.

1.2 Local Government Area

Hastings.

1.3 RTA Region

Northern Region.

1.4 Introduction

The NSW Roads and Traffic Authority (RTA) proposes to upgrade the northbound carriageway of the Pacific Highway from Herons Creek to Stills Road, approximately 58km to 61km north of Taree (the Proposal).

This Preliminary Environmental Investigation (PEI) has been prepared by Environmental Technology Branch (RTA Operations Directorate) on behalf of RTA Pacific Highway Services.

The purpose of the PEI is to summarise any likely environmental constraints and / or potential issues that would need to be considered as part of the preliminary investigations for the Proposal.

1.5 Background

The Proposal forms part of the Pacific Highway Upgrading Program. The Proposal's scope was determined to ensure the standard of carriageway would be consistent with the standard of adjoining sections and to take into account the possibility of providing a service road between Herons Creek (and a possible interchange) and the existing northbound carriageway to provide access to Bago Road.

1.6 Methodology

The method in which this document has been prepared is as follows:

1. A discussion was held with the Project Manager to consider the Proposal.

2. An RTA Environmental Technology representative undertook a site visit on 2 and 3 December 2004 to provide an overview of the Proposal and to discuss any issues relevant to the completion of the PEI.

3. The following agencies and RTA personnel were notified and/or consulted:
   - RTA's Regional Environmental Adviser, Pacific Highway Services;
   - RTA's Aboriginal Program Consultant, Hunter Region;
   - Hastings Council;
   - Department of Infrastructure, Planning and Natural Resources (DIPNR);
   - Department of Primary Industries (DPI) – Fisheries;
   - Department of Primary Industries (DPI) – Forests; and
   - Department of Environment and Conservation (DEC) – National Parks and Wildlife Services and Environment Protection Authority.

4. A desktop search was conducted on the following databases to identify any potential issues:
   - Australian Heritage Database;
   - NSW Heritage Office State Heritage Register and State Heritage Inventory;
   - DEC Aboriginal Heritage Information Management System (AHIMS);
   - National Native Title Claims Search;
   - DEC Atlas of NSW Wildlife – Threatened Flora and Fauna Records;
   - DEH Protected Matters (EPBC Act) Database;
   - DEC Contaminated Land Records;
   - DIPNR Acid Sulphate Soils Risk Map;
   - National Pollutant Inventory; and
   - DPI Noxious Weeds List.

5. A literature review and review of documentation was undertaken with regards to the following:
   - Landform, geology and soils;
   - Flora and fauna;
   - Local European and Aboriginal heritage;
   - Local Environment Plans;
   - Regional Environmental Plans; and
   - State Environmental Planning Policies.

2 Proposal Description

2.1 Location

The Proposal extends for approximately 3.3km along the Pacific Highway between Herons Creek and Stills Road. The Proposal is located approximately 58km north of Taree and approximately 19km south of Port Macquarie.

In a regional perspective, the Proposal is located on the Mid North Coast of NSW, which covers an area of 17,218km^2 and includes the catchments of the Nambucca, Macleay, Hastings and Camden Haven Rivers as well as smaller coastal creeks and the section of coastline extending three nautical miles out to sea. This area extends along the coastline from Valla in the north to near Crowdy Head in the south, including major coastal towns of Nambucca Heads, Macksville, South West Rocks, Kempsey, Port Macquarie, Wauchope and Laurieton. The area extends west from the coastline to the Southern New England Tablelands and includes the major centres of Guyra, Armidale and Walcha (DLWC 2003).

For the purpose of this report, the study area is defined as the area of land that extends 100m west and east of the northbound and southbound carriageways of the Pacific Highway respectively and includes the median between the carriageways. The northern boundary of the study area would be defined as the Stills Road intersection with the Pacific Highway whereas the southern boundary would be the immediately north of the Herons Creek crossing. Please refer to Figures 2.1 and 2.2 for the location of the study area.

2.2 Description of the Existing Environment

The study area is predominantly located within the Burrawan State Forest with the main feature being the existing separated northbound and southbound carriageways of the Pacific Highway. There are no residences within the study area and the only premise is the Herons Creek Public School located approximately 200m north of the Herons Creek crossing. The North Coast Railway is located to the west of the Pacific Highway (at a minimum distance of approximately 170m, north of the Herons Creek crossing), however it is located outside of the study area for the purposes of this report. Located approximately 400m south of the Herons Creek crossing is the village of Herons Creek, which consists of the Boral Timber Mill and a number of rural properties to the northwest and east.

The vegetation present within the study area is consistent with a wet sclerophyll forest with large *Eucalyptus spp* over 40m in height and a soft-leaved understorey, consisting of Bracken (*Pteridium esculentum*) and Soft Tree Ferns (*Dicksonia antarctica*). The vegetation has been disturbed to varying extents from road construction and forestry practices, however some areas (for example, in the middle and along western side of the median) remain relatively intact with little evidence of weed encroachment. The disturbed areas are usually characterised by dense vegetation communities of minimal species diversity and introduced species, for example, Small-leaf Privet (*Ligustrum sinense*) and Crofton Weed (*Ageratina adenophora*).

Cutty Creek is the only natural watercourse within the study area, which is crossed by the existing carriageways of the Pacific Highway approximately 710m north of the Bago Road intersection. There are also a number of unnamed natural and artificial drainage lines within the study area. The study area is located within an area of moderate to gentle undulating slopes with a deep depression associated with Cutty Creek.

Appendix A provides photographs of the study area. A further detailed description of the existing environment is provided in Chapter 5 of this report.

2.3 General Features of the Proposal

During the development of concept options for the Proposal and during the selection of the preferred option the following features would be considered:

Provide a road commensurate in standard to the adjoining sections;

Provide a service road utilising as much of the existing northbound carriageway as possible;

Remove cross median access to Bago Road;

Review the access requirements to Boyds Road, Stills Road and Bobs Creek Road;

Minimise environmental impacts taking into account good route options; and

Ensure road traffic noise meets *Environmental criteria for road traffic noise* (ECRTN) guidelines and consider recommendations from the Northern Pacific Highway Noise Taskforce report.

The Proposal would also be undertaken to achieve the objectives of the Pacific Highway Upgrading Program, which are:

Significantly reduced road accidents and injuries;

Reduced travel times;

Reduced freight transport costs;

A community satisfied with physical development of the route;

A route that supports economic development;

Reconstruction of the route managed in accordance with Ecologically Sustainable Development principles; and

Maximise effectiveness of expenditure.

3 Statutory Position

3.1 Local Environmental Plans

3.1.1 Zoning

The study area is within the Hastings Local Government Area (LGA). Hastings Council regulates land use within this LGA through the *Hastings Local Environmental Plan 2001* (LEP). The study area is located entirely within and is bordered by land zoned 1(f) State Forests. Development for the purposes of roads within this zone is allowed without development consent from Hastings Council.

3.1.2 Tree Preservation Order

Clause 20 of the LEP provides for a Tree Preservation Order (TPO), which protects vegetation and provides for the assessment of the impact of clearing for the reasons of preserving amenity and the ecology of the area of Hastings. However, Clause 20(3) states that the TPO does not apply to trees within a State Forest. Therefore, the removal of trees within Burrawan State Forest would not require development consent or the permission of the Hastings Council. Tree removal from areas outside of Burrawan State Forest would also be permissible without development consent or the permission of the Hastings Council through the adoption of Clause 11C of SEPP 4 (refer to Section 3.3.1 for information regarding SEPP 4).

3.2 Regional Environmental Plans

3.2.1 North Coast Regional Environmental Plan

The North Coast Regional Environmental Plan (REP) applies to land within Hastings LGA and provides local government with State and regional policy guidelines for the preparation of local environmental plans and for certain types of development. The REP sets the basis for new urban and rural development. The emphasis is on progress coupled with careful management. The REP also specifies additional matters for consideration in the assessment of development applications and imposes consent and concurrence provisions for listed heritage items.

There are no items of State and regional heritage significance as listed within Schedule 2 and 3 of the REP within the study area. Similarly, the study area is not within a conservation area of State and regional heritage significance as listed within Schedule 1 of the REP. Therefore, as the Proposal is unlikely to require consent from Council (refer to Section 3.1 of this report) and no items or conservation areas of heritage significance as listed under the REP are likely to be impacted on, the REP is not applicable to the Proposal. However, the objectives within the Divisions of the REP would be considered and reviewed during the detailed EIA process.

3.3 State Environmental Planning Policies

State Environmental Planning Policy No 4 – Development Without Consent and Miscellaneous Exempt and Complying Development

State Environmental Planning Policy No 4 (SEPP 4) is designed to permit development for certain purposes by public utility undertakings, to be carried out without the necessity for development consent to be obtained. Clause 11C 'Classified Roads' of SEPP 4 states:

> *(1) If, in the absence of this clause, development for the purposes of a classified road or proposed classified road may be carried out only with development consent, that development may be carried out without that consent.*
> *(2) In this clause, classified road has the same meaning as it has in the Roads Act 1993.*

The Pacific Highway is defined as a classified road under the *Roads Act 1993*. Should works require tree removal from within areas where consent is required (refer to Section 3.1.2 of the Report), and the works to be undertaken fall under the definition of road work as defined by the *Roads Act 1993*, consent from Hastings Council would not be required for the Proposal.

State Environmental Planning Policy No 44 – Koala Habitat Protection

State Environmental Planning Policy No 44 (SEPP 44) encourages the conservation and management of natural vegetation areas that provide habitat for koalas to ensure permanent free-living populations will be maintained over their present range. The policy applies to 107 local government areas. Local Councils cannot approve development in an area affected by the policy without an investigation of core koala habitat. The policy provides a state-wide approach needed to enable appropriate development to continue, while ensuring there is ongoing protection of koalas and their habitat.

Hastings LGA is identified within Schedule 1 of SEPP 44 as an LGA in which Koalas are known to occur. Consideration of the SEPP 44 criteria would therefore be required during the detailed EIA process. These criterions relate to the percentages of feed tree cover, particularly trees listed under Schedule 2 - Known Feed Trees. The assessment criteria consider the percentage cover of known feed trees, and whether these are greater or less than 15% of the total tree canopy.

Known Koala feed trees, such as *Eucalyptus robusta* (Swamp Mahogany) and *Eucalyptus viminalis* (Ribbon Gum) were identified during the site visit, although no Koalas or evidence of Koala presence within the study area was identified. Further consideration and investigation into the relevance of SEPP 44 would be required during the detailed EIA process.

3.4 Licences and Approvals

Water Act 1912

Should water for bridge and road works and associated ancillary works need to be drawn from any waterways and used, a licence under Section 10, or a permit under Section 18F of the *Water Act 1912* may be required from DIPNR. Any diversion of water for the purposes of the Proposal (or any ancillary works) would also be licensed under Part 2 of the *Water Act 1912*. Any works that are not subject to a licence under Part 2 or a permit of the *Water*

Act 1912 that comprise a 'controlled work' under Part 8 of the Act would require an approval under Part 8 of the Act. Should any weirs or dams be required for the Proposal or structural flood mitigation works undertaken, a licence would also be required from the DIPNR under Part 2 of the *Water Act 1912*.

It should however be noted that at any time after the completion of writing this PEI the above sections of the *Water Act 1912* will be superseded by the *Water Management Act 2000* in the event that a water sharing plan applies to the affected water source. In those circumstances, regard would be given to any new or additional requirements resulting from the applicability of the *Water Management Act 2000* (and any other legislation) to any water source that may be affected by the Proposal.

Protection of the Environment Operations Act 1997

An Environment Protection Licence (EPL) would be sought from DEC under the PoEO Act should the Proposal involve a concrete batch plant within the following category of concrete works as outlined in Schedule 1 of the PoEO Act or should the Proposal involve stockpiling activities, quarrying or borrow pits within the following category of extractive industries as outlined in Schedule 1 of the PoEO Act. However, the Proposal would not require an EPL for construction of a freeway as defined within Schedule 1 of the PoEO Act, as the Proposal is less than 5km in length.

Heritage Act, 1977

Should the Proposal involve the disturbance or excavation of land, when there is reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed, a Section 140 Application would be sought from NSW Heritage Office under Section 139 of the Act. However, the need for permits would be determined following a non-indigenous heritage assessment undertaken and during the detailed EIA process.

National Parks and Wildlife Act, 1974

Should the Proposal involve excavating, moving, removing or exhibiting any Aboriginal objects, a Section 87 permit would be required. Should the Proposal involve knowingly destroying, defacing or destroying an object or an Aboriginal place, a Section 90 permit would be required. However, the need for permits to be sought would be determined after an indigenous heritage assessment has been undertaken and during the detailed EIA process.

Fisheries Management Act, 1994

The Minister must be notified of any proposed dredging and reclamation works associated with the Proposal in accordance with Section 199 of the FM Act. Such works in waters may include, but are not limited to, construction of temporary crossings, bridges, culverts, waterway diversions, geotechnical investigations, excavating or reclaiming the bed or banks of any waterways. Consideration should be given to the type and extent of such proposed works within the development with regard to Cutty Creek.

A permit is also required to temporarily or permanently block fish passage under Section 219 of the FM Act. Such works may include the bunding of Cutty Creek during bridge or culvert construction, use of silt fences across waterways and other similar works. The FM Act, through the Fish Habitat Protection Plan No 1, would also require the RTA to notify the Minister of any proposal to remove or relocate snags within Cutty Creek whether they

propose to undertake the work or to authorise it.

Native Vegetation Conservation Act, 1997

Clearing of native vegetation on State Protected Lands (mapped gazetted lands steeper then 18°) or within 20m of a prescribed stream will require a licence from DIPNR under the *Native Vegetation Conservation Act 1997*, when works are carried out outside the boundary of the proclaimed road reserve.

4 Background Investigations and Consultation

4.1 Background Investigations and Database Searches

The following results were obtained from desktop database searches conducted for the study area. The information below provides a summary of the search results. Copies of all the search results are provided in **Appendix B**.

Australian Heritage Database

A search of the Australian Heritage Database was undertaken on 26 November 2004 for sites listed within the Hastings LGA. The search resulted in 58 items being found. No items were found within Herons Creek and it is not anticipated that the Proposal would impact on any item listed on the Australian Heritage Database. Non-indigenous heritage is further discussed in Section 5.6 of the report.

NSW Heritage Office State Heritage Register/Inventory

A search of the State Heritage Register and Inventory was undertaken on 26 November 2004 for sites listed within the Hastings LGA. A total of 10 records listed on the Register were found. However, no items were found within Herons Creek and it is not anticipated that the Proposal would impact on any item listed on the State Heritage Register.

A total of 130 records listed on the Inventory were found within the Hastings LGAs. None of those items are located within the study area. The closest items are the Kew Police Station building and the Royal Hotel (also in Kew), which are located on the Pacific Highway, approximately 5.8km south of the study area. The majority of items are listed within Port Macquarie, Kendall and Wauchope. It is not anticipated that any item listed on the State Heritage Inventory would be impacted as a result of the Proposal, however, non-indigenous heritage is further discussed in Section 5.6 of the report.

NSW DEC Aboriginal Heritage Information Management System (AHIMS)

A search of the AHIMS database was undertaken on 29 November 2004. The search resulted in four known indigenous sites being located within 2.5km of the study area. Two of these sites are located in the southern end of the study area adjacent the Pacific Highway on the eastern side. These sites were identified during the Route Selection Study for the Moorlands to Herons Creek Pacific Highway Upgrade. The two sites, approximately 250m south of the Bobs Creek Road intersection, are possible Aboriginal scarred trees. It is unlikely that these items would be impacted as a result of the Proposal, however indigenous heritage is further discussed in Section 5.5 of the report.

NSW DEC Atlas of NSW Wildlife - Threatened Flora and Fauna Records

A search of the DEC Wildlife Atlas for records of threatened flora and fauna within 5km of the study area was undertaken on 29 November 2004. The search identified one recording of a threatened flora species (*Acacia courtii*) and 50 recordings of threatened fauna species (20 individual species). Although none of the species were identified during the site inspection, further consideration of threatened flora and fauna species is provided in Section 5.4 of this report.

DEH Protected Matters (EPBC Act) Database

A search of the EPBC Act Database was conducted on 26 November 2004 for records of listed matters of National Environmental Significance (NES) known from within 5km of the Proposal site. A summary of the results is included below in Table 4.1.

Table 4.1: A Summary of EPBC Act Protect Matters for the Proposal

EPBC Act Protected Matters	From within 5km of the study area
World Heritage Properties	None present
National Heritage Places	None present
Wetlands of International Significance	None present
Threatened Ecological Communities	None potentially occurring
Threatened Species	16 species potentially occurring
Migratory Species	9 species potentially occurring
Listed Marine Species	13 species potentially occurring
Commonwealth Land	Telstra Corporation Limited
State and Territory Reserves	Queens Lake Nature Reserve
Regional Forest Agreements (RFAs)	Lower North East NSW RFA

Further consideration of listed matters of NES is provided in Section 5.4 of this report.

NSW DPI Noxious Weeds List

A search of the NSW Department of Agriculture Noxious Weeds List (as declared under the *Noxious Weeds Act 1993*) was undertaken on 26 November 2004 for weeds declared noxious in the Hastings control area. A total of 43 species are listed in the Hastings control area. During the site inspection, two noxious weed species were identified, Lantana (*Lantana camara*), a W3 classified weed, and Crofton Weed (*Ageratina adenophora*) also a W3 classified weed. Further consideration of noxious weeds would be required during the detailed EIA process.

NSW DPI FishFiles Database and Threatened Species List

A search of the DPI FishFiles database was undertaken on 14 December 2004 for records of any threatened species (as listed under the FM Act) known from within the Hastings catchment[1]. The search revealed no records of threatened species. The threatened species lists (Schedule 4 and 5 of the FM Act) were also checked to determine if any threatened species are known from the study area or the Queens Lake catchment. The search revealed one threatened species, which has a natural range within the study area. This species is the Oxleyan Pygmy Perch (*Nannoperca oxleyana*), which is listed as an endangered species in NSW.

[1] The study area is located within the Queens Lake catchment and is not located within the Hastings catchment. The Queens Lake catchment was not given as an option on the FishFiles Database and the Hastings catchment was used to provide an indication of the likelihood of threatened species, as it is the closest catchment available on the FishFiles Database. The closest tributary of the Hastings catchment, Kings Creek, is located approximately 6.5km north of the study area.

NSW DEC Contaminated Land Records

The DEC Contaminated Land Register was searched on 26 November 2004 for known records of contaminated land within the Hastings LGA. No records were found within the DEC Contaminated Land register, however contaminated land is further considered in Section 5.1 of this report.

DEH National Pollutant Inventory (NPI)

A search of the NPI was undertaken using an area search (based on Postcode 2439) on 26 November 2004 for substance emissions from all sources within the area. The area bounded by Postcode 2439 basically covers the small towns and villages of Kendall, Kew, Herons Creek, Logans Crossing and Upsalls Creek. The major source of air pollution for the area is log sawmilling and timber dressing.

DIPNR Acid Sulphate Soil Risk Mapping

A search of DIPNR's ASS Risk Maps was undertaken on 29 November 2004 to identify any areas where there is a probability of ASS occurring with regards to the study area. The study area is outside of the potential areas of risk of ASS. Areas of high risk and low risk occurrence are associated with Herons Creek and Bobs Creek southeast of the study area towards Queens Lake.

4.2 Government Consultation

Relevant state government agencies and stakeholders were contacted and provided with the opportunity to provide preliminary comment on the Proposal. Table 4.2 lists the government agencies and stakeholders that were invited to comment on the Proposal for this PEI. Responses received are summarised in column 1, while column 2 identifies the Section in the PEI where they are addressed. Copies of all correspondences are provided in **Appendix C**.

Table 4.2: Summary of Issues raised by Government Agencies and Stakeholders.

Summarised Issues	Section in PEI Where Addressed
Department of Infrastructure, Planning and Natural Resources (DIPNR)	
A representative of DIPNR was contacted by phone on 8 December 2004 to discuss the Proposal. DIPNR provided the following advice in regard to the Proposal on 8 December 2004 by email. Where relevant issues associated to following should also be considered:	
NSW Coastal Policy 1997 – Proposal needs to be consistent with that Policy.	N/A (not within 1km of coastline)
SEPP 14 Wetlands – Potential impacts need to be identified.	5.3
Groundwater – Potential impacts on groundwater bores/wells and creek flows must be assessed.	5.3; 6
Acid Sulphate Soils – Potential impacts need to be identified.	4.1

Summarised Issues	Section in PEI Where Addressed
Erosion and sediment control – DIPNR would seek to review future erosion and sediment control plans. Erosion controls should aim to stabilise or revegetate disturbed areas to prevent ongoing erosion. The controls must aim to minimise any potential impacts on wetlands and riparian zones. Sufficient room should be allowed within the road reserve for any permanent conservation works such as sediment control basins.	6
Vegetation clearing – Clearing of native vegetation on State Protected Lands (mapped gazetted lands steeper then 18°) or within 20m of a prescribed stream will require a licence from DIPNR under the *Native Vegetation Conservation Act 1997*, when works are carried out outside the boundary of the proclaimed road reserve.	3.4
Riparian Zone – Clearing impacts in the riparian zone along all watercourses should be minimised.	6
Flooding – Impacts of flooding on the Proposal as well as impact on adjacent areas should be carefully considered.	5.3; 6
Gravel and Water Sources – In the event that gravel and fill needs to be imported onto the job then the potential sources of supply need to be investigated. Water sources need to be identified as they may require a permit to extract from the Department.	3.4; 6
Water Quality – Potential impacts need to be identified.	6
Social Impacts – Assessment of cross traffic access impacts along existing roads and within properties, agricultural/forestry management impacts resulting from restricted access and social impacts upon property owners directly and indirectly affected by the Proposal.	5.10; 6
Department of Primary Industry (DPI) – Fisheries	
A representative of DPI Fisheries was contacted by phone on 29 November 2004 to discuss the Proposal. DPI Fisheries provided the following advice in regard to the Proposal on 20 December 2004 by email.	
• Preliminary investigation of route options should consider potential impacts on watercourse crossings and existing aquatic habitat within the study area and downstream of the study area.	5.3; 5.4
• Determination of the preferred route option area should give consideration to the number of waterbodies that may be crossed by the different route options, the habitat classifications for those waterbodies and the presence of important or significant aquatic habitat areas such as freshwater and estuarine wetlands especially SEPP 14 wetlands, and mangroves and seagrass beds within any estuarine system.	5.3; 5.4
• The determination of the preferred route option should consider the potential range of a threatened species, population or ecological community that may exist or potentially exist within the route option areas.	4.1; 5.4

Summarised Issues	Section in PEI Where Addressed
• It is important to ensure that roads and crossings are designed to allow fish passage during both high and low flow conditions to maximise movement options. In determining the preferred route option, consideration should be given to any impacts on fish passage from the proposed route options.	6
• A possible constraint in determining a preferred route is the type and location of any aquaculture, commercial and recreational fishing activities within, upstream and downstream of the route options, which may be impacted upon by the proposed development.	5.3; 5.4
• Consideration should be given to the potential impacts and controls on water quality associated when determining the preferred route option.	6
• Review the need for licenses and permits as described under the *Fisheries Management Act 1994*.	3.4
Department of Primary Industry (DPI) – Forests	
A representative of DPI Forests was contacted by phone on 26 November 2004 to discuss the Proposal. DPI Forests requested that they be forwarded a brief description of the Proposal to enable them to provide a detailed response. To date, a response has not been received.	
Department of Environment and Conservation (DEC) – National Parks and Wildlife Services	
A representative of DEC National Parks and Wildlife Services was contacted by phone on 26 November 2004 to discuss the Proposal. DEC National Parks and Wildlife Services provided the following advice in regard to the Proposal on 10 December 2004 by email.	
• With regard to flora and fauna, all available and relevant databases should be checked to provide useful information for consideration during the route options study.	4.1
• The existing wide median should be considered in regards to its current viability and potential continued use for arboreal animal crossing(s).	5.4; 6
• It is suggested that a search be undertaken of the DEC Aboriginal Heritage Information Management System (AHIMS) to identify known sites within the area. Please be aware that this database is not comprehensive and should only be used as a guide. It is recommended that the Moorland to Herons Creek Pacific Highway Upgrade Route Selection Study – Cultural Heritage Assessment be reviewed.	4.1; 5.5
• During the development of route options, it is important that adequate consideration be given to the ability to adequately address and mitigate air quality, water quality, waste management, soils, noise and vibration impacts. Given the recent concerns expressed along the whole highway with noise impacts, correct identification of any potential issues is important in these early stages of the project. It is also important that the RTA ensure that they have sufficient land to install sediment basins with at least 90th percentile (5 day) Rainfall Depth value.	5.3; 5.2; 5.3; 5.7; 5.8; 6

Summarised Issues	Section in PEI Where Addressed
Department of Environment and Conservation (DEC) – Environment Protection Authority	
A representative of DEC Environment Protection Authority was contacted by phone on 26 November 2004 to discuss the Proposal. DEC Environment Protection Authority provided the following advice in regard to the Proposal (G. Budd *pers. comm.* 2004).	
• The preferred option should address potential noise impacts on receivers and should be designed in such a way that cost-effective noise attenuation (should it be required) be possible. Noise impacts should also consider known and future receivers.	5.7; 6
• Water quality and air quality should be considered during the investigation of the preferred option. The preferred option should be the one that results in the most minimal impact on water and air quality and impacts should be able to be appropriately managed.	5.3; 5.8; 6
• The construction of the northbound carriageway would not require a licence from DEC under the PoEO Act.	3.4
Hastings Council	
A representative of Hastings Council was contacted by phone on 26 November 2004 to discuss the Proposal. Hastings Council provided the following advice in regard to the Proposal (S. Nicholson *pers. comm.* 2004).	
Council noted that the median between the northbound and southbound carriageways was State Forest.	2.2
Council recommended that the access and safety at intersections with local roads, for example Bobs Creek Road and Bago Road be upgraded.	2.3

5 Environmental Constraints

5.1 Landform, Geology and Soils

Existing Environment

The study area is located within an area of natural moderate to gentle undulating slopes, the major landform feature being the deep depression associated with Cutty Creek. The landform of the study area tends to be a common feature of the Herons Creek floodplain and surrounding land, which extends from approximately 2km west of the study area and east approximately 4.5km towards Queens Lake. Broken Bago Range is situated approximately 12km west of the study area which separates the catchments of Camden Haven and Hastings and is approximately 400m in height at the top of the range. The range includes several major peaks and features including Bago Bluff, the Rollover, Ducks Nob, Cold Nob and Rock Nob. Another notable topographical feature of the surrounding region is The Three Brothers (North, Middle and South), which are a series of three mountains ranging between 490m to 558m in height, located approximately 9.1km south of the study area. With regard to the study area, the major landform feature is the deep depression associated with Cutty Creek,

There is limited information available on the geology and soil profiles of the study area. For the purpose of this report, information on geology and soils has been adopted from the *Bago Bluff National Park Draft Management Plan* (NPWS 2004) and the NSW Soil and Land Information System (SALIS 2004). Geologically, the study area is within the Lorne Basin, which formed in the Triassic period approximately 200 million years ago and contains a sedimentary sequence of basal conglomerate, course sandstone, siltstones and mudstones. The Lorne Basin is also characterised by quartz conglomerate, which is very resistant to weathering, older sediments dating from the Carboniferous period, underlying high-quartz volcanic rocks, mostly andesites and dacites, which date from the Devonian period and Granite outcrops derived from Triassic igneous rocks (NPWS 2004). It should be noted however, during the site inspection that there were no major rock outcrops identified.

The natural soils of the study area would generally consist of a fine sandy clay loam to approximately 0.24m in depth followed by a layer of medium heavy silty clay to approximately 0.50m in depth. The soil types for the study area are likely to be Yellow Podsolic or similar and be moderately permeable and moderately well drained with no free water. Soils typical of the study area are also likely to be moderately erodible when exposed and to suffer from sheet erosion (SALIS 2004).

The DEC Contaminated Land Register was searched for known records of contaminated land within the study area and no records were found. However, anecdotal evidence has suggested that there are possibly two areas of contaminated land within the study area. These are:

The former site of a service station located at the southern end of the study area, immediately north of the Herons Creek crossing. There is a possibility that the sub-surface petrol tanks are still located on-site; and

A site of a heavy vehicle accident that resulted in hazardous material being spilt. The accident took place in the 1980s approximately 300m south of the Cutty Creek crossing on the northbound carriageway. The hazardous material / contaminated land was buried, under EPA direction, immediately west of the Highway within the road reserve.

There is also anecdotal evidence that the study area contains an area of unsuitable fill

material. During previous RTA works associated with the construction of the southbound carriageway of the Pacific Highway, an area south of the Cutty Creek culvert was used to receive redundant materials.

Potential Constraints

The Proposal has the following potential constraints with regard to landform, geology and soils:

Limited information is available on the geology and soil profiles of the study area;

The soils of the study area are susceptible to a moderate level of erosion when exposed;

As a result of the topography within the study area, it is likely that earthworks would be moderate, especially in regards to the deep depression associated with Cutty Creek;

The study area could contain two areas of contaminated land that has not been previously recorded. The locations of the land is at the southern end of the study area, immediately north of the Herons Creek crossing, and approximately 300m south of the Cutty Creek crossing on the northbound carriageway; and

The study area could contain an area of unsuitable fill material south of the Cutty Creek culvert, which was used to receive redundant materials during previous RTA works within the study area.

5.2 Climate

Existing Environment

The study area has a warm temperate climate with a strong sub-tropical marine influence generated by the southward flowing East Australian Current. This results in high humidity and rainfall without large daily or seasonal contrasts in temperature. The closest Bureau of Meteorology (BOM) Climatic Station to the Proposal site is at Laurieton (approximately 9.5km southeast of the study area) and climatic conditions experienced here would be indicative of the study area. Summer experiences cool to warm days with average minimum and maximum temperatures for January being 16.2°C and 25.8°C respectively, whereas winters are cold to cool with average minimum and maximum temperatures for July being 5.3°C and 16.6°C respectively. Annual rainfall for Laurieton is approximately 1,549mm. Rainfall is generally higher in late summer and autumn with March receiving the highest monthly average of 186mm. Rainfall is lowest during late winter and early spring with September receiving the lowest monthly average of 77mm (BOM 2004a).

Data on wind speeds and direction is not available for Laurieton and the closest BOM Climatic Station with data available is at Port Macquarie (approximately 18.4km northeast of the study area). During summer, wind patterns for Port Macquarie show a dominance of southwesterly winds in the morning and northeasterly in the afternoon, while winter winds are dominated by winds mainly from the west and southwest. High winds speeds occur more frequently during the afternoon hours (BOM 2004b).

The BOM (2004c) has documented significant weather events resulting in heavy rain, hail and strong winds for the Mid North Coast region. The significant weather events for this region have resulted in wind gusts of 93km/h (January 2000), heavy rain and 2-3cm hail (December 2001 and August 2003) and power blackouts and winds greater than 91km/h (January 2004).

Potential Constraints

The Proposal has the following potential constraints with regard to climate:

During construction, there would be a higher risk of erosion during late summer and autumn as a result of seasonal rainfall;

High wind speeds during the afternoon hours may result in wind erosion during construction; and

The significant weather events have the potential to impact on worker safety and equipment and environmental integrity during construction. Construction issues such as sediment-laden water draining from the site or the formation of dust could be amplified during these adverse weather conditions.

5.3 Water Quality and Hydrology

Existing Environment

Cutty Creek is the only natural watercourse within the study area, which is crossed by the existing carriageways of the Pacific Highway approximately 710m north of the Bago Road intersection. There are also a number of unnamed natural and artificial drainage lines within the study area. The quality of the water within Cutty Creek appeared to be influenced by the vegetation surrounding it and from runoff from the adjacent Highway. The water was a black / brown colour resulting from decomposed organic material and a fine oil film and general rubbish was present on the surface. The catchment of Cutty Creek would be considered moderate in size and consists of number of smaller tributaries such as Ferny Creek to the northwest. The catchment upstream of the study area drains an area of Burrawan State Forest east of Bago Road and south of Internal Break Road (approximately 1.6km northwest of the study area), whereas downstream the catchment consists of a number of rural properties before Cutty Creek drains into Herons Creek (approximately 3.3km southeast of the study area).

Within a broader scale, the study area is located within the Herons Creek catchment, which is a sub-catchment of Queens Lake. Queens Lake is one of the two lakes that form part of the larger Camden Haven Estuary, which has a catchment of approximately 720km^2. Queens Lake is a saline lake and has one of the largest areas of seagrass in NSW and supports a number of oyster leases (DIPNR 2005). There is no SEPP 14 Coastal Wetlands located from within 5km of the study area.

The potential for flooding within the study area would be considered low to moderate. Herons Creek floodplain is predominantly located south and west of the study area and flooding of the southern end of the study area is only expected during major high flow conditions within Herons Creek. Localised flooding associated with high flow conditions of Cutty Creek could also potential occur.

Potential Constraints

The Proposal has the following potential constraints with regard to water quality and hydrology:

During construction there would be potential for sediment-laden water and pollutants such as fuel, hydraulic fluid and pavement materials to be released into Cutty Creek; and

The southern part of the study area in the vicinity of Herons Creek and the area immediately surrounding Cutty Creek could be susceptible to flooding when the creeks experience high flow conditions.

5.4 Biodiversity

Existing Environment

Flora

The study area is located within Burrawan State Forest and the vegetation present is consistent with a wet sclerophyll forest with large *Eucalyptus spp* over 40m in height and a soft-leaved understorey, consisting of ferns. The vegetation has been disturbed to varying extents from road construction and forestry practices, however some areas (for example, in the middle and along western side of the vegetated median and along the outside edge of the carriageways) remain relatively intact with little evidence of weed encroachment. The disturbed areas are usually characterised by dense vegetation communities of minimal species diversity and introduced species and have a lesser defined understorey / top-storey. These areas are located along the eastern side of the median as well as at the northern end (in the vicinity of Stills Road) and southern end (in the vicinity of Bobs Creek Road) of the median. Refer to Table 5.1 for a list of typical flora species present within the study area.

Table 5.1: Flora Species identified within the Study Area

Native Species		Introduced / Weed Species	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**
Eucalyptus saligna	Blue Gum	*Pittosporum revolutum*	Rough-fruit Pittosporum*
Eucalyptus robusta	Swamp Mahogany	*Pittosporum undulatum*	Sweet Pittosporum*
Eucalyptus crebra	Narrow Leaf Ironbark	*Lantana camara*	Lantana
Eucalyptus viminalis	Ribbon Gum	*Bidens pilosa*	Cobblers Peg / Farmers Friend
Eucalyptus pillularis	Blackbutt	*Cinnamomum camphora*	Camphor laurel
Syncarpia glomuliifera	Turpentine	*Verbena bonariensis*	Purple Top
Melaleuca thymifolia	Thyme Honey Myrtle	*Ageratina adenophora*	Croften Weed
Syzygium australe	Brush Cherry	*Zantedeschia aethiopica*	Arum Lilly
Acemena smithii	Lillypilly	*Ligustrum sinense*	Small-leaf Privet
Backhousia myrtifolia	Grey Mrytle	*Andropogon virginicus*	Whiskey Grass
Callicoma serratifolia	Black Wattle	*Onopordum acanthium*	Scotch Thistle
Ceratopetalum apetalum	Coachwood	*Pinus radiata*	Radiata Pine
Elaeocarpus reticulatus	Blueberry Ash		
Callistemon salignus	Willow Bottlebrush		
Tristaniopsis laurina	Water Gum		
Lomandra longifolia	Mat Rush		
Acacia irrorata	Wattle		
Gahnia clarkei	Gahnia		
Themeda australis	Kangaroo Grass		

Native Species		Introduced / Weed Species	
Casuarina cunninhammiana	River Oak		
Allocasuarina torulosa	Forest Oak		
Pteridium esculentum	Bracken		
Blechnum nudum	Strap Water Fern		
Dicksonia antarctica	Soft Tree Fern		
Typha orientalis	Cumbungi		

* Although a native species, *Pittosporum spp.* are considered to be an invasive weed.

Searches of the DEH Protected Matters (EPBC Act) Database and the NSW DEC Atlas of NSW Wildlife Threatened Flora and Fauna Records revealed one threatened flora species that is known to occur from within 5km of the study area and four threatened flora species that may or are likely to occur within 5km of the study area (refer to Table 5.2). During the site inspection none of the species listed within Table 5.2 were observed. However, within the study area, habitat for species listed in Table 5.2 is present, for example, Austral Toadflax is associated with Eucalypt woodlands where Kangaroo Grass occurs.

Table 5.2: Threatened Flora Species Known or Likely to occur from within 5km of the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Presence
Acacia courtii	–	Vulnerable	Vulnerable	Known
Hakea archaeoides	–	Vulnerable	Vulnerable	Likely to occur
Thesium australe	Austral Toadflax	Vulnerable	Vulnerable	Likely to occur
Cryptostylis hunteriana	Leafless Tongue-orchid	Vulnerable	Vulnerable	May occur
Cynanchum elegans	White-flowered Wax Plant	Endangered	Endangered	Likely to occur

Fauna

There is a number of fauna habitat features represented within the study area. The habitat features are mainly associated with the relatively undisturbed areas of the study area and consist of tree hollows, dead standing timber and fallen trees. Other important fauna habitat features of the study area are the diversity of tree species and the area of relatively undisturbed vegetation within and surrounding the study area. The composition and type of habitat features present would provide for foraging, sheltering / roosting and possibly nesting. Despite this, very few fauna species or evidence of fauna species was identified during the site inspection. The few fauna species identified / heard were mainly common native avifauna, for example, *Gymnorhina tibicen* (Australian Magpie). In addition, there was a number of suspected feral *Apis mellifera* (Honeybee) colonies located in the larger Eucalypts within the study area.

Although there were very few fauna species or evidence of fauna species identified during the site inspection, the study area would form part of a large wildlife corridor that links Queens Lake Nature Reserve, approximately 4.1km to the east, Burrawan State Forest, Broken Bago State Forest and Bago Bluff National Park, approximately 8.7km to the west. It

is anticipated that the wildlife corridor would provide for the east-west movement of native avifauna and native cursorial and arboreal mammals and, such as *Petaurus breviceps* (Sugar Glider). In addition, the study area forms the northern end of the Burrawan – Kew Subregional Corridor, which links Herons Creek / Burrawan State Forest to Smiths Creek (approximately 3.2km southwest of the study area) (NPWS 2005).

Searches of the DEH Protected Matters (EPBC Act) Database and the NSW DEC Atlas of NSW Wildlife Threatened Flora and Fauna Records revealed 20 threatened fauna species that are known to occur from within 5km of the study area and 19 threatened fauna species that may or are likely to occur within 5km of the study area (refer to **Appendix B**). During the site inspection none of the threatened species known or likely to occur were observed. However, it should be noted that the study area supports habitat features that are associated with some of these threatened species, for example:

Eucalyptus robusta and *E. viminalis* are known feed trees of *Phascolarctos cinereus* (Koala) and as such are listed under Schedule 2 of SEPP 44 (refer to Section 3.3.2 of this report);

Allocasuarina torulosa is a known feed tree of *Calyptorhynchus lathami* (Glossy Black-cockatoo); and

Large Eucalypts with suitable hollows are present which could be potentially utilised by *Petaurus norfolcensis* (Squirrel Glider) and *P. australis* (Yellow-bellied Glider) for roosting and movement.

Aquatic Ecology

Cutty Creek is the only natural watercourse within the study area, which is crossed by the existing carriageways of the Pacific Highway approximately 710m north of the Bago Road intersection. There are also a number of unnamed natural and artificial drainage lines within the study area. The quality of the water within Cutty Creek appeared to be influenced by the vegetation surrounding it and from runoff from the adjacent Highway. Snags were present within Cutty Creek, however no other habitat features are represented, such as in-stream vegetation. It should also be noted that during the site inspection, the level of the existing culverts of the Pacific Highway is above the existing creek bed. It is anticipated that during low flow conditions, fish passage could potentially be restricted.

No fish species were observed or frogs heard calling from within or surrounding Cutty Creek or other drainage lines. However, Cutty Creek would be classified as a 'Class 2 Moderate fish habitat' under the *Why do fish need to cross the road?: Fish Passage Requirements for Waterway Crossings* (NSW Fisheries 2003). As described above, snags are present within the watercourse as well as other areas of potential refuge value, for example, overhanging banks and deep pools (located adjacent the eastern side of the southbound carriageway). Fish and amphibian species likely to be present would be most likely common and widespread species, such as *Anguilla australis* (Short-finned Eel) and *Retropinna semoni* (Australian Smelt).

Additionally, the study area is within the natural range of the endangered *Nannoperca oxleyana* (Oxleyan Pygmy Perch), as listed under the schedules of the FM Act. However, the Oxleyan Pygmy Perch has specific habitat requirements and is patchily distributed within its range, preferring swamps, creeks and lakes of coastal 'wallum' (NSW Fisheries 2002). As a result of the lack of coastal wallum (Banksia-dominated heath), it is therefore considered unlikely that Cutty Creek or the unnamed natural and artificial drainage lines within the study area would provide suitable habitat for the endangered Oxleyan Pygmy Perch.

Potential Constraints

The Proposal has the following potential constraints with regard to biodiversity:

The vegetation present is consistent with a wet sclerophyll forest with large *Eucalyptus spp* over 40m in height and a soft-leaved understorey and some areas, for example, in the middle and along western side of the vegetated median and along the outside edge of the carriageways, remain relatively intact with little evidence of weed encroachment;

The study area could provide habitats suitable for threatened flora species listed under the TSC Act and EPBC Act;

The study area provides a number of fauna habitat features which are mainly associated with the relatively undisturbed areas of the study area and consist of tree hollows, dead standing timber and fallen trees. Other important fauna habitat features of the study area are the diversity of tree species and the area of relatively undisturbed vegetation within and surrounding the study area. The composition and type of habitat features present would provide for foraging, sheltering / roosting and possibly nesting;

The study area would form part of a large wildlife corridor that links Queens Lake Nature Reserve, approximately 4.1km to the east, Burrawan State Forest, Broken Bago State Forest and Bago Bluff National Park, approximately 8.7km to the west. In addition, the study area forms the northern end of the Burrawan – Kew Subregional Corridor, which links Herons Creek / Burrawan State Forest to Smiths Creek (approximately 3.2km southwest of the study area).

The study area supports habitat features that are associated with threatened species listed under the TSC Act and EPBC Act that are known or likely to exist within and surrounding the study area, for example:

- *Eucalyptus robusta* and *E. viminalis* are known feed trees of the Koala;
- *Allocasuarina torulosa* is a known feed tree species of the Glossy Black-cockatoo; and
- Large Eucalypts with suitable hollows are present which could be potentially utilised by Squirrel Gliders and Yellow-bellied Gliders for roosting.

Cutty Creek would be classified as a 'Class 2 Moderate fish habitat' under the *Why do fish need to cross the road?: Fish Passage Requirements for Waterway Crossings* (NSW Fisheries 2003). Snags are present within the watercourse as well as other areas of potential refuge value, for example, overhanging banks and deep pools (located adjacent the eastern side of the southbound carriageway); and

The study area is within the natural range of the endangered Oxleyan Pygmy Perch as listed under the schedules of the FM Act.

5.5 Indigenous Heritage

Existing Environment

The study area is within the tribal territory of the Ngamba people. The exact boundaries of this tribal territory are unclear, however it is assumed that the northern boundary is Telegraph Point (approximately 27.1km north of the study area), stretching approximately 43.1km south to Taree, east approximately 10.3km to the Pacific Ocean and as far west as Comboyne (approximately 24.7km from the study area). Information about the lifestyle of the indigenous people in the local area is usually found within the writings and observations of explorers, adventurers and settlers. However, previous literature notes that little information is available for the area and as a result, the traditional ways of life of its indigenous people remains poorly understood (Navin Officer 2001).

A search of the NSW DEC Aboriginal Heritage Information Management System (AHIMS)

database was undertaken for the study area. The search resulted in four known indigenous sites being located within 2.5km of the study area. Two of these sites are located in the southern end of the study area adjacent the Pacific Highway on the eastern side. These sites were identified during the Route Selection Study for the Moorlands to Herons Creek Pacific Highway Upgrade. The two sites, approximately 250m south of the Bobs Creek Road intersection, are possible[2] Aboriginal scarred trees. However, during the site inspection, no sites / items of potential indigenous heritage significance were observed.

Based on the previously uncovered indigenous heritage sites and the existing landform and vegetation within the study area the potential for sites / items of indigenous heritage significance to be found within the study area is considered to be moderate. The areas that could potentially contain sites / items of indigenous heritage significance within the study area include Cutty Creek and in the middle and along western side of the vegetated median and along the outside edge of the carriageways (that is, consistent with the relatively intact sections of wet sclerophyll forest).

Potential Constraints

The Proposal has the following potential constraints with regard to indigenous heritage:

The two possible Aboriginal scarred trees located in the southern end of the study area approximately 250m south of the Bobs Creek Road intersection; and

Based on the landform characteristics within the study area and the presence of previously uncovered indigenous heritage sites, the potential for sites / items of indigenous heritage significance to be found is considered to be moderate. The areas of particular interest include Cutty Creek and the relatively intact sections of wet sclerophyll forest.

5.6 Non-indigenous Heritage

Existing Environment

The first European references to the Camden Haven region were made in 1770, when Captain James Cook sailed along the Mid North Coast of NSW in the Endeavour. The ship's logbook makes reference to 'three remarkable large hills lying continuance to each other… As these hills bore some resemblance to each other we called them The Three Brothers' (Navin Officer 2001). A brief summary of the non-indigenous history of the study area and the region surrounding it (which includes the Hastings and Camden Haven region) is provided below:

John Oxley led the first overland expedition to the Hastings and Camden Haven in 1818, noting the richness and diversity of the countryside. Following the success of the expedition, Port Macquarie was recommended as a penal settlement to the Earl of Bathurst and was established in 1821;

The early European occupation of the region's hinterland (which includes the study area) up to the 1860s is not well documented and it is likely that the area remained a southern outpost of Port Macquarie, with industries such as lime-burning, cedar cutting and brush grazing requiring only low level occupation;

By the 1870s logging and saw-milling started to emerge as the most important economic activity for the region's hinterland and by 1900 the Camden Haven area was one of the busiest producers of hardwood timbers in NSW;

[2] A 'possible' classification denotes a scar that conforms to all or most of the scarred tree criteria and where an Aboriginal origin cannot be reliably considered as more likely than alternative natural causes. The characteristics of a possible scar will also be consistent with a natural cause (Navin Officer 2001).

Most early mills followed a boom and bust cycle according to the exploitation of the local resource. However, early in the 19th century some long-term enterprises became established, such as the Herons Creek Timber Mills in 1915, an enterprise which was to evolve into the present Boral Timber Mill at Herons Creek; and

Herons Creek was a settlement established by timber workers around 1890 and consisted mainly of small selections with cleared grasslands suitable for supporting bullock teams. Prior to the establishment of the Herons Creek Timber Mills, logs were transported to Laurieton by flat-bottomed punts (via Herons Creek and Queens Lake) and later to Kendall via a tramline of wooden rails.

A search of non-indigenous heritage registers, inventories and the Hastings LEP was undertaken to determine if any items or places of non-indigenous heritage significance were located within or in the vicinity of the study area. No recorded items or places were located within or in the vicinity of the study area. The closest item is the Saint Mary The Virgin Church located on Blackbutt Forest Road, Herons Creek, which is over 850m south of the study area. Other items include the Kew Police Station building and the Royal Hotel (also in Kew), which are located on the Pacific Highway, approximately 5.8km south of the study area. The majority of listed items are within Port Macquarie, Kendall and Wauchope.

One place that could potentially have non-indigenous heritage significance within the study area is Herons Creek Public School. The School, located on the western side in the southern end of the study area, was first opened in 1893 and was originally only used as a half time school. This meant that the School had to share a teacher with another School near at Kendall (previously known as Camden Haven Public School). The School maintained it's original one classroom until 1940 and since then it has grown to include three main buildings and many smaller buildings (Herons Creek Public School Online 2005).

In addition to Herons Creek Public School, another item of potential non-indigenous heritage significance with the study area is an existing / former monument located within the cleared median approximately 380m south of the Stills Road intersection. The monument consists of a sandstone, or similar boulder approximately 1.5m in height and 1.5m in width mounted on a concrete base. There is also evidence that a plaque was once fixed to the face of the boulder, however it has since been removed. The exact function of the monument is unknown or whether that the monument has been previously transported from an original location to the site within the median. Refer to **Appendix A** to a photograph of the existing / former monument.

Potential Constraints

The Proposal has the following potential constraints with regard to indigenous heritage:

Based on the past history of the study area and region surrounding it, isolated 'relics' associated with the local logging and saw-milling industry could potential exist within the study area;

Herons Creek Public School is likely to have non-indigenous heritage significance and the presence of 'relics' within and surrounding its property boundaries; and

The existing / former monument located within the cleared median approximately 380m south of the Stills Road intersection could potentially have non-indigenous heritage significance.

5.7 Noise and Vibration

Existing Environment

The existing ambient noise levels for the study area and surrounds would be considered low to moderate. Sources of noise within and surrounding the study area would be mainly associated with road traffic using the Pacific Highway and to a lesser extent, forestry practices within Burrawan State Forest and rail traffic using North Coast Railway to the west. Based on a low density transportation level for the Pacific Highway within the study area, a conservative estimate following the *Australian Standard AS 1055.3 (1997) Acoustics - Description and measurement of environmental noise, Part 3: Acquisition of data pertinent to land use* can be undertaken. The background noise level is therefore estimated to be 45dBA for L_{A90}, 0700 – 1800 Monday to Saturday.

The existing vibration levels within the study area and surrounds would be considered negligible and there are no existing sources of vibration within and surrounding the study area.

There is only one noise and vibration receiver within the study area, which is the Herons Creek Public School. The School is located on the western side in the southern end of the study area and the classrooms / buildings are located between 25m and 80m from the existing pavement edge of the northbound carriageway. The School is also considered as a sensitive land use, as described within the Table 2 of *Environmental criteria for road traffic noise* (EPA 1999).

Noise and Vibration Criteria

The Proposal to upgrade the northbound carriageway of the Pacific Highway from Herons Creek to Stills Road would be considered a 'Redevelopment of existing freeway / arterial road' under the *Environmental criteria for road traffic noise* (EPA 1999). As such, the guidelines applicable to the Proposal would be as follows:

Day (0700 – 2200) – $L_{Aeq(15hr)}$ 60dBA; and

Night (2200 – 0700) – $L_{Aeq(9hr)}$ 55dBA.

Where these levels are already exceeded the guidelines state that 'in all cases the redevelopment should be designed so as not to increase noise levels by more than 2dBA'. In addition, Herons Creek Public School would be subject to specific 'existing school' operational noise criteria. The daytime criterion is $L_{Aeq(1hr)}$ 45dBA (Internal).

The DEC's *Environmental Noise Control Manual* (EPA 1993), Chapter 171, sets out noise criteria applicable to construction site noise for the purpose of defining intrusive noise impacts. The guidelines for construction noise are based on a construction period and provide the acceptable noise level as follows:

4 weeks and under – background L_{90} plus 20 dBA;

4 weeks to 26 weeks – background L_{90} plus 10 dBA; and

Greater than 26 weeks – background L_{90} plus 5 dBA.

These guidelines however are only applicable to normal working hours between the hours of 0700 and 1800 Monday to Friday, and 0700 to 1300 Saturdays. For all other times construction noise must be inaudible at the receiver and no construction work is to take place on Sundays or Public Holidays.

German Standard DIN4150 (1999), which sets conservative vibration levels for structural damage at 5mm/second, is generally recognised as setting the most appropriate criteria for architectural assessment. A lower level of 2mm/second is often adopted for heritage structures. These levels would rarely be exceeded by roadworks, however human perception and comfort levels are usually reached at a much lower level. In this regard the

British Standard BS6472 provides the most authoritative criteria for assessment of the impacts of construction vibration on the community. This criteria is measured at the construction boundary in proximity to residential areas during the day and is as follows:

Continuous vibration – 2mm/second; and

Intermittent vibration – 6mm/second.

Potential Constraints

The Proposal has the following potential constraints with regard to noise and vibration:

Herons Creek Public School is located on the western side in the southern end of the study area and the classrooms / buildings are located between 25m and 80m from the existing pavement edge of the northbound carriageway. The School is also considered as a sensitive land use, as described within the Table 2 of *Environmental criteria for road traffic noise* (EPA 1999); and

The existing ambient noise levels for the study area and surrounds would be considered low to moderate, which may result in a larger perceived increase in noise levels during construction.

5.8 Air Quality

Existing Environment

The study area is located approximately 58km north of Taree and approximately 19km south of Port Macquarie. The study area is within Burrawan State Forest and the vegetation present is consistent with a wet sclerophyll forest with large *Eucalyptus spp* over 40m in height. Herons Creek Public School is the only premise within the study area and it located on the western side in the southern end of the study area and the village of Herons Creek is located approximately 950m south of study area. The local air quality within the study area is considered good, with the following sources contributing to atmospheric pollution:

Motor vehicles travelling along the Pacific Highway and local road network; and

Forestry management practices, such as burning of cleared vegetation.

In a regional perspective, the NPI describes the major source of air pollution as being log sawmilling and timber dressing.

The dispersion effects of surface winds would influence the air quality of the study area. As described in Section 5.2 of this report, summer wind patterns show a dominance of southwesterly winds in the morning and northeasterly in the afternoon, while winter winds are dominated by winds mainly from the west and southwest. High winds speeds occur more frequently during the afternoon hours.

Potential Constraints

The Proposal has the following potential constraints with regard to air quality:

Local air quality within the study area is considered good which may result in a larger perceived increase in particulate matter during construction.

5.9 Visual Amenity / Landscape

Existing Environment

The study area is predominantly located within the Burrawan State Forest with the main feature being the existing separated northbound and southbound carriageways of the Pacific Highway. The landform is characterised by natural moderate to gentle undulating slopes with the major landform feature being the deep depression associated with Cutty Creek. The landform of the study area tends to be a common feature of the Herons Creek floodplain and surrounding land, which extends from approximately 2km west of the study area and east approximately 4.5km towards Queens Lake. There are no residences within the study area and the only premise is the Herons Creek Public School located approximately 200m north of the Herons Creek crossing. The visual features described above are not considered to be outstanding and tend to be common to other areas further north and south along the Pacific Highway and throughout the local district and region. The study area is therefore considered to have a moderate level of scenic quality and value.

The existing views of the study area are limited to road users and some of these views are also considered to be localised as a result of the topography and vegetation within the study area.

Potential Constraints

The Proposal has the following potential constraints with regard to visual amenity / landscape:

Remnant *Eucalyptus spp* over 40m in height within the median and along the road edge are visually prominent within the study area.

5.10 Socio-economic Considerations and Land Use

Existing Environment

The study area is located within the Burrawan State Forest with the dominant land use being forestry. There are no residences within the study area and the only premise is the Herons Creek Public School, which is located on the western side in the southern end of the study area. The main property owners within the study area are the Department of Education, State Forests of NSW, the Department of Lands and the RTA. However, there is a strip of property located on the western side of northbound carriageway between Bago Road and Herons Creek Public School, which belongs to the Bunyah Local Aboriginal Land Council.

The closest population centre to the study area is the village of Herons Creek, approximately 950m south of the study area. Demographically speaking, Herons Creek is regularly grouped with other surrounding population centres such as Kew and Kendall to the south and Laurieton and North Haven towards the coast (approximately 9.2km southeast of the study area). This area, referred to as the Camden Haven, is a rapidly growing area with Laurieton as the main service centre. It is also known for being mainly a retirement area and tourist destination. The population of the Camden Haven is 7,355 (ABS population figures for 2001) and with a median age of 56 years it has the oldest population in Australia (Hastings Council 2003). It is anticipated that the population of Herons Creek would be less than 500.

The Pacific Highway is the principal transport corridor connecting Sydney to Brisbane along the NSW coastline. The section of Pacific Highway within the study area not only provides for this interstate traffic, it also provides for a mix of local and regional traffic as well. A number of unclassified local roads form intersections with the Pacific Highway within the study area, these include Bago Road, Stills Road, Boyds Road and Bobs Creek Road. Both Stills Road and Boyds Road are predominantly used as access roads to the surrounding

Burrawan State Forest, whereas Bobs Creek Road and Bago Road provide for local and regional traffic. Bobs Creek Road provides an important access to rural properties located west of the Pacific Highway and north of Herons Creek as well as providing a western access to Queens Lake Nature Reserve. The intersection of Bobs Creek Road and the Pacific Highway also provides for vehicle movements into and out of an access to Herons Creek Public School. Bago Road uses a similar alignment as the North Coast Railway and provides an alternative / southerly route to Wauchope (located approximately 10.2km north of the study area) and services State Forests and a number of rural properties north of the study area. It is anticipated that Bago Road would be used heavily by local and regional traffic as well providing for a certain amount of tourist traffic accessing Wauchope from the Pacific Highway.

Over the three year period from 1 October 2000 to 30 September 2003, 15 accidents were reported within the study area. Of these accidents there were two fatal accidents with two fatalities and five injury accidents with 10 casualties. All 15 accidents occurred during daytime.

Potential Constraints

The Proposal has the following potential constraints with regard to socio-economic and land use:

The study area is located within the Burrawan State Forest

A strip of property located on the western side of northbound carriageway between Bago Road and Herons Creek Public School belongs to the Bunyah Local Aboriginal Land Council; and

The section of the Pacific Highway within the study area provides for this interstate traffic, as well as a mix of local and regional traffic. The roads that form intersections with the Pacific Highway in the study area provide for local and regional traffic accessing State Forests, rural properties, the Pacific Highway and Wauchope as well as supporting a certain amount of tourist traffic accessing Wauchope from the Pacific Highway.

6 Summary and Recommendations

The major environmental constraints identified for the construction and operation of the upgrade of the Pacific Highway between Herons Creek and Stills Road are summarised in Table 6.1.

Table 6.1: Summary of environmental constraints

Factor	Constraint
Landform, Geology and Soils	Limited information is available on the geology and soil profiles of the study area; The soils of the study area are susceptible to a moderate level of erosion when exposed; As a result of the topography within the study area, it is likely that earthworks would be moderate, especially in regards to the deep depression associated with Cutty Creek; The study area could contain two areas of contaminated land that has not been previously recorded. The locations of the land is at the southern end of the study area, immediately north of the Herons Creek crossing, and approximately 300m south of the Cutty Creek crossing on the northbound carriageway; and The study area could contain an area of unsuitable fill material south of the Cutty Creek culvert, which was used to receive redundant materials during previous RTA works within the study area.
Climate	During construction, there would be a higher risk of erosion during late summer and autumn as a result of seasonal rainfall; High wind speeds during the afternoon hours may result in wind erosion during construction; and The significant weather events have the potential to impact on worker safety and equipment and environmental integrity during construction. Construction issues such as sediment-laden water draining from the site or the formation of dust could be amplified during these adverse weather conditions.
Water Quality and Hydrology	During construction there would be potential for sediment-laden water and pollutants such as fuel, hydraulic fluid and pavement materials to be released into Cutty Creek; and The southern part of the study area in the vicinity of Herons Creek and the area immediately surrounding Cutty Creek could be susceptible to flooding when the creeks experience high flow conditions.
Biodiversity	The vegetation present is consistent with a wet sclerophyll forest with large *Eucalyptus spp* over 40m in height and a soft-leaved understorey and some areas, for example, in the middle and along western side of the vegetated median and along the outside edge of the carriageways, remain relatively intact with little evidence of weed encroachment;

Factor	Constraint
	The study area could provide habitats suitable for threatened flora species listed under the TSC Act and EPBC Act; The study area provides a number of fauna habitat features which are mainly associated with the relatively undisturbed areas of the study area and consist of tree hollows, dead standing timber and fallen trees. Other important fauna habitat features of the study area are the diversity of tree species and the area of relatively undisturbed vegetation within and surrounding the study area. The composition and type of habitat features present would provide for foraging, sheltering / roosting and possibly nesting; The study area would form part of a large wildlife corridor that links Queens Lake Nature Reserve, approximately 4.1km to the east, Burrawan State Forest, Broken Bago State Forest and Bago Bluff National Park, approximately 8.7km to the west. In addition, the study area forms the northern end of the Burrawan – Kew Subregional Corridor, which links Herons Creek / Burrawan State Forest to Smiths Creek (approximately 3.2km southwest of the study area). The study area supports habitat features that are associated with threatened species listed under the TSC Act and EPBC Act that are known or likely to exist within and surrounding the study area, for example: - *Eucalyptus robusta* and *E. viminalis* are known feed trees of the Koala; - *Allocasuarina torulosa* is a known feed tree species of the Glossy Black-cockatoo; and - Large Eucalypts with suitable hollows are present which could be potentially utilised by Squirrel Gliders and Yellow-bellied Gliders for roosting. Cutty Creek would be classified as a 'Class 2 Moderate fish habitat' under the *Why do fish need to cross the road?: Fish Passage Requirements for Waterway Crossings* (NSW Fisheries 2003). Snags are present within the watercourse as well as other areas of potential refuge value, for example, overhanging banks and deep pools (located adjacent the eastern side of the southbound carriageway); and The study area is within the natural range of the endangered Oxleyan Pygmy Perch as listed under the schedules of the FM Act.
Indigenous Heritage	The two possible Aboriginal scarred trees located in the southern end of the study area approximately 250m south of the Bobs Creek Road intersection; and Based on the landform characteristics within the study area and the presence of previously uncovered indigenous heritage sites, the potential for sites / items of indigenous heritage significance to be found is considered to be moderate. The areas of particular interest include Cutty Creek and the relatively intact sections of wet sclerophyll forest.
Non-	Based on the past history of the study area and region surrounding it,

Factor	Constraint
indigenous Heritage	isolated 'relics' associated with the local logging and saw-milling industry could potential exist within the study area; Herons Creek Public School is likely to have non-indigenous heritage significance and the presence of 'relics' within and surrounding its property boundaries; and The existing / former monument located within the cleared median approximately 380m south of the Stills Road intersection could potentially have non-indigenous heritage significance.
Noise and Vibration	Herons Creek Public School is located on the western side in the southern end of the study area and the classrooms / buildings are located between 25m and 80m from the existing pavement edge of the northbound carriageway. The School is also considered as a sensitive land use, as described within the Table 2 of *Environmental criteria for road traffic noise* (EPA 1999); and The existing ambient noise levels for the study area and surrounds would be considered low to moderate, which may result in a larger perceived increase in noise levels during construction.
Air Quality	Local air quality within the study area is considered good which may result in a larger perceived increase in particulate matter during construction.
Visual Amenity / Landscape	Remnant *Eucalyptus spp* over 40m in height within the median and along the road edge are visually prominent within the study area.
Socio-economic Considerations including Land Use	The study area is located within the Burrawan State Forest A strip of property located on the western side of northbound carriageway between Bago Road and Herons Creek Public School belongs to the Bunyah Local Aboriginal Land Council; and The section of the Pacific Highway within the study area provides for this interstate traffic, as well as a mix of local and regional traffic. The roads that form intersections with the Pacific Highway in the study area provide for local and regional traffic accessing State Forests, rural properties, the Pacific Highway and Wauchope as well as supporting a certain amount of tourist traffic accessing Wauchope from the Pacific Highway.

The development of a preferred option for the Proposal would aim to avoid the above environmental constraints or minimise any potential impacts associated with the above environmental constraints. Recommendations within Table 6.2 should be followed.

Table 6.2: Recommendations for the Proposal

Factor	Recommendation
Landform, Geology and Soils	Implement an appropriate Soil and Water Management Plan during and after construction; Limit the amount of soil exposure and the duration in which soil is exposed; Undertake further detailed investigation of the geology and soil profiles of the study area and investigate potential sources of fill if required; and Undertake further detailed investigation of the two areas of potential contaminated land and the area of unsuitable fill material.
Climate	Undertake major earthworks outside of late summer and autumn where possible; Implement an appropriate Air Quality Management Plan during construction which addresses high wind speeds; and Monitor significant weather events during construction.
Water Quality and Hydrology	Implement an appropriate Soil and Water Management Plan during and after construction; Undertake hydrologic / hydraulic assessment of the study area with specific attention to the southern end of the study area in the vicinity of Herons Creek and the area immediately surrounding Cutty Creek; Undertake an assessment of the existing water quality (surface and groundwater) of the study area to provide baseline information; and Investigate the need for permanent sediment basins and their potential location.
Biodiversity	An terrestrial ecological assessment of the study area should be undertaken which includes a description of the existing flora and fauna / fauna habitat present, the presence or likelihood of threatened species being present and a discussion of likely impacts as a result of the Proposal and the implementation of safeguards to minimise potential impacts. The assessment should also discuss and evaluate the potential wildlife crossings identified in Section 5.4 of this report; The vegetation in the middle and along western side of the vegetated median and along the outside edge of the carriageways should be retained where possible, with specific emphasis on the larger remnant and regrowth *Eucalyptus spp*, which support hollows. The species diversity should also be retained; Investigate the feasibility of providing a fauna underpass at the existing location of the Cutty Creek culvert (approximately 710m north of the Bago Road intersection) or if this is not feasible, other areas should be investigated for potential fauna crossings; *Eucalyptus robusta* and *E. viminalis* and *Allocasuarina torulosa* should be retained where possible;

Factor	Recommendation
	Consideration and investigation into the relevance of SEPP 44 would be required during the detailed environmental impact assessment process (refer to Section 3.3.2 of this report); All waterway crossings should be designed and undertaken in accordance with *NSW Fisheries Policy and Guidelines for Fish Friendly Waterway Crossings 2003* and *Why do fish need to cross the road?: Fish Passage Requirements for Waterway Crossings 2003*; and An aquatic ecological assessment of the study area should be undertaken which includes a description of the existing aquatic flora and fauna and habitat features present, the presence or likelihood of threatened species being present (with specific attention to *Nannoperca oxleyana* [Oxleyan Pygmy Perch]) and a discussion of likely impacts as a result of the Proposal and the implementation of safeguards to minimise potential impacts.
Indigenous Heritage	An indigenous heritage assessment should be undertaken that considers archaeological and cultural constraints of the study area and involves consultation with the appropriate LALC and RTA's Aboriginal Programs Consultant. Specific attention should be given the two identified possible Aboriginal scarred trees located in the southern end of the study area, the area surrounding Cutty Creek and the relatively intact sections of the wet sclerophyll forest.
Non-indigenous Heritage	A baseline non-indigenous heritage assessment should be undertaken for the Proposal. Within this assessment, the significance of Herons Creek Public School and the existing / former monument should be assessed; and Where possible, a new alignment should avoid both Herons Creek Public School and the existing / former.
Noise and Vibration	Undertake a construction and operation noise and vibration assessment for the Proposal and develop mitigation / attenuation measures for the Proposal in accordance with reference to the *Environmental Criteria for Road Traffic Noise* (EPA 1999); Where possible, avoid a new alignment to the west of the existing northbound carriageway of the Pacific Highway (and therefore bringing the Pacific Highway closer to Herons Creek Public School); and Implement a Noise and Vibration Management Plan during construction, which incorporates best management practice to avoid impacts associated with increased noise levels.
Air Quality	Implement an appropriate Air Quality Management Plan during construction that incorporates best management practice to minimise the potential impacts associated with an increase in particulate matter.
Visual Amenity / Landscape	Undertake an urban and regional design / landscape and visual assessment to provide a road that is integrated into the

Factor	Recommendation
	surrounding environment, and Retain the large remnant and regrowth *Eucalyptus spp* within the median and along the road edge.
Socio-economic Considerations including Land Use	An alignment that results in the severance of the property belonging to Bunyah Local Aboriginal Land Council or the further severance of Burrawan State Forest should be avoided; Undertake a socio-economic impact assessment of the Proposal with regard to road users; Implement an appropriate Traffic Management Plan during construction; and Update the community with regard to the development of the Proposal and undertake consultation with affected stakeholders during the development of the Proposal.

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7 References

Australian Heritage Database, <http://www.ahc.gov.au/register/easydatabase/database.html> (Accessed 26 November 2004)

Australian Standard AS 1055.3 – 1997, *Acoustics - Description and measurement of environmental noise, Part 3: Acquisition of data pertinent to land use*

BOM 2004a, *Climate Averages for Australian Sites* <http://www.bom.gov.au/climate/averages/tables/ca_nsw_names.shtml> (Accessed 14 December 2004)

BOM 2004b, *Wind Roses for Selected Locations in Australia* <http://www.bom.gov.au/climate/averages/wind/selection_map.shtml> (Accessed 14 December 2004)

BOM 2004c, *Monthly Significant Weather Summaries* <http://www.bom.gov.au/inside/services_policy/public/sigwxsum/sigwmenu.shtml> (Accessed 14 December 2004)

Department of Environment and Heritage EPBC Act Database, <http://www.deh.gov.au/erin/ert/epbc/imap/map.html> (Accessed 26 November 2004)

Department of Environment and Heritage National Pollutant Inventory Database, <http://www.npi.gov.au/cgi-bin/npidbsearch.pl?proc=location> (Accessed 26 November 2004)

DIPNR 2005, *Estuaries of New South Wales: Camden Haven Estuary* <http://www.dlwc.nsw.gov.au/care/water/estuaries/inventory/camden.html> (Accessed 21 December 2005)

DLWC 2003, *Integrated Catchment Management Plan for the Mid North Coast Catchment 2002*. DLWC, Sydney, NSW

Environment Protection Authority 1993, *Environmental Noise Control Manual*. EPA, Sydney South, NSW

Environment Protection Authority 1999, *Environmental Criteria for Road Traffic Noise*. EPA, Chatswood, NSW

Hastings Council 2003, *Hastings Community Profile 2003*. Hastings Council, Port Macquarie, NSW

Herons Creek Public School Online 2005, *School History*, < http://www.heronscrk-p.schools.nsw.edu.au/history.html> (Accessed 28 January 2005)

Navin Officer 2001, *Moorland to Herons Creek Pacific Highway Upgrade Route Selection Study: Cultural Heritage Assessment*. (A Report to Ove Arup and Partners) Navin Officer, Deakin, ACT

NPWS 2004, *Bago Bluff National Park Draft Plan of Management*, NPWS, Port Macquarie, NSW

NPWS 2005, *Key Habitats and Corridors in North East NSW*, <http://www.maps.nationalparks.nsw.gov.au/keyhabs/default.htm> (Accessed 24 January 2005)

NSW Department of Environment and Conservation, <http://www.epa.nsw.gov.au/clm/searchregister.aspx> (Accessed 26 November 2004)

NSW Department of Primary Industries (Agriculture) Noxious Weeds List, <http://www.agric.nsw.gov.au/noxweed> (Accessed 26 November 2004)

NSW Department of Primary Industries (Fisheries) FishFiles Database,

<http://fishfiles.fisheries.nsw.gov.au/> (Accessed 14 December 2004)

NSW Fisheries 2002, *Fishfacts, Threatened Species in NSW: Oxleyan pygmy perch Nannoperca oxleyana*. NSW Fisheries, Cronulla, NSW

NSW Fisheries 2003, *Why do fish need to cross the road? Fish Passage Requirements for Waterway Crossings*. NSW Fisheries, Cronulla, NSW

NSW Heritage Office State Heritage Register and Inventory, <http://www.heritage.nsw.gov.au/07_subnav_01.cfm> (Accessed 26 November 2004)

NSW Soil and Land Information System (SALIS), *Soil Profile Report*, <http://spade.dlwc.nsw.gov.au/jsp/spade.jsp> (Accessed 14 December 2004)

Appendix A

Photographs of Site

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Photo 1: Looking south from the Stills Road intersection along the Pacific Highway.

Photo 2: The existing / former monument located within the cleared median approximately 380m south of the Stills Road intersection.

Photo 3: Looking at Cutty Creek east of the southbound carriageway.

Photo 4: Looking at the Cutty Creek culverts on the northbound carriageway.

Photo 5: Looking the Bago Road intersection from the southbound carriageway of the Pacific Highway

Photo 6: Vegetation within the median north of Bago Road.

Photo 7: Looking south from the Bago Road intersection along the northbound carriageway of the Pacific Highway.

Photo 8: Looking north at the Bobs Creek Road and Pacific Highway intersection.

Appendix B

Results of Database Searches

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Appendix C

Consultation

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Herons Creek to Stills Road

Review of Environmental Factors – Appendix C

Hydraulic Investigation.

January 2007

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PACIFIC HIGHWAY UPGRADE

FROM

From Herons Creek to Stills Road

HYDRAULIC INVESTIGATION

OF

TRANSVERSE DRAINAGE STRUCTURES

July 2006

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PACIFIC HIGHWAY UPGRADE FROM HERON CREEK
HYDRAULIC INVESTIGATION OF TRANSVERSE DRAINAGE

Introduction

The Pacific Highway from Herons Creek to Stills Road is part of the Pacific Highway Upgrade. The section of road to be upgraded is approximately 3km in length with the northern end of the project, Stills Road, located 13.5km south of the Port Macquarie Interchange.

The RTA Bridge Section has been requested by the RTA Hunter Region to undertake the hydraulic analysis and check of the transverse drainage structures along this section of the Pacific Highway for the Concept Design.

The scope of this report includes the transverse drainage structures extending from Chainage 56,300m to 59,267m. Along the existing road are 7 transverse drainage structures and in addition to these is a transverse drainage structure located along the service road at Cutty Creek upstream of Drainage Structure T5.

The proposed works for the Upgrade will entail the extensions of the existing drainage structures due to widening of the existing road and new drainage structures for the adjacent proposed auxiliary roads. The Upgrade of the road will consist of 7 existing structures to be extended and 7 new drainage structures.

The existing and proposed structures were analysed for the 1 in 50 year ARI and 1 in 100 year ARI flood events.

Assumptions and Information

The following information and assumptions were used for this investigation.

- The plans containing contour lines and long section of drainage structures were supplied by Brad Spalding of the Hunter Region Technical Services.
- The runoff coefficient for the catchment upstream of the highway of 0.3 was obtained from ARR Vol 2.
- The transverse drainage structures were analysed for the 1 in 50 year and 1 in 100 year flood in accordance to the Upgrading the Pacific Highway Design Guidelines.
- The catchment areas upon which the design flows were supplied by Hunter Region Technical Services.
- It was assumed the culverts would be inlet controlled.
- Where there was an extension the existing pipe, the grade of the existing pipe was adopted for the section of the extended pipe. Some channel excavation may be required at the inlet of the structures in order to a

Catchment Information

The following steps were followed in determining the catchment flow for each of the drainage structures.

A) The catchment areas were provided by the Hunter Region Technical Services.

B) Flows for the 1 in 20 year ARI and 1 in 100 year ARI floods were determined for each catchment area using the Rational Method, with the coefficient of runoff of 0.3 for the 1 in 10 year event.

C) The culverts were analysed for the flows based on the 1 in 20 and 1 in 100 year ARI flood events.

Discussion

The hydraulic analysis involved a comparison of the existing drainage structures to the proposed extended drainage structures. New drainages structures for the additional road were also included in the hydraulic analysis.

In considering the proposed extended drainage structures for analysis it was desirable for the slope of the existing drainage structure to be maintained for the proposed structure. It was found that channel excavations will be required the inlet for the below listed drainage structures.

Drainage identification	Depth of channel excavation
T1	0.627m
T4	2.061m
T5	0.663m

For T4, a drop structure would be a more suitable option at the inlet to avoid excessive excavation as the difference in natural surface level to inlet invert level is greater than 2 metres.

T6 and T8 were not extended for the road upgrade. It was proposed that the existing T6 pipe be shortened by 2.8m of the pipe length and a drainage pit to be constructed at the depressed road median. T8 was not altered for road upgrade.

It was noted however, that the waterway area for T5 is approximately half the area for the upstream drainage structure T8. The contour drawings indicate that the flow for T5 includes the flow for T8 and additional flow from the road reserve.

The analysis of the existing drainage structures show that for the 1 in 100 year storm event, the outlet velocity exceeds 3m/s for T4, T5 and T8. When the proposed conditions were analysed the velocities for the 1 in 100 year storm event were found

to be the same. This indicates that the proposed extension of drainage structures will not worsen the existing conditions in terms of downstream velocities.

The change in velocity from the existing and proposed is marginally observed. It will not be necessary to provide energy dissipaters if the existing outlet has no evidence of scour for outlet velocity less than 3 m/s. For outlet velocities exceeding 3 m/s it is recommended that outlet protection may be required in the form of rock rip-rap within the area of the wing walls of the structures.

Blockage was not considered in this analysis as most of the drainage structures have relatively small openings. If a 50 percent blockage was to be considered in analysis it would be expected that the 1 in 100 year ARI flood level would overtop the highway. In the existing drainage structures no blockage is evident to date. The impact of flooding due to blockage would affect mainly State Forest.

The Probable Maximum Flood was not considered in this analysis as there is a low risk, in terms of impact, upstream of the highway.

The summary of the results are shown in Table 1.

Conclusion

The proposed extension of the transverse drainage structure, including the new structures, will have no significant impact to the existing flood flow distribution. The change in outlet velocity is marginally observed. The level of the service of the highway is trafficable up to the 1 in 100 year ARI.

Fiona Chan
Project Engineer

Phanta Khamphounvong
Waterways Engineer

Attachments

- Table 1 – Summary of the design flows contributing to the transverse drainage structures and results from analysis.
- Catchment and Location plans of Drainage Structures.
- Existing and Proposed Drainage Structure Sections

Design Rainfall using Australian Rainfall and Runoff
Civil and Environmental Engineering
University of Wollongong
Program DESrain

South of Port Macquarie

2 year 1 hour = 40 mm/hr
2 year 12 hour = 9.5 mm/hr
2 year 72 hour = 3 mm/hr
50 year 1 hour = 90 mm/hr
50 year 12 hour = 20 mm/hr
50 year 72 hour = 6.5 mm/hr
F2 factor = 4.34
F50 factor2 hour = 16.25
Skew coeff G = 0.025

	1	2	5	10	20	50	100	200	500 years
5 min	98.76	127.73	166.01	188.59	218.25	257.38	287.39	318.01	359.52
6	92.57	119.84	156.16	177.66	205.84	243.06	271.63	300.81	340.41
10	75.64	98.22	129.05	147.45	171.45	203.28	227.79	252.89	287.04
15	63.13	82.2	108.8	124.79	145.58	173.23	194.59	216.51	246.42
20	54.97	71.73	95.47	109.84	128.44	153.26	172.48	192.24	219.25
30	44.61	58.4	78.4	90.6	106.34	127.42	143.8	160.69	183.83
45	35.73	46.93	63.57	73.81	86.98	104.69	118.5	132.78	152.41
1 hr	30.32	39.92	54.45	63.44	74.98	90.54	102.72	115.32	132.7
1.5	24.16	31.77	43.14	50.15	59.15	71.28	80.75	90.54	104.02
2	20.51	26.93	36.45	42.3	49.83	59.96	67.85	76	87.22
3	16.23	21.27	28.67	33.19	39.02	46.85	52.93	59.22	67.84
4.5	12.82	16.78	22.51	26	30.51	36.55	41.24	46.07	52.69
6	10.85	14.18	18.97	21.87	25.63	30.65	34.54	38.55	44.05
9	8.59	11.2	14.92	17.16	20.07	23.95	26.95	30.04	34.26
12	7.28	9.48	12.58	14.45	16.88	20.11	22.61	25.18	28.68
18	5.69	7.42	9.87	11.35	13.27	15.83	17.81	19.85	22.63
24	4.77	6.23	8.3	9.55	11.18	13.35	15.03	16.75	19.12
30	4.15	5.42	7.23	8.33	9.75	11.65	13.12	14.64	16.71
36	3.69	4.82	6.44	7.43	8.7	10.4	11.72	13.08	14.93
48	3.05	3.99	5.34	6.16	7.23	8.65	9.75	10.89	12.44
72	2.29	2.99	4.02	4.65	5.46	6.54	7.38	8.25	9.43

HERONS CREEK TO STILL ROAD - CONCEPT DESIGN

Table 1 - Existing Condition

Drainage Identification	Structures	Existing Length m	Inlet RL	Outlet RL	Slope %	Road Edge RL	Q50 m3/sec	Upstream Water Level m	Velocity m/sec	Q100 m3/sec	Upstream Water Level m	Velocity m/sec	Road Overtopped 1 in 50	Road Overtopped 1 in100	Outlet Velocity (m/sec) 1 in 50	Outlet Velocity (m/sec) 1 in100
T1	750 RCP	39.28	18.499	18.037	1.18	23.379	0.96	19.59	2.52	1.17	19.88	2.95	No	No	Ok	Ok
T2	1500 RCP	44.48	13.884	13.269	1.38	20.738	4.10	15.62	2.41	5.00	15.90	2.90	No	No	Ok	Ok
T3	900 RCP	59.25	22.629	22.165	0.78	31.087	1.37	23.82	2.48	1.66	24.09	2.88	No	No	Ok	Ok
T4	600 RCP	44.15	25.339	24.936	0.913	30.693	0.69	26.49	2.75	0.84	26.84	3.21	No	No	Ok	High
T5	4 x 1650 RCP	44.5	9.517	9.301	0.485	20.602	26.75	11.86	3.40	32.78	12.47	3.99	No	No	High	High
T6	450 RCP	28.7	24.77	22.892	6.544	27.72	0.15	25.17	2.93	0.18	25.23	2.93	No	No	Ok	Ok
T8	2 x 3000 (W) x 2700 (H)	12.5	10.793	10.787	0.048	14.763	26.59	12.75	3.35	32.59	13.06	3.36	No	No	High	High

Proposed Condition

Drainage Identification	Structures	Proposed Extended Length m	Inlet RL	Natural surface level at Inlet RL	Outlet RL	Slope %	Road Edge RL	Q50 m3/sec	Upstream Water Level m	Velocity m/sec	Q100 m3/sec	Upstream Water Level m	Velocity m/sec	Road Overtopped 1 in 50	Road Overtopped 1 in100	Outlet Velocity (m/sec) 1 in 50	Outlet Velocity (m/sec) 1 in100
T1	750 RCP	55.45	18.69	20.727	18.037	1.18	23.379	0.96	19.59	2.52	1.17	21.47	2.95	No	No	Ok	Ok
T2	1500 RCP	80.87	14.31	14.787	13.189	1.38	20.738	4.10	16.04	2.41	5.00	16.32	2.90	No	No	Ok	Ok
T3	900 RCP	90.88	22.87	25.116	22.165	0.78	31.087	1.37	24.06	2.48	1.66	24.34	2.88	No	No	Ok	Ok
T4	600 RCP	65.12	25.58	27.639	24.936	0.986	30.693	0.69	26.49	2.75	0.84	27.09	3.16	No	No	Ok	High
T5	4 x 1650 RCP	74.66	9.87	10.531	9.506	0.485	20.602	26.75	11.86	3.40	32.78	12.82	3.99	No	No	High	High
T6	450 RCP	26.1	Inlet to be converted to pit		same	6.544	27.72	0.15			0.18						
T8	2 x 3000 (W) x 2700 (H)	12.5	No Change		same	0.048	14.763	26.59			32.59						

New Design

Drainage Identification	Structures	Proposed Length m	Inlet RL	Outlet RL	Slope %	Road Edge RL	Q50 m3/sec	Upstream Water Level m	Velocity m/sec	Q100 m3/sec	Upstream Water Level m	Velocity m/sec	Road Overtopped 1 in 50	Road Overtopped 1 in100	Outlet Velocity (m/sec) 1 in 50	Outlet Velocity (m/sec) 1 in100
TD1	900 RCP	32.50	17.66	17.32	1.0	20.357	1.12	18.87	2.31	1.36	18.84	2.81	No	No	Ok	Ok
TD2	2x1050 RCP	27.90	13.173	12.424	2.68	16.738	4.59	14.76	2.82	4.59	14.76	2.82	No	No	Ok	Ok
TD3	600 RCP	19.19	19.566	18.336	6.43	21.774	0.28	19.75	3.02	0.34	20.14	3.03	No	No	High	High
TD4	450 RCP	34.55	24.956	24.579	1.09	28.089	0.17	25.41	1.40	0.21	25.49	1.64	No	No	Ok	Ok
TD5	450 RCP	20.58	33.242	32.131	5.3	34.338	0.07	33.34	2.07	0.09	33.35	2.25	No	No	Ok	Ok
TD6	450 RCP	22.79	27.939	27.027	3.9	30.107	0.24	28.53	2.24	0.30	28.67	2.40	No	No	Ok	Ok

T2a

LOT 56
DP 47928
BUNYAH LALC

SERVICE ROAD

T2d

LOT 65
DP 754444
STATE FOREST NSW

T3

5730.000

5740.000

LEGEND - DRAINAGE

- TRANSVERSE DRAINAGE
- STORMWATER PIPE
- PIT
- HEADWALL
- CATCH DRAIN
- DIVERSION CHANNEL
- SEDIMENTATION BASIN
- MOORLAND TO HERONS CREEK PROJECT

PRELIMINARY DRAWINGS
NOT FOR CONSTRUCTION. 21/04/06

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TECHNOLOGY & TECHNICAL SERVICES
HUNTER TECHNICAL SERVICES
PROJECT DESIGN

ROADS AND TRAFFIC AUTHORITY OF NSW

SH10 PACIFIC HIGHWAY
HASTINGS COUNCIL
HERONS CREEK TO STILLS ROAD- CONCEPT DESIGN
DRAINAGE PLANS WITH CATCHMENTS

FILE No.	DRAWING	SHEET No.
*/***.****	*.DGN	

REGISTRATION NUMBER
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LOT 56
DP 47928
BUNYAH LALC

SERVICE ROAD

T2a

T2d

To Wauchope

BAGO ROAD

T8

SERVICE ROAD

LOT 65
DP 754444
STATE FOREST NSW

T3

LOT 66
DP 754444
STATE FOREST NSW

T4

LEGEND - DRAINAGE

- TRANSVERSE DRAINAGE
- STORMWATER PIPE
- PIT
- HEADWALL
- CATCH DRAIN
- DIVERSION CHANNEL
- SEDIMENTATION BASIN
- MOORLAND TO HERONS CREEK PROJECT

PRELIMINARY DRAWINGS
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RTA

TECHNOLOGY & TECHNICAL SERVICES
HUNTER TECHNICAL SERVICES
PROJECT DESIGN

ROADS AND TRAFFIC AUTHORITY OF NSW

SH10 PACIFIC HIGHWAY
HASTINGS COUNCIL
HERONS CREEK TO STILLS ROAD- CONCEPT DESIGN
DRAINAGE PLANS WITH CATCHMENTS

FILE No.	DRAWING	SHEET No.
*/***.****	*.DGN	

REGISTRATION NUMBER
**** *** ** ****

T3

LOT 66
DP 754444
STATE FOREST NSW

BAGO ROAD

T4

BURRAWAN
STATE FOREST
STATE FOREST NSW

LOT 66
DP 754444
STATE FOREST NSW

57500.000

57600.000

57700.000

57800.000

EXTEND EXISTING
600 RCP

T3b

T5c

T3c

T4b

T5b

T4

BOYDS ROAD

LOT 66
DP 754444
STATE FOREST NSW

BURRAWAN
STATE FOREST
STATE FOREST NSW

LEGEND - DRAINAGE

- TRANSVERSE DRAINAGE
- STORMWATER PIPE
- PIT
- HEADWALL
- CATCH DRAIN
- DIVERSION CHANNEL
- SEDIMENTATION BASIN
- MOORLAND TO HERONS CREEK PROJECT

PRELIMINARY DRAWINGS
NOT FOR CONSTRUCTION. 21/04/06

No.	Amendment Description	Initials	Date
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TECHNOLOGY & TECHNICAL SERVICES
HUNTER TECHNICAL SERVICES
PROJECT DESIGN

ROADS AND TRAFFIC AUTHORITY OF NSW

SH10 PACIFIC HIGHWAY
HASTINGS COUNCIL
HERONS CREEK TO STILLS ROAD- CONCEPT DESIGN
DRAINAGE PLANS WITH CATCHMENTS

FILE No. */***.****

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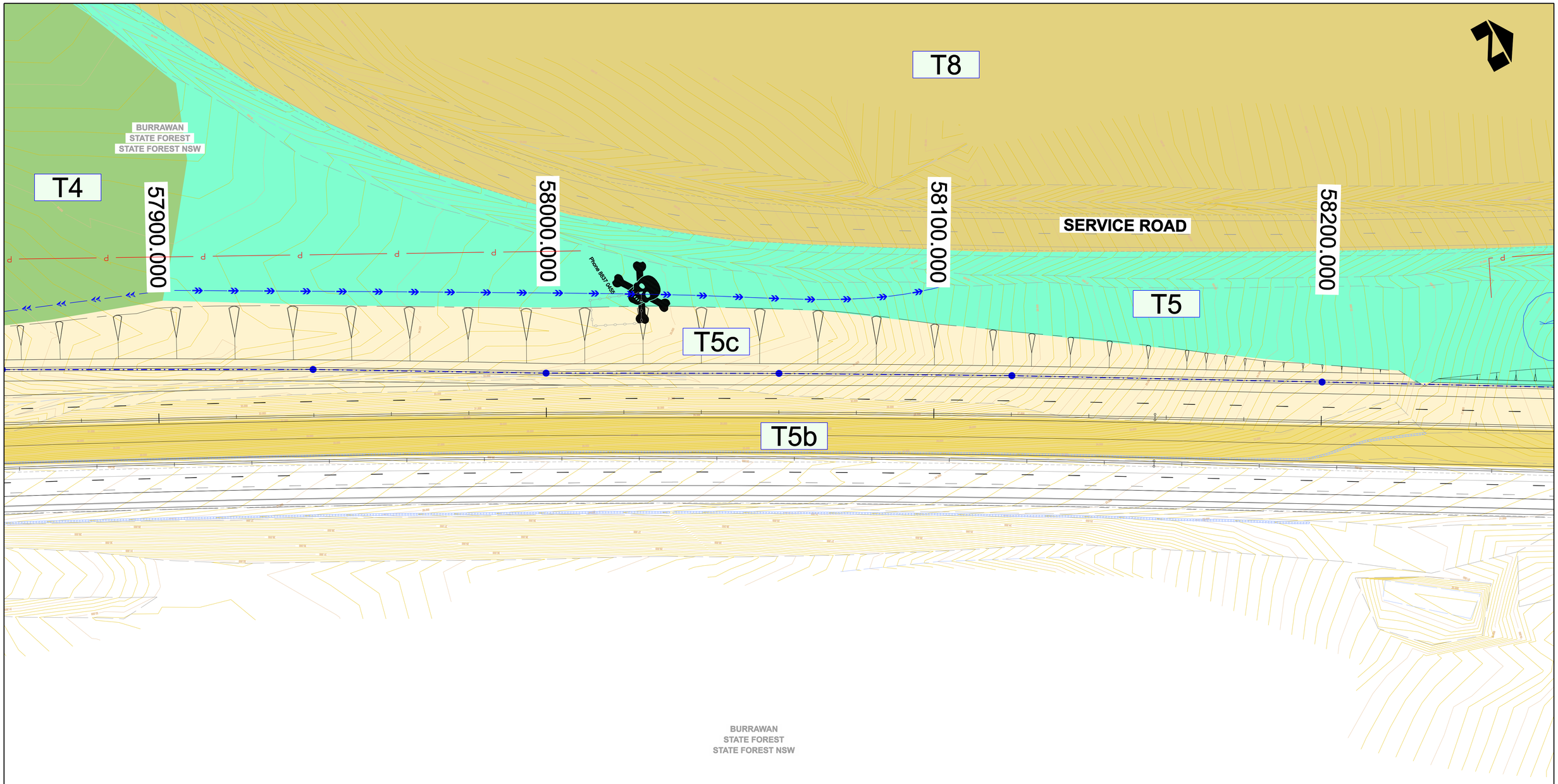

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PROJECT DESIGN

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DRAINAGE PLANS WITH CATCHMENTS

FILE No.	DRAWING	SHEET No.
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REGISTRATION NUMBER
**** *** ** ****

T8

CUTTY CREEK

BURRAWAN
STATE FOREST
STATE FOREST NSW

SERVICE ROAD

58300.000

58400.000

58500.000

58600.000

EXISTING 2 x 3000 W
x 2700 H RCBC

T8

T5

EXTEND EXISTING
4 x 1650 RCP

T5b

T5d

T5f

T5e

T5g

T5i

T5

BURRAWAN
STATE FOREST
STATE FOREST NSW

CUTTY CREEK

LEGEND - DRAINAGE

- TRANSVERSE DRAINAGE
- STORMWATER PIPE
- PIT
- HEADWALL
- CATCH DRAIN
- DIVERSION CHANNEL
- SEDIMENTATION BASIN
- MOORLAND TO HERONS CREEK PROJECT

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HUNTER TECHNICAL SERVICES
PROJECT DESIGN

ROADS AND TRAFFIC AUTHORITY OF NSW

SH10 PACIFIC HIGHWAY
HASTINGS COUNCIL
HERONS CREEK TO STILLS ROAD- CONCEPT DESIGN
DRAINAGE PLANS WITH CATCHMENTS

FILE No.	DRAWING	SHEET No.
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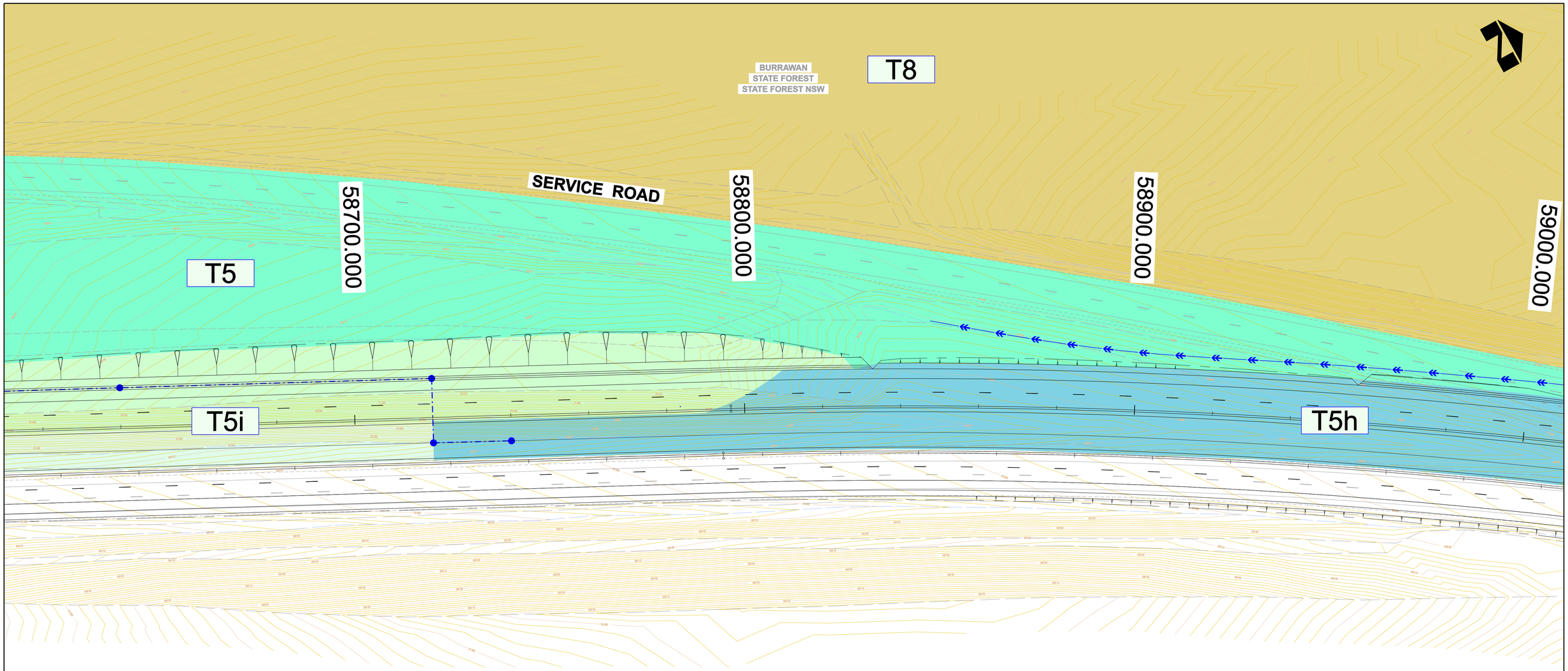

LEGEND - DRAINAGE

- TRANSVERSE DRAINAGE
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- PIT
- HEADWALL
- CATCH DRAIN
- DIVERSION CHANNEL
- SEDIMENTATION BASIN
- MOORLAND TO HERONS CREEK PROJECT

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HUNTER TECHNICAL SERVICES
PROJECT DESIGN

ROADS AND TRAFFIC AUTHORITY OF NSW

SH10 PACIFIC HIGHWAY
HASTINGS COUNCIL
HERONS CREEK TO STILLS ROAD- CONCEPT DESIGN
DRAINAGE PLANS WITH CATCHMENTS

FILE No.	DRAWING	SHEET No.
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REGISTRATION NUMBER
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BURRAWAN FOREST DRIVE

BURRAWAN
STATE FOREST
STATE FOREST NSW

T8

59000.000

59100.000

59200.000

59267.002

T5

T5h

ADJUST EXISITNG 450 RCP
TO SUIT DEPRESSED MEDIAN

EXISTING 2 x 1350 RCP

T6

NO SAG PIT TO PIPES WAS CUND IN MEDIAN

To Kempsey

T6

T7

STILLS ROAD

BURRAWAN
STATE FOREST
STATE FOREST NSW

LEGEND - DRAINAGE

- TRANSVERSE DRAINAGE
- STORMWATER PIPE
- PIT
- HEADWALL
- CATCH DRAIN
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DRAINAGE PLANS WITH CATCHMENTS

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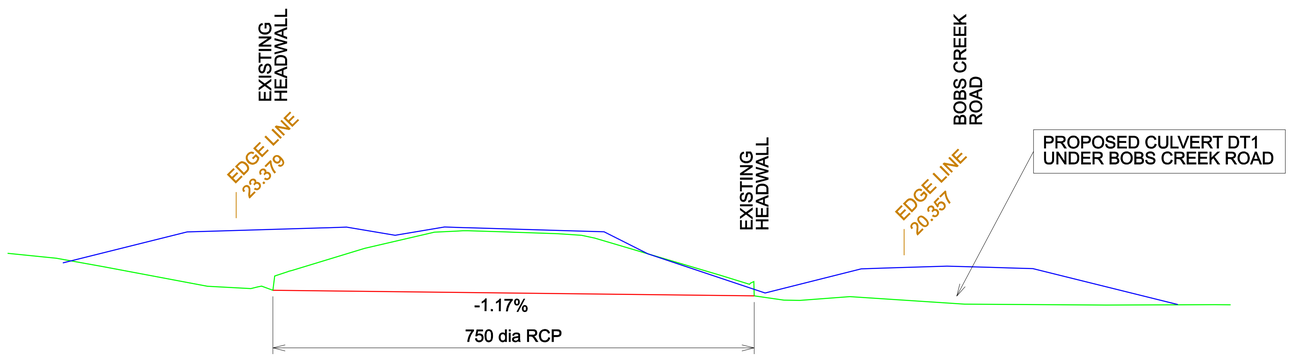

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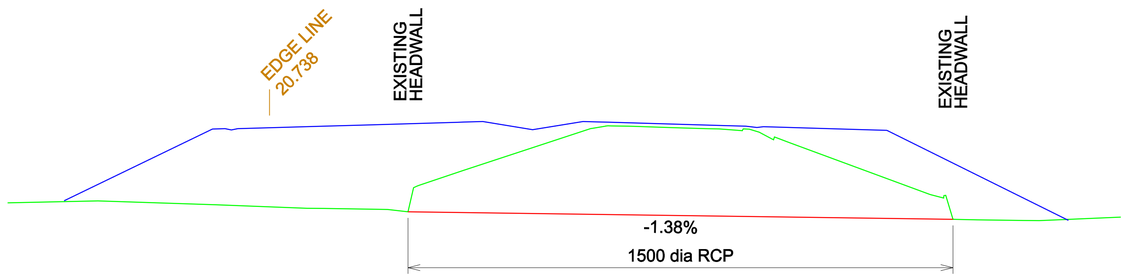

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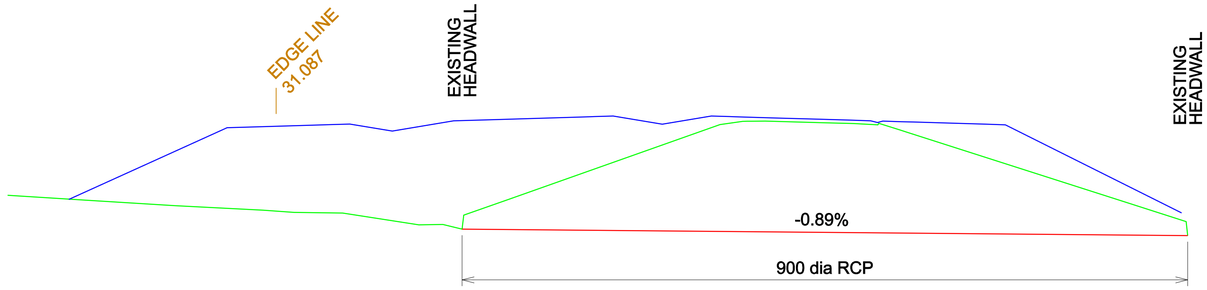

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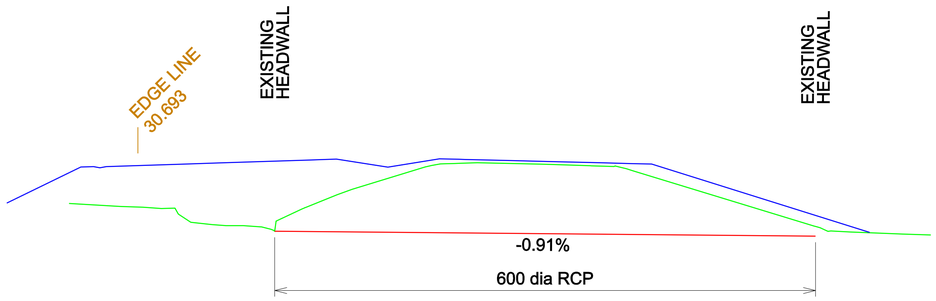

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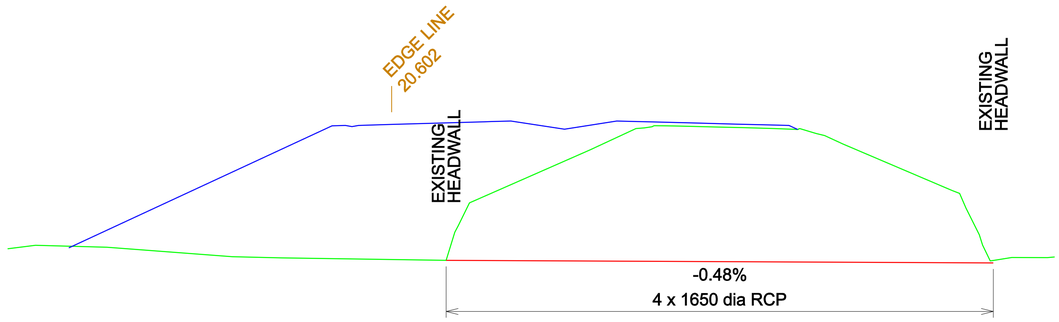

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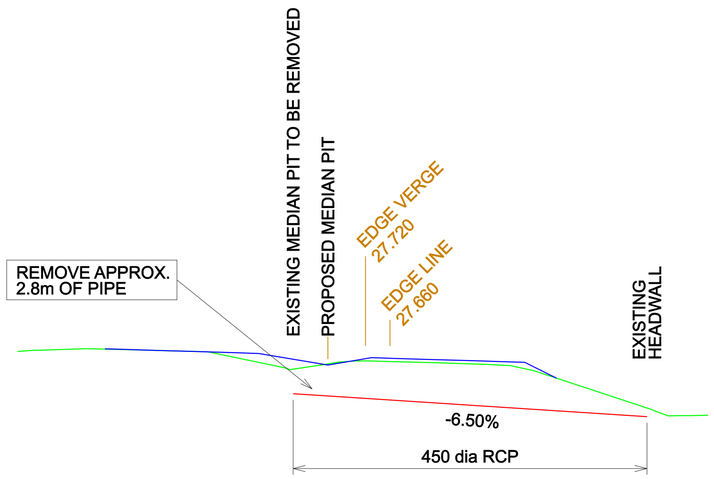

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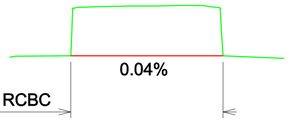

EXISTING LEVELS	10.762	10.793	14.763	14.802	14.855	14.860	14.910	14.902	14.742	10.797	10.579
INVERT LEVELS		10.793								10.797	
DISTANCE	0.000	5.000								17.421	22.421

TRANSVERSE CULVERT - T8
Exisitng 2 x 3000 (w) x 2700 (h) RCBC

PRELIMINARY DRAWINGS
NOT FOR CONSTRUCTION. 28/03/06

No.	Amendment Description	Initials	Date
A3 original	This sheet may be prepared using colour and may be incomplete if copied		

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Coordinate System: MGA Zone 56 | Height Datum: A.H.D.

