Australian Government

New South Wales Government

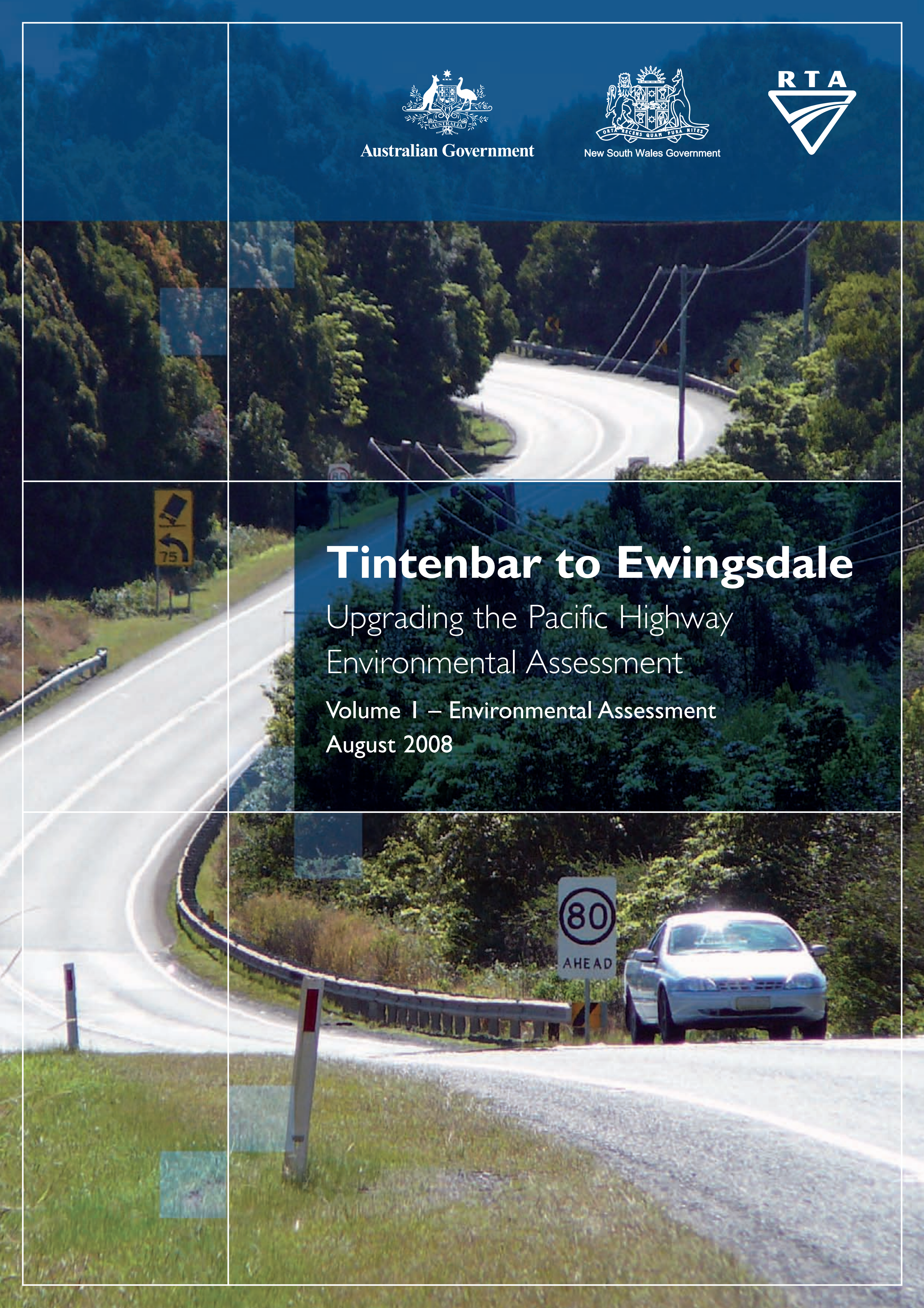
RTA

Tintenbar to Ewingsdale

Upgrading the Pacific Highway
Environmental Assessment

Volume 1 – Environmental Assessment

August 2008



Tintenbar to Ewingsdale

Upgrading the Pacific Highway

ENVIRONMENTAL ASSESSMENT

VOLUME 1
Environmental assessment

RTA/Pub.08.238A
ISBN 978-1-921474-34-7

STATEMENT OF VALIDITY

Submission of Environmental Assessment prepared under Part 3A of the New South Wales Environmental Planning and Assessment Act 1979.

Name:	Peter Rand (key author)
Qualifications:	B.App.Sc
Address:	Arup Pty Ltd Level 10, 201 Kent Street Sydney NSW 2000
In respect of:	Tintenbar to Ewingsdale Pacific Highway Upgrade, Environmental Assessment

Applicant name:	NSW Roads and Traffic Authority
Applicant address:	Pacific Highway Office 21 Prince Street Grafton NSW 2460
Proposed development:	Approximately 17 kilometres of four-lane divided carriageway and associated infrastructure to provide a motorway standard link between the proposed Ross Lane interchange and the Ewingsdale Interchange, as outlined in the Environmental Assessment.
Land to be developed:	Land generally required for the design refinement, construction and operation of the proposed development, as shown in Figures 5.2 a-j of the Environmental Assessment.

Signature: 

Name: Peter Rand

Date: 25th August 2008

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Executive summary

What is proposed?

The proposed Tintenbar to Ewingsdale upgrade of the Pacific Highway (the proposed upgrade) is an important component of the New South Wales Roads and Traffic Authority's (RTA's) Pacific Highway Upgrade Program.

The length of the proposed upgrade would be approximately 17 km, starting at Ross Lane in Tintenbar and extending north to the existing Ewingsdale interchange, near the settlement of Ewingsdale. At Ross Lane, the proposed upgrade would connect to the north end of the proposed Ballina bypass. Generally the proposed upgrade would be in close proximity to existing highway corridor from Ross Lane to the Bangalow bypass. The existing highway would be maintained for local and regional traffic.

From Bangalow, the proposed upgrade would diverge away from the Bangalow bypass to the northeast through Tinderbox Creek valley. From there, the proposed upgrade would avoid the steep grades of St Helena Hill by way of a tunnel approximately 340 m long and 45 m below the ridge line. North of the tunnel, the proposed upgrade alignment would be located immediately to the east of the existing highway before tying into the Ewingsdale interchange.

The general features of the proposed upgrade would be:

> Four-lane divided carriageways (two lanes each way), with a wide median allowing for the future addition of a third lane in each direction.

Connection to the northern end of the Ballina bypass at the proposed Ross Lane interchange. A new northbound on-ramp and a new southbound off-ramp would be provided. The remainder of this interchange will be constructed as part of the Ballina bypass project.

> Upgrading of the existing Ewingsdale interchange to provide full access between the modified local and regional road network and the highway.

> A half interchange at Ivy Lane. North-facing ramps would provide access between the local road network and the proposed upgraded highway to the north.

> A half interchange at Bangalow. South-facing ramps would provide access between the local road network, including to Bangalow and Lismore, and the proposed upgrade to the south. This arrangement would replicate the arrangement with the existing Bangalow bypass which also has south-facing ramps only.

> Six twin bridges and four underpasses allowing roads and creeks to pass underneath the proposed upgrade. These would include twin bridges above Byron Creek and the existing Casino-Murwillumbah railway on the north side of Byron Creek.

> Two bridges carrying local roads over the proposed upgrade, one for Broken Head Road and one about 500 m north of Lawlers Lane providing access to several properties east of the upgrade. Protection screens would be provided on both bridges.

> Signage providing clear directions for traffic at the Ross Lane, Ivy Lane, Bangalow and Ewingsdale interchanges.

> The existing highway would be retained as a continuous road for local and regional traffic. It is further anticipated that between Ross Lane and Bangalow the existing highway would be handed over to the councils. Between Bangalow and Ewingsdale

the existing highway would continue to function as a regional link between Lismore/ Bangalow and the north and would be retained by RTA.

> Twin parallel tunnels under St Helena ridge (one tunnel for each carriageway). The tunnels would each be about 340 m long and about 45 m below St Helena Road.

For more details on the characteristics of the proposed upgrade, refer to **Chapter 5 –** *Concept design*.

Why is it needed?

The Pacific Highway is the major transport link between Sydney and Brisbane, and also serves a growing population on the north coast of NSW. The existing Tintenbar to Ewingsdale section of the Pacific Highway requires upgrading to the standard that is being applied over the broader Pacific Highway Upgrade Program.

The existing highway is mainly two lane single carriageway. It has numerous intersections with local roads and private driveways. It also traverses steeply undulating terrain and as a result there are many tight curves and steep climbs. This leads to two main deficiencies:

> It does not meet safety objectives.

> It is inefficient.

The upgrading of the Tintenbar to Ewingsdale section of the Pacific Highway would have substantial benefits for travel safety and efficiency for local and regional movements by separating through and local traffic and improving the standard of the road.

For more details of the need for the project, refer to **Chapter 2 –** *Strategic and project need*.

What alternatives were considered?

Route options for the proposed upgrade were developed through an iterative process involving a range of environmental, community, engineering, urban design, safety and cost considerations. A long list of options was narrowed down to a shortlist of four. The shortlisted options were then assessed in greater detail and publicly exhibited. From these shortlisted options, the preferred route was selected after consideration of community and government agency submissions, the results of a value management workshop, and a technical assessment of the options. The preferred route provides the best overall balance of functional, ecological, social and economic considerations.

For more details on route selection, refer to **Section 2.7 –** *Alternatives considered*.

What are the main beneficial outcomes expected?

The proposed upgrade would result in a range of benefits such as:

> A safer section of highway.

> Greater transport efficiency and safety for intra-state and inter-state movements.

> Supporting growth and the long-term sustainability of the regional economy.

> Improved access and connectivity for the local community.

> Improved amenity along the existing Pacific Highway.

- Reducing financial costs associated with travel on the Pacific Highway.
- Reducing greenhouse gas emissions in the longer term and energy consumption relative to the base case of 'no upgrade'.

For more details on the beneficial outcomes expected, refer to **Chapter 2 -** *Strategic and project need*.

What are the main adverse outcomes expected?

The proposed upgrade would result in some impacts, such as:

- Acquisition of properties.
- Loss of agricultural land.
- Changes in visual amenity in some areas.
- Loss of a small amount of native vegetation.
- Increased noise for some residents (while for others there would be a decrease).
- Minor surface and groundwater impacts.
- Disruption during construction.

For more details on the impacts expected, refer to **Chapters 8-20**.

How will the likely impacts be managed?

Measures to mitigate and/or manage the impacts have been proposed. The mitigation measures aim to remove or minimise potential impacts through design in the first instance. Where a potential impact is unable to be mitigated through design, further management measures are outlined.

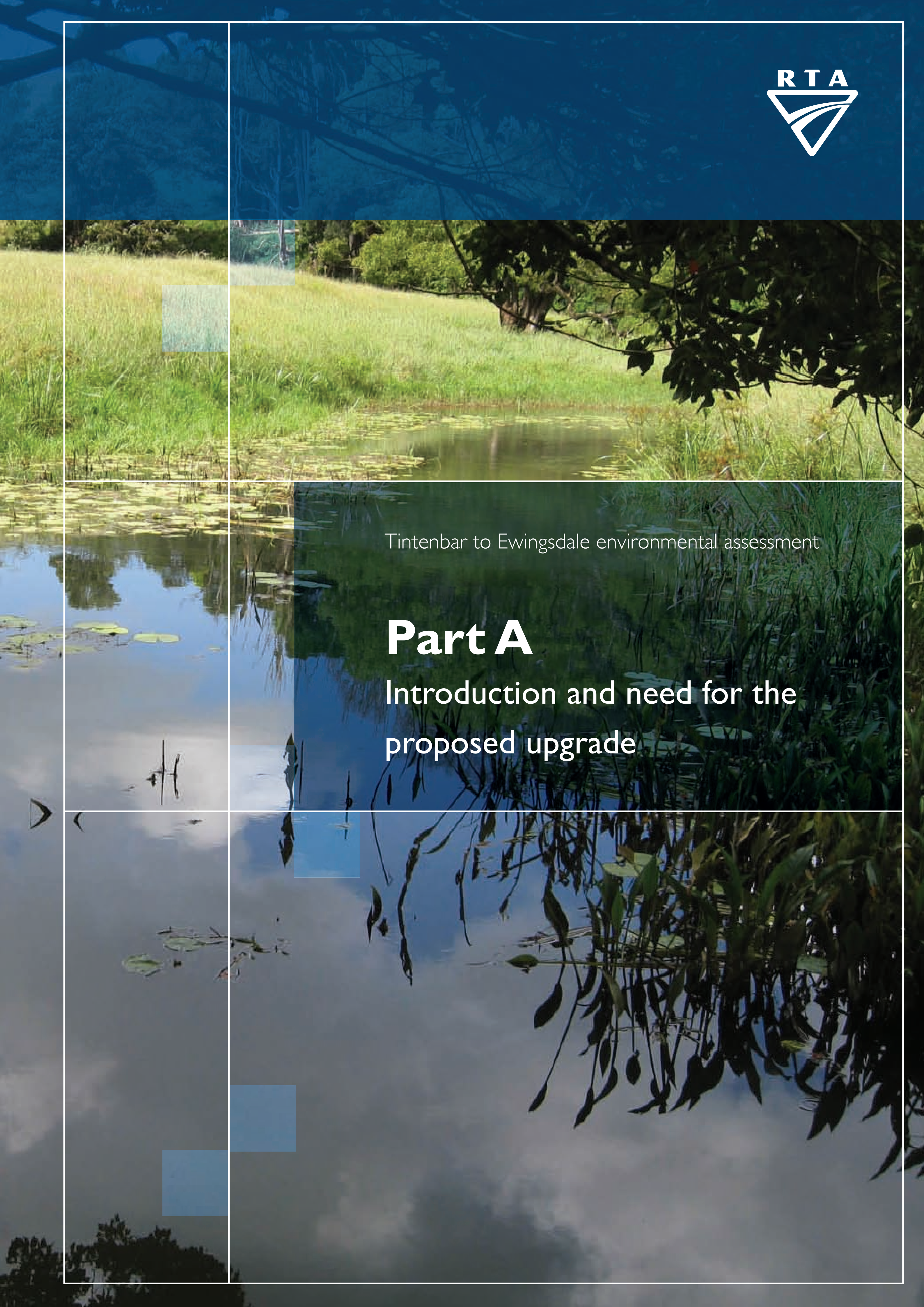
The environmental, social and economic impacts, and measures to minimise those impacts, are discussed in **Chapters 8 to 20**. A draft Statement of Commitments, which lists the outcomes and actions proposed to be achieved, is provided in **Appendix C**.

How can I comment on the proposed upgrade and/or the Environmental Assessment?

The NSW Department of Planning will make the environmental assessment publicly available for a minimum period of 30 days. During this period, it will be available for inspection at the Department of Planning website (**www.planning.nsw.gov.au**), on the project website **www.rta.nsw.gov.au/pacific** (click on Tintenbar to Ewingsdale), at selected RTA offices and in other locations. The RTA will also be conducting community information sessions. A project information line will also be available throughout the exhibition period – 1800 882 787 (toll free).

Any person may make a written submission to the Director-General of the Department of Planning during the exhibition period. Submissions should be made to:

Director – Major Infrastructure Assessment
Department of Planning
GPO Box 39
Sydney NSW 2001



RTA

Tintenbar to Ewingsdale environmental assessment

Part A

Introduction and need for the proposed upgrade

1. Introduction

The proposed upgrade of the Pacific Highway between Tintenbar and Ewingsdale is part of the Pacific Highway Upgrade Program, being implemented by the NSW Roads and Traffic Authority (RTA). It would link the northern end of the approved Ballina bypass to the existing dual carriageway at Ewingsdale west of Byron Bay.

The location of the proposed upgrade of the Pacific Highway between Tintenbar and Ewingsdale is shown in **Figure 1.1.**

Planning for the proposed upgrade began in late 2004, with the announcement of a study area. Milestones since then have included:

> Expansion of the study area in 2005 to include possible route options on the coastal plain.

> A Route Options Development Report (RTA 2005) and public display of a short list of route options in October 2005.

> A Preferred Route Report (RTA 2006) and public display of the preferred route in September 2006.

> A project application and accompanying Project Application Report (RTA 2007), submitted to the Department of Planning in April 2007.

> Requirements for an environmental assessment for the proposed upgrade under Part 3A of the Environmental Planning and Assessment Act 1979, were issued by the Director-General of the Department of Planning in May 2007.

Copies of these documents can be found on the project web site **www.rta.nsw.gov.au/pacific** (click on Tintenbar to Ewingsdale).

The environmental assessment is provided in four volumes. Volume 1 incorporates the main body of the environmental assessment, and Volumes 2, 3 and 4 contain twelve supporting working papers, which provide additional technical background.

The main body of the environmental assessment is divided into four main parts:

Part A – Introduction and Need for the Proposal

Part B – The Proposal

Part C – Environmental Assessment of the Proposal

Part D – Justification and Conclusions

This environmental assessment has been prepared in response to the requirements issued by the Director-General of the NSW Department of Planning. The Director-General's requirements are provided at **Appendix A. Table 1.1** shows where particular issues listed in the Director-General's requirements have been addressed in the environmental assessment.