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HUNTER TECHNICAL SERVICES
PROJECT DESIGN

ROADS AND TRAFFIC AUTHORITY OF NSW
SH10 PACIFIC HIGHWAY
HASTINGS COUNCIL
HERONS CREEK TO STILLS ROAD- CONCEPT DESIGN
TRANSVERSE DRAINAGE PROFILES

FILE No. */***.****
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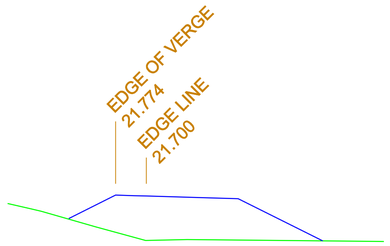

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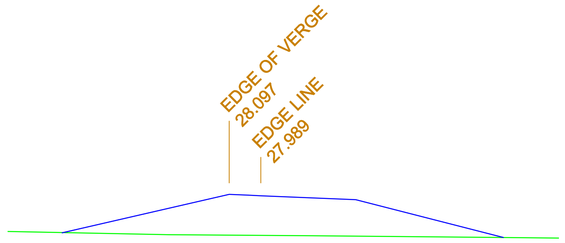

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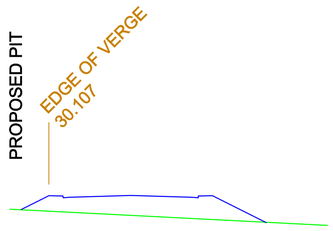

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PROPOSED LEVELS	33.195	34.338	34.319	34.254	34.361	34.256	34.169	34.339	32.131
EXISTING LEVELS	33.242								31.910
INVERT LEVELS									
DISTANCE	0.000								25.976

PROPOSED CULVERT - TD5

Proposed structure to be sized

PRELIMINARY DRAWINGS
NOT FOR CONSTRUCTION. 28/03/06

No.	Amendment Description	Initials	Date
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SCALES

0 10 20 25 50

1:500

Coordinate System: MGA Zone 56 | Height Datum: A.H.D.

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HUNTER TECHNICAL SERVICES
PROJECT DESIGN

ROADS AND TRAFFIC AUTHORITY OF NSW

SH10 PACIFIC HIGHWAY
HASTINGS COUNCIL
HERONS CREEK TO STILLS ROAD- CONCEPT DESIGN
TRANSVERSE DRAINAGE PROFILES

FILE No.	DRAWING	SHEET No.
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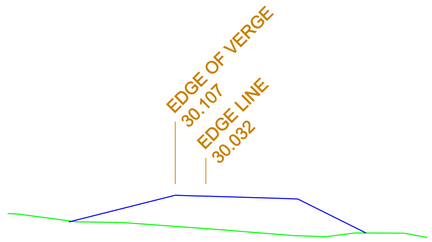

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Herons Creek to Stills Road

Review of Environmental Factors – Appendix D

Noise and Vibration Impact Assessment.

January 2007

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Project No: 05166/1604

Noise and Vibration Impact Assessment
Pacific Highway Upgrade
Herons Creek to Stills Road Section

Prepared for:

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Author:

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Principal / Director

Review:

Neil Pennington
B.Sc., B. Math.(Hons), MAAS, MASA
Principal / Director

March 2006

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3.0 - ROAD TRAFFIC NOISE INDICES 1

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Vibration – Construction and Operational 1
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6.0 - ROAD TRAFFIC NOISE AND VIBRATION ASSESSMENT 1

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Future Existing Predictions (2010) 1
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Construction 1
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Vibration from Road Traffic 1

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Construction Noise 1

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Appendix II – NOISE LOGGER PHOTOS

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1.0 - INTRODUCTION

This report provides the results and findings of a noise and vibration impact assessment of the proposed construction and operation of the proposed upgrade of 3.3km of the Pacific Highway between Herons Creek and Stills Road, approximately 58km north of Taree, NSW.

This report presents the results of the assessment as an input to a Review of Environmental Factors (REF). The following section gives a brief outline of the proposed development, with emphasis solely on factors relevant to acoustics. A more detailed project description is contained in the REF.

2.0 – ROUTE DESCRIPTION

The proposed upgrade of the Pacific Highway would involve widening the existing road to create a new northbound carriageway from just north of Herons Creek to just north of Stills Road at Herons Creek. The proposal would also involve the construction of an interchange and parallel service roads utilising part of the existing northbound carriageway. The new carriageway would be constructed directly alongside and to the west of the existing southbound lane.

The proposed works are located along a 3.3km section of road approximately 58km north of the city of Taree. The location of the proposed works is shown in **Figure 1**.

The proposal site is located predominantly within the Burrawan State Forest. There are no residences located within the study area and the only premises are at the Herons Creek Public School, which is located to the west of the existing highway approximately 200m north of Herons Creek.

3.0 - ROAD TRAFFIC NOISE INDICES

Road traffic noise is the sum of all noise produced by vehicles in a traffic stream. Road traffic noise levels vary throughout the daytime and night-time depending on the prevailing traffic volume, type and speed of vehicles. Because of these time-related variations in traffic noise, a variety of noise descriptors are used. The main descriptors are a measure of the amount of acoustic energy from the traffic stream over the daytime and night-time periods. The most commonly used

descriptors when measuring or assessing traffic noise are the L_{A10} and the L_{Aeq} noise indices, definitions of which appear below.

L_{A10} – The A-Weighted sound pressure level, corresponding to the noise level exceeded for 10% of a particular time period. With respect to traffic noise, the $L_{A10,\ (18\ hour)}$ index is used widely throughout Australia. This index is the arithmetic average of the 18, $L_{A10,\ (1\ hour)}$ noise levels occurring between 6.00 a.m. and midnight.

L_{Aeq} – The A-Weighted, energy-averaged sound pressure level over the measurement period. This is the steady noise level, which contains the same amount of acoustic energy as all the varying noise levels observed during a particular time period. When assessing road traffic noise in NSW, the measurement period is commonly 15 hours (7.00 a.m. to 10.00 p.m.), and 9 hours (10.00 p.m. to 7.00 a.m.), in which case it is specifically referred to as the $L_{Aeq\ (15hour)}$ or the $L_{Aeq\ (9hour)}$ level.

A hypothetical time signal is shown, in **Figure 2** to illustrate various noise level percentiles. Unlike the L_{A10} index, the L_{Aeq} is sensitive to infrequent high level events, such as heavy vehicle movements etc.

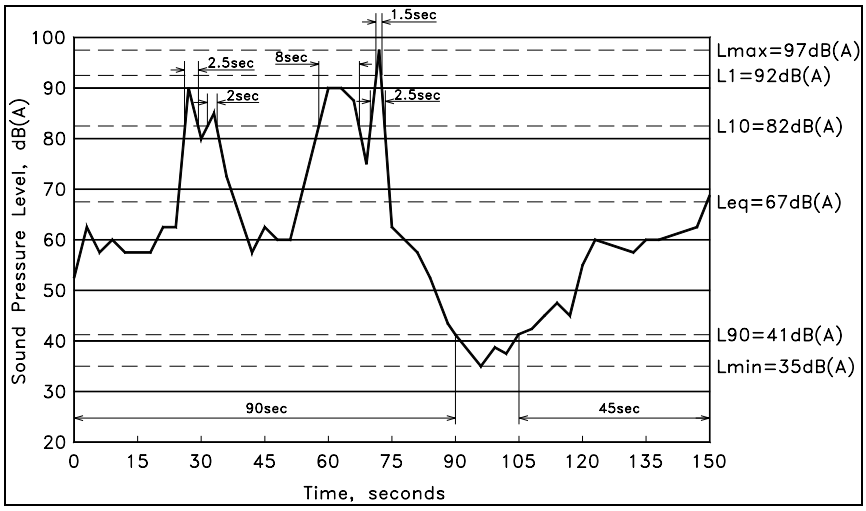

***Figure 2**. Hypothetical time signal to illustrate Ln percentiles*

Historically in Australia the $L_{A10,\ (18hour)}$ index has been used to assess traffic noise. This index is the arithmetic average of the 18, $L_{A10,\ (1hour)}$ noise levels occurring between 6.00 am and midnight. The Department of Environment and Conservation (DEC, formerly EPA) conducted an extensive review of the various noise indices used throughout Australia and the rest of the world in 1998 - 1999. This review considered the relationship between noise and annoyance,

noise prediction requirements and the reproducibility of measurements required for compliance certification.

As a consequence of this study, the DEC and the RTA agreed to jointly adopt the LAeq as the preferred base index.

The current policy of the DEC provides guidance for the assessment of road traffic noise in terms of $L_{Aeq\ (15hour)}$ and $L_{Aeq\ (9hour)}$ levels. These are the energy-averaged levels that occur in the 15 hour period between 7.00 am to 10.00 pm and the 9 hour period between 10.00 pm and 7.00 am respectively. Predictions are based on Annual Averaged Daily Traffic (AADT) flows.

The DEC requires the typical maximum traffic noise levels to be quoted, although this is not a direct part of the assessment procedure, and no criteria are set within the guidelines.

4.0 - AMBIENT NOISE ENVIRONMENT

The existing ambient noise levels were monitored at the Herons Creek School in September 2005. Noise levels were recorded at 15 minute statistical intervals using Acoustic Research Laboratories EL-215 Environmental Noise Loggers. Recordings were done in accordance with relevant EPA guidelines and AS 1055-1997 “Acoustics – Description and Measurement of Environmental Noise”. All of the noise loggers used comply with the requirements of AS1259.2-1990. “Acoustics – Sound Level Meters”, and all have current NATA calibration certification. Calibration of the loggers was performed as part of the instruments uploading and downloading procedure, with all calibration results being within the allowable $\pm$ 0.5 dB(A) range.

The logger was programmed to continuously register environmental noise levels over the 15 minute intervals, with internal software calculating and storing Ln percentile noise levels for each sampling period.

The logger was located in the free field adjacent to the tennis court near the access road into the school, as a result of this a 2dB façade correction was added to all measured data. The location was approximately 80m from the highway, as shown in **Figure 3**.

Results of Ambient Noise Measurements Year 2005

The $L_{eq(15\ hour)}$ and $L_{eq(9\ hour)}$ road traffic noise indices were calculated for each day for each monitoring location. The results of the unattended noise monitoring are presented graphically in **Appendix A,** and the

results are summarised below in **Table 1**. The results shown include the façade correction indicated above.

Noise criteria for schools relate to $L_{Aeq\ (1\ hour)}$ noise levels and thus these values are included in Table 1.

TABLE 1 AMBIENT NOISE LEVELS dB(A)				
Location	$L_{Aeq(15\ hour)}$	$L_{Aeq(1\ hour)}$	Range L_{max}	Avge L_{max}
Herons Creek Public School	57	57	59-89	69

The data from the loggers showed a relatively uniform L_{Aeq} noise level over each 24 hour period of the monitoring. This is considered typical of locations near the Pacific Highway where the traffic mix alters between night and day. That is, during the night traffic volumes decrease but relative and actual numbers of heavy vehicles increase resulting in a similar overall L_{eq} noise level.

Construction noise criteria are calculated based on background (L_{90}) noise levels. The measured background noise level is shown below in **Table 2**. As construction activities will be limited to day time hours, only this period is shown.

TABLE 2 BACKGROUND NOISE LEVELS dB(A) L_{90}	
Location	L_{90} (Day)*
Herons Creek Public School	46

* 7.00 a.m. to 6.00 p.m. Monday to Saturday – 8.00 a.m. to 6.00 p.m. Sunday and Public Holidays.

5.0 - NOISE AND VIBRATION CRITERIA

Operational Noise – Road Traffic

Noise emissions from vehicles travelling on public roads in NSW are assessed according to conditions outlined in the DEC's "Environmental Criteria for Road Traffic Noise" (ECRTN). This document provides a framework that guides the consideration and management of traffic noise issues associated with new building developments near existing or new roads, and new or upgraded road developments adjacent to new or planned building developments. It also provides guidance for the setting of environmental noise criteria applicable to the various situations.

Under the definitions in the ECRTN, the Pacific Highway is classed as an arterial road. The criteria applicable to the proposed works would

be for "redevelopment of existing freeway/arterial road", where "a redeveloped freeway, arterial or sub arterial road is a road corridor in which it is proposed to increase traffic carrying capacity, change the traffic mix or change the road alignment through design or engineering changes".

The recommended criteria for such works are set at 60 dB(A) $L_{Aeq(15\ hour)}$ (i.e. day) and 55 $L_{Aeq(9\ hour)}$ (night).

For an existing school the ENCM indicates that daytime criterion is 45 dB(A) $L_{Aeq(1\ hour)}$ internal. For a school playground affected by noise from a freeway or arterial road, the criterion is 55 dB(A) $L_{Aeq(15\ hour)}$.

The ECRTN also contains the proviso that where noise criteria are already exceeded, in all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB. The ECRTN also suggests that, where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria.

In this context, "feasibility" refers to engineering practicality, while "reasonableness" is to be judged by taking account of:

- Noise mitigation benefits and costs;
- Community views and aesthetic impacts;
- Existing and future noise levels at affected land uses; and
- The benefits of the proposed development.

For all road developments, the criteria should apply on the basis of the traffic volumes immediately after the road opens and on volumes projected for 10 years time.

For proposed "new roads" and road "redevelopments" the RTA Environmental Noise Management Manual (ENMM) states that the RTA believes it is generally not "reasonable" to take action to reduce predicted noise levels to the target noise levels if the noise levels with the proposal, ten years after project opening, are predicted to be:

- Within 2 dB(A) of "future existing" noise levels (the noise levels from existing sources of road traffic noise predicted for the time of project opening); and
- No more than 2 dB(A) above the target noise levels set out in columns 2 and 3 of Table 1 in the ECRTN.

This approach is based on the insignificance of the changes in noise levels involved and the insignificant exceedances of the target noise levels.

It applies only if it can be demonstrated that all "feasible and reasonable" traffic management and other road design opportunities for reducing traffic noise have been exhausted.

For the proposed "redevelopments" of roads where existing noise levels already exceed the ECRTN target noise levels, and all "feasible and reasonable" traffic management and noise reducing design opportunities have been incorporated into the road design, the RTA believes it is generally not "reasonable" to apply additional treatments such as noise barriers/mounds, quieter pavement surfaces and architectural treatment of private dwellings if the predicted design year noise levels:

- Do not exceed the ECRTN allowances (in column 4 of Table 1 in the ECRTN) over the "future existing" noise levels (the noise levels from existing sources of road traffic noise predicted for the time of project opening); *and*

- Will not be acute (i.e. the noise levels are predicted to be less than 65 dB(A) $L_{eq(15\ hour)}$ (day) and 60 dB(A) $L_{eq(9\ hour)}$ (night)).

If either of these two "exceptions" applies, no further investigation of noise controls is required.

The ECRTN also contains road traffic criteria for what it terms as "sensitive land uses". For an existing school the criterion is an internal noise level of 45 dB(A) L_{eq} (1hr). Where existing noise levels exceed the criteria, all feasible and reasonable noise control measures should be evaluated and applied. Where this has been done and the internal noise criteria cannot be achieved, the proposed road should be designed so as not to increase existing road traffic noise levels by more than 2 dB(A) for redeveloped roads.

The internal noise level refers to the noise level at the centre of the habitable room that is most exposed to traffic noise. In the case of buildings used for education or health care, noise level criteria for spaces other than class rooms and wards may be obtained by interpolation from the "maximum" levels shown in Australian Standard 2107 "Acoustics – Recommended design sound levels and reverberation times for building interiors.

Vibration – Construction and Operational

Various authorities have set maximum limits on allowable ground and building vibration in different situations. The DEC has limits for vibration in buildings set out in their "*Environmental Noise Control Manual*" (ENCM). These limits are directed at personal comfort for continuous and intermittent vibrations. **Table 3** shows the multiplying factors applicable in offices and workshops, taken from Chapter 174 of the ENCM, "Noise Control Guideline – Vibration in Buildings".

Vibration associated with passing heavy vehicles, or construction machinery, is considered to be intermittent in nature. Page 174-4 of the ENCM contains a set of curves for various situations as referred to in Table 3. As shown by the curve labelled 60, applicable for intermittent vibration for residential locations through the day, the maximum allowable acceleration at the lower limits between 4 Hz to 8 Hz is 0.5 m/sec^2. This equates to a maximum allowable z-axis velocity of approximately 8 mm/sec.

TABLE 3
DEC VIBRATION CRITERIA – Z-AXIS ACCELERATION LEVELS MULTIPLYING FACTORS

Area, Time	Continuous Vibration	Intermittent or Impulsive
Office – Day	4	128
Office – Night	4	128
Residential – Day	2	60
Residential – Night	1.4	20

There are a number of Standards designed for the assessment of damage to building structures. One that is most frequently referred to is German Standard DIN 4150: Part 3-1986 *Structural Vibration in Buildings – Effects on Structures*.

DIN 4150 presents a series of "safe limit" values below which no damage due to vibration has been observed. Damage is specifically defined as including minor superficial cracking, the enlargement of existing cracks in cement render and the separation of partitions from load bearing walls.

A summary of the relevant sections from DIN 4150 is shown below in **Table 4**.

TABLE 4 STRUCTURAL DAMAGE - SAFETY LIMITS FOR BUILDING VIBRATION					
Group	Type of Source	Vibration Velocity in mm/s			
		At Foundations		Plane of Floor of Uppermost Story	
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All Freqs
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in 1, or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

A more recent standard than DIN 4150 for assessing building damage is British Standard BS 7385: Part 2 – 1993 *Evaluation and Measurement of Vibration in Building part 2*. This standard was developed following a full review of available data, including other international standards, publications, and a review of UK data. The standard concludes by providing guidance for threshold values corresponding to the minimum risk of cosmetic damage from vibration.

A summary of the relevant sections from BS 7385 is shown below in **Table 5**.

TABLE 5 TRANSIENT VIBRATION LEVELS FOR COSMETIC DAMAGE			
Line	Type of Building	Peak Particle Velocity	
		4 Hz to 15 Hz	Greater than 15 Hz
1	Reinforced or framed structures. Industrial or heavy commercial buildings	50 mm/s	50 mm/s
2	Un-reinforced or light framed commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The standard specifically notes:

- Historic buildings should not to be assumed to be more sensitive to vibration (unless structurally unsound); and
- Structures below ground are known to sustain higher levels of vibration and are very resistant to damage, unless in poor condition.

As there are no specific vibration criteria relating to schools, that adopted here is for dwellings as described in Group 2 of Table 4 (above). This sets a maximum vibration velocity of 5mm/sec designed

to restrict structural damage. The detail in Table 3 shows that the criterion designed to satisfy human comfort levels for a residential area during the day is less than the structural damage criterion. It is, therefore, considered that the adopted criterion is the most restrictive and would satisfy both structural and comfort requirements for occupants of the school.

Construction

Noise emanating from construction sites in NSW is subject to conditions detailed in the ENCM. Section 171 of the ENCM specifies construction noise limits at the worst affected receivers as follows:

Level Restrictions

(i) *Construction period of 4 weeks and under*;

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).

(ii) *Construction period greater than 4 weeks and not exceeding 26 weeks*;

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).

Time Restrictions

- Monday to Friday – 7.00 a.m. to 6.00 p.m.
- Saturday – 7.00 a.m. to 1.00 p.m. if audible on residential premises, otherwise 8.00 a.m. to 1.00 p.m.
- No construction work to take place on Sundays or Public Holidays.

The authorities can approve works outside these hours, if it can be demonstrated that the construction activities will have negligible impacts on nearby residential dwellings. Permits are also granted where issues of safety require out of hours operations, or where construction work would result in major traffic disturbances.

Construction activities outside of the hours listed are required to meet normal planning levels applied to operation of an industrial development (typically background plus 5dB(A)). As the only

potentially affected receiver is at the school, which will be closed during the night, this impact of construction activities outside of the hours listed above is not considered further in this assessment.

Construction of the entire road upgrade will take longer than 26 weeks to complete. Works will be carried out in stages, however, with noise impacts in effect "moving" with the work. That is, individual houses, or groups of houses, will only experience elevated noise levels for that period time when construction work is passing in their vicinity.

This does not apply to the construction of overpasses which is confined to specific locations.

The aims and objectives of the construction noise criteria are to limit annoyance and to maintain the amenity of residents. It is in accordance to these objectives to impose a criterion at a residence that is applicable to that period of time when elevated noise levels are experienced.

Based on the background noise levels shown in **Table 2** of this report, construction noise criteria for the various monitored locations are shown below in **Table 6** for durations of less than 4 and between 4 and 26 weeks and greater than 26 weeks.

TABLE 6
CONSTRUCTION NOISE CRITERIA dB(A) L_{10}

Location	4 wks L_{10}	4 – 26 wks L_{10}	> 26 wks L_{10}
Herons Creek Public School	66	56	51

6.0 - ROAD TRAFFIC NOISE AND VIBRATION ASSESSMENT

Procedure

As described previously in this report the project area is predominantly with in the Burrawan State Forest and there are no residential receivers in the vicinity of the road upgrade. As a result traffic noise levels all residential receivers would comply with the criteria detailed herein and no further assessment of these is required.

The works would result in the near lane of the Pacific Highway being marginally closer to the school on its southern approach and in front of the school and marginally further from the school to its north. In addition there would be a new access road constructed to the east of the school and between it and the proposed realigned highway. This road would essentially carry local traffic only.

Predicted noise levels at the school were determined using the United Kingdom Department of Environment's Calculation of Road Traffic Noise (CORTN). These models are accepted by DEC and RTA.

Using the physical properties of traffic volume and mix, ground topography, road gradient, air and ground absorption and source and receiver height, scenarios were modelled using CORTN to predict the Leq (15hr) and Leq (9hr) noise indices. These indices were implemented in the ENM noise prediction programme to produce noise contours of existing and future noise levels. The modelling was based on variations in road alignment and configuration as per diagrams supplied by the RTA for road design.

CORTN shows predicted traffic noise levels at any selected receiver location, based on the physical properties described above. The CORTN model was set up with parameters to suit the existing situation and was checked for accuracy against the long term noise measurements that were made at the school.

Traffic volumes for this section of road were taken from data supplied by RTA from a traffic study undertaken for the project. The traffic study provided projected AADT volumes at Herons Creek which were extrapolated from traffic counting stations to the north and south of the site. AADT figures for the Pacific Highway are shown below in **Table 7**.

TABLE 7
PROJECTED AADT FOR PACIFIC HIGHWAY AT HERONS CREEK

Year	AADT
2005	12946
2010	15897
2020	21800

Future Existing Predictions (2010)

In some cases of road construction the opening of works can take place several years after initial noise logging (and hence determination of criteria) was carried out. In these situations noise levels at sites affected by existing road traffic noise will often increase because of an increase in traffic flow between the time of the original monitoring and the opening date.

To address this situation the ENMM details the concept of the "future existing" noise level. This is the noise level from existing sources of road traffic predicted for the time of project opening.

It is envisaged that works on the current project would commence in 2010. Predicted road traffic flows for 2010 have been used to determine future existing noise levels at the time of road opening.

Without any other variations that may affect the acoustic environment the predicted increase in traffic flow would lead to an increase in received noise of approximately 0.9 dB(A) by the year 2010.

Predicted Traffic Flow (2020)

Predicted traffic flows for 2020 have been used to determine traffic noise levels for that time assuming no construction or variations to the road network have taken place. Without any other variations that may affect the acoustic environment the predicted increase in traffic flow would lead to an increase in received noise in 2020 of approximately 1.4 dB(A) over those of the year 2010.

Construction Noise Assessment

Detailed design of the proposed works would be undertaken prior to the completion of final construction contracts. The successful tenderer would be responsible for determining construction methods. This assessment is, therefore based on the general type of construction activity likely to occur. The construction of the project would involve several phases, an initial earthworks and drainage phase, the construction of overpasses phase, and a pavement laying and landscaping phase.

The earthworks and drainage phase is expected to have the longest duration and also generate the highest construction noise levels. This phase would involve the use of a variety of earth moving machinery undertaking various operations to create the base for the additional carriageway.

The construction of overpasses would likely involve the use of plant such as concrete trucks and pumps, pneumatic and hydraulic hammers, mobile cranes etc.

Surface preparation of the road base would involve compaction with vibratory rollers and final laying of paving. This process would be shorter than the earthworks phase and the machinery would generally produce lower noise emissions.

Typical noise levels of construction plant items were sourced from data in the ENMM and from the Spectrum Acoustics technical database. Sound pressure levels for these at a distance of 7m are listed below in **Table 8**.

TABLE 8 SOUND PRESSURE LEVELS (at 7m)– CONSTRUCTION PLANT ITEMS	
Item	SPL dB(A)
Bulldozer	85
Excavator	80
Water Tanker	84
Grader	84
Concrete Pump	84
Paver	85
Vibrating Roller	82
Backhoe	83
Concrete Vibrator	87
Front End Loader	86
Dump Truck	83
Batching Plant agitator trucks	89
Compressor	80
Generator	86
Concrete Truck	85
Mobile Crane	85
Pneumatic Hammer	88
Concrete Vibrator	80
Concrete Pump	82

The sound pressure levels shown in Table 8 are maximum levels produced when the machinery is operating under full load. The construction noise criteria are set for noise levels determined as $L_{10\ 15\ minute}$. During a full 15 minute period the machinery items to be used on site would operate at maximum sound power levels for only brief stages. At other times the machinery may produce lower sound levels whilst carrying out activities not requiring full power.

In addition to this, mobile machinery would likely move about during the 15 minutes, variously altering the directivity of the noise source with respect to individual receivers.

The logistics of typical road construction work would mean that all of the plant items shown in Table 8 could not operate at the same time. To give a conservative (i.e. worst case) estimate of typical construction noise various configurations of machinery were considered.

Construction Vibration

Typical vibration levels of construction plant items listed below in **Table 9**. These levels have been used to determine potential impacts at nearby receivers.

TABLE 9 TYPICAL VIBRATION LEVELS – CONSTRUCTION EQUIPMENT	
Item	Peak Particle Velocity at 10m (mm/sec)*
Piling	12-30
15 tonne compactor	7-8
7 tonne compactor	5-7
Roller	5-6
Dozer	2.5-4
Backhoe	1
Loader breaking kerbs	6-8

*Source: RTA Environmental Noise Management Manual

7.0 - RESULTS

Road Traffic Noise

A comparison of noise levels for before and after road works are shown in **Table 10**. The results in Table 10 show the predicted future existing traffic noise level at 2010 and the modelled noise level 10 years after the completion of works in 2020 for the school.

TABLE 10 PREDICTED INCREASE IN NOISE LEVELS				
Location	$L_{Aeq(15\ hr)}$ Future Existing	$L_{Aeq(1\ hr)}$ Future Existing	$L_{Aeq(15\ hr)}$ Predicted	$L_{Aeq(1\ hr)}$ Predicted
Herons Creek School	57.9	57.9	60.1	60.1

The results show that the noise levels at the school would increase by slightly more than 2dB(A) as a result of increased traffic volumes and the post construction road alignment.

Construction

Construction noise levels have been predicted at a number of representative distances from the centre of road works. The noise levels from the various phases of construction activities have been determined.

For the initial earthworks phase of construction up to four plant items (eg a roller, dozer, grader and water cart) were considered to be working in close proximity. Such a configuration of machinery would result in sound pressure levels of about 93 dB(A) at 7m (i.e. a combined sound power level of 118 dB(A)).

Due to of the relatively short distance between the noise sources and receivers, the influence of variable meteorological conditions was not considered in the modelling. The calculations also do not take into

account the variable screening effects of topography or intervening structures (eg sheds etc) between the noise sources and the receiver.

Due to the relatively remote nature of the area the nearest residential receiver is approximately 250m from the closest parts of the construction site and Herons Creek Public School is approximately 100m from it. The majority of construction would be at distances greater than 500m from any residence or the school.

The results of the calculations are shown below in **Table 11**.

TABLE 11
TYPICAL CONSTRUCTION NOISE (EARTHWORKS PHASE)

Distance from Centre of Works	Predicted Noise dB(A) L_{10}
100m	70
250m	62
500m	56
1000m	50

On the whole noise from paving activities would be significantly lower than those for the general earthworks. In addition to this the paving works moves along the route at a faster rate and typically would impact on individual receivers for up to 2 weeks only. Based on the noise levels listed in Table 8 the predicted paving noise levels are shown in **Table 12**.

TABLE 12
TYPICAL CONSTRUCTION NOISE (PAVING PHASE)

Distance from Centre of Works	Predicted Noise dB(A) L_{10}
100m	62
250m	54
500m	48
1000m	42

The closest residence to the construction of the overpasses is approximately 1200m away near Herons Creek. Heron's Creek Public School is approximately 1100m from the site of the overpass construction. Based on the details in Table 8 a conservative sound power level of 117 dB(A) (or 92 dB(A) at 7m) was adopted for a scenario where a concrete truck, concrete pump, concrete vibrator, generator, compressor and pneumatic hammer were all operating, and producing maximum noise emissions, in close proximity. Results of calculations are shown below in **Table 13**.

TABLE 13 TYPICAL CONSTRUCTION NOISE (OVERPASS)	
Distance from Centre of Works	Predicted Noise dB(A) L_{10}
1100m	48
1200m	47

The location(s) of any batching plants is yet to be determined and would depend on contractor's requirements. The main source of noise from a batching plant comes from agitator trucks at high revs whilst being loaded and preparing to depart. Noise from the batching plant itself is relatively insignificant.

The number of trucks using the batching plant at any time would vary depending on the capacity of the plant and the stage of operations etc. A scenario of 3 trucks suing the batching plant at the one time has been assessed.

Predicted noise levels are shown in **Table 14**. These do not take into account any screening effects of the batching plant or buildings associated with it.

TABLE 14 TYPICAL CONSTRUCTION NOISE (BATCHING PLANT)	
Distance from Centre of Works	Predicted Noise dB(A) L_{10}
200m	68
500m	60
1000m	54

Construction Vibration

Typical vibration levels of construction plant items at a distance of 10m are listed Table 9.

As there are no residences within 10m of the construction area it can be seen from the above table that the only potential vibration impacts would arise from piling activities.

The attenuation of vibration through the ground is dependant upon site specific factors relating to the strata between the vibration source and receivers. In obtaining an initial indication of likely vibration levels, it can be assumed that the vibration level is inversely proportional to distance. That is, at double the distance from the source the vibration level will be halved.

This indicates that, even at the maximum listed vibration level for piling of 30mm/sec at 10m, received vibration levels would likely be below the criterion at all distances greater than 35m from the piling activity.

Based on the typical vibration levels shown in Table 9 received vibration levels would be less than a peak particle velocity of 5 mm/s at distances of approximately 15m from a 15 tonne roller and less than 12m from a 7 tonne compactor.

Road works with the potential to create vibration are to be carried out in rural areas where residences are generally greater than 10m from the road. To ensure compliance with the criterion, it is recommended that where the construction machinery listed in Table 9 (or other potentially vibration inducing machinery or processes) is to be operated within 15m of an existing building vibration monitoring be undertaken during the first phases of the use of that machinery. It is further recommended that, prior to any construction work being carried out, a dilapidation survey be carried where the construction machinery listed above (or other potentially vibration inducing machinery or processes) is to be operated within 15m of an existing building.

Vibration from Road Traffic

Vibration arising from vehicular movements along road corridors can be divided into the following two broad sources:

- The roughness of the road surface;
- Potholes, bumps or other surface discontinuities.

The site-specific measurements of vibration resulting from existing vehicular movements would indicate that the potential for excessive vibration from the operation of the re-aligned roadway is negligible.

Conservative calculations to determine the vibration arising from a continuous stream of heavy vehicles to residential receivers (10 m from the traffic stream) result in mid-span levels of less than 0.1 mm/s, readily complying with the criterion for residential receivers.

The presence of potholes can result in vibration levels that approach or possibly exceed the criterion, depending upon local parameters. A regular maintenance schedule program readily solves this potential aspect of vibration impact.

8.0 - ANALYSIS OF RESULTS

Road Traffic Noise

The analysis of traffic noise for the year 2020 (with road works completed) and 2010 (future existing) indicate that the project would

increase traffic noise by marginally more than 2 dB(A) at the outside façade of the Herons Creek School.

Noise treatment options for the school would require individual assessment. As the criteria for this is an internal noise level the amount of noise reduction required to meet the relevant criterion would depend on the acoustic integrity of the current façade.

The results in Table 10 show that the façade of the school would need to attenuate at least 15 dB(A) to achieve compliance. Typically the façade of a light framed building will achieve an internal traffic noise reduction of 10 dB(A) with the windows open sufficient to attain adequate air flow. The same façade will typically achieve a 20 dB(A) noise reduction with windows closed.

The noise level would also be 60dB(A) $_{LAeq\ (1hr)}$ outside of the school. This is 5 dB(A) over the applicable criterion for such an area. The actual noise level in the school playground would be dependant upon the orientation of the school buildings and intervening structures between the playground and the road.

The most likely option for noise control to affected external play areas would be the construction of an acoustic barrier along the edge of the road corridor. The assessment of the suitability of an acoustic barrier for noise control would be dependant upon factors such as which areas outside the school are used as play areas, the orientation of the school buildings and intervening structures between the playground and the road the views and wishes of the school and the community. It would also depend upon the topography of the ground and the actual distance between the roadside and the play areas.

As a rule of thumb any acoustic barrier that breaks the line of sight between a noise source and a receiver will reduce received noise by approximately 5 dB(A).

An assessment of the feasibility and reasonability of any proposed barrier would be required to be undertaken upon completion of final road design which would define such factors as the location of the road in the corridor, its RL and the appropriate location of a barrier in relation to road services etc and the RL of the roadside in this location.

Construction Noise

Construction noise levels have been shown to be at or above the 4 – 26 week construction noise criterion at the closest residential receivers and the school whilst construction is underway near the southern extents of the proposal area. These have the potential to cause some

short-term impacts as works approach or recede from individual residences or the school.

Due to the nature of construction work, noise exceedances would likely be sporadic in nature. That is, received noise levels will be dependant upon factors such as;

- The location and proximity to each other of various plant items
- What work is being undertaken at any given time and whether it involves all machinery operating at the maximum sound power levels modelled.

In addition, any impacts on individual residences are likely to be short term only as the construction works are carried out along the northern sections of the road corridor.

The following general recommendations are, therefore, detailed as being applicable to the site.

It is recommended that close liaison with the potentially affected receivers be initiated at the earliest opportunity. Of particular import would be contact with representatives of the school.

Once informed of the project description and aims, the community should be given progress updates at regular intervals or at particular milestones. A contact name and phone number of a responsible person should be given out so that complaints can be dealt with effectively and efficiently. All complaints or communication should be answered.

All personnel working on the job including contractors and their employees should be made aware of their obligations and responsibilities with regard to minimising noise emissions.

Contractors should familiarise themselves with methods of controlling noisy machines and alternative construction procedures. These are explained in AS2436-1981 “Guide to Noise Control on Construction, Maintenance and Demolition Sites”.

Activities that are known or have the potential to create excessive noise should, where possible, be scheduled to occur at times to cause least annoyance to the community. Carrying out such work during early morning should be avoided. This includes start up and idling etc. of heavy machinery prior to commencement of work.

If noisy activities are identified to be carried out in the vicinity of the school, then consideration should be given to carrying out these activities outside of school hours or during school holidays.

If noisy activities must be carried out then a responsible person should inform people in potentially affected residences and also convey to the contractor any special needs of the public.

Regular and effective maintenance of all equipment including vehicles moving on and off the site should be conducted. Prompt attention must be given to repair of loose or rattling parts and broken equipment. All maintenance work should only be carried out by qualified persons.

Mechanical plant should be silenced using best available control technology. Noise suppression devices should be maintained to manufacturer's specifications. Internal combustion engines should be fitted with appropriate, well maintained, high efficiency mufflers.

When selecting contractors and/or equipment for the job, preference must be given to those with capacities best suited to the task at hand. That is the use of larger machines with excess capacity should be avoided unless these can be shown to be quieter than smaller capacity machines.

Machines that are used intermittently such as dozers, graders, rollers, some trucks etc should either be shut down in the intervening periods between work or throttled down to a minimum.

Consider alternatives to reverse alarms such as manually adjustable or ambient noise sensitive types ("smart" reversing alarms). Alternative site management strategies can be developed, in accordance with a site OH & S Plan, with the concurrence of the appropriate OH & S Officer.

Any portable equipment with the potential to create high levels of noise eg compressors, generators etc should only be selected for use if it incorporates effective noise control. This equipment should be located where practical so that natural ground barriers or site sheds etc are between it and the nearest potentially affected receivers.

Noise from batching plants has the potential to exceed long term construction noise goals at a considerable distance from the plant. As discussed the results shown on Table 14 do not make allowance for screening effects of the plant or buildings etc.

The location and orientation of any batching plants should, therefore, be considered with noise emissions and receiver locations ain mind.

Plants should be located as far from any residences as is practicable. The layout of the plant should be designed such that the engines of agitator trucks are oriented away from residences whilst they are being loaded and are they are producing maximum sound levels.

A detailed noise impact assessment of the final location and design of any batching plants should be undertaken prior to installation.

Should it be determined that noise control is required to attenuate traffic noise levels at the Herons Creek School then this should be carried out at the earliest opportunity during the construction phase and, hence, act to minimise potential construction noise impacts.

9.0 - REFERENCES

Environment Protection Authority (EPA), 1994. Environmental Noise Control Manual, Sydney.

Environment Protection Authority (EPA), 1999. Environmental Criteria for Road Traffic Noise, Sydney

Environment Protection Authority (EPA), 2000. NSW Industrial Noise Policy, Sydney.

Roads and Traffic Authority (RTA) 2001 RTA Environmental Noise Management Manual, Sydney

APPENDIX I

NOISE LOGGER CHART

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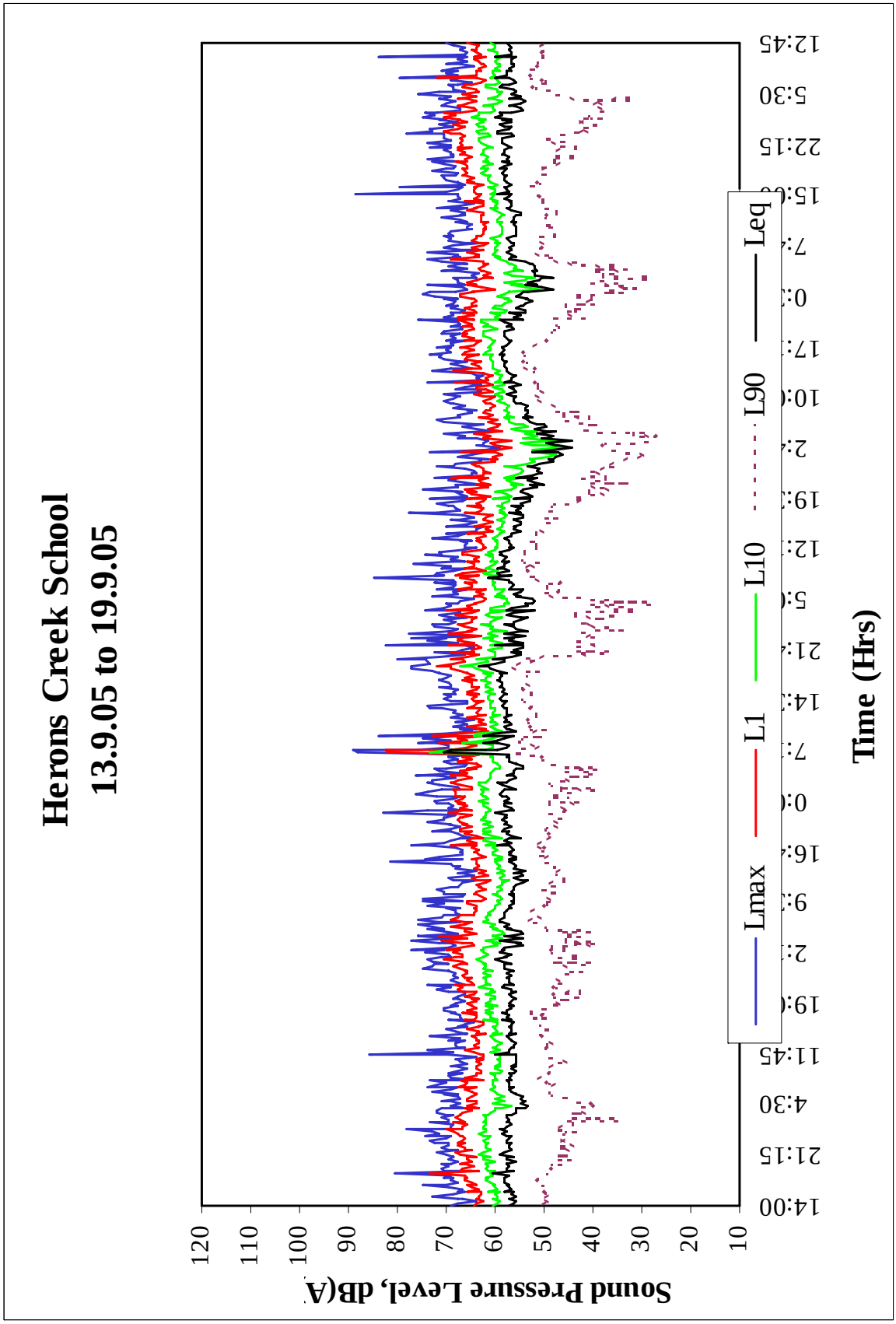
Herons Creek School
13.9.05 to 19.9.05
Sound Pressure Level, dB(A)
120
110
100
90
80
70
60
50
40
30
20
10
Time (Hrs)
14:00
21:15
4:30
11:45
19:
2:
9:
16:
0:
7:
14:
21:
5:
12:
19:
2:
10:
17:
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7:
15:
22:15
5:30
12:45
Lmax
L1
L10
L90
Leq

APPENDIX II

NOISE LOGGER PHOTOS

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View of Pacific Highway from noise logger

Not to scale

FIGURE 1

Site Location Plan

Not to scale

LEGEND:

✕ Noise logger

FIGURE 3

Noise Logger Location

Herons Creek to Stills Road

Review of Environmental Factors – Appendix E

Traffic study.

January 2007

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RoadNet

Traffic Study

Proposed Upgrading of Pacific Highway Herons Creek to Stills Road, Herons Creek

for

RTA Technology and Technical Services, Business Section, Hunter Region

27th February 2006

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Appendix A Plan showing Upgrade Options
Appendix B Economic Analysis
Appendix C Volumes for Noise Assessment

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EXECUTIVE SUMMARY

Introduction

The RTA is investigating road improvements to the Pacific Highway between Herons Creek and Stills Road, Herons Creek, a distance of approximately 3.44km. The section is currently dual carriageways, however the northbound carriageway is of lesser standard having previously been a section of two way Highway. The road alignment contributes to the relatively high accident rate on the section. The project is being developed to improve the alignment of the northbound carriageway, reduce accidents, rationalise property access and upgrade intersections.

The project essentially involves upgrading the northbound carriageway by constructing a new carriageway parallel to the relatively recent southbound carriageway, constructed during the 1980s. This would form the first part of a possible staged upgrading where intersections and access arrangements would be progressively improved. Two main options are proposed, 'A' class with at grade intersections, and 'M' class with access control and grade separation.

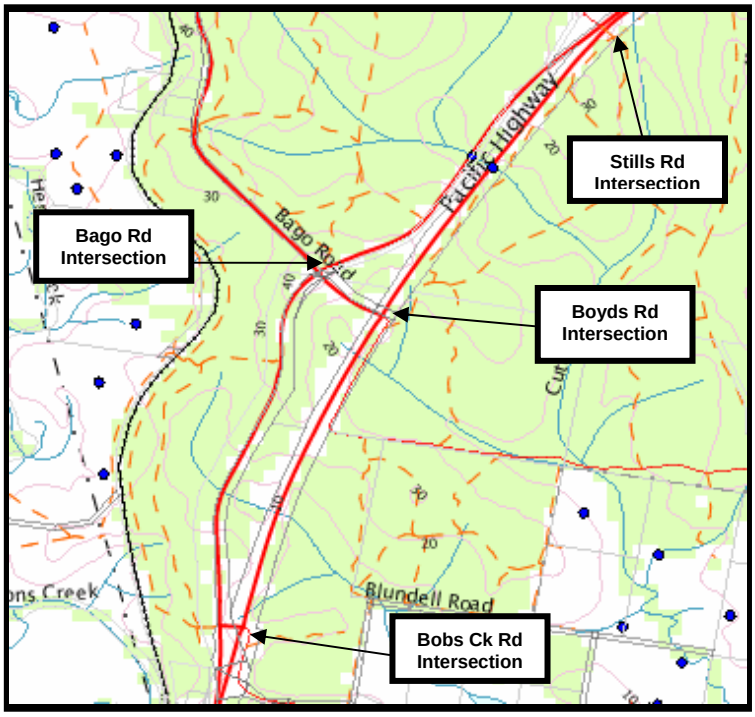
The project may also be staged from the 'A' class to the 'M' class option. The RTA is planning for the long term by incorporating future service roads so that the dual carriageway lengths of the highway can be upgraded to a 'M' class motorway standard when required. The 'M' class option is designed to 110km/hr and requires alternative routes to be available for local traffic through the provision of service roads or local road networks. The local access to the motorway would be via a grade separated interchange located between Bago Road and Bobs Creek Road with separate service roads incorporated for local traffic.

It is assumed for analysis purposes that construction will commence in 2009 and be completed in 2010.

This traffic study contains traffic data, traffic modelling and economic analysis that are used to justify the project and to assist in the design of the road and intersections.

Traffic volumes have been obtained from historical data and recent traffic counts. Traffic projections have been made with regard to growth in through traffic and future urban development in the Hastings Local Government Area.

Figure 1 - Study area



Traffic Volumes

Table 1 shows projections of future traffic volumes on the Pacific Highway at Herons Creek based on a projection of historical traffic data from nearby permanent counting stations. Tables 2 & 3 show the level of service.

Table 1 – Projected AADT and 100th Highest Hour

Projected AADTs at Bobs Ck Rd

Year	AADT
2005	12946
2010	15897
2020	21800
2030	27702

Directional Splits - 100th Highest Hour

Year	Veh/ Hour	30% split	70% split	50% split
2005	1368	410	958	684
2010	1680	504	1176	840
2020	2304	691	1613	1152
2030	2927	878	2049	1464

The northbound carriageway will be transformed into a two-way service road for both the 'A' and 'M' class options. Traffic volumes will be different for the two options because more restricted access control is provided on the 'M' class option, particularly on the western side.

For the 'M' class option the western service road will carry traffic from Herons Creek Village as well as the school, LALC and Burrawan Forest Drive. The estimated volumes are shown in Table 2. The eastern service road will carry lower volumes and will therefore also operate at LOS 'A'.

Table 2 – Projected daily volumes & LOS on Western Service Road

	'A' Class Option	**'M' Class Option**
2010 LOS	200 A	1500 A
2020 LOS	250 A	2063 A
2030 LOS	300 A	2436 A

Road Capacity

The Level of Service (LOS) for the predicted future Highway traffic volumes is shown is Table 3. Traffic flow modelling indicates that this section will meet the requirement to provide LOS C (or better) up until at least 2030.

Table 3 - Projected Volumes and Level of Service (LOS) - Worst Case Split (70/30)

YEAR/OPTION	Pacific Hwy at Bobs Ck Road (Two Way Daily Flow)	Pacific Hwy at Bobs Ck Road (One Way 100th Highest Hour)
Existing Road		
2005	12946	958
LOS NB C/way	A	A
LOS SB C/way	A	A
2010	15897	1176
LOS NB C/way	B	B
LOS SB C/way	B	B
New Road		
2010	15897	1176
LOS 'A' Class	B	B
LOS 'M' Class	B	B
2020	21800	1613
LOS 'A' Class	B	B
LOS 'M' Class	B	B
2030	27702	2049
LOS 'A' Class	C	C
LOS 'M' Class	C	C

Intersection Capacity

Modelling indicates capacity issues are likely to develop by year 2015 at existing junctions for the design hour, with intersections failing by year 2020 (LOS 'F'), unless grade separation is provided.

Intersections in the 'A' class option are expected to operate only slightly better than existing intersections. As with the existing situation capacity issues are likely to develop by year 2015 with intersections failing by year 2020 (LOS 'F'). By this stage the 'M' class option is likely to be constructed.

All intersections in the 'M' class option are expected to operate satisfactorily up to 2030.

Travel Times

Modelling of traffic flows on the existing and proposed highway indicates that average travel speeds on the northbound carriageway will increase from 95kph (100kph posted speed limit) to 105kph (110kph posted speed limit) when the upgrade is complete. Average travel speeds on the southbound carriageway will increase from 100kph (100-110kph posted speed limit) to 105kph (110kph posted speed limit). The new northbound carriageway will also be 220m shorter than existing. These improvements represent a saving of 16 seconds per vehicle for northbound traffic and 5 seconds per vehicle for southbound traffic.

Travel time savings will be relatively minor for this 3.44km long section of highway but when combined with other savings along the Pacific Highway will be significant in aggregate.

There will also be travel time savings for side road traffic entering the Highway. This will result from decreases in delays due to intersection upgrades. These savings will be relatively minor for

the 'A' class option however savings will be much higher for the 'M' class option due grade separation.

Accident Analysis

Accident data on the section of Pacific Highway from Stills Road to Bobs Creek Road, Herons Creek was analysed over the 4.75-year period from 19 July 1999 to 7 April 2004. In this period there were 36 reported accidents with 2 fatalities, 14 injury accidents (23 injuries) and 20 tow aways.

Figure 2 - Accidents

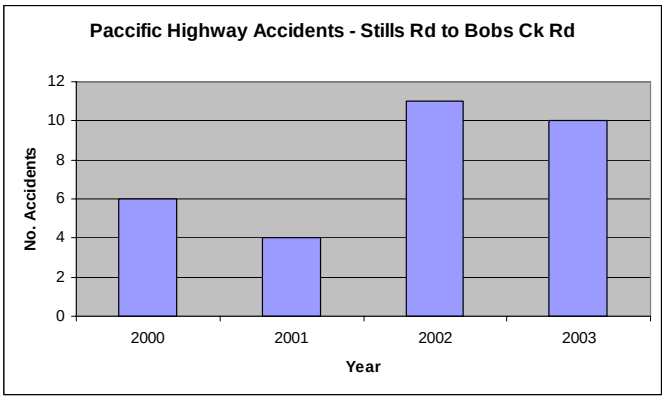


Table 4- Accident Severity by year

Accident Severity	Pacific Highway - Stills Road to Bobs Creek Road			
	2000	2001	2002	2003
Fatal Accident	0	0	2	0
Injury Accidents	2	2	5	2
Towaway	4	2	4	8
Total	6	4	11	10
AADT	10102	10666	11229	11792

* Note – only years with full data are shown.

Analysis of existing accident data and consideration of the nature of the new road indicate that there will be a considerable improvement in the safety performance of the improved road when compared to existing accident rates.

At present, there are 58 accidents per 100MVK on the section. On the basis of comparison with similar roads carrying similar traffic volumes, it is predicted that accident rate on the new road for the 'A' class option will fall to 30 per 100MVK and for the 'M' class option 15 per 100MVK. This represents a saving of at least 4 accidents per year. This is a significant reduction because the accidents are of the more serious nature being fatal, injury or tow away.

Economic justification

The overall economic efficiency of the Project has been examined based on RTA's estimate of cost for the project. This is reflected in the achieved Benefit Cost Ratio (BCR).

Based on costs provided by the RTA, BCR's for the three options are calculated as:

- The 'A' class option - BCR of 1.61
- The 'M' class option - BCR of 2.68
- The 'A' to 'M' Staged option - BCR of 3.01

A key funding requirement for road projects is to provide a return to the community of at least twice the investment. In other works the project should achieve a BCR of 2 or higher. The project will not provide such a return to the community for the 'A' class option with a BCR of 1.61. However both the 'M' class option and staged option will provide a high return on investment showing BCR's of 2.68 and 3.01 respectively.

Cyclists, Pedestrians and Buses

Provision is made in the design for cyclists to safely travel along the corridor by way of a 2.5m wide sealed shoulder. Squeeze points would be avoided in the detailed design (for example at drainage structures or bridges) unless suitable alternative arrangements are made for cyclists. Road crossing points would be limited to intersections at which provision would be made for safe pedestrian and cycle access.

Buses will travel along the deviation but it is unlikely that they will stop. It is expected that all bus stops would be on the local road network.

Pedestrian activity on the deviation would be minimal due to limited access. Accordingly, there is no special provision made for pedestrians. A 2.5m wide sealed shoulder will be provided where pedestrians can walk clear of the traffic if necessary.

Cumulative impacts on the road network

This project will provide only a small improvement to travel time but will have a significant improvement to safety. Together with other improvements to the Highway this project will have the cumulative effect of providing a route that is more attractive to potential users. It will facilitate additional travel on the Highway for tourist and for the movement of freight. It will marginally reduce the cost of travel for road users.

There does not appear to be any adverse cumulative impacts resulting from the proposal.

1 INTRODUCTION

The RTA is investigating road improvements to the Pacific Highway between Herons Creek and Stills Road, Herons Creek, a distance of approximately 3.44km. The section is currently dual carriageways however the northbound carriageway is of lesser standard having previously been a section of two way Highway. The road alignment contributes to the relatively high accident rate on the section. The project is being developed to improve the alignment of the northbound carriageway, reduce accidents, rationalise property access and upgrade intersections.

The project essentially involves upgrading the northbound carriageway by constructing a new carriageway parallel to the relatively recent southbound carriageway, constructed during the 1980s. This would form the first part of a possible staged upgrading where intersections and access arrangements would be progressively improved. Two main options are proposed, these are the 'A' class with at grade intersections, and the 'M' class with access control and grade separation.

The project may also be staged from the 'A' class to the 'M' class option. The RTA is planning for the long term by incorporating future service roads so that the dual carriageway lengths of the highway can be upgraded to a 'M' class motorway standard when required. The 'M' class option is designed to 110km/hr and requires alternative routes to be available for local traffic through the provision of service roads or local road networks. The local access to the motorway would be via a grade separated interchange immediately south of Bago Road with separate service roads incorporated for local traffic.

The project requires an Environmental Impact Assessment (EIA) to be prepared as part of the approvals process. The EIA considers many issues including traffic, transport and economic analysis. RoadNet Pty Ltd has been engaged by the RTA Technology and Technical Services, Business Section, Hunter Region to carry out a traffic study and economic analysis for the preferred option.

A detailed assessment process was undertaken that examined various access arrangements to ensure that the 'Preferred option' best meets current social, economic and environmental objectives. The RTA undertook this selection process.

This traffic study provides existing and future predicted traffic volumes, analysis of intersection performance and includes an economic analysis on the preferred option. The study also examines traffic impacts relating to construction and staging.

The report has been prepared with reference to RTA Guidelines, Austroads Guidelines, Australian Standards, Council's Codes and Department of Planning EIS Guidelines.

2 SCOPE

This report contains:

- A description of the Traffic/Transport requirements on a local, regional and state basis;
- A review and full consideration of existing traffic studies;
- A detailed analysis of the traffic accident history of the section of existing Pacific Highway within the Study Area and of specific locations within that section;
- Consideration of:
    1. Level of Service requirements;
    2. Interchange/intersection options, both location and form;
    3. Property access;
    4. Public transport requirements;
    5. Cyclists/pedestrians;
    6. Heavy vehicles;
- Traffic modelling;
- Intersection modelling;
- Economic analysis;
- An assessment of potential impacts on traffic flows during construction.

3 METHODOLOGY

3.1 Review of existing traffic studies

The traffic volumes used in this study have been obtained from historical count data contained in the RTA's Traffic Volumes Publication and other Pacific Highway Planning Studies.

Reference is also made to existing reports such as:

- Sinclair Knight Merz. ' Pacific Highway Upgrade Johns River to Herons Creek. Traffic Working Paper'. June 2001.
- Sinclair Knight Merz. 'Cumulative Impacts Assessment on the Pacific Highway'. June 2000.
- SMEC. ' Hastings Road and Traffic Study. 2001.
- Auslink Green Paper. 2001.

3.2 Accident Analysis

A detailed analysis of the traffic accident history of the section of the existing Pacific Highway within the Study Area has been made. This has been carried out on the basis of accident data covering the five-year period from July 1999 to April 2004.

The analysis involves examining all elements of the accident records such as time of day, weather conditions, type and severity of accident, traffic units involved, age of driver and accident location within the study area.

Predicted reductions in the number of accidents on the section are used as part of the justification of the project.

3.3 Traffic Data Collection and Analysis

Existing conditions have been quantified by way of vehicle classification traffic counts taken on the northern and southern sections of the project during 2005.

Council has provided classification counts taken on the Pacific Highway either side of the Study Area in April 2005.

RoadNet carried out peak hour intersection counts at the four junctions on the section in February 2005.

Future volumes have been predicted from historic traffic data and from discussions with Council personnel in relation to future development in the immediate locality and in major centres such as Wauchope and Port Macquarie.

Future conditions have been modelled for 10, 20 and 30 years into the future.

3.4 Traffic modelling

Traffic modelling has been carried out to determine the:

- Performance of the section of Highway in terms of travel speeds and Level of Service.
- Performance of intersections.

The performance of the section has been assessed using the Florida Department of Transport Level of Service software, which is based on the Highway Capacity Manual.

The performance of proposed intersections has been modelled using the SIDRA model.

3.5 Economic Analysis

An economic analysis for the Project has been carried out in accordance with the RTA's Economic Analysis Manual, 2004. Costs were based on December 2003 figures updated to June 2005 $. The objective is to generate an economic model for the project that provides a Benefit/Cost ratio that will give an indication of the economic viability of the proposal.

This has been done by quantifying the difference in performance between the existing and proposed traffic arrangements in the Study Area, applying a factor for expected traffic growth and carrying out an analysis in terms of the Economic Analysis parameters. Results are provided in terms of benefit cost ratio and first year rate of return.

This essentially means measuring the difference in travel times along the Highway between the existing arrangement (that has reduced speed limits) and the proposed arrangements (with a desirable 110kph speed limit), plus the difference between the existing cost of accidents and the predicted safer arrangements, plus the expected improvement in riding quality of the new road (which will reduce the wear and tear on vehicles and reduce fuel usage due to improved alignment).

The difference between existing delays and predicted delays for side road traffic at intersections is also considered. Although modelling of existing conditions predicted very high future delays, worst delays have been assumed to be 240 seconds. This assumes vehicles will accept delays of 180 seconds, after this they will find other routes to take. Other routes may increase travel times by 60 seconds. Therefore maximum delays have been assumed to be 240 seconds.

Estimates of cost included in the analysis are to a strategic level of confidence and have been provided by the RTA.

It is assumed only for the purposes of modelling that construction will commence in year 2009 and would become available to traffic in 2010 for both the 'A' class and 'M' class options. Staging from the 'A' to 'M' class option is assumed to occur in 2020.

Other assumptions are detailed in the section 7.2 Traffic Modelling Assumptions.

3.6 Traffic impacts during construction

The project is likely to be staged. The new northbound carriageway would be installed in the first instance with 'at grade' intersections. A grade separated interchange would then be provided to cater for Bago Road traffic.

Together with the above staging, the method and duration of construction, and sources of fill material has been considered in the assessment of traffic and safety impacts.

3.7 Justification of the Project

Justification of the project was determined in this traffic study in several ways. Both options will:

- Improve safety by reducing the number of accidents to a rate consistent with other sections of dual carriageway on the Pacific Highway;
- Improve capacity of intersections;
- Improve travel times;
- Provide a positive return on investment for the 'M' class and 'A' to 'M' Staged options (based on RTA's estimate of cost), i.e. a Benefit Cost Ratio greater than 2.

An assessment of the "do nothing" option has been undertaken in general terms to set the context for considering the proposed upgrading.

4 THE PROPOSAL

4.1 Location

The section of highway to be upgraded extends from the existing alignment at the bridge over Herons Creek to the existing dual carriageway alignment approximately 3.44km to the north at Stills Road. The section is currently a dual carriageway road.

The southbound carriageway was constructed in the 1980's on a high standard alignment designed to form part of a future dual carriageway road. The northbound carriageway is of lesser standard having previously been a section of two way Highway. It was retained to provide overtaking opportunities when the southbound carriageway was constructed.

The section of Highway to the south of Herons Creek is currently a single carriageway two lane road. The RTA has a proposal to upgrade the section to dual carriageway standard, however no time frame is set. The section to the north of Stills Road is a high standard dual carriageway Highway.

The purpose of this current proposal is to provide a road with a standard of travel consistent with the sections of dual carriageway already existing to the north of Stills Road and the proposed new section of dual carriageway to the south of Herons Creek.

Appendix A contains an aerial photograph showing the new alignment and options.

Figure 3 – Study Area

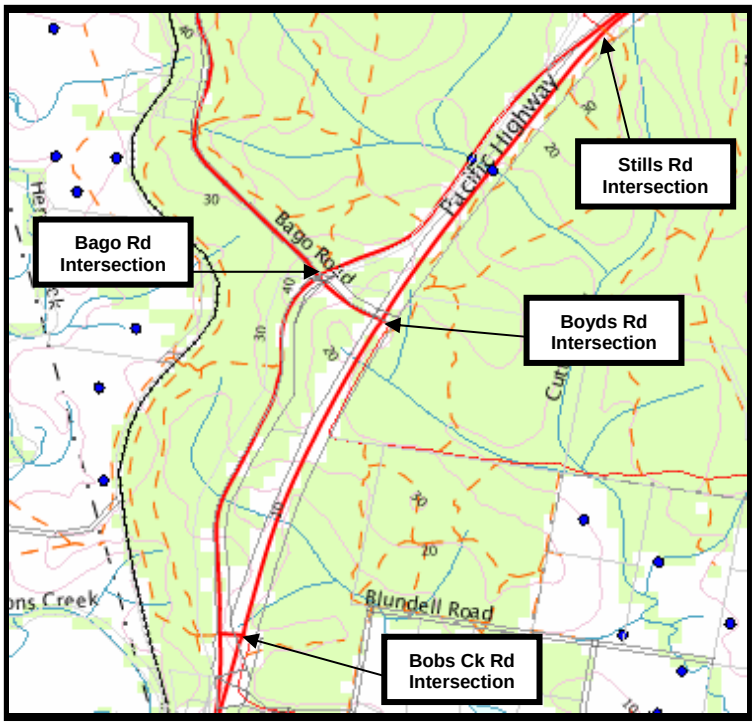


Figure 4 - Locality Sketch

4.2 Description of Proposal

The existing northbound carriageway of the Pacific Highway at Herons Creek was formerly a two-way section of the Highway and has an undulating and winding alignment. A new carriageway is proposed to replace this carriageway to make the Highway an access controlled four-lane Highway to 110km design speed.

The project essentially involves constructing a new northbound carriageway parallel and west of the relatively recent southbound carriageway constructed during the 1980s.

The proposed upgrading of the Pacific Highway will provide a controlled access road which will restrict property access to service roads that will link to controlled intersections.

Two main options are being considered that relate to the level of access. These are the 'A' class (arterial) Road and 'M' class (motorway) Road options. The 'A' class option is essentially a staging option for the 'M' class option.

The **'M' class option** would require that all turning traffic on the section use a new interchange immediately south of Bago Road. Service roads would be provided on both sides and existing intersections and accesses closed. The interchange would be 'Dumbbell' design with a single lane roundabout on each side to control traffic on the ramps and service roads.

The existing northbound carriageway would be transformed into a service road to provide access to properties, Bago Road, Burrawan Forest Drive, Herons Creek School, Bunyah LALC and Herons Creek Road. Herons Creek Road leads to Herons Creek Village. The service road would include a new bridge across Herons Creek.

An eastern service road would connect Bobs Creek Road to the interchange. Boyds Road would link into the service road and the existing junction with the Highway closed.

The **'A' class option** would allow staged upgrading to eventually achieve the 'M' class option. The 'A' class option would retain some 'at grade' intersections and modify others before ultimately providing a new interchange at Boyds Road as part of the 'M' class option.

The existing Bago Road junction with the southbound carriageway would be upgraded to a seagull. The Boyds Road access located opposite would be restricted to left turns only. The existing Bago Road intersection with the northbound carriageway would be modified to suit new traffic arrangements and a roundabout installed. A seagull would be provided at Bobs Creek Road.

The existing Stills Road intersection would be limited to left turns only. Burrawan Forest Drive would be connected to a proposed service road (redundant northbound carriageway) and gain access via Bago Road.

Herons Creek School and Bunyah LALC accesses would be closed and they would gain access to the western service road via Bago Road or Herons Creek Road.

A future interchange would be as for the 'M' class option described above. Treatment of Herons Creek Road and the bridging of Herons Creek may require refinement. For the 'A' class option Herons Creek Road would have a seagull treatment located to the south of its present site.

End treatments will be common to both options. The existing Highway on the southern end is currently a single carriageway two lane road. This is planned to be upgrade to a dual carriageway standard as part of the Pacific Highway Upgrade, Moorland to Herons Creek. This project also has two major options relating to 'A' and 'M' class designs. At this stage the southern section of the Moorland to Herons Creek Pacific Highway Upgrade proposal is likely to be constructed prior to this project.

The proposed northbound carriageway would link into an existing high standard dual carriageway section on the northern end.

See Appendix A for 'M' class option Layout Plans.

4.3 Review of existing traffic studies

4.3.1 Arup Transport Planning. ' Pacific Highway Upgrade – Moorland to Herons Creek. Preferred Option – Working Paper – Traffic and Transport. December 2004.

The Study examined traffic volumes and patterns generally of the Pacific Highway between Moorland and Herons Creek.

The Study makes reference to the Cumulative Impacts Assessment for the Pacific Highway undertaken by Sinclair Knight Merz in year 2000. On the basis of that report and other analysis it was predicted that the Highway at Kew (21km to the south of the study area) would have a year 2021 AADT of 25,720 which equates to a 4.3% traffic growth rate between 1999 and 2006 and a 2.7% growth rate between 2007 and 2021.

The study also identified that the existing Highway between Moorland and Herons Creek operates at a LOS E – at capacity and incidents will cause excessive delays. This did not take into account overtaking lanes available in this section that provide some additional capacity.

4.3.2 Sinclair Knight Merz. 'Cumulative Impacts Assessment on the Pacific Highway'. June 2000.

The Study identified that the Highway at Nabiac would have a year 2020 AADT of 21,380 which equates to a 3% compound or 4.2% linear growth rate.

This equates to an AADV of 16,446. The design hour volume (30^{th} highest hour = 15% of AADV) in year 2020 was calculated as 2,467 (two way) and 1,480 (peak direction).

4.3.3 SMEC. ' Hastings Road and Traffic Study. 2001.

The Study examined traffic volumes and patterns generally through the locality and specifically on several roads including the Pacific Highway.

4.3.4 Auslink Green Paper. 2001.

The Study identified a significant increase in the movement of freight along the Pacific Highway by year 2020. The traffic implications have been taken into account for this project.

4.3.5 Hastings Urban Growth Strategy. 2001.

The study indicated the population of the Hastings Local Government Area will grow at 2.5% linear over the next 15 years.

5 EXISTING ROAD AND TRAFFIC CONDITIONS

5.1 Description of the Study Area

The section of Pacific Highway subject of this study is rural in nature passing through forested areas on both sides.

On the southern end to the south of Herons Creek bridge is Herons Creek Road which leads to the small village of Herons Creek. This intersection is contained within another project - Pacific Highway Upgrade, Moorland to Herons Creek.

The Highway diverges into two carriageways just to the north of the two-lane bridge over Herons Creek.

Herons Creek Public School and Bunyah LALC are also located off the Highway on the southern end where the road diverges. These establishments have direct access onto the Highway on the western side.

Intersections with the Highway from south to north are described in the following. Bobs Creek Road is located to the north of the school access on the eastern side. It services a number of rural properties and provides access to the State Forest. Widened sealed shoulders are provided at both the School and Bobs Creek Road access but with no special provision for turning traffic. Bobs Creek Road is also located at the end of the southbound merge from two lanes to one.

Boyds Road is also located on the eastern side to the north of Bobs Creek Road and directly opposite Bago Road. A wide median area exists between the Highway carriageways thereby creating two separate intersections. Boyds Road provides access to rural properties and the State Forest. Bago Road is an important road through to the town of Wauchope. The Bago Road intersection requires special mention because it has an adverse accident history.

The Stills Road / Burrawan Forest Drive intersection is located on the northern end of the project. Stills road is a forest access track to the east and Burrawan Forest Road is an old highway alignment, which is now used as a forest access road leading to the Oxley Highway.

Major towns in the vicinity of the site include Port Macquarie 22km to the turnoff at the Oxley Highway and then a further 10km to the town centre; Wauchope 17km to the northwest along Bago Road; Kew 21km to the south and Taree 70km to the south. Bago Road is used as an alternative to the Oxley Highway, which joins the Pacific Highway 22km to the north and then a further 9km to Wauchope, a total of 31km. The turnoff to the village of Herons Creek is on the southern end of the section.

5.2 Regional Road Network

5.2.1 Pacific Highway

The Pacific Highway is the major highway travelling north south in NSW linking Sydney and Brisbane. It is an important arterial connection within the overall state network. In this role, the Pacific Highway provides a high standard of accessibility for heavy commercial vehicles, light commercial and passenger car traffic.

The Highway is currently dual carriageways. The northbound carriageway was previously a two-way two-lane section of the Highway and is on a winding and hilly alignment. It was transformed into the northbound carriageway when the southbound carriageway was constructed in the 1980s. The northbound and southbound speed limit through the study site is 100kph, which increases to 110kph to the north of the site. The southbound carriageway is a modern standard highway on a good vertical and horizontal alignment.

5.2.2 Bago Road

Bago Road is a two-lane rural local road that runs in a north-south direction from the Pacific Highway at Herons Creek to Wauchope, a distance of 17km.

Hastings Council advises that counts undertaken in March 2000 on Bago Road showed 1089 vehicles, which included 142 heavy vehicles.

Businesses that specifically rely on access via Bago Road include:

- Bago Gravel Quarry is located in Milligans Road off Bago Road. The operator advises that the quarry is used each day by 3 to 5 trucks (6 to 10 trips) depending upon weather and demand for the product. The trucks all use the Pacific Highway.
- Forestry / logging is conducted in the State Forest. For approximately half of the year log trucks use Bago Road and the Highway. When in operation, approximately 6 trucks per day use the intersection. They turn in all directions.
- Boral Concrete also uses Bago Road and the Highway intersection on a daily basis.

5.3 Local Road Network

5.3.1 Boyds Road

Boyds Road is located opposite Bago Road. The two intersections form two separate cross intersections separated by a connection road across the median for distance of 250m.

Boyds Road carries low traffic volumes as indicated by the traffic counts in Figure 4. There were 4 vehicles in and 3 out in the am peak and 1 in and 1 out in the pm peak.

5.3.2 Bobs Creek Road

Bobs Creek Road mainly serves residential dwellings from the Pacific Highway and has low traffic volumes.

Bobs Creek Road and Pacific Highway intersection is a T intersection with a relatively large median storage area. The median storage area is adequate to cater for the low volumes of vehicles accessing the road.

5.3.3 Herons Creek Road

Herons Creek Road is located to the south of the project. It leads to the Village of Herons Creek and to Herons Creek Mill. The Mill Manager advises that up to 50 large trucks (semis and B-Double) enter and leave the mill each day.

5.4 Existing Traffic Volumes

5.4.1 Intersection counts

Peak hour traffic counts were taken at all intersections on the study length of the Pacific Highway in February 2005 for morning and evening peak hours. Refer to Figures 5 to 8. Side road activity would be highest during these periods however highway flow is often higher during the middle of the day.

Figure 5 - Traffic count at Bago Road / Pacific Highway intersection

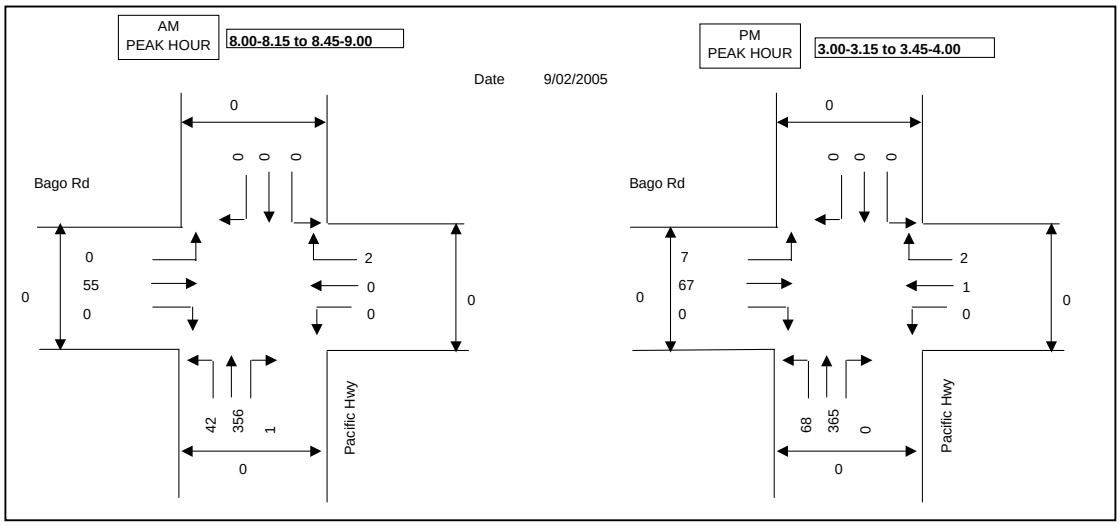
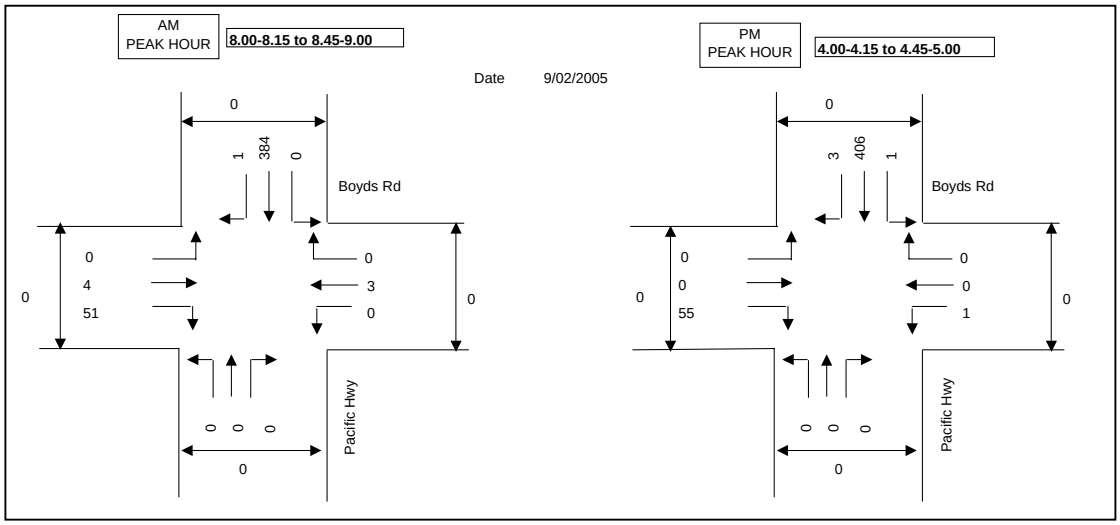


Figure 6 - Traffic count at Boyds Road / Pacific Highway intersection



Note: Bago Road and Boyds Road form cross intersections with the northbound and southbound carriageways respectively. The two intersections are separated by a wide median approximately 250m wide.

Figure 7 - Traffic count at Stills Road / Pacific Highway intersection

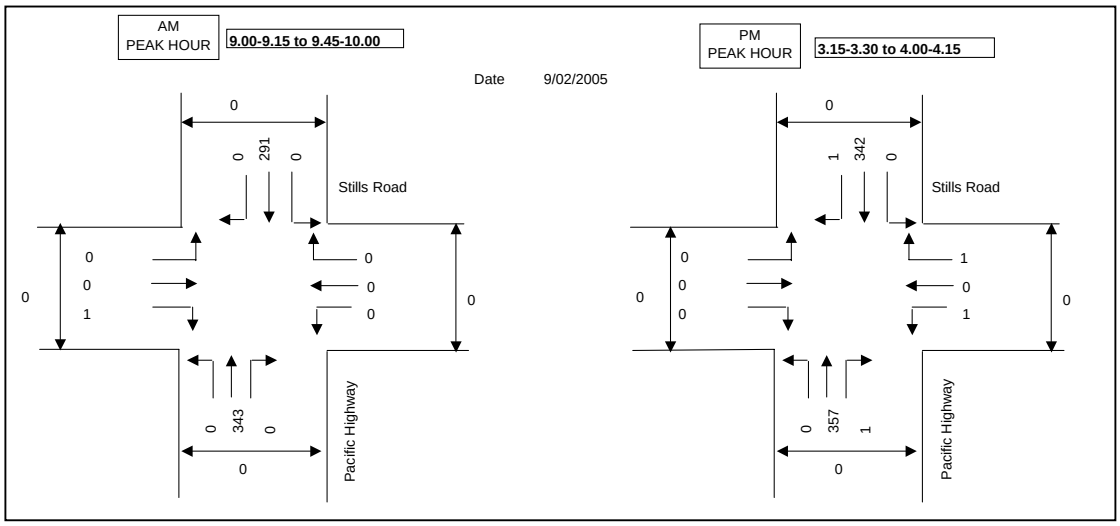


Figure 8 - Traffic count at Bobs Creek Road / Pacific Highway intersection

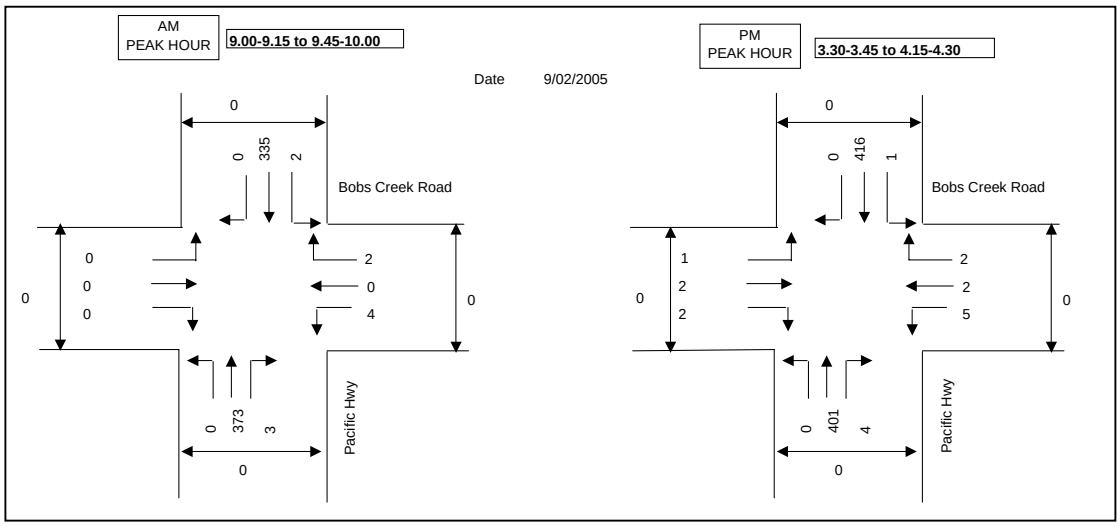
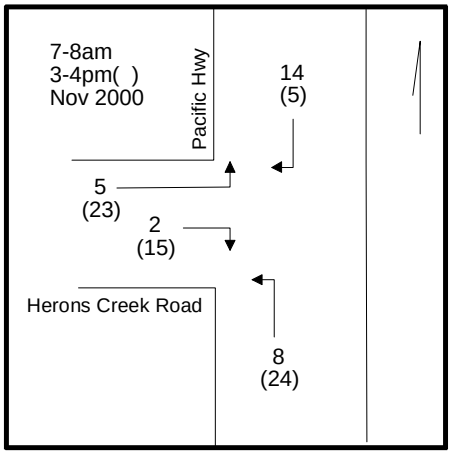


Figure 9 - Traffic count at Herons Creek Road / Pacific Highway intersection

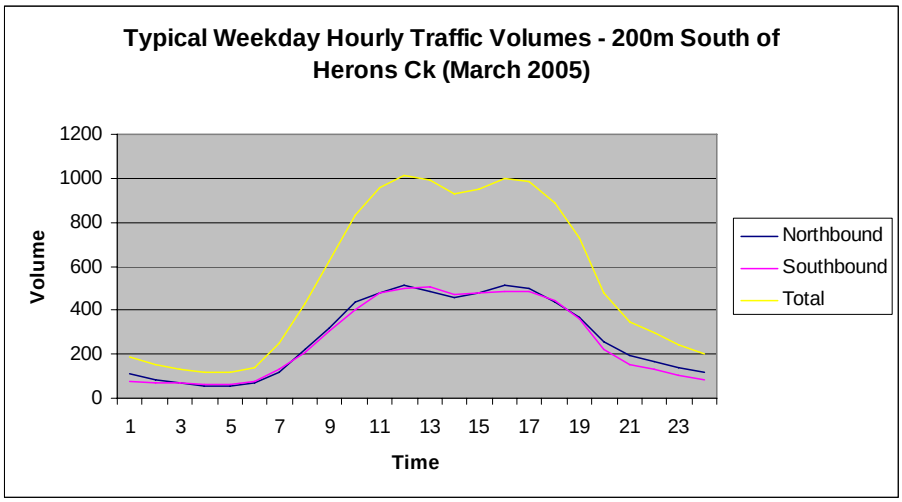


Herons Creek Mill advises that it can generate up to 50 truck movements per day.

5.4.2 Hourly Traffic Volumes

The volumes shown in the following figure are those taken on the survey period in March 2005 and increased by 6.5% to align with the AADT.

Figure 10 – Hourly Volumes on Pacific Highway, south of Herons Creek



5.4.3 Daily Traffic Volumes

The volumes shown in the following figures are those taken on the survey period in February 2005. A correction figure of 6.5% has been applied to the counted figures to align the count period with the week in which the AADT would occur. This has been done by comparing the relevant historical data from a permanent counting station located 20km to the north contained in the RTA's Traffic Counting Publication.

The corrected AADT (2005) 200m South of Herons Creek is 12946 and 50m North of Stills Road is 7740.

Figure 11 – Daily Volumes on Pacific Highway south of Herons Creek.

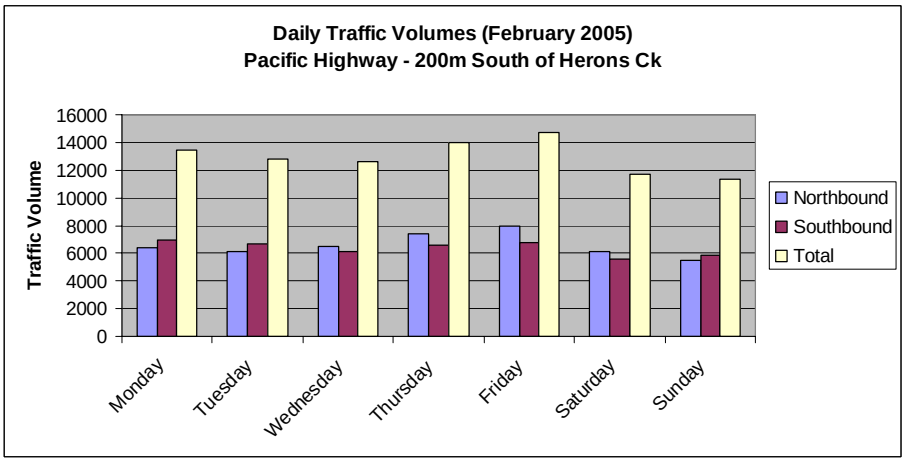
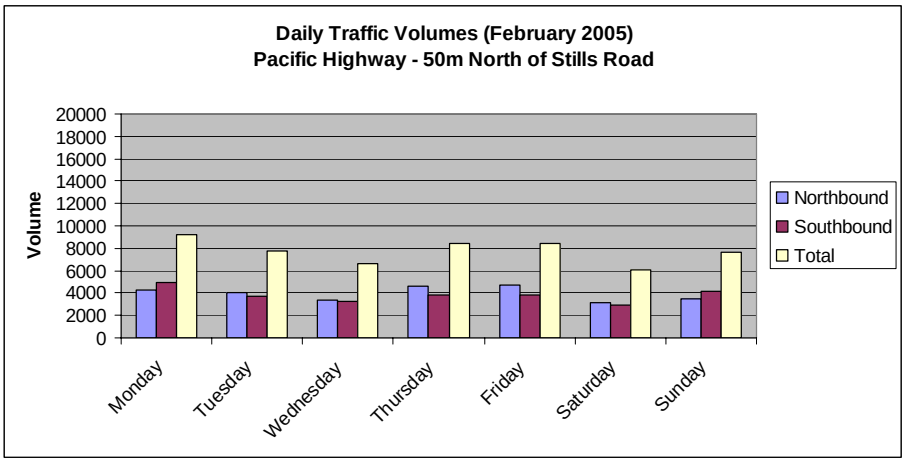


Figure 12 – Daily Volumes on Pacific Highway North of Stills RoadNet.