Table 1.1 - Addressing of the Director-General's requirements

DGRs	Where addressed
> Executive summary.	Executive Summary
A detailed description of the project including:	Part B - Chapters 5-6
> Route alignment and corridor width.	Section 5.2
> Design elements (e.g. requirements for LOS, pedestrian and cyclists, rest areas and service centres etc).	Section 5.3-5.12
> Differentiate the limits of the project with respect to the existing Pacific Highway including operational/maintenance responsibilities.	Section 5.12
> Potential staging.	Section 6.3.8
> Ancillary facilities (e.g. compound site, batching plants etc).	Section 6.6
> Resourcing (e.g. construction material needs, spoil disposal, natural resource consumption including water).	Section 6.5
An assessment of the key issues, with the following aspects addressed for each key issue (where relevant):	Part C - Chapters 9-19, Appendix C
> Describe the existing environment.	Chapters 9-19
> Assess the potential impacts of the proposal at both construction and operation stages, in accordance with relevant policies and guidelines. Both direct and indirect impacts must be considered including potential interactions with the existing Pacific Highway (as relevant).	Chapters 9-19
> Identify how relevant planning, land use and development matters, (including relevant strategic and statutory matters), have been considered in the impact assessment and/or in developing management/mitigation measures.	Section 2.2, Chapter 3
> Describe measures to be implemented to avoid, minimise, manage, mitigate, offset and/or monitor the impacts of the project and the residual impacts.	Chapters 10-19, Appendix C
Draft Statement of commitments	Appendix C
> The SoC must incorporate or otherwise capture all measures to avoid, minimise, manage, mitigate, offset and/or monitor impacts identified in the impact assessment sections of the EA and ensure that the wording of the SoC clearly articulates the desired environmental outcome of the commitment. The SoC must be achievable, measurable (with respect to compliance), and time specific, where relevant.	
Certification of environmental assessment	Front of document
> Certification by the author of the Environment Assessment that the information contained in the Assessment is neither false nor misleading.	
Strategic justification and project	Part A - Chapter 2, Section 2.1 ,
> Outline the strategic outcomes for the Pacific Highway Upgrade Program (PHUP), including with respect to strategic need and justification, the aims and objectives of relevant State planning policies, the principles of Ecologically Sustainable Development, and cumulative and synergistic impacts associated with the program as a whole. Identify how the project fits within these strategic outcomes and how impacts associated with the project will be considered and managed to achieve acceptable environmental planning outcomes across the Pacific Highway Upgrade Program.	

Table 1.1 (cont)

DGRs	Where addressed
Project Justification	Chapter 2 and 21
> Describe the need for and objectives of the project; alternatives considered (including an assessment of the environmental costs and benefits of the project relative to alternatives), and provide justification for the preferred project taking into consideration the objects of the *Environmental Planning and Assessment Act* 1979.	
Land use and property - including but not limited to:	
> Impacts to directly-affected properties and landuses adjacent to the project, including: impacts to landuse viability and future development potential, including property title impacts; land sterilisation and severance impacts; and impacts to the connectivity and contiguity of small settlements including Newrybar and Knockrow.	Section 14.3 (except for connectivity and contiguity impacts which are addressed in Section 17.3.4
> Consideration of project impacts on the attainment of the objectives of *Far North Coast Strategy*.	Section 17.3.6
> Development of a mitigation strategy aimed at promoting appropriate final land uses on lands subject to partial or full acquisition as a result of the project, in consultation with Ballina and Byron Shire Councils.	Section 14.4
Social and Economic - including but not limited to:	Part C, Chapter 17
> Local community socio-economic impacts associated with landuse, property and amenity related changes.	Section 17.3.2 - 17.3.8
> Business (including agricultural producers) impacts on a case by case basis including impacts to the overall viability, profitability, productivity and sustainability of businesses.	Section 17.3.1
> Regional economic impacts to the agricultural sector taking into account the total loss of regional and State Significant farmland as identified in the *Northern Rivers Farmland Protection Project* (Department of Planning, February 2005).	Section 17.3.7
> Regional economic impacts to the tourism sector taking into account agri-tourism impacts and impacts to local amenity, character and scenery.	Section 17.3.8
Surface and ground water - including but not limited to:	Part C, Chapter 10 and 11
> Water quality impacts to the catchments of Emigrant Creek and Wilson River, in consultation with Rous Water, taking into account impacts from both accidents and runoff (i.e. acute and chronic impacts) and considering relevant public health and environmental water quality criteria specified in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* 2000.	Section 10.3 - 11.3
> Groundwater impacts, considering local impacts at each deep cutting and cumulative impacts on regional hydrology. The assessment must consider: extent of drawdown; impacts to groundwater quality; discharge requirements; and implications for groundwater-dependent surface flows (including springs and drinking water catchments), groundwater-dependent ecological communities, and groundwater users including the *Alstonville Basalt Groundwater Source Water Sharing Plan*.	Section 11.3

Table 1.1 (cont)

DGRs	Where addressed
> Flooding impacts, identifying changes to existing flood regimes, in accordance with the *Floodplain Development Manual* (former Department of Natural Resources, 2005) including impacts to existing receivers and infrastructure and the future development potential of affected land.	Section 9.5
> Impacts to waterways to be modified as a result of the project, including ecological, hydrological and geomorphic impacts (as relevant) and measures to rehabilitate the waterways to pre-construction conditions or better.	Section 9.6-9.7, 12.3.8, 12.4
Flora and fauna - including but not limited to:	Part C, Chapter 12
> Consideration of threatened terrestrial and aquatic species, populations, ecological communities and/or critical habitat; and	Section 12.3.2, 12.3.3, 12.3.4
> Assessment of the following issues: native vegetation loss; weed infestation; habitat fragmentation; impacts to wildlife corridors including riparian corridors; impacts to groundwater-dependent communities, riparian and aquatic habitat; and	Section 12.3.1, 12.3.5-12.3.6, 12.3.8 - 12.3.9
> Consideration of regional scale cumulative impacts and identify the significance of the impacts of the project in the context of the Pacific Highway Upgrade Program.	Section 12.3.10
Noise and vibration - including but not limited to:	Part C, Chapter 15
> An assessment of operational road traffic noise impacts including consideration of local meteorological conditions (as relevant) and any additional reflective noise impacts from proposed noise mitigation barriers.	Section 15.2
> An assessment of construction noise and vibration including construction traffic noise and blasting impacts.	Section 15.3
> The assessment(s) must take into account the following guidelines as relevant: *Environmental Criteria for Road Traffic Noise (EPA 1999), Environmental Noise Management Manual* (RTA, 2001), *Environmental Noise Control Manual* (EPA, 1994), *Assessing Vibration: A Technical Guideline* (DEC, 2006a); and *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZECC, 1990).	Section 15.1
Visual amenity and urban design - including but not limited to:	Part C, Chapter 18
> Consideration of project and urban design (including noise barriers, retaining walls and landscaping) consistent with overall design of the PHUP and the existing (and desired) character of affected localities.	Section 5.15, 18.3 and 18.4
> Consideration of the *Noise Wall Design Guideline* (RTA, 2003a).	Section 18.4
Traffic - including but not limited to:	Part C, Chapter 13
> Demonstration of how the project design meets the traffic and transport objectives of the Pacific Highway Upgrade Program.	Section 13.2
> Assessment of operational traffic and transport impacts to the local and regional road network, including direct impacts from traffic rerouting and modified access to the upgraded highway, and indirect impacts from the increased accessibility of the Ballina and Byron Shires.	Section 13.4.1-13.4.6
> Assessment of construction traffic impacts (including spoil haulage).	Section 13.4.7

Table 1.1 (cont)

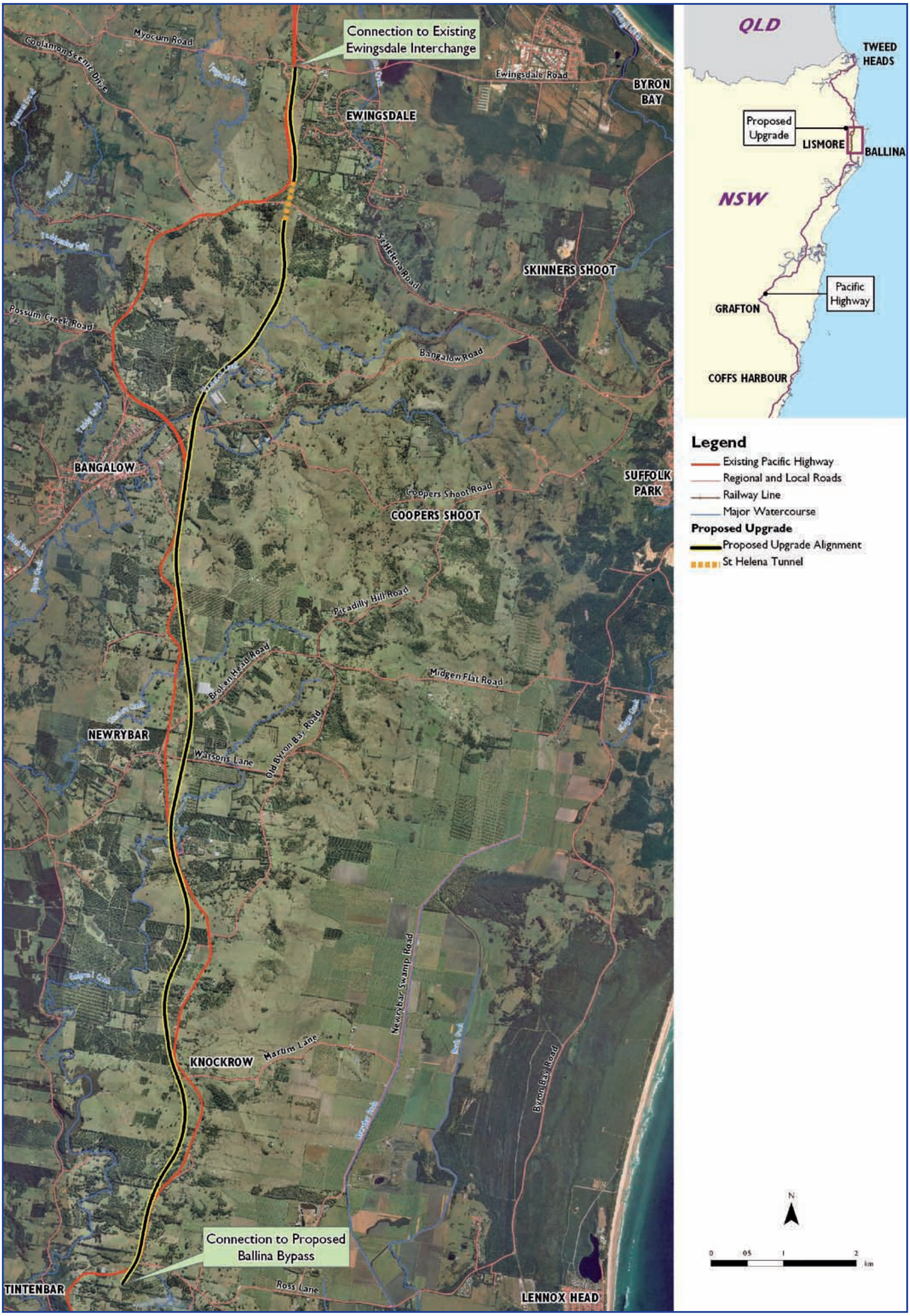
DGRs	Where addressed
Air quality - including but not limited to:	Part C, Chapter 19
> Impacts to sensitive receivers (e.g. Newrybar School); consideration of local meteorological conditions; impacts to road users and other receivers at the tunnel section; and consideration of airborne pollutant impacts on drinking water catchments.	Section 19.4.2-19.4.4
Indigenous heritage - including but not limited to:	Part C, Chapter 16
> The consideration of both artefact and landscape scale mitigation measures, where relevant.	Section 16.4
> Consideration of regional scale cumulative impacts and identify the significance of the impacts of the project in the context of the Pacific Highway Upgrade Program.	Section 16.3.4
Environmental risk analysis	Chapter 8
> Notwithstanding the above key assessment requirements, the EA must include an environmental risk analysis to identify potential environmental impacts associated with the project (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the environmental assessment.	
Consultation	Chapter 4
> You should undertake an appropriate and justified level of consultation with relevant parties during the preparation of the EA, including:	
> Local, State or Commonwealth government authorities and service providers such as Rous Water, the Department of Environment and Climate Change, the Department of Primary Industries, the Department of Water and Energy, the Department of State and Regional Development, Byron Shire Council and Ballina Shire Council.	
> Specialist Interest Groups including Local Aboriginal Councils	
> The public, including affected landowners.	
> The environmental assessment must describe the consultation process, document all community consultation undertaken to date and identify the issues raised (including where these have been addressed in the environmental assessment).	

In deciding on the location of the proposed upgrade, a comprehensive assessment process was undertaken in consultation with the community and in recognition of ecologically sustainable development principles. This was to ensure that the preferred option achieved the best balance between social, environmental and economic constraints and opportunities. While this environmental assessment addresses the likely impacts of the proposed upgrade, it is important to recognise the substantial work that has already taken place to avoid or minimise potential impacts through the earlier assessment of route options. Previous work is described in **Section 2.7** while previous reports can be found on the project web site at **www.rta.nsw.gov.au/pacific** (click on Tintenbar to Ewingsdale).

The proposed upgrade has been developed to the stage of a concept design. On the basis of this concept design, the RTA is seeking project approval for the proposed upgrade under Part 3A of the *Environmental Planning and Assessment Act 1979*. Details and dimensions included are indicative only and are subject to refinement through the approval process and into detailed design and construction. Consideration of design changes and any more substantial modifications to the proposed upgrade would be undertaken as necessary and in accordance with applicable statutory planning requirements.

The RTA has considered the advice of all its specialists in the working papers and from this has developed a range of environmental management measures that are identified in the main body of the environmental assessment and the associated draft Statement of Commitments (**Appendix C**). The RTA proposes to comply with those environmental management and mitigation measures identified in the Statement of Commitments.

Figure 1.1 - The proposed upgrade



2 Strategic and project need

2.1 Strategic outcomes of Pacific Highway Upgrade Program

The proposed upgrade is an important component of the wider Pacific Highway Upgrade Program (**Figure 2.1**) , which is needed to meet the NSW and Commonwealth governments' commitments to upgrade the Pacific Highway between Hexham in NSW and the Queensland border in response to:

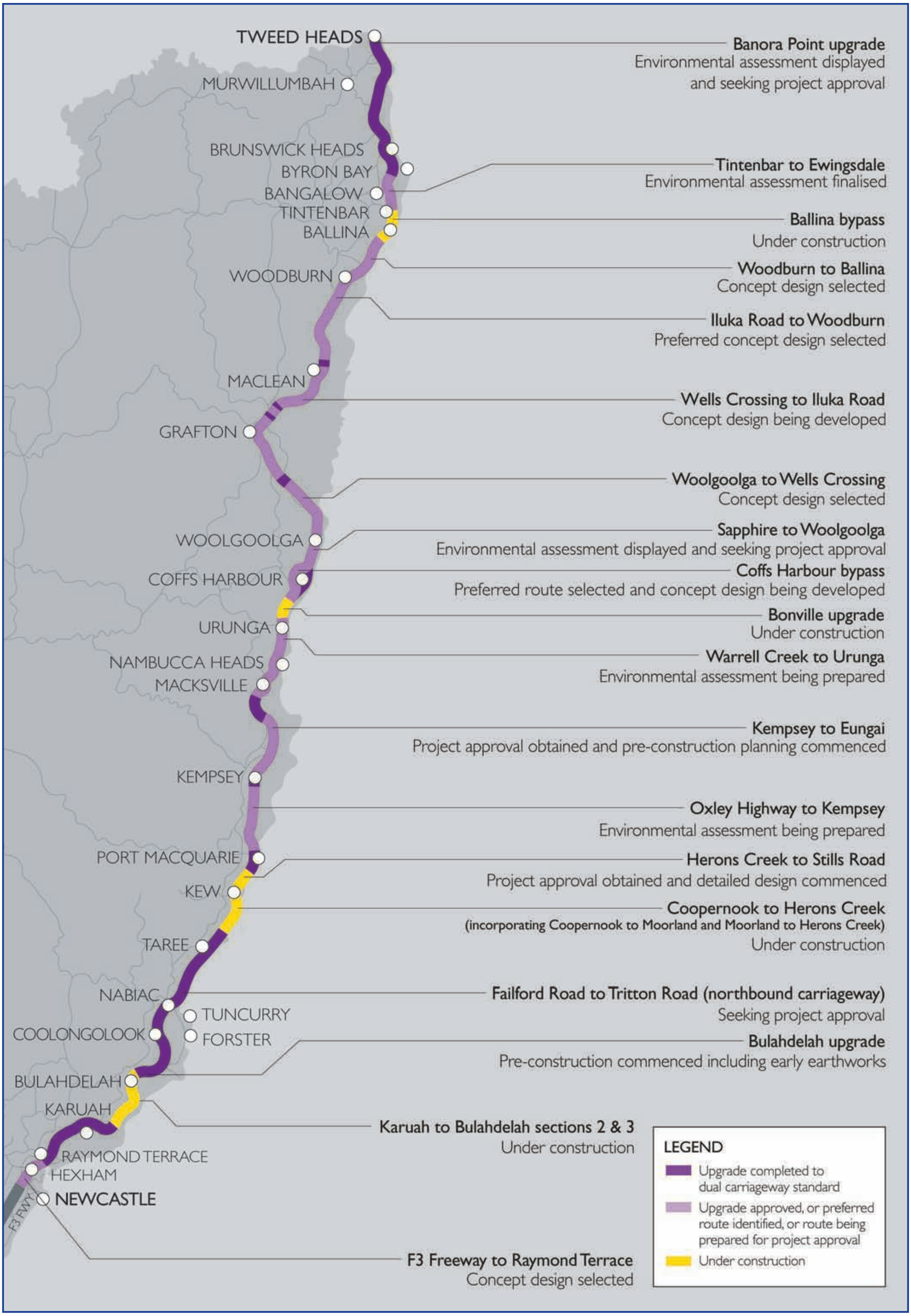
> Current constraints on transport infrastructure and the related need to improve accessibility and transport, both within individual regions and between regions.
> The need to improve the efficiency and integration of transport infrastructure, including improvements in the efficiency and productivity of the freight sector.
> The need to improve road safety.
> Increasing demand for urban development, especially in the relatively narrow coastal strip of NSW.