The difference in volumes between the volumes in figures 11 and 12 relate to turning traffic at Bago Road to and from the south. It is also interesting to note that northbound volumes are higher Wednesday to Saturday and southbound are heavier Sunday to Tuesday.

Table 5 – Average Daily / Average Weekday Volumes

Ratio - Average Daily Traffic to Average Weekday Traffic

Location		Average Daily Traffic	Average Weekday Traffic	ADT / AWT
Pacific Highway - 200m South of Herons Ck	Northbound	6581	6884	0.956
	Southbound	6366	6625	0.961
	Total	12947	13508	0.958

5.4.4 Heavy Vehicles

Table 6 –Vehicle types on Pacific Highway

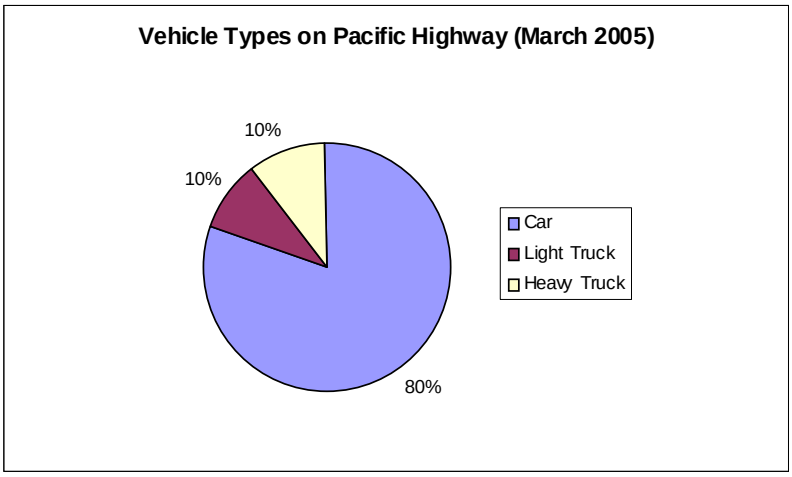
Location	Type of Vehicle	Percent
Pacific Highway - 200m South of Herons Ck	Car	79.4
	Light Truck	9.9
	Heavy Truck	10.6

Car relates to vehicle classes 1 & 2.

Light truck relates to vehicle classes 3, 4 and 5.

Heavy Truck relates to vehicle classes 6 to 12.

Figure 13 – Vehicle Types on Pacific Highway



5.5 Traffic Growth

Data from permanent traffic counting stations to the north and south of the study area were used and extrapolated to provide traffic projections for the project. Figure 14 shows volumes at a site approximately 11km to the north near the Oxley Highway. This has a projected growth rate of 4.56% linear. Figure 15 shows volumes of a site approximately 75km to the south at Nabiac. This has a projected growth rate of 4.05% linear.

The closest site at Oxley Highway with 4.56% growth is used for traffic projections on this project.

Table 7 – Projected AADT at Herons Creek

Year	AADT
2005	12946
2010	15897
2020	21800
2030	27702

Figure 14 – Traffic Projection. Pacific Highway south of Oxley Highway

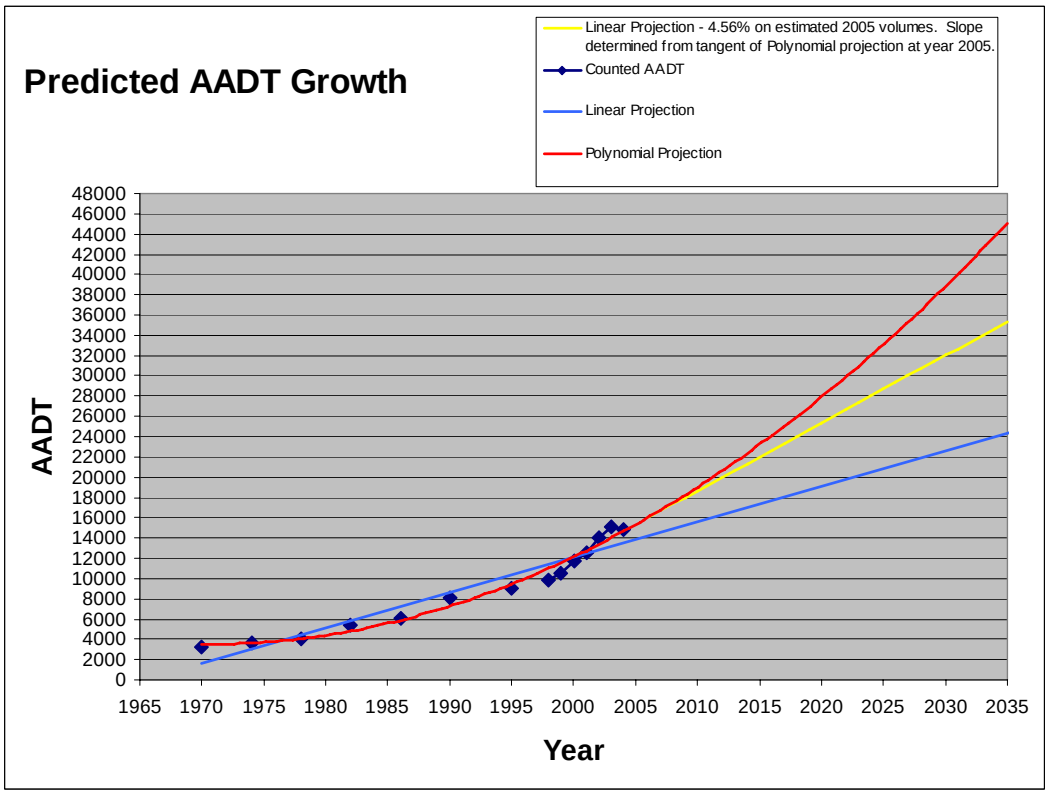
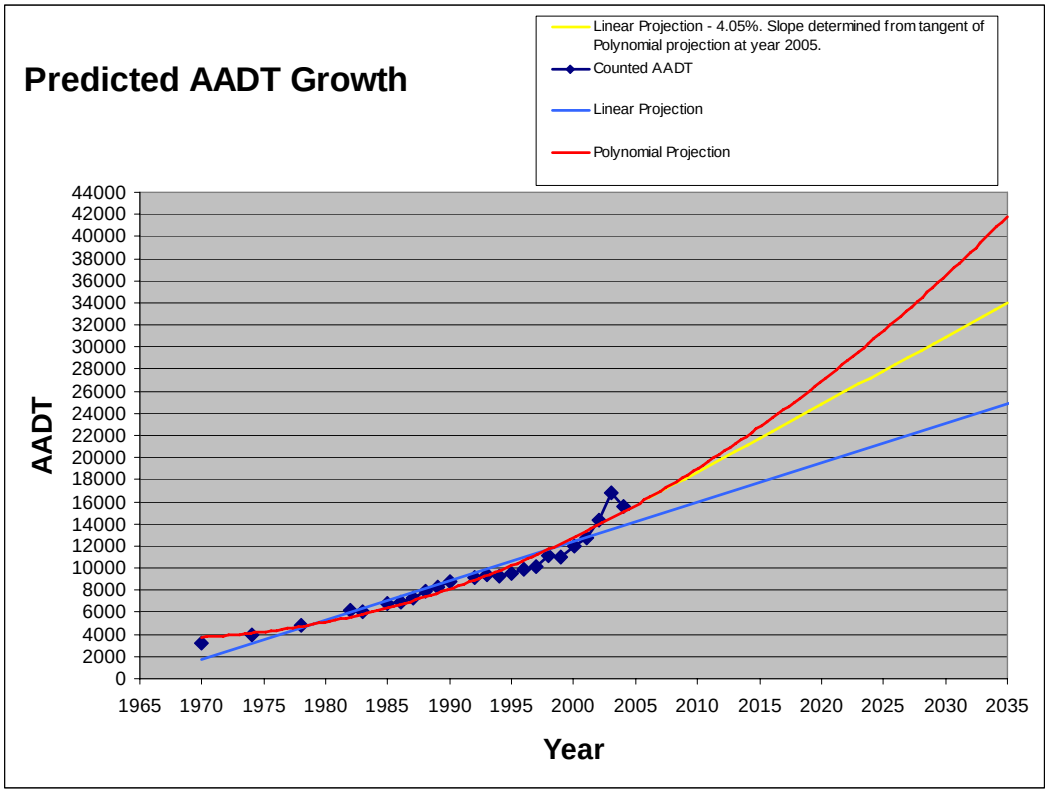


Figure 15 – Traffic Projection. Pacific Highway at Wallamba River, Nabiac



5.6 Calculation of the Design Hour

The project objectives require that the project be designed to accommodate the 100th highest hour at no worse than LOS 'C' 20 years after opening.

The design hour has been obtained using the following methodology.

- A typical week from classification counts undertaken in February 2005.
- The average daily traffic was calculated from this week and a growth factor of 1.065 applied to bring to survey period up to the AADT consistent with data from the previous year.
- 100th highest hour obtained from records of 2004 counts by RTA for all hours of the year. The raw count data had some inaccurate or corrupt data. This data amounted to 35% of the total hours and was deleted for the calculation.
- The 65th highest hour for year 2004 was utilised instead to take account of the reduced sample size. This hour is 61% of the highest hour for the year.

Table 8 – Sorted highest hours from permanent counting station south of Oxley Highway.

Highest Hour	Date	Time	NB	SB	Total
1	20050102	10:00	1189	1392	2581
60	20041226	12:00	1082	509	1591
61	20041009	11:00	660	917	1577
62	20040413	14:00	627	948	1575
63	20040412	13:00	613	954	1567
64	20041009	10:00	603	964	1567
100th 65	20040123	14:00	825	740	1565
66	20040412	14:00	542	1019	1561
67	20040614	15:00	562	997	1559
68	20040409	12:00	1026	529	1555
69	20041224	8:00	913	640	1553
70	20040614	11:00	439	1110	1549

Year 2004 data in axle pairs

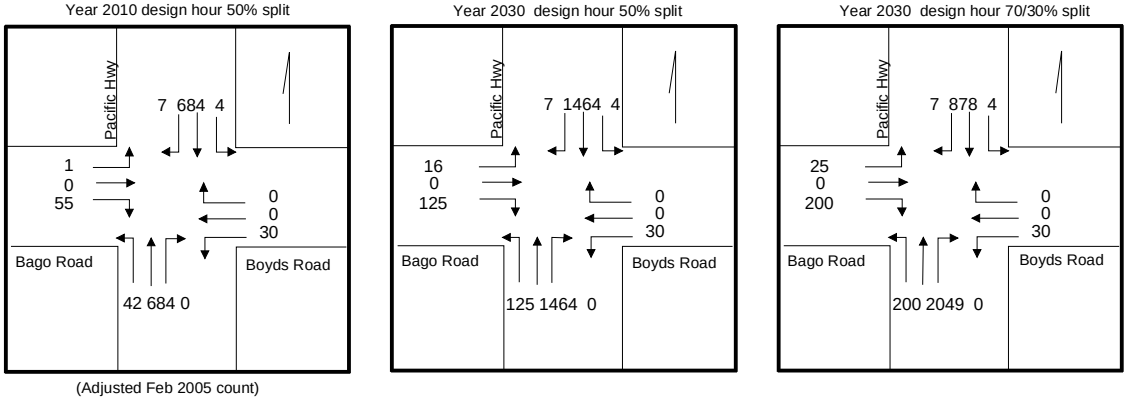
- It was calculated that the 100th highest hour (before correction was 9.78% of the AADT) and the 65th highest hour was 10.57% of the AADT. The adopted percentage for this study is 10.57%.
- The 2005 AADT is calculated as 12946 (vehicles).
- The percentage of heavy vehicles is 19.2%.
- 10.57% of the AADT is 1368vph.
- 1368vph has been increased by 4.56% over 25 years to year 2030 to give a design hour volume of 2928.
- The design hour volume (2928vph) is 114% higher than the year 2005 volumes. For modelling purposes intersection volumes are adjusted by the same proportion to reflect future demand. In addition, the 100th highest hour from historical data had an even directional split (53% northbound and 47% southbound). An examination of the data showed the 95th and 110th highest hours have directional splits of 70/30 in both directions. Both the even (50/50) and the worst-case (70/30) directional splits have been assessed in calculating the level of service.

Table 9 – Design hour directional splits

Directional Splits - 100th Highest Hour

Year	Veh/ Hour	30% split	70% split	50% split
2005	1368	410	958	684
2010	1680	504	1176	840
2020	2304	691	1613	1152
2030	2927	878	2049	1464

Figure 16 - Design hour



5.7 Travel Speeds

Table 10 shows existing and proposed speed limits on the Highway.

Table 10 - Existing and Proposed speed limits.

Pacific Highway	Existing Speed Limit (km/h)		Proposed Speed Limit (km/h)	
Herons Creek to south of Bago Road	NB	SB	NB	SB
	100	100	110	110
South of Bago Road to Stills Road	NB	SB	NB	SB
	100	110	110	110

Intersections (including on and offload ramps) would be designed to take account of the new speed environment.

5.8 B-Doubles

An objective of the Pacific Highway upgrading in general is to cater for efficient movement of freight.

The design of the project makes provision for use by B-Doubles, including adequate turning paths at intersections.

5.9 Cyclists, Pedestrians and Equestrians

The existing northbound carriageway on the Highway is on a winding and undulating alignment with a narrow outside shoulder. The road is unsuitable for bicycle use.

Provision is made in the design of the new carriageway for cyclists to safely travel along the road by way of a 2.5m wide sealed shoulder. Squeeze points would be avoided in the detailed design (for example at drainage structures or bridges) unless suitable alternative arrangements are made for cyclists.

The only crossing point on the Highway would be near Bago Road by way of a road overpass. The overpass would be designed to provide safe pedestrian and cycle access.

Service roads would connect to the overpass. The service roads would carry little traffic and would be suitable for cycle use. Pedestrian activity is currently low and would not be expected to increase significantly. No special facilities are proposed for pedestrians, which means that they would need to walk on the shoulder or grassed verges of the service roads.

Although the existing Highway is set in a typically rural setting no provision is made for equestrian. Equestrian are not expected to use this section of Highway into the future and no special facilities are proposed.

5.10 Public Transport

Busways currently operate a public bus service in the Port Macquarie region, however routes do not incorporate the study section on the Pacific Highway. No public buses currently stop within the section and would be unaffected by the proposals.

Private Coach Services would travel through the section on route north and south, and vice versa, but would be unlikely to stop within the section.

School buses travel through the section of the Pacific Highway during school semesters in the mornings and afternoons. A bus stop currently exists on the Pacific Highway south of the study site at the Herons Creek Road intersection. A school bus currently stops and U turns at Bobs Creek Road.

Provision would be made in the design of the project to accommodate buses associated with Herons Creek School however would not include a stop on the Pacific Highway. Incorporating bus stops into the proposed upgrades is not seen as necessary. Public buses and Coaches are not expected to stop at the site and school bus services will remain unchanged as a result of the upgrades.

5.11 Rest Areas

No rest areas lie within the study site however adequate stopping opportunities exist to the north and south of the site. The Highway service centre at the junction of the Oxley Highway 16km north and the township of Kew 6km south provides stopping opportunities for cars and trucks.

A northbound Highway rest area exists approximately 8km to the north of the works and a southbound rest area is located approximately 12km north. Another rest area is provided just south of Kew. A southbound short stay truck-stopping bay also exists within the northern section of the site.

Rest areas are not seen as necessary within the subject site and are not proposed as part of the Highway upgrade.

6 TRAFFIC ANALYSIS

6.1 General

Traffic modelling has been carried out to compare existing and future traffic conditions on the section and at intersections.

- The Florida Department of Transportation (FDOT) Quality/Level of Service Handbook and analysis software has been used to predict future capacity and performance along the corridor. Reference is also made to AUSTROADS Guide to Traffic Engineering Practice Part 2, Roadway Capacity.
- Intersection modelling has been carried out using the SIDRA models that simulates peak hour flows. The performance is measured by level of service (LOS) and delays.

6.2 Assumptions

General

Traffic on the Pacific Highway will grow at 4.56% linear for the next 25 years.

By year 2010 the northbound carriageway will be replaced. Intersections will initially be 'at grade' seagulls – 'A' class option.

All future through traffic will use an improved Pacific Highway with 110km/h travel speed.

Grade separation will be provided south of Bago Road when needed and all other access closed – 'M' class option. For analysis purposes year 2020 is used for construction of the staged 'M' class option.

Population Growth

Population of the Hastings Local Government Area will grow at 2.5% linear over the next 15 years as predicted in Hastings Urban Growth Strategy (2001).

Planning Years

Traffic forecasts at the 100th highest hourly volume are provided on the basis of historical information for the following periods:

Year 2005 – Existing traffic volumes

Year 2010 – Opening to the public.

Year 2020 – 10 years after construction for noise assessment.

Year 2030 – 20 years after construction to enable analysis of design to operate at a Level of Service 'C' 20 years after construction.

6.3 Highway Capacity

The project aims for a Level of Service no worse than 'C' for the 100th Highest Hourly Volume in 20 years after opening.

A detailed analysis was carried out using the Florida Department of Transportation's (FDOT) software package for the calculation of Level of Service and flows. This software makes provision for more detailed input of the various operational parameters. These include AADT, terrain, % overtaking opportunity, % HV, presence of medians, sheltered turning bays, posted speed zoning, directional flow and design hour flow as a % of AADT. Tables 11 and 12 relate to daily flows with calculations incorporated into the figures that consider the peak hour and directional splits. Table 13 gives details of the output from one direction hourly flow.

Description of Level of Service

A Free Flow whereby drivers are virtually unaffected by others in the traffic stream and can choose their own travel speeds.

B Stable flow with slight inconvenience from others in the traffic stream. Drivers have reasonable freedom to choose their own travel speeds.

C Stable flow with drivers restricted to select desired speed and ability to manoeuvre.

D Approaching unstable flow with drivers being severely restricted in travel speeds in freedom to manoeuvre.

E Unstable flow close to capacity. Minor disturbances in the traffic stream cause breakdown.

F Forced flow with more vehicles approaching than can fit. Queuing and delays result.

Table 11 - Level of Service Vs AADT (FDOT software) BASED ON 70/30 directional split

Rural conditions	A	B	C	D	E
'A' class option. Controlled access 4 lane divided. 100 kph speed limit	15600	25800	36000	43800	48700
'M' class option. Controlled access 4 lane divided. 110 kph speed limit	15400	25300	34300	40700	45100

Table 12 - Level of Service Vs AADT (FDOT software) BASED ON 50/50 directional split

Rural conditions	A	B	C	D	E
'A' class option. Controlled access 4 lane divided. 100 kph speed limit	21800	36100	50400	61300	68100
'M' class option. Controlled access 4 lane divided. 110 kph speed limit	21600	35400	48100	57000	63200

Table 13 - Level of Service Vs VPH – HOURLY FLOW IN PEAK DIRECTION – ie ONE WAY ONLY (FDOT software)

Rural conditions	A	B	C	D	E
'A' class option. Controlled access 4 lane divided. 100 kph speed limit	1150	1910	2660	3240	3600
'M' class option. Controlled access 4 lane divided. 110 kph speed limit	1140	1870	2540	3010	3340

Table 14 shows projections of future traffic volumes on the Pacific Highway at Herons Creek based on a projection of historical traffic data from nearby permanent counting stations. Table 15 shows the level of service.

Table 14 – Projected AADT and 100th Highest Hour

Projected AADTs

Year	AADT
2005	12946
2010	15897
2020	21800
2030	27702

Directional Splits - 100th Highest Hour

Year	Veh/ Hour	30% split	70% split	50% split
2005	1368	410	958	684
2010	1680	504	1176	840
2020	2304	691	1613	1152
2030	2927	878	2049	1464

Table 15 - Projected Volumes and Level of Service (LOS) – Worst Case Split (70/30)

YEAR/OPTION	Pacific Hwy at Bobs Ck Road (Two Way Daily Flow)	Pacific Hwy at Bobs Ck Road (One Way 100th Highest Hour)
Existing Road		
2005	12946	958
LOS NB C/way	A	A
LOS SB C/way	A	A
2010	15897	1176
LOS NB C/way	B	B
LOS SB C/way	B	B
New Road		
2010	15897	1176
LOS 'A' Class	B	B
LOS 'M' Class	B	B
2020	21800	1613
LOS 'A' Class	B	B
LOS 'M' Class	B	B
2030	27702	2049
LOS 'A' Class	C	C
LOS 'M' Class	C	C

The northbound carriageway will be transformed into a two-way service road for both the 'A' and 'M' class options. Traffic volumes will be different for the two options because more restricted access control is provided on the 'M' class option, particularly on the western side.

For the 'M' class option the western service road will carry traffic from Herons Creek Village as well as the school, LALC, Bago Road and Stills Road. The main flow of traffic will be between Bago Road and the interchange roundabout. The estimated volumes are shown in Table 16. The eastern service road will carry lower volumes and also operate at LOS 'A'.

Table 16 – Projected daily volumes & LOS on Western Service Road

	'A' Class Option	**'M' Class Option**
2010	200	1500
LOS	A	A
2020	250	2063
LOS	A	A
2030	300	2436
LOS	A	A

6.4 Performance of Intersections

The performance of the four intersections along the existing road has been modelled for both existing conditions (year 2005) and for predicted future conditions at 2010 (opening of highway) and at 2030 (20 years after opening).

Intersections are also modelled for proposed improvements including the final design layout for both 'A' and 'M' class options. Table 17 contains a summary of the modelling results.

6.4.1 Pacific Highway / Bago Road

Bago Road forms a wide cross intersection with the Pacific Highway. Boyds Road forms the eastern leg of the intersection. The intersection is essentially two separate cross-junctions due to a 200m separation between the northbound and southbound carriageways. Give Way signs are located in Bago Road, Boyds Road and in the median approaches of both sites.

The new northbound carriageway will be located parallel to the existing southbound carriageway and have a 12 metre wide median.

The Bago Road intersection currently operates at Level of Service 'C' with peak hour delays to right turning traffic of 21 seconds. By 2010 the intersection will operate at LOS 'D' and by 2030 LOS 'F' if no upgrade is undertaken.

The performance of the 'A' class option with at grade seagull junction will be LOS 'D' for the design hour at the year of opening in 2010. The intersection is expected to fail by 2020 operating at a LOS 'F'.

The intersection will be closed when the 'M' class grade separated interchange is provided south of Bago Road.

6.4.2 Pacific Highway / Boyds Road

The Boyds Road intersection currently operates at Level of Service 'B' with average peak hour delays to cross traffic of 17 seconds. By 2030 the intersection will operate at LOS 'D' if no upgrade is undertaken.

Boyds Road will ultimately receive high standard access via an interchange on the Highway located approximately 400m to the south of the current intersection. This would be provided for the 'M' class option.

The 'A' class option would see a seagull arrangement for Bago Road traffic, ie from the west. Access at Boyds Road would be restricted to left turns in and out only until an interchange is provided. The timing of the installation would be dependant upon traffic demand and safety considerations.

Operating as a left in and out only the intersection will operate at LOS 'A' in 2010 and LOS 'B' by 2030.

Boyds Road traffic would be required to perform U turns at Herons Creek Road in order to travel north and U turns at Stills Road to gain access from the south. The amount of traffic affected by this proposal is indicated by peak hour traffic counts in Figure 6. This shows that there were 4 vehicles in and 3 out in the am peak and 1 in and 1 out in the pm peak. Assuming that the peak hour comprises 10% of daily traffic flow there may be 70 trips per day affected.

6.4.3 Pacific Highway / Stills Road

The Stills Road intersection currently operates at a LOS 'B'. Without an upgrade to the intersection Stills Road will operate at a LOS 'F' by 2010.

The 'M' class option sees all access closed to the Highway. Service roads would be provided on both sides to connect to the proposed interchange.

The 'A' class option would require the Stills Road intersection to be largely retained as existing to allow for U turns. Traffic counts show that only few vehicles currently use the intersection. The median island would be closed when an interchange is ultimately provided to the south of Bago Road. For the 'A' class option the intersection will operate at LOS 'F' by 2010.

6.4.4 Pacific Highway / Bobs Creek Road / School Access

For the 'M' class option the median would be closed and a service road would be provided along both sides of the Highway from Bobs Creek Road to a new interchange approximately 700m to the north. For Bobs Creek Road it would involve some additional travel to and from the south but this would be offset by the high standard access and improvement to safety.

The 'A' class option would see a seagull arrangement for Bobs Creek Road traffic and no access to the Highway from the School and LALC. This arrangement would provide a reasonable level of service to Bobs Creek Road until an interchange is ultimately provided. It does however have some adverse traffic impacts relating to the median closure.

The amount of traffic potentially affected is indicated by peak hour traffic counts in Figure 8. A review of the 4 hour traffic count period 2 hours in the morning and 2 in the afternoon shows:

- U turns at the median opening - 4 northbound and 2 southbound. These would need to occur elsewhere eg Herons Creek Road and Stills Road
- 12 trips straight across the Highway ie Bobs Creek Road to / from the school. These trips would need to do U turns at either Herons Creek Road or Stills Road.
- 4 trips to the south from the school. These would need to go via Bago Road.

These would incur slightly longer travel times and distances for vehicles performing the manoeuvre.

6.4.5 Pacific Highway / Herons Creek Road

The Pacific Highway / Herons Creek Road intersection is not part of this project. It is included in the Moorland to Herons Creek Upgrade project, however it forms part of the interface between the two projects. The adoption of an 'A' or 'M' class option for one or both projects will impact on that site.

The 'A' class option would see a seagull arrangement for Herons Creek Road traffic. The junction would also need to cater for U turning traffic resulting from the partial closure of Boyds Road. The level of service for this site for year 2030 would be expected to be similar to the Bago Road seagull arrangement that is proposed in the 'A' class option (LOS 'F').

For the 'M' class option no direct access would be permitted and a service road would be provided along the western side of the old Highway from Herons Creek Road to a new interchange located near Bago Road. Modelling shows that the interchange ramps and associated intersections would operate at LOS 'A' in year 2030.

6.4.6 Bago Road / Old northbound carriageway

The intersection will be transformed to a roundabout to make it a safe cross intersection catering for two way flow.

There would be no adverse traffic or safety impacts associated with this site. In fact safety would be significantly improved over the existing arrangements. Modelling shows that the intersection would operate at LOS 'A' in year 2030.

6.4.7 Interchange

A 'Dumbbell' type interchange with a single lane roundabout on each side to control traffic on the ramps and service roads will be constructed in the 'M' class option.

Modelling indicates the interchange along with the roundabouts will operate at a LOS 'A' for the life of the project.

Table 17 – Summary of modelling results for the 100th Highest Hour to Year 2030

Intersection	Year	LOS (Level Of Service)		
		Existing - Do Nothing	A' Class Option	M' Class Option
Stills Road	2005	B	B	B
	2010	F	F	-
	2030	F	F	-
Bago Road	2005	C	C	C
	2010	D	D	-
	2030	F	F	-
Boyds Road	2005	D	D	D
	2010	E	C	-
	2030	F	E	-
Bobs Creek Road	2005	C	C	C
	2010	C	C	-
	2030	F	E	-

Table 18 – Summary of modelling results for seagull intersections to Year 2030

Site	Traffic Split	D/S	LOS	AD (Secs)	MD (Secs)	Q (m)	Comment
Bago Road Seagull	T-Intersection Give Way Signs						
Year 2005	50/50	0.19	C	2	21	4	Satisfactory Performance
	70/30	0.26	D	2	26	6	Satisfactory Performance
Year 2010	50/50	0.35	D	5	26	14	Near Capacity
	70/30	0.6	E	5	43	26	Near Capacity
Year 2030	50/50	1.67	F	136	1272	830	Over Capacity
	70/30	1.67	F	114	1390	836	Over Capacity

Explanation of Terms

Period	AM, PM - morning and afternoon peak hour.
D/S	Degree of Saturation
	Saturation reached at 0.8 (80%) for Give Way sign control and roundabout control
LOS	Level of Service. Measure of intersection performance tied to delays.
	Ranges from A through to F.
	LOS 'A' - Very good with minimal delays
	LOS 'B' - Good with minimal delays
	LOS 'C' - Acceptable delays
	LOS 'D' - Tolerable delays in peak periods
	LOS 'E' - Improved intersection needed.
	LOS 'F' - Oversaturated with congestion and long delays.
AD	Average delay for all movements at the intersection
MD	The movement with the highest average delay - usually the right turn out.
Q	Average number of vehicles queued (usually for the movement with the highest delay).

The proposed seagull junctions at Bobs Creek Road and at Herons Creek Road would be expected to have the same performance as the Bago Road site because:

- there are relatively small volumes of traffic from the side roads.
- access from the side roads is determined by the availability of gaps in the through traffic stream.

6.5 Travel Savings

Modelling of traffic flows on the existing and proposed highway indicates that:

- On the northbound carriageway the current average travel speed is 95kph (the posted speed limit is 100kph). This will increase to 105kph when the new carriageway is completed which will have a posted speed limit of 110kph. The new carriageway will also be 300m shorter than the existing carriageway. This represents a saving of approximately 16 seconds per vehicle.
- On the southbound carriageway the current average travel speed is 100kph (the posted speed limit is 100-110kph). This will increase to 105kph when the new carriageway is completed which will have a posted speed limit of 110kph. This represents a travel time saving of 5 seconds per vehicle

Travel time savings are relatively minor for this 3.44km long section of Highway, but when combined with other savings along the Pacific Highway will be significant in aggregate.

There will also be travel time savings for side road traffic entering the Highway. This will result from decreases in delays due to intersection upgrades. These savings will be relatively minor for the 'A' class option as intersections remain at grade and delay is mainly dependant on Highway traffic flows. However savings will be much higher for the 'M' class option due to the grade separated interchange, which will eliminate delays caused by Highway traffic.

7 ECONOMIC ANALYSIS

7.1 General

An economic analysis for the Project has been carried out for various funding scenarios in accordance with the RTA's Economic Analysis Manual, 1999. The objective is to generate an economic model for the work that provides a strategic Benefit/Cost Ratio (BCR) that will give an indication of the economic viability of the work.

This has been done by setting up a spreadsheet model that carries out an analysis of the corridor in terms of the Economic Analysis parameters. Results are provided in terms of Benefit/Cost Ratio and first year rate of return. Concept Design stage estimates have been used in the benefit cost ratio calculation.

7.2 Assumptions

7.2.1 Options Considered

Two options were considered, the 'A' class option, the 'M' class option.

- Option A – Arterial conditions. Constructed 2009, opened to traffic 2010.
- Option M – Motorway conditions. Constructed 2009, opened to traffic 2010.
- Option A-M Staged construction. Option A opened 2010. Option M opened 2020.

7.2.2 Construction

The new road will be constructed in both the existing road reserve and partly on acquired land, serviced by adjacent 2 lane dual carriageways.

At grade improvements will made to all intersections within the section as part of the 'A' class option.

Option 'M' involves grade separation between Bobs Creek Road and Bago Road in 2010.

The staged option involves opening of the 'A' class option in 2010 with at grade intersections, upgraded to the 'M' class option with grade separation between Bobs Creek Road and Bago Road in 2020.

7.2.3 Estimate of Cost

The RTA has provided costs for the project, which were used in the economic model. These costs were:

- $22.9M for the 'A' class option
- $37.9M for the 'M' class option
- $42.9M for the staged 'A' to 'M' class option

7.2.4 Traffic Volumes

Average Daily Traffic has been used for the analysis, with 2005 figures and growth figures based on the volumes generated for the noise assessment. These figures show actual traffic movements split into light and heavy vehicles as required for calculation of user costs.

7.2.5 Maintenance

Pavement assumed to be "Asphalt over cemented base". Costs based on Port Macquarie District Office 2001 figures updated to June 2005 $.

7.2.6 User Costs

Calculation on methodology set out in RTA Economic Analysis Manual 1999. Costs based on December 2003 figures updated to June 2005 $.

7.2.7 Cost Updating

Maintenance costs adjusted in line with movement of Maintenance Cost Index.

User costs (VOC, Travel Time and Accidents) adjusted in line with Road Cost Index.

7.2.8 Analysis Period

Period of analysis is 30 years from opening - i.e. 2010 to 2040. New road will be open for 25 years for analysis purposes.

7.3 Benefit Cost Ratio (BCR)

Annual costs over the period 2005 to 2040 have been made for the operation of the existing highway and the construction and operation costs of the new Deviation. The annual costs are then discounted to provide net present values (NPVs) of these future costs. The costs include such things as vehicle operating costs, travel time costs, accident costs and maintenance costs. The NPV of the savings between the base case (existing highway) and new road option is compared with the NPV of the project cost to obtain a BCR.

7.4 Factors in analysis

7.4.1 Timetable

For the purposes of this analysis it is assumed that the whole project may be opened in 2010. A 30-year period from 2010 has been adopted for this economic analysis. With the adoption of 2040 as the end date for analysis, the shortest period of service of the new road would then be 25 years.

7.4.2 Corridors for analysis

The corridors analysed consist of:

- Base case – the continued operation of the existing Pacific Highway.
- Realignment of the northbound carriageway to run parallel with the southbound carriageway. The two main options proposed are ‘A’ class with at grade intersections and ‘M’ class with access control and grade separation.

7.4.3 Sections for analysis

The section analysed consists of a section of the Pacific Highway at Herons Creek from the start of the deviated carriageway to Stills Road 3.44km to the north. The section includes the intersections of Bobs Creek Road, Boyds Road, Bago Road and Stills Road.

7.4.4 Pavement types

The existing Pacific Highway between Bobs Creek Road and Stills Road essentially consists of a flexible pavement made up of a flush seal surface on a granular base.

This analysis assumes:

- Base case – Retain existing Seal on Granular as basis for life cycle costing.
- Southern Deviation corridor.
  - Eastern Section. Asphalt on cemented base for life cycle costing (This will provide a high quality riding surface in keeping with the project.)
  - Western Section. Asphalt on cemented base.

7.4.5 Travel speeds

- Travel speed calculations have been based on the existing and proposed speed zoning. Modelling of traffic flows on the existing and proposed highway indicates that:
  - Existing Highway
    - 100kph for northbound section
    - 105kph for southbound section
  - Alignment of northbound carriageway
    - 110kph for northbound section
    - 110kph for southbound

- The affect of traffic volumes on travel speeds has been calculated using the Florida DOT Level of Service software package. This package is based on the US DoT Highway Capacity Manual – 2000.
  - For the base case – retention of the existing Pacific Highway – there are significant declines in travel speed with increased traffic volumes. From about 2008 there will be a need to extend the length of the peak period to permit the movement of the volume expected.
  - By 2033, the existing Pacific Highway would need to flow at peak capacity for 21 hours per day to permit the overall traffic flow predicted.
  - With the provision of dual carriageways and controlled access, travel speeds in the Deviation are not reduced by the traffic volumes predicted within the analysis period.

7.4.6 Geometric parameters

- The alignment and grading can be analysed on the basis of Table B1 of Appendix B of the RTA's Economic Analysis Manual – "Total vehicle operating costs for base grade 2% and base curvature conditions".

7.4.7 Costs

- Construction
  - Analysis has been made on costs provided by the RTA. These costs are to strategic level and include all costs planning, design, property acquisition, construction and provision for contingencies.
- Agency Maintenance Costs
  - Agency maintenance costs have been based on the figures contained in Roadnet's report for the Pacific Highway Office "Pacific Highway – Hexham to Queensland. Development of Maintenance Diaries and Assessment of funding needs 2001 to 2015" – January 2002.
  - The report includes details of the cost of the various maintenance activities for the RTA Port Macquarie District Office, and life cycle maintenance requirements for various pavement types.
  - Costs have been updated in accordance with changes to the Road Cost Index.
  - The maintenance scenarios adopted are based on:
    - A "Typical Life Cycle" for the new corridors and Existing corridor.
    - A "Holding Life Cycle" for the Base case – retention of the existing highway.
    - Allowance has been made for the pavement type and effective age of pavement when applying maintenance regimes to the eastern and western sections.

- Rural Vehicle Operating Costs
  - VOCs are calculated on the basis of the RTA's Economic Analysis Manual – Appendix B Part II – Rural Road Parameters 2002.
  - The vertical alignment essentially consists of low grades, generally less than 4%. As a result, VOCs have been based on Table B1 – "Total Vehicle Operating costs for Base Grade 2% and Base Curvature Conditions."
  - Pavement condition has been adopted as:
    - New corridor – S4 – Sealed, Good.
    - Base case – existing road – S3 – Sealed, Fair.
  - Road Volume Capacity Ratio has been set at:
    - New corridor = 0.3.
    - Base case = 0.8.
- Rural Accident Costs
  - Accident rates have been extrapolated on the basis of existing rates and expected rates for new works.
  - The average cost of a rural accident at 2002 prices is $126,400. (Economic Analysis Manual).
- Travel Time Costs
  - Travel Time Costs are calculated on the basis of the RTA's Economic Analysis Manual – Appendix B Part II – Rural Road Parameters 2002. (Table 17).

7.5 Economic assessment

7.5.1 Economic justification

The overall economic efficiency of the Project has been examined. This is reflected in the achieved Benefit Cost Ratio (BCR).

Based on costs provided by the RTA a BCR's for the three options are calculated as:

- The 'A' class option shows savings of $28.1M to achieve a BCR of 1.61 at a 7% discount rate.
- The 'M' class option shows savings of $77.6M to achieve a BCR of 2.68 at a 7% discount rate.
- The Staged 'A' class to 'M' class option shows savings of $74.3M to achieve a BCR of 3.01 at a 7% discount rate.

A key funding requirement for road projects is to provide a return to the community of at least twice the investment. In other works the project should achieve a BCR of 2 or higher.

Based on RTA's cost the project will not provide such a return to the community for the 'A' class option with a BRC of 1.61. However both the 'M' class option and staged option will provide a high return on investment showing BCR's of 2.68 and 3.01 respectively.

The results have been summarised in the spreadsheet attached as Appendix B.

7.5.2 Timing of the project

Data has been provided to establish how suitable the time frame is for expenditure on the project. This is done by comparison of the First Year Rate of Return (FYRR) with the Discount Rate (DR) used for analysis. If the FYRR is greater than the DR, then the time is appropriate to carry out the work.

Based on the costs provided by the RTA a FYRR achieve by the 'A' class option is 16% and 12% for the 'M' class option. The 'A' to 'M' Staged option will achieve a FYRR of 14%. These results have been summarised in the spreadsheet attached as Appendix B.

This assessment is indicative only and is subject to funding constraints associated with the competing demands in the RTA's construction programme for works throughout NSW.

7.5.3 Support for economic development

Savings are available from an improvement in travel speeds on the northbound and southbound carriageways that will increase from 100kph to 110kph. The improvements will marginally reduce transport costs and incrementally improve accessibility.

The 'M' class option will reduce delays to side road traffic entering the Highway and therefore will reduce travel times at the site.

Funding for construction of the work will also provide an immediate boost to the local economy by providing construction jobs and business for local suppliers.

8 ACCIDENT ANALYSIS

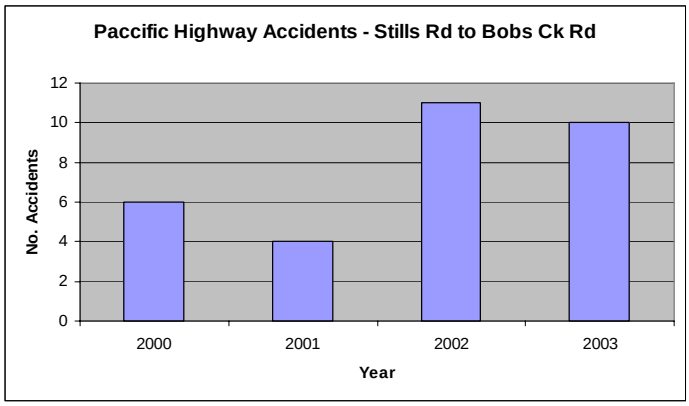
8.1 Accident History

Accident data on the section of Pacific Highway from Stills Road to Bobs Creek Road, Herons Creek was analysed for the 4.75-year period from 19 July 1999 to 7 April 2004. In this period there were 36 accidents reported with 2 fatalities and 23 injuries (refer Table 19). In 2002 reported accidents more than doubled. This is shown in Figure 17.

Table 19 - Accident Statistics (only years with full data are shown)

Accident Severity	Pacific Highway - Stills Road to Bobs Creek Road			
	2000	2001	2002	2003
Fatal Accident	0	0	2	0
Injury Accidents	2	2	5	2
Towaway	4	2	4	8
Total	6	4	11	10
AADT	10102	10666	11229	11792

Figure 17 - Accidents (only years with full data are shown)



The accident rate per million vehicle kilometres (Mvk) has been calculated for years 1999 to 2004 for the study section. Accident rates for the study sections are shown in Table 20.

Table 20 - Accident Rates (Per Million Vehicle Kilometres – Mvk)

Section	2000	2001	2002	2003	Average
Herons Creek Study Area	0.49	0.31	0.81	0.70	0.58

The accident rate is derived from the following formula
[No. Accidents x $1*10^6$] / [AADT x 365 x Route Length (km) x number of years]

Table 20 shows that the rate is actually increasing. The average accident rate for the study area over the 4 year period is 0.58 per Mvk. A typical new dual carriageway section would have an average rate of 0.15 per Mvk.

Further analysis of accidents in the study area is provided in Tables 21-25.

The location, type and number of accidents recorded are shown on Figure 18.

8.2 Traffic Units Involved

Table 21 shows the number of vehicles involved in accidents. Cars were accounted for 73% of vehicles involved in accidents while trucks were involved in 24% of accidents. Approximately half of accidents involved more than one vehicle.

Table 21 - Accidents by Vehicle Type

Vehicle Type	1999	2000	2001	2002	2003	2004	Total
Car	3	5	3	10	8	1	30
Motorbike	0	0	0	0	0	0	0
Large Truck	0	1	1	2	2	1	7
Light	0	0	1	2	0	0	3
Other	0	0	1	0	0	0	1

8.3 Time of Day Distribution

Table 22 shows the accident breakdown by time of day for each year.

The table shows that there is a spread of accidents throughout the 24 hour period across each year. It also shows a concentration of accidents in the periods between 10 am and 12 noon and 2 pm and 4 pm. Approximately one half of fatal and injury accidents occurred in this time period.

Table 22 - Accidents by Hour of the Day

Hour		1999	2000	2001	2002	2003	2004	Total	Percent
00-02	AM	0	0	0	0	1	0	1	2.8
02-04	AM	0	1	0	0	1	0	2	5.6
04-06	AM	0	1	0	0	1	1	3	8.3
06-08	AM	1	0	0	0	0	0	1	2.8
08-10	AM	0	0	2	1	0	0	3	8.3
10-12	AM	0	1	1	5	2	0	9	25
12-14	PM	0	0	0	1	2	0	3	8.3
14-16	PM	0	1	0	4	2	1	8	22.2
16-18	PM	0	0	1	0	0	0	1	2.8
18-20	PM	2	0	0	0	1	0	3	8.3
20-22	PM	0	0	0	0	0	0	0	0
22-24	PM	0	2	0	0	0	0	2	5.6

8.4 Age Group Distribution

Table 23 shows the accident breakdown by age group.

There is generally an even spread of values across all age groups and years. Drivers over the age of 70 accounted for 25% of accidents however only make up 8.2% of the driving population. 5 of the 9 accidents involving drivers over 70 years old occurred at the Bago Road / Pacific Highway intersection. Both fatal accidents also occurred at this intersection with the driver at fault over 70 years old.

Table 23 - Accidents by Age Group

Age Group	1999	2000	2001	2002	2003	2004	Total	Percent
16-19	0	2	1	1	0	0	4	11.1
20-29	0	1	0	3	2	0	6	16.7
30-39	0	0	1	1	3	2	7	19.4
40-49	0	2	1	0	0	0	3	8.3
50-59	1	1	1	0	0	0	3	8.3
60-69	0	0	0	0	2	0	2	5.6
70+	1	0	0	5	3	0	9	25.0
Unknown	1	0	0	1	0	0	2	5.6

8.5 Weather

An analysis of the weather conditions and accident frequency indicates that 70% of accidents occurred during daylight on a dry road surface.

Further details relating to carriageway and curves are shown in Tables 24 and 25.

8.6 Accident Types

An analysis of the number off accidents per accident type for the years 1999 to 2004 found that 47% of accidents for the section of highway were Run Off Road accidents. Vehicles travelling in adjacent directions (intersections only) comprised 30% of accidents while the remaining 23% was due to On Path collisions, U-Turns, Side Swipes, Lane Changes and Rear End collisions.

A further analysis of the Run Off Road accidents shows that 70% of accidents occurred on a dry road surface.

Table 24 shows the Run Off Road accident breakdown and the percentage of those accidents in dry weather.

Table 24 - Run Off Road Accidents

Accident Type	Number of Accidents	Percent of Total Accidents	Percent in Dry Weather
Run Off Road (Northbound)	8	22.2	62.5
Run Off Road (Southbound)	8	22.2	75

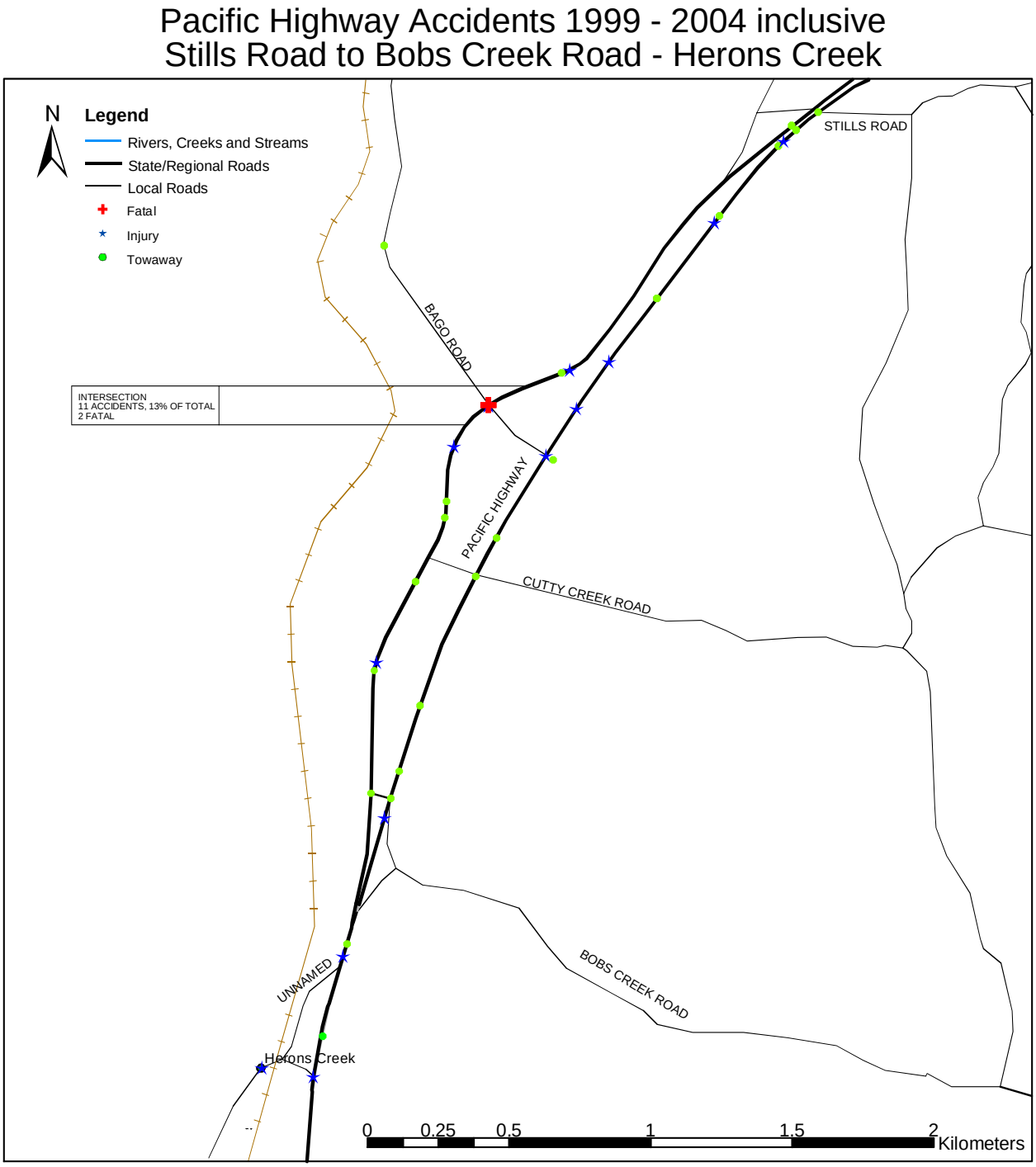
8.7 Accident Locations

Table 25 shows 79% of accidents occurred at the Bago Road / Pacific Highway intersection. Both fatal accidents also occurred at this intersection. A map of accident locations is provided in Figure 17.

Table 25 - Intersection Accidents

Intersection	Number of Accidents	Percent
Bago Road / Pacific Highway	11	78.6
Stills Road / Pacific Highway	0	0
Cutty Creek / Pacific Highway	1	9.1
Bobs Creek Road / Pacific Highway	2	14.3

Figure 18 - Accident Locations



8.8 Accident Summary

A high number of accidents occurred at the Pacific Highway and Bago Road junction. The proposed upgrades to the site will improve safety and may reduce accidents at the intersection.

The realignment of the northbound carriageway may help reduce the number of Run Off Road accidents, which account for 50% of accidents

At present, there are 58 accidents per 100MVK on the section. On the basis of comparison with similar roads carrying similar traffic volumes, it is predicted that accident rate on the new road will fall to 15 per 100MVK. This represents a saving of at least 4 accidents per year. This is a significant reduction because the accidents are of the more serious nature being fatal, injury or tow away.

9 CUMULATIVE TRAFFIC IMPACTS

The cumulative traffic impact of this proposal would be negligible because dual carriageway already exists. The proposal will simply improve the standard of travel and safety along the section. It will also marginally reduce travel time for through traffic by increasing the speed limit.

Overall it will make the Highway more attractive by reducing travel times and improving safety. The work is therefore likely to marginally increase travel on the Highway.

10 RISK ASSESSMENT

10.1 General

Hazards and risks are associated with the construction and operation of the project.

The following sections identify the major hazards and risks associated with construction and operation of the proposal and assess their impact on the project. The issues associated with the construction phase are addressed under the section on Construction Risks and Hazards. The operational issues are addressed in the following section under Operational Risks and Hazards.

10.2 Construction Risks and Hazards

The main risks associated with construction relate to:

- The spillage of fuels or chemicals either by way of leakages of stored materials or by vehicle/ machinery accidents;
- Traffic accidents at construction access points; and
- Workplace accidents.

Construction work will be undertaken by contract and as such these issues will be responsibility of the contractor.

As part of the contract, the contractor would be required to have an approved environmental management system and a Project Environmental Plan for the project that contains procedures for the management of risks and hazards. Furthermore, the requirements for addressing Occupational Health and Safety issues are fully addressed in the standard specifications used in

RTA contracts. Notwithstanding this requirement, the RTA is currently endeavouring to give more consideration to OH&S issues earlier in the planning process.

The contractor would be required to have a quality system that contains mechanisms for handling and storage of hazardous materials and for monitoring procedures to ensure compliance.

The contractor would also need an approved Traffic Management Plan and Traffic Control Plans for specific sites. Appropriate traffic control will be required at the main access points from the construction areas to the existing highway.

Where practical all construction traffic movements should be limited to the new carriageway to avoid conflicts with Highway traffic.

It will be necessary to ensure that access to the Public School is not affected during construction. Construction access and activities should be designed so as to avoid conflicts with school traffic.

The measures identified are aimed at minimising the risk of an incident and the severity of any occurrence during construction.

10.3 Operational Risks and Hazards

The Highway is the primary north south route for trucks transporting dangerous goods. The most common dangerous goods are flammable and combustible liquids, liquefied petroleum gases, flammable gases, toxic materials and reactive materials.

Heavy vehicles account for approximately 20% of total traffic (10% light commercial and 10% heavy commercial). Only a small percentage of these would carry dangerous goods. Research shows that dangerous goods as a percentage of all heavy vehicles in NSW is 1.15%. (Source: EIS Pacific Highway Upgrade Coopernook to Moorland Feb 2000). The likelihood of an incident would therefore be small.

The transport of dangerous goods is controlled by the provisions of Dangerous Goods Act 1997 which defines the categories of goods, labelling, packaging for transport and compatibility with one another for transport. These safeguards minimize the impacts of the severity of any incident.

In terms of response time to an incident full time Fire Stations are provided at Wauchope and Port Macquarie. The NSW Fire Brigade has the responsibility for managing chemical and fuel spills. For spillages it operates under the EPA Guidelines 'Chemical Responses Manual'. The EPA is responsible for offering advice on containment and cleanup. The RTA has procedures for assisting these authorities in the management and cleanup of such incidents. Together these agencies and procedures are considered adequate to fully address any incidents on the options under consideration for this project.

The section of Highway does not pass through environmentally sensitive land (rivers, wetlands etc) so any spillages would likely have a small impact on natural systems.

In the event of an incident, traffic could be diverted and traffic flow maintained with only minor inconvenience on road users due to flexible traffic arrangements available with dual carriageways.

The construction of a new high standard northbound carriageway road would provide a far safer transport corridor than the existing winding northbound carriageway.

Turning bays and stopping areas for maintenance vehicles are required along the route. It is suggested that at least one and possible two turning bays are created. Widened shoulders for maintenance vehicles should be provided where practicable along the route to allow vehicles and workmen to stand clear of passing traffic.

10.4 Constructability

A number of factors need to be considered in assessing the constructability of the second carriageway. The more significant of these have been summarised below.

10.4.1 Funding Risk

The timeframe for completion of construction may be influenced by many factors. Availability of funding across the period of construction is the most critical factor. At this time it appears that funding will available to complete construction by the end of 2010.

10.4.2 Staging

The project may be staged by constructing the 'A' class road in the first instance followed by the 'M' class design that includes an interchange.

Traffic management initiatives may be required during construction. The construction sequence is uncertain at this time and there appears to be no critical aspects that require special staging.

10.4.3 Pavement Type

Pavement type has not been established at this time. However, indications are that a concrete pavement could be provided without undue impact on Highway traffic flow.

Alternatively, an Asphaltic Concrete base layer on a cemented sub base would provide the maximum constructability with a high standard finished road product.

10.4.4 Number and size of structures

A series of culverts will be provided on the eastern end and through the project. The purchase and installation of these should not cause any environmental or delay problems.

10.4.5 Relocation of Utilities

The relevant utility service providers have been contacted and have indicated that relocations can be completed within the construction period at the appropriate stages of construction.

10.4.6 Property acquisition

The RTA already owns the land required for the 'A' class option.

The 'M' class option will require acquisition from State Forests for the interchange and service roads. Land may also be required for the service road bridging of Herons Creek.

Upon completion of concept design and environmental approval of the preferred option relevant properties will be acquired. There is the potential for delays in obtaining properties however this should not affect the timeline for the project. Construction is not due for commencement before year 2010.

10.4.7 Availability of Construction Materials

Part of the current design is to reduce the imported fill requirement and to maximise the use of the existing material, however some additional imported fill will be required. All material for the interchange and overbridge will need to be imported.

They can be sourced from three nearby quarries, a quarry located in Johns River, 15km to the south, Sancrox Quarry located 20 km north of Pacific Highway on Sancrox Road and Maxwell Bros Quarry 20km to the west of Pacific Highway on Rosewood Road. These quarries have limits on the annual production. Material should be able to be sourced from these three sites and possibly others in the locality depending upon the type and quality of material required.

10.4.8 Haulage

Part of the current design is to reduce the imported fill requirement and to maximise the use of the existing northbound pavement material with some excess material requiring disposal. However, it is estimated that some imported fill material will be transported to the site. These volumes are estimated to be:

- 25,370m^3 (solid volume) for the 'A' class option and;
- 124,436m^3 (solid volume) for the 'M' class option.

If a bulking factor of 1.3 is applied for the earth material, this volume can be translated to:

- 32,980m^3 for the 'A' class option and;
- 161,766m^3 for the 'M' class option.

A Class Option

This is expected to generate 33 laden truck movements per day (or 67 two way truck movements) on the basis of 12 weeks construction time for earthworks. Refer to table 26 below for details. This number of truck movements would require a positive traffic control at the access points to the section.

Table 26 – Haulage Movements for Imported Fill Material – A Class

Haulage Movements - 'A' Class Option

Fill	Volume (m 3)	Time in Weeks	Operating days per week	Truck and Trailer capacity (m 3)	Laden trips per day	Total trucks per day (two way)	Hours per day	Trucks per hour (two way)
Imported Fill	32980	12	6	15	33	67	8	8

Assumptions: Bulking factor of 1.3 for fill material

M Class Option

This is expected to generate 163 laden truck movements per day (or 327 two way truck movements) on the basis of 12 weeks construction time for earthworks. Refer to table 27 below for details. This number of truck movements would require a positive traffic control at the access points to the section.

Table 27 – Haulage Movements for Imported Fill Material – M Class

Haulage Movements - 'M' Class Option

Fill	Volume (m 3)	Time in Weeks	Operating days per week	Truck and Trailer capacity (m 3)	Laden trips per day	Total trucks per day (two way)	Hours per day	Trucks per hour (two way)
Imported Fill	161766	12	6	15	163	327	8	41

Assumptions: Bulking factor of 1.3 for fill material

The effects of additional truck movements resulting from the haulage of construction material is significant on the existing highway. The truck movements in and out of the construction site will be in the vicinity of 8 per hour for the 'A' class option and 41 per hour for the 'M' class option. The peak hour traffic on the Highway will be over 1000 vehicles in either direction. This means that proper traffic control is necessary at the site access points in order to ensure safety.

Traffic control such as manual traffic control along with warning signs and speed reduction could be considered for the 'A' class option. With relatively high haulage movements (>41 per hour) for the 'M' class option forms of traffic control such as temporary traffic signals are likely to be required. If the haulage movements are reduced by an increased construction time or a reduced imported fill quantity other forms such as manual traffic control along with warning signs and speed reduction could be considered.

10.4.9 Noise/Vibration/Dust

Noise vibration and dust impacts may be an issue on the southern end of the project near Herons Creek Public School. While noise and vibration issues are dealt with in detail in the Noise Report it is worth mentioning in this traffic study as it may affect constructability in terms of times of operation, construction noise levels, dust control and provision for traffic at school start and finish times.

These issues should not adversely affect the constructability of the project and will be addressed in detail the environmental management plan for the project and incorporated into the contract documentation.

10.4.10 Management of wildlife – avoidance of clearing during breeding / migration

Environmental management measures contained in the studies covering fauna and flora will identify how this can be best achieved. As the work is contained within what is now a wide median area of the existing Highway corridor, it is not expected that these restrictions would affect or prolong the construction period.

10.5 Summary

An assessment has been made of the risks associated with the project. It is concluded that the risk identified are of a manageable proportion and do not constitute a hindrance to the successful and timely completion of the project.

At the time of preparing this report the issues identified above are not envisaged to be of sufficient magnitude that would delay the delivery of the project by the end of 2010.

11 CONCLUSIONS

Progressive upgrading of the existing northbound carriageway under traffic would be very expensive and lead to an unsatisfactory long-term outcome in terms of traffic efficiency and safety.

The 'A' class and 'M' class upgrade options proposed for the section of Pacific Highway will provide an improved LOS to all road users, increase safety and reduce accidents and will offer reductions in travel time.

Modelling and traffic projections indicate by 2030 (20 years after opening) the Pacific Highway for both the 'A' class and 'M' class options will operate at a LOS 'C' for the 100th Highest Hour.

The average travel speed on both the southbound and northbound carriageways will increase to 105kph when the proposal is complete with 110kph sign-posted limit. This represents a saving of 5 seconds per vehicle for southbound traffic and 16 seconds per vehicle for northbound traffic.

Highway travel time savings will be relatively minor for this 3.44km long section but when combined with other savings along the Pacific Highway will be significant in aggregate.

Delays for side road traffic will be only marginally reduced in the 'A' class option. Capacity issues are likely to develop by year 2011 with intersections failing at a LOS 'F' by year 2020. By this stage the 'M' class option is likely to be constructed.

Delays for side road traffic will be much shorter in the 'M' class option than in the 'A' class option. This is due the construction of a grade separated interchange. All intersections in the 'M' class option are expected to operate satisfactorily up to 2030.

Economic analysis shows that only the 'M' class option and 'A' to 'M' Staged class option will provide a return of over twice the investment, based on costs provided by the RTA. The 'A' class option will not provide such a return to the community based on these costs.

Analysis of existing accident data and consideration of the nature of the new road indicate that there will be a considerable improvement in the safety performance of the improved road when compared to existing accident rates.

At present, there are 58 accidents per 100MVK on the section. On the basis of comparison with similar roads carrying similar traffic volumes, it is predicted that accident rate on the new road will fall to 15 per 100MVK. This represents a saving of at least 4 accidents per year. This is a significant reduction because the accidents are of the more serious nature being fatal, injury or tow away.

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APPENDIX A

PLAN SHOWING OPTIONS

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CONCEPT DESIGN

TO WAUCHOPE

TO KEMPSEY

Burrawan Forest Drive

Stills Road

North Coast Railway

Bago Road

Cutty Creek

Service Road

Boyds Road

Herons Creek

Herons Creek Road

HERONS CREEK

TO TAREE

Bobs Creek Road

Stage 1: Burrawan Forest Drive connected to Bago Road using existing northbound lanes.

Stage 1: Proposed roundabout at Bago Road.

Stage 1: Close existing intersection and remove cross-median access.

Stage 1: New northbound carriageway adjacent to existing southbound carriageway would provide improved safety and travel conditions.

Stage 1: New seagull intersection at Bago Road would provide improved safety.

Stage 2: New grade separated interchange near Bago Road would provide improved road safety and access to the Pacific Highway.

Stage 1: Existing northbound carriageway would become a two-way service road providing safer access for locals.

Stage 2: Future connection to Herons Creek village would separate through and local traffic.

Stage 1: New seagull intersection at Bobs Creek Road would provide improved safety.

Herons Creek Public School.

Stage 2: Bobs Creek Road connected to interchange.

Stage 2: Upon completion of the grade separated interchange at Bago Road, the existing Herons Creek Road intersection would close.

Stage 2: Future connection for improved access.

Minor adjustments are required to the adjoining Moorland to Herons Creek upgrade project (EIS exhibited).

N

0 0.5 1km

LEGEND

- Existing property boundaries
- Water courses
- Proposed design boundary
- Stage 2
- Embankment
- Cutting
- Proposed upgrade
- Existing highway
- Local roads

OrthoView aerial photography (2001), cadastral and topographic data under licence to RTA by Department of Lands

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APPENDIX B

ECONOMIC ANALYSIS SUMMARY

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BCR – Analysis Period 2010 to 2040 (Values in June 2005 $M) – Based on costs provided by the RTA

Option A - $M June 2005

	Agency Costs		Road User Costs			Overall	
NPV	Const'n	Mtce	VOC	Tr Time	Accidents	Savings	BCR
4%	19.57	1.88	12.08	14.07	17.44	45.47	2.32
7%	17.46	1.69	7.28	8.64	10.52	28.13	1.61
11%	15.08	1.28	4.12	4.83	5.97	16.20	1.07

First Year Rate of Return 7% discount rate Based on NPV 2005 of costs and benefits		
Costs	2020 Benefit	FYRR
17.46	2.77	16%

Note: First year rate of return is not dependant on the length of the analysis period.

Option M - $M June 2005

	Agency Costs		Road User Costs			Overall	
NPV	Const'n	Mtce	VOC	Tr Time	Accidents	Savings	BCR
4%	32.41	1.88	17.42	97.75	26.15	143.20	4.42
7%	28.93	1.69	10.51	49.63	15.78	77.61	2.68
11%	24.98	1.28	5.96	21.52	8.06	36.82	1.47

First Year Rate of Return 7% discount rate Based on NPV 2005 of costs and benefits		
Costs	2020 Benefit	FYRR
28.93	3.43	12%

Note: First year rate of return is not dependant on the length of the analysis period.

Staged Option - $M June 2005

	Agency Costs		Road User Costs			Overall	
NPV	Const'n	Mtce	VOC	Tr Time	Accidents	Savings	BCR
4%	30.69	1.88	15.43	98.53	22.94	138.78	4.52
7%	24.72	1.69	8.98	50.36	13.31	74.34	3.01
11%	19.26	1.28	4.86	22.16	7.18	35.48	1.84

First Year Rate of Return 7% discount rate Based on NPV 2005 of costs and benefits		
Costs	2020 Benefit	FYRR
24.72	3.43	14%

Travel Costs

State wide values for rural travel - December 2003

TABLE 12: VALUE OF TRAVEL TIME - RURAL						
Vehicle Type	**Proportion**	**Occupancy**	**Value**		**Freight**	**Total**
			$/pers.h	**$/Veh.h**	**$/Veh.h**	**$/Veh.h**
Private Car	43%	1.7	10.15	17.26		17.26
Business Car	23%	1.3	32.48	42.22		42.22
Light commercial	22%	1.3	21.25	27.63	0.53	28.16
Heavy commercial	10%	1	22.87	22.87	10.88	33.76
Road Trains	1%	1	24.27	24.27	30.09	54.35
		Weighted Average - $27.59 per vehicle hour				

CALCULATED Study values for rural travel on SH10 at site June 2005

TABLE 12: VALUE OF TRAVEL TIME - RURAL						
Vehicle Type	**Proportion**	**Occupancy**	**Value**		**Freight**	**Total**
			$/pers.h	**$/Veh.h**	**$/Veh.h**	**$/Veh.h**
Private Car	38.82%	1.7	10.49	17.83		17.83
Business Car	20.77%	1.3	33.56	43.63		43.63
Light commercial	19.86%	1.3	21.96	28.55	0.55	29.10
Heavy commercial	18.55%	1	23.63	23.63	11.24	34.88
Road Trains	2.00%	1	25.08	25.08	31.09	56.18
		Weighted Average - per vehicle hour				**$ 29.36**

Vehicle Operating Costs for Rural Roads

Total Vehicle Operating Costs for Base Grade 2% and Base Curvature Conditions Cents/km (December 2003 Prices)

LIGHT VEHICLES
ROAD VOLUME CAPACITY RATIO = 0

SPEED	ROAD SURFACE/PAVEMENT CONDITIONS										
km/h	E	G1	G2	G3	G4	G5	S1	S2	S3	S4	S5
10	44.6	38.0	34.9	32.5	31.3	30.6	30.2	28.0	26.4	25.2	24.6
20	39.9	33.2	30.1	27.7	26.5	25.8	25.4	23.2	21.5	20.3	19.6
30	38.3	31.7	28.5	26.2	24.9	24.2	23.8	21.6	20.0	18.8	18.1
40	37.8	31.1	28.0	25.6	24.3	23.6	23.2	21.0	19.4	18.2	17.5
50	37.6	30.9	27.8	25.4	24.1	23.4	23.0	20.8	19.1	17.9	17.2
60	37.7	31.0	27.9	25.5	24.2	23.5	23.1	20.9	19.2	18.0	17.2
70	37.8	31.1	28.0	25.6	24.3	23.6	23.2	21.0	19.3	18.1	17.4
80	38.1	31.4	28.3	25.9	24.6	23.9	23.5	21.3	19.6	18.4	17.6
90	38.5	31.8	28.7	26.3	25.0	24.3	23.9	21.7	19.9	18.7	18.0
100	39.0	32.3	29.2	26.8	25.5	24.7	24.4	22.1	20.4	19.1	18.4
110	39.6	32.8	29.7	27.3	26.0	25.2	24.9	22.6	20.9	19.7	18.9

LIGHT VEHICLES
ROAD VOLUME CAPACITY RATIO = 1

SPEED	ROAD SURFACE/PAVEMENT CONDITIONS										
km/h	E	G1	G2	G3	G4	G5	S1	S2	S3	S4	S5
10	49.9	43.2	40.2	37.8	36.6	35.9	35.4	33.3	31.7	30.5	29.9
20	44.1	37.4	34.3	31.9	30.7	30.0	29.6	27.4	25.7	24.5	23.8
30	42.3	35.6	32.5	30.1	28.8	28.1	27.7	25.6	23.9	22.7	22.0
40	41.6	34.9	31.8	29.4	28.2	27.5	27.1	24.9	23.2	22.0	21.3
50	41.5	34.8	31.6	29.3	28.0	27.3	26.9	24.7	23.0	21.8	21.1
60	41.6	34.9	31.8	29.4	28.1	27.4	27.0	24.8	23.1	21.9	21.2
70	41.8	35.1	32.0	29.6	28.3	27.6	27.2	25.0	23.3	22.1	21.4
80	42.3	35.6	32.4	30.1	28.8	28.0	27.7	25.5	23.7	22.5	21.8
90	42.9	36.1	33.0	30.6	29.3	28.6	28.2	26.0	24.3	23.0	22.3
100	43.6	36.8	33.7	31.3	30.0	29.3	28.9	26.7	24.9	23.7	22.9
110	44.3	37.6	34.4	32.0	30.7	30.0	29.6	27.4	25.6	24.4	23.6

HEAVY VEHICLES
ROAD VOLUME CAPACITY RATIO = 0

SPEED	ROAD SURFACE/PAVEMENT CONDITIONS										
km/h	E	G1	G2	G3	G4	G5	S1	S2	S3	S4	S5
10	181.2	156.1	153.2	143.3	136.7	131.3	140.6	128.5	120.4	113.7	108.2
20	152.2	127.1	124.1	114.2	107.5	102.1	111.5	99.3	91.1	84.4	78.7
30	141.6	116.5	113.6	103.7	97.1	91.7	101.0	88.9	80.8	74.1	68.6
40	137.4	112.3	109.4	99.6	93.0	87.6	96.9	84.8	76.7	70.1	64.6
50	135.3	110.2	107.3	97.4	90.8	85.5	94.8	82.7	74.6	68.0	62.4
60	134.8	109.7	106.7	96.9	90.2	84.8	94.2	82.0	73.9	67.2	61.6
70	134.8	109.7	106.7	96.9	90.2	84.8	94.2	82.0	73.8	67.1	61.6
80	135.4	110.3	107.3	97.4	90.8	85.3	94.7	82.5	74.3	67.6	62.0
90	136.3	111.1	108.1	98.2	91.5	86.1	95.5	83.3	75.1	68.3	62.7
100	137.5	112.3	109.3	99.4	92.7	87.3	96.7	84.4	76.2	69.5	63.8
110	139.1	113.9	110.9	101.0	94.3	88.8	98.2	85.9	77.7	70.9	65.2

HEAVY VEHICLES
ROAD VOLUME CAPACITY RATIO = 1

SPEED	ROAD SURFACE/PAVEMENT CONDITIONS										
km/h	E	G1	G2	G3	G4	G5	S1	S2	S3	S4	S5
10	201.0	175.9	173.0	163.1	156.5	151.1	160.4	148.3	140.2	133.5	128.0
20	167.1	141.9	138.9	129.0	122.4	116.9	126.3	114.1	105.9	99.2	93.6
30	154.7	129.6	126.7	116.8	110.2	104.8	114.1	102.0	93.9	87.2	81.7
40	150.0	124.9	122.0	112.2	105.6	100.2	109.5	97.4	89.3	82.7	77.2
50	147.7	122.6	119.7	109.9	103.3	97.9	107.2	95.1	87.0	80.4	74.9
60	147.4	122.2	119.3	109.5	102.8	97.4	106.8	94.6	86.5	79.8	74.2
70	147.7	122.6	119.6	109.7	103.1	97.7	107.0	94.9	86.7	80.0	74.4
80	148.7	123.6	120.6	110.7	104.1	98.6	108.0	95.8	87.6	80.9	75.3
90	150.1	124.9	121.9	112.0	105.4	99.9	109.3	97.1	88.9	82.2	76.5
100	151.9	126.8	123.8	113.9	107.2	101.7	111.1	98.9	90.7	83.9	78.2
110	154.3	129.1	126.1	116.1	109.4	104.0	113.4	101.1	92.8	86.1	80.3

Vehicle Operating Costs for Rural Roads

Total Vehicle Operating Costs for Base Grade 4% and Base Curvature Conditions Cents/km (December 2003 Prices)

LIGHT VEHICLES
ROAD VOLUME CAPACITY RATIO = 0

SPEED	ROAD SURFACE/PAVEMENT CONDITIONS										
km/h	E	G1	G2	G3	G4	G5	S1	S2	S3	S4	S5
10	44.9	38.2	35.2	32.8	31.6	30.9	30.5	28.3	26.7	25.5	24.9
20	40.3	33.7	30.5	28.2	26.9	26.2	25.8	23.6	21.9	20.8	20.1
30	38.7	32.0	28.9	26.5	25.3	24.6	24.2	22.0	20.3	19.1	18.4
40	38.1	31.4	28.3	26.0	24.7	24.0	23.6	21.4	19.7	18.5	17.8
50	38.0	31.3	28.2	25.8	24.6	23.8	23.5	21.3	19.6	18.4	17.7
60	38.2	31.4	28.3	25.9	24.7	23.9	23.6	21.3	19.6	18.4	17.7
70	38.3	31.6	28.4	26.1	24.8	24.1	23.7	21.5	19.8	18.6	17.9
80	38.5	31.8	28.6	26.3	25.0	24.2	23.9	21.7	19.9	18.7	18.0
90	38.9	32.1	29.0	26.6	25.3	24.6	24.2	22.0	20.3	19.0	18.3
100	39.3	32.6	29.4	27.0	25.7	25.0	24.6	22.4	20.6	19.4	18.7
110	39.8	33.1	29.9	27.5	26.2	25.5	25.1	22.9	21.1	19.9	19.1

LIGHT VEHICLES
ROAD VOLUME CAPACITY RATIO = 1

SPEED	ROAD SURFACE/PAVEMENT CONDITIONS										
km/h	E	G1	G2	G3	G4	G5	S1	S2	S3	S4	S5
10	50.2	43.5	40.4	38.1	36.9	36.2	35.7	33.6	32.0	30.8	30.2
20	44.6	37.9	34.8	32.4	31.1	30.4	30.0	27.8	26.1	25.0	24.3
30	42.6	35.9	32.8	30.5	29.2	28.5	28.1	25.9	24.2	23.0	22.4
40	41.0	35.3	32.2	29.8	28.5	27.8	27.4	25.2	23.6	22.4	21.7
50	41.9	35.2	32.0	29.7	28.4	27.7	27.3	25.1	23.4	22.2	21.5
60	42.1	35.4	32.2	29.9	28.6	27.9	27.5	25.3	23.6	22.3	21.6
70	42.3	35.6	32.5	30.1	28.8	28.1	27.7	25.5	23.8	22.6	21.9
80	42.6	35.9	32.8	30.4	29.1	28.4	28.0	25.8	24.1	22.9	22.2
90	43.2	36.5	33.3	30.9	29.7	28.9	28.6	26.3	24.6	23.4	22.6
100	43.8	37.1	33.9	31.5	30.3	29.5	29.2	26.9	25.2	23.9	23.2
110	44.5	37.8	34.6	32.2	30.9	30.2	29.8	27.6	25.9	24.6	23.9

HEAVY VEHICLES
ROAD VOLUME CAPACITY RATIO = 0

SPEED	ROAD SURFACE/PAVEMENT CONDITIONS										
km/h	E	G1	G2	G3	G4	G5	S1	S2	S3	S4	S5
10	181.7	156.6	153.7	143.9	137.3	131.9	141.2	129.1	121.0	114.4	108.8
20	153.6	128.5	125.5	115.6	109.0	103.5	112.9	100.7	92.6	85.9	80.2
30	141.9	116.9	114.0	104.2	97.6	92.2	101.5	89.4	81.3	74.7	69.2
40	139.2	114.1	111.2	101.4	94.8	89.5	98.8	86.7	78.6	72.0	66.5
50	138.7	113.6	110.7	100.8	94.2	88.8	98.2	86.0	77.9	71.3	65.7
60	139.4	114.3	111.3	101.4	94.8	89.3	98.7	86.5	78.4	71.7	66.0
70	139.5	114.4	111.4	101.5	94.8	89.4	98.8	86.6	78.4	71.7	66.0
80	140.1	114.9	112.0	102.0	95.4	89.9	99.3	87.1	78.9	72.1	66.5
90	141.0	116.0	113.0	103.1	96.4	90.9	100.4	88.1	79.9	73.1	67.4
100	142.9	117.7	114.7	104.7	98.0	92.5	102.0	89.7	81.5	74.7	69.0
110	145.7	120.4	117.4	107.4	100.7	95.2	104.7	92.3	84.0	77.2	71.4

HEAVY VEHICLES
ROAD VOLUME CAPACITY RATIO = 1

SPEED	ROAD SURFACE/PAVEMENT CONDITIONS										
km/h	E	G1	G2	G3	G4	G5	S1	S2	S3	S4	S5
10	201.1	176.0	173.1	163.2	156.6	151.3	160.5	148.4	140.3	133.7	128.2
20	168.2	143.1	140.1	130.2	123.6	118.1	127.5	115.3	107.2	100.5	94.9
30	154.7	129.7	126.8	116.9	110.3	105.0	114.3	102.2	94.1	87.5	82.0
40	151.7	126.7	123.8	113.9	107.4	102.0	111.3	99.2	91.1	84.5	79.0
50	151.3	126.2	123.3	113.4	106.8	101.4	110.7	98.6	90.5	83.9	78.3
60	152.2	127.0	124.1	114.2	107.5	102.1	111.5	99.3	91.1	84.4	78.8
70	152.7	127.5	124.5	114.6	108.0	102.5	111.9	99.7	91.5	84.8	79.1
80	153.6	128.4	125.5	115.5	108.9	103.4	112.8	100.6	92.4	85.6	80.0
90	155.2	130.0	127.0	117.1	110.4	104.9	114.4	102.1	93.9	87.1	81.4
100	157.5	132.3	129.3	119.4	112.7	107.2	116.6	104.4	96.1	89.3	83.6
110	161.1	135.9	132.9	122.9	116.1	110.6	120.1	107.8	99.5	92.7	86.9

APPENDIX C

VOLUMES FOR NOISE ASSESSMENT

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State Highway 10 – Pacific Highway
Existing and Predicted Traffic Flows
At Bobs Creek Road

Vehicles per day adjusted to AADT

Year	AADT
2005	12946
2010	15897
2020	21800
2030	27702

Hourly distribution of vehicles - At Bobs Creek Road (Vehicle Class 1 - 12) Representative of years 2005, 2010 & 2020

Hour start	% of VPD in hour	% Cars (CL 1-2)	% Heavy Vehicles (CL 3-5)	% Heavy Vehicles (CL 6-12)
0	1.4	43.2	8.9	47.9
1	1.2	36.0	10.1	54.0
2	1.0	31.4	11.6	57.9
3	0.9	33.3	13.9	52.8
4	0.9	43.8	13.3	42.9
5	1.1	58.8	13.0	27.5
6	1.9	72.1	12.8	15.5
7	3.3	78.3	11.9	9.8
8	4.8	82.4	10.8	6.6
9	6.4	84.8	10.0	5.1
10	7.4	84.8	10.8	4.5
11	7.8	85.1	11.0	3.9
12	7.7	85.0	10.9	4.1
13	7.2	85.2	10.4	4.4
14	7.3	84.8	10.3	5.0
15	7.7	85.6	9.3	5.1
16	7.6	85.0	8.9	5.9
17	6.8	84.5	8.3	7.1
18	5.6	82.8	7.8	9.4
19	3.7	77.3	8.4	14.3
20	2.7	70.8	8.2	21.0
21	2.3	66.1	7.9	26.0
22	1.9	61.8	7.6	30.7
23	1.6	53.2	8.1	38.7

Year 2005

Hour start	No. of Vehicles Per Hour in Day	No. of Cars (CL 1-2)	No. of Heavy Vehicles (CL 3-5)	No. of Heavy Vehicles (CL 6-12)
0	182	79	16	87
1	150	54	15	81
2	131	41	15	76
3	117	39	16	62
4	113	50	15	49
5	141	83	18	39
6	244	176	31	38
7	427	335	51	42
8	620	511	67	41
9	829	703	83	42
10	957	812	104	43
11	1013	861	111	40
12	992	843	108	41
13	935	797	97	41
14	951	806	98	47
15	995	852	93	51
16	981	834	87	58
17	884	747	73	63
18	721	597	56	68
19	475	367	40	68
20	344	244	28	72
21	299	198	24	78
22	243	150	18	74
23	201	107	16	78

Year 2010

Hour start	No. of Vehicles Per Hour in Day	No. of Cars (CL 1-2)	No. of Heavy Vehicles (CL 3-5)	No. of Heavy Vehicles (CL 6-12)
0	224	97	20	107
1	184	66	19	99
2	160	50	19	93
3	143	48	20	76
4	139	61	19	60
5	174	102	23	48
6	300	216	38	46
7	525	411	62	52
8	761	627	82	50
9	1018	863	102	52
10	1176	997	127	53
11	1243	1058	137	49
12	1218	1035	133	50
13	1148	978	119	50
14	1168	990	121	58
15	1222	1046	114	62
16	1205	1025	107	72
17	1086	917	90	77
18	885	733	69	84
19	583	451	49	84
20	423	300	34	89
21	367	243	29	95
22	298	184	23	91
23	247	131	20	95

Year 2020

Hour start	No. of Vehicles Per Hour in Day	No. of Cars (CL 1-2)	No. of Heavy Vehicles (CL 3-5)	No. of Heavy Vehicles (CL 6-12)
0	307	133	27	147
1	253	91	25	136
2	220	69	25	127
3	196	65	27	104
4	191	84	25	82
5	238	140	31	65
6	411	296	53	64
7	720	563	85	71
8	1043	860	113	69
9	1396	1183	140	71
10	1612	1367	174	73
11	1705	1451	187	67
12	1670	1420	182	69
13	1574	1341	164	69
14	1601	1358	165	80
15	1676	1434	156	85
16	1652	1405	147	98
17	1489	1258	124	105
18	1214	1005	95	115
19	800	618	67	115
20	580	411	47	122
21	504	333	40	131
22	409	253	31	125
23	338	180	27	131

Herons Creek to Stills Road

Review of Environmental Factors – Appendix F

Review of Flora and Fauna.

January 2007

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Review of Flora and Fauna
Pacific Highway Upgrade Herons Creek to Stills Road

27 June 2006

Prepared for:
Roads and Traffic Authority
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DISTRIBUTION

Review of Flora and Fauna
Pacific Highway Upgrade Herons Creek to Stills Road
27 June 2006

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This document was prepared for the sole use of the Roads and Traffic Authority and the regulatory agencies that are directly involved in this project, the only intended beneficiaries of our work. No other party should rely on the information contained herein without the prior written consent of HLA-Envirosciences Pty Limited and the Roads and Traffic Authority.

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Plate 4: Former alignment of Pacific Highway between the present day northbound and southbound carriageways, looking south
Plate 5: A logged coupe east of the southbound carriageway of the Pacific Highway, south of Boyds Road
Plate 6: Riparian vegetation associated with Cutty Creek between the northbound and southbound carriages of the Pacific Highway

APPENDICES

Appendix 1: Fauna of the Local Area
Appendix 2: Flora of the Local Area
Appendix 3: TSC Act Section 94 Assessment: Significant effect on threatened species, populations or ecological communities, or their habitats

EXECUTIVE SUMMARY

This report has been prepared by HLA-Envirosciences Pty Limited (HLA), on behalf of the NSW Roads and Traffic Authority (RTA) to investigate the potential effect the proposed upgrade of approximately 3.3 km along the Pacific Highway, between Herons Creek and Stills Road, would have on terrestrial and aquatic flora and fauna. This section of the Pacific Highway is located approximately 58 km north of Taree and 19 km south of Port Macquarie. The project also incorporates modifications to several intersections to improve road safety.

The flora and fauna within the study area, approximately 3.5 km long and extending at least 50 m out from the proposed area of disturbance, was investigated. A desktop review of existing information and a limited field investigation took place in early Spring to confirm the findings of the previous studies and identify significant habitats within the study area. Targeted surveys for threatened and otherwise significant species were undertaken.

No threatened plant species or signs of threatened fauna were observed. Aquatic habitat within the study area is limited to seepages and pools associated with Herons and Cutty Creeks. There are few larger trees that contain hollows or dead trees that are hollow. The majority of trees are relatively young and have not developed hollows.

The shrub understorey and fallen timber has been mostly cleared for fire hazard reduction purposes. This has severely limited the availability of shelter for larger terrestrial reptile and small mammal species. No exfoliated rock habitat or other rocky areas, with the exception of rock exposed during road construction, is present within the study area. There is potential for the degradation of adjacent communities through the spread of exotic species and siltation of riparian habitats. The implementation of the proposed mitigation measures will reduce the potential for significant degradation of habitats.

Approximately 14 ha of remnant vegetation in varying condition will be affected by the proposed highway upgrade, with the majority of disturbance associated with the diamond interchange for the Boyds Road and Bobs Creek Road access. Clearing of woodland will result in the loss of roosting, denning and foraging opportunities for birds and arboreal mammals. Indirect impacts that may result from the proposed development include noise during road construction and increased difficulty for fauna in traversing the highway after widening. There may be some increase in the potential for collision between wildlife and vehicles, particularly where larger trees that are presently protected from forestry activities are found adjacent to the existing highway.

There is an increased potential for the spread of weed species through the movement of soil containing seed, stem and root material if areas where weeds are present are not treated prior to earthmoving activities. There is also the potential for the spread of plant pathogens, such as *Phytophthora* sp. fungi, into the area on equipment used during the construction of the proposed road works. At present there is no evidence of dieback within the study area resulting from *Phytophthora* sp. infection.

In addition, weed management measures will assist in mitigating the potential effect of the proposed highway upgrade on native biodiversity.

1 INTRODUCTION

This report has been prepared by HLA-Envirosciences Pty Limited (HLA), on behalf of the NSW Roads and Traffic Authority (RTA) to investigate the potential affect the proposed upgrade of approximately a 3.3 km length of the Pacific Highway, between Herons Creek and Stills Road, would have on terrestrial and aquatic flora and fauna. This section of the Pacific Highway is located approximately 58 km north of Taree and approximately 19 km south of Port Macquarie.

The aim of the proposed Pacific Highway upgrade is to ensure the standard of carriageway on this section of the Highway is consistent with the standard of adjoining sections.

1.1 Proposed Development

The proposed highway upgrade consists of the construction of a new northbound carriageway within the existing median area, parallel to the existing southbound carriageway. Much of the existing northbound carriageway would become a two-way local service road, linking Bago Road, Burrawan Forest Drive (west), Herons Creek Public School and local properties to the grade separated interchange south of Bago Road.

The upgrade of the Pacific Highway for this section would be undertaken in two stages as detailed below. The proposed development would be designed for 110 km/h travel speed and would provide a high standard four-lane dual carriageway. The carriageways would be separated by a 12 m median (minimum) that would allow the future addition of an extra two lanes if required. The footprint of the proposed development is shown in **Figure 1**.

1.1.1 Stage 1

The new northbound carriageway and the two-way service road from Herons Creek Public School to Burrawan Forest Drive and seagull intersections at Bago Road and Bobs Creek Road would be constructed.

Interchanges
Intersection improvements would be undertaken in Stage 1.

Access
Access to Herons Creek Public School and properties adjoining the existing Highway would be via the two-way service road. New at-grade seagull intersections would provide improved access to the Highway at Bago Road and Bobs Creek Road.

1.1.2 Stage 2

The grade-separated interchange south of Bago Road, the service road from Herons Creek township to Herons Creek Public School and the eastern two-way service road would be built.

Interchanges
A grade-separated interchange near Boyds Road is proposed south of the existing intersection of the Pacific Highway at Bago Road. The interchange would provide a two-lane bridge over the Highway, which would improve all turning movements from Stills Road and Bobs Creek Road, to and from the Highway.

Access
Access to the Highway would only be provided at the grade-separated interchange south of Bago Road. Upon completion of the grade-separated interchange at Bago Road, the existing Herons Creek Road intersection would close.

Access to Herons Creek township, Herons Creek timber mill and Herons Creek Public School would be via a new two-way service road crossing Herons Creek upstream of the existing bridges. Highway intersections at Bobs Creek Road would close and access would be via the interchange south of Bago Road.

1.2 Scope of Works

The scope of works of this report is to:

- Review information currently available, including searches of the Department of Environment and Conservation (DEC) Atlas of NSW Wildlife, DEC PlantNET database and an on-line search of the Commonwealth Department of Environment and Heritage (DEH) for matters of national environmental significance, to identify significant plants and communities that occur within the study area;
- Prepare a list of species found in the area, and those potentially occurring in the area;
- Undertake a field survey in Spring to identify plants, animals, and ecological communities present within the study area;
- Prepare an impact assessment, in accordance with Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act), for threatened species, populations and ecological communities listed under the *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act) potentially affected by the proposal;
- Prepare an impact assessment for threatened species and ecological communities, listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), potentially affected by the proposal;
- In the event that threatened species are affected, determine whether a Species Impact Statement is required under the TSC Act or whether referral to the Commonwealth Environment Minister is required in accordance with the EPBC Act;
- Prepare of a list of suggested measures to mitigate potential effects on flora and fauna; and
- Recommend if further work is required to fully assess the significance of the potential impacts.

1.3 The Study Area

The area investigated in this study is defined as the length of the Pacific Highway along which the proposed works will take place with a buffer zone approximately 50 m wide along either side of the area of the works. The approximate outline of the study area is shown in **Figure 1**.

2 INFORMATION REVIEW

A desktop review of information was conducted to identify significant matters that may occur within the local area. The information reviewed comprised:

- On-line Databases maintained by the Department of Environment and Heritage (DEH);
- Department of Environment and Conservation (DEC) Atlas of NSW Wildlife;
- DEC PlantNET;
- Ecological studies relevant to the local area; and
- Existing vegetation mapping.

2.1 Flora

2.1.1 Previous Studies

Broad-scale Remnant Vegetation Mapping
Broad-scale vegetation mapping for the local area has been completed for the Comprehensive Regional Assessment Aerial Photograph Interpretation (CRAFTI) project. Information completed for the CRAFTI project was designed as part of the Comprehensive Regional Assessment (CRA) to provide baseline data for all eucalypt forests and broad floristic mapping. The information contributed to the Regional Forest Agreement process.

The vegetation mapping in this report was compiled from existing mapping by Forest NSW and DEC as well as modelled community distributions (NPWS 1999). This has led to some difficulty as there is no common classification scheme in the various mapping studies. For example, CRAFTI community E2 '*Eucalyptus siderophloia-E. propinqua-E. acmenoides-E. carnea*' occurs spatially close to Forest NSW community 592 'Grey Gum-Grey Ironbark-White Mahogany'.

The vegetation community mapping in the vicinity of the study area, shown in **Figure 2**, is based on the CRAFTI mapping, with similar community types merged based on community name and spatial proximity. Accordingly, the vegetation community types are:

- Dry Blackbutt League;
- Broad-leaved White Mahogany and Grey Gum/Grey Ironbark/White Mahogany;
- Sydney Blue Gum/Bangalay League;
- Forestry Plantation (Hardwood);
- Moist Blackbutt League;
- Mixed Blackbutt;
- Artificial Community; and
- Cleared/Modified.

The majority of the mapped vegetation in the vicinity of the study area is managed by Forests NSW for the commercial production of timber products. Most vegetation is simply described as part of the Blackbutt League, with riparian vegetation classified as Sydney Blue Gum/Bangalay League. Nearby areas that are not part of the Forests NSW estate have been mapped as "Broad-leaved White Mahogany and Grey Gum/Grey Ironbark/White Mahogany" (NPWS 1999).
The vegetation adjacent to Herons Creek is mapped as 'unnatural non-forest', a class that includes exotic weeds, non-timber plantation, pasture, transmission lines, infrastructure and rural and urban developments.

No remnant vegetation mapping held by the Port Macquarie-Hastings Council was available for review. The conservation significance of the vegetation communities, in areas that have not been modified for infrastructure, forestry and agriculture, is assumed to be high. This assumption is based on conservation value of communities dominated by Blackbutt (*Eucalyptus pilularis*) in the Great Lakes Local Government Area (LGA).

Biosis (2004)

The vegetation to the south of Herons Creek was investigated by Biosis (2004) as part of the impact assessment for the Pacific Highway upgrade between Moorland and Herons Creek. Six communities were recognised and are listed below:

- Coastal Blackbutt Forest;
- Dry Tallowwood Forest;
- Flooded Gum Forest;
- Freshwater Wetland;
- Swamp Sclerophyll Forest; and
- Cleared/Disturbed Vegetation.

As the Moorland to Herons Creek section of the Pacific Highway upgrade is over 20 km in length the community structure is more diverse than that of the study area. Only three of these communities have similarities with the communities around the study area and these are described below.

Coastal Blackbutt Forest

This community was found to be widespread throughout the Biosis (2004) study area. It was described as being dominated by Blackbutt (*E. pilularis*), with co-dominant species in the northern part of the Biosis (2004) study area including Sheoak (*Allocasuarina* sp.), Bloodwood (*Corymbia* sp.), Rough-barked Apple (*Angophora floribunda*) and White Mahogany (*E. acmenoides*). The shrub layer is described as being open and to 5 m tall, typically with Christmas Bush (*Ceratopetalum gummiferum*), *Acacia longifolia*, Hop Bush (*Dodonaea triquetra*), Teatree (*Leptospermum trinervium*) and Coffee Bush (*Breynia oblongifolia*). The understorey has grasses (*Aristida* sp.), *Lomandra longifolia* and *Hibbertia* sp.

Dry Tallowwood Forest

This dry open forest community is dominated by Tallowwood (*E. microcorys*), in association with other eucalypts such as White Stringybark (*E. globoidea*), Blackbutt and Red Ironbark (*E. fibrosa*). It has a lower understorey than the Coastal Blackbutt Forest community with Hop Bush, White Dogwood (*Ozothamnus diosmifolius*), Geebungs (*Persoonia* sp.) and various *Acacia* sp. The understorey contained species such as *Aristida* sp., False Sarsaparilla (*Hardenbergia violacea*), *Hibbertia aspera* and White Root (*Pratia purpurascens*). Biosis (2004) noted the community intergraded with the Coastal Blackbutt community, often making the distinction between the two communities difficult.