The objectives of the program are to:

> Significantly reduce road crashes and injuries.
> Reduce travel times.
> Reduce freight transport costs.
> Develop a route that involves the community and considers its 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 (RTA 1997).

The Pacific Highway Upgrade Program is needed in part because of population growth and the associated pressures that places on transport infrastructure. However, the program itself also plays a role in facilitating that population growth. The proposed upgrade has been developed to be consistent with the strategic outcomes of the program. The strategic outcomes of the program, how the proposed Tintenbar to Ewingsdale upgrade fits within these strategic outcomes, and how impacts associated with the project will be considered and managed to achieve acceptable environmental outcomes across the program are discussed in **Chapter 21 – Strategic and project justification.**

Figure 2.1 - Pacific Highway Upgrade Program current status



2.2 Growth context

The following sections present the strategic need for the proposed upgrade in context of the Pacific Highway Upgrade Program.

2.2.1 Planning for growth

AusLink White Paper

The AusLink White Paper *Building our National Transport Future* (the White Paper) (Commonwealth of Australia 2004) is the Australian Government's formal policy statement on land transport that identifies national objectives for the AusLink investment program.

The White Paper seeks to promote sustainable national and regional economic growth, development and connectivity by contributing to the development of an integrated national transportation network. The Pacific Highway is identified as part of the national network defined in the National Land Transport Plan under the AusLink investment program and is also the key road in the Sydney-Brisbane transport corridor. The overall Pacific Highway Upgrade Program and the proposed upgrade would help to achieve the key objectives of the AusLink investment program by improving connectivity within and between communities in the growing region, enhancing road safety, incorporating ecologically sustainable development principles, and assisting in promoting economic growth and development.

Sydney-Brisbane Draft Corridor Strategy

The *Sydney-Brisbane Draft Corridor Strategy* is a joint publication by the Commonwealth Department of Infrastructure, Transport, Regional Development and Local Government Queensland Main Roads, NSW Department of Planning, NSW Ministry of Transport, Queensland Transport and the RTA. The strategy identifies the Sydney-Brisbane corridor as the busiest on the Australian transport network. In addition to the Pacific Highway's role as a major interstate transport route, the strategy identifies Pacific Highway in the Far North Coast/Northern Rivers region as a key component in linking populations in multiple regional centres with diversified rural and tourism economies and many small to medium sized manufacturing industries.

Deficiencies in the transport corridor are highlighted by the strategy and include safety, amenity, infrastructure capacity, road geometry and aging pavement. To overcome the deficiencies the strategy identifies the achievement of substantial completion of the duplication of the Pacific Highway as a short term priority and completion of the entire Pacific Highway duplication as a long-term priority.

NSW State Infrastructure Strategy

The *State Infrastructure Strategy– New South Wales* 2006-07 to 2015-16 (NSW Treasury 2006) provides strategic direction for planning and delivery of infrastructure in NSW. The strategy lists roadwork initiatives planned throughout NSW, including the Pacific Highway Upgrade Program.

The strategy highlights that the upgrading of the Pacific Highway will continue under the AusLink agreement and that in a recent agreement both governments have each contributed $160 million in addition to the previously agreed funding under the AusLink agreement. The proposed Tintenbar to Ewingsdale upgrade (along with other Pacific Highway Upgrade projects) are identified in the strategy.

The strategy also identifies that the Pacific Highway requires upgrading as soon as possible. The NSW Government will continue to work in partnership with the Australian Government to investigate potential timing, financing and delivery options to accelerate the upgrade of the Pacific Highway.

The NSW Government under the strategy will also continue to work cooperatively with the Australian Government and Australian Rail Track Corporation (ARTC) to increase rail freight capacity and competitiveness, with specific initiatives by NSW to increase the share of port container freight carried by rail. The ARTC's two main investment strategies are:

> A north–south investment strategy worth $1.1 billion to achieve a step–change in rail's competitiveness in the interstate intermodal market.

> Investment of over $200 million in major rail renewals in NSW.

Far North Coast Regional Strategy 2006-31

The *Far North Coast Regional Strategy* aims to guide sustainable growth across the region. The strategy sets out a range of policies and plans. Of particular relevance are the following:

> Ballina will develop as the third major regional centre.

> Land use and transport planning must be integrated to minimise the need to travel, and to encourage energy and resource efficiency.

> The regional transport network must be protected, and passenger interchanges provided in major centres.

> The Pacific Highway will continue to be the primary inter/intra-region road corridor and its efficiency and safety protected. Upgrading of the Pacific Highway will be continued.

> The Casino to Murwillumbah rail corridor will be protected and an extension of the Gold Coast rail system into NSW will be investigated.

North Coast Regional Environmental Plan

The *North Coast Regional Environmental Plan* establishes a regional framework for the development of the NSW North Coast Region.

Part 5 of the environmental plan identifies the strategic importance of improving regional infrastructure along the NSW North Coast. It sets out objectives which recognise the need to safeguard the role and efficiency of the major arterial road system and the need to facilitate maintenance and improvement of transport across the region.

2.2.2 Growth pressures

National transport growth

The AusLink White Paper identifies trade as an important driver of economic growth, and that trade requires efficient transport infrastructure.

Road transport is identified as the dominant mode for moving freight over relatively short distances and where alternatives are not readily available. Total freight is forecast to almost double in the next 20 years.

Cars are identified as the dominant transport mode for domestic passenger travel, accounting for over 80 percent of total kilometres travelled. The AusLink White Paper identifies that private motor vehicle travel will continue to be of critical importance for access to services in regional areas, especially growth nodes such as the NSW coastal belt and south-east Queensland.

Sydney-Brisbane corridor

The Pacific Highway plays a vital role in linking coastal regions between Sydney and Brisbane, providing access to markets and sources of goods and services.

The Sydney-Brisbane corridor includes some of the fastest growing areas of Australia. Forecasts to 2020 in the AusLink White Paper indicate that centres along the Sydney-Brisbane corridor will have continuing strong growth in freight and passenger traffic, fuelled by economic growth and population expansion.

The *State Infrastructure Strategy* projects that the north coast of NSW (stretching from the Hunter Valley to the Queensland border) will increase in population by around 58,200 people, or 11 percent, between 2006 and 2016.

Far North Coast region of NSW

The Far North Coast region of NSW stretches from Evans Head through to the Queensland border. The Department of Planning has identified urban growth areas, including major regional centres, within this region (**Figure 2.2**).

The *NSW State Infrastructure Strategy* predicts that the population in the region will increase by almost 26,000 people, an increase of over 11 percent, by 2016.

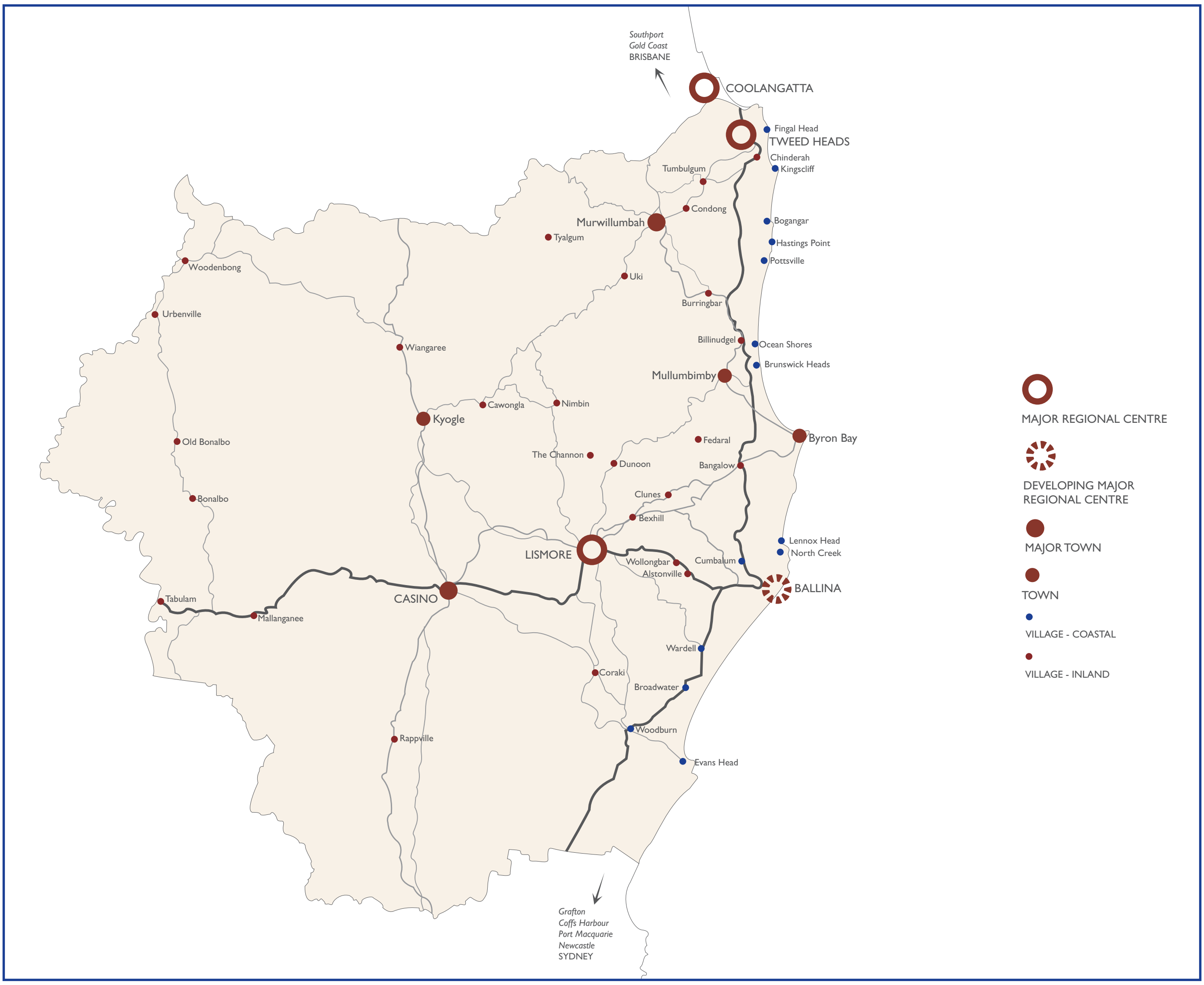
The *Far North Coast Regional Strategy* estimates a regional population of 289,000 by 2031, representing an additional 60,400 people (a 26 percent increase) for the period 2006–2031.

The *Far North Coast Regional Strategy* identifies that the coastal areas of the region have continued to grow at a moderate rate since the 1980s, while growth in the hinterland areas has been low or static. The largest population increases have been in the coastal local government areas of Tweed, Byron and Ballina.

Improved transport routes may result in an increased number of people moving to the Far North Coast for a new lifestyle, more affordable housing and business or employment opportunities. Conversely, population growth tends to put pressure on existing transport networks and increases the demand for road improvements.

Population growth and a growing number of tourists visiting the region have resulted in a change from an economy dominated by agriculture to one now dominated by service sector industries (84 percent), and manufacturing and construction (12 percent).

Figure 2.2- Hierarchy of urban areas on the NSW Far North Coast (DoP, 2006)



Ballina local government area

The *Ballina Urban Land Release Strategy* (Ballina SC 2000) identifies that the annual population growth rate in the shire between 1991 and 1996 was about 3 percent, dropping since the high growth rate of almost 7 percent annually, between 1976 and 1981. A strategy addendum (Ballina SC 2003) identifies that the annual population growth rate was about 2 percent between 1996 and 2001. The strategy considers it reasonable to expect that substantial population growth demands will continue. The 2003 strategy addendum predicts an annual growth rate of approximately 1.7 percent between 2003 and 2021, with the population exceeding 54,000 in 2021. This compares with the population recorded in the 2006 census of 38,461.

Forecast population growth will be focussed around Ballina, Cumbalum, Wollongbar and Lennox Head.

Byron local government area

The population of the Byron Shire according to the 2006 census was 28,766, which is a slight decrease from the 2001 census where the population was recorded at 28,916.

The *Bangalow Settlement Strategy* (Byron SC 2005) identifies that the 2001 population of Bangalow was approximately 1,200. Development of existing land zoned residential is expected to almost double the village's population according to the strategy. This has been partially borne out between 2001 and 2006, with the 2006 census indicating the Bangalow population increasing to 1,758.

2.3 Transport context

The Far North Coast is currently serviced by a transport network comprised of road, rail and air infrastructure and services. The extensive road network includes:

> Two major north–south corridors, the Pacific Highway and Summerland Way.
> An east–west link, the Bruxner Highway.

In a review of alternative corridors (RTA 2006a) it was determined that the Pacific Highway should remain as the primary north-south corridor on the north coast, with the Summerland Way performing a secondary function.

It is estimated that there are 380 million trips made by residents and visitors, and around 20 million tonnes of freight moved within and through the region each year. The road network is especially important with approximately 75 percent of all journeys within the region by car (DoP 2006).

The Pacific Highway is the primary arterial road and the main transport corridor providing access to Ballina, Byron Bay, and Lismore (via Bangalow Road).

2.3.1 Road conditions

With the exception of the Bangalow bypass and the Ewingsdale interchange, the Pacific Highway between Tintenbar and Ewingsdale is single carriageway roadway, generally with one lane in each direction. Overtaking lanes are provided at intermittent locations.

The existing posted speed limit on this section of the highway is 100 km/h with the exception of the following sections:

> Tintenbar Hill to just north of Ross Lane (80 km/h).
> Skinners Creek to the southern end of the Bangalow bypass (80 km/h).
> St Helena Hill (60 km/h).

The speed reduction is part of an ongoing review of NSW roads aimed at improving road safety.

The existing at-grade intersection between the Pacific Highway and Ross Lane.

A significant section of the highway at this location has a geometry that does not meet current RTA standards, and many advisory speed signs are posted along its length.

Figure 2.3, Figure 2.4 and **Figure 2.5** show the grades, vertical curves, and horizontal curves of the existing highway. Results have been colour coded with regard to their compliance to both the RTA's minimum and desirable design criteria for the project.

The combined geometry rating graph, shown on **Figure 2.6** combines the vertical and horizontal information from the other three graphs. It shows that over 50 percent of the existing highway does not comply with at least one minimum design standard.

Other examples of poor geometry are evident on the existing highway. This includes insufficient sight distances, particularly the 28 at-grade intersections and 75 property driveways directly accessing the highway along this section.