Flooded Gum Forest

The community is described by Biosis (2004) as a tall, wet sclerophyll forest dominated by Flooded Gum (*Eucalyptus grandis*), in association with Blackbutt and Sydney Blue Gum (*E. saligna*), with a tall and dense shrub layer. Typical shrub species include Corkwood (*Duboisia myoporoides*), Bolwarra (*Eupomatia laurina*) and Lilly Pilly (*Acmena smithii*). Many vines are also present. The groundcover is sparse and characterised by ferns, including Prickly Rasp Fern (*Doodia aspera*), Rough Maiden Hair (*Adiantum hispidulum*) and Mulga Fern (*Cheilanthes sieberi* subsp. *sieberi*). The community was found mainly in the southern part of the Biosis (2004) study area.

Forests NSW

No vegetation community mapping was available from Forests NSW.

2.1.2 On-line databases

DEC

The NSW Scientific Committee's Final Determinations were reviewed to identify Endangered Ecological Communities (EEC) and endangered populations (EP) protected by the TSC Act that occur in the North Coast. The critical habitat within the local area was identified by reviewing online databases maintained by the DEC.

The records of terrestrial flora species held within the DEC Atlas of NSW Wildlife (ANSWW) were extracted on 12 September 2005. Records were extracted from within a search area generated by establishing a 10 km buffer around the study area. The DEC PlantNET on-line database was also reviewed to identify additional records of significant species in the local area. Records for species that are protected by the provisions of the TSC Act and/or are considered a Rare Or Threatened Australian Plant (ROTAP) species were extracted from the database using a search area bounded by 31°28'30"S, 31° 49'30"S, 152° 37'W and 152° 51'W, covering an area of approximately 10 km from the extremities of the study area.

Nine threatened vascular plant species and five non-threatened ROTAP species, listed in **Table** 1, are recorded in the local area. The ROTAP codes listed in **Table 1** are explained in **Table 2**, based on the descriptions within Briggs and Leigh (1996).

Table 1: Threatened Flora within 10 km of the Study Area

Species	Status TSC Act	EPBC Act Status	ROTAP Code	Database
Casuarinaceae *Allocasuarina defungens*	Endangered	Endangered	2E	PlantNET
Fabaceae (*mimosoideae*) *Acacia barringtonensis*	-	-	3RCa	PlantNET
Fabaceae (*mimosoideae*) *Acacia courtii*	Vulnerable	Vulnerable	2V	ANSWW PlantNET
Goodeniaceae *Goodenia fordiana*	-	-	2RC	PlantNET
Lamiaceae *Plectranthus cremnus*	-	-	3K	PlantNET
Myrtaceae *Callistemon linearifolius*	Vulnerable	-	2RCi	PlantNET
Myrtaceae *Eucalyptus fergusonii subsp. fergusonii*	-	-	3KC	PlantNET
Myrtaceae *Melaleuca biconvexa*	Vulnerable	Vulnerable	-	ANSWW PlantNET
Myrtaceae *Melaleuca groveana*	Vulnerable	-	3RC	ANSWW PlantNET
Orchidaceae *Corybas undulatus*	-	-	3KC	PlantNET
Orchidaceae *Phaius tankervilliae*	Endangered	Endangered	3VC	ANSWW
Proteaceae *Grevillea caleyi*	Endangered	Endangered	2ECi	ANSWW

Species	Status TSC Act	EPBC Act Status	ROTAP Code	Database
Proteaceae *Hakea archaeoides*	Vulnerable	Vulnerable	-	ANSWW PlantNET
Santalaceae *Thesium australe*	Vulnerable	Vulnerable	3VCi	PlantNET

Source: DEC Atlas of NSW Wildlife/PlantNET

Table 2: Explanation of ROTAP Codes for Species listed in Table 1

ROTAP Code	Explanation of Code
2	Geographic range in Australia less than 100 km
3	Geographic range in Australia greater than 100 km
E	Species at risk of disappearing in the wild 10 –20 years if land use at current locations change
V	Species at risk of disappearing in the wild 20 –50 years if land use at current locations change
R	Rare in Australia however there is no identifiable threat at this stage
K	Rare in Australia however the level of threat is unknown
C	Species is reserved in proclaimed conservation reserve
-	Reserved population size unknown
a	At least 1000 plants present in conservation reserves
i	Less than 1000 plants present in conservation reserves

The review of the on-line final determinations by the NSW Scientific Committee identified 11 endangered ecological communities (EEC) that occur within the North Coast Bioregion. These are:

- Subtropical Coastal Floodplain Forest of the NSW North Coast Bioregion;
- Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps Bioregions;
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South east Corner Bioregions;
- Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions;
- Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions;
- Lowland Rainforest on Floodplain in the NSW North Coast Bioregion;
- White Box Yellow Box Blakely's Red Gum Woodland;
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions;
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions;
- River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions; and
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.

Based on these Final Determinations and review of ANSWW records, none of these endangered ecological communities or endangered populations are likely to occur within the local area around the proposed works.

A review of the on-line critical habitat register and recovery plans did not identify the presence of critical habitat for any flora species or community in the local area.

BioNet Database
The BioNet database (http://www.bionet.nsw.gov.au/Area.cfm) was searched for records of threatened and protected flora species occurring within Burrawan State Forest. No records held by NSW State Forests, National Parks & Wildlife Service or the Royal Botanic Gardens were found by the search.

2.2 Fauna

2.2.1 Previous Studies

Biosis (2004)
The ecological assessment (Biosis 2004) for the Pacific Highway upgrade immediately to the south of the present study area, between Moorland and Herons Creek, was reviewed to identify the type of fauna species, particularly significant species, that occur in the local area. The study recorded 90 vertebrate species, including 18 mammal species, five frog species, six reptile species and 61 bird species. Five threatened species were positively recorded within the Biosis (2004) study area. These were the Glossy Black-cockatoo, Black-necked Stork, two insectivorous bat species and the Grey-headed Flying-Fox. A sixth threatened species, the East Coast Freetail Bat (*Mormopterus norfolkensis*), was recorded as only a probably identification based on Anabat echolocation detection records.

The native vegetation between Kew and Herons Creek was noted to occur on the western side of the existing Pacific Highway (Biosis 2004) and was described as being in relatively good condition, with mature trees and mid-understorey containing *Allocasuarina* sp. Closer to the current study area the tree vegetation is mostly cleared and not of significance (Biosis 2004). Mature trees without hollows were noted between Herons Creek and Bobs Creek Road. The vegetation was being utilised by common species of bird (Biosis 2004).

The Ecology Lab (2004)
Aquatic habitats for the Moorland to Herons Creek upgrade of the Pacific Highway were investigated by the Ecology Lab (2004). Six perennial waterways, comprising moderate to major fish habitat, were identified. Many intermittent channels and creek lines were also inspected and described. These waterways were graded as Class 3-4 – “minimal to no fish habitat”.

Seven species of fish and one species of macroinvertebrate were caught from five waterways while electrofishing (Ecology Lab 2004). However, only three of these, all Gudgeons, were found in Herons Creek. No threatened species were recorded while one introduced species – Mosquito Fish (*Gambusia holbrooki*) was recorded in two waterways but not Herons Creek. The waterways of that study area were regarded as supporting a relatively diverse assemblage of fish and mobile invertebrates.

Predation by Mosquito Fish is listed as a Key Threatening Process on Schedule 3 of the TSC Act (Biosis 2004).

2.2.2 On-line databases

DEC

The records of terrestrial species held within the Atlas of NSW Wildlife were extracted on 12 September 2005. Records were extracted from within a search area generated by establishing a 10 km buffer zone around the study area. The endangered populations and critical habitats listed in the TSC Act that occur on the North Coast were identified.

Within the search area, there are records for 270 vertebrate species. These are listed in **Appendix 1**. Thirty-two of the species, listed in **Table 3**, are listed as threatened under the TSC Act.

The review of the on-line Final Determinations by the NSW Scientific Committee found one endangered population that potentially occurs within the region. This is the Emu, *Dromaius novaehollandiae*, population in the NSW North Coast Bioregion.

A review of the on-line critical habitat register and recovery plans did not identify the presence of critical habitat for any fauna species in the local area.

Table 3: TSC Act Threatened Fauna Recorded within 10 km of the Study Area

Species	Status TSC Act
Green and Golden Bell Frog (*Litoria aurea*)	Endangered
Green-thighed Frog (*Litoria brevipalmata*)	Vulnerable
Wallum Froglet (*Crinia tinnula*)	Vulnerable
Australasian Bittern (*Botaurus poiciloptilus*)	Vulnerable
Brown Treecreeper (*Climacteris picumnus*)	Vulnerable
Glossy Black-Cockatoo (*Calyptorhynchus lathami*)	Vulnerable
Black-necked Stork (*Ephippiorhynchus asiaticus*)	Endangered
Pied Oystercatcher (*Haematopus longirostris*)	Vulnerable
Swift Parrot (*Lathamus discolor*)	Endangered
Square-tailed Kite (*Lophoictinia isura*)	Vulnerable
Barking Owl (*Ninox connivens*)	Vulnerable
Powerful Owl (*Ninox strenua*)	Vulnerable
Blue-billed Duck (*Oxyura australis*)	Vulnerable
Osprey (*Pandion haliaetus*)	Vulnerable
Wompoo Fruit-Dove (*Ptilinopus magnificus*)	Vulnerable
Masked Owl (*Tyto novaehollandiae*)	Vulnerable
Sooty Owl (*Tyto tenebricosa*)	Vulnerable
Australian Fur-seal (*Arctocephalus pusillus doriferus*)	Vulnerable
Spotted-tailed Quoll (*Dasyurus maculatus*)	Vulnerable
Dugong (*Dugong dugon*)	Endangered
Humpback Whale (*Megaptera novaeangliae*)	Vulnerable
Little Bentwing-bat (*Miniopterus australis*)	Vulnerable
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)	Vulnerable
Eastern Freetail-bat (*Mormopterus norfolkensis*)	Vulnerable
Yellow-bellied Glider (*Petaurus australis*)	Vulnerable
Squirrel Glider (*Petaurus norfolcensis*)	Vulnerable

Species	Status TSC Act
Brush-tailed Phascogale (*Phascogale tapoatafa*)	Vulnerable
Common Planigale (*Planigale maculata*)	Vulnerable
Koala (*Phascolarctos cinereus*)	Vulnerable
Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*)	Vulnerable
Grey-headed Flying-fox (*Pteropus poliocephalus*)	Vulnerable
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	Vulnerable

Source: DEC Atlas of NSW Wildlife

BioNet Database
The BioNet on-line database was reviewed for records of threatened and protected species for Burrawan State Forest held by Forests NSW. Sixty three species of vertebrate, including nine amphibians, forty-seven birds and seven mammals were found to have been recorded within the State Forest. These included three threatened species, the Glossy Black-Cockatoo, Sooty Owl and Yellow-bellied Glider.

No collections of threatened or protected species were reported in BioNet to be held by NSW Fisheries.

Fisheries Management Act 1994 Schedules
The Fisheries Management Act 1994 also lists threatened species, populations, communities and key threatening processes. Of these, the only potential occurrence within the study area is that of the Oxleyan pygmy perch (*Nannoperca oxleyana*). However, while the Herons Creek area is shown as being within the likely natural distribution of this species, it has not been recorded as occurring south of Wooli, a considerable distance from the study area.

2.3 Matters of National Environmental Significance

The on-line databases maintained by the Commonwealth Department of Environment and Heritage (DEH) were searched to identify any matters of National Environmental Significance (NES) that potentially may occur within 5 km of the centre of the study area. The search was centred on 31^{o} 34' S and 152 ^{o} 44' W. A 5 km search radius was used in order to exclude marine or estuarine species.

Actions that are likely to have a significant impact on a matter of NES are subject to a rigorous assessment and approval process under the environmental assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). An action includes a project, development, undertaking, activity, or series of activities. Administrative guidelines of significance have been developed to assist in determining whether such actions are likely.

The EPBC Act and the administrative guidelines identify six matters of national environmental significance. These are:

- World Heritage properties;
- Ramsar wetlands of international importance;
- Listed threatened species and communities;
- Migratory species protected under international agreements;
- Nuclear actions; and
- The Commonwealth marine environment.

The presence or otherwise of Critical Habitat within 5 km of the study area was also investigated during the search, but no such habitat was identified.

A summary of relevant matters of NES identified by the search is given in **Table 4**. The likely impact on matters that have been identified as having potential to occur within the search area is discussed in **Section 5.5**.

Table 4: Potential for Matters of NES to Occur Within 5 km of the Study Area

Matter	Potential Occurrences in Search Area
World Heritage properties	None
Wetlands of international importance	1
Threatened species and communities	17
Migratory species	9
Nuclear actions	None
Commonwealth marine environment	None

Eleven threatened species of vertebrate and six species of flora, protected by the provisions of the EPBC Act, potentially occur within 5 km of the study area. The species and their potential habitat use within the study area are listed in **Table 5**.

Table 5: Potential for Nationally Threatened Species to occur within 5 km of the Study Area

Species	EPBC Act Status	Presence/Habitat Use Within Study Area
Swift Parrot *Lathamus discolor*	Endangered	Roosting, movement between habitats
Australian Painted Snipe *Rostratula australis*	Vulnerable	None
Regent Honeyeater *Xanthomyza phrygia*	Endangered	Foraging, roosting, movement between habitats
Green and Golden Bell Frog *Litoria aurea*	Vulnerable	Breeding, foraging
Stuttering Frog *Mixophyes balbus*	Vulnerable	None
Giant Barred Frog *Mixophyes iteratus*	Endangered	None
Large Pied Bat *Chalinolobus dwyeri*	Vulnerable	Foraging, roosting, breeding
Spotted-tail Quoll *Dasyurus maculatus maculatus*	Endangered	Foraging
Brush-tailed Rock-wallaby (*Petrogale penicillata*)	Vulnerable	None
Long-nosed Potoroo *Potorous tridactylus tridactylus*	Vulnerable	Foraging
Grey-headed Flying-fox *Pteropus poliocephalus*	Vulnerable	Foraging
Acacia courtii	Vulnerable	None
Leafless Tongue-orchid *Cryptostylis hunteriana*	Vulnerable	Potential habitat
White-flowered Wax Plant *Cynanchum elegans*	Endangered	None
Hakea archaeoides	Endangered	None

Species	EPBC Act Status	Presence/Habitat Use Within Study Area
Milky Silkpod *Parsonsia dorrigoensis*	Vulnerable	None
Austral Toadflax *Thesium australe*	Vulnerable	None

Nine migratory species of bird potentially occur within 5 km of the study area. The species and potential habitat utilisation are listed in **Table 6**.

Table 6: Potential for Protected Migratory Species to occur within 5 km of the Study Area

Species	Type of Presence
White-bellied Sea-Eagle *Haliaeetus leucogaster*	Species or species habitat likely to occur within area
White-throated Needletail *Hirundapus caudacutus*	Species or species habitat may occur within area
Black-faced Monarch *Monarcha melanopsis*	Breeding may occur within area
Spectacled Monarch *Monarcha trivirgatus*	Breeding likely to occur within area
Satin Flycatcher *Myiagra cyanoleuca*	Breeding likely to occur within area
Rufous Fantail *Rhipidura rufifrons*	Breeding may occur within area
Regent Honeyeater *Xanthomyza phrygia*	Species or species habitat may occur within area
Latham's Snipe *Gallinago hardwickii*	Species or species habitat may occur within area
Painted Snipe *Rostratula benghalensis* s. lat.	Species or species habitat may occur within area

Marine species are birds that fly over the Commonwealth marine area. All of the species listed in **Table 6** are marine species. In addition to the species listed in **Table 6**, the following species were also identified during the on-line search for matters of NES:

- Fork-tailed Swift (*Apus pacificus*)
- Great Egret (*Ardea alba*)
- Cattle Egret (*Ardea ibis*)
- Rainbow Bee-eater (*Merops ornatus*)

3 SITE INVESTIGATION METHODS

3.1 Flora Survey

The flora of the study area was investigated by undertaking a limited field survey involving transects to verify existing vegetation community mapping, with the aid of recent aerial photography. These transects involved random meanders in the linear communities along the length of the proposed roadworks, allowing for approximately a 50 m buffer zone. Community descriptions were aligned, where possible, with those defined in remnant vegetation mapping completed for the CRAFTI project (NPWS 1999). Field investigations took place on 5 and 7 October 2005 with a total of approximately 15 hours of survey effort, including one hour of work at night. The species observed are limited to species that were readily identifiable during the time of the survey. The majority of the study area is managed by Forests NSW. A special uses permit is required to undertake plant collection within Forests NSW estate areas. The vegetation and fauna surveys were limited to observation only as a permit could not be obtained in time for the field survey. Targeted survey for significant species was limited to those easily identified given the seasonal constraints. Targeted species are those that are listed as threatened under the NSW *Threatened Species Conservation Act 1995* (TSC Act), the EPBC Act or are a Rare or Threatened Australian Plant (ROTAP) species that has been recorded within in the local area.

The study area was extensively walked over up to 50 m away from the footprint of the proposed upgrade. The survey effort focused on potential habitat for threatened species, with less time spent in highly modified habitats, such as cuttings and bunds. Significant weed species were recorded when observed and species used in garden landscaping were not recorded, except where these had established within the road reserve.

Taxonomic nomenclature used in this report follows that of Harden (1992), Harden (1993), Harden (2000) and Harden (2002), with updates that are consistent with the DEC PlantNET database maintained by the Royal Botanic Gardens, Sydney.

3.2 Fauna Survey

The fauna investigations also took place between 5 and 7 October 2005 and included:

- Incidental observations during the targeted flora survey;
- Aural survey for frogs along Cutty Creek; and
- Identification of potentially significant habitats such as trees with hollow development.

As the aquatic ecology of Herons Creek was investigated during preparation of the EIS for the Moorland to Herons Creek Pacific Highway upgrade (Ecology Lab, 2004) the creek was not included in the current study. The only other identified watercourse in the study area, Cutty Creek, was reduced to very low flow and small pools because of the drought and aquatic surveys were not conducted.

The fauna survey focused on the identification of habitat features and indirect evidence of significant species. Significant species are those that are listed as threatened in the TSC Act or EPBC Act. Incidental observation of fauna took place during the vegetation survey and during other targeted fauna survey, between 0800 and 1930 hours. Observations of birds, amphibians, reptiles, mammals or evidence of these were recorded. Targeted fauna survey involved listening for frog species at Cutty Creek between the existing carriageways and to the west of the northbound carriageway. The survey took place for a minimum of half an hour, beginning at

dusk and using frog call playback. It is estimated that eight hours were spent focusing on fauna and their habitat.

Details of the weather for the local area during the field investigations and preceding four days are provided in **Table 7**. Weather will influence the activity of exothermic fauna such as frogs and reptiles on a particular day. Cooler and extremely hot weather will reduce activity. The metabolic rate drops during cooler weather while species will seek shelter in hotter weather.

The investigation of fauna utilising habitats within the study area was limited by the proximity of the study area to the Pacific Highway and seasonal timing of the field investigations. It was not possible to undertake standard survey methods such as spotlighting for reasons of safety, including that of road users. The linear nature of the remnant vegetation and modified understorey meant that trapping was impractical and unlikely to result in the capture of significant fauna types, while the cooler weather would have reduced insectivorous bat activity. The majority of the study area is managed by Forests NSW. A special uses permit is required to undertake trapping within Forests NSW estate areas. Therefore the survey was limited to observation as a permit could not be obtained in time for the field survey.

Table 7: Weather Details Prior to and During Site Investigations

Date	Min. temp. (°C)	Max. temp. (°C)	Rainfall (mm)	9 am Relative Humidity (%)	9 am Wind Speed (km/h)	3 pm Relative Humidity (%)	3 pm Wind Speed (km/h)
1/09/2005	12	20	0	56	19	63	15
2/09/2005	13	22	2	87	2	65	26
3/09/2005	9	18	0	53	15	62	15
4/09/2005	12	19	39	98	17	75	20
5/09/2005	8	20	2	62	20	61	22
6/09/2005	10	19	0.2	67	15	53	15
7/09/2005	9	20	0	63	7	55	19

Field investigations

4 RESULTS AND DISCUSSION

4.1 Field Investigations – Flora

No threatened species or endangered ecological communities, as identified in **Section 2.1**, were observed within the study area.

Three noxious species were recorded within the study area. The most common species observed was *Lantana camara*, occurring in thickets along sections of the road reserve that had been disturbed during previous road construction. Crofton Weed was present in or near drainage lines, while Small-leaved Privet was common in moist habitats near Herons Creek. All of the noxious weeds are category 'W3' weeds, requiring that the plants be prevented from spreading and their numbers and distribution reduced.

Several environmental weeds also occur in the area. Environmental weeds are not presently considered noxious, but have the ability to alter vegetation communities through the suppression of native species. Two environmental weeds within the study area are Camphor Laurel and Japanese Honeysuckle.

In general, the mown area within the Pacific Highway reserve is dominated by exotic grass and herb species. Common species include Purpletop (*Verbena bonariensis*), *Erogrostis curviflora*, Whiskey Grass (*Andropogon virginicus*), and *Briza minor*. Native species do occur, but these are a result of species establishing in a highly modified environment rather than representative of a natural community. The proposed highway upgrade will mostly affect the mown area, road cuttings dominated by Acacia and Hopbush, and very young eucalypt regeneration. The vegetation in principal sections of the study area, as shown in Error! Reference source not found., is described below.

Herons Creek
The canopy of the riparian vegetation associated with Herons Creek is a mixture of native and exotic species. Native species' diversity is greatest to the east of the existing bridges. The canopy is dominated by White Mahogany (*E. acmenoides*) and Sydney Blue Gum (*E. saligna*), with Kanuka (*Tristaniopsis laurina*) forming a relatively dense understorey. The groundcover was sparse under the dense shrub cover. The vegetation along the aquatic habitat was dominated by *Juncus* sp., *Cyperus eragrostis* and *Schoenoplectus* sp. and herbs including *Viola* sp.

To the west of the bridges the riparian vegetation is dominated by Small-leaved Privet (*Ligustrum sinense*) and Camphor Laurel (*Cinnamomum camphora*). The shrub understorey is dense and highly modified, containing Narrow-leaved Wattle (*Acacia longissima*), Blackwood (*Acacia melanoxylon*). and Tobacco Bush (*Solanum mauritianum*). The ground cover is dominated by exotic species. These include Kikuyu (*Pennisetum clandestinum*), Lamb's Tongues (*Plantago lanceolata*) *Verbena bonariensis*, Flax-leaved Fleabane (*Conyza bonariensis*), Japanese Honeysuckle (*Lonicera japoni*ca), *Watsonia* sp. and *Biddens pilosa*.

The vegetation between the riparian vegetation and Herons Creek Public School is typically tall and dense, dominated by Narrow-leaved Wattle and Blackwood. *Pinus* sp. forms part of the canopy closer to the school property.

Herons Creek School to Bobs Creek Road (west)
Young Tallowwood (*E. microcorys*) dominates the canopy of the vegetation community to the west of the Pacific Highway. Other trees include Blackbutt and White Mahogany. The

understorey is approximately 2 m in height and dominated by fabaceous species such as Dogwood (*Jacksonia scoparia*), White Dogwood (*Ozothamnus diosmifolius*), Hopbush (*Dodonaea triquetra*), *Pultenaea villosa* and Bracken (*Pteridium esculentum*). The ground cover is dominated by Kangaroo Grass (*Themeda australis*), *Lomandra longifolia* and Blady Grass (*Imperata cylindrica var. major*). The hardstand and earthworks to the west of the Bobs Creek Road intersection are dominated by exotic vegetation.

Herons Creek to Bobs Creek Road (east)

The vegetation between Bobs Creek Road and the Pacific Highway is typically a tall shrub and eucalypt regeneration community that has grown since the construction of the Highway. It is dominated by White Dogwood, Hopbush and *Pultenaea villosa*, with emergent young Blackbutt and Tallowwood. The groundcover is dominated by grasses and *Lomandra longifolia*. The community is shown in **Plate 1**. The vegetation south from where Bob Creeks Road turns to the east becomes moister and young Turpentine (*Syncarpia glomulifera subsp. glomulifera*) is present. Blackbutt dominates the canopy toward Herons Creek, with some mature specimens present. A tall shrub understorey that is associated with moister habitats gradually increases toward Herons Creek, particularly in minor drainage lines. Species in the moister areas included Lilly Pilly (*Acmena smithii*) and Cheese Tree (*Glochidion ferdinandi var. ferdinand*). The native understorey is gradually dominated by exotic species closer to the private property adjacent to Herons Creek. Species include Small-leaved Privet, Camphor Laurel, *Cotoneaster* sp. and Japanese Honeysuckle.

Bago Road Intersection

The canopy of the vegetation community in the vicinity of the proposed Bago Road intersection with the existing northbound carriageway is dominated by Blackbutt (*E. pilularis*), with Tallowwood forming a lesser canopy cover. The trees were tallest nearer to the road, as logging activity has reduced the tree height and canopy cover further west of the Pacific Highway. The taller understorey is dominated by *Acacia longifolia*, *Allocasuarina littoralis* and eucalypt regeneration. The lower shrub understorey is dominated by Hopbush and Bracken. Bracken increased in density as the canopy was reduced by logging activity. The area likely to be affected by the proposed intersection is presently a hard stand, with one large Blackbutt potentially within the intersection footprint. The majority of the unsealed surface is highly modified through earthworks associated with road construction and much of the cleared area to the west of the present Pacific Highway is hardstand. The vegetation is typically low and dominated by grasses, such as the exotic Kikuyu, and native species including Kangaroo Grass, *Lomandra longifolia* and Blady Grass.

The vegetation to the south of Bago Road is similar to the vegetation north of the road. It has a lower shrub understorey with a greater density of bracken. The area to be affected by the proposed intersection is also highly modified by road and hardstand construction, as shown in **Plate 2**.

Blackbutt dominates the vegetation between the present northbound and southbound carriageways of the Pacific Highway and the proposed Bago Road intersection. The trees are tall, but relatively immature with no hollow development. The understorey and groundcover is denser, with a more developed litter layer, than the actively managed Forests NSW estate west of the northbound carriageway.

Proposed Diamond Intersection

The vegetation in the vicinity of the proposed diamond intersection within the island between the present northbound and southbound carriageways of the Highway is dominated by Blackbutt and White Stringybark (*Eucalyptus globoidea*) regeneration, as shown in **Plate 3**. The understorey typically comprises young examples of the overstorey species, with scattered lower shrubs also occurring. Shrub species include Narrow-leaved Geebung (*Persoonia linearis*), Coffee Bush (*Breynia oblongifolia*) and Panax Elderberry (*Polyscias sambucifolia*).

Cutty Creek to Stills Road
The vegetation community between Cutty Creek and Stills Road is highly modified. The canopy is dominated by young Blackbutt regeneration, in association with tall shrubs and small trees such as Black Oak (*Allocasuarina littoralis*). There are many shrub species, including *Acacia* spp., *Leptospermum polygalifolium*, Hopbush and *Banksia spinulosa*. The groundcover is dominated by exotic species, including *Erogrostis curviflora*, Purpletop and Whiskey Grass. The former alignment of the Pacific Highway passes through this section of the study area, and there is a large hardstand area that is used for the storage of gravel. The former alignment of the highway and shrub community is shown in **Plate 4**.

Boyds Road to Bobs Creek Road
The vegetation east of the southbound carriageway, between the present Boyds Road and Pacific Highway intersection, is similar to other vegetation on previously cleared areas adjacent to the Pacific Highway. It is dominated by Acacia spp. and young eucalypt regeneration. There is wet sclerophyll forest approximately 50 m east of Boyds Road, dominated by Sydney Blue Gum and Bangalay (*Eucalyptus botryoides*). The understorey is a mixture of shrubs to 3 m and includes Tree Heath (*Trochocarpa laurina*) and Lilly Pilly. The ground cover was sparse, dominated by ferns and taller sedges such as *Gahnia* sp. A feature of the vegetation nearest Boyds Road was the abundance of vines and scrambling species such as *Hibbertia scandens* and Common Silkpod (*Parsonsia straminea*). Lantana and Camphor Laurel were observed near the edge of the community, but were not common. This community is outside of the footprint of the proposed development.

The vegetation community between Bobs Creek Road and the proposed intersection with Boyds Road is dominated by Blackbutt, with an understorey of White Dogwood, *Acacia* spp. and Hopbush. The ground cover is patchy, limited by deep leaf litter and woody debris. Two Blackbutt trees with hollow development are located within the visual screen corridor. The vegetation community behind the visual screen and within the proposed route to the existing Bobs Creek Road has been recently logged, and is shown in **Plate 5**. The understorey is dominated by shrub species that occur in adjacent areas and eucalypt regeneration. The groundcover is limited by the shrubs and eucalypt regeneration, and is typified by *Panicum* sp. *Hibbertia* spp. and *Dampiera purpurea.*

4.2 Field Investigations – Fauna

The habitats for fauna are limited within the study area. Few species were observed within the forest remnants. Most species observed were small birds utilising the denser shrub understorey within logged coupes and roadside regeneration. Commonly observed species include the Superb Fairy-wren (*Malurus cyaneus*), Grey Fantail (*Rhipidura fuliginosa*) and White-plumed Honeyeater (*Lichenostomus penicillatus*). The shrub understorey is generally dense along areas that have been cleared for construction activities and recently logged coupes, as shown in **Plate 5**. There are limited flowering resources in these habitats. Other species observed utilising the shrublands and logged coupes were common to fragmented rural communities, and included Butcherbirds (*Cracticus* spp.) and Australian Ravens (*Corvus coronoides*).

There are few mature trees with significant hollow development. This is likely to be a result of previous road construction activities and on-going forestry operations. The relatively young age of the regeneration, and consequent limited hollow development, is unlikely to provide habitat for arboreal mammals. The forestry activities have thinned out the canopy in many places, resulting in the likely reduction in foraging opportunities and increase in isolation for arboreal species. This is confirmed by the failure to record any arboreal mammals during the survey.

Fallen timber and deeper leaf litter are well-developed within the remnant vegetation between the present northbound and southbound carriageways of the Pacific Highway. However there is unlikely to be a significant terrestrial mammal fauna community due to the relative isolation of these habitats with respect to the highway. The reptile fauna diversity appeared limited, although the Grass Skink (*Lampropholis delicata*) is common within the leaf litter. Fallen timber and debris from forestry activities is common. The woody debris has been burnt in logged coupes and leaf litter is limited.

Aquatic habitat within the study area is limited to pools associated with Herons Creek and Cutty Creek. While other minor drainage lines exist, they typically flow only after heavy rain and were dry during the survey period. Therefore, they are considered not to provide any permanent aquatic habitat.

The larger pools have resulted from the construction of the Pacific Highway. The benthic substrate for both creeks is sandy. The sand is finer and there is a higher silt component in Herons Creek compared to Cutty Creek. Cobbles present in Cutty Creek provide some potential habitat for a diverse macroinvertebrate community. However, no survey was undertaken for macroinvertebrates as the creek was predominantly dry during the survey.

The riparian vegetation of Herons Creek is dominated by exotic species, with marshy areas dominated by grasses. In comparison, the lower riparian vegetation of Cutty Creek between the northbound and southbound carriageways of the Pacific Highway is dominated by *Lomandra longifolia*, as shown in **Plate 6**. The riparian habitat of Cutty Creek to the west of the northbound carriageway is typically deep leaf litter that extended into the aquatic habitat. It has developed over time as leaf and twig material has collected against logs that have fallen across the drainage line.

No frogs were heard calling at Cutty Creek during the night survey, and no tadpoles were observed despite the water clarity being better than Herons Creek. The Common Eastern Froglet (*Crinia signifera*) was heard in aquatic habitats associated with Herons Creek.

5 IMPACT ASSESSMENT

5.1 Existing Impacts

Activities that have affected the study area include road construction and forestry operations. The majority of trees are relatively young and have not developed hollows. The construction of the existing Pacific Highway has resulted in the clearing of taller vegetation from the roadside. Much of the vegetation of cuttings and earthworks is dominated by *Acacia* spp. Forestry operations have resulted in a narrow band of taller vegetation that has few mature trees with hollow development between the Pacific Highway and logged areas. These have been retained for visual amenity. However, the clearing on either side of the retained trees has resulted in high light penetration that has increased vine growth and resulted in a dense fabaceous understorey. The shrub understorey reduces with distance from clearings.

Other existing impacts to the area include vehicular movement. The existing road is likely to reduce the ability for species to move through the local area due to the absence of vegetation cover increasing the likelihood of smaller species being killed by larger carnivores, the increased potential for collision with wildlife and alteration of animal behaviour adjacent to roads in the presence of noise, light and movement.

5.2 Potential Impacts

Potential impacts from the proposed road upgrade include the clearing of approximately 14 ha of vegetation, located mostly east of the existing southbound carriageway between Boyds Road and Bobs Creek Road. Approximately 8.5 ha of forest will be cleared for the construction of the proposed diamond interchange between the present northbound and southbound carriageways of the Pacific Highway. Approximately 5.5 ha of cleared or modified shrublands will be removed for the construction of the proposed northbound carriageway between Boyds Road and Stills Road.

Clearing of remnant vegetation will result in the loss of roosting and foraging opportunities for birds and arboreal mammals. It unlikely there will be a significant reduction in the availability of medium to large tree hollows, as most trees within the footprint of the proposed development are relatively young and lack hollow development.

Indirect impacts that may result from the proposed development include noise during the construction phase and increased difficulty, particularly for arboreal mammals, in traversing the highway after widening. However, the reduced denning opportunities for arboreal mammals from current and past forestry activities has probably resulted in a reduced population, with most activities confined to riparian habitats. There may also be an increase in the potential for collision between wildlife and vehicles as a result of increased vehicle speeds.

There is an increased potential for the spread of weed species through the movement of soil containing seed, stem and root material if areas where weeds are present are not treated prior to earth moving activities. There is also the potential for the spread of plant pathogens, for example *Phytophthora* sp. fungi into the area on equipment used during the construction of the proposed road works. At present there is no evidence of dieback within the study area resulting from *Phytophthora* sp. infection.

5.3 Threatened Species Considerations

The TSC and Fisheries Management Acts identify and protect native plants and animals in danger of becoming extinct in NSW. The purposes of the TSC Act include the conservation of

biological diversity and promotion of ecologically sustainable development, ensuring the impact of any action affecting threatened species, populations and ecological communities is properly assessed, and encouraging the conservation of threatened species, populations and ecological communities. The TSC Act allows for the integration of threatened species assessment into the State's planning system and removes the requirement to obtain a separate threatened species licence in addition to development consent under the EP&A Act.

The Fisheries Management Act also seeks to conserve threatened species, populations and ecological communities of fish and marine vegetation and to promote ecologically sustainable development, including the conservation of biological diversity. Schedules to the Act provide lists of endangered species, populations, ecological communities, species presumed extinct, vulnerable species and key threatening processes.

This section provides an overview of the matters protected by the provisions of these Acts. The detailed assessment of matters potentially affected by the proposed highway upgrade is given in **Appendix 3**.

5.3.1 Threatened, Endangered and Vulnerable Species

The following is a brief summary of the potential for threatened species identified as having potential to occurring within 10 km of the proposed highway upgrade, excluding species that utilise marine or estuarine habitats, to be affected by the proposed upgrade. No marine or estuarine habitat will be affected by the proposed development. No threatened species were recorded within the study area. Where appropriate, detailed assessments of impact have been prepared and are presented in **Appendix 3**. The results of these assessments are summarised in **Table 8**.

Allocasuarina defungens – Endangered
This species was not recorded within the study area and should have been detected if present, given the timing of the field investigations. The habitat for the species is described as moist heath, with *Banksia ericifolia*, *B. oblongifolia*, *Melaleuca nodosa*, *Schoenus brevifolius*, *Pseudanthus orientalis*, *Leptospermum polygalifolium*, *L. semibaccatum*, *Hypolaena fastigata* and *Boronia safrolifera* commonly occurring (Benwell 1993, cited in DEH 2006). This habitat is absent from the study area and therefore this species will not be affected by the proposed development. A detailed assessment of impact has not been prepared.

Acacia courtii - Vulnerable
This species was not recorded within the study area. The habitat for the species is described as steep, dry rocky slopes on shallow soils within dry sclerophyll forest (DEC 2006a) and it is presently known only from the Middle Brother and North Brother Mountains (Harden 2002). This habitat type is absent from within and adjacent to the study area and therefore this species will not be affected by the proposed development. A detailed assessment of impact has not been prepared.

Callistemon linearifolius - Vulnerable
This species was not recorded within the study area. The habitat of the species is described as dry sclerophyll forest on the coast and adjacent ranges (Harden 2002), or open forest in association with *Corymbia eximia*, *Eucalyptus punctata*, *E. umbra*, *Allocasuarina littoralis* or *Angophora costata* (Benson and McDougall 1998). It has been recorded by the author on shallow soils associated with sandstone and also on deeper, poorly draining sandy soils. The habitats within the study area are dissimilar to recorded habitat types and therefore this species will not be affected by the proposed development. A detailed assessment of impact has not been prepared.

Melaleuca biconvexa - Vulnerable
The habitat for *Melaleuca biconvexa* is described as open eucalypt forest and paperbark scrub in medium nutriment Quaternary Alluvium soils along creek lines and poorly drained areas that overlay alluvium or shale (Benson and McDougall 1998). This species was not recorded during targeted surveys of the study area's limited alluvial habitats (in Herons and Cutty Creeks). Alluvial habitats in the study area have been degraded through previous clearing and weed invasion and therefore are unlikely to provide suitable habitat for this species. Therefore, this species will not be affected by the proposed development. A detailed assessment of impact has not been prepared.

Melaleuca groveana - Vulnerable
This species was not recorded within the study area. The habitat is for this species at Yengo National Park is described by (Maryott-Brown and Wilks 1993) as dry woodlands on exposed Narrabeen sandstone ridges and slopes with shallow sandy loam. The species occurs mainly in higher coastal habitats north of Yengo National Park in exposed heaths (Harden 2002). As there are no exposed heaths within the study area this species will not be affected by the proposed development. A detailed assessment of impact has not been prepared.

Phaius tankervilliae - Endangered
This species was not recorded within the study area. The habitat for this species is described as "*swampy grassland or swampy forest, including rainforest, eucalypt and paperbark forest*" (DEC 2006b). This habitat is not present within the study area and this species will not be affected by the proposed development. A detailed assessment of impact has not been prepared.

Grevillea caleyi - Endangered
This species was not recorded within the study area. The distribution of the species is said to be restricted to an 8 km square area 20 km north west of Sydney. The habitat is described as on ridgetops between 170 m and 240 m above sea level, growing in laterite soils, in association with *E. seiberi* and *E. gummifera* (DEC 2006c). The local record is considered by HLA to be an anomaly. This species will not be affected by the proposed development. A detailed assessment of impact has not been prepared.

Hakea archaeoides - Vulnerable
This species was not recorded within the study area. The species habitat is steep, rocky, sheltered slopes, and also in deep gullies within open eucalypt forest (DEC 2006d). This habitat type is absent from within the study area and, therefore, this species will not be affected by the proposed development. A detailed assessment of impact has not been prepared.

Thesium australe - Vulnerable
This species was not recorded within the study area. The species' distribution is widespread, often occurring in damp sites within grassland (Harden 1992). Eddy *et al*. (1998) describe the species as being associated with Kangaroo Grass (*Themeda australis*). There are few damp sites within the study area and none that are associated with Kangaroo Grass grassland. Therefore this species will not be affected by the proposed development. A detailed assessment of impact has not been prepared.

Green and Golden Bell Frog (*Litoria aurea*) - Endangered
This species was not recorded within the study area. The Green and Golden Bell Frog is known to inhabit ephemeral wetlands (Osborne and McElhinney 1996) and also permanent water bodies with emergent vegetation where the species basks during daylight hours and hunts at night (Barker *et al*. 1995). There is no suitable habitat for this species in the study area. Increased predation by the introduced Mosquito Fish (*Gambusia holbrooki*) is thought to be a cause of the species' decline (NPWS 2003a). Mosquito fish have been recorded in watercourses to the south of the study area (Ecology Lab 2004). This species will not be

affected by the proposed development. A detailed assessment of impact has not been prepared.

Green-thighed Frog (*Litoria brevipalmata*) - Vulnerable
Very little information is available regarding the habitat of the Green-thighed Frog. However the species has been recorded breeding in flooded paddocks and temporary pools adjacent to rainforest and also in open forest, with juveniles collected in wet forest (Barker *et al*. 1995). There are few breeding opportunities for this species and aquatic habitats are potentially infested with the exotic Mosquito Fish. Studies on Herons Creek (Biosis 2004) failed to identify the presence of this species. Therefore, it is unlikely this species will be affected by the proposed development. A detailed assessment of impact has not been prepared.

Wallum Froglet (*Crinia tinnula*) – Vulnerable
This small species of frog breeds in acid *Melaleuca* swamps and Wallum areas with poor drainage, preferring shallow freshwater and brackish wetlands with tall and dense emergent vegetation (Barker *et al*. 1995). There are no acid swamps likely to be affected by the proposed highway upgrade and therefore it is highly unlikely the species will utilise habitats within the study area. A detailed assessment of impact has not been prepared.

Australasian Bittern (*Botaurus poiciloptilus*) – Vulnerable
This species was not recorded within the study area. This species is associated with terrestrial wetlands and occasionally estuary habitats where it favours tall reed beds and forages in shallow still water (Marchant and Higgins (1990b). Most aquatic habitats within the study area are degraded through weed invasion, such as Crofton Weed, and none have significant reed beds. It is unlikely the species will utilise habitats within the study area. A detailed assessment of impact has not been prepared.

Brown Treecreeper (*Climacteris picumnus*) - Vulnerable
This species was not recorded within the study area. The species is known to utilise woodlands and forests dominated by *Eucalyptus* spp., especially rough barked species, usually in communities with a sparse but grassy understorey, but not with a dense woody understorey (Higgins *et al*. 2001). The forest community has been modified to open woodland by forestry activity. There is considered to be potential foraging habitat within the study area. A detailed assessment of impact is given in **Appendix 3**.

Glossy Black-Cockatoo (*Calyptorhynchus lathami*) – Vulnerable
This species was not recorded within the study area. The Glossy Black-Cockatoo is dependant on the presence of *Allocasuarina* species as it is a specialist forager of the seeds of these species. It prefers woodland that has mature *Allocasuarina* as an understorey below *Angophora* and *Eucalyptus*, *Allocasuarina* spp. lined watercourses and also stony ridges. Nesting occurs in a hollow of a tall tree that can be living or a dead tree (Higgins 1999). Potential foraging habitat, *Allocasuarina littoralis*, is present within the study area. A detailed assessment of impact is given in **Appendix 3**.

Black-necked Stork (*Ephippiorhynchus asiaticus*) – Endangered
This species was not recorded within the study area. The species is usually associated with permanent and seasonal wetlands in tropical and temperate Australia, where the species forages in saline water that is up to 0.5 m deep for freshwater for small vertebrates, such as fish, snakes, turtles and frogs (Marchant and Higgins 1990a). Aquatic habitats within the study area are small, degraded through weed invasion, by for example Crofton Weed, are ephemeral and none have significant reed beds. It is unlikely the species will utilise habitats within the study area. A detailed assessment of impact has not been prepared.

Pied Oystercatcher (*Haematopus longirostris*) – Vulnerable
This species was not recorded within the study area. This coastal species inhabits intertidal sand and mud flats of large embayments, sandy beaches and occasionally rocky shores (Marchant and Higgins 1993). No habitat for the species is present within the study area or is likely to be affected by the proposed highway upgrade. A detailed assessment of impact has not been prepared.

Swift Parrot (*Lathamus discolor*) - Endangered
This species was not recorded within the study area. In NSW the species inhabits dry open eucalypt woodlands, especially Ironbark and Box associations. In the region it is known to inhabit forests and woodlands dominated by Blackbutt (*E. pilularis*), Spotted Gum (*Corymbia maculata*) and Swamp Mahogany (*E. robusta*). The species mostly feeds on nectar, also consuming sugar exuding insects and sometimes seed (Higgins 1999). There is potential foraging habitat for the Swift Parrot within the study area. A detailed assessment of impact is given in **Appendix 3**.

Square-tailed Kite (*Lophoictinia isura*) – Vulnerable
This species was not recorded within the study area. In NSW the habitats preferred by the Square-tailed Kite are typically ridge and gully habitats, dominated by *Eucalyptus longifolia*, *Corymbia maculata*, *E. elata* and *E. smithii*, with a shrubby understorey. They feed on passerines, foliage insects and small terrestrial vertebrates in open woodland (Marchant and Higgins 1993). While dominant tree species are absent, there is a mosaic of canopy densities and areas with shrubby understoreys. A detailed assessment of impact is given in **Appendix 3**.

Barking Owl (*Ninox connivens*) – Vulnerable
The habitat for the Barking Owl includes areas containing many large trees for roosting and breeding within dry sclerophyll forest and woodlands, and also partly cleared land including farmland (Marchant and Higgins 1993). The study area has potential habitat for the Barking Owl. A detailed assessment of impact is given in **Appendix 3**.

Powerful Owl (*Ninox strenua*) – Vulnerable
The Powerful Owl inhabits dry sclerophyll forests and woodland, often with dense forest nearby (Higgins 1999). The study area has potential habitat for the Powerful Owl. A detailed assessment of impact is given in **Appendix 3**.

Blue-billed Duck (*Oxyura australis*) - Vulnerable
This species is associated with aquatic habitats throughout the year, preferring permanent deeper water in large wetlands (Marchant and Higgins 1990a). In NSW the species is more commonly associated with the Murray-Darling Basin where large flocks congregate during winter. Foraging has been recorded in water up to three metres deep and the Blue-billed Duck rarely uses terrestrial habitats. The decline of this species is thought to be a result of modified drainage regimes, increased salinity, clearing, water extraction and grazing (Marchant and Higgins 1990b). As there are no large aquatic habitats within the study area a detailed assessment of impact has not been prepared.

Osprey (*Pandion haliaetus*) – Vulnerable
This species was not recorded within the study area. The Osprey is said to be tolerant of human activity (Marchant and Higgins 1993). The species is usually associated with coastal, littoral and terrestrial wetlands (including inland rivers) habitats, nesting in a prominent open position near water (Marchant and Higgins 1993). There is no aquatic habitat within the habitat that the species is likely to utilise and a detailed assessment of impact has not been prepared.

Wompoo Fruit-Dove (*Ptilinopus magnificus*) – Vulnerable
The Wompoo Fruit-dove is associated with large undisturbed areas of tropical or sub-tropical rainforest in coastal and montane locations where it usually is seen in the dense canopy

(Higgins and Davies 1996). The species is reliant on fruit baring trees, palms, vines and epiphytes (Higgins and Davies 1996). Breeding occurs in dense mid-strata of rainforest. No rainforest or significant fruit baring trees will be affected by the proposed upgrade of the Pacific Highway. A detailed assessment of impact has not been prepared.

Masked Owl (*Tyto novaehollandiae*) – Vulnerable
This species was not recorded within the study area. Known habitat types for this species include tall dense forests, open forest and woodland with a sparse understorey that includes large hollows for roosting and breeding. Breeding takes place in near vertical hollows, in tall, often prominent trees. Prey items are mainly terrestrial mammals. Most records are within 300 m of lowland sclerophyll forest, lowland forest, Red Gum forest and valley floor forest (Higgins 1999). There is potential foraging habitat within and adjacent to the study area. A detailed assessment of impact is given in **Appendix 3**.

Sooty Owl (*Tyto tenebricosa*) – Vulnerable
This species was not recorded within the study area. The Sooty Owl is usually associated with gullies on escarpments 500 m or more above mean sea level, in or adjacent to tall old growth montane sclerophyll forests and rainforests with potential nesting dead trees. The forests usually have tall emergent vegetation, and a dense understorey that has moister vegetation types including Lilly Pilly (*Acmena smithii*), *Pittosporum* sp., Blackwood (*Acacia melanoxylon*), Tree Ferns (*Cyathea* sp.) and Coachwood (*Ceratopetalum apetalum*). Foraging for arboreal and terrestrial mammals (occasionally birds, reptiles and insects) is usually restricted to dense forest, especially rainforest gullies, although the species will forage in other vegetation communities. (Higgins 1999). While there is wet sclerophyll forest adjacent to the study area, the habitats are well below the altitude usually associated with the species. It is unlikely the species will utilise habitats within the study area. A detailed assessment of impact has not been prepared.

Australian Fur Seal - Vulnerable
The Australian Fur Seal is a marine species. Marine habitat will not be affected by the proposed upgrade of the Pacific Highway. A detailed assessment of impact has not been prepared.

Spotted-tailed Quoll (*Dasyurus maculatus*) – Vulnerable
This species was not recorded within the study area. The Spotted-tailed Quoll is partly arboreal and is mostly nocturnal, inhabiting a wide variety of habitats. These include rainforest, woodland, coastal heathland and riparian forests from the coast to the snowline. Den sites include caves, crevices and also hollow logs (Edgar and Belcher 1998). There is potential foraging habitat within and adjacent to the study area. A detailed assessment of impact is given in **Appendix 3**.

Dugong (*Dugong dugon*) - Endangered
The Dugong is a marine species. Marine habitat will not be affected by the proposed upgrade of the Pacific Highway. A detailed assessment of impact has not been prepared.

Humpback Whale (*Megaptera novaeangliae*) - Vulnerable
The Humpback Whale is a marine species. Marine habitat will not be affected by the proposed upgrade of the Pacific Highway. A detailed assessment of impact has not been prepared.

Little Bentwing-bat (*Miniopterus australis*) – Vulnerable
This species was not recorded within the study area. The Little Bent-wing Bat roosts in subterranean locations and forages beneath the canopy of dense forest and woodlands (Dwyer 1998a). While the species is unlikely to roost within the study area, it will potentially forage. A detailed assessment of impact is given in **Appendix 3**.

Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) – Vulnerable
This species was not recorded within the study area. The roost sites for this species include underground mine workings, caves, stormwater culverts and occasionally buildings (Dwyer 1998b). While the species is unlikely to roost within the study area, it will potentially forage. A detailed assessment of impact is given in **Appendix 3**.

Eastern Freetail-bat (*Mormopterus norfolkensis*) – Vulnerable
This species was not recorded within the study area. Habitat preferences for this species are assumed to be dry sclerophyll forest and woodland east of the Great Dividing Range. It has also been recorded in rainforests, flying over a creek. It mainly roosts in trees, although it has been know to utilise man made structures (Allison and Hoye 1998). There are potential roosts and foraging habitat within the study area. A detailed assessment of impact is given in **Appendix 3**.

Large-footed Myotis (*Myotis adversus*) – Vulnerable
This species was not recorded within the study area. Although the species has been known to utilise tree hollows, it mainly roosts in subterranean locations close to water such as caves. In the southern range of its distribution it will also utilise man-made structures including abandoned underground mines, tunnels, under bridges and building cavities (Churchill 1998). The species will utilise most riparian communities, foraging mainly for insects and also fish (Churchill 1998). The species is unlikely to roost or forage within the study area as there are no significant water bodies or riparian habitat. A detailed assessment of impact has not been prepared.

Greater Broad-nosed Bat (*Scoteanax rueppellii*) – Vulnerable
This species' preferred habitat includes gullies and river systems that drain the Great Dividing Range within moist sclerophyll forest, dry sclerophyll forest and rainforest below elevations of 500 m (Hoye and Richards 1998). The species has a direct flight, and utilises watercourses and constructed paths in denser forests. The species roost in tree hollows and occasionally buildings (Hoye and Richards 1998). There are potential roosts and foraging habitat within the study area. A detailed assessment of impact is given in **Appendix 3**.

Grey-headed Flying-fox (*Pteropus poliocephalus*) – Vulnerable
This species was not recorded within the study area. The species forages on a wide variety of flowers and fruits, such as figs, palms (Tidemann 1998) and commercial crops as well as nectar and pollen from flowering Myrtaceous species including *E. microcorys* (Eby 1995, cited in Benson and McDougall 1997). There is potential foraging habitat within and adjacent to the study area. A detailed assessment of impact is given in **Appendix 3**.

Yellow-bellied Glider (*Petaurus australis*) – Vulnerable
This species was not recorded within the study area. This species is the largest of the gliding possums, inhabiting tall, mature wet eucalypt forest. It mainly forages on eucalypt sap and insect exudates, while eucalypt blossom, arthropods and pollen provide important nutriment. Sap is obtained by scarring the trunk of a tree. Diurnal dens are usually hollows in large living smooth barked *Eucalyptus* spp. (Russell 1998). There is potential foraging habitat within and adjacent to the study area. A detailed assessment of impact is given in **Appendix 3**.

Squirrel Glider (*Petaurus norfolcensis*) – Vulnerable
This species was not recorded within the study area. The Squirrel Glider utilises dry sclerophyll habitats and woodlands where it dens in tree hollows. It feeds on insects, nectar, pollen, sugary insect exudates and sap. Trees utilised include Forest Red Gums (*E. tereticornis*). Acacia species that exude sap are also favoured (Suckling 1998). There is potential foraging habitat within and adjacent to the study area. A detailed assessment of impact is given in **Appendix 3**.

Brush-tailed Phascogale (*Phascogale tapoatafa*) – Vulnerable
This species was not recorded within the study area. The Brush-tailed Phascogale is mainly arboreal, feeding on nectar, insects, spiders, small vertebrates and ants in large trees. Mating and the raising of young take place in a tree hollow. The species will utilise tree hollows, stumps and even globular bird nests during the day (Soderquist 1998). There is potential foraging habitat within and adjacent to the study area. A detailed assessment of impact is given in **Appendix 3**.

Common Planigale (*Planigale maculata*) - Vulnerable
The Common Planigale inhabits a wide variety of habitats including rainforest, sclerophyll forest, grasslands and marshes, surviving within outer suburbs of major population centres where it often falls prey to domestic and feral predators (Redhead 1998). The species occur in wetter habitats with terrestrial refuge sites like rocks or fallen timber, feeding on a wide variety of insect prey (Redhead 1998). Potential habitat is found to the east of the proposed development footprint, and will not be affected by the proposed upgrade of the Pacific Highway. A detailed assessment of impact has not been prepared.

Koala (*Phascolarctos cinereus*) – Vulnerable
This species was not recorded within the study area. Tree species that occur within the study area that are known foraging species include Tallowwood (*E. microcorys*) (Schedule 2, SEPP 44). There is potential foraging habitat within and adjacent to the study area. A detailed assessment of impact is given in **Appendix 3**. Additional assessment regarding Koala habitat is given in **Section 5.4**.

Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*) – Vulnerable
The Eastern Chestnut Mouse is mostly found in dense, wet heath and swamps, particularly those that were burnt 18 months to four years previously (DEC 2006e). There is no potential habitat within or adjacent to the study area. A detailed assessment of impact has not been prepared.

Oxleyan pygmy perch (*Nannoperca oxleyana)* – Endangered
This is a small freshwater fish endemic to the coastal region of eastern Australia, from northern NSW to coastal south-eastern Queensland. It has specific habitat requirements and is patchily distributed within this range. It occurs mainly in swamps, creeks and lakes of coastal “wallum” (Banksia-dominated coastal heath). These waters are usually acidic, with low salinity and low conductivity and are often darkly stained (NSW Fisheries 2006). It prefers slow-moving or still waters with plenty of shelter in the form of dense aquatic vegetation (e.g. sedges) or undercut, root-filled banks. This species was not recorded in the study area and, based on the information above, no likely habitat occurs. Therefore a detailed assessment of impact is not required.

Table 8: Summary of Threatened Species Assessments

Species Name	Common Name	Act	Status	Factors Considered in the Assessment (see Appendix 3)*						
				a	b	c	d	e	f	g
Climacteris picumnus	Brown Treecreeper	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Calyptorhynchus lathami	Glossy Black-Cockatoo	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Lathamus discolor	Swift Parrot	TSC	E	No	n/a	n/a	No	n/a	n/a	n/a

Species Name	Common Name	Act	Status	Factors Considered in the Assessment (see Appendix 3)*						
				a	b	c	d	e	f	g
Lophoictinia isura	Square-tailed Kite	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Ninox connivens	Barking Owl	TSC	V	No	n/a	n/a	No	n/a	No	n/a
Ninox strenua	Powerful Owl	TSC	V	No	n/a	n/a	No	n/a	No	n/a
Tyto novaehollandiae	Masked Owl	TSC	V	No	n/a	n/a	No	n/a	No	n/a
Dasyurus maculatus	Spotted-tailed Quoll	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Miniopterus australis	Little Bentwing-bat	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Mormopterus norfolkensis	Eastern Freetail-bat	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Scoteanax rueppellii	Greater Broad-nosed Bat	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Pteropus poliocephalus	Grey-headed Flying-fox	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Petaurus australis	Yellow-bellied Glider	TSC	V	No	n/a	n/a	No	n/a	No	n/a
Petaurus norfolcensis	Squirrel Glider	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Phascogale tapoatafa	Brush-tailed Phascogale	TSC	V	No	n/a	n/a	No	n/a	n/a	n/a
Phascolarctos cinereus	Koala	TSC	V	No	n/a	n/a	No	n/a	No	n/a

Notes:

Status codes: E - Endangered; V - Vulnerable.

Yes: impact of the proposal would be significant.

No: impact of the proposal is not likely to be significant.

n/a: the particular factor is not applicable to the species.

5.3.2 Endangered Ecological Communities

No endangered ecological communities were recorded within the study area. Endangered ecological communities listed in Schedule 4 of the Fisheries Management Act all occur in western NSW and therefore will not be affected by the proposed development.

5.3.3 Endangered Populations

No endangered populations listed under Schedule 1, Part 2 of the TSC Act or Schedule 4 of the Fisheries Management Act are present within the study area or will be affected by the proposed highway upgrade.

5.3.4 Key Threatening Processes

A key threatening process (KTP) is defined in the TSC Act as a process that:

- Adversely affects two or more threatened species, populations or ecological communities; or
- could cause species, populations or ecological communities that are not currently threatened to become threatened.

The proposed highway upgrade potentially involves the following three key threatening processes:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.
- Removal of dead wood and dead trees.

These are discussed in detail in **Appendix 3**.

In addition the 'Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. lat)' is proposed for listing as a KTP. While the proposed highway upgrade will not involve the planting of Lantana, there is the potential for the spread of the species in disturbed areas through the movement of soil containing stem and seed material. The preliminary determination for the invasion, establishment and spread of Lantana is discussed in **Appendix 3**.

Key threatening processes listed in Schedule 6 of the Fisheries Management Act are:

- Degradation of native riparian vegetation along New South Wales water courses;
- Hook and line fishing in areas important for the survival of threatened fish species;
- Installation and operation of in stream structures and other mechanisms that alter natural flow regimes of rivers and streams;
- Introduction of fish to waters within a river catchment outside their natural range;
- Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales;
- Removal of large woody debris from New South Wales rivers and streams;
- The current shark meshing program in New South Wales waters.

Herons and Cutty Creeks are the principal watercourses potentially affected by the proposed upgrade of the Pacific Highway. As the majority of the works will occur in areas that are already influenced by the Highway, and the Herons Creek area will be managed as part of the Moorland to Herons Creek upgrade, none of these KTPs is expected to occur as a result of the proposed works.

5.3.5 Critical Habitat

There is no Critical Habitat declared under the provisions of the TSC Act within the study area.

5.4 State Environmental Planning Policy No 44 — Koala Habitat Protection

The aims of State Environmental Planning Policy No 44-Koala Habitat Protection (SEPP No.44) are *'to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline:*

(a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, and
(b) by encouraging the identification of areas of core koala habitat, and
(c) by encouraging the inclusion of areas of core koala habitat in environment protection zones.'

The study area is located within the Port Macquarie-Hastings Council which is listed in Schedule 1 of SEPP No.44. The study area also contains Tallowwood (*E. microcorys*), which is listed in Schedule 2 of SEPP No.44 as a species that is a known food resource for Koalas. As Tallowwood does not constitute more than 15 per cent of the canopy cover, it is considered that potential Koala habitat, as defined in SEPP No.44, is not present.

Core Koala habitat is defined as an area with a resident Koala population, including recent sightings, especially where females and young are present. No Koalas or evidence of Koalas were observed within the study area. There are many records within the NSW DEC Atlas of NSW Wildlife within a 20 km x 20 km grid centred on the study area, and Forests NSW has a record of the species from within the study area.

While it is possible that Koalas will pass through the site, it is unlikely there is a resident population due to the proximity of the existing highway. The study area is therefore not considered to be core Koala habitat. Therefore the provisions for the protection of core Koala habitat under SEPP No.44 do not require further consideration.

5.5 EPBC Act Considerations

Under the EPBC Act, an action will require approval from the Commonwealth Environment Minister if:

- The action has, will have, or is likely to have a significant impact on a matter of national environmental significance; and
- The action is not the subject of one of a list of exceptions.

Administrative guidelines of significance have been developed to assist in determining whether an action should be referred to the Environment Minister for a decision on whether approval is required. In particular, they are intended to provide guidance on whether a proposed action is likely to have a significant impact on any of the matters of national environmental significance. The following assessment has been undertaken using the EPBC Act administrative guidelines on significance.

5.5.1 World Heritage properties

There are no World Heritage properties located within 5 km of the proposed road upgrade, and none will be affected by the proposed development.

5.5.2 Ramsar wetlands of international importance

There are no Wetlands of International Importance protected under the provisions of the EPBC Act that occur within 5 km of the proposed road upgrade.

5.5.3 Listed threatened species and communities

It is unlikely that the Swift Parrot is reliant on habitats directly affected by the proposed development as an insignificant number of potential foraging trees will be cleared. The species is a winter visitor to the area and is therefore likely to utilise winter flowering trees. The species also forages, to a lesser extent, on seeds, psyllids, lerps and fruit (Higgins 1999). The area potentially affected by the proposed highway upgrade is not significant in the context of foraging resources in the local area. Therefore the proposed roadworks are unlikely to have any significant impact on this species.

The other threatened species that have a high dietary component of nectar or pollen are the Regent Honey-eater and Grey-headed Flying Fox. None of the tree species recorded within the area potentially affected by the Highway upgrade, either directly or indirectly, are listed as favoured food types of the Regent Honey-eater (Higgins *et al*. 2001). The Grey-headed Flying-fox forages readily within Spotted Gum; however, the impact to this species is not likely to be significant given the limited number of trees to be removed.

No habitat for the Painted Snipe will be affected by the proposed development. The species utilises swamps that have dense shore or emergent vegetation (Marchant and Higgins 1993), a habitat type that does not occur in the area.

No habitats that are typical of the Green and Golden Bell Frog (Pyke and White 1996) will be affected by the proposed development. Aquatic habitats near the proposed development are infested with the Mosquito Fish (*Gambusia holbrooki*), a known threat to the species (NPWS 2003a).

No aquatic habitat that is suitable for either *Mixophyes* spp. occurs within the area impacted by the proposed development. Habitat for the Stuttering Frog is described as in montane forests east of the Great Dividing Range (Cogger 2000) in rainforest (Barker *et al*. 1995) and wet sclerophyll habitats mostly near permanent water (Robinson 1993). The Giant Barred Frog inhabits coastal riverine rainforest and upland areas, including the Border Ranges, the Conondale Range (Barker *et al*. 1995) and historically south to Narooma (Cogger 2000). It is currently restricted to permanent rocky rainforest streams and slower moving rivers in montane areas. A small section of Cutty Creek will be potentially affected by the proposed development but this does not contain the habitats described for these species. Therefore they are unlikely to be affected by the proposed roadworks.

The Long-nosed Potoroo is generally restricted to coastal heath, dry sclerophyll forest and wet sclerophyll forest that have an annual rainfall above 760 mm. A relatively thick ground cover is a major habitat requirement for the species. It is more common in areas with light sandy soil where it forages for arthropods and their larvae, roots, tubers and fungi (Johnston 1998). Dry sclerophyll forest with dense understorey or groundcover will be removed as a result of the proposed highway upgrade. However these are either associated with forestry activity or are narrow strips of vegetation adjacent to the exiting highway. The Long-nosed Potoroo is highly unlikely to have a permanent population residing within the remnant vegetation between the existing north and southbound carriageways, due to the risk of disturbance associated with passing vehicles.

The Spotted-tail Quoll is likely only to utilise the study area for foraging, as no potential den sites were observed. The species may establish dens within vegetation associated with drainage lines that are excluded from forestry activities; however the forestry activities are likely to reduce the availability of terrestrial fauna on which the species feeds. The removal of relatively small areas of vegetation is highly unlikely to lead to a long-term decrease in the size of a local population or adversely affect habitat critical to the survival of this species.

The remnant trees and regenerating forests are likely to be potential foraging habitat for the Large Pied Bat. The habitat type to be affected by the proposed development is not significant in the context of the surround forests and woodlands. There are at least 2000 ha of forest managed for timber production, and the proposed development will affect approximately 14 ha of relatively young regrowth and shrublands. Therefore, in accordance with the EPBC administrative guidelines, there is unlikely to be a significant impact on this species as a result of the proposed roadworks.

The known distribution of the Leafless Tongue-orchid is along the east coast of Australia from south-east Queensland to eastern Victoria. It is known to occur in sub-regions of the Northern Rivers Catchment Management Region. This species flowers between December and February so it is unlikely it would have been identified during the field survey. It is associated with a range of vegetation formations and classes, notably dry sclerophyll forests, grassy woodlands, heathlands and wet sclerophyll forests. No detail is available of its essential habitat, but it appears to favour coastal environments and woodland dominated by Scribbly Gum, Silvertop Ash, Red Bloodwood and Black Sheoak. None of these species is dominant in the woodland likely to be cleared by the proposed roadworks. Therefore, the 14 ha of vegetation previously affected by forestry or road construction activities that is likely to be removed is unlikely to represent a significant area of habitat. No significant impact to this species is expected.

There are no nationally Threatened Ecological Communities located within 5 km of the proposed road upgrade, and none will be affected by the proposed development.

5.5.4 Listed Migratory Species

Nine migratory species have the potential to utilise the study area. The White-bellied Sea-Eagle (*Haliaeetus leucogaster*) and White-throated Needletail (*Hirundapus caudacutus*) are both unlikely to roost or breed within the study area, but are likely to fly over it. Both species are capable of extended flights, including over open water (Higgins 1999) and do not require woodland for movement.

The Black-faced Monarch (*Monarcha melanopsis*), Spectacled Monarch (*Monarcha trivirgatus*), Satin Flycatcher (*Myiagra cyanoleuca*) and Rufous Fantail (*Rhipidura rufifrons*) all utilise denser vegetation types (Frith 1982); however the Spectacled Monarch rarely utilises dry woodlands (Frith 1982). All three are capable of long distance travel and the proposed widening of the existing highway is unlikely to hinder the species' movement.

Regent Honeyeater (*Xanthomyza phrygia*) utilises habitats in the local area as flowering species, such as *Eucalyptus robusta*, flower profusely (Higgins *et al*. 2001). The species is nomadic, usually breeding west of the Great Dividing Range, and frequents open woodland habitats (Higgins *et al*. 2001) and therefore will not be impeded by a widening of the existing highway. Species in which the Regent Honeyeater is known to forage will not be significantly affected by the proposed highway upgrade.

Two migratory species, Latham's Snipe (*Gallinago hardwickii*) and the Painted Snipe (*Rostratula benghalensis* s. lat.) both utilise swampy habitats. However the Painted Snipe is usually associated with large swampy habitats dominated by emergent reeds (Marchant and

Higgins 1993), a habitat type that is absent from the study area. The Latham's Snipe will potentially utilise the small area of swampy habitat associated with Herons Creek, as the species is known to roost in a variety of habitats, including tussock grasslands and freshwater meadows, and also readily utilises man made aquatic environments, for example drains with sedges (Higgins and Davies 1996). The area of swampy habitat within the study area is outside of the development footprint.

No migratory species protected by the provisions of the EPBC Act will be significantly affected by the proposed highway upgrade.

5.5.5 Nuclear Actions

As discussed in Section 2.3, the proposal does not involve any nuclear actions.

5.5.6 The Commonwealth Marine Environment

Commonwealth Marine Area constitutes the waters between 3 nautical miles (5.556 km) from the coastal baseline to 200 nautical miles (370.4 km) seaward of the coastal baseline. The Commonwealth Marine Area is located outside of the area of the proposed works and will not be affected by the proposed development.

5.5.7 Summary

Based on the above assessment against the EPBC Act administrative guidelines on significance, a referral to the Commonwealth Environment Minister is not required.

5.6 Impact Mitigation

While it is unlikely that there will be a significant impact to threatened species potentially occurring within the study area, the proposed highway upgrade has the potential for affecting the local biodiversity through weed invasion and siltation of riparian habitat. In order to mitigate these impacts, the following measures are recommended:

- Washing down all vehicles and equipment used in construction activities to avoid the importation of weeds and soil borne pathogens;
- Control of weeds prior to earth moving activities to minimise their spread;
- Use of seed sourced from local *Eucalyptus* sp. and shrubs, in particular species that have abundant nectar and pollen, in rehabilitation work; and
- Protection of the riparian habitat associated with Herons and Cutty Creeks from sediment during construction.

6 CONCLUSIONS

The study area contains habitats that have been affected by activities such road construction and forestry activities. This has resulted in the reduction in area of the natural woodland and forest communities, loss of foraging and roosting opportunities and degradation of habitats through reduced structural diversity and increase in weed influence. Approximately 14 ha of remnant vegetation in varying condition will be affected by the proposed highway upgrade, with the majority of disturbance associated with the diamond interchange, Boyds Road and Bob Creek Road access.

No flora or fauna species protected by the *Threatened Species Conservation Act 1995, Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999* were directly observed within the study area. The majority of trees with large to medium hollow development are located in the island created by the Bob Creeks Road access, or within areas presently used for commercial timber production, and are located outside of the proposed development footprint.

There is potential for the degradation of adjacent communities through the spread of exotic species and siltation of riparian habitats. The implementation of the proposed mitigation measures will reduce the potential for significant degradation of habitats.

7 REFERENCES

Allison, F.R. and Hoye, G.A. 1998. Eastern Freetail-bat Mormopterus norfolkensis. In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Barker, J., Grigg, G.C. and Tyler, M.J. (1995). *A Field Guide to Australian Frogs*. Surrey Beattie and Sons, Chipping Norton.

Benson, D. and McDougall, L. (1997). Ecology of Sydney plant species part 5: Dicotyledon families Flacourtiaceae to Myrsinaceae. *Cunninghamia* 5(2): 330-544.

Benson, D. and McDougall, L. (1998). Ecology of Sydney plant species Part 6: Dicotyledon family Myrtaceae. *Cunninghamia* 5(4): 808-987.

Benwell, A.S. (1993). *Recovery Plan for Allocasuarina defungens*.

Biosis (2004). Working Paper No. 7 Flora and Fauna Assessment. In: Arup (2004). *Moorland to Herons Creek EIS*. Prepared for Ove Arup & Partners by Biosis Research Pty Limited.

Briggs, J.D. and Leigh, J.H. (1996). *Rare or Threatened Australian Plants*. CSIRO.

Churchill, S. (1998). *Australian Bats*. Reed New Holland, Sydney.

Cogger, H.G. (2000). *Reptiles and Amphibians of Australia*. Reed.

DEC (2005). *Draft Recovery Plan for the Large Forest Owls: Powerful Owl Ninox strenua Sooty Owl Tyto tenebricosa Masked Owl Tyto novaehollandiae*. Department of Environment and Conservation, Sydney, NSW.

DEC (2006a). *North Brother Wattle – profile. Department of Environment and Conservation*, Hurstville. Available from: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx. Accessed 16/1/2006.

DEC (2006b). *Caley's Grevillea – profile. Department of Environment and Conservation*, Hurstville. Available from: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx. Accessed 16/1/2006.

DEC (2006c). *Lady Tankerville's Swamp Orchid – profile. Department of Environment and Conservation*, Hurstville. Available from: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx. Accessed 16/1/2006.

DEC (2006d). *Big Nellie Hakea – profile. Department of Environment and Conservation*, Hurstville. Available from: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx. Accessed 16/1/2006.

DEC (2006e). *Eastern Chestnut Mouse – profile. Department of Environment and Conservation*, Hurstville. Available from: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx. Accessed 16/1/2006.

DEH (2006). *Allocasuarina defungens in Species Profile and Threats Database, Department of the Environment and Heritage*, Canberra. Available from: http://www.deh.gov.au/sprat. Accessed 16/1/2006.

Dwyer, P.D. (1998a). Little Bentwing-bat Miniopterus australis. In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Dwyer, P.D. (1998b). Common Bentwing-bat Miniopterus schreibersii. In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Eby, P. (1995). The biology and management of flying-foxes in NSW. *Species management report number 18*. Llewellyn, L. (ed). NPWS, Hurstville.

Ecology Lab (2004). Working Paper No. 6 Aquatic Ecology. In: Arup (2004). *Moorland to Herons Creek EIS*. Prepared for Ove Arup & Partners by The Ecology Lab Pty Limited.

Eddy, D., Mallinson, D., Rehwinkel, R., & Sharp, S. (1998). *Grassland Flora: a field guide for the Southern Tablelands (NSW & ACT)*. Environment ACT, NSW NPWS, World Wide Fund for Nature, Australian National Botanic Gardens, Canberra.

Edgar, R. and Belcher, C. (1998). Spotted-tailed Quoll Dasyurus maculatus. In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Fitri, L. and Ford, H. (1997). Status, habitat and social organisation of the Hooded Robin, Melanodryas cucullata in the New England Region of New South Wales. *Australian Birdwatcher* 17, 142-155.

Frith, H.J. (ed.) (1982). *The Readers Digest Complete Book of Australian Birds*. Readers Digest Service, Sydney.

Harden, G.J. (ed.) (1992*). Flora of New South Wales. (Vol.3)*. UNSW Press.

Harden, G.J. (ed.) (1993). *Flora of New South Wales. (Vol.4)*. UNSW Press.

Harden, G.J. (ed.) (2000). *Flora of New South Wales. (Vol.1)*. UNSW Press.

Harden, G.J. (ed.) (2002). *Flora of New South Wales. (Vol.2)*. UNSW Press.

Higgins, P.J. (Ed.) (1999). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbirds*. Oxford University Press, Melbourne.

Higgins, P.J. and Davies, S.J.J.F. (Eds.) (1996). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipe to Pigeons*. Oxford University Press, Melbourne.

Higgins, P.J., Peter, J.M. and Steele, W.K. (Eds.) (2001). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 5: Tyrant-flycatchers to Chats*. Oxford University Press, Melbourne.

Hoye, G.A. and Richards, G.C. (1998). Greater Broad-nosed Bat Scoteanax rueppelli. In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Johnston, P.G. (1998). Long-nosed Potoroo Potorous tridactylus. In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Marchant, S. and Higgins, P.J. (Eds.) (1990a). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 1A: Ratites to Petrels*. Oxford University Press, Melbourne.

Marchant, S. and Higgins, P.J. (Eds.) (1990b). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 1B: Australian Pelican to Ducks*. Oxford University Press, Melbourne.

Marchant, S. and Higgins, P.J. (Eds.) (1993). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2: Raptors to Lapwings*. Oxford University Press, Melbourne.

Maryott-Brown, K. and Wilks, D. (1993). Ra*re and Endangered Plants of Yengo National Park and Adjacent Areas*. NPWS Hurstville, NSW.

NPWS (1999). *Forest Ecosystem Classifications for Upper and Lower North East Regions*. Prepared for: the Joint Commonwealth NSW Regional Forest Agreement Steering Committee by the National Parks and Wildlife Service CRA Unit Northern Zone.

NPWS (2003a). *NSW Threat Abatement Plan. Predation by Gambusia holbrooki – The Plague Minnow*. NPWS Hurstville, NSW.

NPWS (2003b). *Recovery Plan for the Yellow-bellied Glider Petaurus australis*). NPWS Hurstville, NSW.

NPWS (2003c). *Draft Recovery Plan for the Barking Owl*. NPWS Hurstville, NSW.

NPWS (2003d). *Draft Recovery Plan for the Koala*. NPWS Hurstville, NSW.

NSW Fisheries (2006). *Oxleyan pygmy perch*. NSW Department of Primary Industries Fisheries. Available from http://www.fisheries.nsw.gov.au/threatened_species/general/content/fn_oxleyan_pygmy_perch.htm (Accessed 27 June 2006).

NSW Scientific Committee (2001). *Final Determination: Grey-headed Flying-fox*. Crown copyright.

NSW Scientific Committee (2004a). *Final Determination: Clearing of Native Vegetation*. Crown Copyright.

NSW Scientific Committee (2004b). *Final Determination: Removal of dead wood, dead trees and logs*. Crown Copyright.

NSW Scientific Committee (2004c). *Final Determination: Invasion of native plant communities by exotic perennial grasses*. Crown Copyright.

NSW Scientific Committee (2006). *Preliminary Determination: Lantana camara*. Crown Copyright.

Osborne, W.S. and McElhinney, N.A. (1996). Status, habitat and preliminary observations on the calling of the Green and Golden Bell frog (Litoria aurea) on Bowen Island, Jervis Bay National Park. In 'The Green and Golden Bell Frog (Litoria aurea): Biology and Conservation.' Pyke, G.H. and Osborne, W.S. (eds.), *Australian Zoologist* 30(2):218-223.

Pyke G.H. and White A.W. (1996). Habitat requirements for the Green and Golden Bell Frog Litoria aurea (Anura: Hylidae). *Australian Zoologist* 30: 224-232.

Redhead, T.D. (1998). Common Planigale Planigale maculata. In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Robinson, M. (1993). *A Field Guide to the Frogs of Australia*. Australian Museum/Reed.

Russell, R. (1998). Yellow-bellied Glider Petaurus australis. In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Soderquist, T. (1998). 'Brush-tailed Phascogale Phascogale tapotafa.' In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Suckling, G.C. (1998). Squirrel Glider Petaurus norfolcensis. In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Tidemann, C.R. (1998). Grey-headed Flying-fox Pteropus poliocephalus. In: *The Mammals of Australia*. Australian Museum/Reed New Holland, Sydney.

Figures

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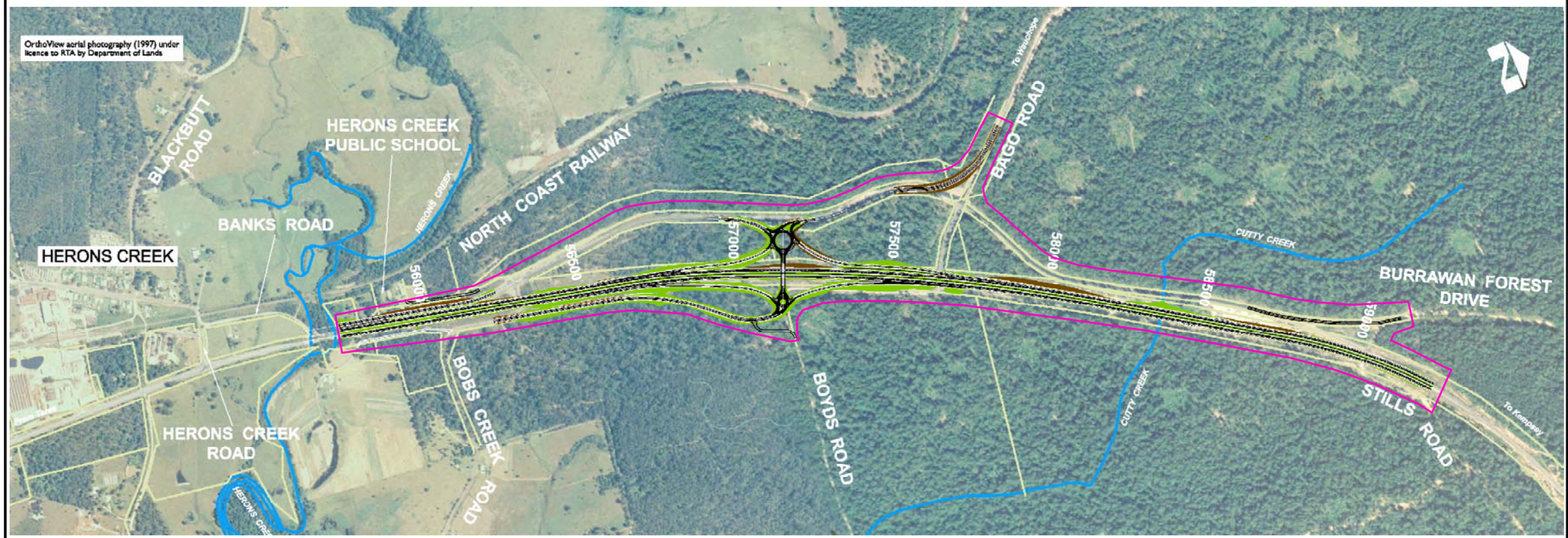


PROJECT-FILE NAME	**N6033103**
DATE	**July 2006**
DRAWN	**SJK**
APPROVED	**NMcE**

Legend

Study Area Boundary

0 100 200 300 400 500

Metres

LOCATION OF PROPOSED WORKS AND STUDY AREA

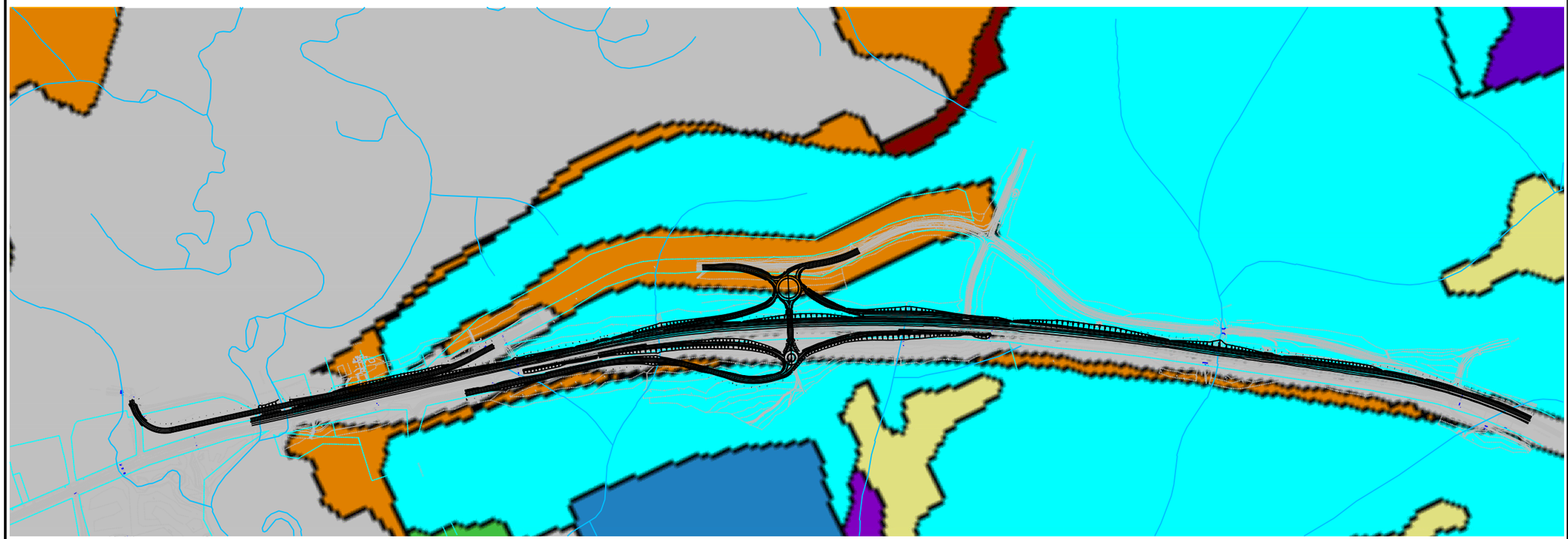
Roads & Traffic Authority
Pacific Highway Upgrade
Herons Creek to Stills Road
Herons Creek, NSW

HLA

FIGURE

1

A3



PROJECT-FILE NAME	N6033103
DATE	July 2006
DRAWN	SJK
APPROVED	NMcE

Legend

- Dry Blackbutt League
- Sydney Blue Gum / Bangalay League
- Forestry Plantation (Hardwood)
- Moist Blackbutt League
- Mixed Blackbutt
- Cleared / Modified
- Broad-leaved White Mahogany and Grey Gum / Grey Ironbark / White Mahogany
- Artificial Community

0 100 200 300 400 500

Metres

VEGETATION COMMUNITIES AROUND THE STUDY AREA

Roads & Traffic Authority
Pacific Highway Upgrade
Herons Creek to Stills Road
Herons Creek, NSW

HLA

FIGURE

2

Source: NPWS (1999)

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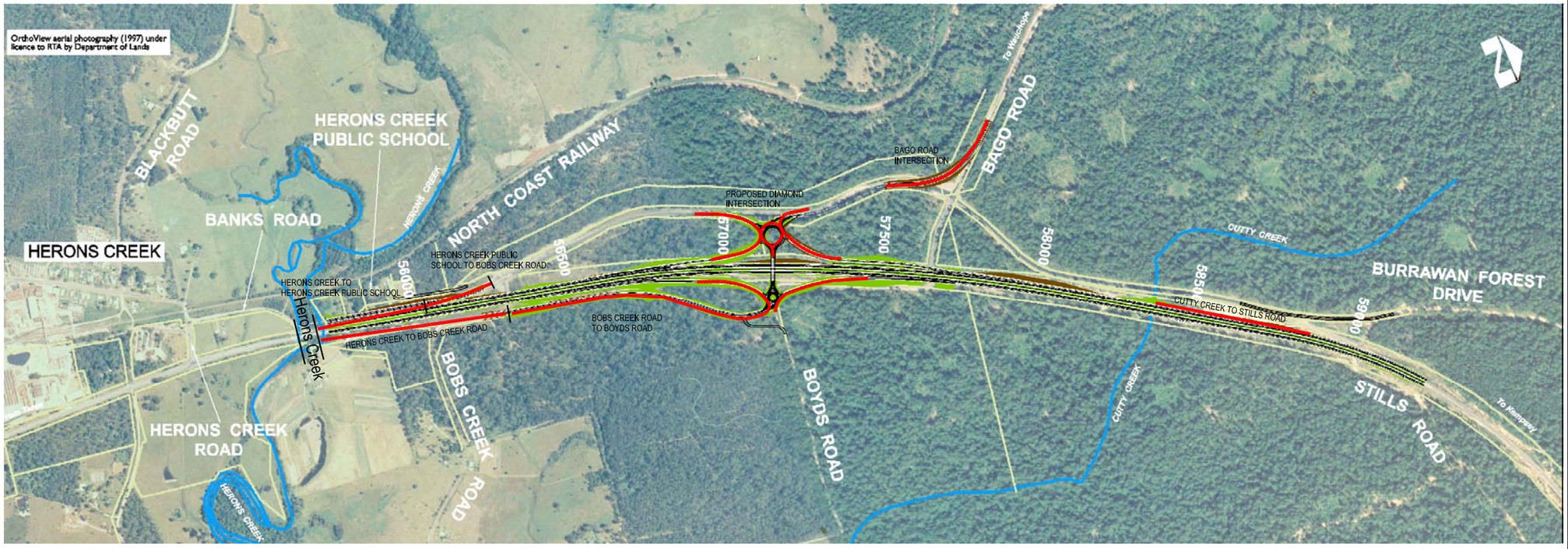

PROJECT-FILE NAME	**N6033103**
DATE	**July 2006**
DRAWN	**SJK**
APPROVED	**NMcE**

PRINCIPAL SECTIONS OF THE PROPOSED WORKS

Roads & Traffic Authority

Pacific Highway Upgrade

Herons Creek to Stills Road

Herons Creek, NSW

HLA

FIGURE

3

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Plates

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Plate 1: Tall shrub regeneration, looking south from Bobs Creek Road/Pacific Highway intersection

Plate 2: Area affected by proposed intersection at Bago Road and present northbound carriageway of the Pacific Highway

Plate 3: Vegetation between existing northbound and southbound carriageways in the vicinity of the proposed diamond intersection

Plate 4: Former alignment of Pacific Highway between the present day northbound and southbound carriageways, looking south

Plate 5: A logged coupe east of the southbound carriageway of the Pacific Highway, south of Boyds Road

Plate 6: Riparian vegetation associated with Cutty Creek between the northbound and southbound carriages of the Pacific Highway

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Appendices

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Appendix 1: Fauna of the Local Area

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NSW Status – Status as per *Threatened Species Conservation Act 1995* (TSC Act) and *National Parks and Wildlife Act* 1975 (NPW Act).
- P - Protected (NPW Act)
- U - Unprotected / feral (NPW Act)
- E1 - Endangered (Schedule 1, TSC Act)
- V - Vulnerable (Schedule 2, TSC Act)

Record Origin of record
- WA- DEC Atlas of NSW Wildlife)
- PS Present Study
  - o Observed
  - f Tracks/scratchings
  - y Bone or teeth
  - w Heard call
  - m Miscellaneous
  - ? Likely identification

Class: *Amphibia*

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Anura* Family: *Hylidae*				
Litoria aurea	Green and Golden Bell Frog	E1	N	WA-
Litoria brevipalmata	Green-thighed Frog	P	N	WA-
Litoria caerulea	Green Tree Frog	P	N	WA-
Litoria dentata	Bleating Tree Frog	P	N	WA-
Litoria fallax	Eastern Dwarf Tree Frog	P	N	WA
Litoria freycineti	Freycinet's Frog	P	N	WA-
Litoria gracilenta	Dainty Tree Frog	P	N	WA-
Litoria jervisiensis	Jervis Bay Tree Frog	P	N	WA-
Litoria lesueuri	Lesueur's Frog	P	N	WA-
Litoria nasuta	Rocket Frog	P	N	WA-
Litoria peronii	Peron's Tree Frog	P	N	WA-
Litoria tyleri	Tyler's Tree Frog	P	N	WA
Litoria verreauxii	Whistling Tree Frog	P	N	WA-
Order: *Anura* Family: *Myobatrachidae*				
Adelotus brevis	Tusked Frog	P	N	WA-
Crinia signifera	Common Eastern Froglet	P	N	WA-
Crinia tinnula	Wallum Frog	V	N	WA-
Limnodynastes dumerilii	Eastern Banjo Frog	P	N	WA-
Limnodynastes peronii	Brown-striped Frog	P	N	WA-
Limnodynastes tasmaniensis	Spotted Grass Frog	P	N	WA-
Mixophyes fasciolatus	Great Barred Frog	P	N	WA-
Paracrinia haswelli	Haswell's Frog	P	N	WA-
Pseudophryne coriacea	Red-backed Toadlet	P	N	WA-
Uperoleia laevigata	Smooth Toadlet	P	N	WA-

Class: *Aves*

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Anseriformes* Family: *Anatidae*				
Anas castanea	Chestnut Teal	P	N	WA-
Anas superciliosa	Pacific Black Duck	P	N	WA-
Aythya australis	Hardhead	P	N	WA-
Chenonetta jubata	Australian Wood Duck	P	N	WA-
Cygnus atratus	Black Swan	P	N	WA-
Dendrocygna arcuata	Wandering Whistling-Duck	P	N	WA-
Dendrocygna eytoni	Plumed Whistling-Duck	P	N	WA-
Oxyura australis	Blue-billed Duck	V	N	WA-
Order: *Anseriformes* Family: *Anhingidae*				
Anhinga melanogaster	Darter	P	N	WA-
Order: *Apodiformes* Family: *Apodidae*				
Apus pacificus	Fork-tailed Swift	P	N	WA-
Hirundapus caudacutus	White-throated Needletail	P	N	WA-
Order: *Caprimulgiformes* Family: *Aegothelidae*				
Aegotheles cristatus	Australian Owlet-nightjar	P	N	WA-
Order: *Caprimulgiformes* Family: *Caprimulgidae*				
Eurostopodus mystacalis	White-throated Nightjar	P	N	WA-
Order: *Caprimulgiformes* Family: *Podargidae*				
Podargus strigoides	Tawny Frogmouth	P	N	WA-
Order: *Charadriiformes* Family: *Charadriidae*				
Charadrius bicinctus	Double-banded Plover	P	N	WA-
Vanellus miles	Masked Lapwing	P	N	WA-
Vanellus tricolor	Banded Lapwing	P	N	WA-
Order: *Charadriiformes* Family: *Haematopodidae*				
Haematopus longirostris	Pied Oystercatcher	V	N	WA-
Order: *Charadriiformes* Family: *Lardidae*				
Larus novaehollandiae	Silver Gull	P	N	WA-
Order: *Charadriiformes* Family: *Scolopacidae*				
Actitis hypoleucos	Common Sandpiper	P	N	WA-
Gallinago hardwickii	Latham's Snipe	P	N	WA-
Numenius madagascariensis	Eastern Curlew	P	N	WA-
Order: *Ciconiiformes* Family: *Ardeidae*				
Ardea alba	Great Egret	P	N	WA-
Ardea ibis	Cattle Egret	P	N	WA-
Ardea intermedia	Intermediate Egret	P	N	WA-
Ardea pacifica	White-necked Heron	P	N	WA-

Class: *Aves* - Continued

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Ciconiiformes* Family: *Ardeidae* - Continued				
Botaurus poiciloptilus	Australian Bittern	V	N	WA-
Egretta novaehollandiae	White-faced Heron	P	N	WA-
Egretta sacra	Eastern Reef Egret	P	N	WA-
Nycticorax caledonicus	Nankeen Night Heron	P	N	WA-
Order: *Ciconiiformes* Family: *Ciconiidae*				
Ephippiorhynchus asiaticus	Black-necked Stork	E1	N	WA-
Order: *Ciconiiformes* Family: *Threskiornithidae*				
Platalea flavipes	Yellow-billed Spoonbill	P	N	WA-
Platalea regia	Royal Spoonbill	P	N	WA-
Threskiornis molucca	Australian White Ibis	P	N	WA-
Threskiornis spinicollis	Straw-necked Ibis	P	N	WA-
Order: *Columbiformes* Family: *Columbidae*				
Columba leucomela	White-headed Pigeon	P	N	WA-
Geopelia cuneata	Diamond Dove	P	N	WA-
Geopelia humeralis	Bar-shouldered Dove	P	N	WA-
Geopelia placida	Peaceful Dove	P	N	WA-
Leucosarcia melanoleuca	Wonga Pigeon	P	N	WA-
Macropygia amboinensis	Brown Cuckoo-Dove	P	N	WA-
Phaps chalcoptera	Common Bronzewing	P	N	WA-,PSo
Ptilinopus magnificus	Wompoo Fruit-Dove	V	N	WA-
Ocyphaps lophotes	Crested Pigeon	P	N	WA-,PSo
Streptopelia chinensis	Spotted Turtle-Dove	U	E	WA-
Order: *Coraciiformes* Family: *Alcedinidae*				
Alcedo azurea	Azure Kingfisher	P	N	WA-
Order: *Coraciiformes* Family: *Halcyonidae*				
Dacelo novaeguineae	Laughing Kookaburra	P	N	WA-
Todiramphus macleayii	Forest Kingfisher	P	N	WA-
Todiramphus sanctus	Sacred Kingfisher	P	N	WA-
Order: *Coraciiformes* Family: *Coraciidae*				
Eurystomus orientalis	Dollarbird	P	N	WA-
Order: *Cuculiformes* Family: *Centropodidae*				
Centropus phasianinus	Pheasant Coucal	P	N	WA-
Order: *Cuculiformes* Family: *Cuculidae*				
Cacomantis flabelliformis	Fan-tailed Cuckoo	P	N	WA-
Cacomantis variolosus	Brush Cuckoo	P	N	WA-
Chalcites lucidus	Shining Bronze-Cuckoo	P	N	WA-
Cuculus pallidus	Pallid Cuckoo	P	N	WA-
Eudynamys orientalis	Pacific Koel			
Scythrops novaehollandiae	Channel-billed Cuckoo	P	N	WA-