Figure 2.3 - Condition of existing highway - grades

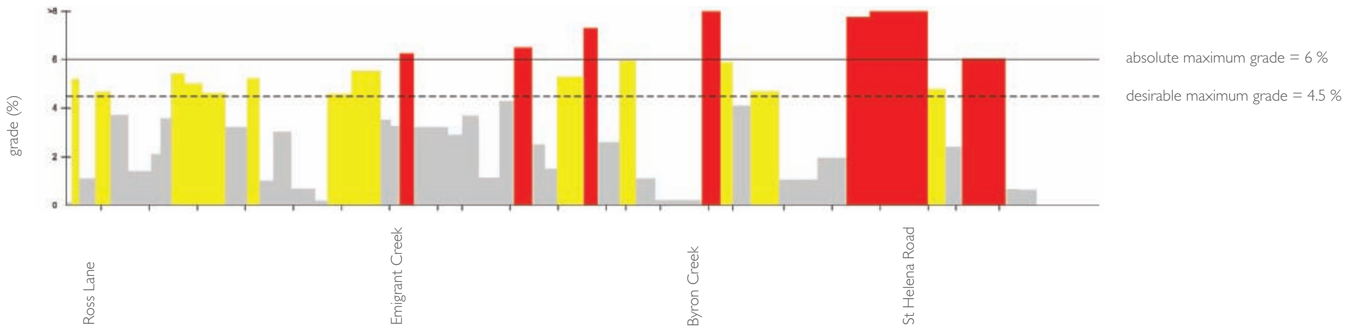


Figure 2.4 - Condition of existing highway - vertical alignment

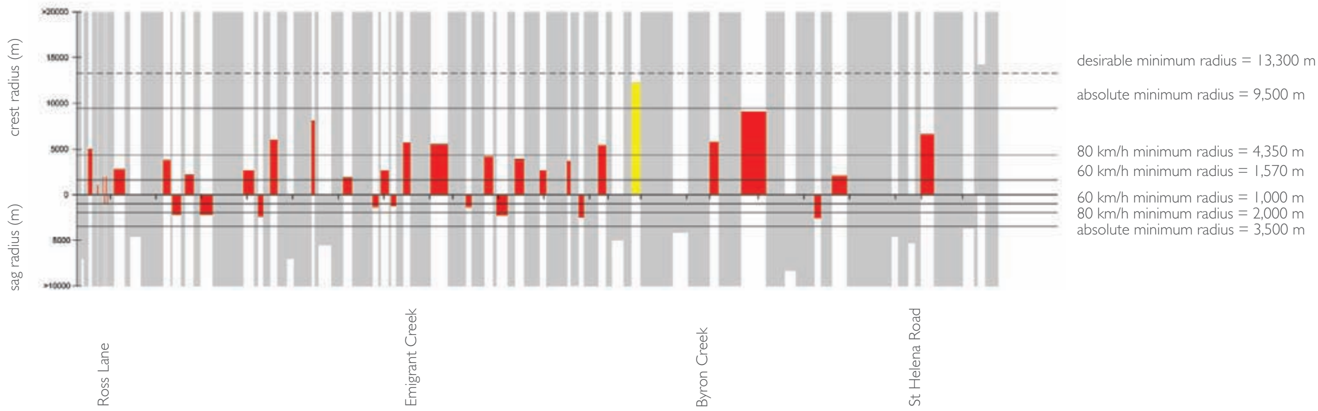


Figure 2.5 - Condition of existing highway - curve radius

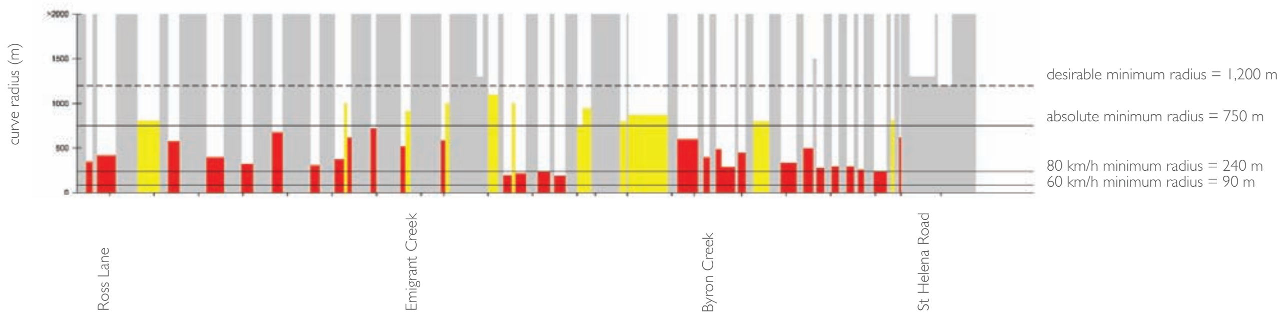
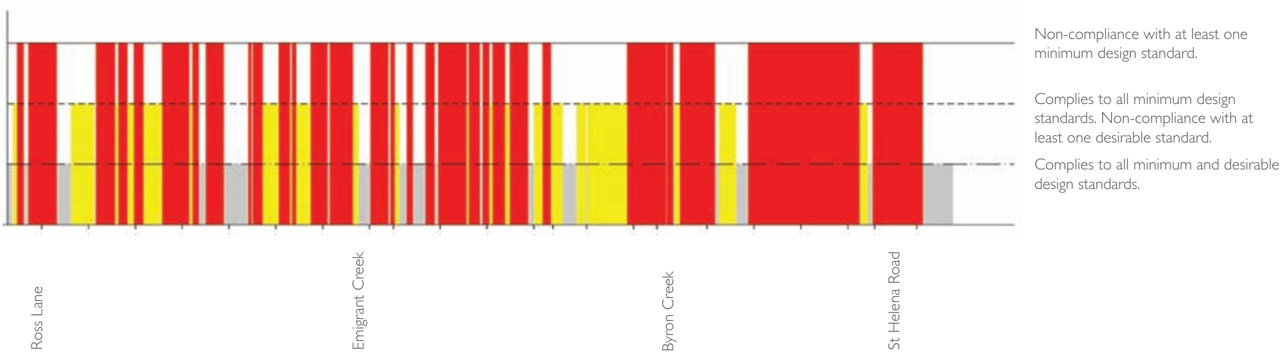


Figure 2.6 - Condition of existing highway - combined geometry



2.3.2 Local road network

The existing highway serves an important function for local traffic. It is adjacent to and provides immediate access to the townships of Tintenbar, Knockrow, Newrybar, Bangalow and Ewingsdale. In conjunction with local roads it also provides access to the communities of Fernleigh, Brooklet, Coopers Shoot, Skinners Shoot, Possum Creek and Coorabell.

Direct access from the existing highway is also provided for the following businesses and facilities:

> Macadamia Castle.
> Various properties undertaking agricultural activities.
> A lookout at the corner of Coolamon Scenic Drive.
> A rest area and toilet facilities south of St Helena Hill.

More detail on the local road network is included in **Chapter 13 - Traffic**.

2.4 Need and anticipated benefits

The contextual evaluation of the existing highway discussed in **Section 2.2** and **2.3** identifies its inadequacies. These can be summarised in terms of two fundamental factors:

> It does not meet safety objectives.
> It is inefficient.

These two primary inadequacies are discussed below, with a detailed assessment discussed in **Chapter 13 - Traffic.**

Highway safety

The need for the upgrade is strongly supported in road safety terms, both at the local and regional level. The accident rate (described in more detail in **Chapter 13 - Traffic**) along the Tintenbar to Ewingsdale section of the highway is 36 per one hundred million vehicle kilometres travelled (MVKT), well above the average of 32.8 accidents per 100 MVKT (RTA, 2004) for rural two-lane roads and further still above the target of 15 accidents per 100 MVKT that has been set by the RTA for the Pacific Highway. For the five-year period 1 May 2002 to 30 April 2007, approximately three percent of reported accidents resulted in a fatality (seven in total) on this section of the Pacific Highway, compared with a state-wide average of 1 percent (RTA accident data, 2003-2007).

This situation is ongoing and difficult to resolve without an improved road. The high accident rate is related to poor road geometry (**Figures 2.3-2.6**) and a large number of at-grade intersections with local roads. The RTA currently minimises the accident rate for the existing highway through its ongoing review of speed restrictions and road conditions.

In regional terms, it is desirable that motorists be provided with a uniform standard for safe roads. Continuity of high quality road conditions directly correlates with lower levels of accidents, especially fatalities. Additionally, the predictability of an improved highway with uniform road conditions would reduce driver fatigue and frustration, which are both factors that contribute to accidents. Safety issues associated with this section of the Pacific Highway are therefore related to adjacent road conditions to the north and south, and fit within the framework of the overall Pacific Highway Upgrade Program.

Highway efficiency

Highway efficiency refers to the ease with which a highway user can travel through a given section of highway. In the case of the Tintenbar to Ewingsdale section, the existing highway is inefficient because:

> Its vertical and horizontal geometry generally require a lower travel speed when compared with a typical dual carriageway configuration.

> It is largely a two-lane single carriageway, which results in traffic speed being influenced by slow moving vehicles.

> There are a large number of at-grade intersections with local roads that result in variable traffic speed from vehicles entering and exiting the highway.

Traffic volumes are predicted to increase for the foreseeable future. Therefore, the magnitude of the above problems could similarly be expected to increase as the existing highway approaches capacity.

The inefficiencies of the existing highway affect different types of vehicle users in different ways. Direct implications of highway inefficiency include:

> Increased time and cost involved in transporting freight.

> Increased commuting and general travel time for local residents.

> Increased travel time, and reduction in amenity of travel experience for locally based tourists.

> Increased travel time and reduction in amenity of travel experience for tourists and other private vehicle users passing through this section of the highway en route to destinations to the north and south.

Indirect implications of the above potentially include:

> Negative effects on local and regional economic growth through the inefficiencies in freight transport.

> Negative effects on local and regional tourism industry because of inefficiencies and frustrations in using the highway network.

> Negative effect on the implementation of regional urban planning strategies, which have been developed (in part) on the basis of there being an efficient road transport network.

> High motor vehicle fuel consumption and emissions.

Benefits

The benefits of the proposed upgrade relate to addressing the needs discussed above. Specifically:

> Accident rates are anticipated to reduce to the RTA target of 15 accidents per 100 MVKT, including reductions in fatalities and injuries. This figure is based on accident rates typically achieved on roads built to a similar standard.

> Typical travel time savings for this section of the highway would be at least 2.5 minutes for trucks and 2 minutes for cars when compared with travel on the existing highway. The time saving would be expected to be greater in peak holiday times and would increase through time as traffic volumes increase, as the performance of the existing highway reduces markedly when experiencing higher traffic volumes.

The above would flow on to a range of more specific benefits, including:

> Reduction in the economic and social impacts of traffic accidents.
> Improved efficiency of access within the local area for residents and tourists, through a higher standard of highway and the removal of traffic from the existing Pacific Highway.
> Support for economic development of the area through improved access for tourists and lower freight costs.
> Support for economic development of New South Wales and south-east Queensland through improved access for tourists and lower freight costs.

2.5 Relationship between the strategic outcomes of the Pacific Highway Upgrade Program and the Tintenbar to Ewingsdale upgrade

The Pacific Highway Upgrade Program has defined objectives which have been developed with an understanding of the planning strategies and growth forecasts. The proposed Tintenbar to Ewingsdale upgrade has sought to further build upon these objectives such that they are location and community specific whilst still achieving the overall Pacific Highway Upgrade Program objectives and strategic outcomes. This is represented in the improvements that would result for the local community in ease of access throughout the local area, as well as specific environmental management measures relating to factors such as visual impact, noise and water quality. **Section 2.6** tabulates the project objectives in relation to the Pacific Highway Upgrade Program objectives. **Chapter 21 – Strategic and project justification**, further illustrates the relationship between the overall Pacific Highway Upgrade Program and the proposed upgrade, through consideration of impacts of the project and how these will be managed to achieve acceptable environmental outcomes across the program in accordance with principles of ecologically sustainable development.

2.6 Objectives of the project

Project specific objectives were developed in the context of the Pacific Highway Upgrade Program with the input of the community liaison group established for the project. These are described in **Table 2.1.**

Table 2.1 - Project objectives

Pacific Highway Upgrade Program objectives	Project objectives

Significantly reduce road accidents and injuries	> Develop a project that meets the following design criteria:
	  > Four-lane divided carriage between Ross Lane and Ewingsdale joining the northern end of the proposed Ballina Bypass and the existing dual carriageway roadway at Ewingsdale with potential to expand to six lanes if required with minimal disruption.
	  > Grade separation of local roads and the proposed highway Limited access conditions, i.e. no private access points along the proposed highway upgrade.
	  > Concept design for a 110 km/h design speed for the vertical alignment and 110 km/h design speed for the horizontal alignment.
	  > Concept design that incorporates pedal cyclists' requirements.
	> Develop a project with a target crash rate of a maximum of 15 crashes per 100 million vehicle kilometres travelled over the project length.
	> Develop a project that retains or replaces existing rest areas within the study area and is consistent with RTA policies on rest areas.
	> Where possible, improve safety of travel on the existing Pacific Highway (through the study area) until the proposed upgrade is operational.

Reduce travel times	> Develop a project that reduces travel time for Pacific Highway traffic. > Develop intersections and interchanges designed to at least a Level of Service C, 20 years after opening for the 100th Highest Hourly Volume. > Develop a project that provides adequate flood immunity on at least one carriageway, target 1:100 year flood event. > Develop a project that minimises disruption and delay during construction.
Reduce freight transport costs	> Develop a project that reduces overall freight transport costs. > Develop a project that meets freight transport vehicle requirements.

Table 2.1 (cont)

Pacific Highway Upgrade Program objectives	Project objectives
Develop a route that involves the community and considers their interests	> Meet the objectives of the community involvement plan and the community liaison group. > Seek the experience, expertise, and input of the community to better inform each stage of the upgrade process. > Adopt a policy of transparency in the development and assessment of route options. > Investigate feasible routes in the initial stages of the study.
Develop a route that involves the community and considers their interests (cont)	> Minimise uncertainty in affected communities by undertaking the route selection process as efficiently as possible. > Mitigate the impact of noise levels associated with the project (including engine braking noise), and meet the Environment Protection Authority Target Noise Levels where it is reasonable and feasible to do so and implement the adopted recommendations from the Northern Pacific Highway Noise Taskforce. > Develop a project that takes account of air quality concerns at locations of sensitive receptors. > Develop a project that minimises impacts on the scenic value of the area. > Develop a project that is enjoyable for users, but minimises impacts on nearby residents. > Develop a project that minimises the physical impacts of the route, including community severance and access patterns. > Develop a project that minimises the impact on property.
Provide a route that supports economic development	> Develop a project that minimises the impacts on businesses dependent on Pacific Highway traffic. > Develop a project that minimises the impacts on prime agricultural lands. > Develop a project that improves accessibility for local industries, utilities and emergency services.
Manage the upgrading of the route in accordance with ESD principles	> Develop a project that addresses environmental safeguards and measures necessary to mitigate environmental impacts. > Develop a project that minimises the impacts on sensitive ecological constraints. > Assess route options with consideration of environmental, social and economic evaluation criteria. > Apply RTA and Department of Environment and Conservation (DEC) Guidelines for managing environmental issues (biodiversity, water quality, Acid Sulfate Soils). > Assess and address cumulative environmental impacts.
Provide the best value for money	> Maximise the use of the existing road reserve and other road assets for duplicated sections of the project where possible > Minimise the Whole of Life Costs of the project.

2.7 Alternatives considered

The following section provides a summary of the alternatives considered during the route development and selection phases from the initial long list of options through to the final preferred route.

2.7.1 Route selection

Route options for the Pacific Highway upgrade were developed through an iterative process involving a range of environmental, engineering, urban design, community, safety and cost considerations structured around the route options stages shown in **Figure 2.7.**

Figure 2.7 - Route selection process

The preferred route for the proposed upgrade was announced by the Minister for Roads in September 2006, thereby completing the route selection phase of the project.

Documentation supporting the selection of the preferred route, including the *Tintenbar to Ewingsdale – Upgrading the Pacific Highway: Preferred Route Report* (RTA 2006a) and a series of working papers was released and publicly exhibited during September 2006. The preferred route report was also placed on the RTA project website immediately following the announcement of the preferred route. All of these documents can be downloaded from the proposed upgrade website **www.rta.nsw.gov.au/pacific** (click on Tintenbar to Ewingsdale).

2.7.2 Route options development

Route options were developed through an iterative process, commencing with the mapping and documenting of environmental and design constraints in the study area. Preliminary assessments considered a wide range of potential issues, including transport and safety, topography, geology and soils, hydrology, aquatic and terrestrial ecology, air quality and climate, land use, planning, cultural heritage, visual amenity and noise. The methodology generally included a review of:

> Maps and aerial photographs.
> Previous investigations in the study area.
> Technical databases and relevant technical and academic papers.
> Byron Shire and Ballina Shire councils local environmental plans (LEPs).
> Site walkover surveys and field investigations.
> Community and agency consultation.
> Technical modelling.

Using interactive computer modelling and constraints mapping, it was possible to investigate a large number of possible route options. Routes were progressively adjusted to avoid as many constraints as possible while still achieving the design criteria and maintaining project objectives and functionality. The resulting long list of route options was made up of sections which through multiple combinations produced over 200 route options.

The process adopted to evaluate and rank the long list of route options included two steps:

> Assessment of the performance of each section against initial evaluation criteria performance measures with the project team's pairwise weightings used as the base case.

> Application of pairwise weightings from the community liaison group and government agencies to test sensitivity of performance of each option to the evaluation criteria performance measures.

A separate assessment was carried out for two northern tunnel approach options to determine which option(s) should be shortlisted. Assessment of the tunnel approaches did not identify any major differences between the two options.

The shortlisted options were termed Option A, Option B, Option C and Option D, and are shown in **Figure 2.8.** There were also two minor variations in tunnel approaches at St Helena ridge, which were referred to as T1 and T2 and fall within the area labelled as tunnel section on **Figure 2.8.** The main characteristics of the options are as follows:

> Option A incorporated an upgrade generally following the existing highway corridor.

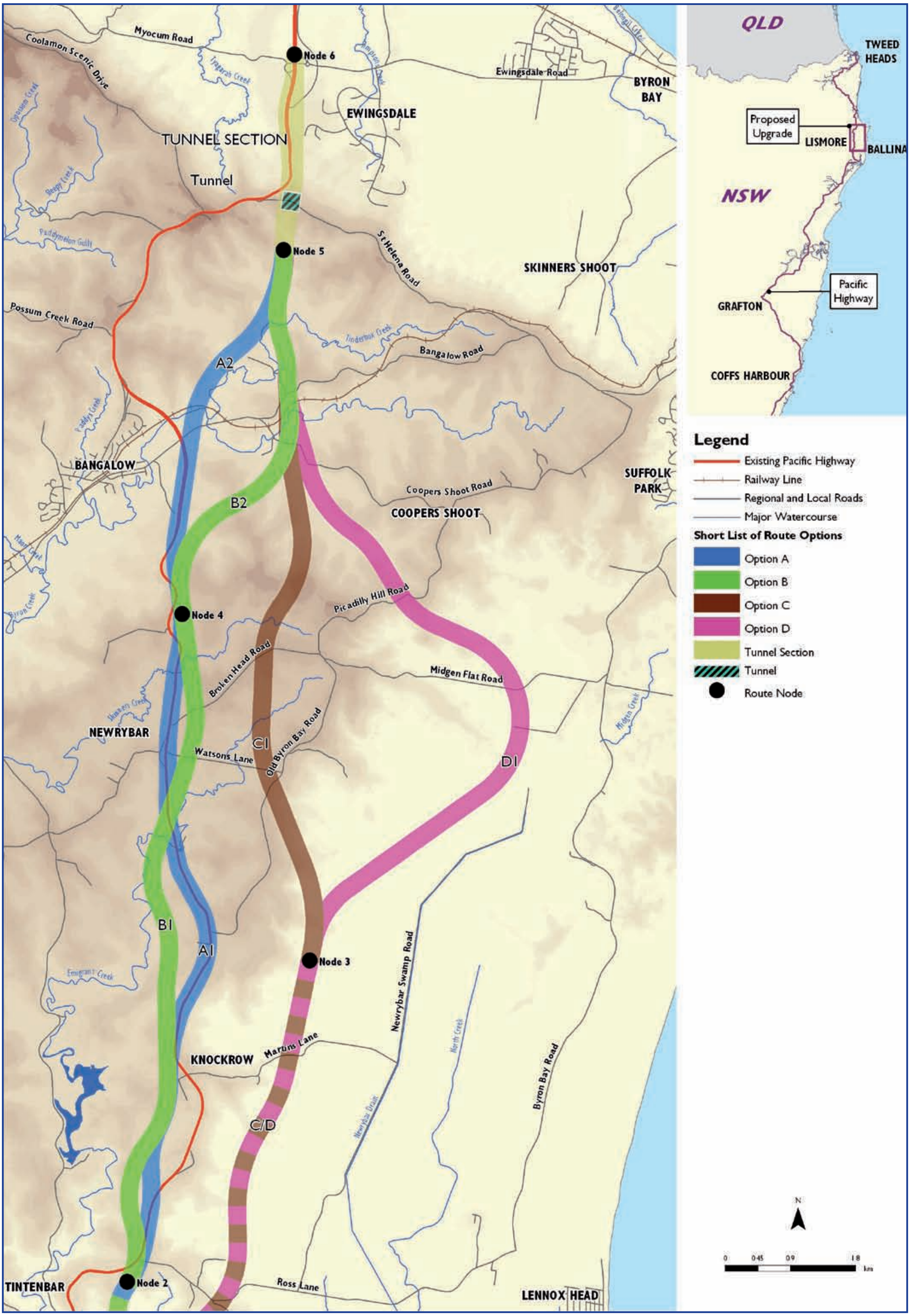
> Option B was a plateau option in an entirely new corridor.