Class: *Aves* - Continued

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Falconiformes* Family: *Accipitridae*				
Accipiter cirrocephalus	Collared Sparrowhawk	P	N	WA-
Aquila audax	Wedge-tailed Eagle	P	N	WA-
Aviceda subcristata	Pacific Baza	P	N	WA-
Order: *Falconiformes* - continued Family: *Accipitridae*				
Circus approximans	Swamp Harrier	P	N	WA-
Elanus axillaris	Black-shouldered Kite	P	N	WA-
Haliastur sphenurus	Whistling Kite	P	N	WA-
Haliaeetus indus	Brahminy Kite	P	N	WA-
Hieraaetus morphnoides	Little Eagle	P	N	WA-
Lophoictinia isura	Square-tailed Kite	V	N	WA-
Pandion haliaetus	Osprey	V	N	WA-
Order: *Falconiformes* Family: *Falconidae*				
Falco berigora	Brown Falcon	P	N	WA-
Falco peregrinus	Peregrine Falcon	P	N	WA-
Order: *Galliformes* Family: *Phasianidae*				
Coturnix ypsilophora	Brown Quail	P	N	WA-
Order: *Galliformes* Family: *Rallidae*				
Fulica atra	Eurasian Coot	P	N	WA-
Porphyrio porphyrio	Purple Swamphen	P	N	WA-
Rallus pectoralis	Lewin's Rail	P	N	WA-
Order: *Passeriformes* Family: *Acanthizidae*				
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	P	N	WA-
Acanthiza lineata	Striated Thornbill	P	N	WA-
Acanthiza pusilla	Brown Thornbill	P	N	WA-
Acanthiza nana	Yellow Thornbill	P	N	WA-
Acanthiza reguloides	Buff-rumped Thornbill	P	N	WA-
Gerygone mouki	Brown Gerygone	P	N	WA-
Gerygone olivacea	White-throated Gerygone	P	N	WA-
Sericornis frontalis	White-browed Scrubwren	P	N	WA-
Order: *Passeriformes* Family: *Artamidae*				
Artamus leucorynchus	White-breasted Woodswallow	P	N	WA-
Cracticus nigrogularis	Pied Butcherbird	P	N	WA-
Cracticus torquatus	Grey Butcherbird	P	N	WA-,PSo
Gymnorhina tibicen	Australian Magpie	P	N	WA-,PSo
Strepera graculina	Pied Currawong	P	N	WA-,PSo
Order: *Passeriformes* Family: *Campephagidae*				
Coracina novaehollandiae	Black-faced Cuckoo-shrike	P	N	WA-,PSo
Coracina tenuirostris	Cicadabird	P	N	WA-

Class: *Aves* - Continued

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Passeriformes* Family: *Climacteridae*				
Climacteris erythrops	Red-browed Treecreeper	P	N	WA-
Climacteris picumnus	Brown Treecreeper	V	N	WA-
Cormobates leucophaeus	White-throated Treecreeper	P	N	WA-
Order: *Passeriformes* Family: *Corvidae*				
Corvus coronoides	Australian Raven	P	N	WA-,PSo
Corvus orru	Torresian Crow	P	N	WA-
Corvus sp.	Unidentified corvid	P	N	WA-
Order: *Passeriformes* Family: *Dicaeidae*				
Dicaeum hirundinaceum	Mistletoebird	P	N	WA-
Order: *Passeriformes* Family: *Dicruridae*				
Dicrurus bracteatus	Spangled Drongo	P	N	WA-
Grallina cyanoleuca	Magpie-lark	P	N	WA-
Monarcha melanopsis	Black-faced Monarch	P	N	WA-
Monarcha trivirgatus	Spectacled Monarch	P	N	WA-
Myiagra cyanoleuca	Satin Flycatcher	P	N	WA-
Myiagra inquieta	Restless Flycatcher	P	N	WA-
Myiagra rubecula	Leaden Flycatcher	P	N	WA-
Rhipidura fuliginosa	Grey Fantail	P	N	PSo
Rhipidura leucophrys	Willie Wagtail	P	N	WA-,PSo
Rhipidura rufifrons	Rufous Fantail	P	N	WA-
Order: *Passeriformes* Family: *Estrildidae*				
Neochmia temporalis	Red-browed Finch	P	N	WA-,PSo
Order: *Passeriformes* Family: *Eupetidae*				
Cinclosoma punctatum	Spotted Quail-thrush	P	N	WA-
Psophodes olivaceus	Eastern Whipbird	P	N	WA-
Order: *Passeriformes* Family: *Hirundinidae*				
Hirundo neoxena	Welcome Swallow	P	N	WA-,PSo
Petrochelidon ariel	*Fairy Martin*	P	N	WA-
Petrochelidon nigricans	*Tree Martin*	P	N	WA-
Order: *Passeriformes* Family: *Maluridae*				
Malurus cyaneus	Superb Fairy-wren	P	N	WA-,PSo
Malurus lamberti	Variegated Fairy-wren	P	N	WA-
Stipiturus malachurus	Southern Emu-wren	P	N	WA-
Order: *Passeriformes* Family: *Meliphagidae*				
Acanthorhynchus tenuirostris	Eastern Spinebill	P	N	WA-
Anthochaera carunculata	Red Wattlebird	P	N	WA-
Anthochaera chrysoptera	Little Wattlebird	P	N	WA-

Class: *Aves* - Continued

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Passeriformes* Family: *Meliphagidae*- Continued				
Lichenostomus chrysops	Yellow-faced Honeyeater	P	N	WA-
Lichenostomus leucotis	White-eared Honeyeater	P	N	WA-,PSo
Lichmera indistincta	Brown Honeyeater	P	N	WA-
Manorina melanocephala	Noisy Miner	P	N	WA-,PSo
Meliphaga lewinii	Lewin's Honeyeater	P	N	WA-,PSo
Melithreptus lunatus	White-naped Honeyeater	P	N	WA-
Myzomela sanguinolenta	Scarlet Honeyeater	P	N	WA-
Philemon corniculatus	Noisy Friarbird	P	N	WA-
Phylidonyris nigra	White-cheeked Honeyeater	P	N	WA-
Phylidonyris novaehollandiae	New Holland Honeyeater	P	N	WA-
Order: *Passeriformes* Family: *Muscicapidae*				
Zoothera sp.	unidentified ground thrush	P	N	WA-
Order: *Passeriformes* Family: *Oriolidae*				
Oriolus sagittatus	Olive-backed Oriole	P	N	WA-
Order: *Passeriformes* Family: *Pachychephalidae*				
Colluricincla harmonica	Grey Shrike-thrush	P	N	WA-
Falcunculus frontatus	Crested Shrike-tit	P	N	WA-
Pachycephala pectoralis	Golden Whistler	P	N	WA-
Pachycephala rufiventris	Rufous Whistler	P	N	WA-
Order: *Passeriformes* Family: *Pardalotidae*				
Pardalotus punctatus	Spotted Pardalote	P	N	WA-
Pardalotus striatus	Striated Pardalote	P	N	WA-
Order: *Passeriformes* Family: *Petrocidae*				
Eopsaltria australis	Eastern Yellow Robin	P	N	WA- PSo
Microeca fascinans	Jacky Winter	P	N	WA-
Tregellasia capito	Pale-yellow Robin	P	N	WA-
Order: *Passeriformes* Family: *Pittidae*				
Pitta versicolor	Noisy Pitta	P	N	WA-
Order: *Passeriformes* Family: *Ptilonorhynchinae*				
Ailuroedus crassirostris	Green Catbird	P	N	WA-
Ptilonorhynchus violaceus	Satin Bowerbird	P	N	WA-
Sericulus chrysocephalus	Regent Bowerbird	P	N	WA-
Order: *Passeriformes* Family: *Sturnidae*				
Acridotheres tristis	Common Myna	U	E	WA-
Order: *Passeriformes* Family: *Zosteropidae*				
Zosterops lateralis	Silvereye	P	N	WA-PSo

Class: *Aves* - Continued

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Pelecaniformes* Family: *Pelecanidae*				
Pelecanus conspicillatus	Australian Pelican	P	N	WA-
Order: *Pelecaniformes* Family: *Phalacrocoracidae*				
Phalacrocorax carbo	Great Cormorant	P	N	WA-
Phalacrocorax melanoleucos	Little Pied Cormorant	P	N	WA-
Phalacrocorax sulcirostris	Little Black Cormorant	P	N	WA-
Phalacrocorax varius	Pied Cormorant	P	N	WA-
Order: *Pelecaniformes* Family: *Sulidae*				
Morus serrator	Australasian Gannet	P	N	WA-
Order: *Podicipediformes* Family: *Podicipedidae*				
Tachybaptus novaehollandiae	Australasian Grebe	P	N	WA-
Order: *Procellariiformes* Family: *Procellariidae*				
Fulmarus glacialoides	Southern Fulmar	P	N	WA-
Order: *Psittaciformes* Family: *Cacatuidae*				
Cacatua galerita	Sulphur-crested Cockatoo	P	N	WA-
Cacatua sanguinea	Little Corella	P	N	WA-
Cacatua tenuirostris	Long-billed Corella	P	N	WA-
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo	P	N	WA-
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	N	WA-
Eolophus roseicapillus	Galah	P	N	WA-
Order: *Psittaciformes* Family: *Psittacidae*				
Alisterus scapularis	King Parrot	P	N	WA-
Glossopsitta pusilla	Little Lorikeet	P	N	WA-
Lathamus discolor	Swift Parrot	E	N	WA-
Platycercus adscitus eximius	Eastern Rosella	P	N	WA-
Platycercus elegans	Crimson Rosella	P	N	WA-
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet	P	N	WA-
Trichoglossus haematodus	Rainbow Lorikeet	P	N	WA-
Order: *Strigiformes* Family: *Strigidae*				
Ninox boobook	Southern Boobook	P	N	WA-
Ninox connivens	Barking Owl	V	N	WA-
Ninox strenua	Powerful Owl	V	N	WA-
Order: *Strigiformes* Family: *Tytonidae*				
Tyto alba	Barn Owl	P	N	WA-
Tyto novaehollandiae	Masked Owl	V	N	WA-
Tyto tenebricosa	Sooty Owl	V	N	WA-
Order: *Turniciformes* Family: *Turnicidae*				
Turnix varia	Painted Button-quail	P	N	WA-

Class: *Mammalia* (*Eutheria*)

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Artiodactyla* Family: *Bovidae*				
Bos taurus	Cattle	U	E	WA-
Order: *Cetacea* Family: *Delphinidae*				
Orcinus orca	Killer Whale	P	N	WA-
Order: *Cetacea* Family: *Balaenopteridae*				
Megaptera novaeangliae	Humpback Whale	V	N	WA-
Order: *Chiroptera* Family: *Molossidae*				
Mormopterus norfolkensis	Eastern Little Mastiff-bat	V		WA-
Nyctinomus australis	White-striped Mastiff-bat	P	N	WA-
Order: *Chiroptera* Family: *Pteropodidae*				
Pteropus poliocephalus	Grey-headed Flying-fox	V	N	WA-
Pteropus scapulatus	Little Red Flying-fox	P	N	WA-
Order: *Chiroptera* Family: *Rhinolophidae*				
Rhinolophus megaphyllus	Eastern Horseshoe-bat	P	N	WA-
Order: *Chiroptera* Family: *Vespertilionidae*				
Chalinolobus gouldii	Gould's Wattled Bat	P	N	WA-
Chalinolobus morio	Chocolate Wattled Bat	P	N	WA-
Miniopterus australis	Little Bent-wing Bat	V	N	WA-
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	N	WA-
Nyctophilus geoffroyi	Lesser Long-eared Bat	P	N	WA-
Nyctophilus gouldi	Gould's Long-eared Bat	P	N	WA-
Scoteanax rueppellii	Eastern Broad-nosed Bat	V	N	WA-
Vespadelus darlingtoni	Large Forest Bat	P	N	WA-
Vespadelus pumilus	Eastern Forest Bat	P	N	WA-
Vespadelus sp.	Unidentified Eptesicus	P	N	WA-
Vespadelus vulturnus	Little Forest Eptesicus	P	N	WA-
Order: *Fissipedia* Family: *Canidae*				
Canis lupus	Dingo, domestic dog	U	E	WA-
Vulpes vulpes	Fox	U	E	WA-
Order: *Fissipedia* Family: *Felidae*				
Felis catus	Cat	U	E	WA-
Order: *Lagomorpha* Family: *Leporidae*				
Lepus capensis	Brown Hare	U	E	WA-
Order: *Perrisodactyla* Family: *Equidae*				
Equus caballus	Horse	U	E	WA-

Class: *Mammalia* (*Eutheria*) - Continued

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Pinnipedia* Family: *Otariidae*				
Arctocephalus pusillus doriferus	Australian Fur-seal	V	N	WA-
Order: *Rodentia* Family: *Muridae*				
Hydromys chrysogaster	Water-rat	P	N	WA-
Melomys burtoni	Grassland Melomys	P	N	WA-
Melomys cervinipes	Fawn-footed Melomys	P	N	WA-
Mus musculus	House Mouse	U	E	WA-
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	V	N	WA-
Rattus fuscipes	Bush Rat	P	N	WA-
Rattus lutreolus	Swamp Rat	P	N	WA-
Rattus rattus	Black Rat	U	E	WA-
Rattus sp.	Rat	P	N	WA-
Order: *Sirenia* Family: *Dugongidae*				
Dugong dugon	Dugong	E1	N	WA-

Class: *Mammalia* (*Marsupialia*)

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Dasyuromorphia* Family: *Dasyuridae*				
Antechinus flavipes	Yellow-footed Antechinus	P	N	WA-
Antechinus stuartii	Brown Antechinus	P	N	WA-
Dasyuridae sp	Undentified dasyurid	P	N	WA-
Dasyurus maculatus	Tiger Quoll	V	N	WA-
Phascogale tapoatafa	Brush-tailed Phascogale	V	N	WA-
Planigale maculata	Common Planigale	P	N	WA-
Sminthopsis murina	Common Dunnart	P	N	WA-
Sminthopsis sp.	Unidentified Dunnart	P	N	WA-
Order: *Diprodonta* Family: *Burramyidae*				
Acrobates pygmaeus	Feathertail Glider	P	N	WA-
Order: *Diprodonta* Family: *Macropodidae*				
Macropus sp.	Unidentified macropod	P	N	WA-
Macropus giganteus	Eastern Grey Kangaroo	P	N	WA-,PSo
Macropus rufogriseus	Red-necked Wallaby	P	N	WA-
Thylogale thetis	Red-necked Pademelon	P	N	WA-
Wallabia bicolor	Swamp Wallaby	P	N	WA-
Order: *Diprodonta* Family: *Petauridae*				
Petaurus australis	Yellow-bellied Glider	V	N	WA-
Petaurus breviceps	Sugar Glider	P	N	WA-
Petaurus norfolcensis	Squirrel Glider	V	N	WA-
Petaurus sp.	Unidentified glider	P	N	WA-

Class: *Mammalia* (*Marsupialia*) - continued

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Diprodonta* Family: *Phalangeridae*				
Trichosurus caninus	Mountain Brushtail Possum	P	N	WA-
Trichosurus sp.	Unidentified possum	P	N	WA-
Trichosurus vulpecula	Common Brushtail Possum	P	N	WA-
Order: *Diprodonta* Family: *Phascolarctidae*				
Phascolarctos cinereus	Koala	V	N	WA-
Order: *Diprodonta* Family: *Pseudocheiridae*				
Petauroides volans	Greater Glider	P	N	WA-
Pseudocheirus peregrinus	Common Ringtail Possum	P	N	WA-
Order: *Peramelina* Family: *Peramelidae*				
Isoodon macrourus	Northern Brown Bandicoot	P	N	WA-
Isoodon/Perameles sp.	Unidentified Bandicoot	P	N	WA-
Perameles nasuta	Long-nosed Bandicoot	P	N	WA-

Class: *Mammalia* (*Prototheria*)

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Monotremata* Family: *Ornithorhynchidae*				
Ornithorhynchus anatinus	Platypus	P	N	WA-
Order: *Monotremata* Family: *Tachyglossidae*				
Tachyglossus aculeatus	Short-beaked Echidna	P	N	WA-,PSf

Class: *Reptilia*

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Serpentes* Family: *Boidae*				
Morelia spilota	Carpet or Diamond Python	P	N	WA-
Order: *Serpentes* Family: *Colubridae*				
Boiga irregularis	Eastern Brown Tree Snake	P	N	WA-
Dendrelaphis punctulata	Green Tree Snake	P	N	WA-
Order: *Serpentes* Family: *Elapidae*				
Demansia psammophis	Yellow-faced Whipsnake	P	N	WA-
Hemiaspis signata	Black-bellied Swamp Snake	P	N	WA-
Pseudechis porphyriacus	Red-bellied Black Snake	P	N	WA-
Pseudonaja textilis	Eastern Brown Snake	P	N	WA-
Rhinoplocephalus nigrescens	Eastern Small-eyed Snake	P	N	WA-
Vermicella annulata	Bandy Bandy	P	N	WA-

Class: *Reptilia* - continued

Scientific Name	Common Name	NSW Status	Origin	Record
Order: *Squamata* Family: *Agamidae*				
Amphibolurus muricatus	Jacky Lizard	P	N	WA- PSo
Hypsilurus spinipes	Southern Angle-headed Dragon	P	N	WA-
Physignathus lesueurii	Eastern Water Dragon	P	N	WA-
Order: *Squamata* Family: Gekkonidae				
Saltuarius swaini	Southern Leaf-tailed Gecko	P	N	WA-
Order: *Squamata* Family: *Pygopodidae*				
Lialis burtonis	Burton's Snake-lizard	P	N	WA-
Order: *Squamata* Family: *Scincidae*				
Calyptotis ruficauda		P	N	WA-
Ctenotus robustus	Striped Skink	P	N	WA-
Egernia major	Land Mullet	P	N	WA-
Egernia striolata	Tree-crevice Skink	P	N	WA-
Lampropholis amicula	Friendly Sunskink	P	N	WA-
Lampropholis delicata	Grass Skink	P	N	WA- PSo
Lampropholis guichenoti	Garden Skink	P	N	WA-
Saiphos equalis	Yellow-bellied Three-toed Skink	P	N	WA-
Tiliqua scincoides	Eastern Blue-tongued Lizard	P	N	WA-
Order: *Squamata* Family: *Varanidae*				
Varanus varius	Lace Monitor	P	N	WA-PSo

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Appendix 2: Flora of the Local Area

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Nomenclature follows Harden (1992, 1993, 2000 and 2002) and subsequent recent revisions.
N/I – Indicates species origin
- N - native to local area
- I - not native to Australia and includes species native to Australia but not to local area
- I? - Likely to be not native to Australia

NSW Status
- U - Unprotected
- P13 - Schedule 13 species (National Parks and Wildlife Act 1975)
- E1 - Endangered (Threatened Species Conservation Act 1995)
- V - Vulnerable (Threatened Species Conservation Act 1995)
- Nx - Indicates species listed as Noxious.

Class: *Cycadopsida*

Scientific Name	Common Name	NSW Status	N/I	Record
Zamiaceae				
Lepidozamia peroffskyana		U	N	WA

Class: *Filicopsida*

Scientific Name	Common Name	NSW Status	N/I	Record
Adiantaceae				
Adiantum aethiopicum	Common Maidenhair	P13	N	WA
Adiantum hispidulum	Rough Maidenhair	P13	N	WA
Cheilanthes austrotenuifolia	Rock Fern	U	N	WA
Cheilanthes sieberi subsp. sieberi	Mulga Fern	U	N	WA
Pellaea falcate	Sickle Fern	U	N	WA
Aspleniaceae				
Asplenium australasicum forma australasicum	Bird's Nest Fern	P13	N	WA
Asplenium nidus		P13	N	WA
Blechnaceae				
Blechnum cartilagineum	Gristle Fern	U	N	WA
Blechnum indicum	Swamp Water Fern	U	N	WA
Doodia aspera	Prickly Rasp Fern	U	N	WA
Doodia caudata		U	N	WA
Cyatheaceae				
Cyathea australis	Rough Treefern	P13	N	WA
Davalliaceae				
Nephrolepis cordifolia	Fishbone Fern	U	N	WA
Dennstaedtiaceae				
Hypolepis muelleri	Harsh Ground Fern	U	N	WA
Pteridium esculentum	Bracken	U	N	WA
Dicksoniaceae				
Calochlaena dubia	Common Ground Fern	U	N	WA
Dicksonia spp.		P13	N	WA
Dryopteridaceae				
Lastreopsis decomposita	Trim Shield Fern	U	N	WA

Class: *Filicopsida* - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Lindsaeaceae				
Lindsaea linearis	Screw Fern	U	N	WA
Ophioglossaceae				
Botrychium australe	Parsley Fern	U	N	WA
Polypodiaceae				
Platycerium bifurcatum	Elkhorn	P13	N	WA
Pyrrosia confluens var. confluens	Horseshoe Felt Fern	U	N	WA
Thelypteridaceae				
Christella dentata		U	N	WA

Class: *Lycopsida*

Scientific Name	Common Name	NSW Status	N/I	Record
Lycopodiaceae				
Lycopodium spp.		U	N	WA

Class: *Magnoliopsida* (*Liliidae*)

Scientific Name	Common Name	NSW Status	N/I	Record
Anthericaceae				
Thysanotus tuberosus	Common Fringe-lily	U	N	WA
Araceae				
Alocasia brisbanensis	Cunjevoi	U	N	WA
Gymnostachys anceps	Settler's Flax	U	N	WA
Arecaceae				
Archontophoenix cunninghamiana	Bangalow Palm	P13	N	WA
Asparagaceae				
Asparagus aethiopicus	Asparagus Fern	U	I	WA
Asteliaceae				
Cordyline stricta	Narrow-leaved Palm Lily	U	N	WA
Colchicaceae				
Wurmbea biglandulosa		U	N	WA
Commelinaceae				
Tradescantia fluminensis	Wandering Jew	U	I	WA
Cyperaceae				
Baumea articulate	Jointed Twig-rush	U	N	WA
Baumea juncea		U	N	WA
Carex appressa	Tall Sedge	U	N	WA
Carex breviculmis		U	N	WA
Carex gaudichaudiana		U	N	WA
Carex longebrachiata	Bergalia Tussock	U	N	WA
Carex maculata		U	N	WA
Cyperus eragrostis	Umbrella Sedge	U	I	WA
Cyperus laevis		U	N	WA

Class: *Magnoliopsida* (*Liliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Cyperaceae - continued				
Cyperus lucidus		U	N	WA
Cyperus trinervis		U	N	WA
Fimbristylis dichotoma	Common Fridge-sedge	U	N	WA
Gahnia aspera	Rough Saw-sedge	U	N	WA
Gahnia clarkei	Tall Saw-sedge	U	N	WA
Gahnia melanocarpa		U	N	WA
Lepidosperma laterale		U	N	WA
Lepidosperma quadrangulatum		U	N	WA
Schoenoplectus mucronatus		U	N	WA
Schoenus apogon	Fluke Bogrush	U	N	WA
Scleria mackaviensis		U	N	WA
Dioscoreaceae				
Dioscorea transversa	Native Yam	U	N	WA
Hydrocharitaceae				
Halophila ovalis		U	N	WA
Hypoxidaceae				
Hypoxis hygrometrica	Golden Weather-grass	U	N	WA
Iridaceae				
Patersonia glabrata		U	N	WA
Juncaceae				
Juncus kraussii subsp. australiensis	Sea Rush	U	N	WA
Juncus mollis		U	N	WA
Juncus pallidus		U	N	WA
Juncus usitatus		U	N	WA
Lomandraceae				
Lomandra elongata		U	N	WA
Lomandra filiformis	Wattle Matt-rush	U	N	WA
Lomandra filiformis subsp. coriacea		U	N	WA
Lomandra filiformis subsp. filiformis		U	N	WA
Lomandra hystrix		U	N	WA
Lomandra longifolia	Spiny-headed Mat-rush	U	N	WA
Lomandra multiflora subsp. multiflora	Many-flowered Mat-rush	U	N	WA
Lomandra spicata		U	N	WA
Luzuriagaceae				
Eustrephus latifolius	Wombat Berry	U	N	WA
Geitonoplesium cymosum	Scrambling Lily	U	N	WA
Orchidaceae				
Caladenia carnea	Pink Fingers	P13	N	WA
Calanthe triplicate	Christmas Orchid	P13	N	WA
Chiloglottis reflexa		P13	N	WA
Chiloglottis spp.		P13	N	WA
Dendrobium tetragonum	Tree Spider Orchid	P13	N	WA
Phaius tankervilliae		E1	N	WA
Plectorrhiza tridentate	Tangle Orchid	P13	N	WA
Pterostylis erecta		P13	N	WA
Pterostylis spp.		P13	N	WA
Philydraceae				
Philydrum lanuginosum	Frogsmouth	U	N	WA

Class: *Magnoliopsida* (*Liliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Phormiaceae				
Dianella caerulea	Blue Flax-lily	U	N	WA
Dianella caerulea var. producta		U	N	WA
Dianella revoluta		U	N	WA
Thelionema caespitosum		U	N	WA
Poaceae				
Andropogon virginicus	Whisky Grass	U	I	WA
Aristida vegans	Threeawn Speargrass	U	N	WA
Austrostipa verticillate	Slender Bamboo Grass	U	N	WA
Axonopus fissifolius	Narrow-leafed Carpet Grass	U	I	WA
Chloris gayana	Rhodes Grass	U	I	WA
Cymbopogon refractus	Barbed Wire Grass	U	N	WA
Cynodon dactylon	Common Couch	U	N	WA
Deyeuxia parviseta		U	N	WA
Dichelachne micrantha	Shorthair Plumegrass	U	N	WA
Digitaria breviglumis		U	N	WA
Digitaria parviflora	Small-flowered Finger Grass	U	N	WA
Echinopogon caespitosus	Bushy Hedgehog-grass	U	N	WA
Echinopogon caespitosus var. caespitosus	Tufted Hedgehog Grass	U	N	WA
Echinopogon ovatus	Forest Hedgehog Grass	U	N	WA
Ehrharta spp.		U	I	WA
Entolasia marginate	Bordered Panic	U	N	WA
Entolasia stricta	Wiry Panic	U	N	WA
Eragrostis brownie	Brown's Lovegrass	U	N	WA
Eragrostis leptostachya	Paddock Lovegrass	U	N	WA
Eragrostis sororia		U	N	WA
Imperata cylindrica var. major	Blady Grass	U	N	WA
Lachnagrostis filiformis		U	N	WA
Microlaena stipoides var. stipoides		U	N	WA
Oplismenus aemulus		U	N	WA
Oplismenus imbecillis		U	N	WA
Ottochloa gracillima		U	N	WA
Panicum lachnophyllum	Don't Panic	U	N	WA
Panicum simile	Two-colour Panic	U	N	WA
Paspalidium distans		U	N	WA
Paspalum dilatatum	Paspalum	U	I	WA
Paspalum orbiculare	Ditch Millet	U	N	WA
Paspalum urvillei	Vasey Grass	U	I	WA
Paspalum wettsteinii	Broad-leaved Paspalum	U	I	WA
Pennisetum clandestinum	Kikuyu Grass	U	I	WA
Phragmites australis	Common Reed	U	N	WA
Poa labillardierei var. labillardierei	Tussock	U	N	WA
Poa sieberiana		U	N	WA
Poa spp.		U	?	WA

Class: *Magnoliopsida* (*Liliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Poaceae - continued				
Setaria pumila	Pale Pigeon Grass	U	I	WA
Setaria spp.		U	I	WA
Sporobolus africanus	Parramatta Grass	U	I,Nx	WA
Sporobolus diander		U	N	WA
Sporobolus virginicus var. minor	Marine Couch	U	N	WA
Stenotaphrum secundatum	Buffalo Grass	U	I	WA
Tetrarrhena juncea	Wiry Ricegrass	U	N	WA
Themeda australis	Kangaroo Grass	U	N	WA
Ripogonaceae				
Ripogonum discolour	Prickly Supplejack	U	N	WA
Smilacaceae				
Smilax australis	Sarsaparilla	U	N	WA
Smilax glyciphylla	Sweet Sarsparilla	U	N	WA
Uvulariaceae				
Tripladenia cunninghamii		U	N	WA
Xanthorrhoeaceae				
Xanthorrhoea johnsonii		U	N	WA
Xanthorrhoea malacophylla		U	N	WA
Typhaceae				
Typha orientalis	Broad-leaved Cumbungi	U	N	WA
Typha spp.		U	N	WA
Zingiberaceae				
Alpinia caerulea	Native Ginger	U	N	WA
Zosteraceae				
Zostera capricorni		U	N	WA

Class: *Magnoliopsida* (*Magnoliidae*)

Scientific Name	Common Name	NSW Status	N/I	Record
Acanthaceae				
Brunoniella australis	Blue Trumpet	U	N	WA
Brunoniella pumilio	Dwarf Blue Trumpet	U	N	WA
Pseuderanthemum variabile	Pastel Flower	U	N	WA
Amaranthaceae				
Alternanthera denticulata	Lesser Joyweed	U	N	WA
Apiaceae				
Centella asiatica	Pennywort	U		WA
Daucus glochidiatus	Native Carrot	U	N	WA
Hydrocotyle acutiloba		U		WA
Hydrocotyle bonariensis		U	I	WA
Hydrocotyle geraniifolia	Forest Pennywort	U	N	WA
Hydrocotyle peduncularis		U	N	WA
Hydrocotyle sp. aff. acutiloba		U	N	WA
Hydrocotyle tripartita	Pennywort	U	N	WA

Class: *Magnoliopsida* (*Magnoliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Apocynaceae				
Alyxia ruscifolia	Prickly Alyxia	U	N	WA
Melodinus australis	Southern Melodinus	U	N	WA
Melodinus guilfoylei	Bellbird Vine	U	N	WA
Parsonsia straminea	Common Silkpod	U	N	WA
Parsonsia velutina		U	N	
Parsonsia ventricosa		U	N	
Tabernaemontana pandacaqui	Banana Bush	U	N	WA
Araliaceae				
Polyscias sambucifolia	Elderberry Panax	U	N	WA
Schefflera actinophylla	Umbrella Tree	U	I	WA
Asclepiadaceae				
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	U	I	WA
Gomphocarpus physocarpus	Balloon Cotton Bush	U	I	WA
Marsdenia lloydii	Corky Marsdenia	U	N	WA
Asteraceae				
Ageratina adenophora	Crofton Weed	U	I,Nx	WA
Ageratum houstonianum		U	I,Nx	WA
Bidens pilosa	Cobbler's Pegs	U	I	WA
Centratherum punctatum subsp. australianum		U	N	WA
Chrysanthemoides monilifera subsp. rotundata	Bitou Bush	U	I,Nx	WA
Cirsium vulgare	Spear Thistle	U	I	WA
Conyza bonariensis	Flaxleaf Fleabane	U	I	WA
Conyza sumatrensis	Tall fleabane	U	I	WA
Enydra fluctuans		U	N	WA
Euchiton gymnocephalus	Creeping Cudweed	U	I	WA
Gamochaeta spicata		U	I	WA
Helichrysum elatum		U	N	WA
Hypochaeris radicata	Catsear	U	I	WA
Lagenifera gracilis	Slender Lagenophora	U	N	WA
Ozothamnus diosmifolius	White Dogwood	U	N	WA
Senecio amygdalifolius		U	N	WA
Senecio diaschides		U	N	WA
Senecio madagascariensis	Fireweed	U	I	WA
Senecio minimus		U	N	WA
Sigesbeckia australiensis		U	N	WA
Sigesbeckia orientalis subsp. orientalis	Indian Weed	U	N	WA
Sonchus oleraceus	Common Sowthistle	U	I	WA
Tagetes minuta	Stinking Roger	U	I	WA
Taraxacum officinale	Dandelion	U	I	WA
Vernonia cinerea		U	N	WA
Avicenniaceae				
Avicennia marina subsp. Australasica	Grey Mangrove	U	N	WA

Class: *Magnoliopsida* (*Magnoliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Bignoniaceae				
Pandorea pandorana	Wonga Wonga Vine	U	N	WA
Casuarinaceae				
Allocasuarina littoralis	Black Sheoak	U	N	WA
Allocasuarina torulosa	Forest Oak	U	N	WA
Casuarina glauca	Swamp Oak	U	N	WA
Celastraceae				
Cassine australis	Red Olive Plum	U	N	WA
Cassine australis var. angustifolia		U		
Cassine australis var. australis	Red Olive-berry	U	N	WA
Maytenus silvestris	Narrow-leaved Orangebark	U	N	WA
Chenopodiaceae				
Salsola tragus 'strobilifera'		U	N	WA
Sarcocornia quinqueflora subsp. quinqueflora		U	N	WA
Clusiaceae				
Hypericum perforatum	St. Johns Wort	U	I,Nx	WA
Convolvulaceae				
Calystegia marginata		U	N	WA
Dichondra repens	Kidney Weed	U	N	WA
Ipomoea cairica		U	I	WA
Ipomoea indica	Blue Morning Glory	U	I	WA
Polymeria calycina		U	N	WA
Cunoniaceae				
Callicoma serratifolia	Black Wattle	U	N	WA
Ceratopetalum gummiferum	Christmas Bush	P13	N	WA
Schizomeria ovata	Crabapple	U	N	WA
Dilleniaceae				
Hibbertia aspera	Rough Guinea Flower	U	N	WA
Hibbertia dentata	Twining Guinea Flower	U	N	WA
Hibbertia diffusa		U	N	WA
Hibbertia empetrifolia subsp. empetrifolia		U	N	WA
Hibbertia scandens	Climbing Guinea Flower	U	N	WA
Hibbertia vestita		U	N	WA
Droseraceae				
Drosera spatulata		U	N	WA
Ebenaceae				
Diospyros australis	Black Plum	U	N	WA
Diospyros pentamera	Myrtle Ebony	U	N	WA
Elaeocarpaceae				
Elaeocarpus obovatus	Hard Quandong	U	N	WA
Elaeocarpus reticulatus	Blueberry Ash	U	N	WA
Epacridaceae				
Leucopogon juniperinus	Prickly Beard-heath	U	N	WA
Trochocarpa laurina	Tree Heath	U	N	WA

Class: *Magnoliopsida* (*Magnoliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Escalloniaceae				
Cuttsia viburnea		U	N	WA
Euphorbiaceae				
Baloghia inophylla	Brush Bloodwood	U	N	WA
Breynia oblongifolia	Coffee Bush	U	N	WA
Claoxylon australe	Brittlewood	U	N	WA
Cleistanthus cunninghamii		U	N	WA
Croton verreauxii	Native Cascarilla	U	N	WA
Drypetes deplanchei subsp. deplanchei	Yellow Tulipwood	U	N	WA
Glochidion ferdinandi var. ferdinandi	Cheese Tree	U	N	WA
Phyllanthus gunnii		U	N	WA
Poranthera microphylla		U	N	WA
Eupomatiaceae				
Eupomatia laurina	Bolwarra	U	N	WA
Fabaceae (Caesalpinioideae)				
Senna septemtrionalis	Arsenic Bush	U	I	WA
Fabaceae (Faboideae)				
Crotalaria lanceolata subsp. lanceolata		U	I	WA
Daviesia genistifolia	Broom Bitter Pea	U	N	WA
Daviesia ulicifolia	Gorse Bitter Pea	U	N	WA
Daviesia umbellulata		U	N	WA
Derris involuta		U	N	WA
Desmodium rhytidophyllum		U	N	WA
Desmodium varians	Slender Tick-trefoil	U	N	WA
Erythrina X sykesii	Coral tree	U	I	WA
Glycine clandestina		U	N	WA
Glycine microphylla		U	N	WA
Hardenbergia violacea	False Sarsaparilla	U	N	WA
Jacksonia scoparia	Dogwood	U	N	WA
Kennedia rubicunda	Red Kennedy Pea	U	N	WA
Platylobium formosum subsp. parviflorum		U	N	WA
Podolobium ilicifolium	Prickly Shaggy Pea	U	N	WA
Pultenaea retusa		U	N	WA
Pultenaea villosa		U	N	WA
Trifolium repens	White Clover	U	I	WA
Trifolium spp.		U	I	WA
Vicia sativa subsp. angustifolia	Narrow-leaved Vetch	U	I	WA
Fabaceae (Mimosoideae)				
Acacia binervata	Two-veined Hickory	U	N	WA
Acacia brownie	Heath Wattle	U	N	WA
Acacia courtii		V	N	WA
Acacia falcata		U	N	WA
Acacia floribunda	White Sally	U	N	WA
Acacia implexa	Hickory Wattle	U	N	WA
Acacia irrorata	Green Wattle	U	N	WA

Class: *Magnoliopsida* (*Magnoliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Fabaceae (Mimosoideae) - continued				
Acacia longifolia		U	N	WA
Acacia longifolia subsp. sophorae	Coastal Wattle	U	N	WA
Acacia longissima	Narrow-leaved Wattle	U	N	WA
Acacia maidenii	Maiden's Wattle	U	N	WA
Acacia melanoxylon	Blackwood	U	N	WA
Acacia myrtifolia	Red-stemmed Wattle	U	N	WA
Acacia ulicifolia	Prickly Moses	U	N	WA
Archidendron grandiflorum	Pink Lace Flower	U	N	WA
Flacourtiaceae				
Scolopia braunii	Flintwood	U	N	WA
Gentianaceae				
Centaurium spicatum	Spike Centaury	U	N	WA
Geraniaceae				
Geranium homeanum		U	N	WA
Geranium solanderi	Native Geranium	U	N	WA
Goodeniaceae				
Dampiera purpurea		U	N	WA
Goodenia hederacea	Ivy Goodenia	U	N	WA
Goodenia stelligera		U	N	WA
Haloragaceae				
Gonocarpus micranthus subsp. ramosissimus		U	N	WA
Gonocarpus tetragynus		U	N	WA
Lamiaceae				
Ajuga australis	Austral Bugle	U	N	WA
Plectranthus parviflorus		U	N	WA
Salvia coccinea		U	I	WA
Westringia amabilis		U	N	WA
Lauraceae				
Cassytha filiformis		U	N	WA
Cassytha glabella		U	N	WA
Cassytha pubescens		U	N	WA
Cinnamomum camphora	Camphor Laurel	U	I	WA
Cryptocarya glaucescens	Jackwood	U	N	WA
Cryptocarya microneura	Murrogun	U	N	WA
Cryptocarya triplinervis	Three-veined Cryptocarya	U	N	WA
Endiandra discolour	Rose Walnut	U	N	WA
Neolitsea dealbata	White Bolly Gum	U	N	WA
Lobeliaceae				
Pratia purpurascens	Whiteroot	U	N	WA
Pratia surrepens	Mud Pratia	U	N	WA
Loganiaceae				
Logania albiflora		U	N	WA
Mitrasacme alsinoides		U	N	WA

Class: *Magnoliopsida* (*Magnoliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Loranthaceae				
Amyema congener subsp. congener		U	N	WA
Amyema pendulum		U	N	WA
Malvaceae				
Sida rhombifolia	Paddy's Lucerne	U	I	WA
Meliaceae				
Synoum glandulosum subsp. glandulosum	Scentless Rosewood	U	N	WA
Menispermaceae				
Stephania japonica var. discolour	Snake Vine	U	N	WA
Monimiaceae				
Wilkiea huegeliana	Veiny Wilkiea	U	N	WA
Moraceae				
Ficus coronata	Creek Sandpaper Fig	U	N	WA
Ficus fraseri	Sandpaper Fig	U	N	WA
Maclura cochinchinensis	Cockspur Thorn	U	N	WA
Myrsinaceae				
Aegiceras corniculatum	River Mangrove	U	N	WA
Embelia australiana		U	N	WA
Rapanea howittiana	Brush Muttonwood	U	N	WA
Rapanea variabilis	Muttonwood	U	N	WA
Myrtaceae				
Acmena smithii	Lilly Pilly	U	N	WA
Acmena smithii var. minor		U	N	WA
Angophora floribunda	Rough-barked Apple	U	N	WA
Angophora subvelutina	Broad-leaved Apple	U	N	WA
Archirhodomyrtus beckleri	Rose Myrtle	U	N	WA
Babingtonia similis		U	N	WA
Backhousia myrtifolia	Grey Myrtle	U	N	WA
Callistemon acuminatus	Tapering-leaved Bottlebrush	U	N	WA
Callistemon salignus	Willow Bottlebrush	U	N	WA
Choricarpia leptopetala	Brush Turpentine	U	N	WA
Corymbia gummifera	Red Bloodwood	U	N	WA
Corymbia intermedia	Pink Bloodwood	U	N	WA
Eucalyptus acmenoides	White Mahogany	U	N	WA
Eucalyptus amplifolia	Cabbage Gum	U	N	WA
Eucalyptus bancrofti	Orange Gum	U	N	WA
Eucalyptus biturbinata		U	N	WA
Eucalyptus carnea	Thick-leaved Mahogany	U	N	WA
Eucalyptus fergusonii subsp. fergusonii		U	N	WA
Eucalyptus globoidea	White Stringybark	U	N	WA
Eucalyptus grandis	Flooded Gum	U	N	WA
Eucalyptus microcorys	Tallowwood	U	N	WA
Eucalyptus pilularis	Blackbutt	U	N	WA
Eucalyptus placita A	Grey Ironbark	U	N	WA

Class: *Magnoliopsida* (*Magnoliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Myrtaceae - continued				
Eucalyptus propinqua	Small-fruited Grey Gum	U	N	WA
Eucalyptus punctata	Grey Gum	U	N	WA
Eucalyptus pyrocarpa	Large-fruited Blackbutt	U	N	WA
Eucalyptus resinifera subsp. resinifera	Red Mahogany	U	N	WA
Eucalyptus robusta	Swamp Mahogany	U	N	WA
Eucalyptus saligna	Sydney Blue Gum	U	N	WA
Eucalyptus seeana	Narrow-leaved Red Gum	U	N	WA
Eucalyptus siderophloia	Grey Ironbark	U	N	WA
Eucalyptus tereticornis	Forest Red Gum	U	N	WA
Euryomyrtus ramosissima subsp. ramosissima		U	N	WA
Gossia bidwillii	Python Tree	U	N	WA
Leptospermum liversidgei		U	N	WA
Leptospermum polygalifolium		U	N	WA
Lophostemon confertus	Brush Box	U	N	WA
Melaleuca biconvexa		V	N	WA
Melaleuca groveana		V	N	WA
Melaleuca linariifolia		U	N	WA
Melaleuca quinquenervia	Broad-leaved Paperbark	U	N	WA
Melaleuca styphelioides	Prickly-leaved Tea Tree	U	N	WA
Rhodamnia rubescens	Scrub Turpentine	U	N	WA
Syncarpia glomulifera	Turpentine	U	N	WA
Syzygium oleosum	Blue Lilly Pilly	U	N	WA
Tristaniopsis laurina	Kanuka	U	N	WA
Oleaceae				
Jasminum volubile		U	N	WA
Ligustrum lucidum	Large-leaved Privet	U	I	WA
Ligustrum sinense	Small-leaved Privet	U	I	WA
Notelaea longifolia	Large Mock-olive	U	N	WA
Notelaea ovata		U	N	WA
Oxalidaceae				
Oxalis corniculata	Creeping Oxalis	U	I	WA
Oxalis exilis		U	N	WA
Passifloraceae				
Passiflora subpeltata	White Passionflower	U	I	WA
Pittosporaceae				
Billardiera scandens var. scandens		U	N	WA
Pittosporum multiflorum	Orange Thorn	U	N	WA
Pittosporum revolutum	Rough Fruit Pittosporum	U	N	WA
Pittosporum undulatum	Sweet Pittosporum	U	N	WA
Plantaginaceae				
Plantago debilis		U	N	WA
Plantago lanceolata	Lamb's Tongues	U	I	WA

Class: *Magnoliopsida* (*Magnoliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Polygalaceae				
Comesperma volubile		U	N	WA
Polygonaceae				
Muehlenbeckia gracillima		U	N	WA
Persicaria strigosa		U	N	WA
Primulaceae				
Anagallis arvensis	Scarlet/Blue Pimpernel	U	I	WA
Proteaceae				
Banksia integrifolia	Coast Banksia	U	N	WA
Grevillea caleyi		E1	N	WA
Hakea archaeoides		V	N	WA
Lomatia silaifolia	Crinkle Bush	P13	N	WA
Persoonia conjuncta		U	N	WA
Persoonia linearis	Narrow-leaved Geebung	U	N	WA
Persoonia sericea		U	N	WA
Persoonia stradbrokensis		U	N	WA
Ranunculaceae				
Clematis aristate	Old Man's Beard	U	N	WA
Clematis glycinoides	Headache Vine	U	N	WA
Ranunculus plebeius		U	N	WA
Rhamnaceae				
Alphitonia excelsa	Red Ash	U	N	WA
Cryptandra propinqua		U	N	WA
Pomaderris ligustrina		U	N	WA
Rosaceae				
Rubus moluccanus var. trilobus	Molucca Bramble	U	N	WA
Rubus parvifolius	Native Raspberry	U	N	WA
Rubiaceae				
Durringtonia paludosa		U	N	WA
Galium propinquum	Maori Bedstraw	U	N	WA
Morinda jasminoides	Sweet Morinda	U	N	WA
Opercularia aspera	Coarse Stinkweed	U	N	WA
Opercularia diphylla		U	N	WA
Pomax umbellata		U	N	WA
Rutaceae				
Acronychia oblongifolia	Common Acronychia	U	N	WA
Zieria smithii	Sandfly Zieria	U	N	WA
Santalaceae				
Exocarpos cupressiformis	Native Cherry	U	N	WA
Sapindaceae				
Alectryon subcinereus	Wild Quince	U	N	WA
Cupaniopsis parvifolia		U	N	WA
Dodonaea triquetra	Large-leaf Hop-bush	U	N	WA

Class: *Magnoliopsida* (*Magnoliidae*) - continued

Scientific Name	Common Name	NSW Status	N/I	Record
Sapindaceae - continued				
Guioa semiglauca		U	N	WA
Jagera pseudorhus var. pseudorhus forma pseudorhus	Foambark Tree	U	N	WA
Rhysotoechia bifoliolata subsp. bifoliolata	Two-leaved Tuckeroo	U	N	WA
Solanaceae				
Nicotiana suaveolens	Native Tobacco	U	N	WA
Physalis minima	Wild Gooseberry	U	N	WA
Physalis peruviana	Cape Gooseberry	U	I	WA
Solanum densevestitum		U	N	WA
Solanum mauritianum	Wild Tobacco Bush	U	I	WA
Sterculiaceae				
Commersonia fraseri	Brush Kurrajong	U	N	WA
Thymelaeaceae				
Pimelea ligustrina		U	N	WA
Pimelea linifolia subsp. linifolia		U	N	WA
Tremandraceae				
Tetratheca thymifolia	Black-eyed Susan	U	N	WA
Ulmaceae				
Trema tomentosa var. viridis	Native Peach	U	N	WA
Verbenaceae				
Clerodendrum floribundum		U	N	WA
Clerodendrum tomentosum	Hairy Clerodendrum	U	N	WA
Lantana camara	Lantana	U	I,Nx	WA
Verbena bonariensis	Purpletop	U	I	WA
Verbena rigida	Veined Verbena	U	I	WA
Verbena spp.		U	I	WA
Violaceae				
Viola betonicifolia	Native Violet	U	N	WA
Viola hederacea	Ivy-leaved Violet	U	N	WA
Vitaceae				
Cayratia clematidea	Slender Grape	U	N	WA
Cissus Antarctica	Water Vine	U	N	WA
Cissus hypoglauca	Giant Water Vine	U	N	WA
Tetrastigma nitens		U	N	WA

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Appendix 3: TSC Act Section 94 Assessment: Significant effect on threatened species, populations or ecological communities, or their habitats

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An assessment under Section 94 of the TSC Act to determine whether an action proposed is likely to significantly affect threatened species, populations or ecological communities, or their habitats, is required when the proposed action is not on land that is critical habitat and the application is not accompanied by a species impact statement. The following is the assessment of impact to species identified in **Section 5.3**, considered likely to have habitat present within the study area.

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

Brown Treecreeper (*Climacteris picumnus*) – Vulnerable
The species is known to utilise woodlands and forests dominated by *Eucalyptus* spp., especially rough barked species, usually in communities with a sparse but grassy understorey, but not with a dense woody understorey (Higgins *et al*. 2001). Breeding typically takes place in a small horizontal hollow (Higgins *et al*. 2001). Open habitats within the study area have been created by road construction and forestry activities, reducing the tree density and age structure of the original forests. Habitats with older trees are located in areas that are infrequently logged. These areas have a dense understorey, and it is unlikely the species breeds within these habitats. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Glossy Black-Cockatoo (*Calyptorhynchus lathami*) – Vulnerable
This species was not recorded within the study area, either directly through observation or indirectly through evidence of foraging. The Glossy Black-cockatoo is dependant on the presence of *Allocasuarina* species as it is a specialist forager of the seeds of these species. Given that the species breeds during autumn and winter, and assuming the species would be foraging nearby, it is expected the characteristic discarded remains of *Allocasuarina* sp. follicles would be present. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Swift Parrot (*Lathamus discolor*) – Vulnerable
The Swift Parrot breeds in Tasmania and migrates to the mainland, arriving in region mainly by April, but as early as January. The species returns for the breeding season starting in spring, with some birds noted in November in the region (Higgins 1999). The proposed development will not interfere with the breeding of the species. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Square-tailed Kite (*Lophoictinia isura*) – Vulnerable
This species was not recorded within the study area. No large raptor nests were observed. It is therefore unlikely that a viable local population is reliant on habitats adjacent to the existing highway.

Barking Owl (*Ninox connivens*) – Vulnerable
The Barking Owl did not respond to the playback of territorial calls and was not observed within the study area. It is unlikely the species utilises the study area in any significant way. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Powerful Owl (*Ninox strenua*) – Vulnerable
It is unlikely the species utilises the study area. Breeding usually takes place from mid-autumn to mid-winter in a large tree within forest (Higgins 1999). Large trees with hollows are limited in the study area and adjacent forests as a result of past forestry activities. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Masked Owl (*Tyto novaehollandiae*) – Vulnerable
It is unlikely the species utilises the study area significantly. No trees with vertical spouts, the preferred nest site of the Masked Owl (Higgins 1999), were observed within the study area. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Spotted-tailed Quoll (*Dasyurus maculatus*) – Vulnerable
This species was not recorded within the study area. There are no potential den sites within the study area and it is therefore unlikely the species utilises the study area significantly. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Little Bentwing-bat (*Miniopterus australis*) – Vulnerable
The Little Bent-wing Bat requires specific nursery sites in subterranean locations to raise young, the southern-most being in the Macleay River catchment (Dwyer 1998a), approximately 100 km to the north of the study area. There are no subterranean habitats within the study area that would be utilised for roosting, apart from minor culverts. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Eastern Bentwing-bat (*Miniopterus schreibersii* oceanensis) – Vulnerable
The roost sites for this species includes underground mine workings, caves, stormwater culverts and occasionally buildings, however nursery caves have specific temperature and humidity regimes (Dwyer 1998b). There are no subterranean habitats within the study area that would be utilised for roosting, apart from culverts and bridges. However the proposed development will require the construction of additional structures, rather than the loss of roosting habitat. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Eastern Freetail-bat (*Mormopterus norfolkensis*) – Vulnerable
The species mainly roosts in trees, although it has been know to utilise man-made structures (Allison and Hoye 1998). There is unlikely to be a significant reduction compared to the hollows and dead trees located in the protected riparian habitats within the Forest NSW estate. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade if the removal of trees with hollows takes place outside of the breeding period.

Greater Broad-nosed Bat (*Scoteanax rueppellii*) – Vulnerable
The species has no significant habitat within the area potentially impacted by the proposed route. Habitat is limited to riparian vegetation, and less than 20 m of riparian habitat associated with Cutty Creek and Herons Creek may be affected by the proposed development. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Grey-headed Flying-fox (*Pteropus poliocephalus*) – Vulnerable
This species is particularly dependant on wintering camps (NSW Scientific Committee 2001). No camps, including abandoned camps typified by canopy branches stripped of foliage, were identified within the study area. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Yellow-bellied Glider (*Petaurus australis*) – Vulnerable
There are few trees with potential den sites within the proposed highway upgrade footprint as a result of forestry activity and road construction. It is unlikely the species would spend a significant amount of time in the habitats near the Pacific Highway due the light, noise and movement of vehicles. It is therefore unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Squirrel Glider (*Petaurus norfolcensis*) – Vulnerable
There are few trees with potential den sites within the proposed highway upgrade footprint as a result of forestry activity and road construction. It is unlikely the species will utilise hollows near the existing Pacific Highway due to disturbance from vehicles, while the width of the existing highway is unlikely to impede the movement of the species in the local area. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Brush-tailed Phascogale (*Phascogale tapoatafa*) – Vulnerable
The species will utilise tree hollows, stumps and even globular bird nests during the day (Soderquist 1998). There are few trees with hollows within the study area; however there are some larger trees with hollow development outside of the study area associated with protected riparian habitat. The species is unlikely to utilise habitats near the existing highway due to the risk collision of collision with vehicles, particularly during the dispersal phase of the species life cycle, in spring (Soderquist 1998). It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Koala (*Phascolarctos cinereus*) – Vulnerable
This species was not observed within the study area, however there is a record within the study area (Forests NSW) and many records from within adjacent Forests NSW estate. There is potential for the species to utilise the study area when moving between known habitats. The habitat utilisation is likely to be low. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

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

The following Endangered Population occurs within the North Coast Bioregion:

- *Dromaius novaehollandiae* Emu population in the NSW North Coast Bioregion and Port Stephens LGA.

Emus have been recorded within the North Coast Bioregion within the Port Stephens LGA and north of Coffs Harbour. The species has not been recorded with the Port Macquarie-Hastings LGA and was not observed during the present study. The Emu population in the NSW North Coast Bioregion and Port Stephens LGA will not be impacted by the proposed highway upgrade.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

The following endangered ecological communities listed under Schedule 3 of the TSC Act occur within the North Coast Bioregion:

- Byron Bay Dwarf Graminoid Clay Heath Community.
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions.

- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.
- Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions.
- Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions.
- Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion.
- Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps Bioregions.
- River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.
- Subtropical Coastal Floodplain Forest of the NSW North Coast Bioregion Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions.
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.
- *Themeda* grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney basin and South East Corner Bioregions.

None of the listed endangered ecological communities were identified within the study area.

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

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

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

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

Brown Treecreeper (*Climacteris picumnus*) – Vulnerable
The species is known to utilise woodlands and forests dominated by *Eucalyptus* spp., especially rough barked species, usually in communities with a sparse but grassy understorey, but not with a dense woody understorey (Higgins *et al*. 2001). Open habitats within the study area have been created by road construction and forestry activities reducing the tree density and age structure of the original forests and are potentially foraging habitat. Forestry activities have created similar habitats throughout the local area. It is unlikely there will be an adverse effect to the life cycle of a viable population by the proposed highway upgrade.

Glossy Black-Cockatoo (*Calyptorhynchus lathami*) – Vulnerable
The Glossy Black-Cockatoo is dependant on the presence of *Allocasuarina* species as it is a specialist forager of the seeds of these species. The Glossy Black-Cockatoo prefers woodland that has mature *Allocasuarina* as an understorey below *Angophora* and *Eucalyptus*, *Allocasuarina* spp. lined watercourses and stony ridges. Nesting occurs in a hollow of a tall tree that can be living or dead (Higgins 1999). Potential foraging habitat, in the form of Black Oak (*Allocasuarina littoralis*), is present within the study area. The majority of the Black Oak, including patches dominated by the species, is located within roadside regeneration or near the present intersection of Bago Road and the northbound carriageway of the Pacific Highway. The Black Oak near Bago Road is not within the footprint of the proposed highway upgrade. No

significant potential breeding habitat was identified within the footprint of the proposed highway upgrade. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Swift Parrot (*Lathamus discolor*) -Endangered
In the region it is known to inhabit forests and woodlands dominated by Blackbutt (*E. pilularis*), Spotted Gum (*Corymbia maculata*) and Swamp Mahogany (*E. robusta*). The species mostly feeds on nectar, also consuming sugar exuding insects and sometimes seed (Higgins 1999). An insignificant amount of Blackbutt will be removed as part of the proposed development. Most trees are relatively young due to forestry activities and past road construction and are unlikely to constitute a significant foraging resource. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Square-tailed Kite (*Lophoictinia isura*) – Vulnerable
In NSW the habitats preferred by the Square-tailed Kite are typically ridge and gully habitats, dominated by *Eucalyptus longifolia*, *Corymbia maculata*, *E. elata* and *E. smithii*, with a shrubby understorey. While dominant tree species are absent, there is a mosaic of canopy densities and areas with shrubby understories. The species' hunting technique is to dive on smaller birds in the open from high perches at the edge of forests and woodlands (Higgins 1993a), and it is possible that forestry operations have benefited the species by creating open areas within forests. However, the hunting technique would make the species vulnerable to colliding with vehicles along the existing highway. The clearing is highly unlikely to isolate the species from moving between habitats as the species occurs in landscapes with a mosaic of woodland and open areas, where they feed on passerines, foliage insects and small terrestrial vertebrates (Marchant and Higgins 1993). The proposed widening is unlikely to increase the potential for collisions between the species and vehicles if the traffic volume does not increase. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Barking Owl (*Ninox connivens*) – Vulnerable
The habitat for the Barking Owl includes areas containing many large trees for roosting and breeding within dry sclerophyll forest and woodlands, and also partly cleared land including farmland (Marchant and Higgins 1993). The riparian habitat adjacent to the study area is potential habitat for the Barking Owl. However, it is within protected areas outside of the footprint of the proposed highway upgrade. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Powerful Owl (*Ninox strenua*) – Vulnerable
The Powerful Owl inhabits dry sclerophyll forests and woodland, often with dense forest nearby (Higgins 1999). The roost is usually in closed forest and nesting usually occurs in large living *Eucalyptus* species trees. The species specialises on feeding on medium to large arboreal prey. The forestry activities are likely to have substantially reduced the number of hollows for arboreal prey and therefore it is unlikely that the study area or adjacent habitats, with the exception of protected riparian habitats, have a significant arboreal mammal population. It is unlikely that the removal of relatively young trees is important to the long-term survival of the species in the locality.

Masked Owl (*Tyto novaehollandiae*) – Vulnerable
Prey items are mainly terrestrial mammals. Most records are within 300 m of lowland sclerophyll forest, lowland forest and valley floor forest (Higgins 1999). The potential for foraging within the study area is reduced by the modification of the habitats from forestry and road construction activities. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Spotted-tailed Quoll (*Dasyurus maculatus*) – Vulnerable
The Spotted-tailed Quoll is a partly arboreal and is a mostly nocturnal species inhabiting a wide variety of habitats, including woodlands (Edgar and Belcher 1998). Den sites include caves, crevices and also hollow logs. The species is unlikely to have den sites within the study area sue to past forestry activities, including fire hazard reduction, is likely to remove fallen timber. The construction of the proposed northbound carriageway is unlikely to further isolate a potential population through increased mortality resulting from collision, as traffic volumes will not increase simply as a result of the construction of the proposed southbound carriageway. Local traffic will be diverted to the existing northbound carriageway, resulting in a decrease in traffic volume for the proposed local traffic section of road. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Little Bentwing-bat (*Miniopterus australis*) – Vulnerable
The Little Bent-wing Bat roosts in subterranean locations (Dwyer 1998a). With the exception of pipes managing flows below the Pacific Highway and the Herons Creek bridge, there is no roosting habitat within the study area. An additional culvert and bridge will be constructed will be as part of the proposed highway upgrade. The species forages under the canopy of dense forest and woodlands (Dwyer 1998a), and therefore will potentially forage within the study area. However the foraging habitat is insignificant in terms of the area of similar and forested habitat that exists within the adjacent Forests NSW estate. The foraging habitat of the species will not be isolated, as the clearing of a strip of woodland will not restrict the flight to the species. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Eastern Bentwing-bat (*Miniopterus schreibersii* oceanensis) – Vulnerable
The roost sites for this species includes underground mine workings, caves, stormwater culverts and occasionally buildings (Dwyer 1998b). With the exception of pipes managing flows below the Pacific Highway and the Herons Creek bridge, there is no roosting habitat within the study area. An additional culvert and bridge will be constructed will be as part of the proposed highway upgrade. However the foraging habitat is insignificant in terms of the area of similar and forested habitat that exists within the adjacent Forests NSW estate. The foraging habitat of the species will not be isolated, as the clearing of a strip of woodland will not restrict the flight to the species. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Eastern Freetail-bat (*Mormopterus norfolkensis*) – Vulnerable
Little is known about the habitat preferences for this species. However it is assumed to include dry sclerophyll forest and woodland east of the Great Dividing Range (Churchill 1998). It has also been recorded in rainforests, flying over a creek (Allison and Hoye 1998). It mainly roosts in trees, although it has been know to utilise manmade structures (Allison and Hoye 1998). There are potential roosts and foraging habitat within the study area. Trees and dead trees with hollow development were observed within the study area, however all were observed outside of the footprint of the proposed highway upgrade. The foraging habitat is insignificant in terms of the area of similar and forested habitat that exists within the adjacent Forests NSW estate. The foraging habitat of the species will not be isolated, as the clearing of a strip of woodland will not restrict the flight to the species. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Greater Broad-nosed Bat (*Scoteanax rueppellii*) – Vulnerable
The species has no significant habitat within the area potentially affected by the proposed development. Habitat is limited to riparian vegetation, potentially used for foraging, Less than 20 m of riparian habitat associated with Cutty Creek and Herons Creek may be affected by the proposed development .The foraging habitat of the species will not be isolated, as the clearing of a strip of woodland will not restrict the flight to the species. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Grey-headed Flying-fox (*Pteropus poliocephalus*) – Vulnerable
The species forages on a wide variety of flowers and fruits, such as figs, palms (Tidemann 1998) and commercial crops as well as nectar and pollen from flowering Myrtaceous species including *E. microcorys* (Eby 1995, cited in Benson and McDougall 1997). Tallowwood (*E. microcorys*) is common within the study area and therefore the species is likely to forage within and adjacent to the study area where similar vegetation communities occur. However the foraging habitat is insignificant in terms of the area of similar and forested habitat that exists within the adjacent Forests NSW estate. The foraging habitat of the species will not be isolated, as the clearing of a strip of woodland will not restrict the flight to the species. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Yellow-bellied Glider (*Petaurus australis*) – Vulnerable
This species inhabits tall, mature wet eucalypt forest, where it mainly forages on eucalypt sap and insect exudates, while eucalypt blossom, arthropods and pollen provide important nutriment (Russell 1998). Sap is obtained by scarring the trunk of a tree (Russell 1998). Tree species within the study area that are known for obtaining sap include *Eucalyptus pilularis* and *Eucalyptus saligna* (NPWS 2003). Diurnal dens are usually hollows in large living smooth barked *Eucalyptus* spp. (Russell 1998). Habitat for the species is present near the study area, particularly within the protected riparian habitats where trees can mature to form hollows. However, disturbance as a result of earlier highway works and logging means it is unlikely that this species occurs close to the Pacific Highway. Therefore the proposed widening of the highway to accommodate the proposed northbound carriageway is unlikely to reduce foraging or denning opportunities for the species, or expose the species to an increased risk from predators or collision with vehicles as the trees on either side of the road are relatively young.

Squirrel Glider (*Petaurus norfolcensis*) – Vulnerable
This species was not recorded within the study area. The Squirrel Glider utilises dry sclerophyll habitats and woodlands where it dens in tree hollows. It feeds on insects, nectar, pollen, sugary insect exudates and sap (Suckling 1998). There is potential foraging and breeding habitat near but not in the study area. The widening of the highway to accommodate the proposed northbound carriageway is unlikely to reduce foraging or denning opportunities for the species, or expose the species to an increased risk from predators or collision with vehicles as the trees on either side of the road are relatively young.

Brush-tailed Phascogale (*Phascogale tapoatafa*) – Vulnerable
The Brush-tailed Phascogale is mainly arboreal, feeding on nectar, insects, spiders, small vertebrates and ants in large trees (Soderquist 1998). Mating and the raising of young take place in a tree hollow (Soderquist 1998). The species will utilise tree hollows, stumps and even globular bird nests during the day (Soderquist 1998). The construction of the proposed northbound carriageway is unlikely to further isolate a potential population of the species, as the species is presently forced to move terrestrially across the existing highway, the species is presently. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

Koala (*Phascolarctos cinereus*) – Vulnerable
Known foraging species for the Koala that occur within the study area include Tallowwood (*E. microcorys*) (Schedule 2, SEPP 44). While there are many records of the Koala in the local area, the area of habitat types to be removed is insignificant compared to the less modified, but more extensive habitats found in the adjacent Forests NSW estate. The construction of the proposed northbound carriageway is unlikely to further isolate a potential Koala population, as traffic volumes will remain the same after construction. It is unlikely the potential habitat to be removed or modified is important to the long-term survival of the species in the locality.

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

No declared critical habitat will be affected by the proposed highway upgrade, either directly or indirectly.

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

The only finalised recovery plan prepared for a threatened species that potentially may occur within 10 km of the proposed highway upgrade is for the Yellow-bellied Glider (NPWS 2003b). Some of the actions listed in the recovery plan are:

- To reduce edge effects, minimise foraging distances, increase types of resources available and reduce the linear nature of habitat; and
- Ensure that appropriate consideration is given in the design of roads and easement corridors, and to consider mitigation measures, such suspended crossings, where linear gaps as narrow as 50 m are created when retention of vegetation is not possible.

The combination of low trees and widening of the road reduces the distance gliders can travel through the air. As the Pacific Highway is a major transport route, there is a high potential for the species to collide with vehicles. However, the condition of the vegetation along the Highway is such that this species is unlikely to occur in the vicinity of the Highway and the likelihood of gliders attempting to cross the Highway is low. Minimisation of vegetation clearing will assist in maintaining glide paths for this species. Monitoring for the presence of gliders will provide indications of whether further mitigation measures are required.

There are also three recovery plans that are pending finalisation, these being for:

- the Barking Owl;
- large forest owls; and
- the Koala.

Barking Owl

The recovery plan for the Barking Owl includes the objective of undertaking threat abatement and mitigation. Threats to the species include clearing, removal of dead wood, competition with feral honey bees and collision with vehicles (NPWS 2003c). The proposed clearing is unlikely to remove a significant area of owl habitat, as no trees with suitable hollows were observed in areas to be cleared. Traffic volumes, while potentially increasing as a result of regional growth, are unlikely to increase solely as a result of the proposed highway upgrade. Therefore it is unlikely the species will be placed at greater risk from collision with vehicles.

Large forest owls

Two of the species that are included within the recovery plan for large forest owls, the Powerful Owl and the Masked Owl, may potentially utilise the study area. A specific recovery objective is to reduce clearing in large forest owl habitat (DEC 2005). The proposed clearing is unlikely to reduce the breeding opportunities for both species, or habitat for species that are hunted by these owls.

Koala

The recovery plan for the Koala includes the objective of the development of appropriate road design in Koala habitat (NPWS 2003d). An action by the NSW DEC is to create a register of Koala black spots and recommend appropriate management measures to reduce the incidence of death or injury to koalas from collision with vehicles (DEC 2003d). Another action is to advise

that new roads avoid known Koala habitat (DEC 2003d). The proposed highway upgrade, while involving the widening of the highway corridor, is not considered a new road and the risk of collision involving the species in not likely to significantly increase.

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

The following three Key Threatening Processes (KTP) will operate or may increase as a result of the proposed highway upgrade:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.
- Removal of dead wood and dead trees.

In addition, the invasion, establishment and spread of Lantana is the subject of a preliminary determination. Each of these KTPs is discussed below in the context of the proposed highway upgrade.

Clearing of native vegetation (Final Determination)

The clearing of native vegetation may result in the loss of local populations of individual species, and is the major cause of the loss of biological diversity. For species of restricted distribution, clearing of native vegetation may result in total extinction, for more widespread species there may be loss of local genotypes (NSW Scientific Committee 2004a). Processes that may result from the clearing of native vegetation are discussed below.

Fragmentation

The proposed highway upgrade will result in the fragmentation of the remnant between the existing northbound and southbound carriageways for the construction of the proposed diamond interchange. There will be a further fragmentation resulting from the construction of the Bobs Creek Road access. The clearing will reduce the habitat for terrestrial fauna. There is unlikely to be a significant terrestrial fauna diversity in these areas as the habitats have already been simplified by past forestry and road construction activities. It is unlikely that the proposed clearing will result in the extinction of any species presently occurring within the remnant due to a stochastic event.

Expansion of dryland salinity

There is no evidence of salinity, for example scalding or areas that are dominated by salt tolerant plant species, within or adjacent to the study area. It is unlikely that there will be an expansion of dryland salinity as a result of the proposed highway upgrade.

Riparian zone degradation

The riparian zones within the study area are restricted to intermittently flowing drainages with minor pooling. Herons Creek has already been degraded by sedimentation caused by agricultural run-off, while the proposed crossing of Cutty Creek has been degraded by previous road construction. It is unlikely there will be a significant degradation in water quality as a result of the proposed road construction if standard sediment capture practices are used.

Increased greenhouse gas emissions

It is unlikely the proposed development will result in a significant increase in greenhouse emissions, or result in the significant reduction of absorption of greenhouse gases.

Increased habitat for invasive species

There is the potential for invasive species to increase in diversity and density within the areas presently dominated by native species adjacent to the existing road where exotic species are

present, and also in some forested areas where weeds such as Lantana are presently in low density. Careful management of the soil and proposed roadside vegetation will be required to reduce the potential of the further spread of exotic species in areas presently dominated by native species.

Loss of leaf litter layer

There will be a loss of leaf litter in the area of road pavement and shoulders of the proposed highway upgrade. There will be some accumulation of leaf litter in areas where regeneration or landscaping allows a modified tree and shrub community to develop. It should be noted that much of the land within the study area presently has little leaf litter as a result of forestry activity for management of fire fuel.

Loss or disruption of ecological function

A loss of native ecological function may occur in areas developed for the road pavement and adjacent areas where low grasses and herbaceous species will be managed by slashing. These areas tend to have increased exotic species density and diversity. Some ecological function can be potentially retained by the use of species that provide a foraging resource to animals, for example profusely flowering eucalypt species that are naturally endemic to an area that also assist the dispersal of animals and pollen.

Changes to soil biota

The clearing for the proposed highway upgrade is likely to result in changes to the soil biota, including the removal of most macro invertebrates in areas under the road pavement, to a reduction in organisms where the surface has been reshaped and to a lesser extent where only the vegetation has been cleared.

Invasion of native plant communities by exotic perennial grasses (Final Determination)

Some species of exotic grasses have vigorous growth, prolific seed production and effective seed dispersal, enabling many exotic perennial grasses to compete strongly with, or in some places displace, native vegetation (NSW Scientific Committee 2004b). The final determination notes that the dense monocultures of perennial grasses that develop after invasion threaten local vegetation, potentially resulting in local and regional declines of many native species and communities. Disturbances that may lead to the establishment of invasive perennial exotic grasses species include road works and management of roadside areas.

Invasive perennial grasses that were observed within the study area and are listed as species that invade native plant communities include Whisky Grass (*Andropogon virginicus*), Rhodes Grass (*Chloris gayana*), and Kikuyu (*Pennisetum clandestinum*), particularly near Herons Creek. If these species are controlled prior to earth works that may assist in the spread of these species, and that invasive exotic perennial grass not be used in revegetation works it is unlikely that this KTP will result as of the proposed highway upgrade.

Removal of dead wood and dead trees (Final Determination)

Woody debris and standing dead trees are an important component of the structure of forest and woodland and helps determine the habitat value for a wide range of fauna, with 120 species of vertebrate in NSW dependant on tree hollows for breeding or denning (NSW Scientific Committee 2004c). The Final Determination for the Removal of dead wood and dead trees reviews the impacts of the removing standing dead trees and woody debris on the ground. The impacts include the reduction of the availability of hollows over time and the input of material to the litter layer. This process is exacerbated by the failure of regeneration of these plant communities and the resulting reduction in natural accumulation of dead wood. Dead wood provides habitat for many insect species, which in turn form important components of the diet of many species, such as birds (Fitri and Ford 1997). The proposed highway upgrade will result in the removal of some woody debris; however the majority of the study area is managed for fire fuel reduction, while much of existing easement is typified by young tree and shrub regeneration

that has not reacted a stage where woody debris have accumulated. The proposed highway widening will not result in the significant reduction of woody debris.

Invasion, establishment and spread of Lantana (Lantana camara L. sens. lat) (Preliminary Determination)

The 'Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. lat)' has been proposed as a Key Threatening Process (NSW Scientific Committee 2006). Lantana is thought to be allelopathic, able to inhibit or suppress by chemical means the germination and/or growth of other plant species. The preliminary determination notes that eucalypt seedlings generally fail to establish under Lantana, thereby allowing Lantana to form dense thickets due to reduced competition. The thickets may adversely affect the richness of some soil faunal assemblages, for example ants, and provide habitat for declared vermin and other pests.

While the proposed highway upgrade will not involve the planting of Lantana, there is the potential for the spread of the species in disturbed areas through the movement of soil containing stem and seed material and the competitive advantage Lantana within forest may gain from increased light penetration from clearing adjacent trees. Lantana will have to be controlled within the reserve to ensure that this species is not allowed to create infestations and be a source of invasion for adjacent lands.

Herons Creek to Stills Road

Review of Environmental Factors – Appendix G

Aboriginal and Historic Heritage Assessment

January 2007

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Aboriginal and Historic Heritage Assessment – Proposed Upgrade of Pacific Highway, Herons Creek to Stills Road NSW

19 July 2006

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Aboriginal and Historic Heritage Assessment – Proposed Upgrade of Pacific Highway, Herons Creek to Stills Road NSW

19 July 2006

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This document was prepared for the sole use of the Roads and Traffic Authority and the regulatory agencies that are directly involved in this project, the only intended beneficiaries of our work. No other party should rely on the information contained herein without the prior written consent of HLA-Envirosciences Pty Limited and the Roads and Traffic Authority.

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PLATES

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Plate 2: Northern end of transect 1 looking west. This photograph overlooks the southern alluvial flat of Herons Creek (delineated by the vegetation to the right of the photograph), which is considered to be a PAD due to the high potential for subsurface deposits

Plate 3: The northern end of transect 1 looking northwest towards Herons Creek Bridge (H38) This concrete beam bridge has been identified as of historical interest by Navin Officer (2001)

Plate 4: Herons Creek Bridge, H38, looking east. The deposits in the foreground, largely multiple silty fluvial sediments, are considered a PAD. Herons Creek is just out of photograph to the left

Plate 5: Transect 2 looking south. The Pacific Highway is out of photograph to the left and Herons Creek is behind the camera. The area in the foreground is an alluvial flat of Herons Creek, while an older alluvial flat (with the house situated upon it) is evident in the background. Both have been identified as a PAD

Plate 6: A section of the older alluvial flat pictured in **Plate 5**. This section, looking south towards Herons Creek Road, reveals an *in situ* podsol composed of an organic clayey loam dark brown A horizon overlying a bleached Ae (or A2) horizon overlying an orange clay B horizon. The preservation of this soil, which can take substantial time to form, has been identified as a PAD

Plate 7: Switchboard tree stump located on the corner of Herons Creek Road and Pacific Highway was identified by Navin Officer (2001) as a historical relic. It is identified in this study as H36

Plate 8: Transect 3 looking north. This area has been heavily modified by roads and stopping bays as is demonstrated here

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Plate 21: Transect 5 looking east. Soil profiles in this location revealed a typical truncated duplex soil

Plate 22: Transect 5 looking southeast. While visibility was low in this location, the area has been repeatedly logged and substantial impacts (through road construction and logging) have occurred
Plate 23: Transect 10 looking southeast. In many locations surrounding Bago Road, clear evidence of truncated clay orange B horizons are evident, indicating substantial erosion and reduction of any subsurface potential

APPENDICES

Appendix A: Consultation Log and Aboriginal Community Statements.
Appendix B: AHIMS Site Search information.

1 INTRODUCTION

The Roads and Traffic Authority (RTA) is upgrading the Pacific Highway between the F3 Freeway and the Queensland Border. As part of this upgrade, the RTA has commissioned HLA-Envirosciences Pty Ltd (HLA) to prepare a Review of Environmental Factors for the section of the route between Herons Creek Road to Stills Road, Heron's Creek. The area is located in the Hastings – Port Macquarie LGA.

A Review of Environmental Factors (REF) is required for the proposed upgrade to fulfil the requirements of Part 5 of the *Environmental Planning and Assessment Act* (1979), and to take into account all matters affecting or likely to affect the environment as a result of the proposed development. A key aspect of the REF is the Aboriginal and European heritage, which HLA presents here.

The report provides information about the nature of any Indigenous and European archaeological issues within the development area, identify the development impacts (if any) on these sites, and to provide management recommendations. This was done through:

- validation of known sites and/or items within the study area through the relevant register searches and archaeological survey;
- conducting an archaeological survey of the study area to locate any additional sites and/or items;
- assessing the study area to delineate any areas of high archaeological sensitivity or potential;
- consulting with the relevant local Aboriginal community groups;
- assessing the historical context of the site, and identifying whether any previous heritage surveys have been carried out;
- assessing the impacts of the proposed construction on any known archaeological materials and areas of archaeological potential within the study area;
- assessing the significance of any archaeological material identified; and
- presenting recommendations for the management and/or mitigation of construction impact to the archaeological resource identified.

This study has been undertaken to the standards outlined in the following documents:

- the NSW Department of Environment (formerly National Parks and Wildlife Service) *Aboriginal Cultural Heritage Standards and Guidelines Kit* (1997);
- the DEC *Aboriginal Cultural Heritage and the Integrated Development Assessment Guidelines* (2000);
- the DEC *Interim Community Consultation Requirements for Applicants* (2005); and
- the Heritage Office *Heritage Manual* (1996) Guidelines.

1.1 Study Area

The proposed development extends for approximately 3.3 km along the Pacific Highway between Herons Creek and Stills Road. The area is located approximately 58 km north of Taree and approximately 19 km south of Port Macquarie.

The study area is predominantly located within the Burrawan State Forest with the main feature being the existing separated northbound and southbound carriageways of the Pacific Highway. The North Coast Railway is located to the west of the Pacific Highway at a minimum distance of approximately 170 m, north of the Herons Creek crossing. The village of Herons Creek is located approximately 400 m south of the Herons Creek crossing. It consists of small residential landholdings, the Boral Timber Mill and a number of rural properties to the northwest and east.

The vegetation present within the local area is consistent with a wet sclerophyll forest with large Eucalyptus spp. over 40 m in height and a soft-leaved understorey, consisting of Bracken (*Pteridium esculentum*) and Soft Tree Ferns (*Dicksonia antarctica*). The vegetation has been disturbed to varying extents from road construction and forestry practices. However some areas (for example, in the middle and along western side of the median) remain relatively intact with little evidence of encroachment by weeds such as Small-leaf Privet (*Ligustrum sinense*) and Crofton Weed (*Ageratina adenophora*).

The area likely to be affected by the proposed development is crossed by two watercourses, Herons Creek and Cutty Creek. Herons Creek is located at the southern-most extent of the proposed development, with Cutty Creek located further to the north, approximately 700 m north of the intersection of Bago Road. There are also many unnamed natural and artificial drainage lines within the study area. The study area is located within an area of moderate to gentle undulating slopes with a deep depression associated with Cutty Creek.

1.2 Description of Proposed Development

The section of the highway between Herons Creek and Stills Road is currently dual carriageway. The northbound carriageway was previously a section of the Pacific Highway a two-way two-lane section of the highway and is on a poor horizontal and vertical alignment. It became the northbound carriageway when the southbound carriageway was constructed in the 1980s. The existing speed limit on this section of the Pacific Highway is 100 km/hour in both directions, increasing to 110 km/hour to the north of the section.

The Proposal consists of the construction of a new northbound carriageway within the existing variable width median area, parallel to the existing southbound carriageway. Much of the existing northbound carriageway would become a two-way local service road, linking Bago Road, Burrawan Forest Drive (west), Herons Creek Public School and local properties to the proposed grade separated interchange south of Bago Road.

The upgrade of the Pacific Highway for this section could be undertaken in stages. The proposed development would be designed for 110 km/h travel speed and would provide a high standard four-lane dual carriageway. The carriageways would be separated by a 12 m median that would allow the future addition of an extra two lanes on each carriageway if required.

1.3 Study Team

The survey was undertaken by Alan Williams and Cornelia de Rochefort, Archaeologists between 30 and 31 November 2005. The HLA archaeologists were accompanied by Trevor Roberts of the Bunyah LALC (refer to **Section 2** below for more detail). Cornelia de Rochefort and Alan Williams undertook the research and report components, while Jakub Czastka provided technical review. Tom Farrell undertook Peer Review with administrative and drafting support from Kim Wilkinson and Tim Osborne.

1.4 Report Structure

The report structure outlines the sections of the report and their contribution to the study.

Section 2 of this report outlines the Aboriginal community consultation and involvement undertaken for the project, with details of the consultation log and community statements provided in **Appendix A**. **Section 3** summarises the regional archaeological and environmental context for the assessment of the study area that was obtained through background research. This review specifically targets known sites within the area, past reports and landscape evolution. **Section 4** outlines the methods used to undertake the field survey. **Section 5** provides the results of the archaeological survey and assessment of the study area. It then combines the results of the background research and site survey to provide a predictive model of archaeological potential for the site. **Section 6** provides the results of the archaeological potential and historic assessment undertaken using the results and the model. **Section 7** provides a summary of the statutory controls relevant to the project and provides recommendations and management options based on these controls. This management strategy also identifies any additional issues raised by Aboriginal community group representatives, and incorporates these issues where possible. **Section 8** lists the references used in preparing the report.

A summary of the statutory requirements regarding Aboriginal heritage is provided in **Section 7.1**. This is based on experience with the heritage system in NSW and does not purport to be legal advice. It should be noted that legislation, regulations and guidelines change over time and users of the report should satisfy themselves that the statutory requirements have not changed since the report was written.

1.5 Limitations

This assessment is based on the existing environmental and archaeological knowledge of the study area, within the larger context of the Port Macquarie region. If previously recorded surface archaeological materials are found within the immediate locality, they are identified and discussed. This discussion has been based on the reports prepared by others (as cited in this report) and HLA has relied on these reports and has not sought to independently verify the results and interpretations in these reports.

Predictions have been made about the probability of subsurface archaeological materials occurring within the study area. It is possible that materials may occur in any landscape context, and the assessment of subsurface materials refers to the likelihood of occurrence based on surface indications and environmental context.

HLA has undertaken a search of the Aboriginal Heritage Information Management System (AHIMS) held within the Department of Environment and Conservation (DEC). The search results are provided in **Appendix B**.

As stated in the qualifying letter from the Acting AHIMS Administrator, Register searches are constrained by the amount of data in the register and the quality of that data (for example grid references can be inaccurate). Large areas of NSW may not have been systematically searched and may contain Aboriginal objects and other heritage values not recorded on AHIMS.

In addition, the AHIMS reports database can only be searched by the title of the report, which may not indicate the geographical location of the area covered. This means that it is possible that some known sites and some reports may have been omitted from this study. Sites and reports are added and removed from AHIMS and therefore the accuracy of information provided from AHIMS is only valid on the day the register is searched and to the nature of the search.

2 ABORIGINAL COMMUNITY CONSULTATION

In response to two recent Land and Environment Court (LEC) rulings (Carriage v Stockland Development Pty Ltd (No 4) [2004] NSWLEC 3553 and Williams v The Director General of the Department of Environment and Conservation v Ors [2004] NSWLEC 613), the Department of Environment & Conservation (DEC) has developed the *Interim Community Consultation Requirements for Applicants* (DEC, 1 January 2005). These new requirements have expanded and developed on the current guidelines (*Aboriginal Cultural Heritage Standards and Guidelines*, DEC 1997), making the consultation process longer and more thorough.

For this reason HLA undertook the following steps with regard to this project:

- Contacted the Northeast Environment Protection and Regulations Division of DEC (Northeast EPRD) for advice on the relevant Aboriginal stakeholders;
- Contacted the Bunyah LALC to identify their interest in the project and any relevant Aboriginal groups;
- Contacted Port Macquarie - Hastings Council;
- Searched the Native Title Tribunal to identify possible Native Title holders;
- Searched the Office of Registrar of Aboriginal Corporations; and
- Through the RTA, advertised in the *Port Macquarie News, Camden Haven Courier, Port Macquarie Express, Hastings Gazette, National Indigenous Times,* and *Koori Mail* newspapers between the end of September and early November 2005, allowing 10 days for registrations of interest.

Initial consultation was undertaken with Mike Dibbs of the Bunyah LALC. He was asked to identify their interest in the project and advise HLA of other relevant Aboriginal individuals or communities in the area. He sought to be involved in the project and was provided with a copy of HLA's survey methodology on which to comment.

HLA received a letter from Northeast EPRD on 30 August 2005 identifying no additional groups in the Hastings region.

The Native Title Search revealed no existing claims or land use agreements. No response was received from the Office of the Registrar DEC.

The newspaper advertisements led to a number of registrations of interest, specifically from Edward Moran (Ananawan Gundungarra Elders), Gordon Brown, and Deirdre Alley. The LALC was also keen to participate in the project. Hence, each of these individuals or groups was sent the proposed survey methodology for comment in early November 2005.

Following the expiration of the methodology comment period, HLA contacted each of the groups and advised them of the proposed fieldwork dates. Only Bunyah LALC provided a response to HLA's invitation to attend the fieldwork.

The fieldwork was undertaken on 30 and 31 November 2005 between Herons Creek and Stills Road with Trevor Roberts of the Bunyah LALC .

At the completion of the survey, discussions between HLA and the Bunyah LALC did not identify any major issues in regards to Aboriginal sites or places, although discussions with Bunyah LALC did reveal concerns in regards to potential Aboriginal heritage over the southern parts of Herons Creek.
Details of all community consultation that was undertaken as part of this project can be found in **Appendix A**.

3 BACKGROUND RESEARCH

The background research section has been split into the following areas: environmental context, historical overview, previously recorded sites, geotechnical context and regional archaeological context.

3.1 Environmental Context

Soils form through a variety of processes, predominantly diagenesis (the breakdown of bedrock into soil) and pedogenesis (the development of diagenetic material into soils), but can be highly diverse due to varying conditions such as climate, topography, parent material, organisms and time. The natural chemical and physical constitution of the soil is also impacted by the underlying rock, with grain size, clay minerals, plant nutrients, and the retention capacity of the soil affected. Soil characteristics such as depth and erodibility, as well as the natural processes that affect these features, impact upon the detection of archaeological evidence within the landscape.

Soil analysis has important ramifications for archaeological research through the potential impact of different soils on human activity (such as agricultural exploitation) and the impact of the soils on archaeological evidence (such as post-depositional movement). The soils known to occur throughout the study area are identified here in order to delineate their nature and potential impact on the survival and location of archaeological material.

The Herons Creek study area lies within the Hastings river catchment, Port Macquarie district. The soils of the study area have mostly formed on the Triassic sediments and volcanics of the Lorne Basin. These comprise red and grey mudstones, lithic sandstones, and conglomerates, tuffaceous sandstones, felsic volcanic and minor coal units that form part of the Camden Haven Group. The study area traverses two main soil groups; Burrawan and Herons Creek. The Burrawan soil landscape occurs on low undulating hills with broad crests and drainage depressions on lithic sandstones and conglomerates of the Lorne Basin. Local relief is 10-30 m and slopes are 5-10%. Well drained red or brown Kurosols are found on crests with depths of 50-200 cm, while red Kandosols are found on flats with depths >200 cm. These hard setting soils are strongly acidic, sodic, erodible and susceptible to gully erosion. The Herons Creek soil landscape consists of a narrow to moderately broad floodplain and low terrace surfaces. Local relief is <10 m, elevation is <100 m and slopes are <5%. Soil types are usually red and brown Kandosols, greater than 300 cm in depth and gravely stratic Rudosols (alluvial soils), generally 50-200 cm in depth (Arup 2004).

The region surrounding Herons Creek consists of two vegetation communities, Tall open Coastal Blackbutt Forest and Dry Tallowwood Forest. The former vegetation community is dominated by Blackbutt. Other canopy species include She-oaks (*Casuarina spp.*), Bloodwoods (*Corymbia spp.*), Rough barked Apple (*Angophora floribunda*), Smooth Barked Apple (*Angophora costata*), White mahogany (*E. acmenoides*) and Tallowwood. Understoreys typically contain Gorse Bitter Pea (*D. ulicifolia*), while ground strata generally consist of *Lomandra sp.* and Kangaroo Grass (*Themeda australis*). Dry Tallowwood forest is more common along the survey route and is classified as dry open forest dominated by Tallowwood. Other canopy species include Blackbutt, Red Iron bark, Grey Gum, White Stringybark (*E. globoidea*) and Pink Bloodwood. Understorey shrub species include *Leptospermum sp., Acacia sp.* and Narrow-leaved Geebung. Again, common ground stratum species are Kangaroo Grass and *Lomandra sp.* (Harrington *et al.* 2004). There is significant weed infestation, particularly adjacent to the roadside, with substantial dense weedy growth dominated by Lantana.

3.2 Aboriginal History

The Herons Creek to Stills road study area is located within the tribal territory of the Ngamba people (Tindale 1974). This territory stretched from Telegraph point south to the Manning River at Taree, east to the Pacific Ocean and west to Comboyne. Again, information regarding the socio-economic practices of Aborigines of New South Wales has been captured in the writings of early settlers and explorers. Captain Cook had sighted Aborigines and smoke from their campfires on the Camden haven in 1770 (CHHS 1991:7) and, while travelling down the Hastings, Oxley (1820:310) noted that the "numerous smokes arising from native fires announced a country well inhabited." Oxley made contact with Aboriginal people at Kings Creek near Wauchope, where two Aboriginal persons in a canoe crossed over the creek to the exploring party. Oxley gave them a tomahawk after "detaining" the canoe (Oxley 1820:327). Oxley's (1820:328) exploratory journeys in 1818 throughout the region noted that the natives along the northern shores of Queens Lake "seem very numerous". He also noted many large canoes, reporting that one canoe was "significantly large to hold nine men" (Oxley 1820:328). According to notes left by Lt. Parker King, Aboriginal huts on the Hastings were more substantial than those built further south. The huts had domed roofs, an entry on the sheltered side away from the sea winds, and were capable of holding 8-10 people (Rogers 1982:38) Oxley (1820:332) reported finding similar bark huts along the shores of Queens Lake on the Camden Haven.

Like most other areas along the coast of NSW, Aborigines used the normal array of material equipment, including wooden spears, clubs, shields, boomerangs, digging sticks, bowls, stone tools and fibre nets and bags. In the Hastings region, composite fishing spears barbed with bone points were used as well as fishing lines attached to shell hooks (Collins 1995a). Foodstuffs included the usual array of aquatic resources including shellfish and fish, while Fitzpatrick (1914:43) wrote that the principal foods eaten by Aborigines included, turtle, possum, koala, kangaroo rat, lizards, flying fox, echidna and diamond snake, the latter two listed as having been considered a great delicacy.

Similar to the Manning Valley, the Hastings region also appears to have consisted of relatively semi-settled populations, with major river corridors serving as a focus of activity (Belshaw 1978). Oxley (1820:315,328) wrote that numerous Aborigines occupied both the coastal area and the upper Hastings Valley, while Collins' (1995) collation of available ethnographic data adds to this interpretation by arguing that Aborigines were present throughout all parts of the river valleys through the year. According to Collins (1995*a*), this ethnographic data dispels the large-scale seasonal movement theory of McBryde (1974, 1976), whereby population movements are argued to have occurred on a seasonal basis, with groups spending winter in the foothills and the warmer months at the coast. Coleman (1982:4) argues that original patterns of movement within the coastal zone of NSW consisted of inter-tribal movements occurring parallel to the coastline rather than from coast to inland. However, contrary to this view Collins (1995) argues that the ethnographic accounts of Howitt (1904) and Breton (1833:234) show links between people of the Hastings and Liverpool Plains, and groups from the Hastings are said to have travelled to the Tablelands for ceremonial purposes. In summary, Aboriginal groups of the North Coastal NSW region consisted of potentially large populations supported along the coastline and major river corridors. Intra-tribal and inter-tribal communication and movements appear to have been important for ceremonial reasons, within the contact era, and possibly for economic purposes as well.

Following initial exploration, sustained and unavoidable contact with Europeans was effected in 1821 with the establishment of Port Macquarie as a penal settlement and hostility closely followed the appropriation of Aboriginal land. The result was often violent conflict, reduction in tribal size and a consequent weakening in Aboriginal social and economic sustainability (Collins 1995*a*). Unlike in the Manning Valley, where hostilities between local tribes and European settlers resulted in massacres and killings, hostile events are generally not recorded in local oral

history or official records of the Camden Haven region south of Port Macquarie. Instead, Aboriginal people appear to have resided on unofficial encampments and fringe settlements, seeking work from local industries and towns and subsistence from food rations and bush foods (Navin Officer 2001).

3.3 European History

In 1818 Surveyor-General John Oxley led an expedition to trace the course of the Macquarie River and to search for the much-anticipated yet elusive Australian inland sea. It was during this expedition that the Hastings River and its inlet were discovered. Oxley's overland expedition, travelling south from the Hastings in the same year, discovered the Camden Haven and Manning River valleys. Oxley named the Hastings inlet 'Port Macquarie' and reported back favourably to the Governor regarding the potential suitability for settlement of this location. The following year Governor Macquarie sent John Oxley back to this area, accompanied by Phillip Parker King, with orders for them to extensively survey the area to the east of the mouth of the Hastings and report on the nature of its potential. This survey confirmed Oxley's initial observations on the area as a potentially favourable port, as it featured a wide and safe harbour and fertile lands with timber, in addition to coal and flint resources being located nearby (Griffin and Howell 1996: 1-2; McLachlan 2002: 27-40).