> Options C and D were partly located on the eastern coastal plain.

Options A and B were divided into segments referred to as A1, A2, B1 and B2. A1 and B1 were located south of a point near Lawlers Lane (north of Newrybar), while A2 and B2 were north of this point.

Further details relating to the development and selection of the shortlisted route options can be found in the *Tintenbar to Ewingsdale Upgrading the Pacific Highway - Route Options Development Report* (RTA 2005) and the *Tintenbar to Ewingsdale Upgrading the Pacific Highway - Preferred Route Report* (RTA 2006a). These reports are available on the project website **www.rta.nsw.gov.au/pacific** (click on Tintenbar to Ewingsdale).

Figure 2.8 - Shortlist of route options



2.7.3 Selection of the preferred route

The selection of the preferred route was based on the outcome of three independent assessment streams that were developed to identify the environmental costs and benefits, as well as economic cost and value for money. The three streams were:

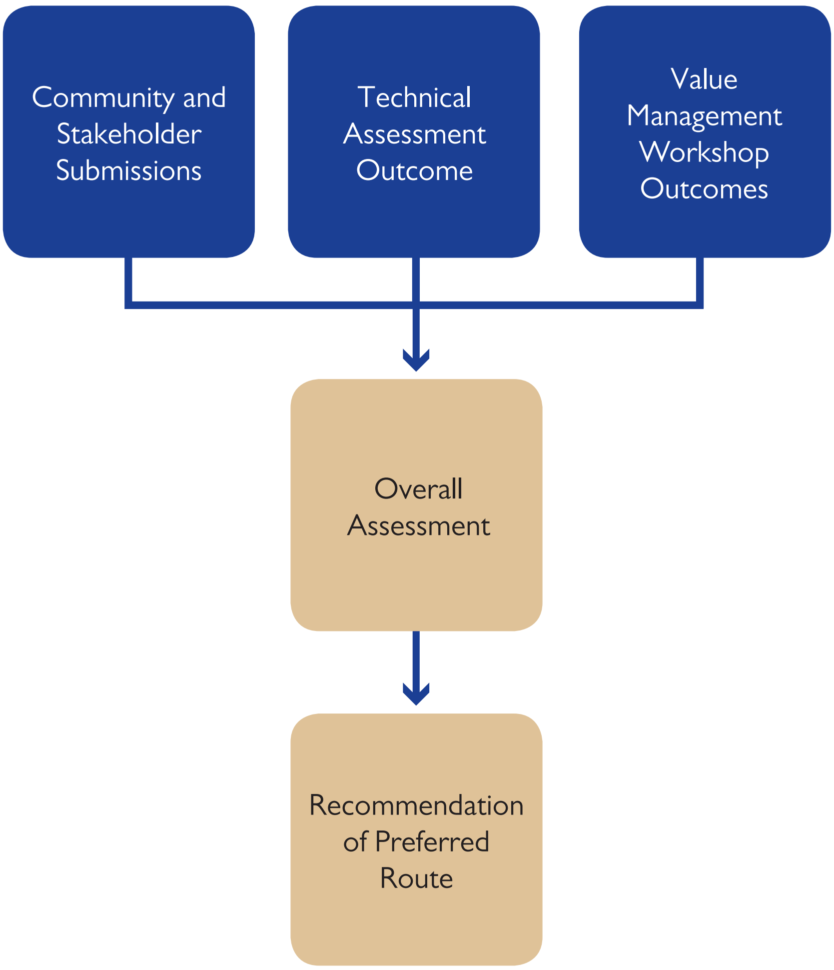
> Community and agency submissions on the route options display, which are documented in the Tintenbar to Ewingsdale: Upgrading the Pacific Highway – Route Options Submissions Report (RTA 2006b).

> The outcomes of the value management workshop for the shortlisted route options documented in the Tintenbar to Ewingsdale: Upgrading the Pacific Highway – Value Management Workshop Report (RTA 2006c).

> A technical assessment that included refinement of the shortlisted route options as well as updated engineering, environmental and economic investigations. The technical assessment (and a summary of the outcomes of the previous two streams) is described in the Tintenbar to Ewingsdale: Upgrading the Pacific Highway – Preferred Route Report (RTA 2006a).

An overall assessment of the shortlisted route options was carried out by comparing the outcomes of the three streams. The process is outlined in **Figure 2.9**

Figure 2.9 - Process for recommending the preferred route



The overall assessment of the short list of route options considered the results of the three streams. This assessment is described below.

Option A, B, C and D assessment

Option C was the worst performing option in the value management workshop and it performed poorly in the technical assessment; additionally community and agency submissions generally preferred Options A and B over Option C. Option C performed worse than all other options in terms of potential impacts on the natural and cultural environment.

Option D performed poorly in the technical assessment, and community and agency submissions generally preferred Options A and B over Option D. The value management workshop results regarding Option D were uncertain. The reasons for the poor performance of Option D were mainly its performance in terms of safety and functionality compared to the other options as well as potential impacts on the natural and cultural environment.

Costs for Options C and D were significantly higher than costs for Options A and B. The combination of poorer performance and higher costs resulted in low value for money.

Options C and D's clearly inferior results compared to Options A and B suggested that they should not be considered further. A more detailed evaluation was then made of Options A and B which included subdividing each into two sections (A1, A2, B1 and B2). These are shown in **Figure 2.8**.

A1 and B1 assessment

The technical assessment identified that combinations of subsections for A1 and B1 perform better than A1 and B1 as stand alone sections. Further assessment of Sections A1 and B1 was therefore carried out on a subsection basis with subsections referred to as A1a, b and c, and B1a,b and c. Subsections A1-a and B1-a were between the southern extremity of the sections and Martins Lane at Knockrow. Subsections A1-b and B1-b were between Martins Lane and a point near the existing crossing of Emigrant Creek. Subsections A1-c and B1-c were between Emigrant Creek and a point approximately 500 m south of the existing Bangalow bypass.

A1-a versus B1-a assessment

Subsections A1-a and B1-a were not directly compared in the community and agency submissions or at the value management workshop, but potential impact on Emigrant Creek Dam was an area of concern raised in both streams.

In terms of the technical assessment, A1-a performed similarly to B1-a. A1-a has lower natural and cultural environment impacts, primarily because it is further from Killen Falls and Emigrant Creek Dam. In addition, it more closely matched the Ballina bypass EIS design and allowed full use of land already acquired by the RTA for the Ballina bypass. A1-a was also about $5 million less expensive than B1-a. On the basis of similar performance at a lower cost, A1-a provided greater value for money than B1-a.

Compared to B1-a, A1-a performed similarly in the technical assessment, better addressed issues raised in the other two streams, and provided greater value for money. A1-a was the preferred section.

A1-b versus B1-b assessment

Subsections A1-b and B1-b were not directly compared in the community and agency submissions or at the value management workshop, but potential impacts on high value agriculture and Emigrant Creek were areas of concern raised in both streams.

In terms of the technical assessment, Section B1-b performed better than A1-b, particularly in terms of safety and had a similar cost. On the basis of better performance at a similar cost, B1-b provided greater value for money.

A1-c versus B1-c assessment

Subsections A1-c and B1-c were not directly compared in the community and agency submissions or at the value management workshop, but potential impacts on Newrybar and the Newrybar Public School were areas of concern raised in both streams.

In terms of the technical assessment, B1-c performed much better than A1-c. B1-c was estimated to cost about $10 million less than A1-c. B1-c therefore provided greater value for money.

B1-c performed better in the technical assessment and better addressed key issues raised in the other two streams. B1-c was the preferred section.

A2 versus B2 assessment

A key outcome of the value management workshop was the recommendation that Section B2 should not be considered further.

Results of the technical assessment indicated that A2 and B2 were very similar, thus the only significant difference was the cost. A2 was significantly less expensive than B2, mainly due to higher structure costs in B2. Additionally, A2 utilised almost half of the existing Bangalow bypass. On the basis of similar performance at a much lower cost, A2 provided greater value for money.

On the basis of value for money considerations A2 was the preferred section.

T1 versus T2 assessment

While the performance of T1 and T2 were considered similar in the value management workshop, T2 was generally preferred in the community and agency submissions. In the technical assessment of T1 and T2, T2 was preferred based on a small performance advantage.

T2 was more expensive than T1; however T2 provided benefits which off-set the additional capital costs. These benefits included:

> Lower grades providing ongoing benefits over the project life in travel time savings, accident reduction, fuel savings and reduced greenhouse gas emissions.

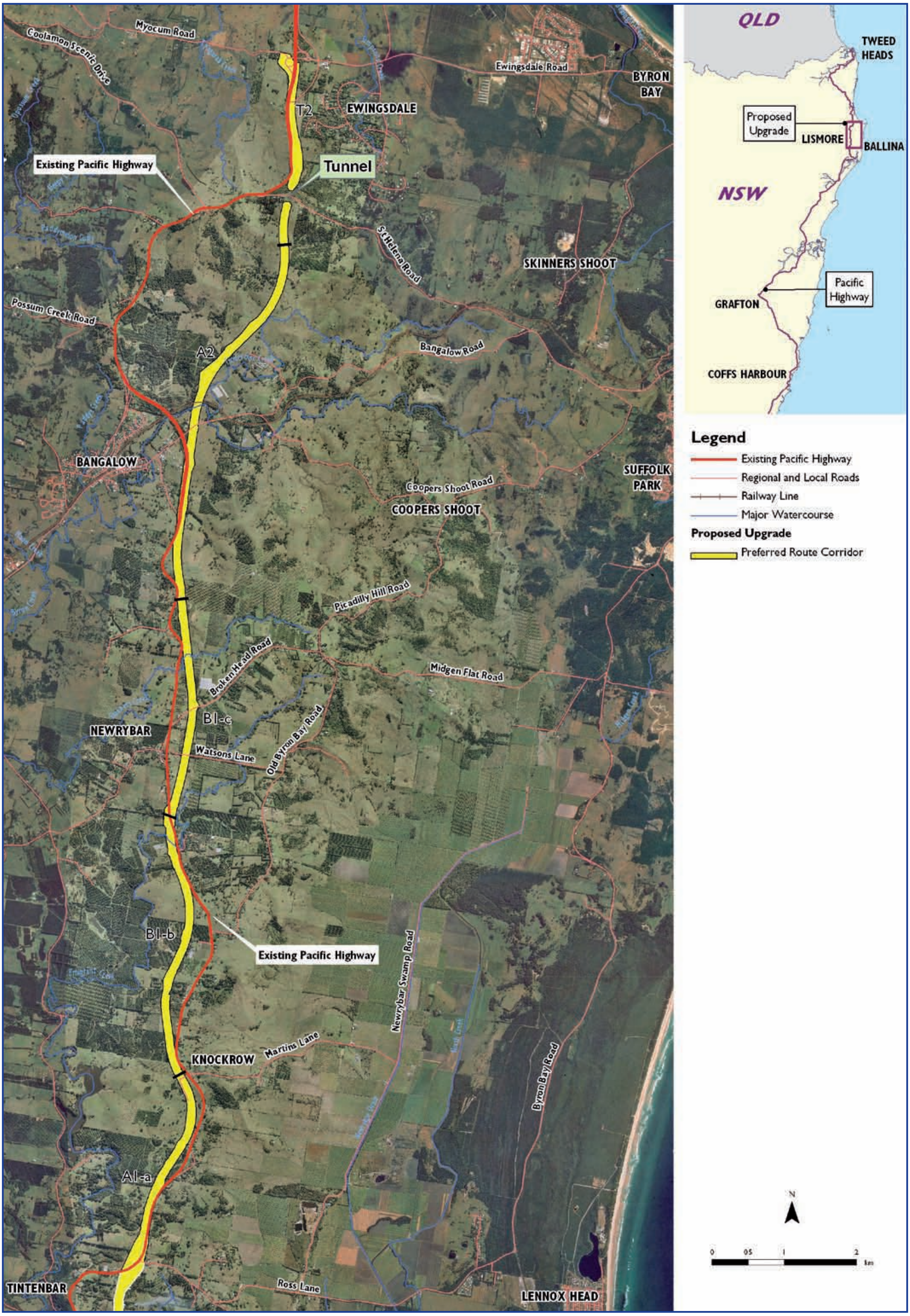
> Less complex construction and traffic management, thus easier and safer to build.

Considering the results of the three streams and the above benefits, the additional cost of T2 was considered justified in terms of value for money considerations. T2 was the preferred section.

Following the development, assessment and refinement of the route options, the option made up of: **A/B, A1-a, B1-b, B1-c and A2 and T2** was considered the best route in terms of meeting project objectives and the principles of ecologically sustainable development.

The preferred route was announced by the Minister for Roads and placed on exhibition for community comment in September 2006 **(Figure 2.10)**. **Chapter 4** provides details of the display.

Figure 2.10 - Preferred route as shown at public display in September 2006



2.8 Why the preferred route was chosen

As described above, the preferred route was determined through a selection process which sought to meet the objectives of the project, the Pacific Highway Upgrade Program and the *Environmental Planning and Assessment Act 1979*, particularly in relation to ecologically sustainable development. This process involved the consideration of alternatives with the resultant preferred route selected because it:

> Provides the best overall balance between functional, ecological, heritage, social, and economic considerations and provides for staging opportunities.
> Best meets the objectives of both the Pacific Highway Upgrade Program and the Tintenbar to Ewingsdale project.
> Achieves high safety standards.
> Provides for grade separation of the upgraded Pacific Highway and the local road system.
> Provides a good outcome in terms of transport efficiency.
> Provides reasonable physical separation from existing and proposed major residential areas such that acceptable visual and traffic noise outcomes could be achieved with sensitive urban design.
> Considers the outcomes of the value management workshop and community submissions.
> Allows for potential water quality risk reductions to Emigrant Creek Dam.
> Provides good road user benefits for a reasonable construction cost.
> Retains 'Macadamia Castle', a local landmark.
> Retains the existing highway as a local/tourist road.
> Has a lower impact on the escarpment and visual amenity compared to coastal options.
> Utilises the highest amount of existing and planned highway reserves.
> Avoids known Aboriginal heritage sites.
> Minimises length through State significant agricultural land.
> Has a lower impact on endangered ecological communities compared to coastal options.
> Has a lower risk associated with soft soils, flooding and land slips compared to coastal options.
> Has the minimum impact on wildlife corridors compared to other options.
> The T2 tunnel has reduced travel time, lower greenhouse gas emissions, and less road user costs than the T1 tunnel.
> Impacts on agricultural properties could be reduced, where possible, through discussions with individual land owners and refinement of the design.

Since the preferred route announcement, the concept design has been developed and is presented in **Part B** as the proposal upon which the environmental assessment has been undertaken.

For a detailed description of the selection process for the preferred route, refer to the *Preferred Route Report* (RTA 2006a). This is available on the project web site **www.rta.nsw.gov.au/pacific** (click on Tintenbar to Ewingsdale).

3 Planning and approvals

3.1 Part 3A and the project approval process

On 5 December 2006, the NSW Minister for Planning declared the proposed Tintenbar to Ewingsdale upgrade to be a project to which Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) applies. By a separate order made on the same day, the Minister for Planning declared the proposed upgrade to be a critical infrastructure project, on the basis that it was essential to the State for economic or social reasons. (The orders were published in the Government Gazette on 8 December 2006).

The proposed upgrade will, therefore, be assessed under Part 3A as a major project and follow the Part 3A project approval process.

The Part 3A approval process is illustrated in **Figure 3.1**. More information is available from the Department of Planning (**www.planning.nsw.gov.au**).

If the proposed upgrade is approved under the Part 3A process, the decision on whether or not to proceed with construction rests with the Chief Executive of the RTA.

3.2 Other approvals and licences

3.2.1 NSW Government approvals and licences

As the proposed upgrade is a scheduled activity, being a freeway or tollway construction outside the metropolitan area and greater than 5 km in length. An environmental protection licence would be required for construction under part 3 of the *Protection of the Environment Operations Act 1997*. Under section 75V of the EP&A Act such a licence cannot be refused if it is necessary for the carrying out of an approved project, and as such authorisations are to be substantially consistent with the Part 3A approval.