Acting swiftly, Lachlan Macquarie decided that this new port would be settled, and wrote to Earl Bathurst:

> *19th July 1819.*
> *Port Macquarie will be of great advantage as a place of banishment, from hence the present place of banishment [Newcastle] being too near to Sydney as it enables criminals sent thither to effect their escape back to this place…Port Macquarie will further be useful because of the good timber it will afford.*
> (Macquarie 1819)

Finally, following a period of upheaval based on Governor Macquarie's retirement, Francis Allman and 60 convicts settled Port Macquarie in March 1821. As early as the mid 1820s, shell from surrounding regions such as Queens Lake was being burnt for the manufacture of lime for the building program at Port Macquarie (CHHS 1997). The settlement was initially ephemeral and close to the shore, where provisions, stores and tools could be unloaded (Rogers 1982). However, by 1822 a substantial settlement had been constructed that included public buildings such as the Commandant's residence, barracks, Chief Constable's residence, provision store, granary, guard house. Temporary bark huts for up to 300 convicts were also constructed (Rogers 1982). By 1826 the settlement had grown to over 1,500 people.

In 1830 Port Macquarie was opened to free settlement. One of the first settlers was Captain Archibald Clunes Innes who settled at Lake Burrawan (re-named Lake Innes) some six miles (10km) from the town (McLachlan 2002). However, by the 1840s depression the previous influx of free settlers had declined and the town only retained some 1,000 people, less than in the convict days (Griffin and Howell 1996).

The first outlying villages of the region appeared in the 1850s and 1860s to meet the needs of farming communities. Of the several villages located in the north of the Hastings region, Wauchope emerged as the dominant town. As the timber industry grew the town began to rival Port Macquarie as the regional centre (Turner 1990:11). Further south the towns of the Camden Haven area were generally later in development, and prior to the 1860s the region is likely to have served as a southern outpost of Port Macquarie, with the timber cutting, bush grazing and lime burning industries facilitating only a low level of occupation (Navin Officer 2001). The nature of the environment made it unsuitable for sheep and early agriculture focused on

dairying, beef and maize production. As in the Manning valley district, dairying became a significant local industry in the late nineteenth century (HO & DUAP 1996).

The most successful and long standing industry of the region is timber cutting. Cedar cutters were amongst the first Europeans to access the Camden Haven-Hastings hinterland and by far the most important economic activity within the study area up to the modern day has been logging and saw milling (HO & DUAP 1996). In the Hastings region the timber industry became increasingly important after 1870, a period which witnessed growing colonial demand for timber for housing and for hardwoods for use as railway sleepers. By the 1880s there were two mills in operation at Hamilton and Rawdon Island, the former described in 1882 as the largest mill south of the Maria River. Further south in the Camden Haven area, the first mill was started in 1873 by Joseph Laurie and his brothers. This subsequently grew into Laurieton. The Fagan brothers and Shipman and Fitzmaurice set up mills further inland, contributing to the town of Camden Haven (later Kendall), and Dunn and Bogan opened a mill close to the river mouth. Other mills followed and by the turn of the century the area was one of the busiest producers of hardwood in the State (Turner 1990:14).

The settlement of Herons Creek was established by timber cutters in 1890. The area's surrounding timber resources were quickly exploited and early logging involved hauling mill logs and girders to Bobs Creek Wharf for transport to Laurieton. Herons Creek and Kendall were connected via a wooden rail tramline, which included branch lines to other parts of the forest. The early settlement of Herons Creek consisted of a series of small selections with grasslands maintained for supporting bullock teams, while the first house was built by George William Crane on the bank of the creek in 1850 (Navin Officer 2001). By 1915 Alf Noon had established a saw mill at Herons Creek. By 1920 two saw mills, those of Noon and Brown and 'Browns Mill', had amalgamated to form Herons Creek Timber Mills Ltd (Fenning 1997). In the 1920s the area immediately north of Herons Creek along the current proposed development route became dedicated state forest, with intensive logging practices involving the complete removal of tree stands in the region. In fact every tree in the Burrawan State Forest today is a regrowth tree, with the oldest trees being no older then 90 years. Logging has been continuing in the study area on a rotational basis every 10 years for the past 50 years (John Fullton, State Forests NSW, pers. comm.).

Transportation has played a major role in determining the pattern of settlement and development within the greater Hastings area. Sea transport, which colonists thought would offer easy access to Port Macquarie, proved difficult due to sailing ships being frequently delayed, damaged, or lost seeking to negotiate the Port Macquarie bar (McLachlan 2002). As such, with the opening of the region to free settlement, the first settlers travelling to Port Macquarie proceeded overland, travelling along what was to become the Great North Road. The original route to Port Macquarie from the Manning Valley involved crossing the Manning and then Lansdowne Rivers, after which travellers turned east along South and Middle Brother Mountains to arrive at Watson Taylors Lake. After crossing the Camden Haven River, travellers followed the southern base of the North Brother Mountain, eventually reaching the soldiers outpost, located south of Laureiton. During the convict era, soldiers were stationed there to prevent convict runaways from reaching the Manning and Port Stephens. After crossing the arm of Queens Lake, travellers could either journey along the coast or turn inland along the western shores of Lake Innes (CHHS 1997:12).

In 1839 Governor Phillips, recognising the need for access to the Great Dividing Range, directed James Ralfe to survey a road between New England and the Hastings. The road was eventually completed by convict gangs under the command of Colonel Charles Gray in 1842. However, the road was never easy and it was abandoned after the withdrawal of the last of the convict labourers in 1847(Turner 1990). Major transformations to the local economy were ushered in with the addition of Wauchope to the North Coast Railway in 1915, linking the region to more southerly districts of NSW. In 1917 the railway reached Kempsey making it possible for

travellers and freight to connect with Queensland Railways (Turner 1990:12). Between 1928 and 1933 the Oxley highway was constructed along the old New England Road, linking the Hastings with the interior once more. Under the direction of the NSW Main Roads Board the Pacific Highway was gradually improved, benefiting industry and commerce of the region (Turner 1990:12).

3.4 Archaeological Context

The archaeological background section outlines the known Aboriginal and historic sites and other studies undertaken in the area. This section will then provide site predictions for the study area in question.

3.4.1 Aboriginal Sites surrounding the Study Area

HLA undertook a search of the AHIMS for all sites within a 20 km radius surrounding the development area on 18 August 2005. This revealed a total of 62[1] previously recorded archaeological sites within the region). Of these, approximately 31 (50%) of the recorded sites are defined as open camp sites comprising stone artefacts and isolated finds. The remaining archaeological sites are shelter sites with associated middens (14.2% - 8 sites), scarred trees (11.1% -7 sites), stone arrangements (3.2% - 2 sites), a natural mythological site (1.5% - 1 site), a burial (1.5% - 1 site), a ceremonial site (1.5% - 1 site), and 11 (17%) un- denominated.

Sites within the region are generally located 2 to 10 km away from the proposed development area. However, sites #30-6-0149 an artefact scatter and # 30-9-0146 a scarred tree, are located directly within the proposed highway upgrade impact zone.

3.4.2 Regional Aboriginal Context

To provide a more comprehensive review of the nature of the local archaeology in the region a summary of previous archaeological investigations undertaken within the vicinity of the study area is provided.

Historically, archaeological investigation within the Hastings Shire, and particularly in the Port Macquarie region, has been limited with little systematic research or comprehensive archaeological site survey work being conducted. However, with the upgrading of the Pacific highway, archaeological research has been generated in what was previously an archaeologically unknown area.

Collins (1997a, 1998a, 1999a, 2000) has conducted numerous surveys relating to the Pacific Highway upgrade. In 1997, one artefact scatter was identified near Coopernook Creek and in 1999 a subsurface testing program on the northern bank of the Lansdowne River recovered five stone artefacts. Similar results were obtained by Collins' other studies, where an archaeological assessment of the Taree to Coopernook Bypass identified no Aboriginal sites and one PAD near Ghinni Ghinni Creek in 1998. The subsequent sub-surface testing program only uncovered three stone artefacts.
In 1980, a stone arrangement consisting of three earth mounds topped with stones was located by the Forestry Commission at Herons Creek, a few kilometres south-west of the present study area. This was reported to the NPWS (NPWS #30-6-24) and the area excluded from logging. The site is included in the Forestry Department's Kendall Management Area and Management Plan. Another important site known as the North Brother Mythological Site (NPWS #30-3-23) is

[1] It should be noted that while 62 Aboriginal sites were identified, a number of these are multiple different site types. Hence, the discussion of site types may have a different number to the actual number of Aboriginal sites.

located approximately 15 km south of Herons Creek. Studies conducted at Middle Brother Mountain by Dean-Jones (1989) did not identify any Aboriginal sites in a survey for a proposed UHF/VHF transmitting station, while Navin (1992) also did not identify any sites in the course of a survey for a proposed hard rock quarry on Middle Brother Mountain.

The paucity of artefactual material in the region is a common factor, with many studies failing to locate any sites at all (Brayshaw 1977; Coleman 1981; Haglund 1982; Happ and Bowdler 1983; Bell 1983; Bonhomme 1986; Dean-Jones 1988; Comber 1990; Collins 1999b). Byrne (1990) also failed to locate any sites, although his was a preliminary predictive study, with only a small field component. His survey related to a water pipeline and water storage facilities, located close to the present study area. Similarly, Bonhomme's (1988a) survey for a proposed residential subdivision at Laurieton did not discover any archaeological sites. However, Sullivan's (1995 cited in Navin Officer 2001) revision of the study area recorded two scarred trees and one isolated find. In 1983, Happ and Bowdler (1983a) located an open artefact scatter and midden site near Bonny Hills, approximately 10 km east of the present study area and Coleman (1981) recorded three middens and a scarred tree at Laurieton, approximately 15 km south east of the present study area. Archaeological investigations conducted in the Kew region near Herons Creek by Collins (1995b) identified one scarred tree in an 18 ha area, while subsequent studies near Queens Lake (Collins 1997b) and at the Kew Kendall Sewerage Treatment Plant north east of Kew, approximately 500 m east of the Pacific Highway (Collins 1998b), identified no Aboriginal sites.

The overall low site density is unusual. As previously stated, the Port Macquarie region would have provided great ecological diversity suitable to Aboriginal lifestyle. The area would have supported a relatively high density Aboriginal population, as did the rest of the coast of New South Wales. Poor ground visibility and land clearance might account for this lack of recorded sites. Each of the above surveys reported poor ground visibility and, as Byrne (1990) stated, "...the area (is) one of the most difficult in Australia vis a vis site detectability." Land clearance in relation to agriculture and logging may also have destroyed and/or seriously disturbed many sites, making their detection difficult.

3.4.3 Historic Sites Searches

Heritage registers at State and Commonwealth level were searched to ascertain whether known historic sites or landscapes were listed within the study area. The results are presented below.

3.4.3.1 Register of the National Estate

A search of the Register was conducted for the Hastings - Port Macquarie LGA. No heritage items are listed on the Register within the proposed development area. The nearby Middle Brother Mountain is listed on the Register as an indicative place for its natural rather than cultural significance.

3.4.3.2 State Heritage Registers

The State Heritage Register and Inventory are administered by the NSW Heritage Office. Items on the register are protected by the *NSW Heritage Act* (1977), while items on the inventory generally come from the region's LEP and are protected under guidelines in this planning instrument (outlined in **Sections 3.4.3.3** and **3.4.3.4**). There are no heritage items listed under the Heritage Act for the Herons Creek to Stills Road study area.

3.4.3.3 National Trust Register

No items within the proposed study area are classified or listed on the Trust Register.

3.4.3.4 Port Macquarie-Hastings Local Environmental Plan (LEP)

No heritage items are listed on the Port Macquarie-Hastings LEP (2005) within the study area.

3.4.4 Regional Historical Context

In order to provide a more comprehensive review of the nature of the local historical archaeology in the region, a summary is presented below of previous archaeological and historical investigations undertaken within the vicinity of the two study areas.

The Municipality of Hastings Heritage Study (MHHS 1991) identified a number of historical themes that have shaped the region. These are early exploration and settlement; Port Macquarie's unique convict experience; pastoral and agricultural diversification and expansion; the transport network; mining; and urban development and industrialisation (Turner 1990). This thematic study identified some important phases in the development of the region, specifically the early penal settlement, changes in modes of transportation, the timber industry and twentieth century commercial dairying. All of these developments have had an important impact on the pattern and course of settlement. The various towns and surrounding districts still retain structures, buildings and material evidence that reflect these underlying trends, and as part of the MHHS (1991) an archaeological assessment was carried out in the area by Consultant Archaeological Services (Higginbotham 1990) in order to review the relationships between the historic themes of the region and the physical remains that represent those themes.

The establishment of Port Macquarie as a penal settlement is one of the most significant aspects of the history of the area. Associated heritage items consist mostly of built heritage items such as remains of the penal settlement, the old general cemetery, convict built drains and wells, the former hospital and St Thomas' Church. Historically, transportation has played a significant role in determining settlement patterns and development within the region. Shipping and river transport remained a significant mode of transportation into the twentieth century, while major effects on the local economy were facilitated with the arrival of the railway line at Wauchope in 1915. Items that represent the maritime significance of the area include training walls at Camden Haven and Hastings River, Pilot stations at Port Macquarie and Camden Haven, and boatsheds. A comprehensive survey of railway bridges was not carried out as part of the MHHS, with only a goods shed and the station master's cottage at Wauchope having been identified as significant. Later transportation developments include the Pacific and Oxley Highways (MHHS 1991:12). The alignment of the early Oxley Highway has been documented, while there is also evidence of remnants of early stone pitched embankments, which are believed to date from the early twentieth century. While a comprehensive survey of road bridges has not been carried out, the bridges at Ralfes Creek, Yarras and Kindee are considered to be excellent examples of differing bridge construction techniques that were used in the early twentieth century (MHHS 1991:13).

Evidence of the timber industry includes mill sites and associated infrastructure. Timber mill sites are located in the areas of Wauchope, Bellangry, Kendall, Telegraph Point and Sancrox. The alignment of the former tramway for hauling timber from the forest to the mill near Kendall has been recorded, although no physical trace was found. A range of extractive industries were also assessed in the archaeological heritage survey. No remains of the sand mining industry have been identified. The most significant representative sites are the former gold mine at Cells Creek and a tin mine at Rolands Plains (Higginbotham 1990; MHHS 1991).

3.5 Synthesis and Archaeological Predictions

3.5.1 Aboriginal

From the details of the archaeological investigations provided above, a synthesis on the nature of the archaeological context of the greater Herons Creek region can be constructed. Archaeological characteristics such as location and distribution of sites within landscape units, site type, site integrity, and stone artefact density can be deduced. These features are necessary for determining the survey methodology to be undertaken, and for predicting the nature of site types and site distribution within the study area.

It seems clear that a number of factors are important in site location. Patterns of site location according to terrain and vegetation were described by Klaver and Heffernan's (1991) Greater Taree Heritage Study, which indicated that:

- 70% were located in flat terrain, predominantly in coastal heath, and also along estuarine stream bank corridors, woodland, dry sclerophyll eucalypt forest and in subtropical rainforest;
- 19% were located in undulating to hilly terrain either in dry sclerophyll eucalypt forest, along estuarine stream bank corridors, or in coastal heath;
- 8% of sites were found in rugged terrain, predominantly in dry sclerophyll eucalypt forest; and
- 3% were found in highly to steep terrain.

These factors agree with most of the research above and reveal that sites are likely to occur close to permanent water sources, located predominantly within flat terrain. Estuarine stream bank corridors and coastal heath vegetation communities form the predominant association with the occurrence of archaeological sites, indicating that the predominance of archaeological sites within the north of NSW occur along the coast.

Archaeological studies to date indicate that the densest and most diverse archaeological remains are generally found along the coast owing to the diverse nature of the coastal resource base. However, the Hastings region also appears to have consisted of relatively semi-settled populations, with major river corridors serving as a focus of activity. Furthermore, according to available ethnographic data, Aborigines appear to have been present throughout all parts of the river valleys throughout the year (**see Section 3.2.**). Therefore it should be recognised that the archaeological site patterning within the study area will to a degree reflect sampling bias, whereby the likelihood of actually finding archaeological sites within the area is low, owing to poor ground surface visibility and site integrity.

The entire study area has been subject to extensive logging, which precludes the likelihood of finding any archaeological sites. Furthermore, previously recorded site distributions within the study area will also reflect the likely down slope movement of archaeological remains from higher slopes into lower lying catchment areas. Down slope movement in the study area is primarily caused by erosion processes (sheet wash, gullying and scouring), resulting in the removal of A horizon sediments and the *in situ* archaeological remains. The end result of this process is the location of archaeological sites, such as stone artefacts, in lower areas amongst disturbed A and B horizon sediments. Indeed, floodplains and low lying flat areas have been demonstrated as potential locations for archaeological sites within the area.

If sites are present within the study area, they most likely would be open artefact or flaked stone scatters. Carved or scarred trees, although rare, may be located within the study area. Rock shelters, engraving or art sites, or axe-grinding grooves are not expected because the survey

area lacks surface exposures of sandstone or limestone. Earth mounds and/or stone arrangements may be present. However, the likelihood of them surviving logging operations is low. The narrowness of the study area may also preclude the possibility of finding sites.

3.5.2 Historic

Section 3.4.4 outlined the historic themes which have shaped the development of the Hastings district. Historic structures and material evidence which are reflective of these themes are likely to be focused around early centres and corridors of occupation. These include the settlements of Herons Creek and Port Macquarie districts, and the road corridors which connected these settlements. The main historic items that are likely to occur will be related to early settlement and the timber, agricultural and extractive industries. Historic sites relating to these aforementioned themes which may be present within the study area are:

- timber mills and associated structures and dwellings such as selector's and timber- getter huts, remains of machinery, tracks, tramways and spring board tree notches;
- road bridges;
- agricultural and industrial sites such as dairies, factories and quarries;
- remains of former structures and dwellings such as houses, huts and homesteads;
- remains of agricultural features such as old fence lines, drainage channels and ridge and furrow plough lands;
- old transport and access routes, such as old highway alignments and stock routes; and
- moveable heritage, which includes domestic artefacts such as pottery and bottles, and agricultural and industrial implements and equipment.

4 SURVEY METHODOLOGY

This section details the field methodology employed and the results of the survey and analysis.

4.1 Survey and Terrain Mapping Methodology

The aim of the field survey was to identify the archaeological sensitivity of the study area. This assessment was determined by the criteria outlined below in **Section 4.2.**

The presence or absence of archaeological materials and the terrain features and integrity of sites were documented using a specifically designed recording form (see **Table 1**). A range of environmental attributes affects the detection of archaeological material during site surveys. Some of these features are vegetation cover, soil type and presence of naturally occurring surface rock. Ground surface visibility is a major influence of artefact detection. The nature (i.e. size, colour, material type) of the archaeological material also affects the effectiveness of the field survey. To assess the reliability of the survey results the following features were recorded for the site. The range of attributes relating to each of these environmental features across the site is reproduced on the next page. Terminology for all landscape descriptions was obtained from McDonald *et al.* (1998).

- Landform unit;
- Environmental setting within landform unit;
- Fall of slope along transect;
- Type of vegetation cover;
- Visibility levels measured as percentage of soil surface visible per transect;
- Type of ground exposure, i.e. erosion or disturbance from mining activities;
- Frequency of exposures, i.e. number in each transect;
- Size of exposures;
- Depth of soil erosion;
- Soil type and profile level exposed;
- Evidence of downslope movement of soil and rock particles;
- Presence of naturally occurring rock suitable for artefact production; and
- Presence of archaeological material.

Photography was used to document the environmental and archaeological features of the survey area.

Table 1: Terrain Recording Form

Survey Area							
AMG Reference	Start……			End……			
Landform Unit	Crest		Ridge			Hillock	
	Simple Slope		Upper Slope			Mid Slope	
	Lower Slope		Flat			Open Depression	
	Closed Depression		Stream 1st	2nd	3rd	4th	
Slope	Level		Very Gently Inclined			Gently Inclined	
	Moderately Inclined		Steep			Very Steep	
Exposure	Eroded		Aggraded			Human Action	
Geomorphological Agent	*Gravity:*	Collapse		Particle Fall			
	Precipitation:	Soil Creep		Mass Movement		Sheet Wash	
	Stream Flow:	Overbank	Channelled	Flood		Watertable	
	Biological	Human		Animal			
Human Action:	Road	Residential	Earthworks	Industrial		Pastoral	
	Other……						
Level of Disturbance	1	2	3	4	5	6	7	8
Exposure	No. of exposures……			Exposure area……			
Soil Type			L				
Soil Profile Exposed	Exposed:	A	A2	B	C	Vertical Profile:	Yes	No
Geology							
Locally Available Material	Silcrete	Mudstone	Quartz	Tuff		Quartzite	
	Chert	FGS	Pet Wood	Sandstone			
Vegetation	Tall = trees>10m		Mid= shrubs+trees<10m			Low= grasses	
Groundcover	Dense= 70%		Mid-dense=30-70%			Sparse=10-30%	
	Very sparse= 10%		None				
Stone Artefacts	Absent	Present	Number……				
Raw Materials Used	Silcrete	Mudstone	Quartz	Tuff		Quartzite	
	Chert	FGS	Pet Wood	Sandstone			

Most of the categories on this recording sheet are self-explanatory with the exception of levels of disturbance and fall of slope, which require a key to the rating system. Levels of disturbance and fall of slope were classified according to the criteria listed below. This key, along with the following guide to the soils in the local landscapes, was printed on the reverse of each recording form to assist with consistency in the identification of these features.

Level of disturbance criteria

0) No effective disturbance

1) No effective disturbance except for hoofed animals

2) Limited clearing

3) Extensive clearing

4) Complete clearing: pasture but not cultivated

5) Complete clearing: pasture cultivated at some stage

6) Cultivation, rain fed

7) Cultivation, irrigated

8) Highly disturbed, eg. mining, urban development, road

Fall of slope criteria

A guide to the slope classes covered by the landform units present in the study area can be obtained from McDonald *et al* (1998:37).

- Moderately inclined slopes = 10% to 32% range
- Gently inclined slopes = 3% to 10% range
- Very gently inclined slopes = 1% to 3% range
- Level <1%

Summary

The aim of the survey and recording methodology was to divide the surveyed site into landscape zones and areas of land use that reflect the potential for archaeological material to exist in these sections. This data would then be assessed against the background information on the site and used to produce archaeological sensitivity areas for the site (see **Section 5** and **Figure 4**).

4.2 Archaeological Potential

The archaeological potential of the study area, both Aboriginal and historic, was assessed on four criteria:

- the presence of known surface archaeological materials;
- the probability of undetected surface archaeological materials;
- the probability of subsurface archaeological materials; and
- the terrain integrity of each transect area.

The presence or absence of surface archaeological materials and the level of effective ground surface visibility were documented during the field survey. The probability of additional surface artefacts occurring was based on these attributes. The assessment of the subsurface

archaeological potential of the study area was based on the known patterning of archaeological materials in the respective regions and field observations of the environmental characteristics and terrain integrity. These characteristics included the availability of stone materials, proximity to water resources, soil depth and landform unit.

A summary of the data recorded for each transect is presented using the following categories:

- variability of landscape (low, medium or high);
- visibility levels (low, medium or high);
- conditions for artefact detection (low, medium or high);
- effectiveness of surface survey (low, medium or high);
- availability of raw materials (present/absent);
- degree of ground disturbance from human activities (low, medium or high);
- presence of flaked stone artefacts (present/absent); and
- potential for subsurface artefacts (low, medium or high).

Comparison of these categories enables an analysis of the features exhibited within each transect, facilitating an assessment of the overall archaeological integrity and potential of each area.

Based on the results of this analysis of environmental and archaeological features a rating of low, moderate or high archaeological potential was assigned to each portion of the site. The definition of these categories is as follows:

Low Archaeological Potential:	Areas where archaeological materials are not likely to occur, as a result of removal or disturbance from land use history. Some indication of the natural soil profile or natural terrain remains, but is limited and not likely to contain archaeological materials.
Moderate Archaeological Potential:	Areas where archaeological materials may occur. Some indication of the natural soil profile or natural terrain remains, but where high site or artefact density is unlikely to occur.
High Archaeological Potential:	Areas known or likely to contain surface or sub surface archaeological materials or site(s). The natural soil profile or natural terrain is evident, and site(s) and artefact(s) are known to occur in this context.

4.3 Historical Significance Assessment

An assessment of significance is undertaken to explain why a particular site is important and to enable the appropriate site management strategies to be determined. Cultural significance is defined in the Australian ICOMOS Charter for the Conservation of Places of Cultural Significance (the Burra Charter) as ‘aesthetic, historic, scientific or social value for past, present or future generations’ (Article 1.1). Cultural significance may be derived from the fabric of a place, association with a place, or the research potential of a place. The significance of a place is not fixed for all time, and what is of significance to us now may change as similar items are located, more historical research is undertaken and community tastes change.

The process of linking this assessment with a site's historical context has been developed through the Department of Urban Affairs and Planning (now DOP) and the Heritage Council of NSW State Heritage Inventory Program (SHIP) and is outlined in the Heritage Assessment Guidelines of the NSW Heritage Manual (1996). The Heritage Assessment Guidelines establish seven evaluation criteria, reflecting significance categories and representativeness, by which a place can be evaluated in the context of State, Regional or Local historical themes. These Guidelines were updated in mid August 2001 by the guideline Assessing Heritage Significance, which reflects legislative changes to the Heritage Act. It is understood that the guidelines in the Heritage Manual will be successively upgraded to reflect the new assessment criteria.

The significance criteria are:

Criterion (a) – an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area).

Criterion (b) – an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area).

Criterion (c) – an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).

Criterion (d) – an item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.

Criterion (e) – an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area).

Criterion (f) – an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).

Criterion (g) – an item is important in demonstrating the principal characteristics of a class of NSW's:

cultural or natural places; or

cultural or natural environments

(or a class of the local area's:

cultural or natural places; or

cultural or natural environments).

Different components of a place may make a different relative contribution to its heritage value. Loss of integrity condition may diminish significance. In some cases it may be useful to specify the relative contribution of an item or components. While it is useful to refer to **Table 2** when assessing this aspect of significance, it may need to be modified to suit its application to each specific item.

Table 2: Significance Grading Levels

Grading	Justification	Status
Exceptional	Rare or outstanding item of local or State significance. High degree of intactness. Item can be interpreted relatively easily.	Fulfils criteria for local or State listing.
High	High degree of original fabric. Demonstrates a key element of the item's significance. Alterations do not detract from significance.	Fulfils criteria for local or State listing.
Moderate	Altered or modified elements. Elements with little heritage value but which contribute to the overall significance of the item.	Fulfils criteria for local or State listing.
Little	Alterations detract from significance. Difficult to interpret.	Does not fulfil criteria for local or State listing.
Intrusive	Damaging to the item's heritage significance.	Does not fulfil criteria for local or State listing.

Following Kerr (2000), the cultural significance of a precinct or element within a precinct can be expressed in three broad ways (these encompass the significance criteria above) through:

- the ability to demonstrate an aspect of the precinct's significance. For example the fabric of the site could demonstrate how a site was used;
- the association of the precinct with an important event or a particular person. The association may not require physical evidence of the event; and
- the ability of archaeological remains in a precinct to answer relevant research questions.

These three ways of expressing significance apply as much to archaeological remains as they do to the built environment or the landscape. It is conceivable that archaeological remains may not have any research potential but have strong historical associations or a high ability to demonstrate an aspect of history.

The relationship between an item and its historical context underlies this assessment process. Historical themes provide a context within which the heritage assessment criteria are applied, especially if historical values are critical to an understanding of an item's heritage significance.

5 SURVEY RESULTS

The archaeological field survey of Herons Creek to Stills Road was conducted on 30 and 31 November 2005 by Alan Williams (HLA), Cornelia de Rochefort (HLA) and Trevor Roberts (Bunyah LALC).

The survey covered the majority of the area and recorded all information on a survey recording sheet as described in **Section 4.1** and on base maps of the site provided by the RTA. The results for each study area are presented in **Table 3.**

Herons Creek to Stills Road was split into ten transects (**Figure 3**). Each transect was individually described for potential surface and subsurface archaeology. The start, end and any other relevant features were located with GPS, while multiple photographs were taken of each transect.

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Table 3: Survey Result Summary for Herons Creek to Stills Road

Transect	1	2	3	4	5	6	7	8	9	10
Start AMG Co-ordinate	474284E, 6504933N	474293E, 6505474N	474285E, 6505497N	474378E, 6505650N	474524E, 6506336N	474643E, 6506743N	474600E, 6506945N	475531E, 6508289N	475531E, 6508289N	474715E, 6507572N
End AMG Co-ordinate	474348E, 6505425N	474243E, 6504948N	474417E, 6506643N	474504E, 6506122N	474789E, 6506966N	474929E, 6507377N	475522E, 6508391N	474950E, 6507405N	474789E, 6506966N	474623E, 6507693N
Approximate Transect Area	49,900 m^2	39,825 m^2	60,000 m^2	24,850 m^2	137,200 m^2	44,750 m^2	90,000 m^2	55,000 m^2	75,000 m^2	7,650 m^2
Geological Unit	Byabbara Beds sandstone	Byabbara Beds sandstone	Camden Haven sandstone	Camden Haven sandstone	Camden Haven sandstone	Camden Haven sandstone	Camden Haven sandstone	Camden Haven sandstone	Camden Haven sandstone	Camden Haven sandstone
Soil Landscape	Kandosols	Podsols	Anthroposols	Kandosols	Kandosols	Kandosols	Rudosols	Rudosols	Kandosols	Kandosols
Terrain Unit	Alluvial flats, simple slope	Alluvial flats, simple slope	Simple slope	Simple slope	Simple slope, flat	Simple slope, crest	Simple slope, crest	Simple slope	Simple slope	Simple slope, crest
Slope	Flat, very gentle	Flat, very gentle	Moderate	Moderate	Flat, very gentle	Gentle, moderate	Moderate	Flat, very gentle	Flat, very gentle	Moderate
Geo. Agent	Soil creep, mass movement, human	Soil creep, mass movement, human	Human	Soil creep, mass movement, human	Soil creep, human	Soil creep, mass movement, human	Soil creep, mass movement, human	Human	Soil creep, mass movement, human	Sheetwash, mass movement, human
Human Action	Pastoralism, structures	Pastoralism, structures	Structures, roads, clearing	Logging, roads	Logging, roads, clearing	Logging, roads, clearing	Roads, clearing	Roads, clearing	Roads, clearing	Roads, clearing
Erosion Action	Colluvial, alluvial	Colluvial, alluvial	Human	Colluvial, human	Colluvial, human	Colluvial, human	Colluvial, human	Human	Colluvial, human	Colluvial, human
Level of Disturbance	5	5	8	6	5	5	7	8	8	8
Exposure Area	2,495 m^2	1,991 m^2	3,000 m^2	1,243 m^2	82,320 m^2	3,133 m^2	6,300 m^2	22,000 m^2	30,000 m^2	6,120 m^2
% of Transect Exposed	5	5	5	5	60	7	7	40	40	80
Visibility (%)	10	10	5	5	60	7	7	40	50	100
Soil Profile	A	A, Ae, B	A	A, B	A, B	A, C	A, B	A, C	A, C	B
Vertical Profile	No	Yes	No	No	No	Yes	No	Yes	Yes	Yes

Transect	1	2	3	4	5	6	7	8	9	10
Vegetation	Low	Low, mid	Low	Mid, tall	Mid, tall	Mid, tall	Mid, tall	Low, mid	Low, mid	Low
Groundcover	Dense	Dense	Mid dense	Dense	Mid dense	Dense	Mid dense	Sparse, mid dense	Mid dense	Sparse
Artefacts/\Sites	#30-6-0149	Absent	Absent	#30-9-0146	Absent	Absent	Absent	Absent	Absent	Absent

Following guidelines for site surveys as required by DEC, **Table 4** has been presented to show the available exposure and detection of the survey.

Table 4: Survey Coverage of the Study Area.

Transect no.	Landform unit.	Total Area of LF unit (m^2)	Exposure (%)	Area of Exposure (m^2)	Visibility %	Area available for detection (m^2)	% of landform available for site detection
1	Alluvial flats, simple slope	49,900	5	2,495	10	250	1
2	Alluvial flats, simple slope	39,825	5	1,991	10	199	0
3	Simple slope	60,000	5	3,000	5	150	0
4	Simple slope	24,850	5	1,243	5	62	0
5	Simple slope, flat	137,200	60	82,320	60	49,392	36
6	Simple slope, crest	44,750	7	3,133	7	219	0
7	Simple slope, crest	90,000	7	6,300	7	441	0
8	Simple slope	55,000	40	22,000	40	8,800	16
9	Simple slope	75,000	40	30,000	50	15,000	20
10	Simple slope, crest	7,650	80	6,120	100	6,120	80
AVERAGE		*58,418*	*25*	*15,860*	*29*	*8,063*	*15*
TOTAL		**584,175**		**158,602**		**80,633**	

While **Table 4** shows that the effective coverage of the site was generally low[2], many of these figures represent heavily disturbed and modified areas of the site such as transect 4 (**Plate 8**) and transect 3 (**Plate 14**), both of which has been heavily modified by the current Pacific Highway and have virtually no potential for surface archaeological material. Generally, with between one and two Aboriginal community members and two HLA member standing roughly 15 metres apart, transects were some 45 to 60 metres or so wide, and typically these transects were walked over several times.

While the investigation did not completely cover the study area, the distribution and coverage of the ten transects allowed a comprehensive understanding of the study area and it's archaeological potential. Overall the survey covered 58 ha (equivalent to 584,175 m^2), which represents some 59% of the section of proposed development area[3]. Of this, some 15% or 8 ha (equivalent to 80,633 m^2) had effective coverage.

The following provides a brief description of each transect in relation to the landform, visibility and any sites found. All transects are presented in **Figure 3**. It should be noted that the proposed development areas are situated along the current Pacific Highway and as such are generally heavily modified. Typically, these areas are manipulated for the benefit of the existing road, such as the development of batters or the cutting of slopes. In addition, services such as optic fibre cables are often located along the edges of the road for ease of access and

[2] Although it should be noted that effective coverage survey values are generally between 0 to 20% and rarely exceed these values due to high vegetation growth on the east coast of NSW.

[3] Broadly, the length of the road sections (3.3 km) multiplied by the average width of the proposed development area (between 100 to 250 metres) provides an area of about 990,000 m^2 (or 99 ha) for the overall proposed development area.

maintenance. With regard to the creeks and streams that run throughout the study areas, many of them appear to have been formed through the current road development (i.e. causing hydrological changes that focus runoff into one area, which leads to the formation of an ephemeral stream) and those that are naturally occurring are generally heavily modified.

Transect 1 ran along the eastern side of the Pacific Highway from the southeastern edge of the proposed impact zone to Herons Creek (**Plate 1**). The area was very gently sloping and ran down from the south to Herons Creek in the north. Low, dense vegetation minimised visibility in this area. Within the transect a number of smaller ephemeral tributaries were identified as running parallel with Herons Creek in an east-west orientation, although it seems likely that these have been artificially created by the development of the nearby Pacific Highway focussing surface runoff. Much of the northern end of the transect was composed of an alluvial flat formed from Herons Creek (**Plate 2**). However, while the alluvial flat is identified as a PAD elsewhere, the multiple ephemeral tributaries had severely impacted the alluvial flat, and better preserved sections of it are found in transect 2. One site had previously been recorded in this transect, #30-6-0149, which is discussed in **Section 5.1.1**.

It should be noted that the bridge crossing Herons Creek has also been previously identified by Navin Officer (2001) as a historical site (**Plates 3** and **4**) (for discussion, see **Section 5.1.1**).

Transect 2 ran to the west of the Pacific Highway between Herons Creek Road and Herons Creek (**Plate 5**). This area was composed of two flat areas divided by a steep slope (like a set of stairs) and has been interpreted as two alluvial flats. The upper alluvial flat revealed the development of a podsol in a nearby section (a soil profile that can take substantial time to develop) and was considered the older flat, while the younger flat was considered to be lower and closer to Herons Creek. The podsol identified appeared to be *in situ* and consisted of a dark organic A horizon overlying a bleached silty Ae (or A_2) overlying a clay orange B horizon (**Plate 6**). While vegetation coverage was dense (and hence visibility poor), the area has previously been identified as a PAD by Navin Officer (2001). This PAD was extended by HLA to the upper alluvial flat as, although geological in nature, it would also have formed an ideal settlement location near Herons Creek and the soil profile implies it has not been too disturbed in the recent past. In addition, there was evidence of a dead and substantially deteriorated tree stump with axe marks, on the corner of Herons Creek Road and the Pacific Highway that has previously been recorded by Navin Officer (2001) (**Plate 7**)(see **Section 4.5** for discussion).

Transect 3 ran from Herons Creek (past the public school) finishing in a stopping bay about 1 km north of the creek (**Plate 8**). The proposed impact zone, and hence transect, largely involved the investigation of the road verge and various parking/stopping bays in this area. The transect consisted of a gentle to moderate slope from Herons Creek up to the north end of the transect, a trend continuing on to Bago Road. The northern end of the transect revealed heavy modification, most likely from the development of the Pacific Highway and consisted of rehabilitated stockpiles of material from an unknown source. Vegetation cover was minimal in most areas as much of the road verge and stopping bays were sealed. Where vegetation was present to the north of the transect it was composed of regrowth and recent growth.

Transect 4 runs to the east of the Pacific Highway from Herons Creek, north to the end of Bobs Creek Road. Similarly to transect 3, this transect has a gentle to moderate slope from Herons Creek up to Bobs Creek Road, where it levels off (**Plate 9**). In contrast to transect 3, this area (aside from around Bobs Creek Road) is heavily forested and visibility was limited. However, Herons Creek is eroding to the north and has formed steep cliffs down to the water in this location, suggesting the opposite side of the bank was far more suitable for settlement. Navin Officer (2001) identified a scarred tree, #30-9-0146, in this area, which was located and recorded again by HLA personnel (**Plates 9** and **10**) (see **Section 5.1.1** for discussion).

Transect 5 encompasses one of the largest areas of proposed impact within this study area, namely about 50,000 m^2 of State Forest to the south of Boyds Road. The areas adjacent the road have been heavily modified through battering for the existing road along the entire east and west sides of the southbound carriageway, which includes this transect (**Plates 13** and **14**). The exposure of the area was relatively poor due to the mid-dense/dense low and tall vegetation present in this transect (**Plate 15**). However, investigation revealed that substantial logging had taken place in these areas; this had severely disturbed the ground surface. In addition, soil profiles evident revealed only a thin layer of organic material overlying an orange clay B horizon, suggesting that the topsoil has eroded at some point in the past (**Plates 21** and **22**). All tributaries identified in this transect were artificially created by the installation of the Pacific Highway and the subsequent impact to the local hydrology, and hence none revealed any evidence of historical deposits or sites.

Transect 6 was located in a tract of State Forest that is situated between the two carriageways of the Pacific Highway (**Plates 16, 17** and **18**). Areas to the south of the transect have previously been cleared, while the wooded areas to the north showed evidence of previous vegetation removal by State Forest. Areas adjacent the road on both sides reveal previous clearance and modification, with the verges often being deliberately graded to bedrock and angled towards the road. Visibility was poor in transect 6 but multiple sections revealed a minimal soil profile, generally with the orange clay B horizon below a very thin organic layer.

Transect 7 followed either side of the northern Pacific Highway carriageway from south of Bago Road to Stills Road, a distance of some 2 km (**Plate 20**). The transect consisted of a number of slopes and crests, rising at Bago Road and ultimately dropping to a plateau south of Stills Road. The proposed impact along this 2 km stretch of road is largely constrained to the road verges, which have all previously been altered and showed substantial evidence of regrowth and bedrock exposures. Cutty Creek is located near Bago Road in this transect (**Plate 19**). However, investigations of the creek reveal it to be heavily modified and eroding across this study area, and hence lacking any depositional units that could be considered PADs.

Transect 8 ran along the median strip to the north of the study area (**Plate 20**). This transect is flat and has sporadic low and mid vegetation. The transect is composed of mainly modified bedrock with a limited soil profile in places. The area has been used for dumping road materials, turning and stopping bays and, as such, retained few natural features for archaeological consideration.

Transect 9 ran along the eastern side of the study area from the survey's northern extent to Boyds Road. The entire transect consisted of a modified easement largely revealing a graded bedrock slope coming up to the road.

Transect 10 was undertaken along a section of Bago Road covered by the proposed impact zone (**Plate 23**). Similar to transects 8 and 9, this transect is adjacent to a road and has been heavily altered. The transect was moderately to steeply sloped with no vegetation cover. In this location, it appears more likely that the vegetation removal during the development of Bago Road has led to substantial erosion of the soil profile downslope. The remains of an orange clay B horizon are clearly evident across the transect with some evidence of gleying where water is trapped in the erosion scars and rills running down the edges of the road.

5.1 Sites Identified

Five sites were identified during the assessment; these are discussed below and presented in **Figure 4**.

5.1.1 Aboriginal Sites

Three recorded Aboriginal sites were encompassed within the study area.

5.1.1.1 Site #30-6-0149: Isolated Find

No record of this site card for this site could be located within the AHIMS register. Hence, the only information on this isolated find comes from the original report by Navin Officer (2001). The report identified an isolated find, A6, specifically a light grey fine-grained meta sedimentary retouched broken flake with secondary flaking and usewear along one margin (51x25x13 mm) The location of this artefact was outlined to be just north of Clulies Road in an area of ploughed ground (**Plate 1**). The site was considered to be an *ex situ* isolated find with low potential for subsurface deposits.

The site could not be re-identified by HLA archaeologists, the coordinates given for the site being some distance to the south of Clulies Road. While detailed investigation of the surrounding area, including the field to the north of Clulies Road, was undertaken the site could not be identified. Given the time and use of the field for cattle and horse grazing, as well as recent developments such as the nearby driveway and fencing, it is possible that the site has accidentally been destroyed.

This site is within the proposed impact zone.

5.1.1.2 Site #30-9-0146: Scarred Tree

No record of the site card for this site could be located within the AHIMS register. Hence, the only information on this scarred tree comes from the original report by Navin Officer (2001). Navin Officer (2001) identify a scarred tree, A7, not far from the junction of Bobs Creek Road and the Pacific Highway in this study's transect 4 The coordinates provided fell between two trees with scars (**Plates 9** and **10**), neither of which in HLA's opinion were created by Aboriginals. The Bunyah LALC representative agreed with this opinion. Substantial investigation of the surrounding area was undertaken to identify any further trees with scars, but none was located.

It is HLA's opinion that this site should be removed from the AHIMS system, since it is clearly a tree that has been scarred (and heavily damaged) by fire.

This area is within the proposed impact zone.

5.1.1.3 Herons Creek PAD

Navin Officer (2001) identified the southern side of Herons Creek on both sides of the Pacific Highway as a PAD of approximately 150 x 50 m (**Plates 2, 5** and **6**). HLA agrees with this interpretation, the area being an ideal location for both settlement and the retention of subsurface deposits. In addition, HLA feels that the older and higher alluvial flat just north of Herons Creek Road should also be considered a PAD, since it would also be suitable for settlement and provides evidence of developed and *in situ* stratigraphy (i.e. the presence of a developed podsol).
HLA would suggest that, while the eastern side of the Highway is a continuation of the PAD to the west of the road, investigations only be undertaken on the western side. The reason for this is that a number of ephemeral tributaries, which have most likely been formed due to the road construction affecting the hydrology, are located on and near the alluvial flat on the eastern side of the Highway, and these will have eroded and destroyed many of the upper deposits that are evident in the alluvial flat to the west. It seems likely that the western part of the alluvial flat will

therefore have a higher potential for retaining undisturbed archaeological deposits than the eastern side.

This area is within the proposed impact zone.

5.1.2 Historical Sites

Two historical sites were identified as part of this study and are illustrated in **Figure 4**.

5.1.2.1 H36: Tree Stump

Navin Officer (2001) identified a scarred tree stump, H36, on the corner of Herons Creek Road and Pacific Highway (**Plate 7**). The tree retains a number of springboard or axed notches.
Navin Officer (2001) assessed this site as having no significance and suggested that the destruction of this site should be preceded by a notification to the Director of NSW Heritage Office to seek an exemption and an archival recording of the site. Re-location of the site is also an alternative.

It is likely that this site will be impacted by the proposed development.

5.1.2.2 H38: Herons Creek Bridge

Navin Officer (2001) identified Herons Creek Bridge as a concrete beam highway bridge, possibly of pre-1948 origin (**Plates 3** and **4**). Navin Officer further identified that, of the 173 concrete beam bridges currently in use by the RTA, 63 have been modified, including Herons Creek Bridge. Navin Officer outlined that this bridge should be studied in detail in an RTA heritage assessment of pre-1948 bridges of the Northern Region. Recommendations from this assessment should determine the subsequent function of Herons Creek Bridge.

5.2 Interpretive Framework

One of the greatest drawbacks in consultancy-based archaeology is that the level of interpretation provided for individual development driven projects is constrained by unavoidable time and financial factors. There is an absence of rigorous regional or local government-funded archaeological studies which would serve to provide foundational research frameworks for subsequent studies. The result is a distinct lack of cohesion or connectedness across archaeological studies. Interpretations are often 'isolated' in being relevant to a particular study area only. The following section makes an attempt to address this issue. It does so by providing a model of regional archaeological structure based on a model developed by Foley (1981a; 1981b), at the same time providing further interpretive resolution by assessing site formation models. Although by no means the last word on the subject, it at least establishes a framework for interpreting archaeological versus natural patterning for the study area, as well as addressing the nature of the original archaeological patterning. The authors will seek to develop this 'model' approach in subsequent studies and the ensuing section should be viewed with this in mind.

5.2.1 Site Formation and Integrity

Observations during the survey attempted to create a geomorphological model of the landscape in order to better understand the age and formation processes identified in the survey and their potential to retain archaeological deposits. This section aims to develop on **Section 3** which used previous studies to form site prediction.

Exposures identified on many of the slopes revealed a texture contrast or duplex soil, specifically a thin coarse silt/sand Oa or A1 onto a well developed clayey B horizon or bedrock. This discrepancy in sediment grain size indicates that the O/A horizon does not belong to the B horizon and, combined with the sharp contact between the two, indicates that the O/A1 is of colluvial origin and comes from upslope. The original topsoil has most likely been eroded into the drainage lines and river systems (**Figures 8** and **9**).

Examples of these colluvial processes can be seen on many of the slopes along the route, although good examples include transect 5 near Bobs Creek Road (see **Plates 12, 21** and **22**). The processes of sheetwash, soil creep and mass movement were also observed, such as in transects 5 and 6 (see **Plates 18, 21** and **22**). This type of geomorphological activity essentially deposits archaeological material at the base of slopes and within alluvial flats (**Figure 5**). These types of sites can be considered to represent lag gravels, which include artefacts and natural gravels, rather than *in situ* knapping floors (single events) or knapping locations (multiple knapping events superimposed/overprinted over one another). The concentration of archaeological material in these locations therefore, represents natural accumulation (patterning) rather than archaeological accumulation. HLA suspects (based on multiple personal observations in this region) that much of the 'archaeological' site patterning recorded for the region actually represents natural site formation processes – a fact previously noted by Margrit Koettig's model for studies in other parts of NSW (Koettig 1985; Koettig *et al* 1992 - see **Figure 5**).

Due to these processes, which are accelerated through deforestation and development, areas such as ridgelines and crests will be almost devoid of sediments, these having slipped downslope (**Figure 9**). Indeed, large areas of exposed subsoil and bedrock can be seen along the survey on slopes and crests, exposed through the movement of sediments (**Plates 11** and **13**). Erosion, such as sheetwash (massive amounts of sediments being fluvially transported downslope with surface flow and deposition of sediments), is promoted by the absence of vegetation on exposed land surfaces noted during the survey, and is clearly evident throughout the study area (**Plates 4, 13, 18** and **23**).

Plates 18 and **23** show that many of the transects are simply resting on exposed subsoil (truncated B horizon deposits) or an indurated C horizon or bedrock. The reason for this is the erosional nature of the landscape (see **Figures 8** and **9** in particular). For this reason, attempts at subsurface investigation are likely to be quite unsuccessful in these locations, particularly in regard to archaeological integrity.

It should also be noted that sections across this landscape revealed that most of the soil profiles were very thin before reaching bedrock (**Plate 12**). This means that even if *in situ* profiles were located, they would most likely be disturbed throughout their sequence by bioturbation (for example, larger artefacts to move up a profile and smaller artefacts to move down a profile). Typically, these types of processes - which can extend to a metre below the surface - will move artefacts and stones disturbance, completely destroying their archaeological integrity.

Throughout the study area, evidence suggests that large areas have been previously altered through the long-term use of the site for accommodation, pastoralism and logging. For this reason much of the vegetation is recent regrowth, with many areas indicating very little topsoil is present (**Plate 18**). Human disturbance in some areas is still obvious, i.e. the settlement, underground services, and associated road infrastructure.

In summary, exposed areas along the survey, particularly on ridgelines and slopes, reveal a typical pattern of active downslope erosion through mass movement, soil creep and more extreme sheetwash. These deposits are aggrading at the base of slopes and in creek catchments. A common pattern can therefore be identified across the study area, with exposed bedrock and sub soil horizons on crests and slopes, following the erosion of their upper soil unit

(subsequent to deforestation and clearing) downslope. These latter deposits accumulate at the base of slopes and in creek catchments and become integrated into the pedogenesis of these areas, often leading to the translocation and subsequent void filling of clay through the profile, promoting localised flooding.

5.2.2 Archaeological Models

Models represent simplified representations of a more complex reality (Shaw and Jameson, 1999: 403). They can be used to tackle 'tactical' issues such as the break-up of stone artefacts, to larger 'strategic' problems such as the spread of microlith industries across Australia. Further, the model known as the 'statistical cycle' (after Orton, 1980) is an expression of the way that archaeologists interact with their material in a research (or consultancy) setting. This sees the relationship between theory and data as mediated through models, which vary in their complexity and expression. The distinct advantage of this approach is that it does not confine the archaeologist to any particular paradigm of research.

The basic model that will be utilised here to look at 'archaeological structure' (simply the way that artefacts are distributed across the landscape) is based on the work of Foley (1981a; 1981b). At a simplistic level, **Figure 6** (left image) graphically expresses what is considered to be a fair representation of the distribution of activities within a home range (the area in which resources are exploited), whilst **Figure 6** (right image) graphically expresses the subsequent pattern of artefacts. This model is based on the concept that archaeological data relates primarily to long term, gross behavioural characteristics (Foley, 1981a: 1). The 'home range' is not tied in to any precepts concerning the short, medium, or long-term 'settlement' of a particular area. The home range concept can also be likened to 'site catchment analysis', a phrase first explicitly coined by Higgs in the 1970s (Vita-Finzi and Higgs, 1970), which refers to the evaluation of the natural resources within an easily exploitable distance of a given settlement or site. The limits of the model are (after Foley, 1981a: 1) "*(a) that it applies primarily to small scale, mobile societies, principally hunter-gatherers; (b) that it is predominantly useful for populations using a lithic technology, and treats lithic artefacts only; and (c) that it is most appropriate in stable or degrading, moderately uniform landscapes with good surface visibility.*"

The basic hypothesis outlined by Foley (1981a: 2) was that the archaeological record is spatially continuous and the nature of the distribution should be viewed in terms of a variable artefact density across the landscape (what he called the "regional archaeological structure"). From HLA's general experience within NSW, it is **rare** that any given location within the landscape does not contain some evidence of Aboriginal archaeology – and only then because it has been disturbed or deposits removed or destroyed.

Foley (1981a: 2) considered that spatial continuity resulted from the operation of three processes: behaviour and discard (i.e. human activities such as making tools or gathering food-stuffs); accumulation (i.e. the archaeological record usually reflects repeated events 'superimposed' over one another such as a knapping location) (**Figure 7**); and post-deposition (i.e. processes that occur after a site has been abandoned such as burial, slope wash or ploughing). This is the theoretical basis of Foley's now famous (to archaeologists) "off-site" archaeological model. For the purposes of this study, post-depositional processes form the focus of assessment, since for many of the landforms present (particularly slopes and to a lesser degree alluvial terraces/flats), natural and post-Contact man-made processes have either created or exaggerated 'archaeological' patterning.

With the arrival of Europeans in Australia and the introduction of farming and the development of urban centres and associated infrastructure, the Australian landscape was (and continues to be) put under a variety of processes detrimental to the stability of land surfaces, particularly soils. In effect, a landscape that was *relatively* stable (except at times of climatically introduced stress - e.g. the absence of vegetation due to smaller water budgets during the Last Glacial

Maximum between c.27,000 – 17,000 years Before Present (BP) or, localised cycles of erosion/deposition and soil formation within particular catchments) for long periods of time has, in the space of just over 200 years, been subject to problems of slope instability and the subsequent erosion of soil mantles. These processes serve to alter the archaeological patterning of objects and sites, which includes processes that alter horizontal and vertical site integrity, in addition to removing and/or destroying Aboriginal sites. From the perspective of *archaeological* significance (cultural significance is different because Aboriginal people consider all Aboriginal objects and sites, regardless of condition, as significant), the study area has been markedly affected by deforestation, various slope processes, the action of water (rilling, gullying etc.) and direct human impacts like the construction of roads and dams. Furthermore, long term pastoral practices have served to erode, destroy or rework archaeological artefacts and sites.

Figures 5, 6, 8 and **9** illustrate these processes in 'schematic' form. However, the general post-depositional processes indicated by these models are reasonably accurate (qualitative) representations of what happens to soil mantles (and the artefacts on and within them) when surface vegetation is removed or stressed and when soil mantles are eroded and/or reworked. There are techniques (largely borrowed and adapted by archaeologists from sedimentology and geomorphology) to ascertain the main post-depositional processes that have affected sites and artefacts. These range from specific archaeological techniques like the refitting of artefacts, to plotting 'rose' diagrams using orientation and dip data taken on artefacts.

5.2.3 Discussion

With the current understanding of general Aboriginal settlement patterns within the Forster and Port Macquarie regions, Aboriginal people are known to have been living in the area since the mid to late Holocene (5,000 years BP to present), although it seems likely people were moving through the area much earlier, possibly around or before the Last Glacial Maximum (c.27,000 – 17,000 years BP). The most common site type encountered is small open artefact scatters, although isolated finds, scarred trees, and stone arrangements are also present.

Based on archaeological surveys (and more limited test excavations) in the general areas surrounding the study area (see **Figure 1**), some basic conclusions can be reached concerning the nature and distribution of Aboriginal archaeological sites. Firstly, it can be concluded that all landforms surveyed have provided evidence of Aboriginal sites, including flats, slopes, benched areas, spurs and ridgelines. This picture is somewhat biased towards archaeological sites adjacent to water courses, creek lines and the time of year and density of vegetation cover encountered at the time of the archaeological surveys (affecting visibility and hence detectibility of archaeological sites). Furthermore, because of these issues of detectibility, Aboriginal sites are usually most visible in areas experiencing erosion. It is true to say that the ability to detect Aboriginal sites is largely influenced by this fact, in the absence of subsurface testing programs. The density of Aboriginal sites, however, varies according to landform. Taking into account Foley's model outlined above (see also **Figures 6** and **7**), this is to be expected.

With regard to this specific study area, there are few (if any) places within its curtilage that retain deep soil profiles with the potential for accumulating archaeological material. Abundant evidence indicates a downward movement of soils and sediments into drainage channels, leaving minimal soils and exposed bedrock on the ridges and crests reducing the likelihood of buried material.

One of the most obvious aspects of the general landscape context of the study area is the overall condition of the land. In most areas surveyed, topsoils were observed to be minimal (e.g. **Plates 12, 18** and **22**) and/or reworked from elsewhere. Furthermore, previous pastoralism, logging, road construction and other human activities have caused immense impact to the large areas of the current study area reducing the survivability and integrity of any potential

archaeology (**Plates 8, 15, 19** and **20)**. Other detrimental processes such as salt scalding that cause and intensify the erosion of soil mantles, are also present within the survey area.

In terms of general archaeological patterning (regional structure), the continuous exploitation of an area over time by hunter-gatherers leads to an increase in the absolute density of artefacts and the effects of blurring are seen ('accumulation' process described above). Hunter-gatherer people set up camps (be they short, medium or long-term) based on the habitat context (Foley, 1981b: 159), rather than the exact location of any particular settlement (for example, pastoralists re-using huts in upland pastures grazed only during the summer months). This is true of water courses and creek lines in general, where repeated visitation over very long periods of time can create a very dense archaeological pattern of stone artefacts (although the erosion and deposition of artefact concentrations by fluvial processes have to be considered and 'filtered' out). Conversely, sites on slopes, breaks of slope and footslopes are often the result of slope processes (water, gravity) and concentrate artefactual material to resemble sites. Finally, the more recent human actions (such as drainage excavations, dam construction etc) can expose sites.

6 ARCHAEOLOGICAL AND HISTORIC ASSESSMENT

This section outlines the Aboriginal sensitivity (or significance) and the historic significance of each of the sites identified in **Section 5.1**.

6.1 Archaeological Potential

The assessment of the archaeological sensitivity of each survey unit is based on the following three criteria (following the discussion in **Section 4.2**). Terrain integrity is also considered a criterion, but is integrated within the general discussion of sensitivity in **Section 6.2**:

Criterion 1 The presence of known surface archaeological materials.

The known locations of previously recorded archaeological sites within the study area have been plotted on the topographic map of the region (**Figure 1**). A review of archaeological work in the region and the AHIMS site cards, as well as the archaeological survey and assessment, have identified that a number of previously recorded sites are near the study area.

62 known sites are located within a 20 km radius of the study area based on the AHIMS search. Of these, the majority (50%) represent open camp sites (artefact scatters) with scarred trees and middens (largely along the coast) making up the remainder. Therefore, although the numbers of archaeological sites recorded in the general area is low (particularly if one compares this area to other areas of NSW), this is almost certainly an underestimation based on the paucity of archaeological studies in the area, compounded by the active colluvial and erosional landscapes that serve to truncate, bury or remove archaeological sites.

Within the proposed Herons Creek study area, two sites were identified - #30-6-0149 an artefact scatter and # 30-9-0146 a scarred tree.

Criterion 2 The probability of undetected surface archaeological materials.

The probability of undetected surface materials occurring within the study area is assessed on a number of characteristics. These include:

- The analysis of effective ground surface visibility within the study area.
- The terrain context and integrity of areas.

Ground surface visibility is the most common obstacle in the detection of archaeological material. Low, dense vegetation limits effective survey coverage to a low, or moderately low level. The likelihood of detecting surface archaeological materials in these densely vegetated areas is low. Therefore, this assessment relies on the terrain context and the level of landscape integrity within each transect.

The terrain integrity within the study area has been documented to identify whether archaeological material could still be found in those areas, or whether they would have been removed as a result of past disturbance. The probability (classified as low, moderate or high) of surface archaeological materials occurring within specific landscape contexts may then be considered.

Ground exposure was highly variable across the study area, dependent upon where grass cover was very dense. Surface exposure varied between 5% to 80% (average exposure 25%), where visibility within these exposures was between 5% to 100% (average visibility 29%), meaning that the average land available for the detection of Aboriginal archaeological sites was highly variable, lying between 0% and 80%, the average area available for detection in any

particular landform being 15% for the study area. While the lack of visibility does provide potential for undetected sites, the lack of topsoils in many places combined with their colluvial nature when present indicates that the potential for archaeological material within the study area is low.

Criterion 3 The probability of subsurface archaeological materials.

The assessment of the subsurface archaeological potential of the survey area is based on a number of criteria, including:

- The known patterning of surface and subsurface archaeological materials throughout the local region.
- The terrain characteristics of known archaeological (surface and subsurface) sites.

The field survey examined terrain contexts where subsurface archaeological materials may have occurred in currently uncleared land, such as in upturned tree bowls or exposed sections, but failed to find any evidence. This information allows the probability (classified as low, moderate or high) of subsurface archaeological materials occurring within specific landscape contexts to be established.

Existing levels of terrain integrity and the demonstrated patterns of the surface and subsurface distribution of archaeological materials in the study area were used as the main evidence in the following evaluation. As there is only very limited evidence of buried archaeological material (i.e. known stratified sites) in the region, this evaluation is based upon the potential for intact natural soils to exist. Following geomorphological models (see **Section 5.2.1**) and vertical sections sporadically located across the two study areas, evidence suggests that the areas have undergone massive erosion and truncation with the remnants of a B horizon under relatively modern colluvial topsoils (which are not always present). This form of soil profile, both by its very nature and through previous archaeological excavations across NSW by HLA, imply a very low potential for any buried *in situ* archaeological materials. The main exception to this form of erosion appears to occur along the southern alluvial terraces of Herons Creek, which provides evidence of *in situ* podsols.

6.1.1 Zones of Archaeological Potential

Zones of archaeological sensitivity can be delineated on the basis of this assessment of the probability of additional archaeological material occurring in the study area. This assessment relates to the probability of material occurring and does not address scientific significance or the cultural significance of the material to Aboriginal community members.

Low or Nil Archaeological Sensitivity

The areas indicated on **Figure 4** that are affected by the human structures, underground services, and/or roads or represent areas where skeletal soils and/or etch surfaces dominate, are assessed to be of low or nil archaeological sensitivity where archaeological material is unlikely to occur as the terrain has been significantly altered.

Moderate Archaeological Sensitivity

Areas of moderate archaeological sensitivity include the southern parts of Herons Creek in the northern study area that retain *in situ* or potentially deep subsurface deposits. These areas are presented in **Figures 4**.

High Archaeological Sensitivity

Two Aboriginal sites have been identified within the study area, namely #30-6-0149 and #30-9-0146. While HLA could not relocate the isolated find, nor agree with Navin Officer's (2001) determination of a scarred tree, both sites have been identified as of high sensitivity.

6.1.2 Cultural Significance

Following the survey the Aboriginal communities involved in this consultation process were formally asked to provide a statement of cultural significance and a response to the management recommendations outlined in the draft copy of the report sent with the letter.

A response was received from Trevor Roberts on 3 March 2006. His comments outlined his endorsement of the survey and identified no Aboriginal sites or objects within the study area. Hence, he had no comments to make regarding the cultural significance.

6.2 Historical Assessment Criteria

This section addresses each of the assessment criteria outlined in **Section 4.3** and how they apply to the sites identified in **Section 5.1**, namely H36 and H38.

> ***Criterion (a)*** *– an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area)*
>
> H36 is not relevant to this significance criterion.
>
> Herons Creek Bridge is a substantial crossing developed during the installation of the Pacific Highway in this area and as such is part of an iconic road that, in one form or another, runs along the entire east coast of Australia.
>
> ***Criterion (b)*** *– an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local to area)*
>
> H36 is not relevant to this significance criterion.
>
> Herons Creek Bridge, H38 is not relevant to this significance criterion.
>
> ***Criterion (c)*** *– an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area)*
>
> H36 reveals locally significant technological features and aspects of logging in the late 19th Century, namely switchboard grooves.
>
> Herons Creek Bridge, H38, as with many other bridges in the northern region, reveals a specific locally significant form of bridge building of the early 20th century.
>
> ***Criterion (d)*** *– an item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons*
>
> H36 is not relevant to this significance criterion.
>
> Herons Creek Bridge, H38 is not relevant to this significance criterion.

Criterion (e) *– an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area)*

H36 is not relevant to this significance criterion.

Herons Creek Bridge, H38 is not relevant to this significance criterion.

Criterion (f) *– an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area)*

H36 is not relevant to this significance criterion.

Herons Creek Bridge, H38 is not relevant to this significance criterion.

Criterion (g) *– an item is important in demonstrating the principal characteristics of a class of NSW's:*

cultural or natural places; or
cultural or natural environments
(or a class of the local area's:
cultural or natural places; or
cultural or natural environments).

H36 is not relevant to this significance criterion.

Herons Creek Bridge, H38 is not relevant to this significance criterion.

Based on the research discussed here, the assessed significance of the five historic sites is presented in **Table 5**.

Table 5: Significance Assessment

Heritage Item	Significance Criteria							Significance Grading*
	A	B	C	D	E	F	G	
H36			X					Little
H38	X		X					Moderate

***** refer to **Table 2** in **Section 4.3.** for definitions.

6.2.1 Summary Statement of Historical Significance

The two historic sites identified as part of the archaeological assessment, while of technological significance, reveal little about the activities and culture of the two areas. Switchboard grooves identified in the tree stump, H36, reveal a particular logging technique common to the late 19th Century. These features are common across NSW and simply indicate that logging occurred in both study areas, information which was previously known. These items are not considered to be able to provide additional information on the cultural heritage of the area, and as such are not considered of any great Local or State significance.

Herons Creek Bridge is a concrete beam bridge from pre-1948 which has undergone substantial alteration. This form of bridge is common in the northern region. Navin Officer (2001) identified over 150 similar examples of this type of bridge construction. Due to the technological aspects of the bridge and its association with the Pacific Highway, a highly significant State road, the bridge has been identified as of Local significance.

6.3 Summary

The archaeological survey and assessment divided the survey area into areas of low, moderate or high archaeological sensitivity. The assessment was based on three criteria: the presence of known surface archaeological materials, the probability of undetected surface archaeological materials, and the probability of subsurface archaeological materials. In short, the assessment was based on the results of the field survey within the broader framework of the archaeological understanding of site distribution within this region.

In summary, there is a low to nil potential for *in situ* archaeological material to occur in the areas affected by previous development, i.e. roads, services, or buildings or areas where skeletal soils and/or etch surfaces dominate. These areas are considered to be the whole of the study area.

Areas to the south of Herons Creek were identified as having the potential to retain *in situ* subsurface deposits and have been identified as a PAD and hence of moderate significance. Four sites were identified, specifically #30-6-0149, #30-9-0146 with regard to Aboriginal heritage, and H36, and H38 in relation to historic heritage. Each of these sites has been identified as of high sensitivity.

Table 6 lists the archaeological sensitivity of all Transects recorded and areas examined. **Figures 4** illustrate these locations.

Table 6: Archaeological Sensitivity of Areas Examined

Low or Nil Archaeological Sensitivity	Moderate Archaeological Sensitivity	High Archaeological Sensitivity
Areas impacted by human structures, underground services and/or roads, in addition to areas indicating skeletal soils and etch surfaces on upper to mid slopes and ridgelines were considered as low to nil sensitivity.	Two alluvial terraces south of Herons Creek have been identified as moderate sensitivity	Four sites have been identified as of high significance, namely #30-6-0149, #30-9-0146, H36 and H38.

7 STATUTORY CONTROLS AND MITIGATION MEASURES

This section discusses the statutory controls relating to Aboriginal heritage and proposes a management strategy including appropriate mitigation measures.

7.1 Statutory Controls

Sites of cultural heritage significance are protected or controlled by a number of varying levels of statutory control that vary according to Authority and site type. The nature and levels of controls on the project area are set out below.

COMMONWEALTH

Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation (EPBC Act) Act, 1999* requires the approval of the Commonwealth Minister for the Environment and Heritage for actions that may have a significant impact on matters of National Environmental Significance (NES).

As of 1 January 2004 the EPBC Act also provides for the identification, conservation and protection of places of national heritage significance as a matter of NES. In addition the EPBC Act provides for the management of Commonwealth heritage places and establishes the Australian Heritage Council.

Aboriginal and Torres Strait Islander Heritage Protection Act 1984

The Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Heritage Protection Act) is the principal Commonwealth legislation protecting Indigenous heritage. The Act complements state and territory legislation and is intended to support state and territory laws and processes.

Under the Heritage Protection Act the responsible Minister can make temporary or long-term declarations to protect areas and objects of significance under threat of injury or desecration. The Heritage Protection Act also encourages heritage protection through mediated negotiation and agreement between land users, developers and Indigenous people.

Since the passage of this legislation:

- around 200 applications have been lodged under the Act;
- eight declarations have been made protecting objects of significance to Indigenous people;
- emergency (i.e. temporary) declarations have protected five significant places; and
- two long-term declarations remain in place, one protecting women's sites under threat from a dam near Alice Springs and the other (with effect from July 2000) protecting Boobera Lagoon in northern New South Wales.

On 17 December 1998 responsibility for administration of the Heritage Protection Act was transferred by Administrative Arrangement Orders from ATSIC to the Environment and Heritage portfolio and the Heritage Protection Act is now administered by the Department of Environment and Heritage (DEH).

NEW SOUTH WALES

***National Parks and Wildlife Act* (1974)**

The *National Parks and Wildlife Act* (1974) (NPW Act) was amended in 2001 and some of the terms relating to Aboriginal archaeology were changed and the provisions tightened.

Under the provisions of the NPW Act 1974 (as amended), Aboriginal archaeological sites are defined as Aboriginal objects (formerly called relics). Aboriginal object "*means any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains*".

It should be noted that this definition technically would seem to exclude PADs as they are clearly not deposits, objects or material evidence; rather they are potential aboriginal objects.

The most relevant section of the legislation is section 90, which deals with the destruction of Aboriginal objects and is reproduced below.

90 Destruction etc of Aboriginal objects or Aboriginal places

> *(1) A person must not destroy, deface, damage or desecrate, or cause or permit the destruction, defacement, damage or desecration of, an Aboriginal object or Aboriginal place.*
>
> > *Maximum penalty: 50 penalty units or imprisonment for 6 months, or both (or 200 penalty units in the case of a corporation).*
>
> *(1A) Subsection (1) does not apply with respect to an Aboriginal object that is dealt with in accordance with Aboriginal tradition pursuant to section 85A.*
>
> *(1B) Subsection (1) does not apply with respect to an Aboriginal object or Aboriginal place that is dealt with in accordance with a heritage impact permit issued by the Director-General.*
>
> *(1C) It is a defence to a prosecution for an offence against subsection (1) if the defendant shows that:*
>
> > *(a) he or she took reasonable precautions and exercised due diligence to determine whether the action constituting the alleged offence would, or would be likely to, impact on the Aboriginal object or Aboriginal place concerned, and*
> >
> > *(b) the person reasonably believed that the action would not destroy, deface, damage or desecrate the Aboriginal object or Aboriginal place.*
>
> *(2) The Director-General may issue a heritage impact permit subject to such conditions and restrictions as are specified therein.*
>
> *(2A) The Director-General may take action under subsection (2) in relation to an Aboriginal object or Aboriginal place listed on the State Heritage Register (within the meaning of the Heritage Act 1977) only after consulting the Director of the Heritage Office.*

(3) A person whose application for a heritage impact permit is refused, or who is dissatisfied with any condition or restriction subject to which a heritage impact permit is given, may appeal to the Minister.

(4) The Minister:

(a) may refuse to grant the appeal, or

(b) may grant the appeal wholly or in part, and may give such directions in the matter as seem proper.

(5) The decision of the Minister on the appeal is final and is binding on the Director-General and the appellant, and shall be carried into effect accordingly.

(6) Where the regulations prescribe:

(a) the manner in which an appeal is to be made under this section—the appeal shall be made in that manner, or

(b) the period within which an appeal is to be made under this section—the appeal shall be made within that period.

(7) Where the Director-General fails to grant an application (other than an application for approval in respect of integrated development within the meaning of section 91 of the Environmental Planning and Assessment Act 1979) for a heritage impact permit, the application shall, for the purposes of this section, be deemed to be refused upon the expiration of:

(a) subject to paragraph (b)—7 days after the application was received by the Director-General, or

(b) where the regulations prescribe some other period—that other period.

(8) If a court finds a person guilty of an offence under subsection (1), the court may, in addition to or in substitution for any pecuniary penalty for the offence, direct the person to take any action to mitigate the damage to, or to restore, the Aboriginal object or Aboriginal place concerned or to take such other action in relation to the Aboriginal object or Aboriginal place as the court considers appropriate in the circumstances.

(9) The court may specify the actions to be taken to mitigate the damage or to restore the Aboriginal object or Aboriginal place under subsection (8) and may order the person to provide security for the performance of any obligation imposed under that subsection.

It should be noted that section 90 applies to all Aboriginal objects irrespective of whether they are considered to be disturbed or not. The issue is whether reasonable precautions and due diligence was exercised to determine whether an Aboriginal object or place was going to be destroyed, defaced, damaged or desecrated or not. Thus if an area was identified as having archaeological potential and was disturbed or destroyed, the defence of reasonable precautions and due diligence would not be available.

Section 87 of the Act covers permits to allow certain actions under section 86. This includes disturbing or excavating any land, or causing any land to be disturbed or excavated, for the purpose of discovering an Aboriginal object.

Environmental Planning and Assessment Act (1979)

The *Environmental Planning and Assessment Act* (EP&A Act) requires that consideration be given to environmental impacts as part of the land use planning process. In NSW, environmental impacts are interpreted as including cultural heritage impact. Three parts of the EP&A Act are most relevant to Heritage. Part 3 relates to planning instruments including those at local and regional levels, Part 4 controls development assessment processes and Part 5 refers to approvals by determining authorities.

Under the EP&A Act, Environmental Planning Instruments (EPIs) typically have provisions that protect items of environmental heritage. The proposed development is a 'designated development' as listed under Schedule 3 of the *Environmental Planning and Assessment Regulation 2000*.

Heritage Act (1977)

The *Heritage Act* (1977, amended 1999) is legislation designed to facilitate the effective management of the heritage of New South Wales. In respect of archaeology, the Act affords protection to 'relics'. A relic is defined under the Act as:

> *Any deposit, object or material evidence relating to the settlement of the area that comprises NSW, not being an Aboriginal settlement, and which is fifty or more years old.*

Protection provisions are set out in section 139 of the Act, which states;

> *1) A person must not disturb or excavate any land knowing or having reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed unless the disturbance or excavation is carried out in accordance with an excavation permit.*
>
> *2) A person must not disturb or excavate any land on which the person has discovered or exposed a relic except in accordance with an excavation permit.*

For relics listed on the State Heritage Register, a permit under section 60 of the Act is required to carry out activities that will result in removal or any form of disturbance. Unlisted relics are also afforded protection under the Act and a permit under section 140 is required for removal or disturbance. Permit applications are submitted to the NSW Heritage Office and processing applications can take from three to eight weeks or more.

If the proposed works are only minor in nature, and will have minimal impact on the heritage significance of the place, they may be excepted from the provisions of section 139. On 7 March 2003 the Minister for Planning revoked all existing standard exceptions and granted new exceptions. The new standard exceptions relate to a broader range of minor development and will result in a more streamlined heritage approval process. Wording relating to these exceptions is set out below.

> *'Excavation or disturbance of land of the kind specified below does not require an excavation permit under section 139 of the Heritage Act provided that the Director of the New South Wales Heritage Office (the Director) is satisfied that the criteria in (a), (b) or (c) have been met and the person proposing to undertake the excavation or disturbance of land has received a notice advising that the Director is satisfied:*
>
> *(a) where an archaeological assessment has been prepared in accordance with Guidelines published by the Heritage Council of New South Wales which indicates*

that there is little likelihood of there being any relics in the land or that any relics in the land are unlikely to have State or local heritage significance;

(b) where the excavation or disturbance of land will have a minor impact on the archaeological resource;

(c) where the excavation or disturbance of land involves only the removal of fill which has been deposited on the land.

A person proposing to excavate or disturb land in the manner described in paragraph 1 must write to the Director and describe the proposed excavation or disturbance of land and set out why it satisfies the criteria set out in paragraph 1. If the Director is satisfied that the proposed development meets the criteria set out in paragraph (a), (b) or (c) the Director shall notify the applicant.'

7.2 Management Strategy

This project involved the Aboriginal and historic heritage investigation of a section of the existing Pacific Highway between Herons Creek and Stills Road, south of Port Macquarie. The survey investigated over 59% of the study area, with effective coverage being acceptable but low due to substantial vegetation cover.

The majority of proposed development areas were within 50 m of the existing Pacific Highway, which has had substantial effects on the surrounding area, most notably the modification of the surface drainage into singular channels. Other impacts include the levelling and grading of the road, forming substantial easements and slopes leading to and from the road. The study area reveals substantial clearing and farming, as well as over 80 years of logging by State Forests , which has promoted soil erosion and vegetation removal.

While the effective coverage across much of the study area was limited due to the dense vegetation, exposures and sections combined with the relief of the study areas revealed that the potential for archaeological site retention in the two areas was poor. Soil profiles reveal only a thin layer of topsoil in places, overlying truncated B horizon deposits or bedrock. Furthermore, the topsoil has clear evidence of being recent and/or colluvial in nature and indicates downslope movement of sediments and materials (**Figures 7, 8** and **9**). The relief of the study areas is highly variable but is generally gentle to moderately steep slopes with some elements of flattened spurs and crests. These types of environment were not particularly conducive to Aboriginal settlement, as discussed below.

Given the existing regional information of Aboriginal studies in the area, it seems likely that the Hastings region appeared to have consisted of relatively semi- settled populations, with major river corridors serving as a focus of activity. Furthermore, according to available ethnographic data, Aboriginals appear to have been present throughout all parts of the river valleys throughout the year, which is particularly relevant to Herons Creek.

In relation to historic heritage, the information on the areas is reasonably well known. Early land use consisted of logging, agriculture and pastoralism with the focus of activities largely occurring near Port Macquarie. Potential archaeological sites include foundations and structures relating to these industries, although due to the heavy modification (or general underdevelopment in the case of State Forests lands) of the study areas, only limited historical heritage was located.

Five sites were located in the study area, three Aboriginal and two historic. In relation to Aboriginal sites, all three were previously identified by Navin Officer (2001) during an initial

survey of Herons Creek. The three sites consisted of #36-6-0149, an isolated find; #36-9-0149, a scarred tree; and a PAD at Herons Creek southern alluvial flat. The isolated find was located just off Clulies Road, south of Herons Creek, in a ploughed field and could not be re-identified by HLA personnel due to the ongoing disturbance of the area (the problem of site location was exacerbated by the fact that the recorded site co-ordinates were inaccurate). In relation to the scarred tree, HLA tried to locate the site (despite the absence of a site card in AHIMS) and identified two trees with scars in the interpreted site's vicinity. Neither HLA personnel nor the Bunyah LALC representative considered that either scar was man-made as both lacked the appropriate diagnostic features, such as *overgrown callus growth* or the typical *elliptical* shape of an artificial scar (Long 2003). Navin Officer (2001) suggested that #36-9-0149 could have been the result of fire.

Unfortunately regardless of the ephemeral nature of #36-6-0149 and #36-9-0146, i.e. the lack of information on the sites or the identification of the sites themselves (by HLA), under the *National Parks and Wildlife Act 1974*, the areas that were previously recorded by Navin Officer (2001) as composing these two sites (regardless of spatial inaccuracies) are protected. Hence, the areas have been identified as of high sensitivity and discussions with DEC onto how to proceed are likely to be required if they are to be impacted.

Navin Officer (2001) identified the southern alluvial flat of Heron Creek as a PAD. Given the regional information on the settlement and movement of Aboriginal people in this region, it seems likely that this large flat area adjacent Herons Creek would have been used by Aboriginal people. Hence, HLA agrees with Navin Officer (2001) and has continued to identify this area as a PAD for further subsurface investigation. In addition, HLA personnel located an additional alluvial flat, clearly older due to its height and distance from the creek, which retained an *in situ* podsol. For this reason, the PAD has been extended to this area for investigation as well. While the PAD has been identified as occurring on both the east and west side of the Pacific Highway, due to modified drainage and hydrology the western side is likely to preserve the most intact profile and investigations should concentrate on these areas. Typically, alluvial flats retain substantial depositional units and future subsurface investigations should consider detailed borehole programs to provide accurate interpretation of the geomorphology in these locations. Given the immediate location of the alluvial terraces to the current Pacific Highway, it seems highly likely that some areas of these terraces (and hence the PAD) will be impacted by the proposed development. **Figure 2** suggests that impacts will occur to the northern end of the lower alluvial flat through the construction of the bridge, while road widening south of the bridge will impact the PAD on both sides of the existing Pacific Highway.

Two historic sites were identified during the course of the survey, H36 and H38. H36 consists of the remains of a Eucalypt with switchboard/axe grooves to one side and was previously identified by Navin Officer (2001). It is located on the corner of Herons Creek Road and Pacific Highway. The site is in poor condition, with possible termite and fire damage. The lack of site specific information combined with the local knowledge of past and current logging in this area has warranted a low significance rating for this site. While consideration to its retention should be given, the low significance of this item allows for its removal if required. Consultation with the NSW Heritage Office and archival recording of the site should be undertaken prior to any form of impact upon this site and a S.139 Exception be obtained. Given the site's association with logging and the past and present logging throughout the area, relocation of the site nearby is a suggested management strategy that would retain its cultural landscape.

H38, Herons Creek Bridge, was identified by Navin Officer (2001) as significant on the basis of its pre-1948 construction and concrete beam structure. The bridge is known to be one of 173 similar bridges in the northern region of NSW. It has been identified as of moderate significance due to its relationship with the Pacific Highway and the retention of much original fabric. Recommendations have not been provided regarding H38, since Navin Officer (2001) identified

a RTA regional study on concrete beam bridges in preparation that will make a number of management strategies in relation to this bridge and others.

7.3 General Recommendations

- Aboriginal objects are protected under the *NPW Act 1974* (as amended), regardless of location. Should any objects be identified during the course of site works, all works must cease and the DEC (Northeastern Branch, EPRD, Regional Archaeologist) contacted in regard to appropriate permit requirements before any further impact is undertaken.
- Historical relics are protected under the *Heritage Act 1977*, regardless of location. Should any relics be identified during the course of site works, all works must cease and the NSW Heritage Office contacted in regard to appropriate permit requirements before any further impact is undertaken.
- Should **suspected** skeletal material be uncovered during the course of site works, all works must cease and the DEC, the NSW Police and the NSW Coroner's office contacted immediately, **regardless** of any existing DEC permits for the proposed development.

7.4 Specific Recommendations

- If impact is likely to occur upon Herons Creek PAD as is suggested in **Figure 2**, then a section 87 "Preliminary Research Permit" should be sought from the Department of Environment & Conservation (NSW) to investigate Herons Creek PAD. This Section 87 application should include a Research Design outlining the method for surface and subsurface investigation of the PAD identified in **Figure 4.**
- If further investigations of the PAD are required, a 'Care and Control' permit application should be applied for by the Aboriginal communities, allowing them to collect and care for any artefacts uncovered during the investigation;
- If #36-6-0149 and #36-9-0146 are to be impacted by the works, then discussions should be held between the RTA and DEC in relation to their management. While HLA was unable to locate #36-6-0149, and HLA disagrees with the assessment of #36-9-0146, these "sites" are still protected under the National Parks and Wildlife Act 1974. Hence, discussions with DEC should seek to identify the most appropriate course of action in relation to these sites, either a) the application for a Section 90 "Consent to Destroy" for both sites; or b) removal of the sites from the AHIMS system and reconsideration of these sites as Aboriginal objects;
- If H36 is likely to be impacted by the proposed development, then notification to the NSW Heritage Office regarding the intended destruction of H36 with a request that determination be made as to whether the intended impact falls under an existing exemption or requires a Section 139 permit. Regardless of the NSW Heritage Office's decision, the preservation and archival recording of H36 should be considered;
- Navin Officer (2001) identified an RTA commissioned regional study on concrete beam bridges in the northern region that is being undertaken/to be undertaken. Heritage management recommendations regarding Herons Creek Bridge, H38, should be taken from that report with regard to its preservation or destruction;

- All contractors who work within the confines of the study area should be made aware of the *NPW Act 1974* (as amended) and the fact that it is an offence to move, disturb or destroy Aboriginal objects without the written permission of the Director General of the DEC. Should Aboriginal objects be located outside of the area covered by the S90, or suspected skeletal material be found, all works should cease and the DEC Regional archaeologist for Northeastern Branch, EPRD contacted immediately.

8 REFERENCES

Arup (2004). *Pacific Highway Upgrade- Moorland to Herons Creek. Preferred Option- Working Paper- Geotechnics.* Prepared by Arup for NSW Roads and Traffic Authority.

Barker, B (2004). *The Sea People: Late Holocene Marine Specialisation in the Whitsunday Islands, Central Queensland.* Pandas Books: The Australian national University.

Bell, D. (1983). Report on an archaeological survey of a proposed Keys-type residential development near Laurieton, mid-north coast of NSW.

Belshaw, J. (1978). Population distribution and the pattern of seasonal movement in northern N.S.W. In I. McBryde (ed.) *Records of Times Past. Ethnohistorical essays on the culture and ecology of the New England tribes.* Australian Institute of Aboriginal Studies: Canberra.

Bonhomme, T. (1986). An archaeological survey of a proposed bridge location at the Hastings River, Settlement Point, Port Macquarie, NSW.

Bonhomme, T. (1988a). *An Archaeological Survey and Preliminary Assessment of Sites in the Proposed North Tuncurry Development Area, NSW.* A Report to the Great Lakes Shire Council, Forster, NSW.

Bonhomme, T. (1988b). *An archaeological survey of a proposed residential development site at Deauville, Laurieton, NSW*.

Brayshaw, H. (1977). Report of an archaeological survey of the route of a proposed transmission line between Taree and Kempsey.

Byrne, D. (1990). Survey for Aboriginal archaeological sites at Port Macquarie.

Breton, W.H. (1833). *Excursions in N.S.W., W.A. and Van Dieman's Land. 1880-1833.* London
Camden Haven Historical Society (CHSS) (1987) *Early History of Camden haven.* LJ Lane Print Laurieton Bay: Laurieton.

CHHS (1997). *Early History of Camden Haven.* Published by Camden Haven Historical Society.

Coleman, J. (1981). Report on a survey of a section of the Hastings River.

Coleman, J. (1982). A new look at the North Coast: Fish traps and Villages. In S. Bowdler (ed.) *Coastal Archaeology in Eastern Australia.* Pp. 1-10. Research School of Pacific Studies, Australian National University: Canberra.

Collins, J. (1995a). *Aboriginal Archaeology Area 13 (Thrumster) Port Macquarie, NSW*, Report Prepared for Hastings Council.

Collins, J. (1995b). *Archaeological Survey of a Proposed Quarry Extension at Kew, Mid-North Coastal NSW.* Report to Mitchell McCotter and Associates.

Collins, J. (1997a). *Pacific Highway Proposed Coopernook Traffic relief Route Aboriginal archaeological assessment*. Report to Connell Wagner Pty Ltd.

Collins, J. (1997b). *Proposed Camden Haven High School "Site 1" Ocean Drive East of Kew NSW Mid-North Coast.* Report to NSW DPWS (Education Branch Schools Section
Collins, J. (1998a.). *Pacific highway Proposed Upgrade Taree Bypass to Coopernook Bypass: Aboriginal Heritage assessment.* Report to Connell Wagner.

Collins, J. (1998b). *Kew Kendall Sewerage Scheme EIS. Archaeological assessment of a Proposed Sewerage Treatment Plant Reconstruction Site near Kew, NSW Mid-North Coast.* Report to SMEC.

Collins, J. (1999a). *Pacific Highway Coopernook Traffic Relief Route Archaeological Investigation of the Area to be affected by the Northern Abutment of Lansdowne Bridge.* Report to Connell Wagner Pty Ltd.

Collins, J. (1999b). *Pacific Highway Upgrade Mooreland. Aboriginal Heritage Assessment.* Report to Connell Wagner Pty Ltd.

Collins, J. (2000). *Pacific Highway Taree Bypass to Coopernook Bypass Archaeological Investigation of the area to be affected by the Southern Abutment of Ghinni Ghinni Bridge.* Report to Connell Wagner Pty Ltd.

Comber, J. (1990). *Archaeological Survey of a Proposed Road Deviation between Herons Creek and Ryans Road, Port Macquarie.* Report to Envirosciences Pty Ltd.

Cunningham, P. (1872) *Two Years in New South Wales.* London.

Dean-Jones, P. (1988). Report on an archaeological survey of the route of the proposed Port Macquarie ring road.

Dean-Jones, P. (1989). *Report on Archaeological Survey at Middle Brother Mountain, Hastings Shire.* Report to Planning Workshop, NBN Pty Ltd.

Department of Planning and National Parks and Wildlife Service (1989). *Aboriginal heritage of the North Coast*. A Discussion Paper prepared by the Department of Planning and the National Parks and Wildlife Service. Department of Planning; Grafton.

Fenning, C. (1997). *Echoes of the axe. The Stories of the People who made the Timber Industry on the Mid North Coast of New South Wales.* Impulse Printing, Brisbane.

Fitzpatrick, F.A. (1914). *Peeps into the Past* Cumberland Argus Ltd, Parramata.

Foley, R (1981a). A model of regional archaeological structure. *Proceedings of the Prehistoric Society* **47**:1-17.

Foley, R. (1981b). Off-site archaeology and human adaptation in eastern Africa: an analysis of regional artefact density in the Amboseli, southern Kenya. Oxford: *British Archaeological Reports International series 97*. *Cambridge monographs in African archaeology 3.*

Griffin, G. and Howell, R. (1996). *Port Macquarie. The Winding Sheet*. Uptin Print, Port Macquarie.

Haglund, L. (1992). Report on an Aboriginal relics survey of a Telecom cable route near Port Macquarie, NSW.

Happ, G. and S. Bowdler, (1983). An archaeological survey of a proposed 132Kv transmission line route from Kempsey to Port Macquarie NSW.

Harrington, R., T.O'Sullivan, T. English, E. Gorrod, M. Predavec and S. Harrington, (2004). *Pacific Highway Upgrade - Moorland to Herons Creek. Environmental Impact Statement*. *Terrestrial Flora and Fauna Report.* Prepared by Biosis Research for Ove Arup and Partners.

HO & DUAP (1996). *Regional Histories of New South Wales*. Heritage Office and Department of Urban Affairs and Planning: NSW.

Higgingbotham, E. (1991). *Historical Archaeology of Hastings Municipal Council, NSW, Appendix A2.* Consultant Archaeological Services. Report Prepared for Suters Architects Snell.

Howitt, A.W. (1904). *The Native Tribes of Eastern Australia.* Macmillan: London.

Kerr,J (2000) *The Conservation Plan*. National Trust NSW: Sydney.

Klaver, J. and Heffernen, K. (1991). *Greater Taree Aboriginal Heritage Study. Technical Report and Conservation Study.* Report to Greater Taree City Council.

Koettig, M., and P. J. Hughes, 1985. Archaeological Investigations at Plashett Dam, Mount Arthur North, and Mount Arthur South in the Hunter Valley. Vols 1 - 3.. Report to the Electricity Commission of NSW and Mount Arthur South Coal Pty Ltd.

Lines-Kelly, R (2000). *Soil Sense: Soil management for NSW North Coast Farmers*. North Coast Soil Management Working Party, NSW Agriculture and Acid Soil Action: NSW.

Long, A. (2003) *Scarred Trees – An Identification and Recording Manual.* A report to Aboriginal Affairs Victoria.

Macquarie, L. (1819). *Macquarie Papers 1818-1822*. Mitchell Library.

McBryde, I. (1974). *Aboriginal Prehistory in New England.* Sydney University Press: Sydney.

McBryde, I. (1976). Subsistence patterns in New England Prehistory. *Occasional Papers in Anthropology No.6*. University of Queensland.

McDonald, R. C., R. F. Isbell, J. C. Speight, J. Walker, and M. S. Hopkins (1998). Australian Soil Survey and Land Survey Field Handbook: Canberra, CSIRO.

McLachlan, I. (2002). *Place of Banishment. Port Macquarie 1818 to 1832.* Uptin Print, Port Macquarie.

MHHS (1991). *Municipality of Hastings Heritage Study, Final Report, July 1991.* Suters Architects Snell.

NPWS, ed., 1997. *Aboriginal Cultural Heritage Standards and Guidelines Kit*: Sydney, NSW National Parks and Wildlife Service.

Navin, K. (1992). *Archaeological Survey for Aboriginal Sites: Middle Brother Mountain, North of Taree, NSW.* Report to Sinclair Knight & Partners Pty Ltd.

Navin Officer (2001). *Moorland to Herons Creek Pacific Highway Upgrade Route Selection Study. Cultural Heritage Assessment.* Report prepared by Navin Officer Heritage Consultants to Ove Arup and Partners.

O'Conner, S. (1992). The timing and nature of prehistoric island use in northern Australia. *Archaeology in Oceania* 27:49-60.

Orton, C. (1980). *Mathematics in Archaeology.* Cambridge, Cambridge University Press.

Oxley, J (1820). *Journal of two expeditions into the Interior of New South Wales.* Facsimile Edition 1964, Libraries Board of South Australia Adelaide.

Pierce, R.G. (1971). *The effects of aquatic foods on the diet and economy of the Aborigines on the north coast of New South Wales at the time of first European settlement.* BA (Hons) Thesis, University of New England.

Rogers, F. (1982). *Port Macquarie, a History to 1850.* Hastings District Historical Society, Port Macquarie.

Shaw, I. & Jameson, R. (1999). *A Dictionary of Archaeology.* Malden Mass, Blackwell Publishers.

Tindale, N. (1974). *Aboriginal Tribes of Australia.* University of California Press.

Turner, J.W. (1990). *Historical Themes of Hastings Municipality*. Hastings Heritage Study Appendix A1. Report prepared for Suters Architects Snell.

Vita-Finzi, C. & Higgs, E (1970). Prehistoric Economy in the Mount Carmel area of Palestine: Site Catchment Analysis. *Proceedings of the Prehistoric Society* **36**: 1-37.