Prior to approval, any additional aboriginal archaeological studies that require subsurface investigations would require a permit under section 87 of the *National Parks and Wildlife Act 1974*.

3.2.2 Commonwealth approvals

Based on the results of the ecological assessment (described in **Chapter 12 – Ecology**), it was decided that the proposed upgrade was unlikely to have a significant impact on any of the identified Commonwealth listed threatened and migratory species. Accordingly, the proposed upgrade has not been referred to the Commonwealth Minister for the Environment, Water, Heritage and the Arts for approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Figure 3.1 - Part 3A approval process

STEP 1 PREPARATION OF ENVIRONMENTAL ASSESSMENT

↓

Prepare and submit Project Application (including Project Application Report and supporting information) to Department of Planning

↓

Planning Focus Meeting

↓

Environmental Assessment requirements issued by the Director General of the Department of Planning

↓

Preparation of Environmental Assessment and draft Statement of Commitments

↓

STEP 2 LODGEMENT, EXHIBITION, CONSULTATION AND REVIEW

↓

Submit Environmental Assessment with draft Statement of Commitments to Department of Planning

↓

Pre-exhibition evaluation by Department of Planning to consider adequacy of Environmental Assessment in relation to Environmental Assessment requirements - consult agencies/council

↓

The Director General of the Department of Planning exhibits Environmental Assessment and invites submissions (minimum 30 days)

↓

Proponent responds to issues and finalises Statement of Commitments in a submissions report, which is provided to Department of Planning. A Preferred Project Report may also be prepared and made public if any changes are proposed to minimise impact

↓

STEP 3 ASSESSMENT AND DETERMINATION

↓

Assessment by the Director General of the Department of Planning. Director General drafts Assessment Report with recommended approval conditions or refusal - consults agencies/councils

↓

Department of Planning finalises Assessment Report with recommendations and submits to Minister for Planning

↓

Minister's decision

3.3 Other relevant planning instruments

Table 3.1 summarises other relevant environmental planning instruments relevant to the proposed upgrade. As the proposed upgrade is a Part 3A project these state environmental planning policies, regional environmental plans and local environmental plans do not necessarily apply, however their objectives were considered in the development and assessment of the proposed upgrade.

Table 3.1 - Environmental Planning Instruments

Environmental Planning Instrument	Aim/Purpose	Application/Consistency
State Environmental Planning Policy (Infrastructure)	The policy is to assist in the effective delivery of public infrastructure throughout the State.	> Clause 94 of the Infrastructure SEPP would apply to the development of a road, identifying that such development may be carried out without consent.
State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP44)	SEPP 44 aims to encourage the proper conservation and management of natural koala habitat	> SEPP 44 does not apply to the proposed upgrade. However, the RTA has adopted a similar approach to assessing koala habitat as described under SEPP 44. This assessment in relation to core koala habitat is discussed in ***Working Paper 4 – Terrestrial flora and fauna assessment.***
North Coast Regional Environmental Plan 1988	The North Coast Regional Environmental Plan (NCREP) establishes a regional framework for the development of the NSW North Coast Region. Part 5 of the NCREP identifies the strategic importance of improving regional infrastructure along the NSW North Coast. It recognises the need to safeguard the role and efficiency of the major arterial road system and the need to facilitate maintenance and improvement of transport across the region.	> The proposed upgrade accords with the NCREP in meeting the need to facilitate transport across the region. It is an essential component of the strategic planning for the North Coast region envisaged under the plan.

Table 3.1(cont)

Environmental Planning Instrument	Aim/Purpose	Application/Consistency
Ballina Local Environmental Plan 1987	The Ballina Local Environmental Plan (LEP) establishes the framework for the range of land use activities that may occur within the Shire. The LEP sets standards and objectives that must be met to obtain development approval.	> The southern part of the proposed upgrade is within Ballina local government area (LGA). The proposed upgrade would pass through the following zones under the Ballina Local Environmental Plan: -1(a1) Rural (Plateau Lands Agriculture) -1(b) Rural (Secondary Agricultural Land) -1(d) Rural (Urban Investigations) -7(c) Environmental Protection (Water Catchment) > Roads are not prohibited in any of these zones.
Byron Local Environmental Plan 1988	The Byron LEP is a performance based planning instrument which requires development proposals to demonstrate consistency with its overall aims and objectives as well as specific zone objectives.	> The northern part of the proposed upgrade is within Byron LGA. The proposed upgrade would pass through the following zones under the Byron LEP: - 1(a) General Rural Zone, - 1(b) and 1(b2) Agriculture Protection Zones. - 7(d) Scenic Escarpment Zone. - 9(a) Proposed Road Reserve Zone > Roads are not prohibited in any of these zones.
New Ballina Local Environmental Plan	Ballina Shire Council has commenced actions for the preparation of a new LEP. It will consider elements of the current LEP as well as reflect the current needs and visions of the Shire including any new ideas or new issues and pressures which may need to be addressed as part of the Shire's future development.	> It is understood that a new LEP is unlikely to be adopted before the end of 2009. Consultation with Ballina Council was undertaken regarding the development of the new LEP and the proposed upgrade, with specific regard to remnant land management and building entitlements along the proposed upgrade alignment.

4 Consultation

4.1 Overview

A comprehensive community and stakeholder involvement program has been undertaken for the proposed upgrade. The principal objective of the community consultation process has been to keep people well informed and to involve them in the proposed upgrade during each stage of its development. The program commenced from early in the development of the proposed upgrade and has continued into the preparation of this environmental assessment.

The community has provided considerable knowledge that has been reviewed and considered by the project team and provided important input to the development of the proposed upgrade.

A community liaison group, agricultural focus group and Aboriginal focus group were formed. These groups were made up of representatives of the local community.

The groups and the broader community have raised a number of important issues regarding the planning process and the overall direction of the project. These included broad issues such as the extent of the study area and the project objectives, through to specific concerns regarding the assessment methodology and implementation.

In addition to community consultation, extensive stakeholder consultation was undertaken throughout the duration of the project starting during the inception stages. Stakeholder consultation is still an ongoing process and to date has played an important role in delivering the proposed upgrade with minimal impacts. Stakeholders involved in the consultation process have included a range of organisations such as local and state authorities, local schools, fire brigade and the water authority.

Overall, there has been a high level of community interest and involvement in the proposed upgrade.

4.2 Parties consulted

During the preparation of the environmental assessment, numerous parties were consulted to provide information on the development of the proposed upgrade and discuss issues and possible management options. Consultation mechanisms included meetings between the party and project team, workshops such as the value management, corridor assessment and planning focus meetings, and verbal and written correspondence to the project team and the Department of Planning during the development of the Director-General's requirements for the environmental assessment. No direct consultation was undertaken with Commonwealth agencies, with no referral to the Commonwealth being deemed appropriate under the *Environment Protection and Biodiversity Protection Act, 1997.* **Table 4.1** provides a summary of the parties consulted the level of consultation and the key topics discussed.

Table 4.1 Summary of consultation with relevant parties

Party consulted	Level of consultation	Key topics discussed
Rous Water	Direct engagement through meetings, workshops and written and verbal correspondence Consultation between project team including specialists and Rous Water	> Need for a water quality impact assessment > Water quality issues in Emigrant Creek and Wilsons River drinking water catchments > Outcomes of water quality impacts assessment > Formal comments from Rous Water on water quality assessment and their requirements for a risk management process > Identification and quantification of the risks associated with the proposed highway upgrade > Final acute and chronic pollution risk assessment > Land use planning / remnant land strategy > Route options development > Value management issues > Preferred route > Environmental assessment and concept design
Department of Environment and Climate Change (DECC)	Direct engagement through workshops and written correspondence	> Route options development > Value management issues > Preferred route > Environmental assessment and concept design
Department of Primary Industries	Direct engagement through workshops and written correspondence	> Route options development > Value management issues > Preferred route > Environmental assessment and concept design > Land use planning / remnant land strategy
Department of Water and Energy	Direct engagement through workshops and written correspondence	> Route options development > Value management issues > Preferred route > Environmental assessment and concept design

Table 4.1 (cont)

Party consulted	Level of consultation	Key topics discussed
Department of State and Regional Development	Direct engagement through workshops and written correspondence	> Expanded study area > Regional issues relating to specific agricultural industries and consultation with members of the industry within the study area > Route options development > Preferred route > Environmental assessment and concept design
Byron Shire Council	Direct engagement through meetings, workshops and written and verbal correspondence	> Project inception and expanded study area > Council involvement within the project > Selection process for short list of route options including pairwise and corridor assessment workshop > Summary of community feedback > Interchange locations and local road access options > Traffic volumes > Project progression and future timetable > Value management issues > Preferred route > Environmental assessment and concept design development > Land use planning/remnant land
Ballina Shire Council	Direct engagement through meetings, workshops and written and verbal correspondence	> Project inception and expanded study area > Council involvement within the project > Selection process for short list of route options including pairwise and corridor assessment workshop > Summary of community feedback > Interchange locations and local road access options > Traffic volumes > Project progression and future timetable > Value management issues > Preferred route > Environmental assessment and concept design development > Land use planning/remnant land

Table 4.1 (cont)

Party consulted	Level of consultation	Key topics discussed
Department of Education and Training/Newrybar School	Direct engagement through formal meetings, written and verbal correspondence	> Establishment of a project consultative group for consultation > Preferred route selection process > School issues raised during route options development phase > Issues and concerns with the preferred route > Assessment process for noise, traffic, air quality and visual and landscape > Noise and visual impacts from location between two highways > Construction issues > Future consultation
Local Aboriginal Land Council (Jali)	Direct engagement through meetings, workshops and written and verbal correspondence	> Project inception and expanded study area > Route options development > Site investigations > Aboriginal heritage > Preferred route > Environmental assessment and concept design
Aboriginal focus group	Direct engagement through formal meetings, workshops and written and verbal correspondence	> Preferred route > Presentation and review of draft Cultural Heritage working paper > Environmental assessment and concept design
Bundjalung Elders Council Aboriginal Corporation	Telephone call	> Happy to be represented by Jali
Arakwal Aboriginal Corporation	Telephone call and meeting arranged	> No successful contact achieved
Burabi Aboriginal corporation	Telephone call	> Invitation to be involved
Tweed Byron Local Aboriginal Land Council	Telephone call	> Invitation to be involved

Table 4.1 (cont)

Party consulted	Level of consultation	Key topics discussed
Agricultural focus group	Direct engagement through formal meetings, workshops and written and verbal correspondence	> Project inception and expanded study area > Route options development > Preferred route selection > Agricultural constraints and opportunities > Farmland protection project and DPI agricultural land classification > Project team agricultural industries presentation > Agricultural evaluation criteria > Agriculture assessment process methodology > Regional economy modelling > Environmental assessment and concept design
Community liaison group	Direct engagement through meetings, workshops and written and verbal correspondence	> Project objectives > Meeting procedure issues > Vote of no confidence and community feedback > Update on project milestones > Project progression including specialists' presentations > Design criteria presentation > Expanded study area > Outcomes from workshops eg. corridor assessment workshop and value management workshop > Constraints identification and mapping > Evaluation criteria and pairwise process for short list of route options > Advantages and disadvantages of shortlist for value management workshop > Presentations of agricultural assessment, noise impact assessment and hydrology assessment > Ongoing consultation with the community

Table 4.1 (cont)

Party consulted	Level of consultation	Key topics discussed
NSW Fire Brigade	Direct engagement through meetings, workshops and written and verbal correspondence	> Environmental assessment and concept design > Tunnel design > Transportation of dangerous goods through tunnel
Directly and indirectly affected property owners	Direct engagement through workshops and written correspondence	> Route options development > Site investigations > Preferred route > Environmental assessment and concept design > Ongoing consultation through communication and feedback mechanisms
Northern Rivers Regional Development Board	Direct engagement through workshops and written and verbal correspondence	> Regional issues relating to specific agricultural industries > Route options development > Preferred route > Environmental assessment and concept design

During the environmental assessment and concept design phase, the project team invited stakeholders to provide comments. In addition to the above parties the project team attempted to consult with the following parties; however no responses were received:

> Northern Rivers Tourism.
> Northern Rivers Catchment Authority.
> Australian Rail Track Corporation.
> Optus.

4.3 Consultation process

A communications strategy was established at the beginning of the project and was revised after the preferred route was selected. Three key aspects of consultation activities were identified. These were:

> Information provision.
> Direct engagement with the project team.
> Opportunities to provide input into the environmental assessment and concept design activities.

4.3.1 Consultation process during route selection

During the selection of the shortlisted route options, the following consultation activities were undertaken:

- Distribution of community update.
- Community information sessions at project inception and after announcement of the expanded study area.
- Establishment of project information line.
- Community liaison and agricultural focus group meetings.
- Progress updates in local media.
- Corridor assessment workshop.
- Property owner meetings.
- Route options display (staffed and static displays).
- Planning focus meeting.

A route options display was held once the shortlist of route options was selected and published in the *Route Options Development Report* (RTA 2005). The public display commenced on 21 October 2005 and concluded on 2 December 2005.

A range of consultation tools were used to facilitate and encourage feedback on the route options, including advertisements, information brochures, landowner meetings (over 100 meetings were held), route options displays, a community information centre, and staffed and static displays. Other activities included:

- Project information line.
- Community liaison and agricultural focus group meetings.
- Aboriginal focus group meetings.
- Community update.
- Corridor assessment workshop.
- Property owner meetings.
- Ewingsdale Progress Association and Ewingsdale residents meeting.
- Value management workshop.
- Progress updates in local media.
- Preferred route display (staffed and static displays).
- Phone calls to directly affected landowners and community liaison group.
- Letters with property maps to directly affected landowners.
- Meetings with Rous Water, Ballina Shire and Byron Shire councils and Newrybar Public School.

Staffed display of the preferred route at Newrybar Hall in 2006.

The preferred route was announced by the Minister for Roads on 26 September 2006 and was displayed until 3 November 2006. Project team members staffed the display to attend to any questions or queries by community members. Immediately prior to the announcement community liaison group members and directly affected landowners were contacted by telephone to inform residents of the display. During the display period, directly affected landowners were encouraged to meet with the project team to discuss property impacts, acquisition processes and the next steps for the project.

4.3.2 Consultation during the environmental assessment and concept design

The community involvement approach for the concept design and environmental assessment phase of the project sought to address issues identified during the route selection phase, and to respond to any further issues raised by the local community.

In particular, it focussed on addressing the issues of affected landowners and key interest groups during the development of the concept design. Consultation activities during this phase include:

- Community update.
- Landowners meetings.
- Landowner letters and property maps.
- Rous Water workshops.
- Council meetings.
- School meetings and presentations.
- Strategic access display.
- Value management workshops.
- Planning focus meeting.
- Project information line and project website.
- Media advertisements.
- Aboriginal focus group and stakeholder meetings.

Landowner meetings

Landowner meetings during the environmental assessment and concept design phase were a dominant component of consultation. Individual landowner meetings were held through this phase to identify and discuss individual property issues for consideration in the concept design development.

Rous Water meetings

The project team held several meetings with Rous Water to present and discuss the technical investigations undertaken to assess water quality and the impacts on the Emigrant Creek dam drinking water catchment. Rous Water was also consulted during the environmental assessment and concept design phase, regarding the possible management options and technical reports (see **Section 10.6** and *Working Paper 2 – Water Quality Assessment*).

Aboriginal consultation

In addition to the ongoing meetings with the Aboriginal focus group, consultation with Aboriginal organisations was undertaken during the environmental assessment and concept design phase, as specified by the DECC in the *Interim Guidelines for Aboriginal Community Consultation- Requirements for Applicants* (DEC, 2005a). Meetings were held with representatives from the Aboriginal community and Jali Local Aboriginal Land council's site officer participated in the heritage field survey of the proposed upgrade. Further details of the Aboriginal consultation are reported in *Working Paper 9 – Heritage Assessment.*

Planning focus meeting

After the submission of the Project Application Report, a planning focus meeting was organised by the Department of Planning. In addition to representatives of the project team and the Department of Planning, this meeting was attended by the key government agencies, Rous Water and both Ballina Shire and Byron Shire councils.

Based on the outcomes of the planning focus meeting agencies were invited to make a submission to the Department of Planning to highlight their issues and concerns with the proposed upgrade. These submissions were used by the Department of Planning to prepare the Director-General's environmental assessment requirements.

Ballina Shire and Byron Shire councils

Following the announcement of the preferred route, the project team continued to consult with both councils, providing presentations on the preferred route and facilitating discussions on key issues. These issues included interchanges and access, water quality and remnant land.

Newrybar Public School

As part of the consultation plan developed in initial meetings with Newrybar Public School and the Department of Education and Training, formal meetings were held to present the selection process and the next stages of the project, and to discuss issues and management relating to visual amenity, noise and construction timing.

4.4 Issues raised during consultation

As outlined above, a route options display and a preferred route display were held to communicate project milestones to the community and present an opportunity for both stakeholders and community members to provide feedback.

During the route options display, 19,192 submissions were received including two form submissions and one petition. The *Route Options Submissions Report* (RTA 2006b) provides a detailed summary and response to the community and stakeholder issues raised.

The announcement and public display of the preferred route resulted in 14 submissions, including 13 from community members and one from the NSW Department of Primary Industries.

A summary of issues raised to date by the community and stakeholders and where they are addressed in the environmental assessment is shown in **Table 4.2** opposite.