Figures

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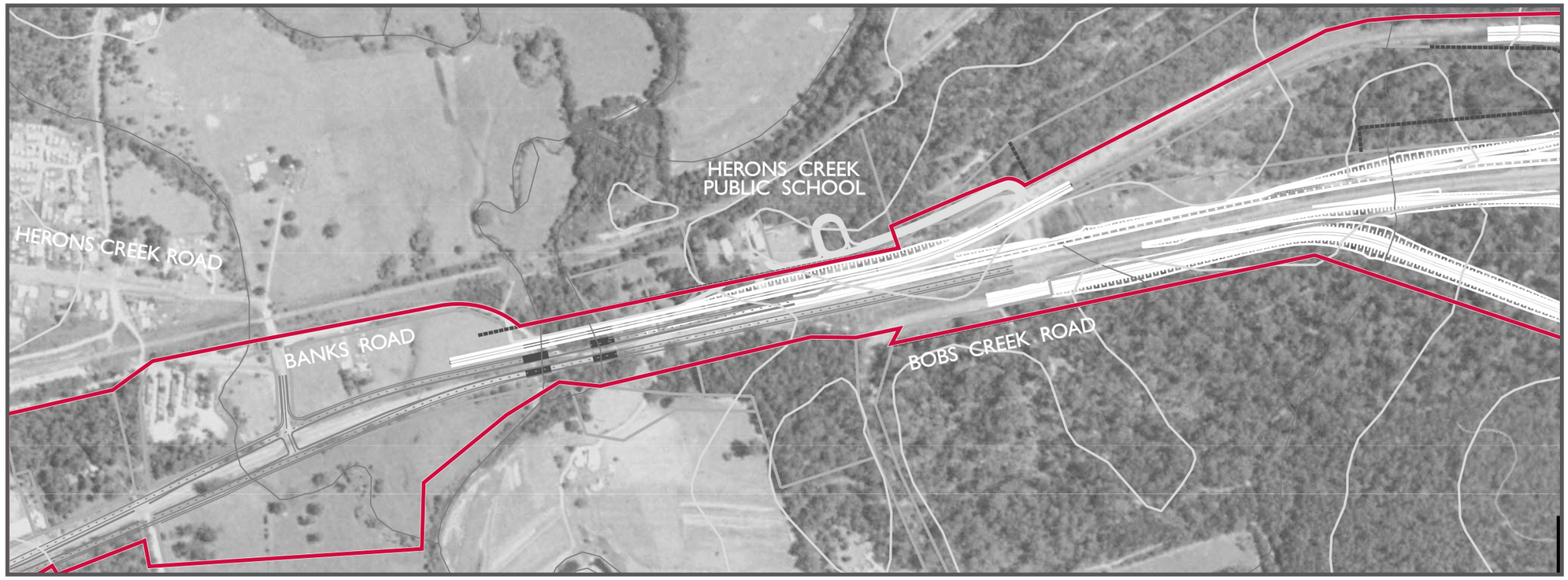
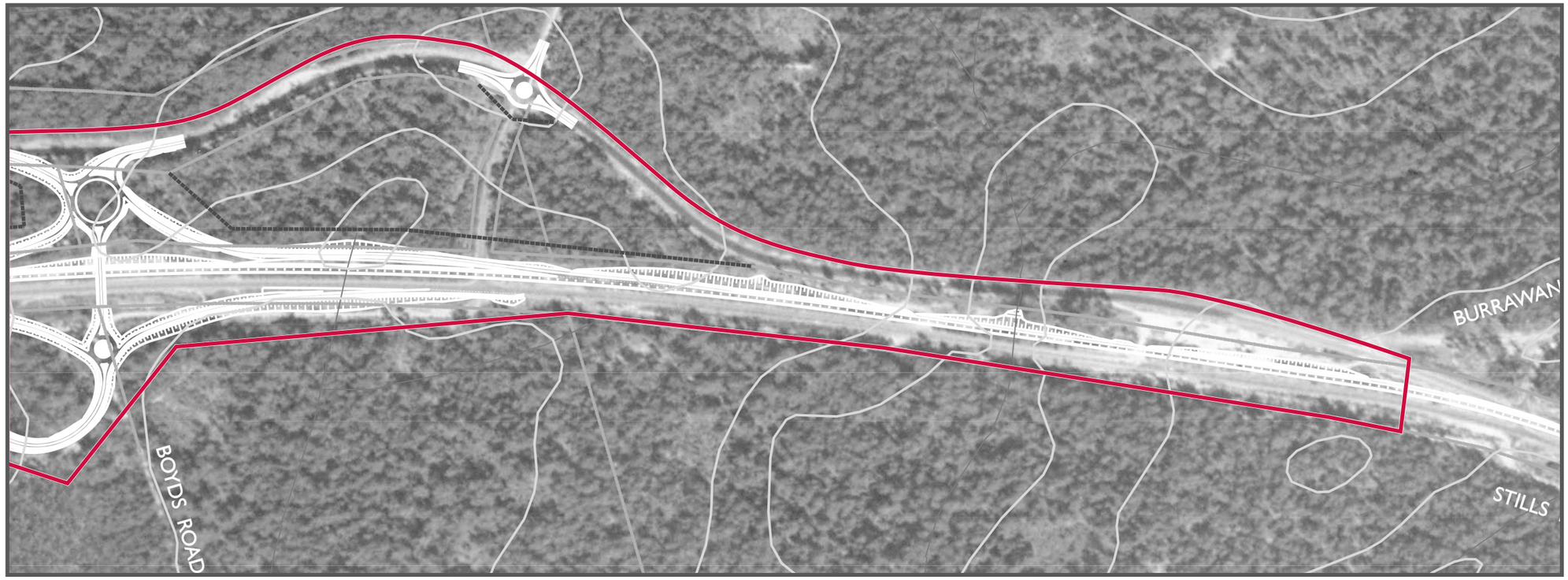


Southern Section



Northern Section

PROJECT-FILE NAME	**N6033102**
DATE	**21 July 2006**
DRAWN	**TO**
APPROVED	

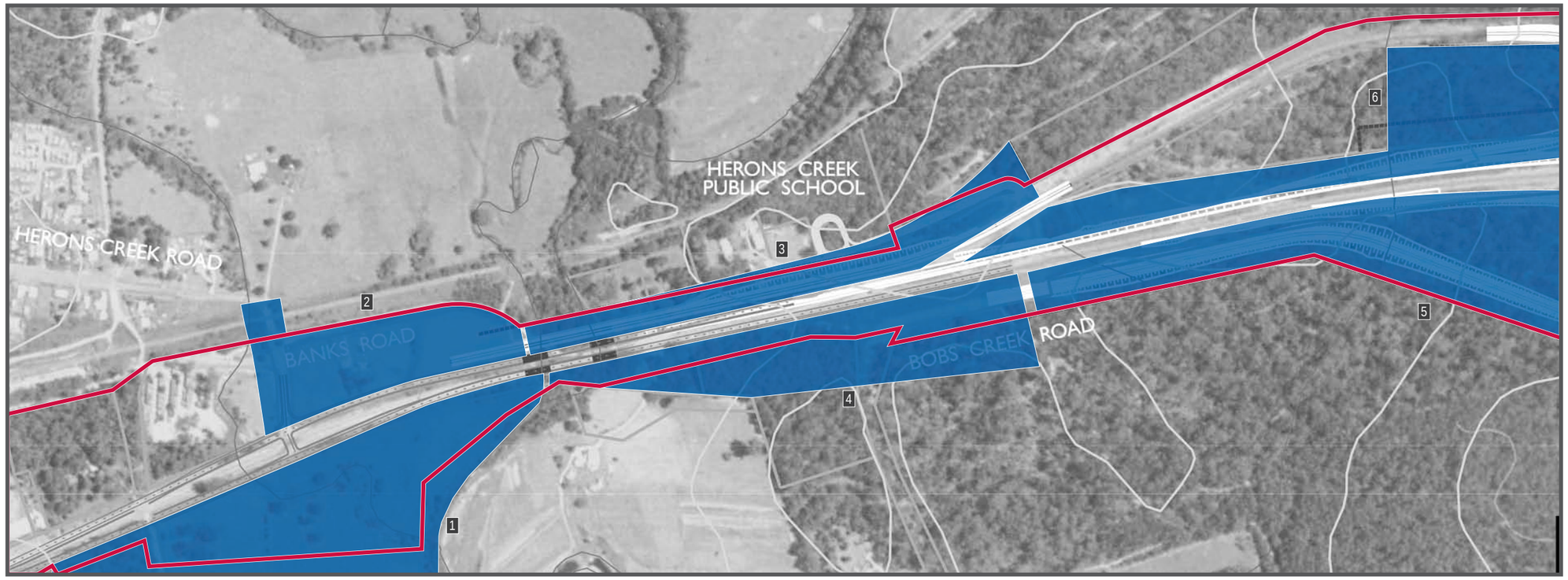
Study area

Proposed Development Area
Roads and Traffic Authority NSW
Aboriginal Heritage Assessment -
Herons Creek to Stills Road NSW

HLA

0 125m

FIGURE **2**



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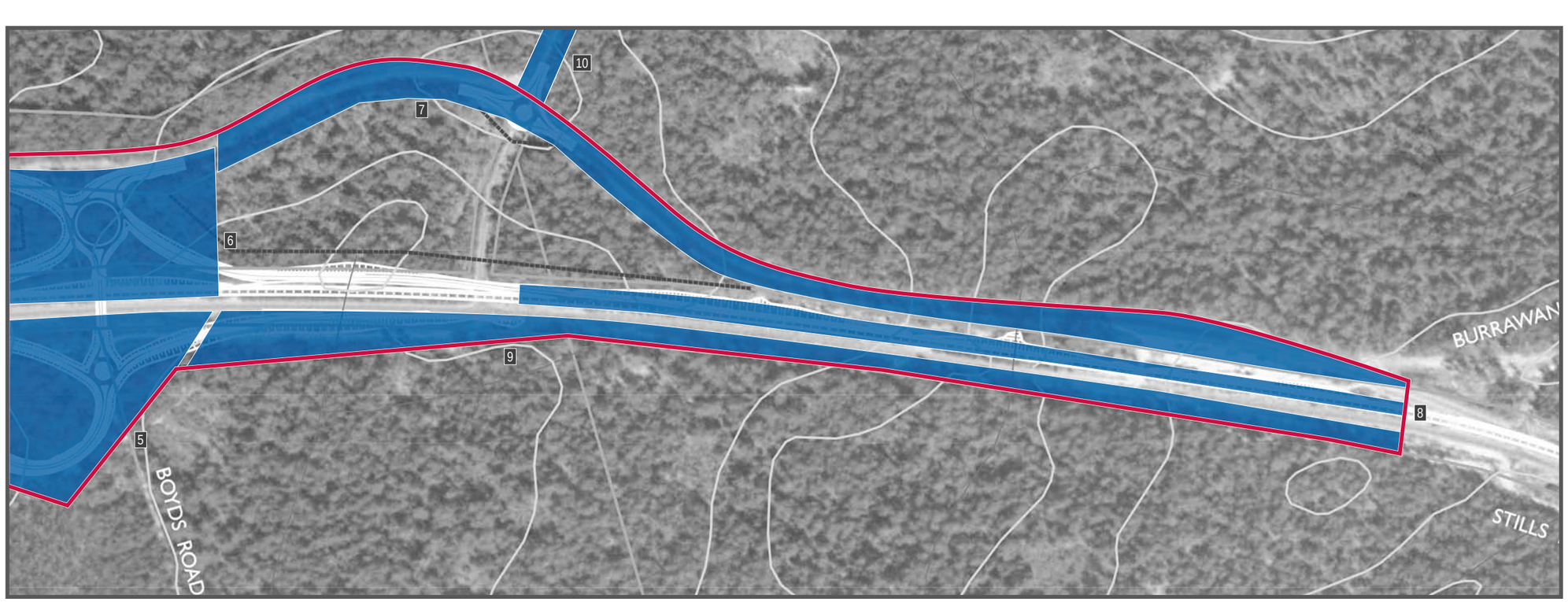


Northern Section

PROJECT-FILE NAME N6033102
DATE 21 July 2006
DRAWN TO
APPROVED

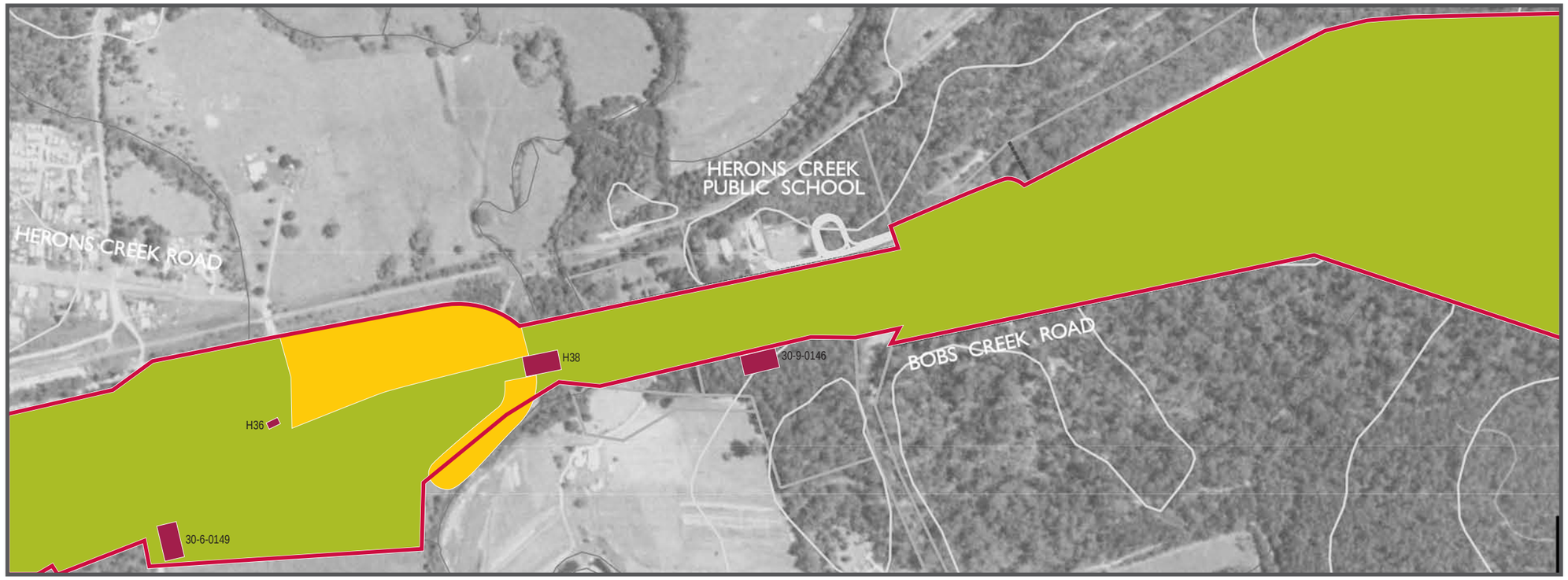
Study area
Survey transect

Map of Survey Transects
Roads and Traffic Authority NSW
Aboriginal Heritage Assessment -
Herons Creek to Stills Road NSW

HLA

0 125m

FIGURE 3



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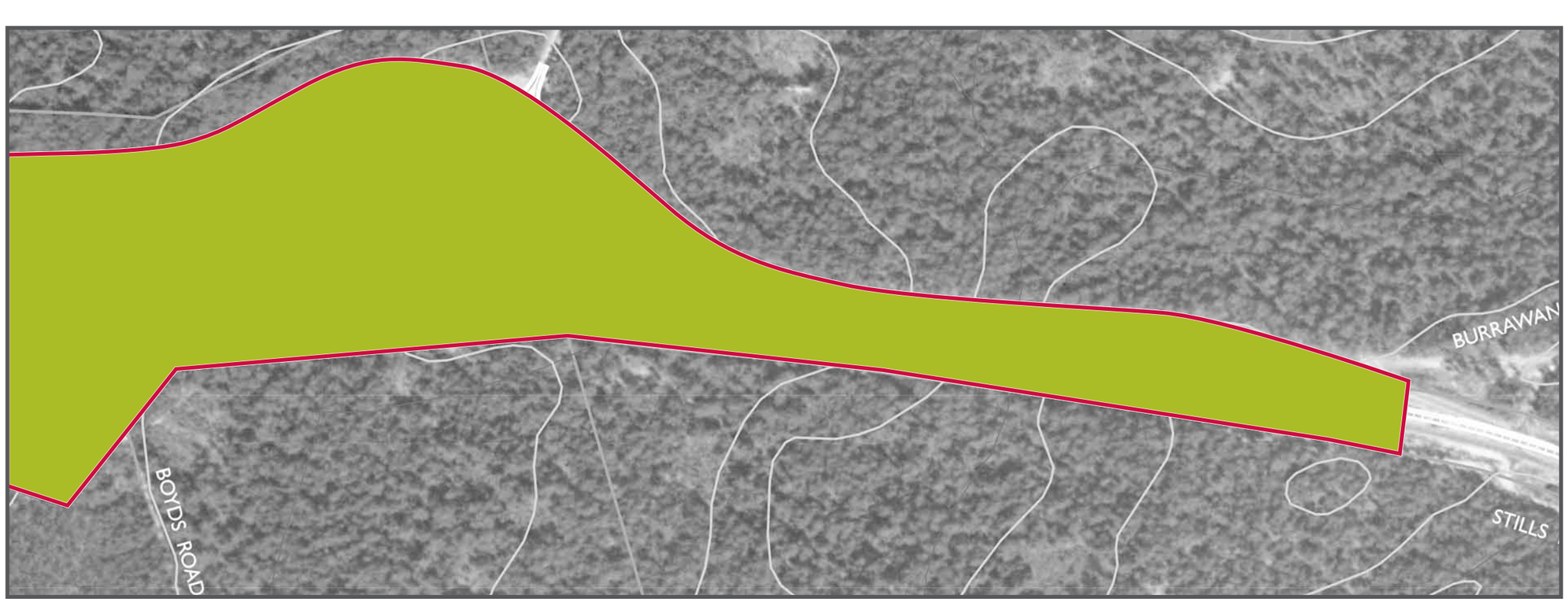


Northern Section

PROJECT-FILE NAME	N6033102
DATE	24 July 2006
DRAWN	TO
APPROVED	

Study area
Historical Site
Medium potential
Low potential

Herons Creek to Stills Road Archaeological Sites and Areas of Archaeological Potential
Roads and Traffic Authority NSW
Aboriginal Heritage Assessment -
Herons Creek to Stills Road NSW

HLA

0 125m

FIGURE 4

1= Before erosion commences, Unit A over Unit B
2= Sheet erosion reveals some archaeological material across the unit
3= Sheet wash and gullying expose the base of Unit A and Also Unit B / the artefacts are redeposited in the reworked soil at the base of the slope (Unit C)
4= Mostly Unit B exposed / artefacts have been moved and incorporated into the reworked deposit at the base of the eroding face

HLA

Koettig's Model of Site Formation and Post - Depositional Processes (Koettig et al 1985)
Roads and Traffic Authority NSW
Aboriginal Heritage Assessment -
Herons Creek to Stills Road NSW

FIGURE
5

PROJECT-FILE NAME **N6033102** DATE **21 July 2006** DRAWN **TO** APPROVED

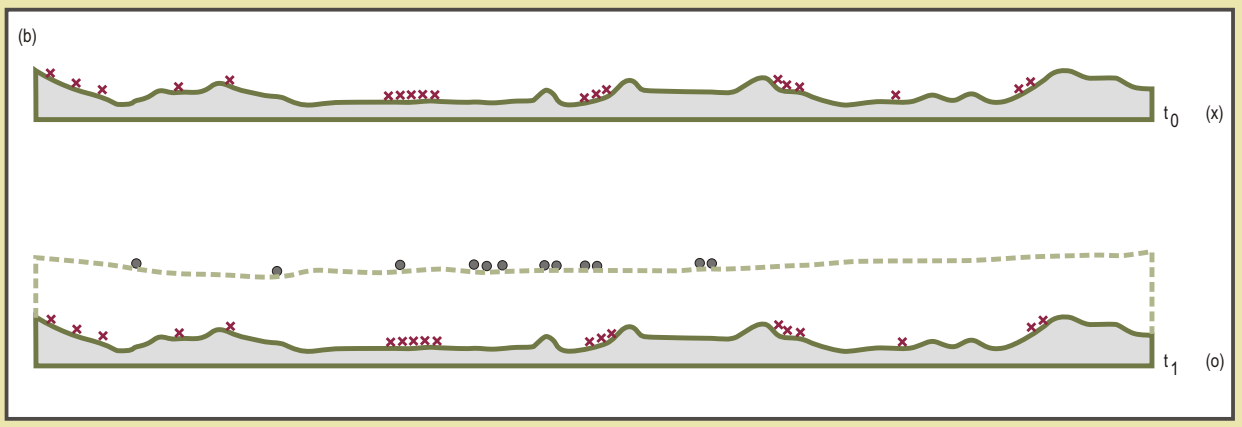
HLA

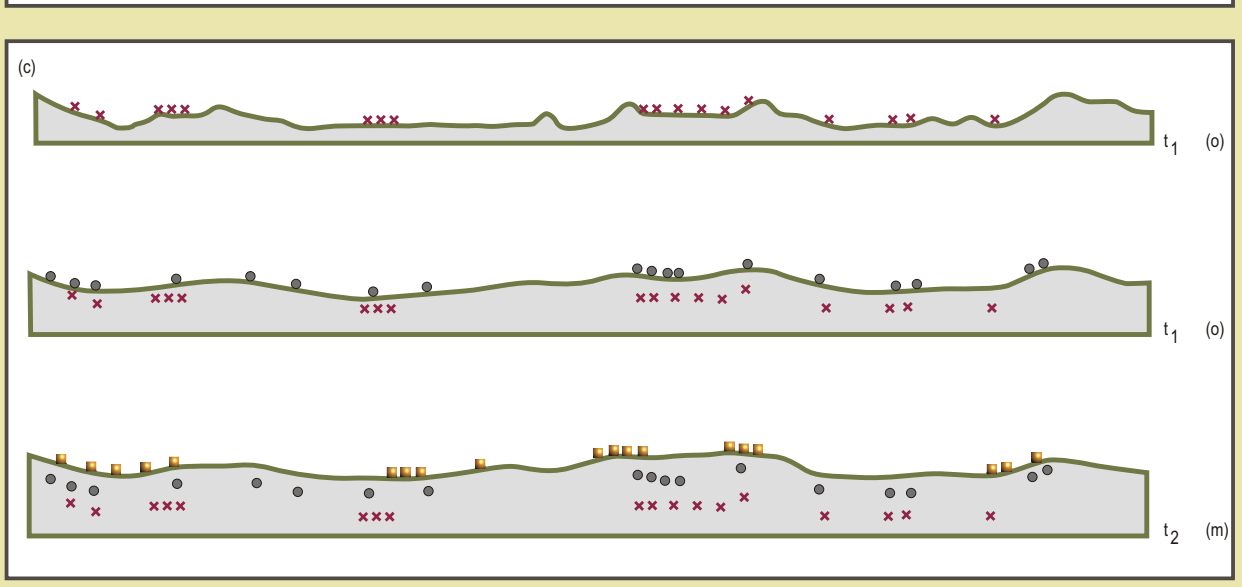
Modelled Distribution of Activities within Home Range (Left) and Consequent Patterning of Artefacts (right) (after Foley, 1981a)
Roads and Traffic Authority NSW
Aboriginal Heritage Assessment -
Herons Creek to Stills Road NSW

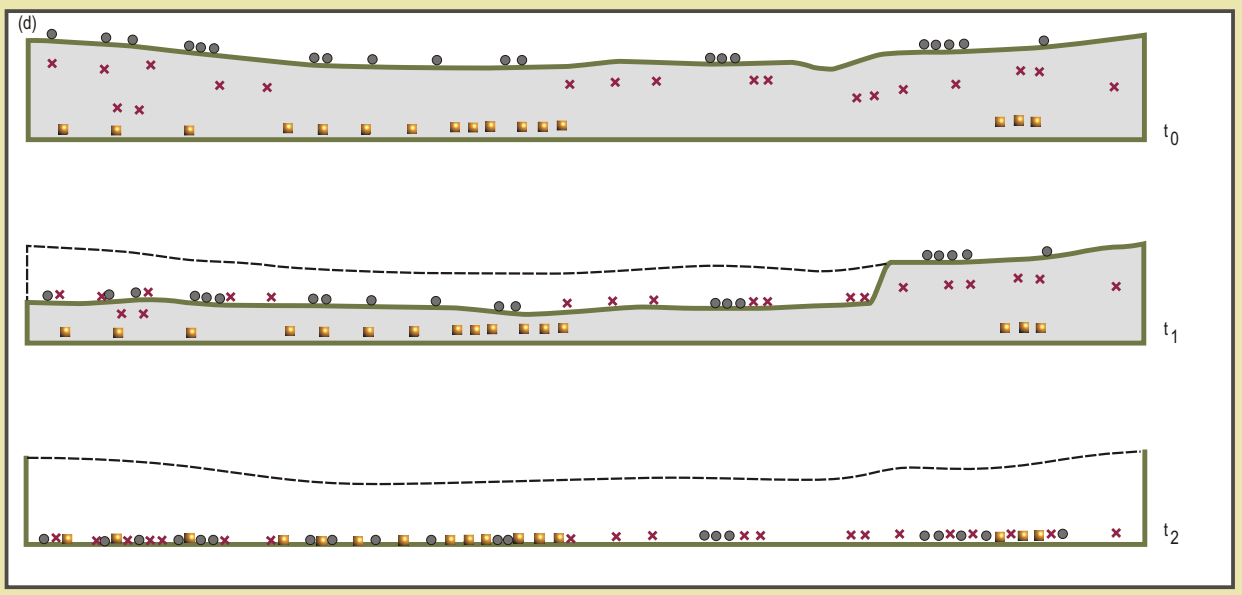
Temporary camps
Lithic source
Animal migration
Swamp

FIGURE
6

PROJECT-FILE NAME N6033102 DATE 21 July 2006 DRAWN TO APPROVED







Cumulative Effects of Artefact Discard and Site Formation (After Foley, 1981b)
Roads and Traffic Authority NSW
Aboriginal Heritage Assessment -
Herons Creek to Stills Road NSW

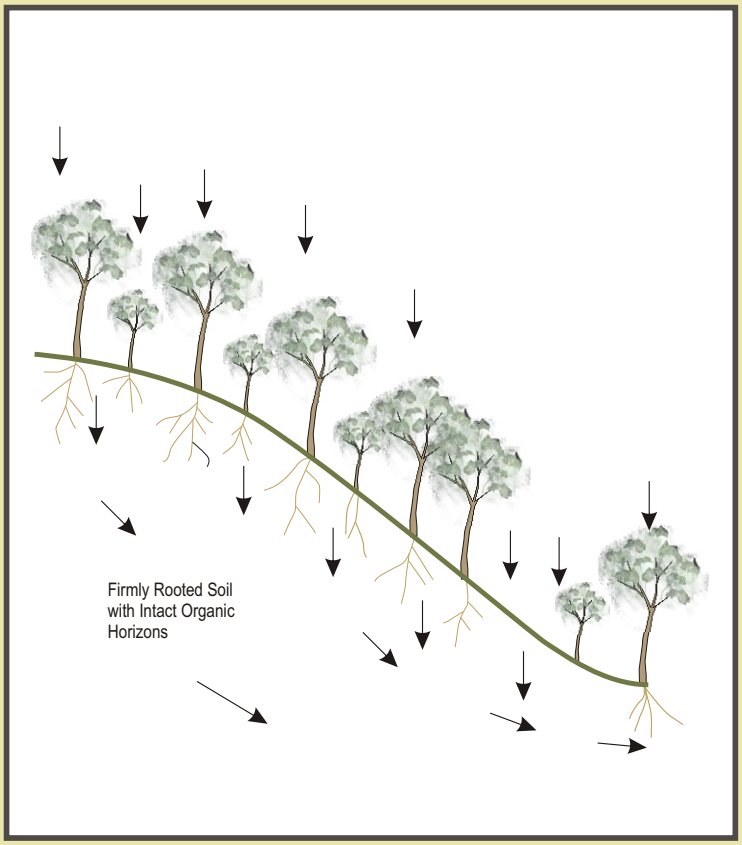
a Cumulative effect of simple artefact discard
b Cumulative effect of artefact discard on landscape suddenly buried
c Cumulative artefact discard on a gradually degrading landscape
d Effect of gradual exposure on artefact distribution
e Effect of bioturbation on artefact distribution

FIGURE
7

PROJECT-FILE NAME **N6033102** DATE **21 July 2006** DRAWN **TO** APPROVED

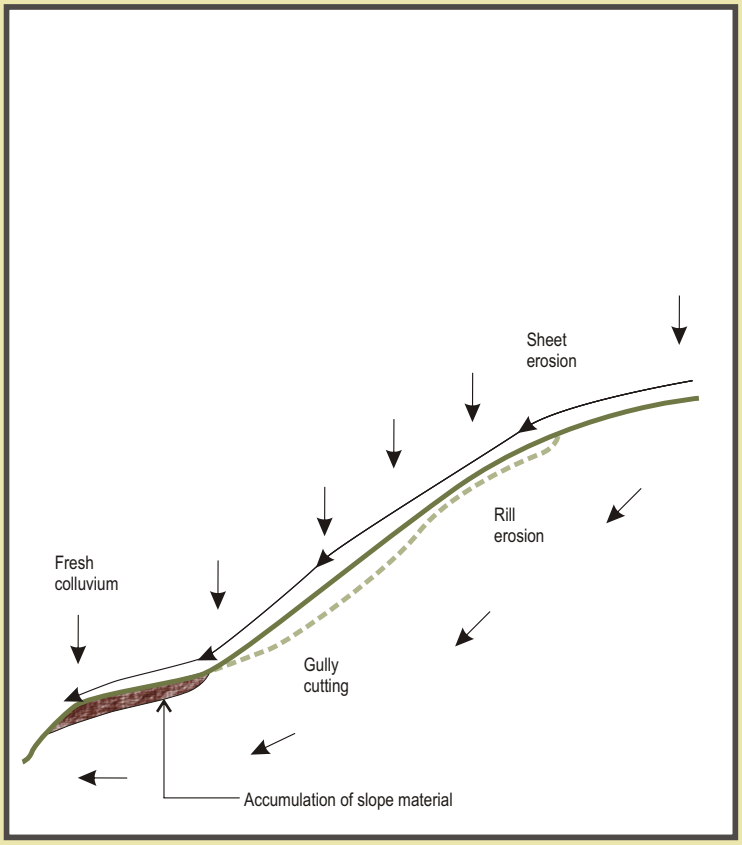
WOODED SLOPE

- Considerable interception
- Maximum infiltration
- Throughflow
- Retarted runoff and protracted seepage



OPEN FIELD/CLEARED SLOPE

- No interception
- Rapid, unimpeded runoff
- Limited infiltration



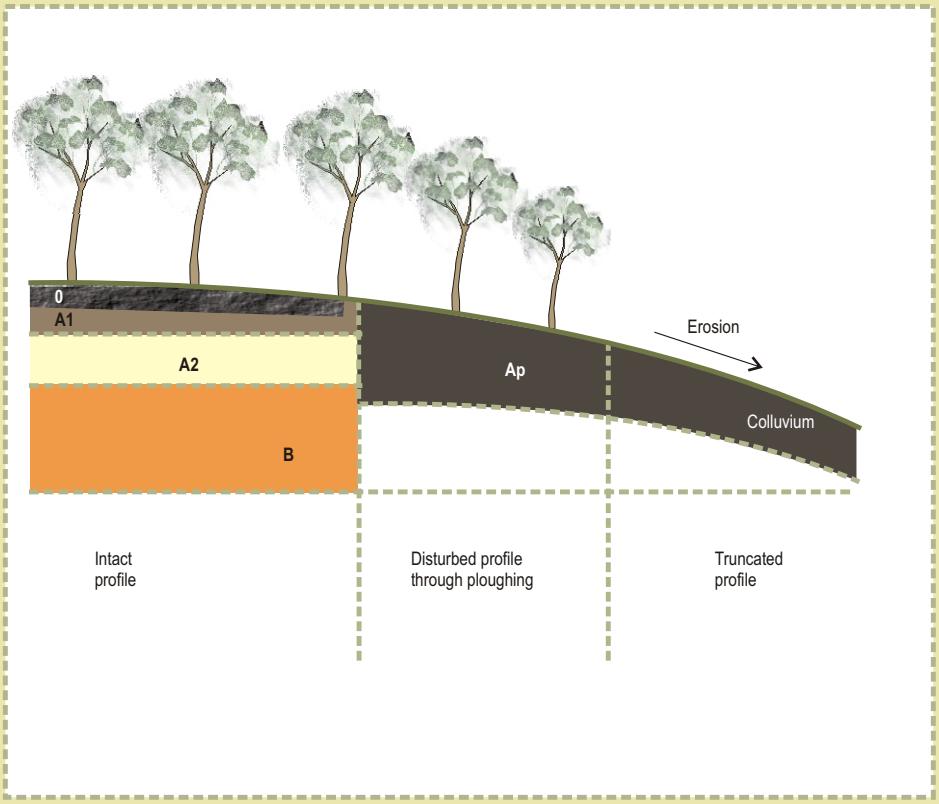
HLA

Contrasting Run-Off and Infiltration
on Wooded Slopes and Cultivated Slopes (after Butzer, 1976)
Roads & Traffic Authority NSW
Aboriginal Heritage Assessment -
Herons Creek to Stills Road NSW

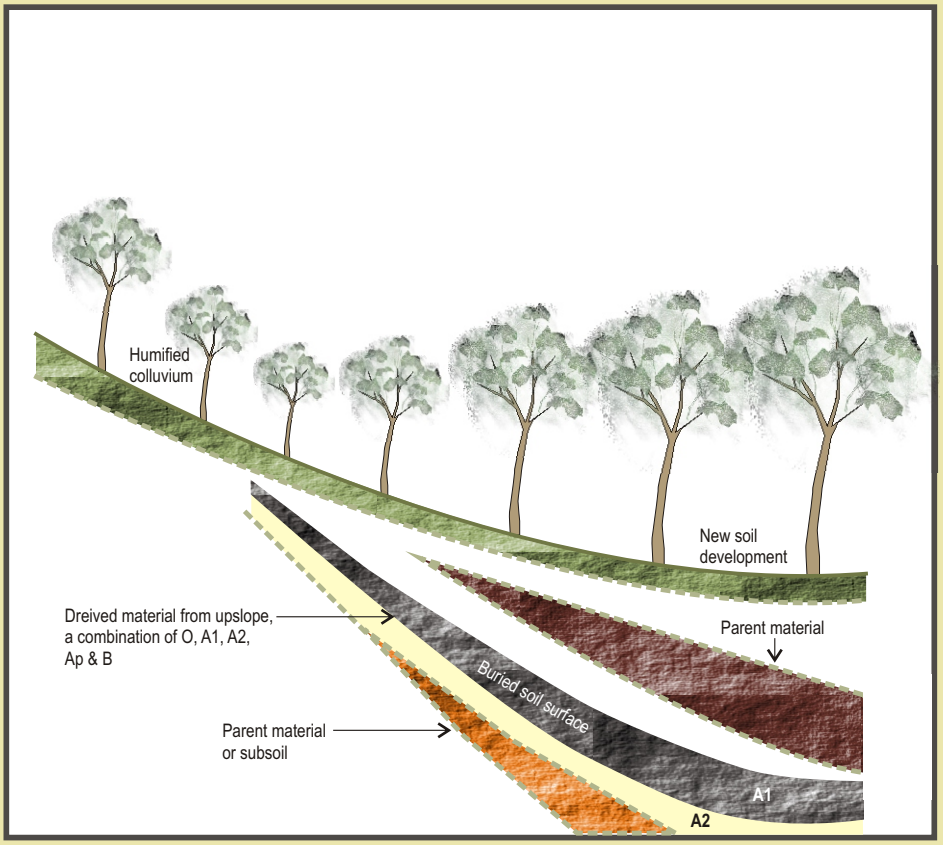
FIGURE
8

PROJECT-FILE NAME **N6033102** DATE **21 July 2006** DRAWN **TO** APPROVED

UPSLOPE



DOWNSLOPE

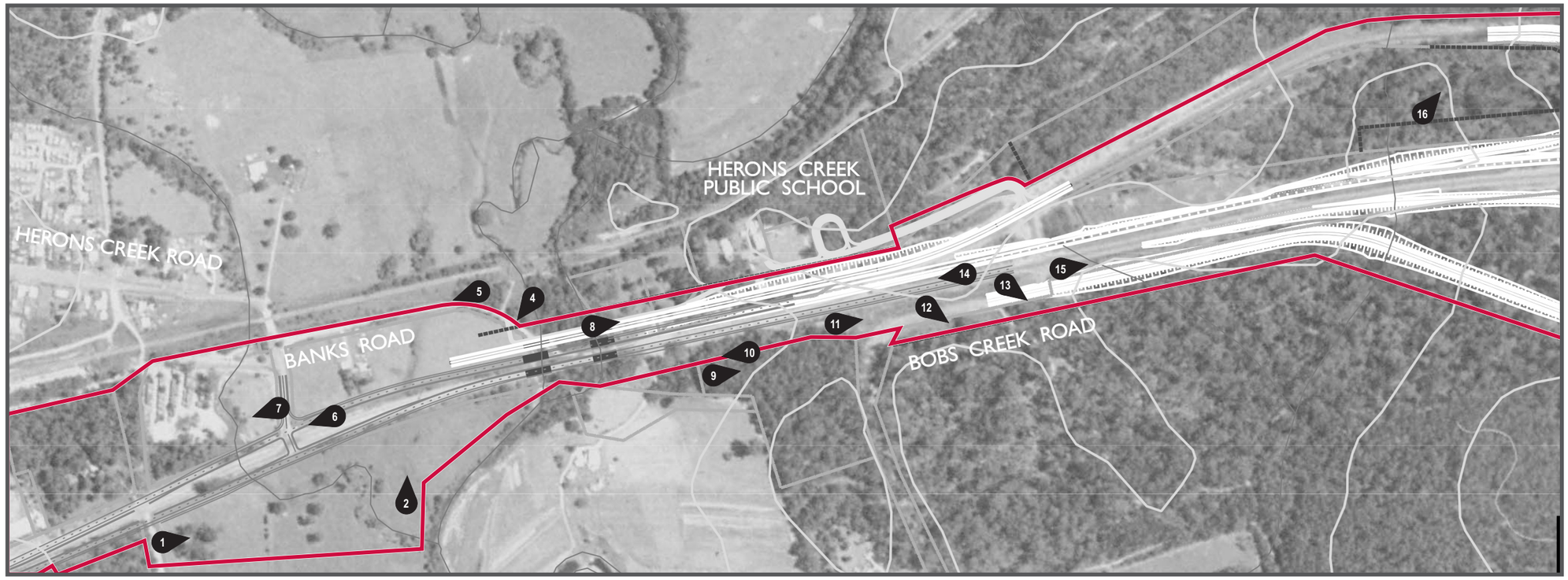


HLA

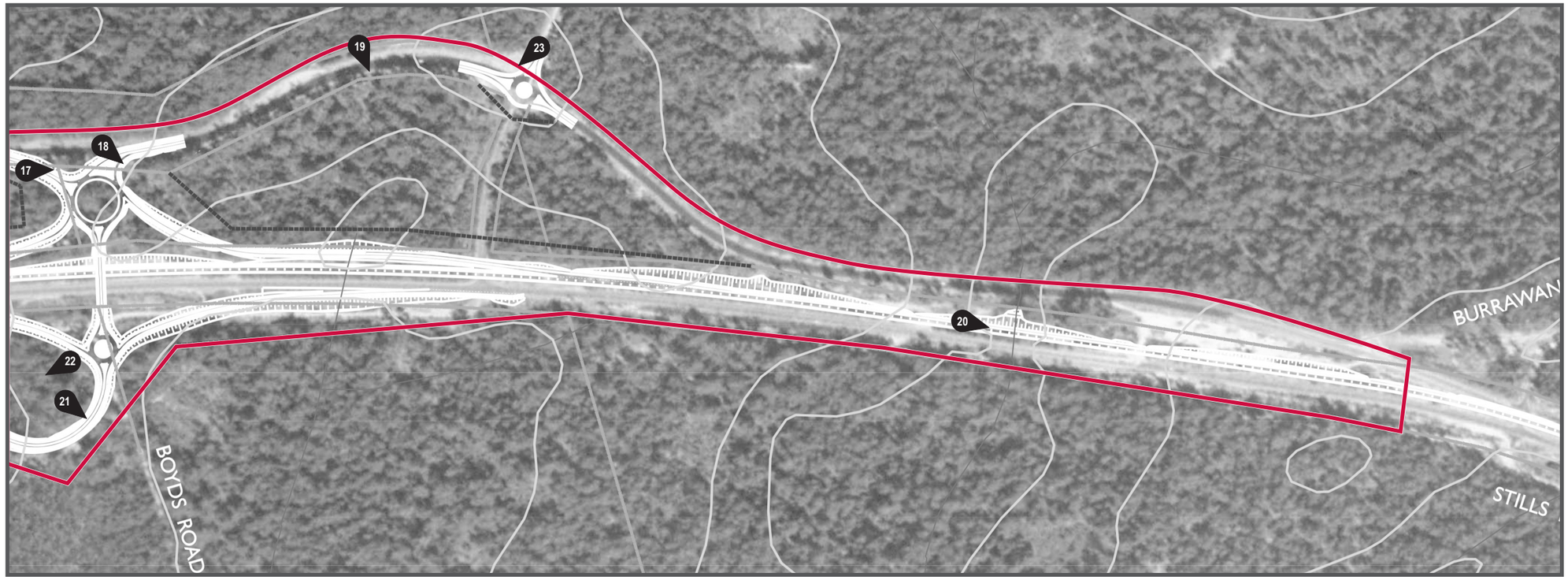
Upslope Soil Disturbance or Truncation, and Downslope Colluvial Deposition of Soil (after Butzer, 1982)
Roads and Traffic Authority NSW
Aboriginal Heritage Assessment -
Herons Creek to Stills Road NSW

FIGURE
9

PROJECT-FILE NAME **N6033102** DATE **21 July 2006** DRAWN **TO** APPROVED



Southern Section



Northern Section

PROJECT-FILE NAME	**N6033102**
DATE	**21 July 2006**
DRAWN	**TO**
APPROVED	

Study area

18 Photograph location and direction of view

Photograph Locations and Directions of View
Roads and Traffic Authority NSW
Aboriginal Heritage Assessment -
Herons Creek to Stills Road NSW

HLA

0 125m

FIGURE **10**

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Plates

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PLATE 1

Transect 1, looking north towards Herons Creek (marked by the trees in the background). #37-6-0149, an isolated find, identified by Navin Officer (2001) should be located in the foreground, but no evidence of it could be found

PLATE 2

Northern end of transect 1, looking west. This photograph overlooks the southern alluvial flat of Herons Creek (delineated by the vegetation to the right of the photograph), which is considered to be a PAD due to the high potential for subsurface deposits

PLATE 3

Then northern end of transect 1, looking northwest towards Herons Creek Bridge (H38). This concrete beam bridge has been identified as of historical interest by Navin Officer (2001)

PLATE 4

Herons Creek Bridge, H38, looking east. The deposits in the foreground, largely multiple silty fluvial sediments, are considered a PAD. Herons Creek is just out of photograph to the left

PLATE 5

Transect 2, looking south. The pacific highway is out of photograph to the left and Herons Creek is behind the camera. The area in the foreground is an alluvial flat of Herons Creek, while an older alluvial flat (with the house situated upon it) evident in the background, both have been identified as a PAD

PLATE 6

A section of the older alluvial flat pictured in Plate 23. This section, looking south towards Herons Creek Road, reveals an in situ podsol composed of an organic clayey loam dark brown A horizon overlying a bleached Ae (or A2) horizon overlying an orange clay B horizon. The preservation of this soil, which can take substantial time to form, has been identified as a PAD

PLATE 7

Switchboard tree stump located on the corner of Herons Creek Road and Pacific Highway was identified by Navin Officer (2001) as a historical relic. It is identified in this study as H36

PLATE 8

Transect 3, looking north. This area has been heavily modified by roads and stopping bays as can be demonstrated here

PLATE 9

One of two scarred trees located in transect 4 that is thought to have been identified by Navin Officer (2001) and subsequently identified as #37-9-1049

PLATE 10

An alternative scarred tree located within the vicinity of the tree in Plate 27 – an possible alternative

PLATE 11

The northern section of transect 2, looking north, over Bobs Creek Road

PLATE 12

Typical truncated soil profile located in the Bobs Creek Road region. An exposed truncated orange clay B horizon overlain by an Am, or a duripan type unit. This latter unit is common in Australia through the leaching of water and salts to the surface through evaporation

PLATE 13

Transect 4, looking northeast. An example of the grading to bedrock that has occurred along the southern edge of the current Pacific Highway, limiting any subsurface potential

PLATE 14

Transect 4, looking south. Another example of heavy road modification along the edges of the Pacific Highway

PLATE 15
Transect 5, looking north

PLATE 16
Transect 6, looking west. This photograph reveals the variability in visibility in some locations

PLATE 17

Transect 6, looking north. This area has been preferentially logged for over fifty years

PLATE 18

Transect 6, looking northeast. Soil exposures through this area suggest that much of the topsoil is recent shallow organic topsoil. Typically, as can be seen here, all that remains is truncated clayey B horizon

PLATE 19

Cutty Creek, within transect 7, looking northeast. Near the Pacific Highway, the creek has been heavily disturbed and is generally eroding rather than depositing, both factors limiting subsurface potential

PLATE 20

Transect 7,. looking north. As can be seen in the back right of the photograph, the central median strip in this location is very narrow and heavily impacted

PLATE 21

Transect 5, looking east. Soil profiles in this location revealed a typical truncated duplex soil

PLATE 22

Transect 5, looking southeast. While visibility was low in this location, the area has been repetitively logged and substantial impacts (through road construction and logging) have occurred

PLATE 23

Transect 10, looking southeast. In many locations surrounding Bago Road, clear evidence of truncated clay orange B horizons are evident, indicating substantial erosion and reducing any subsurface potential

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Appendices

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Appendix A: Consultation Log and Aboriginal Community Statements

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Client: RTA Project No.: N6033201 Site.: Failford Road to Tritton Road, Herons Creek to Stills Road

GROUP	REPRESENTATIVE CONTACTED	DATE	COMMENTS	HLA REPRESENTATIVE
Forster Tuncurry LALC	Heritage Unit	10Aug05	Sent two e-mails to Forster Tuncurry regarding their project and seeking their interest.	Alan Williams
Bunyah LALC	Mike Dibbs	10Aug05	Phoned Mike to advise him of the project and that I would send through additional information	Alan Williams
Bunyah LALC	Mike Dibbs	10Aug05	Sent fax to Mike outlining the project and seeking his interest in the project	Alan Williams
DEC	Brendan Diacono	10Aug05	Letter to Brendan requesting information on relevant Stakeholders of the area.	Alan Williams
Native Title Tribunal		11Aug05	Requested a search of Native TitleClaims in the general area of the two proposed study areas	Alan Williams
Office of Registrar		11Aug05	Requested a search of registered land claims in the general area of the two proposed study areas	Alan Williams
Forster LALC		18Aug05	Spoke with the Forster LALC who advised that they would be interested in participating in the project.	Alan Williams
Forster LALC	Robert Yettica	18Aug05	Faxed the survey methodology to Forster LALC, providing 21-days for community comment. Followed this fax with a phone call to advise that the methodology had been sent.	Emma Harrison
Bunyah LALC	Mike Dibbs	18Aug05	Called and spoke with Mike, who confirmed his groups' interest in the survey. I advised Mike that the methodology would be sent later today and that the fieldwork would be occurring around early to mid-September and that we would be in touch regarding this.	Emma Harrison
Bunyah LALC	Mike Dibbs	18Aug05	Faxed the survey methodology to Bunyah LALC, advising of the 21-day comment period and that fieldwork would commence directly after community comments had been received.	Emma Harrison
Bunyah LALC	Mike Dibbs	15Sep05	Meeting with LALC and RTA reps (David Kilby, Greg Baird, Ben Phillipson and Mary-Lou Buck). Discussed study area, methodology, DEC interim guidelines. All okay – i.e. pursue newspaper ad, survey methodology and timing	Chaz

Forster LALC	Robert Yettica	16Sep05	Meeting with LALC and RTA reps (David Kilby, Greg Baird, Ben Phillipson). Discussed study area, methodology, DEC interim guidelines. All okay – i.e. pursue newspaper ad, survey methodology and timing	Chaz
Forster LALC	Robert Yettica	21Sep05	Robert had chased up the Guiwain Elder Group in Taree in regards to study area – they do not involve themselves in cultural heritage matters within the area of our study.	Chaz
	Gordon Brown	18.Oct.05	Sent letter and methodology to Mr Gordon Brown who responded to the newspaper advertisement	Cornelia de Rohefort
	Diedre Ally	31.Oct.05	Sent letter and methodology to Ms Diedre Ally who responded to the newspaper advertisement	Cornelia de Rochefort
Ganangarra Ananawan Elders Tribal Council	Kim Moran	31.Oct.05	Sent letter and methodology to Ms Kim Moran who responded to the newspaper advertisement	Cornelia de Rochefort
Bunyah LALC	Mike Dibbs	10.11.05	Mike has heard of the Morans, but does not consider them to belong to the area, claims they are further north near Kempsey. He is consulting the elders for me	Alan Williams
Ganangarra Ananawan Elders Tribal Council	Edward Moran	11.11.05	Received fax from the Ganangarra Ananawan Elders Tribal Council, registering their interest in participating in the project	Cornelia de Rochefort
Forster LALC	Robert Yettica	10.11.05	Sent letter advising interested parties of the dates of field work and HLA's standard terms of agreement.	Cornelia de Rochefort
Forster LALC	Robert Yettica	15.11.05	Received signed documentation from Robert regarding insurance details and standard terms of engagement	Cornelia de Rochefort
Ganangarra Ananawan Elders Tribal Council	Edward Moran	21.11.05	Sent letter advising interested parties of the dates of field work and HLA's standard terms of agreement.	Cornelia de Rochefort
	Diedre Ally	21.11.05	Sent letter advising interested parties of the dates of field work and HLA's standard terms of agreement.	Cornelia de Rochefort
	Gordon Brown	21.11.05	Sent letter advising interested parties of the dates of field work and HLA's standard terms of agreement.	Cornelia de Rochefort
Bunyah LALC	Mike Dibbs	24.11.05	Sent letter advising interested parties of the dates of field work and HLA's standard terms of agreement.	Cornelia de Rochefort
Bunyah LALC	Mike Dibbs	24.11.05	Received signed documentation from Mike regarding insurance details and standard terms of engagement	Cornelia de Rochefort
Forster LALC	Robert Yettica and Robbie Paulson	28-29.11.05	Participated in the physical inspection of the Failford Road study area	Alan Williams, Cornelia de Rochefort

Bunyah LALC	Trevor Roberts	30-31.11.05	Participated in the physical inspection of the Herons Creek study area	Alan Williams, Cornelia de Rochefort
Bunyah LALC	Trevor Roberts	3.3.06	Provided comments on the survey	Alan Williams
Forster LALC	Robert Yettica	16.5.06	Draft report sent for comment	HLA Newcastle

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03 MAR 20

BUNYAH LOCAL ABORIGINAL LAND COUNCIL

SITE SURVEY REPORT

Date of Survey: 30th November 2005

Location: Pacific Highway, Herons Creek to Stills Road, Herons Creek

Reason for Survey: The areas surveyed is the location of a planned re-alignment of the Pacific Highway. The survey was to determine if the land affected contained any Aboriginal artifacts or sites of significance.

Survey carried out by: Trevor Roberts

Results of survey: No artifacts or sites of significance were located on the areas surveyed

Report: A large percentage of the total area surveyed has been significantly disturbed during previous roadworks. There was a substantial regrowth cover on most of the area surveyed but a good examination of the surface was possible.
There was a substantial number of small rocks located, both on top of the ground and immediately under the surface, which were not local. They were probably from roadmaking materials brought from elsewhere.

Recommendation: In view of the fact that no artifacts or sites of significance were found the Bunyah Local Aboriginal Land Council have no objections whatsoever to the planned roadworks proceeding.

T. Roberts

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Trevor Roberts: Sites Officer

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Appendix B: AHIMS Site Search information

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This information has been omitted due to cultural sensitivities

Herons Creek to Stills Road

Review of Environmental Factors – Appendix H

Landowner and stakeholder meeting notes.

January 2007

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Herons Creek to Stills Road Pacific Highway Upgrade
Notes from Meetings with Land Owners, July 2005

Faye Hargreaves (Communications Consultant), Greg Baird (Project Development Manager, RTA Pacific Highway Office) and David Kilby (Project Manager, RTA Technical Services) held meetings with land owners in the study area for this project on Wednesday 20 and Thursday 21 July 2005. At each meeting the background behind the project, the concept design currently being finalised, and any potential impacts of the project on the land owner's property was discussed. The following table documents the issues raised and actions agreed at each meeting.

Land Owner	Meeting Details	People Present	Issues Raised	Actions
Hastings Council	20 July at 4.00pm, Hastings Council, cnr Burrawan and Lord Streets, Port Macquarie	Cliff Toms (Technical Services Manager), Andy Atkinson, Matthew Owens (Planning Manager), Murray Thomson (Water Supply Manager)	▪ It was asked whether Council will have any influence on the handover of the current northbound Highway when it becomes a service road, and who will maintain, fund and own the road ▪ It was suggested that Boral Timber would have concerns about the extra distance involved in having to drive to the intersection to access the Highway ▪ Concern was raised that drivers of northbound heavy vehicles may exit the Highway at the junction further south (near Kew), to get to the mill to avoid the extra distance to the interchance and back to the mill - this would result in more traffic on the service road ▪ Council is concerned about the redistribution of heavy traffic and not so concerned about light vehicles ▪ The industrial zone at Herons Creek will need to be serviced with water from Sancroix so there needs to be a	▪ Faye to keep Council informed as the project progresses

Land Owner	Meeting Details	People Present	Issues Raised	Actions
			corridor to install a pipeline along the Burrawong Forest Drive alignment – this project will probably make this easier. ▪ There are no current plans for subdivision in this corridor ▪ Herons Creek School is under the control of the Department of Education, but Council would support the retaining of a school, whether is remains at Herons Creek or is relocated ▪ Council would like to see the current Bago Road intersection smoothed out ▪ Council asked if the RTA has considered building an interchange at Herons Creek rather than Bago Road	
Boral Timber	21 July at 8.30am, Boral Timber, 420 Herons Creek Road, Herons Creek	Graham Wood	▪ Boral Timber supports the current proposal for a grade separated interchange immediately south of Bago Road as this would be safer than the current access directly onto the Highway, and does not want an intersection with the Highway at Herons Creek ▪ Graham is concerned about the safety of children on the roads at Herons Creek and fears an accident involving traffic from Boral Timber ▪ Graham has concerns about a seagull intersection at Herons Creek Road ▪ Graham provided the RTA with some information from ERM's Statement of Environmental Effects ▪ Boral Timber has a 2 shift operation and	▪ Faye to keep Graham informed as the project progresses

Land Owner	Meeting Details	People Present	Issues Raised	Actions
			typically there are 50 trucks or 100 truck movements per day, which does not include traffic generated from employees and sales representatives ▪ The busiest days at Boral Timber are those immediately after a period of rain ▪ It is currently difficult to turn out onto the Highway at Herons Creek Road during holiday periods ▪ The acceleration lane needs to be longer if it goes up hill as it's more difficult for trucks to get up to a fast enough speed ▪ Boral Timber would oppose any of its land where there is infrastructure in place being acquired but there would be less concern about acquisition of land at the northern side the site ▪ The land in the middle of the two sides of the Boral Timber site is owned by Manfred and Crystal Doorne	
Herons Creek School	21 July at 10.00am, Herons Creek School, 5499 Pacific Highway, Herons Creek	Karen Adams, School Principal	▪ The school caters for 11 children from 6 families – three families from Herons Creek, 2 from Laurieton and 1 from Wauchope ▪ The school is unlikely to grow significantly in the foreseeable future, but is viable for at least the next five years ▪ Access to the school is difficult and the road is not wide enough for 2 cars to pass – 2 families have already crashed ▪ Karen supports the proposed access to the school from a service road rather	▪ Greg to ask Roger Fenner to send Karen a copy of the summary booklet from the Moorelands to Herons Creek EIS ▪ Greg to let Karen know how much land would need to be acquired from the school ▪ Faye to continue to send copies of the CLG meeting minutes to Karen

Land Owner	Meeting Details	People Present	Issues Raised	Actions
			than the Highway as it would be safer ▪ Some land would need to be acquired from the school property, Karen did not think this would be a major problem ▪ Noise walls could be installed as part of the construction works if required so the school would be quieter ▪ There may be a visual impact on the school, but any trees removed would be replaced, preferably before construction commences ▪ There would be pedestrian access to the school from Herons Creek over a new bridge ▪ The service road would have cycle facilities	
Bunyah Local Aboriginal Land Council (LALC)	Thursday 21 July at 11.30am, Bunyah LALC, High Street, Wauchope	Mike Dibbs, Amos Donovan	▪ The LALC owns a strip of land along the existing northbound carriageway ▪ Once the existing Highway becomes a service road, access to the LALC land would be possible anywhere along it ▪ The project may possibly need to acquire a small amount of LALC land near the Bago Road intersection in order to smooth out that intersection and adjoining the school as shown on the Moorland to Herons Creek project ▪ There are some scarred trees in the vicinity of Bobs Creek Road ▪ The LALC is generally supportive of the project and does not foresee any major issues	▪ Faye to continue to keep the LALC informed as the project progresses

Land Owner	Meeting Details	People Present	Issues Raised	Actions
Volcanic Resources	Thursday 21 July at 12.30pm, Volcanic Resources Quarry, Milligans Road, Wauchope	Mark Roach	▪ On a typical busy day there are 20-30 trucks coming to the site, therefore approximately 50 truck movements ▪ About 60% of the trucks leaving the quarry travel south to destinations including Sydney, the Central Coast and Newcastle and 40% travel north to Port Macquarie ▪ The life span of the Quarry is expected to be another 40-50 years ▪ It is currently dangerous crossing the Highway at the Bago Road intersection ▪ Mark suggested merging the service road with the Highway at Stills Road ▪ Land has recently been bought by Pioneer to possibly develop another quarry near Wauchope, but the timing of this is uncertain ▪ Volcanic Resources Quarry is a supplier of sub-base material and decorative stone	▪ Faye to continue to keep Mark informed as the project progresses
Ronald Allen	Thursday 21 July at 2.00pm, 5494 Pacific Highway, Herons Creek	Ronald Allen	▪ Mr Allen's access direct onto the Highway would need to be replaced with access onto a service road ▪ Mr Allen believes that the current access onto the Highway is unsafe ▪ Mr Allen is currently in the process of purchasing land from the LALC as he was having to pay rent to use the driveway to his property	▪ Faye to continue to keep Mr Allen informed as the project progresses
Colin and Margaret	Thursday 21 July at 3.00pm, 68 Bobs	Colin Stubbing, Margaret Stubbing	▪ This property will not be directly affected by the proposal and incorrect	▪ Greg to pass on these concerns to Roger Fenner

Land Owner	Meeting Details	People Present	Issues Raised	Actions
Stubbing	Creek Road, Herons Creek		information was provided to the RTA concerning the boundaries of this property ▪ Mr and Mrs Stubbings are concerned about the increasing noise from the Highway ▪ Concern was raised about the safety of school children in Herons Creek, particularly at the bus stop, with the current volume of heavy traffic on the Highway ▪ Mr and Mrs Stubbing are concerned about access for logging trucks from Bobs Creek Road	
NSW State Forests	Thursday 21 July at 4.00pm, Maher Street, Wauchope	Matt Potter	▪ There has been no change to the State Forests' position on this project since the Planning Focus Meeting ▪ State Forests would prefer minimal impact on their timber resource ▪ It would be easier to access the 'island' between the current northbound and southbound carriageways once the current northbound carriageway becomes a service road ▪ Sufficient access would need to still provided for harvesting traffic and firefighting vehicles (B-doubes are used) ▪ Any members of the study team wishing to access State Forests land need to apply for a permit ▪ State Forests would prefer not to have any of their land acquired for the project and will seek compensation.	▪ Greg/David to ensure any members of the study team requiring access to State Forests land obtains a permit

Land Owner	Meeting Details	People Present	Issues Raised	Actions

Herons Creek to Stills Road

Review of Environmental Factors – Appendix I

Concept Design Submissions report.

January 2007

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Faye Hargreaves Consulting Pty Ltd
Community Consultation & Facilitation
ABN: 89 118 237 906

Herons Creek to Stills Road Pacific Highway Upgrade Concept Design Submissions Report

September 2006

Version 1

P.O. Box 598, Lane Cove NSW 1595 Phone: (02) 9420 4984 Mobile: 0412 436 121 Email: fayehargreaves1@optusnet.com.au

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1 Introduction

1.1 Background

In October 2004, the NSW Roads and Traffic Authority (RTA) commenced planning for an upgrade of the Pacific Highway from Herons Creek to Stills Road, which is between Kew and the Wauchope / Port Macquarie interchange on the NSW mid north coast. This upgrade would replace a 3.3 kilometre length of the existing northbound carriageway. It would raise the standard of this section to be consistent with adjoining sections of the Highway, which would improve safety and traveling conditions.

In January 1996 the NSW and Australian governments announced their joint commitment to a 10 year program to upgrade the Pacific Highway between Hexham and the Queensland border. As of the end of June 2006, a total of 233 kilometres are now double-lane divided road. The remaining 466 kilometres of highway are under construction, have been approved for construction or have had a preferred route identified. The Pacific Highway is an AusLink National Network road. Its upgrading is funded by NSW and Australian governments. For the 10 years to June 2006, some $2.3 million has been invested. The NSW Government will have contributed $1.66 billion and the Australian Government will have contributed $660 million.

In December 2005, the NSW State and Federal governments announced a jointly funded program of $960 million for the three years to 2009. In May 2006 the Federal Budget announced an additional $160 million, to be matched by NSW, for the period to 2009.

The State and Federal governments are currently examining how the entire length of the highway can be upgraded to dual carriageway in the next 10 years.

A Concept Design for the Herons Creek to Stills Road Pacific Highway Upgrade was placed on public display for five weeks from 10 February 2006 to 17 March 2006.

Faye Hargreaves Consulting Pty Ltd has been commissioned by the RTA to undertake community and stakeholder consultation during the planning phase of the Herons Creek to Stills Road Pacific Highway upgrade project. This Submissions

Report describes the specific stakeholders and the wider community consulted concerning the project's Concept Design, consultation activities carried out, and the issues raised during consultation. It also provides responses to the issues raised and describes ongoing consultation activities for the upcoming stages of the project's development.

1.2 Project Objectives

The Herons Creek to Stills Road upgrade forms part of the NSW Government's Pacific Highway Upgrading Program. The objectives of this program are to:

- significantly reduce road accidents and injuries;
- reduce travel times;
- reduce freight transport costs;
- develop a route that involves the community and considers their interests;
- provide a route that supports economic development;
- ensure reconstruction of the route is managed in accordance with ecologically sustainable development principles; and
- provide the best value for money.

The specific objectives of the Herons Creek to Stills Road upgrade are to:

- develop a safe high speed dual carriageway;
- minimise direct access to the Highway by the provision of service roads;
- develop a Concept Design that meets or exceeds B-Double requirements, including at intersections, where required;
- maximise the use of the existing road pavement and reserve;
- satisfy the technical and procedural requirements of the RTA with respect to design of the project;
- allow for all connections, modifications and improvements necessary to upgrade the existing Highway where it is retained as part of the project;
- consider delay management strategies to minimise disruption to local and through traffic and maintain access to affected properties and land during construction;
- provide sufficient flood immunity;
- address community expectations;
- retain or replace existing rest areas within the study area; and
- provide a strategy for future upgrades to be easily integrated into the project.

2 Community Involvement

2.1 Consultation Objectives

The needs and interests of stakeholders and the community are varied. A personalised approach to consultation was used for this project, which focused on developing good relationships with a relatively small number of stakeholders.

The consultation objectives as documented in the Community Involvement Plan for Herons Creek to Stills Road Pacific Highway upgrade project were to:

- ensure the local community, Government authorities and interest groups are kept informed of the progress of the project;
- ensure environmental and community impacts are properly addressed;
- consider and where appropriate, take action on, issues raised by the community and other stakeholders;
- communicate project milestones and community benefits and likely impacts to the public;
- advise the community through advertising, particularly if the works have an impact on traffic flow through the area;
- advise affected stakeholders on when and how they might be affected; and
- advise affected stakeholders how they can obtain further information or communicate concerns and complaints or suggestions.

2.2 During Preparation of Concept Design

The Community Involvement Plan for this project involved the implementation of a number of different communication mechanisms to enable an effective two-way flow of information between the study team and the community. The consultation activities carried out leading up to and during the preparation of the Concept Design for this project included:

- a toll free project information line (1800 232 290);
- a community update in February 2005;
- a planning focus meeting in February 2005;
- a public information session in February 2005;

- establishment of a community liaison group. Two meetings were held with this group at the Camden Haven Golf Club in Kew, one in April 2005 and one in June 2005;
- individual meetings with owners of potentially affected properties during July 2005. These included Boral Timber, Herons Creek School, the Bunyah Aboriginal Land Council, Volcanic Resources, ForestsNSW and several private land owners;
- a briefing with Port Macquarie Hastings Council in July 2005; and
- provision of information on the RTA's website www.rta.nsw.gov.au.

2.3 During Public Display of Concept Design

The Concept Design for the Herons Creek to Stills Road Pacific Highway upgrade was on public display from Friday 10 February 2006 to Friday 17 March 2006. The public display of the Concept Design was widely advertised in local newspapers. Consultation activities carried out during the public display of the Concept Design included:

- seven formally advertised static displays throughout the display period. These were located at Laurieton Library, Greater Taree Council, Hastings Council, Port Macquarie RTA Motor Registry, Wauchope RTA Motor Registry, RTA Hunter Regional Office; and RTA Pacific Highway Office;
- three staffed displays. These were held at Wauchope RTA Motor Registry on Tuesday 21 February, and Port Macquarie RTA Motor Registry and Laurieton Library on Wednesday 22 February. The staffed displays provided an opportunity for members of the community to individually discuss issues of concern with the project team;
- production of 1500 community update brochures providing information on the Concept Design. These were distributed to all identified stakeholders and made available for the general public at each of the display locations or through calling the toll free project information line;
- personal delivery of a letter and information on the Concept Design to potentially affected land owners;
- a community liaison group meeting held on 1 March 2006 at the Camden Haven Golf Club in Kew;
- briefings with individuals and groups on request; and
- an update on the RTA's website www.rta.nsw.gov.au.

3 Submissions on the Concept Design

3.1 Overview of Submissions Received

A total of 13 written submissions were received concerning the displayed Concept Design for the Herons Creek to Stills Road Pacific Highway upgrade. Eleven telephone calls to the toll free project information line were recorded during the public display period. Key issues raised in written submissions, during calls to the project information line and during meetings with the project team are summarised in this Chapter. A register of submissions is provided in *Appendix A*.

3.2 NSW Government Agency Submissions

Written submissions on the Concept Design were received from the following NSW Government agencies:

- Department of Natural Resources;
- ForestsNSW;
- Department of Planning;
- Department of Primary Industries; and
- Department of Environment and Conservation.

A meeting was also held with ForestsNSW in Wauchope on 14 March 2006. The issues raised in these submissions and the RTA's responses to them are summarised in *Table 3.1*.

Table 3.1 Issues Raised by NSW Government Agencies

Issue	Response
Planning and Land Use	
01: The Concept Design for this project identifies adjustments are required to the previously exhibited Moorland to Herons Creek proposal.	The adjustments to the Moorland to Herons Creek proposal are minor and in keeping with the intent of the EIS. The Department of Planning's comments have been forwarded to the Moorland to Herons Creek project team for consideration.
02: The exhibited Moorland to Herons	The Concept Design addresses existing

Creek EIS identifies that vehicular access to Herons Creek School will be via an intersection at Bobs Creek Road, which will permit both northbound and southbound access, and that Stage 1 of the Concept Design shows vehicular access to be via Bago Road. This change increases the distance for vehicles accessing the school from Herons Creek. The RTA should consider whether this arrangement adequately addresses the issue that direct access to the south of the school is unsatisfactory due to unsafe vehicle movements, including school buses, and children crossing the Highway at this location.	safety concerns at Bobs Creek Road. The RTA acknowledges that travel distances to Herons Creek School from the Highway would be greater.
03: Boyds Road is a forest access road, and needs to accommodate B doubles.	Access for B doubles will be provided.
04: Request to have a forestry service road on the east of the Highway either side of Cutty Creek.	Will consider this in the finalisation of the Concept Design.
05: Stills Road is not used for log haulage but for fire fighting only.	The concept is to eliminate all access to the Highway unless at an interchange. Consideration will be given to leaving Stills Road as an emergency access point with left in / left out access only and possibl y through a gate. The project team will investigate this.
06: ForestsNSW advised that Boyds Road is used for timber extraction in either direction.	Access to Boyds Road will be provided for both directions in the 'A' and 'M' class proposals. Access will probably be incorporated with the Bobs Creek Road access point.
07: ForestsNSW advised that Burrawan Forest Drive south of Aintree Close is owned by ForestsNSW and is not a public road. This section of road was deleted from being a public road following previous acquisition of land from ForestsNSW. Burrawan Forest Drive north of Aintree Close is public road vested in Council and has its southern access to the Highway at Aintree Close.	Noted.
08: Request that the existing northbound carriageway from Bago Road northward to Stills Road be transferred to ForestsNSW upon implementation of the HC2SR project.	Noted for consideration.

9: ForestsNSW will seek compensation for any land acquired and loss of long term production.	Compensation for land acquired will be in accordance with the NSW Treasury Direction 469.03 regarding transfer of realty between government departments.
10: ForestsNSW requests that RTA valuers talk to ForestsNSW after the Concept Design is finalised.	RTA valuers will be contacting all affected land owners when road boundaries have been confirmed in the Concept Design.
11: ForestsNSW want to harvest timber on land to be resumed/cleared during the development.	To be dealt with during the acquisition process.
12: ForestsNSW intend to utilize the area of State Forest which will be made accessible following realignment of the carriageway.	Noted.
Concept Design	
13: All issues of concern to the Department of Natural Resources have been addressed.	
14: The roundabout shown on the Concept Design does not appear to provide an exit/entrance onto Boyds Road, which would be required by log traffic.	Suitable access for all vehicles will be provided onto Boyds Road. Consultation with ForestsNSW regarding access will continue.
15: Forests NSW requested that (as part of the HC2SR project) the RTA provide a parallel fire/access road from Boyds Road to Bobs Creek Road to allow for vehicles to head north on the Highway.	Will make provision for this movement in the Concept Design.
Bushfires	
16: A fire protection trail is needed along the eastern boundary of the Highway. The previous trail on State Forest land was removed during Highway construction 10 years ago and there is currently no access along this boundary. If the RTA will be using wildlife fencing along the boundary between State Forest land and the Highway, the fire trail would need to be constructed on the State Forest side of the fence. The Bago Service Road is sufficient for fire access on the western boundary.	The RTA is working with ForestsNSW regarding the provision of suitable fire trails.
Noise	
17: Concern about potential noise impacts at Herons Creek School due to increased	Noted. Potential noise impacts are being assessed as part of the REF for the project.

traffic volume.	
18: The CDR does not detail the likely impacts of the preferred route on noise receivers within the study area, nor is a comparison made of the noise impacts between the three route options.	The REF being prepared for the project will identify all relevant environmental impacts associated with the project, including potential for noise impacts on noise receivers within the study area. The RTA will take these matters into account when determining the REF, and when considering the project for approval. Any proposed mitigation measures will be documented in the REF and REF Decision Report.
19: Whilst the CDR indicates that there is one residence and a school within the study area, the noise impact to these receivers has not been quantified. The predicted noise impacts and the feasibility of mitigation measures should be determined for this concept design.	Noise monitoring is being conducted as part of the REF. Should the results indicate intervention is required, the most suitable types and locations for noise reducing measures such as noise walls/mounds, low noise pavement and acoustic treatments would be determined at the detailed design stage. Practicality, technical feasibility, visual impact and cost would all need to taken into account to determine an appropriate treatment.
20: Any increase in noise levels during construction would be an actual increase in noise levels and not a perceived increase as stated in the CDR.	An actual noise increase may occur during construction. Perceptions of such an increase may vary from person to person.
21: Concern about encroachment onto school grounds and impacts on the heritage significance of Herons Creek School.	Land acquisition will be kept to the minimum required. The RTA will continue to consult with the school Principal and Department of Education. No heritage items will be affected by the Proposal.
Air Quality	
22: Whilst the CDR does not provide any data on air quality it appears from the information available that there is little to differentiate between the route options with regard to air quality.	The preferred route would produce a net reduction in ongoing vehicle emissions when compared with the 'do nothing' case.
23: Any increase in particulate matter during construction would be an actual increase and not a perceived increase as stated in the CDR.	An actual increase in levels of particulate matter may occur during construction. Perceptions of such an increase may vary from person to person.
Water Quality	
24: DEC notes that no water quality testing was undertaken as part of the preliminary environmental investigations for the selection of a preferred route.	Noted.

25: The observations made in the CDR on the visual assessment on water quality of Cutty Creek indicate that existing Pacific Highway runoff is having an adverse impact on water quality. Upgrading the Highway in this section provides an opportunity to improve water quality through the installation of water quality controls on the new alignment. Opportunities should also be explored to link the existing carriageway to new water quality control structures or systems.	This suggestion will be considered as part of the ongoing concept design process for this project.
26: It is unclear from the CDR of the type, location and design of permanent and temporary (construction stage) water control structures. Such structure should be considered during the concept design stage to ensure that sufficient space is allowed for the construction, operation and maintenance of these structures.	Appropriate type, location and design of permanent and temporary water treatment basins will be determined as part of the ongoing concept design process.
27: The indirect impacts of the proposal on downstream flora and fauna species, populations and endangered ecological communities (EECs) require consideration. Proposed crossings of streams (eg at the southern end of the Bobs Creek Road service road) and works around Cutty Creek have potential to contribute sediment, road surface pollutants and debris to aquatic ecosystems, especially within Herons Creek and, ultimately, Queens Lake. The likely effect on these impacts of the quality of SEPP14 wetlands located just south of the inflow of Herons Creek to Queens Lake should be discussed. Similarly, the CDR should consider the likely impact of the proposal on any EECs located downstream of the study area.	Noted.
Contaminated Sites	
28: The CDR indicates that an area was located in the median of the Highway which had minor levels of pesticide contamination. Whilst the results of the assessment of this area have not been provided, the site should be managed in accordance with the provisions of the *Contaminated Land Management Act, 1997,* and DEC guidelines.	Noted.

Indigenous Heritage	
29: The CDR does not discuss measures to mitigate the potential impact of the proposal on Aboriginal heritage sites, items and places of local and regional significance to the Ngamba People. DEC recommends that further surveys, consultation and development of an appropriate mitigation strategy be undertaken in direct consultation with the Bunyah Local Aboriginal Land Council and DEC's Aboriginal Heritage Unit.	The REF being prepared for the project will identify all relevant environmental impacts associated with the project, including potential for impact on Aboriginal objects, sites and places. The RTA will take these matters into account when determining the REF, and when considering the project for approval. The RTA has undertaken appropriate consultation with the Aboriginal community in accordance with the DEC *Interim Community Consultation Requirements for Applicants* and RTA policy. The consultation will be described in the project REF, and any proposed mitigation measures will be documented in the REF and REF Decision Report.
Flora and Fauna	
30: The extension of the service road will require the construction of additional bridges across Herons Creek that may have riparian and aquatic ecology impacts. It should be noted that Herons Creek is classified as a Class 1 – Major Fish Habitat.	The REF being prepared for the project will identify all relevant environmental impacts (including additional bridges across Herons Creek) associated with the project.
31: Consideration should be given to any impacts on fish passage. Roads and crossings should be designed to allow fish passage during both high and low flow conditions to maximise movement options.	The issue of fish passage will be addressed in the REF.
32: The project should give consideration to the number of waterbodies that may be crossed by the different route options, the habitat classifications for those waterbodies and the presence of important or significant aquatic habitat areas such as freshwater and estuarine wetlands especially SEPP 14 wetlands, and mangroves and seagrass beds within any estuarine system.	Noted. The route options considered are confined within a narrow corridor.
33: The project should consider the potential range of a threatened species, population or ecological community that may exist or potentially exist within the route option areas. Examples of such species listed as vulnerable or threatened, and will need to be considered, include the Black Cod (*Epinephelus daemelii*), Oxleyan Pygmey Perch (*Nannoperca oxleyana*) and Green Sawfish (*Pristis zijsron*).	The REF being prepared for the project will identify all relevant environmental impacts associated with the project, including potential for impact on threatened species or ecological community. The RTA will take these matters into account when determining the REF and when considering the project for approval. Mitigation measures may be required to ameliorate any potential impacts identified.

34: Any areas of aquaculture, commercial and recreational fishing activities within, upstream and downstream of the study area which may be impacted on by the proposal should be considered.	Noted.
35: NSW Fisheries requests that consideration be given to the potential impacts and controls on water quality. Areas of particular concern are the potential for discharge of sediment, acid from exposure to acid sulphate soils, and other pollutants into nearby receiving water and wetlands.	Noted. Water quality will be addressed in the REF.
36: The RTA may need to obtain a permit to harm marine vegetation. This may include cutting, removing, damaging, trimming, shading or otherwise injuring marine vegetation. The Department of Primary Industries has a policy requirement for compensation for the loss of marine vegetation harmed or removed during the planning and construction of a major road project.	The REF being prepared for the project will identify all relevant environmental impacts associated with the project, including removing, damaging or otherwise injuring marine vegetation. Permits required to harm marine vegetation will be documented in the REF and REF Decision Report for the project.
37: The removal of existing tracts of native vegetation will contribute to the loss, fragmentation and modification of habitat for a range of fauna and flora species, populations and communities. Stands of moist eucalypt forest dominated by Blackbutt *Eucalyptus pilularis* and Tallowwood *E.microcorys* and riparian communities will be impacted on by the construction of the Bago Road interchange and associated service roads and ramps and cutting and embankment work. These impacts will be most evident at the site of the proposed Bago Road interchange, the proposed northbound exit ramp, and along the southern end of the proposed new service road that will connect to Bobs Creek Road, especially where it crosses a tributary of Herons Creek.	The REF being undertaken for the project will assess the extent of native vegetation clearing that would be required in order to implement the project. The REF will document the potential impacts of native vegetation clearing associated with the project. This will include potential impacts on fauna and flora species, populations and communities. The RTA will take these matters into account when determining the REF, and when considering the project for approval. Mitigation measures may be required to ameliorate any potential impacts identified. Any proposed mitigation measures will be documented in the REF and REF Decision Report for the project.
38: A range of threatened flora (eg *Asperula asthenes, Phaius australis, Hibbertia hexandra*) and fauna (eg green thighed frog, glossy black cockatoo, Latham's snipe, brush tailed phascogale, koala, common bent wing bat, common planigale) may occur within or near the study area. There is also considerable potential for the occurrence of regionally	The REF being undertaken for the project will include discussion of any threatened flora or fauna species that have been found to occur within the study area. The REF will include discussion of any regionally significant fauna and flora that have been found to occur within the study area. The REF will discuss the potential for threatened and regionally significant flora and fauna to occur within the

significant fauna and flora in or near the study area. The CDR states that an initial site inspection of flora "could not find any of the threatened species" and that "there were very few fauna species or evidence of fauna species identified during the initial site inspection". However, no information is provided on the level of survey or inspection effort, durations, date (ie time of day and year), replication, surveyor qualifications/ experience, and stratification of flora and fauna surveying that were undertaken. Also, no reference to the Moorland to Herons Creek EIS and its working papers, prepared by Arup Pty Ltd in June 2005, has been made in the flora and fauna section of the CDR. This document contains details on the occurrence and habitat requirements of terrestrial and aquatic flora and fauna that occur or are likely to occur in or near the southern end of the study area. DEC recommends that the CDR be reviewed to consider the full complement of threatened and regionally significant flora and fauna species likely to be affected by the proposal construction activities in the study area. This will require sourcing of existing documents, including the results of surveys undertaken in the adjacent Burrawan State Forest, EIS related surveys, DEC's Wildlife Atlas, ROTAP database and other databases such as Bird Atlas II.	study area, and identify any potential impacts that may be associated with implementation of the project. The RTA will consider potential impact on threatened and regionally significant flora and fauna when determining the REF, considering the project for approval, and identifying any mitigation measures that may be required to ameliorate the potential impacts identified. Proposed mitigation measures will be documented in the REF and REF Decision Report for the project. The REF will reference any documents considered to be relevant to this study that were considered during preparation of the REF. Methodology used to determine the presence or otherwise of threatened and regionally significant flora and fauna in the study will be included in the REF.
39: The CDR briefly refers to the presence of some fauna habitat features in the study area. It is worth noting that even disturbed areas may provide foraging and breeding habitat for frogs, insects, birds, reptiles and mammals. Microhabitat features that can provide these services include ponds in artificial drainage systems, rock and log substrates, vine clusters in the lower and mid canopy layers, understorey shrubs and ground cover vegetation, hollow-bearing live and dead trees, and revegetated road verges and median strips. The "diversity of tree species" is not in itself a fauna habitat feature, however the foliage of Blackbutt and Tallowwood are important food sources for koalas. It would seem highly unlikely that, given the availability of some of these habitat features in the study area, "very few fauna species or evidence of fauna species was identified". DEC	The REF being prepared for the project will identify all relevant environmental impacts associated with the project, including any potential impact on fauna habitat. The RTA will take these matters into account when determining the REF, and when considering the project for approval. Mitigation measures may be required to ameliorate any potential impacts identified. Any proposed mitigation measures will be documented in the REF and REF Decision Report for the project.

recommends that more information be provided in a revised version of the CDR to adequately address this aspect and thus allow a more informed assessment of the potential ecological impact of the proposal to be made.	
40: In a regional landscape context, the study area occurs within forest partly disturbed by clearing for agriculture, forestry, roads and villages but with residual links to DEC estate (Queens Lake NR and Queens Lake SCA to the east/northeast, and Bago Bluff NP to the west) and other native vegetation. These tracts of forest form parts of two wildlife corridors (Bulls Ground-Queens Lake Regional Corridor and Burrawan-Kew Subregional Corridor) that provide connectivity for fauna dispersing and moving through this landscape. The CDR refers to the potential use of these habitat linkages by "cursorial" mammals – which should presumably read as "scansorial" mammals. DEC advises that the CDR be amended to include this point.	The REF being prepared for the project will identify all relevant environmental impacts associated with the project, including any potential for impact on corridors used by fauna moving through the study area. The RTA will take these matters into account when determining the REF, and when considering the project for approval. Amongst others, mitigation measures such as fauna crossings would be considered by the RTA, and could be included in the project if appropriate. Any proposed mitigation measures will be documented in the REF and REF Decision Report for the project. The review of flora and fauna undertaken as part of the REF will address the range of key threatening processes prescribed under Schedule 3 of the *Threatened Species Conservation Act 1995* and the potential impact of the proposal on these processes.
41: Construction of the proposed interchange, and new road system will increase the degree of edge incursions into the adjacent forest especially in less disturbed areas such as the site identified for the new interchange and its exit ramp on the western side of the existing Highway. The CDR should consider the type and potential impact of these effects on fauna and flora communities and habitats in these areas. Edge effects include pest plant and animal incursion, increased bushfire risk, and heightened potential for human incursion resulting in, for example, rubbish dumping and bushrock removal. As part of this work, the CDR should also consider the range of key threatening processes prescribed under Schedule 3 of the *Threatened Species Conservation Act 1995* and the potential impact of the proposal on these processes.	The REF being prepared for the project will identify all relevant environmental impacts associated with the project, including potential edge effects. The RTA will take these matters into account when determining the REF, and when considering the project for approval. Mitigation measures may be required to ameliorate any potential impacts identified. Any proposed mitigation measures will be documented in the REF and REF Decision Report for the project.
42: The CDR lists proposed environmental mitigation measures that will be developed during the environmental impact assessment process. The CDR would benefit from an expansion of these points	Any proposed mitigation measures will be documented in the REF and REF Decision Report for the project.

to emphasise the application of current 'best practice' interventions in the mitigation of the potential impact of the proposal on the biodiversity of the study area. For instance, the CDR could outline the type and location of proposed fauna crossings, fencing, habitat tree management protocol, and structures to intercept and retain sediment and road surface pollutants. Consideration of these mitigation measures at the concept design stage will be helpful in identifying resource needs and likely costs and facilitating the integration of these interventions into the overall concept design process.	
Environmental Management	
43: It is critical that the feasibility of mitigation measures to address specific issues and impacts is assessed and the results of this assessment considered through the route development process.	Noted.

3.3 Local Government

A submission was received from Port Macquarie Hastings Council. *Table 3.2* summarises the issues raised in this submission and the RTA's responses.

Table 3.2 Issues Raised by Council

Issue	Response
Planning and Land Use	
44: The RTA proposed as part of Stage 1 to connect Burrawan Forest Drive to Bago Road using the existing northbound lanes. Parts of Burrawan Forest Drive north of the exiting connection with the Pacific Highway have been closed as a result of the existing Pacific Highway upgrade. Council requests that the RTA address the need or otherwise to re-open the closed sections of Burrawan Forest Drive.	The project no longer proposed to connect Burrawan Forest Drive to Bago Road.
Concept Design	
45: Council has no objection to the Concept Design as exhibited.	Noted.

3.4 Community Submissions

Six written submissions were received from the wider community. These included submissions from Boral Country Concrete & Quarries, Bago Wines, Boral Timber and three from local residents.

Table 3.3 summarises the issues raised by the community in written submissions, during meetings and during calls to the project telephone information line. The RTA's responses to these issues are also documented.

Table 3.3 Issues raised by the community

Issue	Response
Planning and Land Use	
46: The volume of traffic projected in the report is conservative, particularly considering the recent extension of industrial areas and rural residential subdivisions along Bago Road.	The growth factors used for the Highway and other road traffic projections in the report are based on average growth factors for this area. The proposed Concept Design has the capacity to cater for significantly higher growth should that occur.
47: The necessity to provide a service road from the Herons Creek Timber Mill to the interchange has not been demonstrated. If the present site lines of the existing Highway are adopted then a separate bridge over Herons Creek would need to be constructed to provide for service road traffic.	A separate bridge over Herons Creek would be constructed for the service road. A grade separated interchange and overbridge would allow mill trucks to enter and leave the Highway without turning across through traffic and would allow them to pull clear of through traffic to exit and enter the Highway.
48: The current and projected future volume of traffic generated from the Herons Creek Mill has not been stated, but it is expected that this would be minimal compared to the overall traffic including heavy vehicle movements on Bago Road.	Traffic modeling undertaken for the Herons Creek to Stills Road project has considered: ▪ Traffic counts, including heavy vehicle counts at Herons Creek Road (north), undertaken in November 2000 for the *Moorland to Herons Creek* project. ▪ Counts undertaken in March 2000 by Port Macquarie Hastings Council on Bago Road; and ▪ Counts undertaken in 2005 for this project.
49: It has been stated that it would be desirable to provide an alternate route to the Highway carriageways to the north of the interchange in the event of the closure of the highway during an emergency, and that the reopening of the southern section of Burrawan Drive is an option being	The RTA's design standards for an "M" class road require the provision of an alternative route. Investigations are ongoing. The suitability of Burrawan Forest Drive will be assessed as part of these investigations.

considered. Bago road already provides such an alternative route via Wauchope and the Oxley Highway, as has been so utilised in the past. In addition, the reopening of this section of Burrawan Forest Drive would re-introduce traffic to the route of the old Pacific Highway which accounted for many accidents and fatalities in the Sapling Creek area, which would be undesirable.	
50: A decline in traffic using Bago Road referred to in the Concept Design Report was a direct consequence of a 10 tonne load limit being placed on the wooden bridge over the north coast rail line. Since its replacement by a concrete bridge the load limit was removed and traffic useage increased.	The decline in traffic along Bago Road was included in the Concept Design Report as background information. Design traffic volumes are based on counts undertaken in 2005.
51: The accident record shown in the Concept Design Report commenced 19 July 1999, and while significant, it would have been useful if figures had been shown recording accidents since the date of opening of the Herons Creek bypass in 1998.	Noted. Five years is the standard reporting period for traffic crashes. Crashes before 1999 have also been considered.
52: It has been stated that a container terminal is planned at Herons Creek alongside the railway line. If this is the case, then this would need to be taken into account in future planning.	Noted. Port Macquarie Hastings Council has been contacted regarding future developments. The project team will continue to liaise with Council regarding this project.
53: The service road providing access to Herons Creek Road, at Stage 2, should be suitable for the truck movements to the Boral Timber operation.	The road and all intersections provided will be suitable for truck movements.
Concept Design	
54: An interchange coming directly off Bago Road should be strongly considered. Bago Road is an extremely busy road. The Concept Design requires Bago Road traffic to travel an extra 500 metres and negotiate a service road and a roundabout. The convenience of local service roads to connect with the interchange should be weighed against the inconvenience and added danger to the comparable majority of traffic using Bago Road.	An interchange coming directly off Bago Road was investigated (see Concept Design Report). The proposed location is considered to be the best option. Only a small percentage of traffic is required to travel the additional distance.
55: The stated advantage of Option F over Option A regarding the amount of	The reasons why Option F was chosen are detailed in Sections 5 and 6 of the Concept

earthworks required needs further explanation. Any regrading involving the removal of spoil along Bago Road could be relocated as fill required in the construction of the overbridge.	Design Report dated February 2006.
56: Option A would provide a safer entry to the service road on its western side for Mr Crisp, as he would not have to contend with the large volume of traffic involved in Option F situated to the south of his entry point were preferred.	Traffic volumes and travel speeds would be significantly lower than existing traffic on the current northbound carriageway. Safe property access would be provided.
Safety Issues	
57: The Concept Design (Option F) is a safe and practical way of addressing the intersection of the Highway and Bago Road.	Noted.
58: The intersection of the Highway and Herons Creek Road at Stage 1 should be designed to allow easy and safe access and egress for employees of Boral Timber and heavy vehicle movements, especially B-doubles. Consideration should be given to the time it will take trucks exiting Herons Creek Road onto the south lanes of the Highway, to achieve a safe speed due to the 600 metre incline on the Highway.	Noted. The design of this intersection will be appropriately addressed
59: A service road, then a roundabout, would create a higher risk of accidents as a result of more directional changes.	The proposed design meets the RTA's safety guidelines. A roundabout is a safe intersection treatment. The final intersection layout is being considered by the project team as part of the refinement of the Concept Design.
60: If the school remains viable then 40kmh speed restrictions would need to be maintained.	Appropriate speed zoning will be applied on the service road in accordance with RTA policy.
61: Emphasis is made on the number of accidents involving drivers aged over 70 years at the Bago Road intersection without further explanation. This information appears discriminatory.	The Concept Design report states that 5 of the 9 crashes at the Bago Road / northbound carriageway intersection involved drivers over 70 years old. This statement is based on the RTA traffic accident database.
62: Concern about conflicts with pedestrians and cyclists accessing Herons Creek School.	Adequate provision for pedestrians and cyclists will be included in the final design.
63: The needs of the school children, that presently travel by bus from the	The needs of school children have been considered by the project team. Bus routes

intersection of Herons Creek Road and the Highway, should be considered and their safety addressed due to the vehicular movements in and out of Boral's operations.	will change to complement an "M" class scheme.
Property Issues	
64: The development of the land to be acquired on the north east of Boral's property should take into consideration that no runoff should enter Boral's property that will affect the stormwater management controls already in place. Acquisition of land should have no impact on Boral's current operation. Work to be carried out on the acquired land should have no negative visual impact on the Herons Creek operations.	Noted for consideration during Concept Design development. The land acquisition referred to is part of the Moorland to Herons Creek project. This submission has been forwarded for their consideration.
Tourism Issues	
65: A tourist destination not mentioned in the Concept Design Report is the Broken Bago Vineyards situated along Milligans Road off Bago Road where cellar sales and tastings are conducted, and also a monthly jazz entertainment is held.	Noted for inclusion in Concept Design refinement.
66: Could the presence of the brown tourist signs indicating Bago Vineyards as a tourist destination be maintained?	To be considered as the part of the signposting scheme for the project.
Consultation Process	
67: A feedback survey form and reply paid envelope should have been included with the Concept Design Community Update.	This suggestion will be taken into account for use during consultation on future projects.
68: Would like to be kept up to date concerning further developments to the project.	Noted.

4 Next Steps

4.1 Review of Environmental Factors

The Concept Design will be refined following consideration of the issues raised by stakeholders and the community. A review of environmental factors (REF) is currently being prepared to assess the ecological and social impacts of the refined proposal and this will also be placed on public display.

4.2 Ongoing Consultation

Consultation will continue during the refinement of the Concept Design and public display of the REF. Ongoing consultation activities will include:

- the toll free project information line;
- meetings with the community liaison group;
- a community update announcing the public display of the REF;
- correspondence with the contacts on the project's stakeholder database concerning the public display of the REF;
- advertising in local newspapers announcing the public display of the REF;
- meetings with individuals and stakeholder groups on request; and
- updates on the RTA's website www.rta.nsw.gov.au.

Appendix A: Submissions Register

Table A1 provides a register of the submissions received during the public display of the Herons Creek to Stills Road Pacific Highway Upgrade Concept Design and a summary of the issues raised in each submission. This can be used by authors of submissions to cross reference where the issues raised in their submissions have been addressed.

Table A1: Submissions Register

Name	Sub'n No	Issues Raised	Issue No
Bago Wines	06	Tourism Issues	66
Boral Country Concrete & Quarries	04	Concept Design, Safety Issues	54, 59
Boral Timber	10	Planning and Land Use, Safety Issues, Property Issues	53, 57, 58, 63, 64
Crisp, Danny	03	Concept Design, Planning and Land Use, Safety Issues, Tourism Issues	46, 47, 48, 49, 50, 51, 52, 55, 56, 60, 61, 65
Department of Environment and Conservation	12	Environmental Management, Flora and Fauna, Indigenous Heritage, Noise, Air Quality, Water Quality, Contaminated Sites	17, 18, 19, 20, 22, 23, 24, 25, 26, 27, 28, 29, 37, 38, 39, 40, 41, 42, 43
Department of Natural Resources	02	Concept Design	13
Department of Planning	07	Planning and Land Use, Noise Issues, Flora and Fauna	01, 02, 07, 21, 30
Department of Primary Industries	11,13	Flora and Fauna	31, 32, 33, 34, 35, 36
Dowling, Barry	03	Concept Design, Planning and Land Use, Safety Issues, Tourism Issues	46, 47, 48, 49, 50, 51, 52, 55, 56, 60, 61, 65
ForestsNSW	05	Planning and Land Use, Concept Design,	03, 04, 05,

		Bushfires	06, 07, 08, 09, 10, 11, 12, 14, 15, 16
Montgomery, Les	01	Consultation Process	68
Port Macquarie Hastings Council	08	Planning and Land Use, Concept Design	44, 45
Squadrito, Joseph	09	Consultation Process	68

Herons Creek to Stills Road

Review of Environmental Factors – Appendix J

Planning Focus meeting report.

January 2007

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Pacific Highway Upgrade
Failford Road to Tritton Road
and
Herons Creek to Stills Road

Planning Focus Meeting Notes

16 February 2005

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Pacific Highway Upgrade
Herons Creek to Stills Road
and
Failford Road to Tritton Road

Planning Focus Meeting Notes

16 February 2005
Camden Haven Golf Club, Kew

RTA Technical Services Branch

MANIDIS ROBERTS
environment + community

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RTA Technical Services Branch

Pacific Highway Upgrade
Failford Road to Tritton Road and
Herons Creek to Stills Road

Planning Focus Meeting Notes

16 February 2005
Camden Haven Golf Club, Kew

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1 INTRODUCTION

In October 2004, the Premier of NSW, Bob Carr, announced a planning project for the upgrading of the Pacific Highway at the following locations:

- A 3.3km stretch of highway between Failford Road and Tritton Road, Possum Brush.
- A 3.3km stretch of highway between Herons Creek and Stills Road.

The proposal involves upgrading the existing northbound carriageway to provide a high standard dual carriageway. As part of the $2.2 billion Pacific Highway Upgrading Program, this would improve safety and travelling conditions on these sections of the state road network. The NSW Roads and Traffic Authority (RTA) have commenced investigations concerning these projects.

Community involvement plans are being prepared for these projects. These plans are being developed to provide opportunities for community involvement. Part of the plans involve consultation with government agencies, utilities and service providers by inviting representatives from these organisations to a Planning Focus Meeting, which covered both projects.

This report provides details of the preparation for the meeting, the meeting structure and meeting outcomes.

2 MEETING PREPARATION

2.1 Contact Approach

A contact list was established by calling each of the following organisations:

- Hastings Council.
- Great Lakes Council.
- Greater Taree City Council.
- NSW Department of Environment and Conservation DEC).
- NSW Department of Infrastructure, Planning and Natural Resources (DIPNR).
- NSW State Forests, Mid North Coast Region.
- NSW Fisheries.
- NSW Department of Education.
- NSW Fire Brigade.
- NSW Police.
- NSW Ambulance Service.
- State Emergency Services.
- Rural Fire Service.
- NRMA.
- Country Energy.

Each organisation was asked to identify a representative as a contact for the project. A brief telephone discussion was conducted with the representative where possible to explain the background to the project.

2.2 Invitation Letter

A letter of invitation to provide background to the project was drafted and subsequently approved by the RTA. It was sent to the identified contacts from the organisations listed above. The letter of invitation and the list of invitees are included in **Appendix A**. The invitees were asked to respond to the invitation and those that did not were contacted by telephone.

3 MEETING STRUCTURE

3.1 Participants

A total of 19 people attended the Planning Focus Meeting, including representatives from the RTA and Manidis Roberts. Eleven representatives sent their apologies. Some of the apologies sent alternative representatives in their place, and others had provided preliminary issues for inclusion in the planning process. All those who declined the invitation were offered the opportunity to be kept informed through minutes of the meeting and further information as it becomes available.

Attendance

The following representatives were in attendance at the planning focus meeting.

- Bob Higgins – RTA, General Manager Pacific Highway.
- Mark Eastwood – RTA, Senior Project Development Manager.
- Greg Baird – RTA, Project Development Manager.
- Ben Phillipson – RTA, Project Development Officer.
- Bob Davis - RTA Technical Services, Project Director.
- David Kilby – RTA Technical Services, Project Manager.
- Ian Gossip – RTA Technical Services.
- Brad Spalding – RTA Technical Services, Designer,
- Mike Bulmer – RTA Technical Services, Transportation and Planning.
- Simone Garwood - RTA Environmental Technology, Project Leader Environment.
- Brett Hoffman – RTA, Environmental Officer.
- Faye Hargreaves – Manidis Roberts, Community Relations.
- Andrew Atkinson – Hastings Council.
- John Hulme – Great Lakes Council.
- Omar Faruqi – Greater Taree City Council.
- Glenn Atkinson – DIPNR.
- John Fulton – NSW State Forests.
- Geoff Kitcher – Country Energy.
- Greg Banks – RFS.

Apologies

Apologies were received from the following people:

- Cameron Perry – RTA Environmental Officer.
- Phil Davies – RTA Technical Services, Project Leader Civil.
- Ross Prestipino – ACVM, Value/Risk Management.
- Greg Blaze – Greater Taree City Council.
- Kim Forsyth – DEC.
- Ross Brylynkski – DEC.
- David Thompson – DIPNR.
- Lisa Mitchell – DIPNR.
- Matt Potter – NSW State Forests.
- Greg Davey – NSW Fisheries.
- Noel McManus – Department of Education.

3.2 Meeting Outline

Faye Hargreaves, the facilitator, opened the meeting, explained the agenda and asked all participants to introduce themselves. The Planning Focus Meeting agenda is provided in **Appendix B**.

Bob Higgins and Mark Eastwood provided an overview of the Pacific Highway Upgrade Program and its objectives, and Greg Baird introduced the study team.

David Kilby outlined the Herons Creek to Stills Road study area and regional setting. Simone Garwood outlined the environmental elements of the project. There was discussion concerning potential issues that need consideration during assessment of the Herons Creek to Stills Road project.

After a break for morning tea, David Kilby outlined the Failford Road to Tritton Road study area and regional setting. Simone Garwood then outlined the environmental elements of the project. There was then discussion concerning potential issues that need to be considered during assessment of the Failford Road to Tritton Road project.

4 MEETING OUTCOMES

4.1 Herons Creek to Stills Road

The issues raised during discussion concerning the Herons Creek to Stills Road project were recorded and are presented in **Table 4.1**. Any agreed actions for the project team are also presented in this table. Some issues raised are a reiteration of the importance of work already planned during the project, so these issues are noted but require no action.

Table 4.1: Issues concerning the Herons Creek to Stills Road Project

Organisation	Issue	Action
DIPNR	▪ Need for adequate erosion and sediment control at Herons Creek. ▪ Expect the upgraded northbound carriageway to be parallel to the existing southbound one. ▪ No significant issues concerning clearance of native vegetation in the median strip. ▪ Soil mapping is available for the project team's use if not already provided. ▪ No acid sulfate soils in the study area. ▪ Potential issue with the steep vertical alignment of the Bago Road approach to the Highway.	▪ Noted.
Country Energy	▪ Too early to make any comments. ▪ Will get involved once the route has been selected and at least a concept design is available.	▪ Provide concept design to Country Energy.
State Forests	▪ Concerned about any impact on their commercial timber resources. ▪ Practical access to B double standard both northbound and southbound needs to be maintained for harvesting purposes. ▪ Would like to harvest the vegetation in the existing median strip, but there is currently no safe access. An option that provides safe access to log this vegetation is required. ▪ Would prefer a route option than involves the northbound and southbound Highways running parallel to each other to avoid an 'island' of vegetation. ▪ Sufficient access for fire management / control is needed.	▪ Noted.

	▪ Aboriginal land adjoins the southbound carriageway to the west. ▪ Need a fire management plan with access points and preferably a parallel fire trail. ▪ Noted that the Highway passes through an area of working State Forest and the visual landscape will change over time. Recommended that when the RTA is considering urban / regional design on this project, RTA should not assume visual landscape will remain as it is now – because the area is subject to logging which may change the appearance of the area significantly.	
Hastings Council	▪ The Bago Road intersection is the main area of concern. ▪ Asked how the Herons Creek to Moorelands project fits into the scope of this project.	▪ Consult with Herons Creek to Moorelands project team.
Rural Fire Service	▪ Access for emergency services vehicles to be maintained and maximized both during and after construction.	▪ Consult with emergency services during design process.
Greater Taree City Council	▪ Questioned the need for grade separation at Bago Road.	▪ Noted.
DEC	▪ Need to maintain median crossings for arboreal mammals.	▪ Noted.
NSW Fisheries	▪ Impacts on water crossings. ▪ Agricultural impacts.	▪ Noted.

4.2 Failford Road to Tritton Road

The issues raised during discussion concerning the Failford Road to Tritton Road project were recorded and are presented in **Table 4.2**. Any agreed actions for the project team are also presented in this table. Some issues raised are a reiteration of the importance of work already planned during the project, so these issues are noted but require no action.

Table 4.2: Issues concerning the Failford Road to Tritton Road Project

Organisation	Issue	Action
Greater Taree City Council	▪ Pacific Blue Metal owns the quarry along Possum Brush Road. A few years ago there was a fatal accident along this road. The court ordered PBM to upgrade the road. Council provided a design for this upgrade, but PBM is yet to implement it. ▪ The PBM quarry is a major supplier to some of the Pacific Highway Upgrade projects in the vicinity, including Coopernook.	▪ Noted.

Great Lakes Council	▪ The quarry on Bullocky Way has access limitations placed on it as part of its DA. This may prevent use of the Bullocky Way / Pacific Highway intersection, which will mean use of Failford Road instead. ▪ The Bullocky Way subdivision has finished and there is no more available land. ▪ Bullocky Way is used as a shortcut from Failford to Taree, and from Taree to Failford, which the residents of Bullocky Way don't like. ▪ Residents of Bullocky Way would like the Bullocky Way speed limit reduced from its current 80 km/hr limit.	▪ Check DA conditions for quarry on Bullocky Way.
DEC	▪ Need to maintain median crossings for arboreal mammals.	▪ Noted.
NSW Fisheries	▪ Impacts on water crossings. ▪ Agricultural impacts.	▪ Noted.
Rural Fire Service	▪ Most emergency vehicles come from Taree. ▪ Need to be able to get across the median through either formal or informal crossings. ▪ Require a 'U' turn access at Possum Brush Road. ▪ Believes there is increased residential development along Possum Brush Road, which is causing concern.	▪ Investigate increased development and incorporate in traffic modeling.
State Forests	▪ Possum Brush Road is the main access to the forests to the west and B double access will be needed along this road, as B doubles are being increasingly used for forestry. ▪ Questioned funding and timing.	▪ Noted.
DIPNR	▪ Ensure adequate room is provided for sediment control. ▪ The environmental assessment carried out for the proposal needs to be appropriate for that proposal. The decision on what studies and assessment is required should be based on the nature, magnitude and quantity of issues associated with the proposal. This applies whether the assessment is done in the form of an REF or an EIS.	▪ Noted.

4.3 Summary

Overall, the meeting was considered a success. The participants were pleased to be involved at this early stage. Representatives who were not able to attend the meeting will be given a copy of the meeting notes and further opportunities to raise issues and make comments. Consultation with these organisations will continue throughout the project.

APPENDIX A LETTER OF INVITATION

04 February 2005

Name
Position
Company
Postal Address
Location

OUR REFERENCE: 04047

Dear Sir/Madam,

Proposed Upgrading of the Pacific Highway, Herons Creek to Stills Road, and Failford Road to Tritton Road, Planning Focus Meeting

In October 2004, the Premier of NSW, Bob Carr, announced a planning project for the upgrading of the Pacific Highway between the following locations:

- A 3.3km stretch of highway between Failford Road and Tritton Road, Possum Brush.
- A 3.3km stretch of highway between Herons Creek and Stills Road.

The proposal involves upgrading the existing Northbound carriageway to provide a high standard dual carriageway. This would improve safety and travelling conditions on these sections of the state road network. Plans showing the study areas are enclosed for your information.

The NSW Roads and Traffic Authority (RTA) has engaged Manidis Roberts to assist with community consultation for this project.

As part of the consultation process, a representative from your organisation is invited to a Planning Focus Meeting prior to you providing written advice on any interests, concerns or requirements you have, statutory or otherwise, regarding this study. Nomination of a contact officer from your organisation will also assist in maintaining regular liaison with the RTA.

It is intended that liaison on relevant issues will be maintained with individual agencies and organisations during the course of the EIA preparation. Some members of the RTA project team may need to make direct contact with your organisation during the study and would be directed through your nominated contact person.

We would be pleased if you could attend the Planing Focus meeting to examine issues and considerations to be addressed during the planning project. The meeting will be held at the Camden Haven Golf Club, 185 Kendall

Road, Kew, on Thursday 17 February from 9.30am to 12.30pm. Lunch will be provided from 12.30pm to 1.30pm. Please call our project hotline 1800 232 290 or email fayeh@manidisroberts.com.au to confirm your attendance.

I look forward to working with you on this project.

Yours faithfully,
MANIDIS ROBERTS

Faye Hargreaves
Environmental Consultant

APPENDIX B AGENDA

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MANIDIS ROBERTS
environment + community

Manidis Roberts Pty Ltd
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AGENDA

SUBJECT	Planning Focus Meeting		
DATE	17 February 2005	OUR REF	04047
LOCATION	Camden Haven Golf Club		
PREPARED BY	Faye Hargreaves		

ATTENDEES:

Faye Hargreaves, Manidis Roberts	David Kilby, RTA	Bob Davis, RTA	Simone Garwood, RTA
Mike Bulmer - RTA	Brad Spalding - RTA	Ben Phillipson - RTA	Greg Baird - RTA
Omar Faruqi – Greater Taree City Council	John Hume, Great Lakes Council	Glenn Atkinson, DIPNR	Ross Brylynski - DEC
John Fulton, State Forests	Geoff Kitcher – Country Energy	Greg Banks, RFS	

ITEM		TIME	SPEAKER
1	Welcome and Introductions	9.30 am	Faye Hargreaves
2	Project Overview	9.45 am	Bob Higgins
3	Project Objectives	10.00 am	Bob Higgins
4	Herons Creek to Stills Road	10.15 am	David Kilby / Simone Garwood
5	Failford Road to Tritton Road	10.30 am	David Kilby / Simone Garwood
6	Key Issues	10.45 am	Bob Higgins
7	General Discussion	11.00 am	Faye Hargreaves
8	Close and Lunch	12.30 pm	Faye Hargreaves

Herons Creek to Stills Road

Review of Environmental Factors – Appendix K

Urban Design and Landscape report.

January 2007

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Prepared for: RTA

Prepared by: KIAH infranet

PACIFIC HIGHWAY UPGRADE
Herons Creek to Stills Road

Urban and Landscape Concept Design Report
February 2007

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1 Introduction

The NSW Roads and Traffic Authority (RTA) is proposing to finalise the route option selection on various sections of the Pacific Highway to complete the upgrade of the highway.

Kiah-Infranet PTY Ltd have been commissioned to prepare a strategic urban and landscape concept report. The report also provides a brief visual assessment of the project and key mitigation strategies. However, it is noted that most of the project is located within state forest and has limited impacts to private properties.

This report is consistent with the Pacific Highway Urban Design Framework from the RTA – Urban Design Guidelines for the SH10 from Hexham to Tweed Heads. The guideline states that the upgrade should have an overarching urban design vision summarised as: 'a sweeping, vegetated highway, providing panoramic views to the Great Dividing Range and the rivers, forests, farmlands, and coastline of the Pacific Ocean. Sensitively designed to fit into the landscape and be unobtrusive. Characterised by simple, attractive road infrastructure.'

2 General Context

This project encompasses the proposed upgrade of approximately 3.3km of the Pacific Highway between Herons Creek and Stills Road, which is between Kew and the Wauchope/Port Macquarie. Hence the project forms part of the NSW and Federal Governments agreed 10 year Pacific Highway Upgrading Program.

The project is a small section of the overall upgrade of the Pacific Highway. The adjoining section to the north has been upgraded while the section to the south has not. The section to the south is contained in the Coopernook to Herons Creek project. Although the proposed section is currently already built as a dual carriageway, the current formation of the northbound carriageway is considered substandard and was built in the 1980. The existing northbound carriageway has relatively small horizontal and vertical curves which lead to lower travel speed and an existing intersection at Bago Road has been prone to accidents. The southbound carriageway is suitable for high-speed travel (110km/hr). See figure 1

Various options were considered and evaluated by the design team. These included a Western Option (Option 1), a Central Option (Option 2) and an Eastern Option (Option 3). Refer to Herons Creek to Stills Road, Upgrading the Pacific Highway - CONCEPT DESIGN REPORT, February 2006.

The preferred Option identified in that report is the Central Option. This option proposes a duplication of the carriageway for the northbound traffic on the western verge of the existing southbound carriageway. Key advantages of this option include:

- Minimum impacts to existing vegetation;
- minimum property acquisition; and
- maximises the use of the existing northbound carriageway for local roads.

This study focuses on the preferred option and its refinement from an urban and landscape design perspective. The report makes key suggestions which in conjunction with other issues may or may not be adopted in the final design. See Figure 2.

Figure 1 - Project overview

3 Project Parametres

A key design parameter for the project is its ability to function in a two stage design process. In the first stage, if required, the road classification would be "A" class. This means it is designed as a Controlled Access Road and must be developed with a strategy for conversion to "M" class standard in the future.

A "M" class road is designed for a 110 km/h Freeway standard with no access for traffic between interchanges and with grade separation at all intersections and local traffic requires an alternative route.

For the potential future conversion from "A" class to "M" class it is required that no changes to the alignment be undertaken to minimise any further impacts. In addition, the design should have the potential for the road to be developed to a 6 lane road in the future.

The proposed urban landscape design will be based on the 'M" class, however key comments will be provided to key issues arising from the interim "A" class.

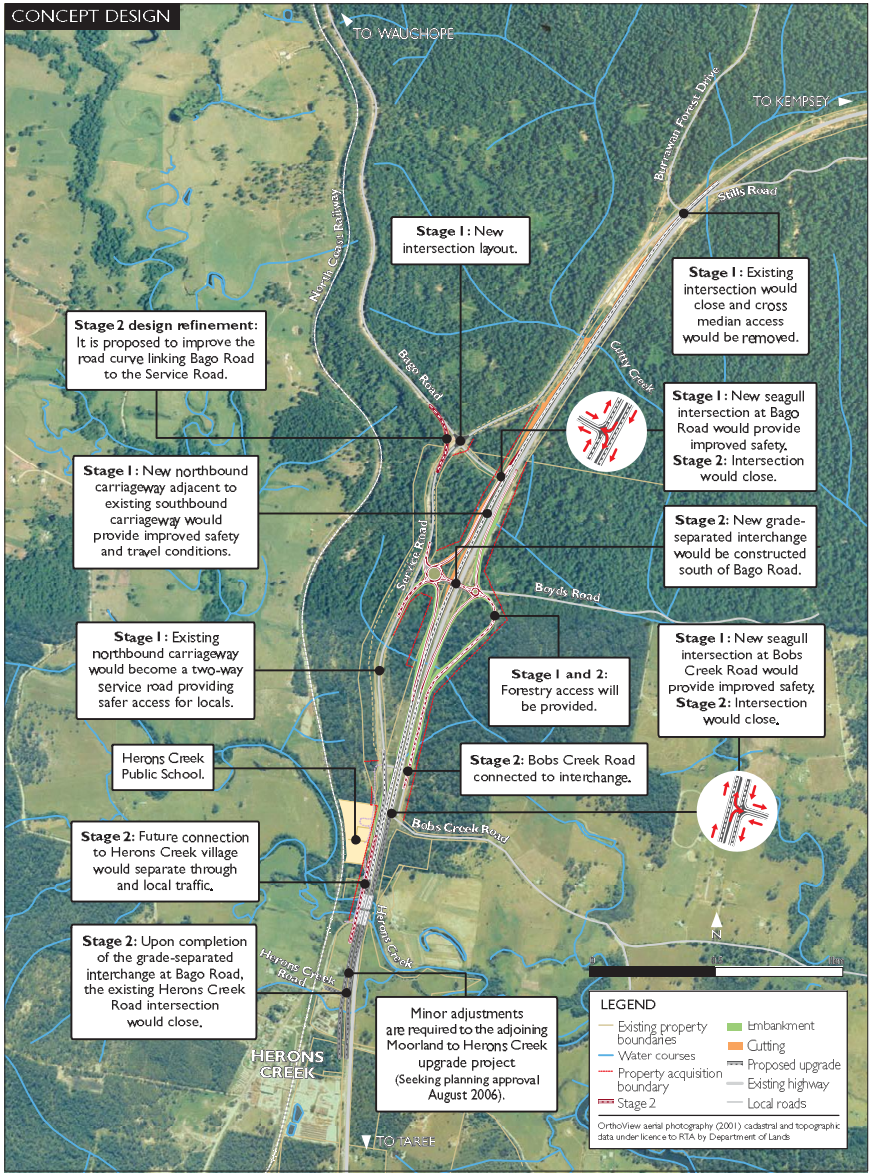


Figure 2 - Preferred Option

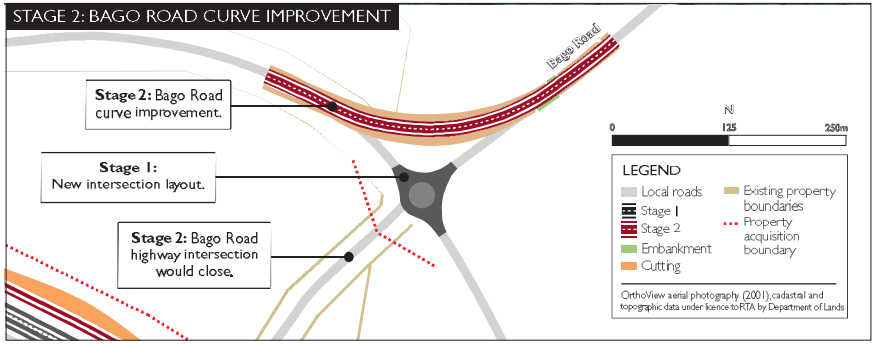


Figure 3 - Preferred Option

4 Site Analysis

The study area is located predominantly within a bushland setting with an undulating topography. The road crosses two significant creeks, Cutty Creek to the north and Herons Creek to the south.

Three key features of the landform were identified being two depressions, at Herons Creek and at Cutty Creek and a predominant rise in the topography to the west of the existing southbound carriageway nearby Bago Road. The Herons Creek floodplain defines to southern end of the project and flows to Queens Lake to the east.

The study area is located within Burrawan State Forest and the vegetation present is consistent with a wet sclerophyll forest with large Eucalyptus species over 40m in height and a soft-leaved under storey, consisting of ferns. The vegetation has been disturbed to varying extents from road construction and forestry practices; however some areas (for example, in the middle and along western side of the vegetated median and along the outside edge of the carriageways) remain relatively intact with little evidence of weed encroachment.

The disturbed areas are usually characterised by dense vegetation communities of minimal species diversity and introduced species and have a lesser defined under storey / top-storey. These areas are located along the western verge of the southbound carriageway and are probably a result of the original construction of the southbound carriageway. Other areas of disturbance include the northern end of the project nearby Stills Road and in the area of Bobs Creek Road.

Geologically, the study area is within the Lorne Basin, which contains a sedimentary sequence of basal conglomerate, course sandstone, siltstones and mudstones.

The general character of the route is fairly enclosed for both carriageways with the northbound carriageway offering a better setting and visual quality than the southbound. Panoramic views are only achieved in a southbound direction when approaching Herons Creek.

See figure 4 on land use.

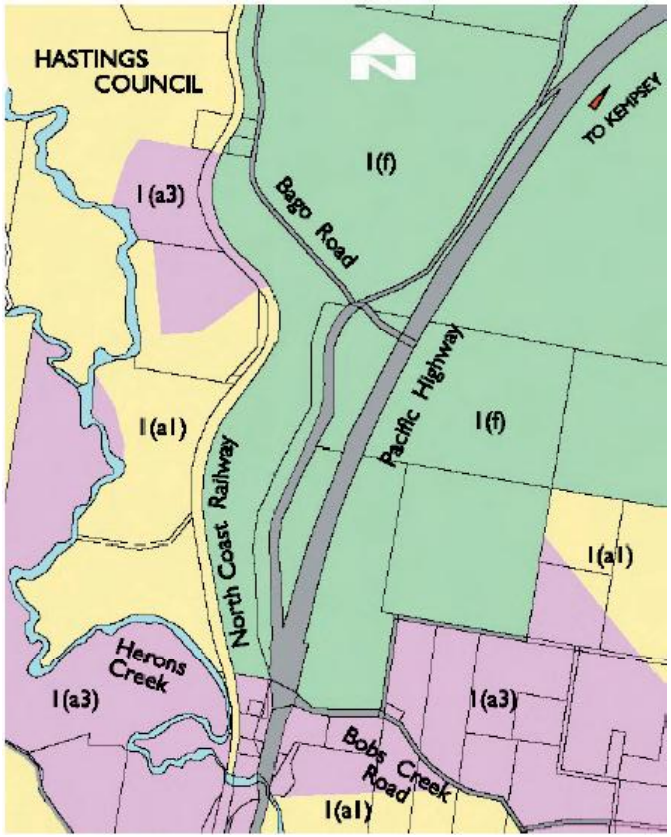


Figure 4: Land use

1(a1) Rural
1(a3) Rural Agricultural protection
1(f) State Forests

The photo journey illustrated in figure 5 to 7 provides an overview of the features of the project area.

Key elements include:

- Intersections with local roads
- Creek crossing, particularly Herons Creek
- Forest/bushland setting throughout most of the corridor
- Local school at western verge of the road

Figures 8 to 10 illustrate the topography and identify key opportunities and constraints for the project from an urban and landscape design perspective.

The road crosses through a series of ridgelines and valleys. Two of these are more pronounced, Cutty Creek and Herons Creek.

Figure 5 - Southern section

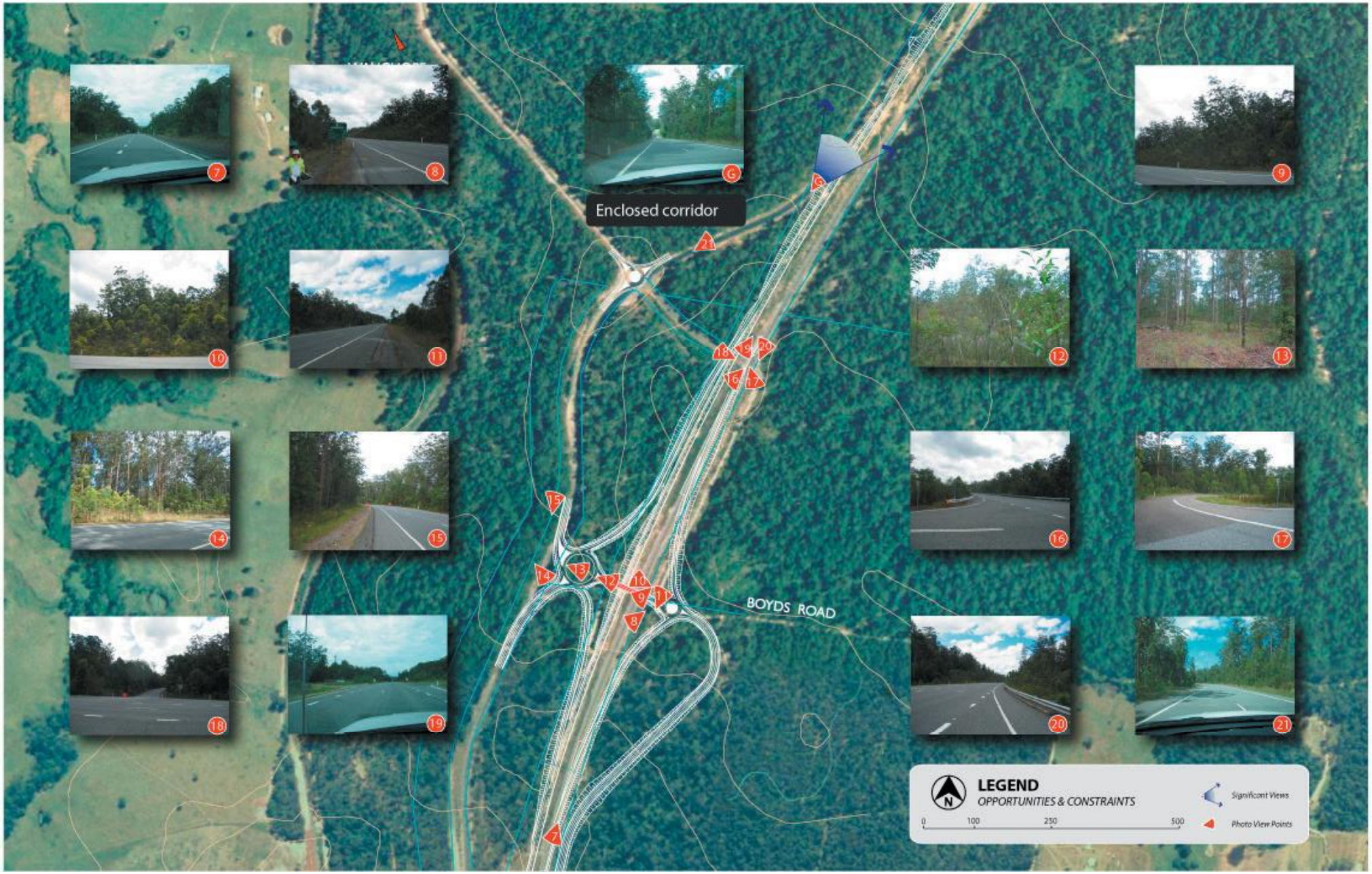


Figure 6 - Central section

Figure 7 - Northern section

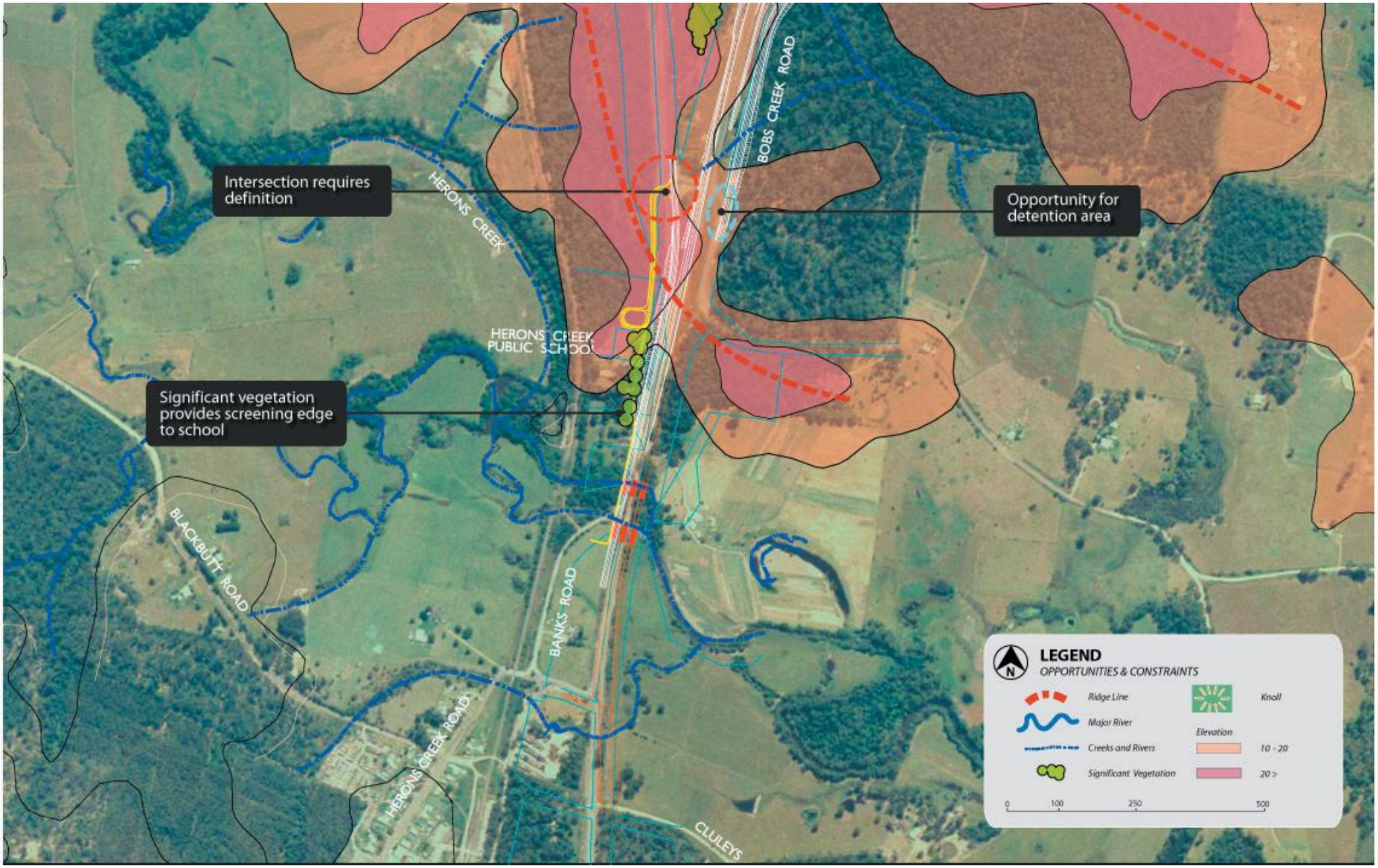


Figure 8 - Southern section - Topography and general opportunities and constraints

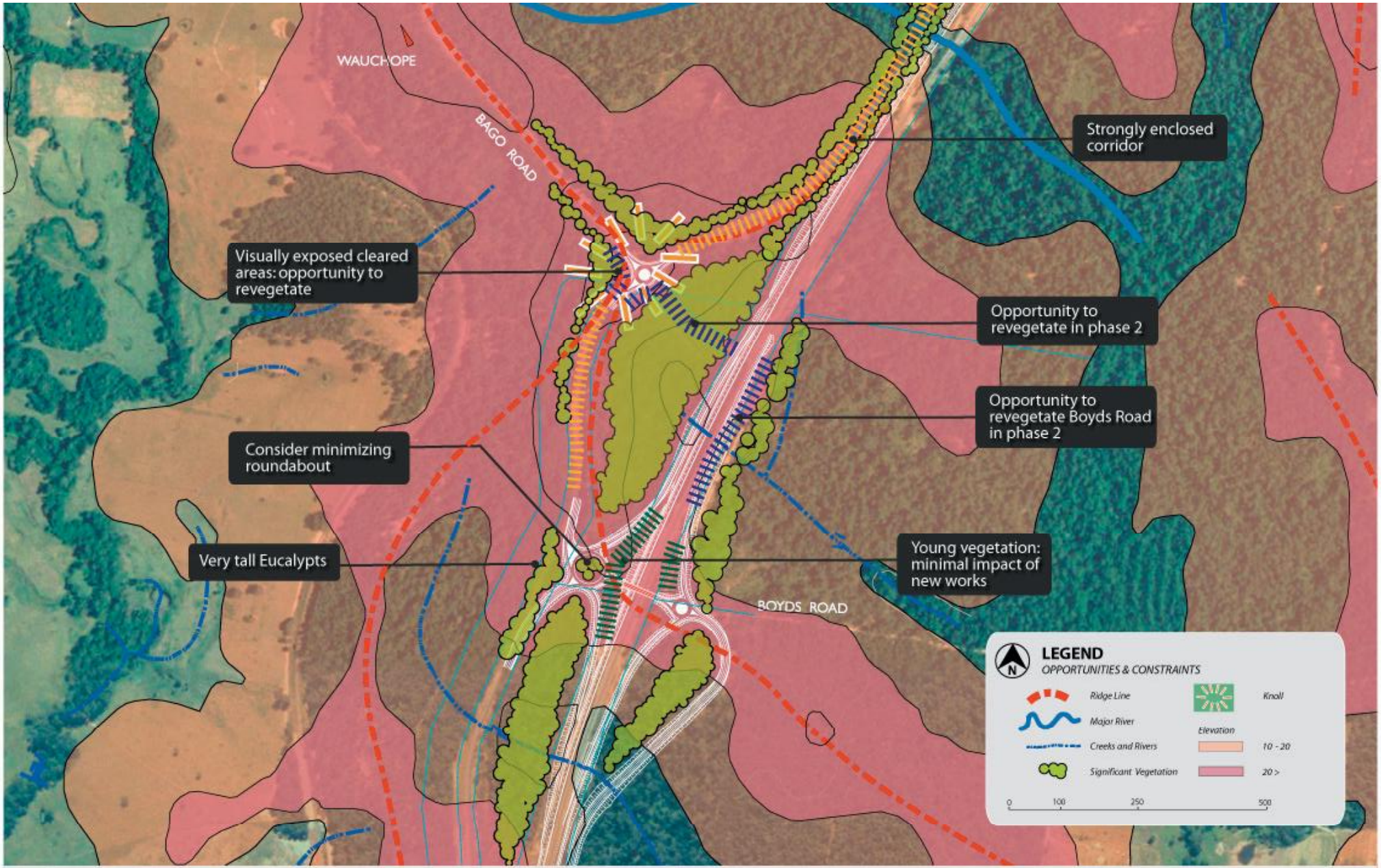


Figure 9 - Central section - Topography and general opportunities and constraints

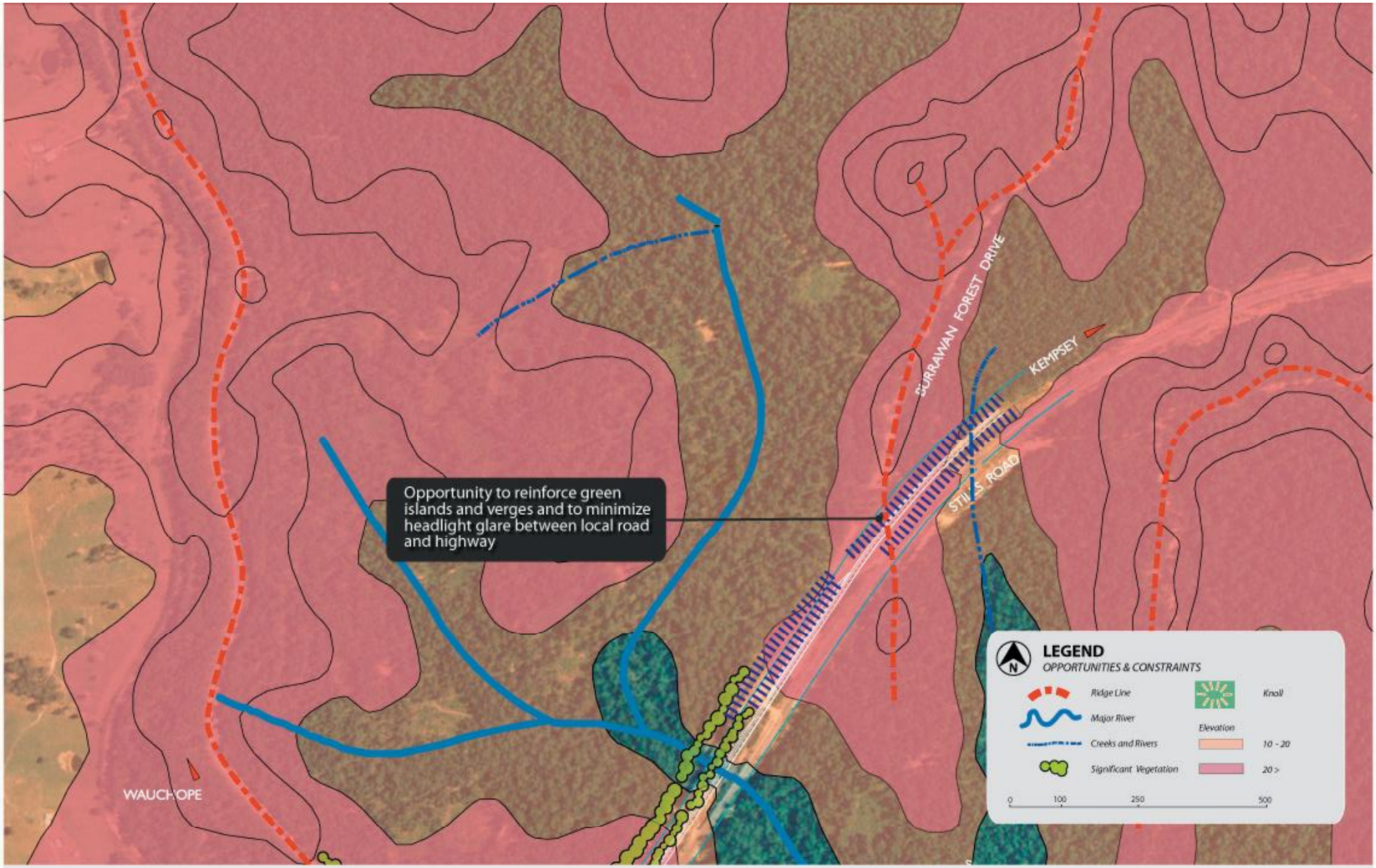


Figure 10 - Northern section - Topography and general opportunities and constraints

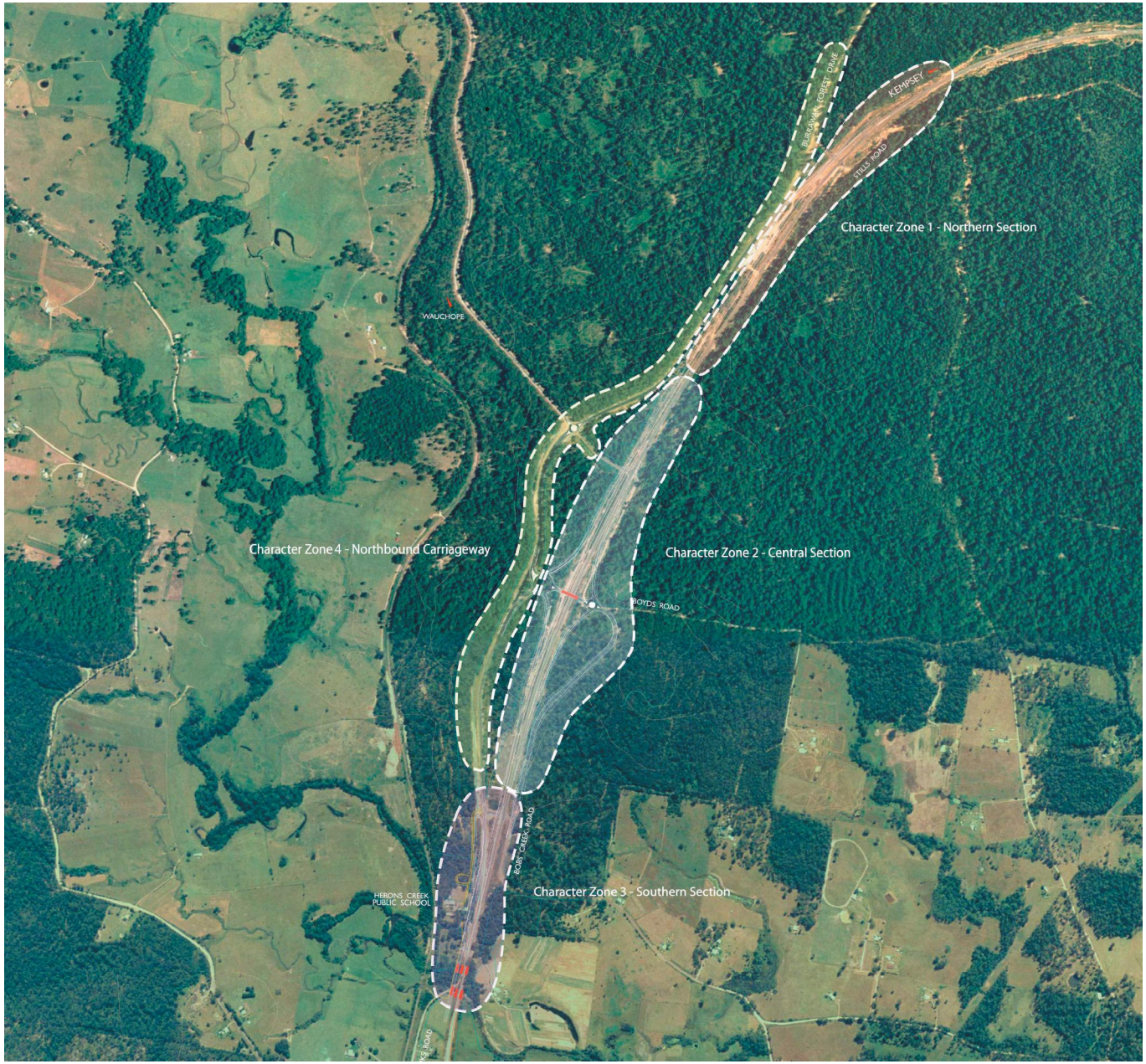


Figure 11 - Character Zones

5 Character Zones and Design Principles

The project has been divided into 4 character zones:

Northern Section, where the northbound and southbound carriageways diverge. This section is characterised by open medians and partially cleared verges.

Southbound Carriageway to Bobs Creek Road, characterised by softly undulating landscape with a forest background.

Southern End, which is the most urban area in the project. Key features are Herons Creek and Herons Public School.

Northbound Carriageway from Bobs Creek Road to North of Bago Road. This section is dominated by tall trees and a visually enclosed corridor.

See figure 11

5.1 Character Zone 1 – Northern End

The northern end of the project is characterised by the wide road corridor. This is where the two carriageways join from the south. The lack of vegetation along the median and past clearing at the intersection with Stills Road creates a somewhat open character within the corridor. However, the road is flanked on both sides by dense vegetation/forest which limits panoramic views.

Opportunities and constraints:

- Reinforce forest setting and create a more enclosed character.
- Improve intersection's legibility.
- Improve visual character of the median and verges.
- The elimination of the access of Burrawan Forest Drive from the Pacific Highway in the 'M" class scenario would marginally improve road safety. This has mainly to do with the low volume traffic on this local road.

Key principles include:

- Improve/re-instate vegetation along the verges to reinforce forest setting.
- Re-instate vegetation at the intersection with Burrawan Forest Drive in "M" class scenario.
- Define intersection at Stills Road with accent planting to improve legibility of intersection. The planting will ensure that required sight distances are not affected.
- Consider the introduction of frangible vegetation within median to reduce headlight glare and add visual interest.

5.2 Character Zone 2 – Southbound Carriageway to Bobs Creek Road

This zone is dominated by an enclosed character with views to either side to the Burrawan State Forest. A pronounced depression in the landform occurs at Cutty Creek. From here and travelling southbound the topography gently rises between Bago and Boyds Roads. Further south the road gently dips towards Herons Creek and minor distant views to the ranges beyond open up.

A new grade separated interchange is proposed in the vicinity of Boyds Road, requiring the reconfiguration of Boyds and Bobs Creek Roads.

View looking south from Burrawan Forest Drive

View looking east at the intersection of Stills Road

View looking north from Burrawan Forest Drive

Approach towards Stills Road intersection

Intersection of Bago Road with the southbound carriageway

View of Boyds Road adjacent to the highway

View looking south along southbound carriageway in the vicinity of the proposed grade separated interchange. Bushland dominates the setting.

View of the vegetation setting at the location of the proposed grade separated interchange

Opportunities and constraints:

- Reinforce creek crossing.
- Ridgeline nearby Boyds Road provides suitable location for grade separated interchange in the “M” class configuration.
- Opportunity to re-instate forest along the eastern section of Bago Road and along northern section of Boyds Road in the ‘M” class scenario.
- Opportunity for ponding north and south of Cutty Creek at clearing on the western verge.
- Introduce median between carriageways. The vegetation of the western verge of the existing southbound carriageway is considered low in quality and impacts are therefore limited.
- Utilise abandoned local road corridors to visually integrate landform of new formation.

Key principles include:

- Re-instate vegetation along sections of abandoned local roads.
- Introduce riparian vegetation at Cutty Creek to add interest and visually reinforce creek crossing.
- Consider the introduction of retaining walls at creek crossing to minimise footprint of project and impacts to existing vegetation.
- Introduce dense and frangible vegetation within median to visually reinforce creek crossing.
- Introduce median to improve road safety and allow for potential future expansion to 6 lane carriageway.
- Consider locating retention/detention ponds nearby Cutty Creek in areas of poor vegetation/clearing.
- Consider opportunities to integrate ponding within diamond interchange to minimise impacts to existing vegetation outside road corridor.
- Screen median at key locations such at creek lines, curved alignments to minimise headlight glare and when carriageway is adjacent to local roads.
- Roll batters at major cuttings to integrate with the landform. South of Cutty Creek, a significant cutting is required on the western verge.
- Along the northern end of Boyds Road, soften batters of southbound exit ramp in ‘M’ class configuration by utilising existing road clearing within abandoned road corridor. This will provide a better visual integration of the project at this interchange.
- Minimise distance between local roads and highway while still allowing a buffer corridor for vegetation screening between the two road categories. This is to minimise clearing of forest to the outside verges while ensuring proper headlight screening is provided to ensure road safety.
- Visually reinforce the interchange setting by introducing/extending Dry Tallowwood Forest.

5.3 Character Zone 3 – Southern End

Towards the southern end of the project, the setting changes from forest to a more urban environment. Cultural vegetation appears on the western verge of the road, views open up to pastureland beyond and views to distant hills can be seen. It is at this location that the northbound and southbound carriageways join to a single lane configuration. There is a school on the western side of the corridor on top of a pronounced cutting.

Opportunities and constraints:

- Corridor is confined by school property and service roads to both sides of the highway.
- Panoramic views open south of Herons Creek.
- Access from private properties requires to be reconfigured.
- Opportunity for revegetation at abandoned intersection Bobs Creek Road.
- Headlight glare poses a safety issue due to adjacent local roads.
- Noise impacts to school.

Key principles include:

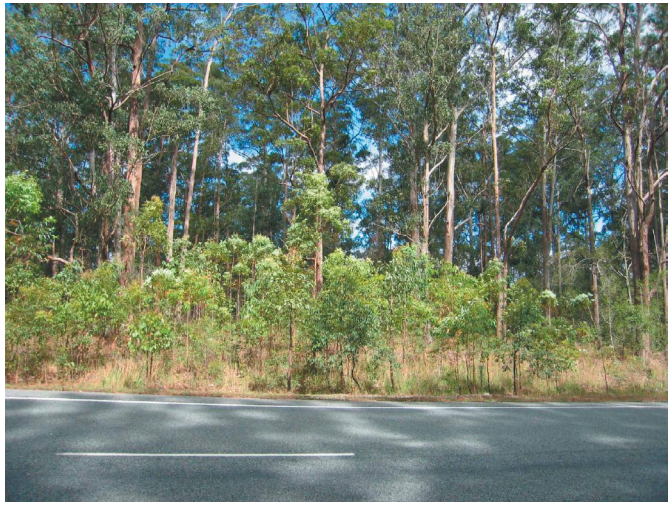
- Split local roads vertically in alignment wherever possible to mitigate headlight glare and integrate with topography.
- Locate access road from property nearby Herons Creek on the eastern side of the alignment to minimise night time glare and minimise potential impacts to heritage items.
- Express creek crossing at Herons Creek by introducing vegetation within median. This will also add interest by contrasting with the open character and panoramic views south of the creek.
- Consider introducing retention/detention ponds within cleared areas.
- Consider the introduction of a small retaining wall between new service road along western verge and school grounds. This will reduce impacts to the school but also assist in mitigating noise levels. It should be noted that the school may cease operation.
- Introduce accent planting at the intersection of the service road and access drive to school.

View looking south towards the hills in the distance

View of Boyds Road adjacent to the highway

View of the intersection at Bobs Creek Road

School at the western side of the corridor



View of the vegetation setting at the location of the proposed grade separated interchange. Tall trees define the setting.

Young vegetation defines the western verge of the existing southbound carriageway where the overpass is proposed

View of the intersection of the northbound carriageway with Bago Road. There is a lot of vegetation clearing due to safety of the intersection.

View looking north, north of Bago Road intersection. Tall trees create an enclosed character.

5.4 Character Zone 4 – Northbound Carriageway

The existing northbound carriageway has a more enclosed character then the southbound. The forest is dominated by tall trees and the road is more curvilinear in the horizontal and vertical alignment. The intersection at Bago Road is located on a crest and is considered a dangerous intersection. As a result extensive clearing has been undertaken at the south-western verge to improve sightlines. In the "M" configuration, the existing northbound carriageway would be converted into a local road as the extension of Bago Road.

A large roundabout would be introduced as part of the grade separated interchange on the eastern verge on the northbound carriageway, south of Bago Road and on a crest. The vegetation in these area is not considered on significant value, particularly as one approaches the western verge of the southbound carriageway.

From Bago Road intersection, the road dips and meets the southbound carriageway nearby Burrawan Forest Drive.

Opportunities and constraints:

- Re-instate vegetation along abandoned sections of road.
- Improve safety of Bago / intersection.
- Maintain access to heritage site. There is a former sandstone block/monument located within the cleared median between the two carriageways approximately 380m south of the Stills Road intersection.

Key principles include:

- Revegetate the verges wherever possible as clearance width would be reduced as a result of converting to local road status.
- Maintain informal character at interchange and roundabouts.
- Revegetate abandoned sections of road such as at the interchange.
- Utilise already cleared areas at the intersection with Bago road to realign road and improve safety.
- Provide an informal access from the existing northbound carriageway to the monument.

Figures 12 to 14 provide an overview of key urban and landscape design principles for the project.

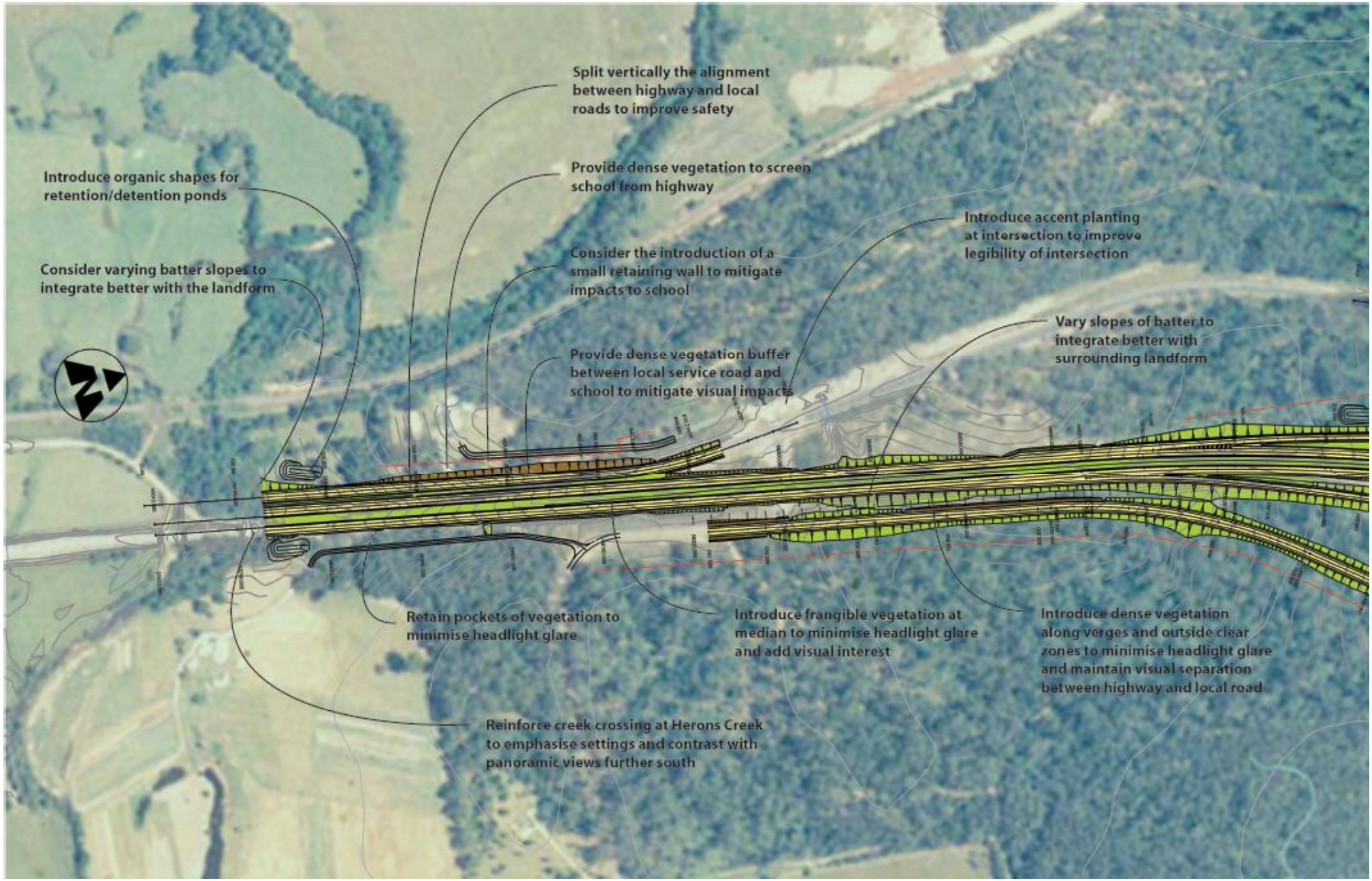


Figure 12 - Design Principles - Plate 1

Figure 13 - Design Principles - Plate 2

Figure 14 - Design Principles - Plate 3

6 Urban and Landscape Design Concept

The concept plans shown on figure 15 to 21 show the overall concept treatment for the landscape design. Due to its forest setting and limited urban interface, the only major infrastructure component is the overpass at the new interchange.

The design takes a pragmatic approach towards delivering key parameters for the project. This includes:

The concept design has a 12 metre wide median which allows for a future 3rd lane for each carriageway to be constructed in the median. This is in accordance with the Pacific Highway design guidelines;

measures to improve road safety such as screening of headlight glare, in particular with local service roads;

maintaining as much as possible clear zones whitout hazards to improve road safety and minimise maintenance costs;

minimisation of retaining structures above road level to reduce costs but also because of the high absorption capacity of the setting and because it will eventually provide a much lower visual impact;

integration of the highway and local roads with the existing topography; and

simplicity of design for bridge structures, however following the aesthetic principles and guidelines set out by the RTA for these type of structures.

Legend

Existing Vegetation

Existing Vegetation

Vegetation

Mix A Coastal Blackbutt Forest - Mixed canopy

Mix A Coastal Blackbutt Forest - Shrubs and Grasses

Mix B Broad-leaved White Manhagany - Mixed Canopy

Mix B Broad-leaved White Manhagany - Shrubs and Grasses

Mix C Dry Tallowwood Forest - Mixed canopy

Mix C Dry Tallowwood Forest - Shrubs and Grasses

Open Median

Median with Frangible Vegetation

Native Grasses Type 1

Native Grasses Type 2

Accent Vegetation

Native Grasses with Trees

Advanced Trees

Other

Water Quality Control Pond

Wetland Filter

Proposed Road Boundary

Figure 15 - Landscape Concept Design Plan - 1 1:2000

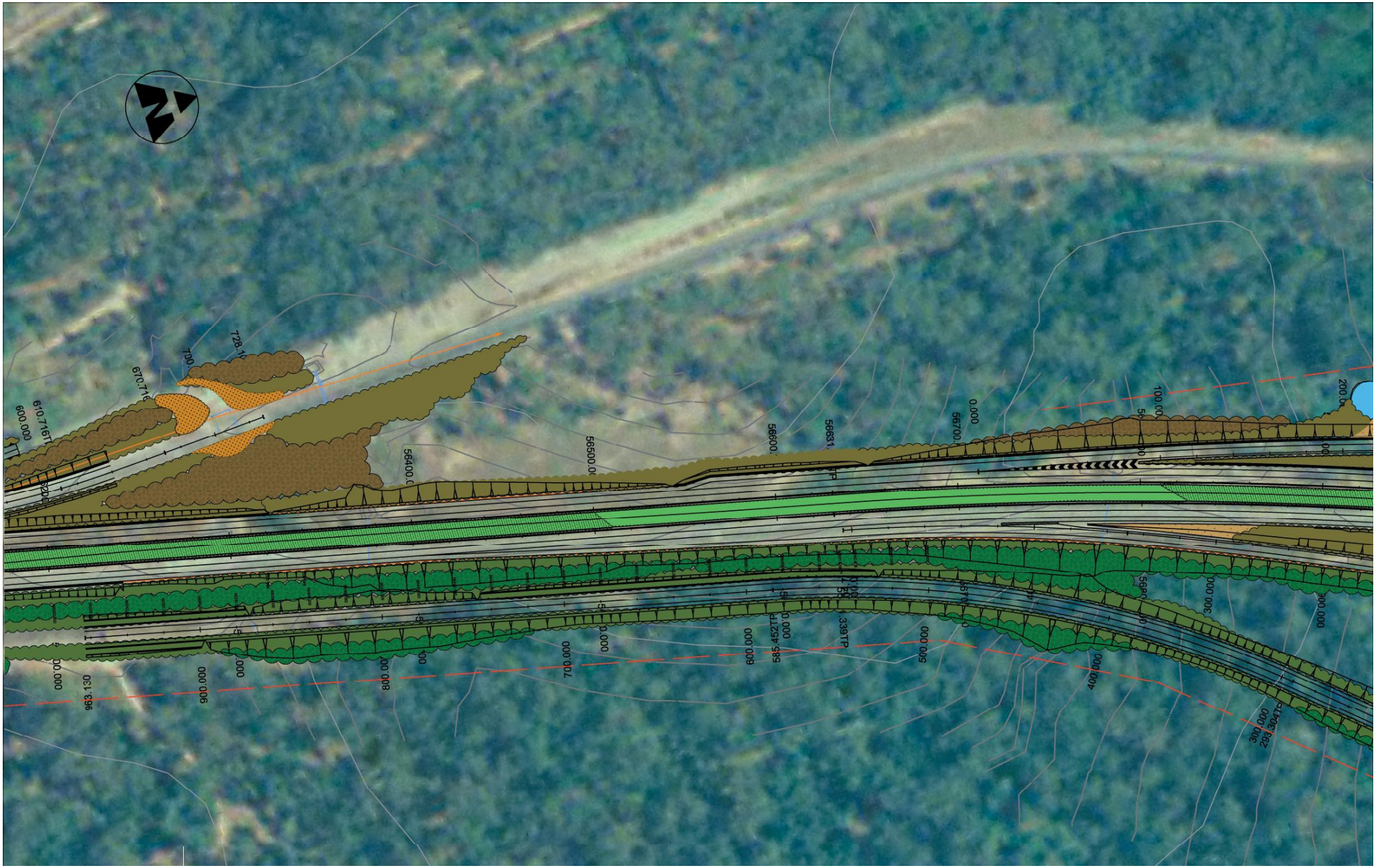


Figure 16 - Landscape Concept Design Plan - 2 1:2000

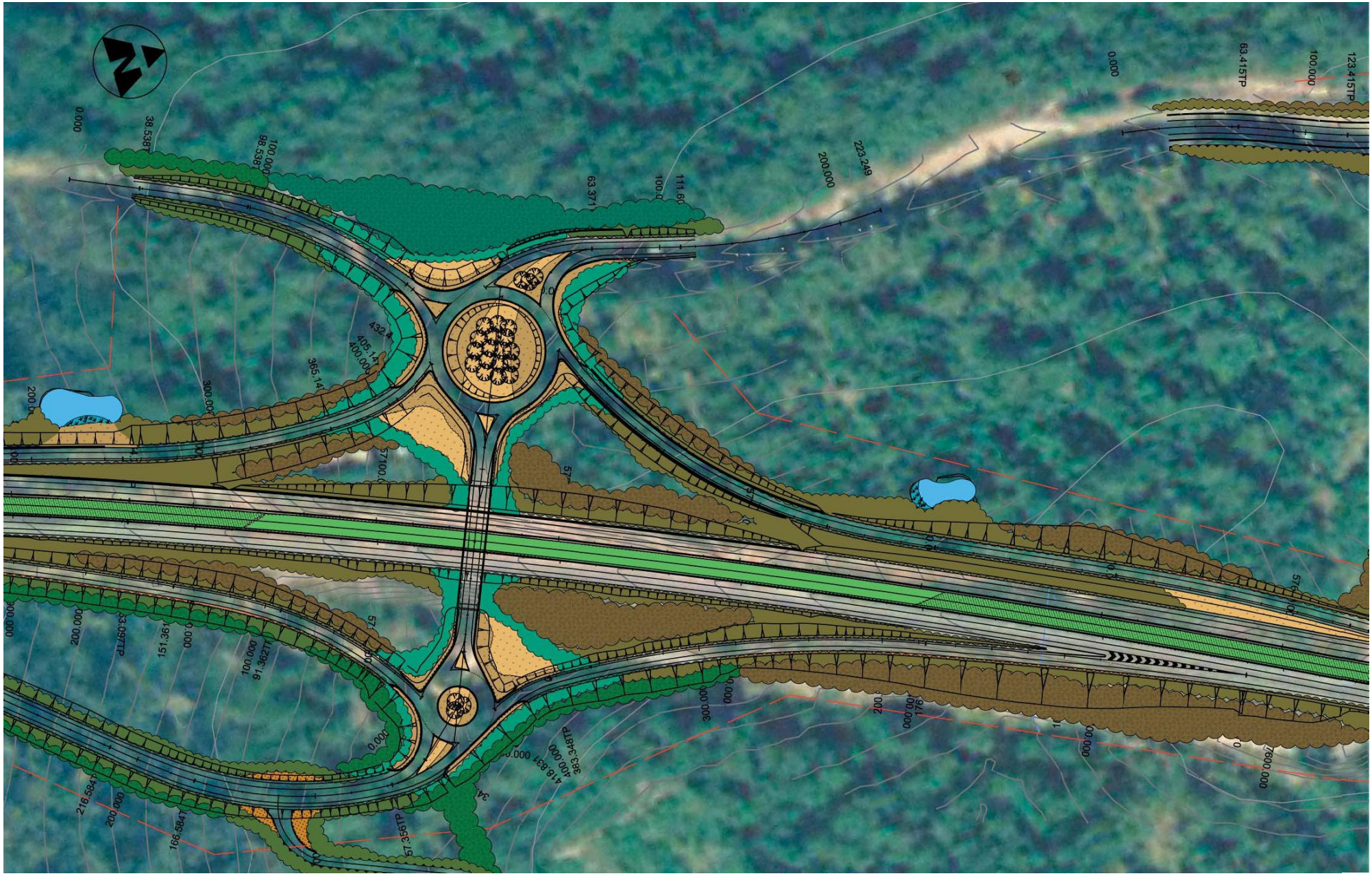


Figure 17 - Landscape Concept Design Plan - 3 1:2000

Figure 18 - Landscape Concept Design Plan - 4 1:2000

Figure 19 - Landscape Concept Design Plan - 5 1:2000

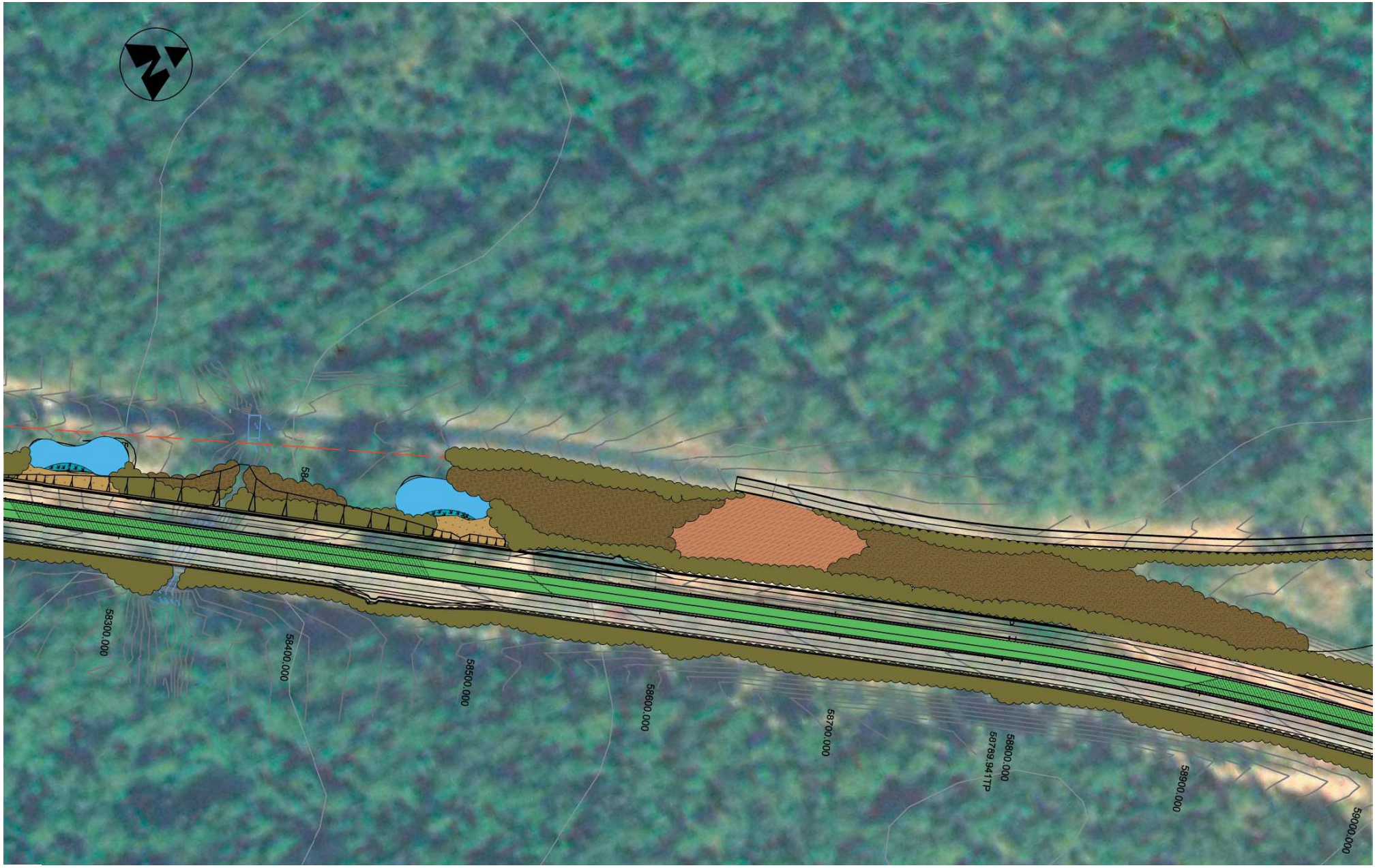


Figure 20 - Landscape Concept Design Plan - 6 1:2000

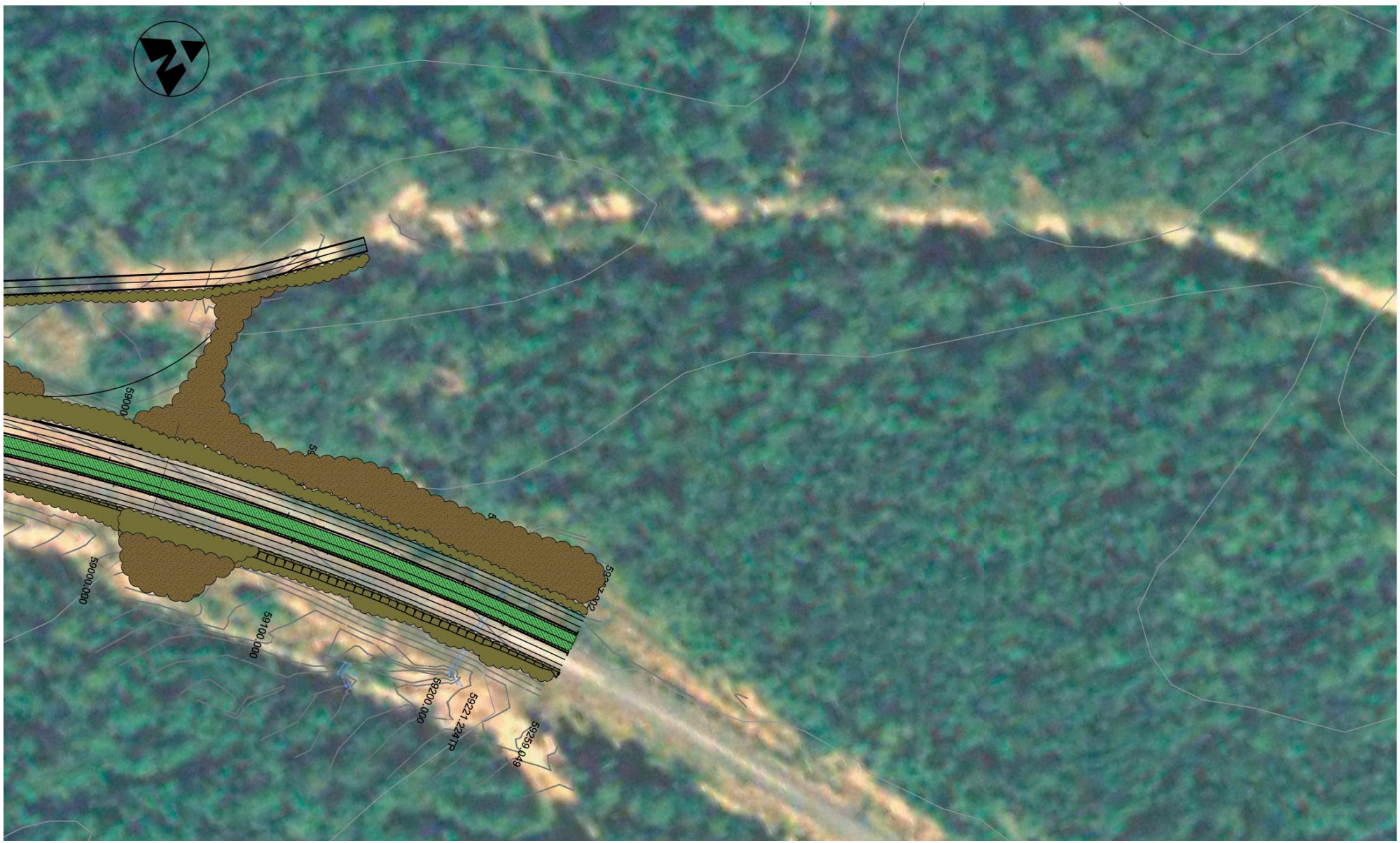


Figure 21 - Landscape Concept Design Plan - 7 1:2000

6.1 Planting Mixes

The landscape design concept evolved by identifying and allocating key vegetation types to different areas within the project. Three mixes were identified from various sources including Review of Flora and Fauna, Pacific Highway Upgrade Herons Creek to Stills Road and the Terrestrial Flora / Fauna Study for the Moorland to Herons Creek project.

The three mixes are:

Coastal Blackbutt Forest (Plant Mix A);
Broad Leaved White Mahagony (Plant Mix B); and
Dry Tallowwood Forest (Plant Mix C)

All species selected are native to the project area.

Plant Mix A – Coastal Blackbutt Forest	
Scientific Name	**Common Name**
Trees	
Allocasuarina littoralis	She Oak
Angophora floribunda	Rough-barked Apple
Corymbia intermedia	Pink Bloodwood
Eucalyptus acmenioides	White Mahogany
Eucalyptus pilularis	Blackbutt
Eucalyptus microcorys	Tallowood
Shrubs	
Acacia longifolia	
Breynia oblongifolia	Coffee Bush
Ceratopetalum gummiferum	Christmas Bush
Daviesia ulicifolia	Gorse Bitter Pea
Dodonaea triquetra	Hop Bush
Leptospermum trinervium	
Pultenaea villosa	
Xanthorrhoea spp.	Grass Tree
Jacksonia scoparia	Dogwood
Ozothamnus diosmifolia	White Dogwood
Low Shrubs & Ground Covers	
Hibbertia aspera	
Hibbertia monogyna	
Scaevola romosissima	
Rubus hillii	Molucca Bramble
Grasses & Tussocks	
Aristida vagans	Threeawn Speargrass
Imperata cylindica	Blady Grass
Lomandra filiformis	Wattle Mat Rush
Lomandra longifolia	Spike Rush
Stipa pubescens	
Themeda australis	Kangaroo Grass

Plant Mix B – Broad-leaved White Mahogany	
Scientific Name	**Common Name**
Trees	
Eucalyptus acmenoides	White Mahogany
Eucalyptus botryoides	Bangalay
Eucalyptus punctata	Grey Gum
Eucalyptus saligna	Sydney Bluegum
Eucalyptus siderphloia	Grey Ironbark (C)
Eucalyptus tereticornis	Red Gum
Tristaniopsis laurina	Water Gum
Leptospermum polygalifolium subsp. *cismontanum*	
Shrubs	
Acmena smithi	Lilly Pilly
Allocasuarina torulosa	Forest Oak
Alphitonia excelsa	Red Ash
Banksia integrifolia subsp. *integrifolia*	Coast Banksia
Callistemon salignus	White Bottlebrush
Glochidion ferdinandi	Smooth Cheese Tree
-Lophostemon confertus	Brush Box
Melaleuca styphelioides	Prickly Paperbark
Melaleuca biconvexa	Paperbark
Melaleuca linariifolia	Flax Leafed Paperbark
Persoonia levis	Broad-leaved Geebung
Pimelea linifolia subsp. *linifolia*	Rice Flower
Low Shrubs and Grasses	
Backhousia myrtifolia	Ironwood
Gahnia spp.	Saw-sedge
Lomandra spicata	Mat Rush
Lomandra spp.	Matrush
Vine	
Gissus app.	Native Grape
Hibbertia dentata	Twining Guinea Flower

Plant Mix C – Dry Tallowwood Forest	
Scientific Name	**Common Name**
Trees	
Corymbia intermedia	Pink Bloodwood
Eucalyptus globoidea	White Stringybark
Eucalyptus fibrosa	Red Ironbark
Eucalyptus microcorys	Tallowood
Eucalyptus pilularis	Blackbutt
Shrubs	
Acacia longifolia	
Acacia floribunda	Coastal Wattle
Acacia irrorata	Green Wattle
Breynia oblongifolia	Coffee Bush
Dodonaea triquetra	Hop Bush
Leptospermum polygalifolium	
Ozothamnus diosmifolius	*White Dogwood*
Persoonia linearis	Narrow leafed Geebung
Persoonia levis	Broad leaved geebung
Polyscias sambucifolia	Panax Elderberry
Grasses & Tussocks & Groundcovers	
Aristida vagans	Threeawn Speargrass
Hardenbergia violacea	Violet
Hibbertia aspera	Guines Flower
Lomandra filiformis	Wattle Mat Rush
Lomandra longifolia	Spike Rush
Lomandra multiflora	Flowered Mat Rush
Themeda australis	Kangaroo Grass

6.2 Interchange

The interchange is considered a major feature of the project and is located on a crest/cutting to minimise earthworks for the bridge structure. Key features include:

Ramps:
The interchange is a full interchange with ramps catering for all directions from/to the highway.

Roundabouts:
Roundabouts on either side of the highway. On the western side the roundabout is larger to cater for the fifth leg while providing continuity with the new service road between Herons Creek and Bago Road. Both roundabouts can cater for B-Doubles.

Bridge:
The bridge is designed as a simple span structure with a central pier. Abutments are spill type to provide an open character. The headstock is modified to visually integrate it with the piers and a 'V' shape adds to the slenderness of the piers.

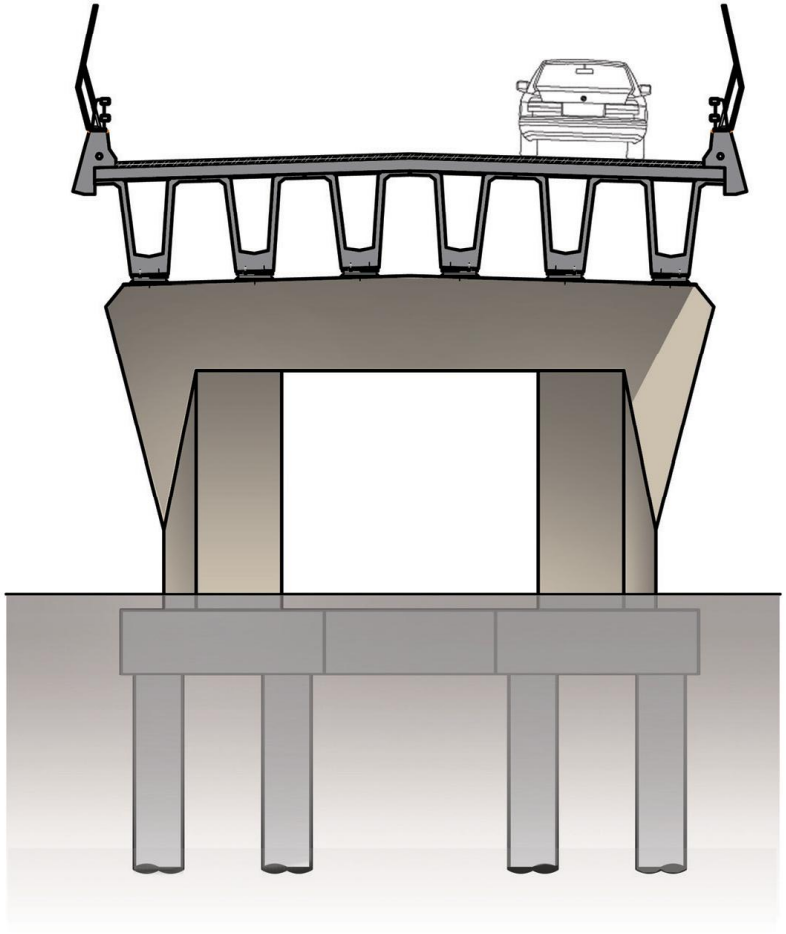


Figure 22 - Cross section of overpass - scale 1:100

Figure 23 - Elevation of overpass - scale 1:250

6.3 Earthworks

The key earthworks principles applied through the project are outlined below with illustrative sections:

Rounding off tops of batters and ends of cuttings to integrate the new works with the existing landform.

Varying batter slopes at key locations to create a less engineered outcome. Batters between service roads and highway/exit ramps would be rounded to create a more integrated landform. Batters adjacent to abandoned roads would be soften to introduce variety in slopes.

Cutting for roads would be located to integrate with the landform and express the topography. The service road adjacent to the school would reflect this approach.

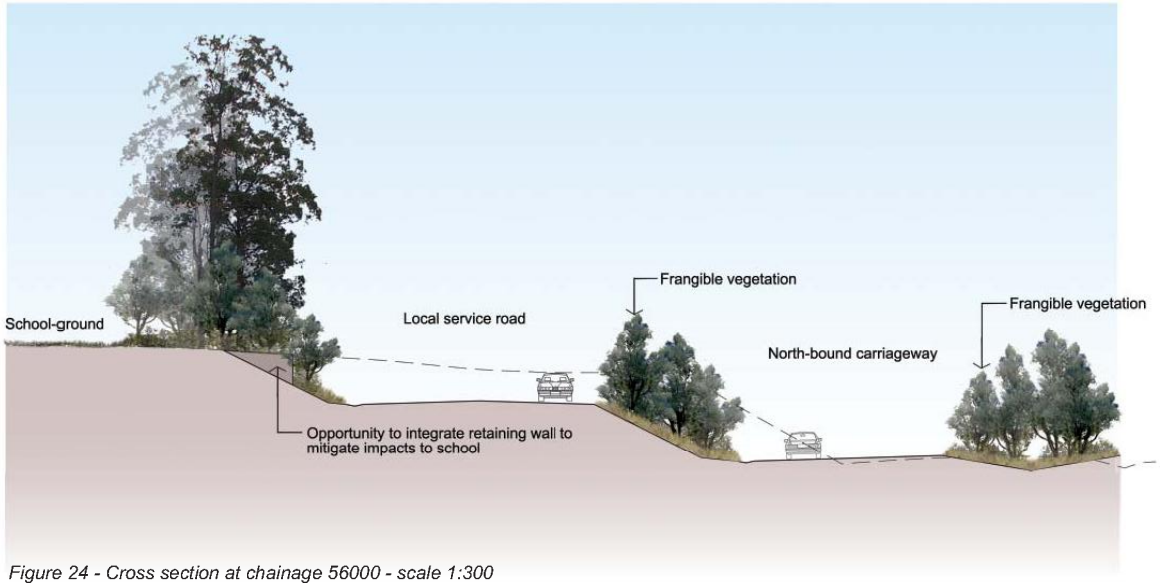


Figure 24 - Cross section at chainage 56000 - scale 1:300

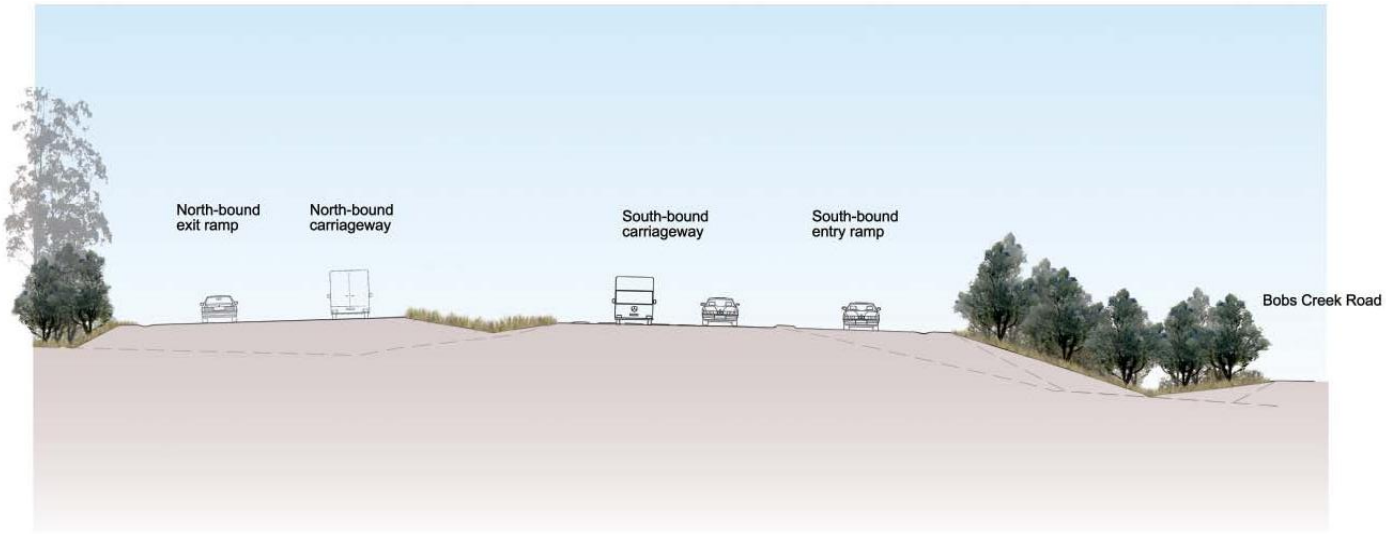


Figure 25 - Cross section at chainage 56680 - scale 1:300

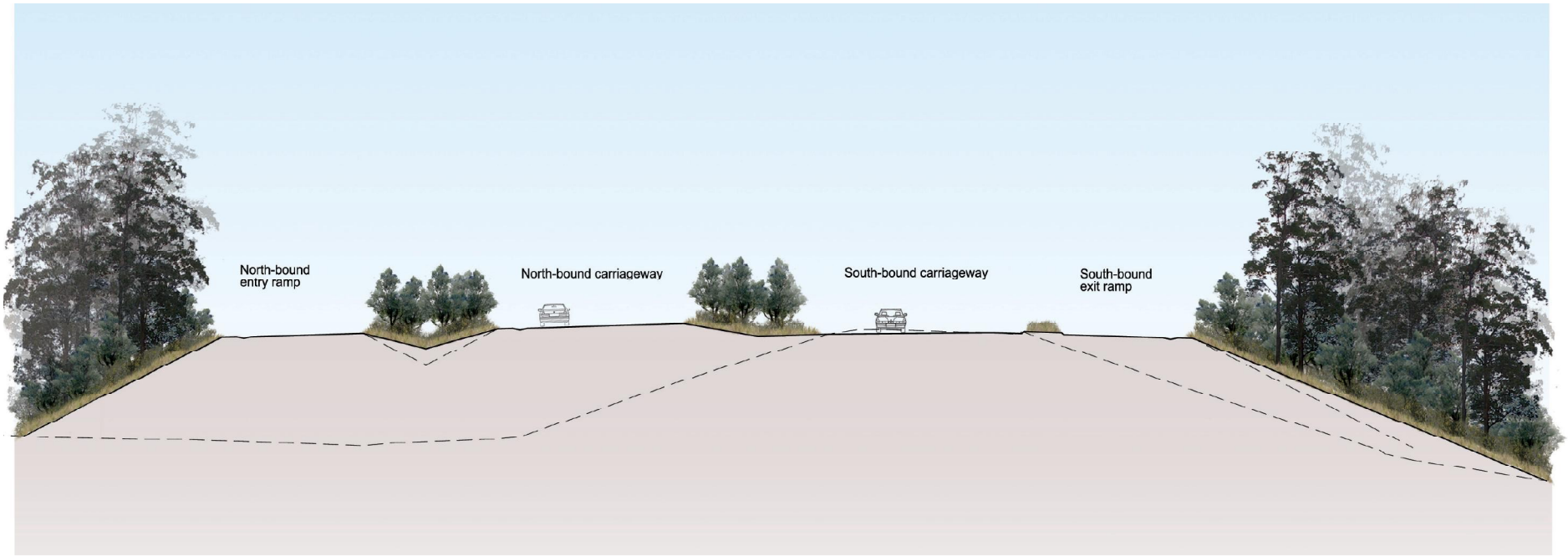


Figure 26 - Cross section at chainage 57480 - scale 1:300

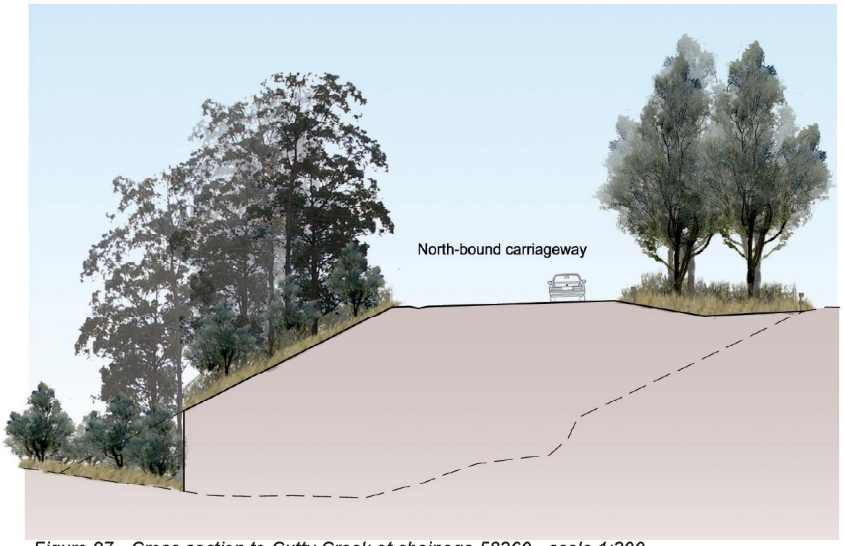


Figure 27 - Cross section to Cutty Creek at chainage 58360 - scale 1:300

7 Visual impact Assessment

The following table provides an overview of the considered visual impact within each character zone. The assessment is based on the visual sensitivity of the site which includes factors such as the viewer's location, duration of view, sensitivity of the setting etc.

This is superimposed on the magnitude of the change which in term depends on such factors as the scale of the project, distance of the viewer etc.

Zones	Character	Visual sensitivity	Magnitude of visual effect	Visual Impact
Character Zone 1	Lack of definition at verges	Low	Low	Low
Character Zone 2	Enclosed	Medium - Low	Medium - Low	Medium to Low
Character Zone 3	Road is exposed to private properties	Medium/High	High	High
Character Zone 4	Enclosed	Medium to High	Low	Medium to Low

7.1 Zone 1

Along this zone the visual sensitivity of the setting is considered low because of the limited exposure from surrounding areas/private properties and because the existing verges partially lack definition due to vegetation clearance. In addition, the open median does not help integrate the road with the setting. The absorption capacity is considered high because of the enclosed character and limited visual exposure and the partial mediocre setting/vegetation quality. Hence the visual effect is considered of a low magnitude resulting in a overall low visual impact.

Key mitigating strategies include:
Introduce planting within median to create a more enclosed character fitting with the setting.
Revegetate/define verges

7.2 Zone 2

This zone is considered visually more sensitive because it provides a higher quality setting then the previous zone. This is partially because the topography is more undulating creating subtle variations of viewsheds which add interest to the journey. The corridor within this zone is enclosed and the bushland/forest visually dominate the setting. Visual exposure to private residences outside the corridor is extremely limited and impacts to the existing verge by the carriageway duplication is considered limited in visual and ecological value. As a result, the visual sensitivity is categorised as medium to low, where the overall forest setting is considered the main sensitivity factor.

As with the previous zone, the absorption capacity is considered high because of the enclosed character and limited visual exposure and the partial mediocre setting/vegetation quality. The visual effect is considered of a low magnitude and so is the overall visual impact.

7.3 Zone 3

Zone 3 is the most sensitive zone within the proposed project due to its interface with local accesses and the location of Herons Public School. The overall road corridor widens at this location in order to provide for local service roads on both sides of the highway. The most sensitive site is the school where property from the school ground needs to be acquired to provide the service road on the western verge. As a result, the road will be highly exposed to the school. On the eastern verge, impacts are predominantly to existing vegetation. The visual sensitivity of the setting is considered medium to high.

The magnitude of the visual effect would be high particular to the school ground because of its proximity to the road corridor and its sensitivity as an educational facility where prolonged views from the playgrounds are affected. Hence, the visual effect is considered high although this is the only property that is adversely affected.

The resulting visual impact is considered high.

Mitigating strategies include:

Introducing dense vegetation screening between service road and school as well as between service road and northbound carriageway.

Integrating service road within the landform, resulting in a lower visual exposure of the service road.

Introducing a small retaining wall between service road and school would assist in further reducing the visual exposure of the local road and mitigate noise impacts.

Allowing the introduction of a noise attenuation barrier in the future.

7.4 Zone 4

The visual setting within this character zone is considered high in quality because of the enclosed nature and the strong presence of the forest underlined by the tall Ironbark and Tallowwoods. There are no private residences affected along the corridor, however because of the high quality visual setting, this zone is considered medium to high in visual sensitivity.

The magnitude of the visual effect is considered low, predominantly because of the limited visual exposure and the limited proposed changes to the existing northbound carriageway. These changes are predominantly confined to the proposed interchange area at Bago Road and the improved curved alignment at the existing intersection with Bago Road. In both cases visual impacts/effects are predominantly limited to drivers and hence would be considered low in magnitude.

As a result, the overall visual impact in this zone is considered medium to low.

Mitigating strategies include:

Revegetation of verges/clear zones and abandoned road sections.

Visual reinforcement of endemic species at roundabout to express the site's qualities.

The overall project in its "M" Class development is considered to have a medium to low visual impact. The project would greatly contribute to improving safety along the Pacific Highway as well as improving the amenity for the local community

8 Conclusion

The design is consistent with the urban design objectives and strategies set out in the preferred option report. This includes:

The new northbound carriageway would be integrated with the adjoining landform and southbound carriageway while meeting design standards. This is partially due to the gentle undulating topography where cuts and fills are limited.

The design reinforces the forest character through which the road passes and revegetation strategies are proposed for disturbed areas or sections of abandoned roads by using local vegetation species.

The proposed project is a short section of the Pacific Highway Upgrade (3.3km). These section offers limited memorable settings, however care has been taken to reinforce key settings to add interest to the journey. These include the overpass at Bago Road interchange, visually reinforcing creek crossings and reinforcing views to distant ranges.

The project adds value to the local community through the introduction of a new network of service / local roads that improves safety and the amenity for the local community. There is limited exposure of the highway to local residents with the exception of Herons Public School. Measure such as integrating local roads within the landform and limiting the visual exposure of local roads and the highway mitigate some of these impacts.

The design attempts to minimise the amount of hazards within the clear zone to avoid using safety barriers and improve safety while also maintaining a more open character. Key areas would be the exception in order to visually reinforce the setting and add variety.

The bridge structure at the interchange reflects a simple and 'clean' design that complies with the RTA Aesthetic Guidelines for Bridges. Headstocks, would be integrated with the piers, screen are terminated with transitions at either end and abutments would be the spill through type to maintain an open character.

Currently, no noise mitigation barriers have been considered. The most affected area is the school and at this point it is not clear whether the school will be closed. Should noise barriers be required, they would be screened with dense vegetation and painted black to recede their visual presence.