Table 4.2 - Key issues raised by the community and stakeholders during the concept design and environmental assessment process

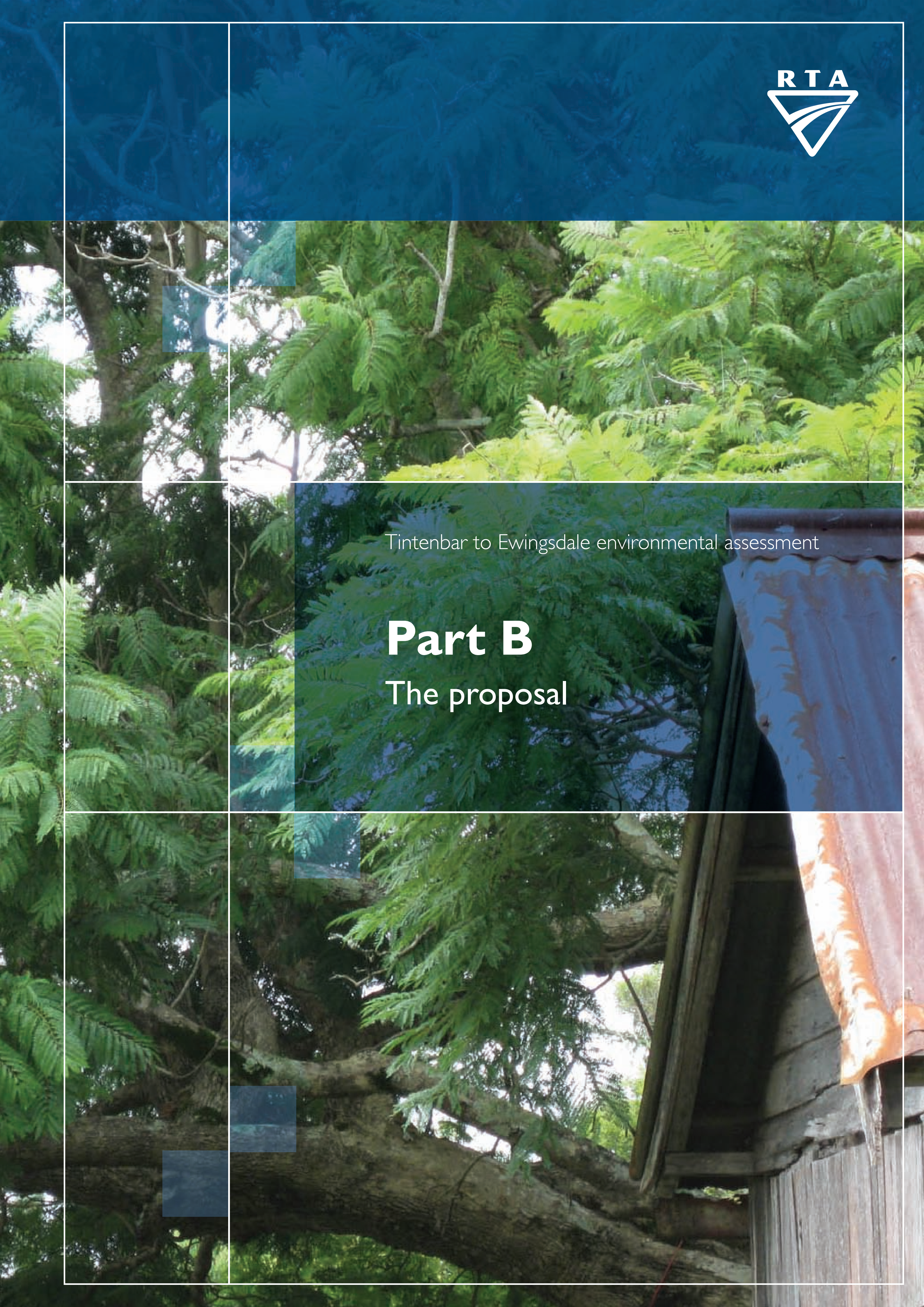
Issue category & specific issue raised	Where addressed
Access	Chapters 5 and 13
> Access to the proposed highway only at two interchanges > Adequate access provisions, such as underpasses and culverts for stock, trucks and machinery	
Traffic	Chapter 13
> Increase in traffic volumes on the local road network	
Ecology	Chapter 12
> Increased habitat fragmentation > Introduction of weeds and animals > Disturbance of ecologically significant areas > Disturbance of riparian zones > Impact of landscaping design on the value of flora and fauna > Measures to restore, maintain and reconnect areas of native vegetation > Impacts on threatened and endangered species > Feasibility of mitigation measures during both construction and operation > Impacts on biological ecological and physical characteristics of local streams and bushland > Impact on areas containing subtropical rainforest > Need for protection and rehabilitation of riparian zones > Impacts on wildlife corridors > Impacts of construction runoff on fish > Impacts on groundwater dependant ecosystems	
Aboriginal and non-indigenous heritage	Chapter 16
> Exclusion of the Byron Shire Council draft Community-Based Heritage Study > Assessment of the significance of potential heritage items > Impacts on Aboriginal cultural values	
Land acquisition	Chapter 14
> Need for a land acquisition plan > Severance effects on individual properties	
Agricultural issues	Chapters 14 and 17
> Loss of regionally significant land > Decrease in farm size and the resulting decrease in production > Changes to farm layout and the impacts on operation > Interference with spray drift buffers > Impacts are unique to each property and need to be assessed accordingly > Interference with macadamia research	

Table 4.2 (cont)

Issue category & specific issue raised	Where addressed
Construction	Chapter 6
> Source and amount of construction material	
> Appropriate quality material is used	
> Impact of demand on the local minerals supply industry	
> Minimisation and management of waste streams created during construction	
> Cut/ fill balance of the project	
Hydrology	Chapter 9
> Potential for flooding during and after construction	
> Impacts on land, infrastructure and assets from any changed flooding regime	
> Application of best practice for stormwater management	
> Impacts associated with contaminated runoff	
> Loss of potential increase in the storage of the catchment	
> Impacts on surface water hydrology due to increased hard surfaces	
> Severance to water by construction of upgrade	
Contamination	Chapter 20
> Assessment and treatment of contaminated soils	
Water quality	Chapters 5 and 10
> Potential risk of impacts on water quality from road run off	
> Requirements and sources for construction	
> Site disposal and waste water re-use opportunities	
> Impact on riparian zones and water quality	
> Water quality risk assessment workshop was over simplified	
> Protection of drinking water supplies	
> Impact of vehicle accidents on water quality	
> Comprehensive water quality monitoring	
> Potential contamination from air borne sources	
Air quality	Chapter 19
> Emissions generated during construction and operation	
> Location of sensitive receptors	
> Impacts on air quality due to increased traffic	
Noise and vibration	Chapter 15
> Location of high generating noise sources	
> Impacts on building structures from blasting	
> Timing of activities in relation to sensitive noise receptors	
> Feasibility of mitigation measures prior to construction	
> Landscaping of noise barriers	

Table 4.2 (cont)

Issue category & specific issue raised	Where addressed
Social	Various
> Highway safety in relation to vehicle incidents > Hazardous vehicle use of the highway > Emergency response plan for fuel and chemical spills > Provision of timely and accurate information > Mental health impacts on the community in relation to uncertainty of land tenure > Road signage to inform users of appropriate authority to contact in the occurrence of an incident > Interference with community rescue projects > Telephone and power interference during construction > Request for self appointed legal aid to be covered by RTA > Compensation for adjacent land owners	
Visual amenity	Chapter 18
> Visual impact of the proposal	



Tintenbar to Ewingsdale environmental assessment

Part B

The proposal

5 Concept design

5.1 Overview

The concept design on which this environmental assessment is based on an initial functional layout developed as part of the design development process. It has been developed in response to design, community and environmental constraints, and in accordance with the principles of ecologically sustainable development. It also satisfies the project objectives outlined in **Chapter 2 – Strategic and project need.** It addresses and responds to all constraints and principles identified and established as part of this study. The concept design is intended to define a robust and buildable concept that provides:

> A definition of property acquisition requirements sufficient to allow acquisition to proceed.

> A clear description of the design principles, extent of impacts and impact mitigation requirements.

> A basis for estimating the cost of the proposed upgrade.

> A sound and clear basis for the later development of detailed designs to the standard required to support the construction contract.

Matters raised in representations to this environmental assessment could result in adjustments to the concept design, which would be included in the consideration of approval by the Minister for Planning.

The length of the proposed upgrade would be approximately 17 km starting at Ross Lane in Tintenbar and extending to the north to the existing Ewingsdale interchange, near the settlement of Ewingsdale (**Figure 5.1**). At Ross Lane, the proposed upgrade would connect to the north end of the Ballina bypass. Generally the proposed upgrade would be in close proximity to the existing highway corridor from Ross Lane to the Bangalow bypass. The existing highway would be maintained for local and regional traffic.

From near Bangalow, the proposed upgrade would diverge from the Bangalow bypass to the northeast through Tinderbox Creek valley. From there, the proposed upgrade would avoid the steep grades of St Helena Hill by way of a tunnel approximately 340 m long and 45 m below the ridge line. North of the tunnel, the proposed upgrade would be located immediately to the east of the existing highway before tying into the Ewingsdale interchange.

The general features of the proposed upgrade would be:

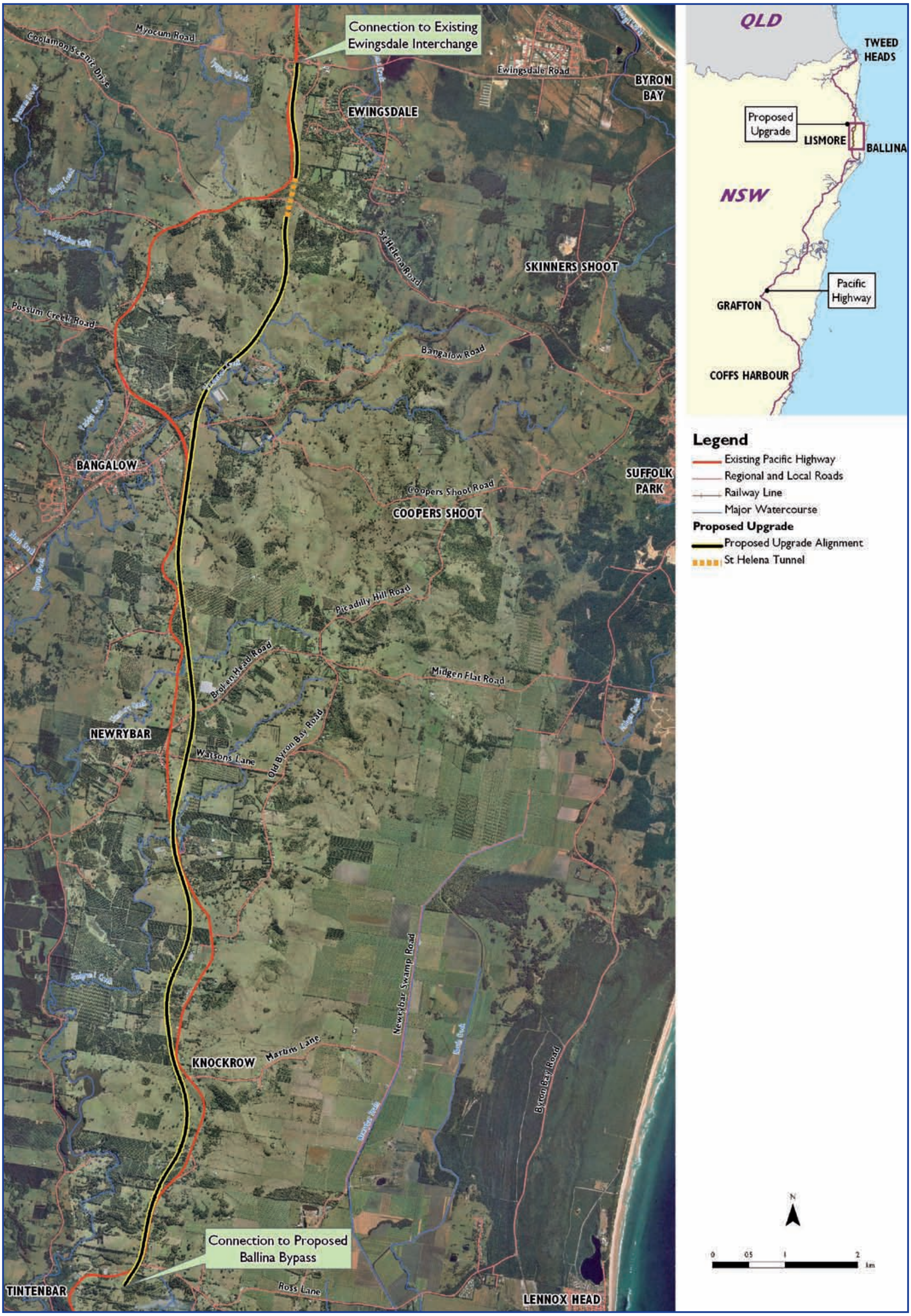
> Four-lane divided carriageways (two lanes in each direction), with a wide median allowing for the future addition of a third lane in each direction.

> Class M standard over the full length of the proposed upgrade. In accordance with the RTA's Pacific Highway Design Guidelines, 'Class M' projects are designed to 110 km/h (posted speed) freeway standard. This means a controlled access road with divided carriageways, no access for traffic between interchanges, grade separation at all intersections and alternative routes available for local traffic through the provision of service roads or local arterial road networks.

- Connection to the northern end of the Ballina bypass at the proposed Ross Lane interchange. A new northbound on-ramp and a new southbound off-ramp would be provided. The remainder of this interchange will be constructed as part of the Ballina bypass project.
- Upgrading of the existing Ewingsdale interchange to provide full access between the modified local and regional road network and the highway.
- A half interchange at Ivy Lane. North-facing ramps would provide access between the local road network and the proposed upgraded highway to the north.
- A half interchange at Bangalow. South-facing ramps would provide access between the local road network, including to Bangalow and Lismore, and the proposed upgrade to the south. This arrangement would replicate the arrangement with the existing Bangalow bypass which also has south-facing ramps only.
- Six twin bridges and four underpasses allowing roads and creeks to pass underneath the proposed upgrade. These would include twin bridges above Byron Creek and the existing Casino-Murwillumbah railway on the north side of Byron Creek.
- Two bridges carrying local roads over the proposed upgrade, one for Broken Head Road and one about 500 m north of Lawlers Lane providing access to several properties east of the upgrade. Protection screens would be provided on both bridges.
- Emergency u-turn and median crossovers at about 2.5 km intervals. These facilities incorporate lay-bys where vehicles could safely pull off the upgraded highway.
- A range of water quality management measures including intercept drains to divert clean water around the road reserve, landscape and vegetation treatments to assist in reducing water quality impacts and sediment basins to intercept run-off before discharging into the natural watercourses.
- Medians and outer verges, including safety barriers where required.
- Signage providing clear directions for traffic at the Ross Lane, Ivy Lane, Bangalow and Ewingsdale interchanges.
- Relatively flat gradients compared to the existing highway, with the maximum grade just south of Bangalow being approximately 5.4 percent over and approximately 700 m long section. There would also be a 4.4 percent grade over a 1.4 km section on the north side of the tunnel. An additional southbound climbing lane would be provided in both sections so that slow moving trucks would not be a significant safety hazard to other vehicles.
- The existing highway would be retained as a continuous road for local and regional traffic. It is further anticipated that between Ross Lane and Bangalow the existing highway would be handed over to the councils. Between Bangalow and Ewingsdale the existing highway would continue to function as a regional link between Lismore/ Bangalow and the north, and would be retained by RTA.
- Two significant diversions of the existing highway are proposed to retain it as a continuous local road. The first is just north of Emigrant Creek where the existing highway would be diverted underneath the bridge taking the proposed upgrade over Emigrant Creek. The other diversion is where the existing highway south of the Ewingsdale interchange is being diverted to a roundabout on the western side of the interchange.
- Additional local roads and property access would be provided including:
  - Safe access to all properties affected by the proposed upgrade, either directly to the existing highway or indirectly via a new local access road.

- New local roads as required to link the proposed interchanges with the existing highway and other local access roads.
- The proposed upgrade would incorporate twin parallel tunnels under St Helena ridge. The tunnels would each be about 340 m long and about 45 m below St Helena Road. One tunnel would be provided for each carriageway, separated by a rock pillar. The northbound tunnel would be 11.5 m wide between barriers, providing sufficient width for line marking as three lanes in each direction if required in the future. The southbound tunnel would be 12.5 m wide to incorporate the southbound climbing lane while still allowing 1 m wide shoulders on each side. In view of the additional southbound lane proposed initially, there is no provision for adding an additional lane to the southbound carriageway through the tunnel. The precise dimensions of the tunnel may be modified slightly during detailed design.
- Intersections and interchanges designed to achieve at least a level of service C, 20 years after opening for the 100th highest hourly volume (refer to **Section 13.3.2** for a description of level of service).

Figure 5.1 - Proposed upgrade alignment



5.2 Alignment

The proposed concept design alignment is described below and shown in detail in **Figure 5.2a-j.** Dimensions provided would be subject to refinement during detailed design.

The road corridor width for the concept design has been determined allowing a minimum of about 15 m between the edge of earthworks and the acquisition boundary. The width of the proposed road reserve is typically about 80 m where there are no cut or fill embankments required. The width increases (up to a maximum of about 250 m) with the scale of associated earthworks and where other elements such as interchanges are required.

5.2.1 Ross Lane to Emigrant Creek

The proposed upgrade commences at Ross Lane, connecting to the northern end of the Ballina bypass (**Figure 5.2a**). Between Ross Lane and Emigrant Creek the upgrade would generally be located in a corridor just west of the existing highway, varying from immediately adjacent to the existing highway to up to 500 m from the existing highway.

To allow the proposed upgrade to be constructed as close as possible to the existing highway the southbound off-ramp for the Ross Lane interchange would connect to the existing highway about 1 km north of Ross Lane. From here traffic would use the existing highway to access Ross Lane and Tintenbar.

Local access to the properties on the western side of the proposed upgrade would be maintained by constructing an access road parallel to the proposed upgrade. The access road would start from the Ross Lane interchange and extend about 1.2 km north providing access to seven properties.

The alignment keeps as close to the existing highway as possible, but would avoid the nearby Rous Water storage tank and treatment facilities (**Figure 5.2b**). Sufficient clearance has also been allowed for Rous Water to construct a proposed new storage tank adjacent to its existing facilities. Following the existing highway as closely as possible also reduces the impact on agricultural properties that generally extend to the west from the existing highway towards Emigrant Creek and Emigrant Creek dam.

South of Martins Lane, an underpass linked to the existing highway would provide access to properties on the western side of the proposed upgrade. From the underpass, the access road would extend about 400 m to the south and 2 km to the north. Properties east of the proposed upgrade would retain their access to Martins Lane west or to the existing highway.

From Martins Lane, the proposed upgrade would diverge to the west, avoiding any direct impact on Macadamia Castle and a cluster of residences adjacent to the existing highway (**Figure 5.2c**).

North of Macadamia Castle, the proposed upgrade would run parallel to and about 400 m west of the existing highway for a length of about 600 m and then, from Ivy Lane, would merge back onto a corridor immediately west of the existing highway.

At Ivy Lane, a half interchange with north-facing ramps is proposed. This would provide access between the local road network and the proposed upgrade to the north.

At Yarrenbool Place, about 250 m south of Hambly Lane, the proposed upgrade would cross an unnamed creek on twin bridge structures approximately 115-130 m long and then cross Emigrant Creek on twin bridges structures approximately 165-180 m long just north of Hambly Lane (**Figure 5.2d**).

Figure 5.2a - Proposed upgrade detail

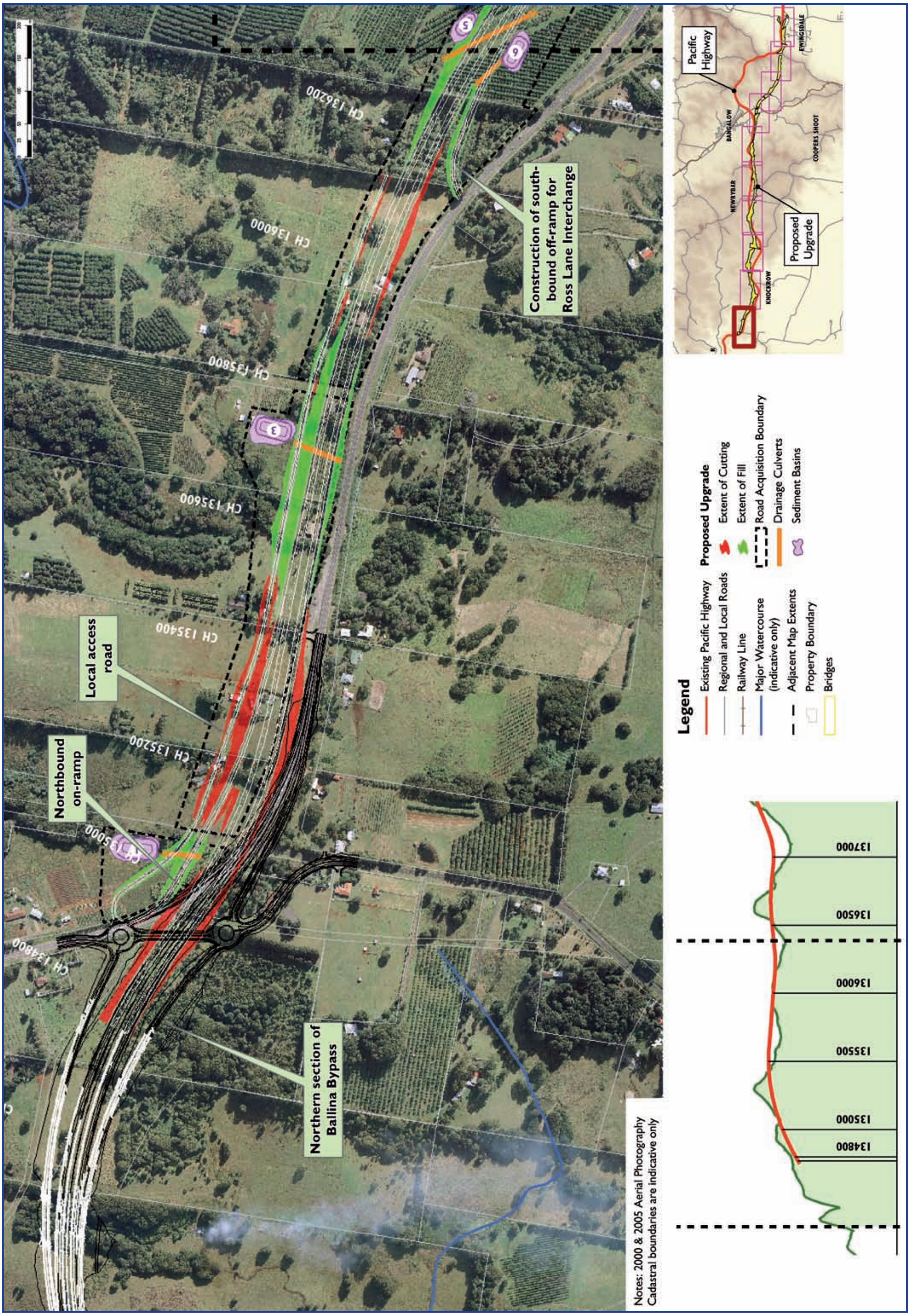


Figure 5.2b - Proposed upgrade detail

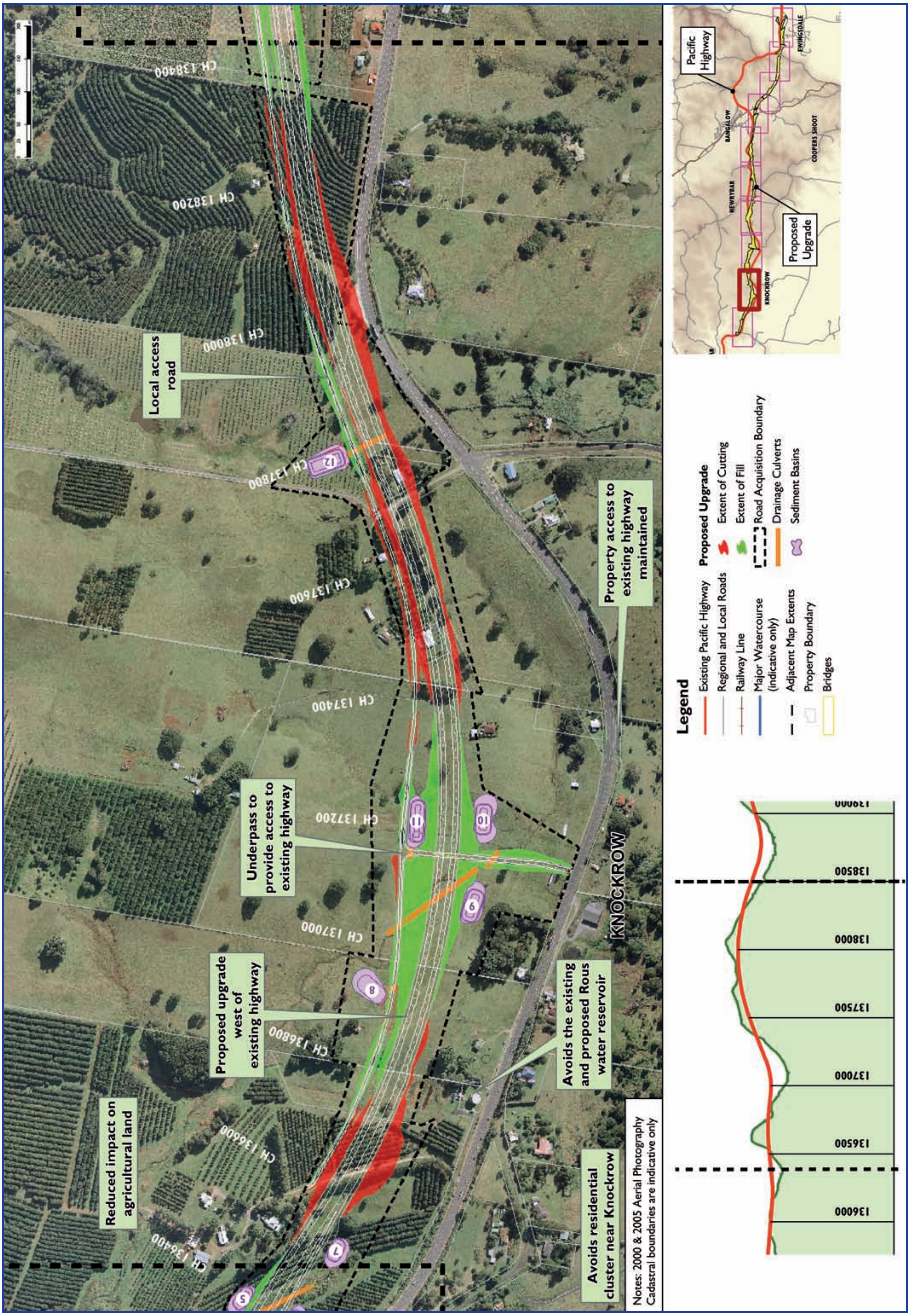
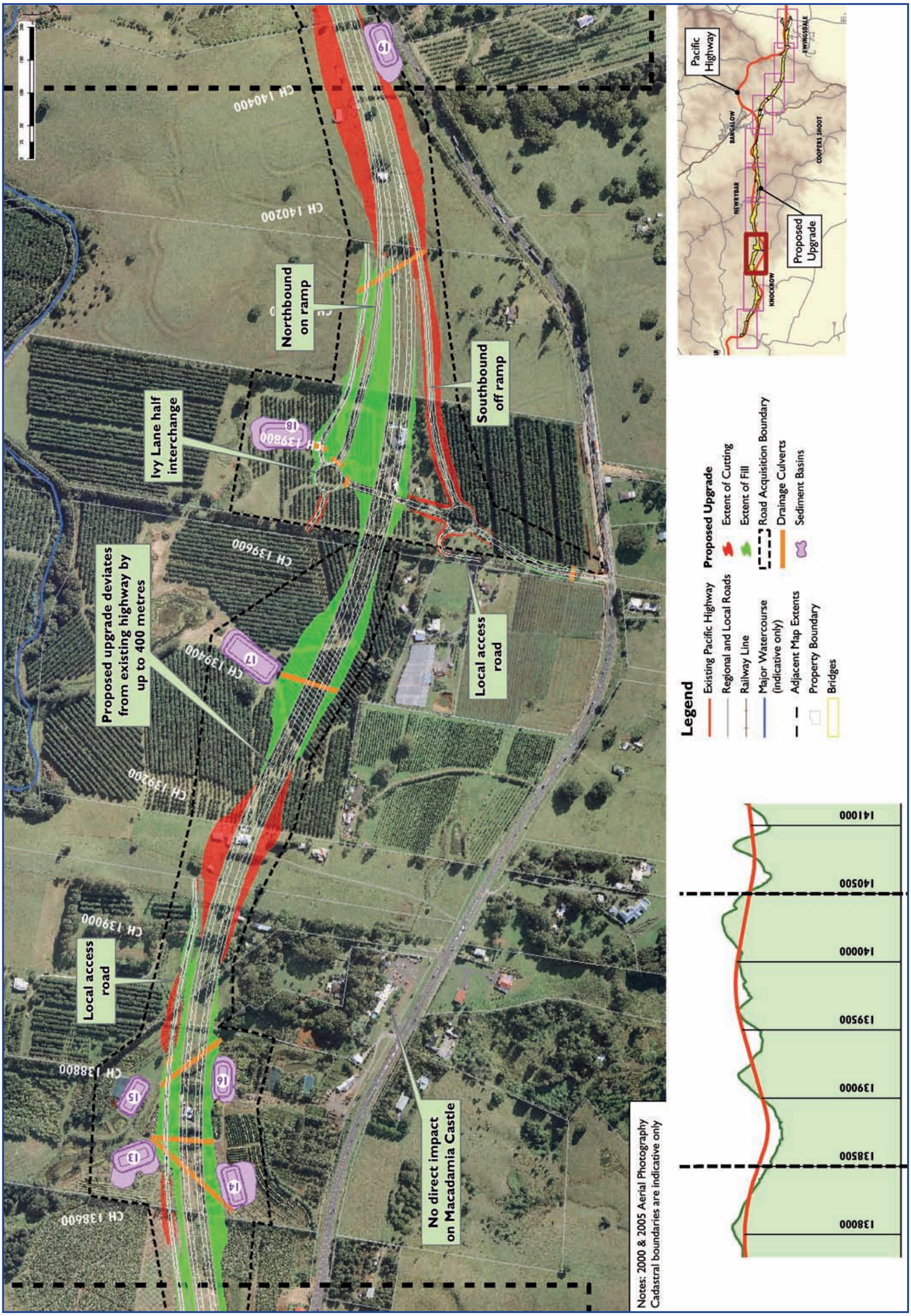


Figure 5.2c - Proposed upgrade detail



5.2.2 Emigrant Creek to Bangalow Road

Between Emigrant Creek and Bangalow Road, the proposed upgrade would generally be located in a corridor just east of the existing highway, varying from immediately adjacent to up to 400 m from the existing highway (**Figure 5.2d**).

About 200 m north of the Emigrant Creek crossing, the proposed upgrade would cross to the eastern side of the existing highway. The existing highway would be diverted underneath the proposed bridge taking the proposed upgrade over Emigrant Creek before reconnecting back onto the existing highway about 600 m south of Newrybar. The total length of the diversion would be about 750 m and would achieve an 80 km/h design speed.

After crossing to the eastern side of the existing highway the proposed upgrade would gradually diverge away from the existing highway. Between Watsons Lane and Broken Head Road the alignment would be parallel to, and about 300 m east of the existing highway as it passes Newrybar village.

An underpass would be provided to allow Watsons Lane traffic to pass underneath the proposed upgrade. A minimum of 4.8 m vertical clearance would be available for Watsons Lane traffic, consistent with RTA requirements for local roads.

North of Watsons Lane, the proposed upgrade would pass to the east of Newrybar Public School where a landscaped mound has been added between the proposed upgrade and the school to provide visual and noise mitigation (**Figure 5.2e**).

The proposed upgrade would pass underneath Broken Head Road in a cutting about 12 m deep. Broken Head Road would cross above the proposed upgrade on a bridge about 135 m long, providing continued access to Newrybar village, Newrybar Public School and the existing highway. The bridge would incorporate pedestrian and cyclist facilities for use by school students and Newrybar residents. There would be no provision for vehicular access between Broken Head Road and the proposed upgrade.

North of Broken Head Road, the alignment would move back towards the existing highway, crossing Skinners Creek on twin bridges about 185-195 m long before merging onto the start of the 9(a) proposed road reserve zone designated for highway usage.

There is no requirement for an access road on the eastern side for the most part through this section since all properties would retain access to Broken Head Road. All houses and properties to the west of the proposed upgrade would retain their access to Broken Head Road and to the existing highway.

For about 1.7 km north of Skinners Creek, the proposed upgrade would be just to the east of the existing highway and avoid the tight curves and steep grades of the existing highway.

Opposite Lawlers Lane, the proposed upgrade would climb to a crest that would form the highest point along the 17 km length (**Figure 5.2f**). It would reach an elevation of about 122 m above sea level, although this would still be about 13 m below the highest level of the existing highway in this section. About 300 m north of the crest, a bridge would be provided above the proposed upgraded to connect properties to the east with the existing highway.

From the crest of the hill and to the north of the local access bridge, the alignment would descend towards Bangalow with a grade of approximately 5.4 percent for a length of about

700 m. The descent would pass through a major cutting up to about 30 m deep and about 500 m long. An additional southbound climbing lane would be provided through this section so that slow moving trucks would not be a significant safety hazard to other vehicles. The additional southbound lane would be developed within the wide median, commencing near the connection to the Bangalow bypass and merging back to two lanes on the south side of the crest, just before the local access bridge. The reduced median width would require a median barrier for safety. The design would allow a third northbound lane to be added in the median in the future if required. In view of the additional southbound lane proposed initially, there is no provision for adding an additional lane to the southbound carriageway in the future.

The upgrade alignment would then connect to the southern end of the Bangalow bypass.

The northbound carriageway of the Bangalow bypass would be converted to a two-way local road while the southbound carriageway would become the northbound carriageway of the proposed upgrade (**Figure 5.2g**). A new southbound carriageway for the proposed upgrade would be constructed on the eastern side of the existing Bangalow bypass.

Through this section a local access road about 1.2 km long would be provided east of the proposed upgrade to provide access to two properties south of Bangalow Road.

At Bangalow, a half interchange with south-facing ramps is proposed. This arrangement would replicate the arrangement with the existing Bangalow bypass. The interchange would incorporate twin bridges above Bangalow Road, each about 60 m long. It would also provide access between the local road network, including Bangalow and Lismore, and the proposed upgrade to the south.

5.2.3 Bangalow Road to Ewingsdale

At Bangalow Road, the existing Bangalow bypass curves to the north-east and climbs steeply beside the Bangalow township. The proposed upgrade would continue in a northerly direction, crossing Byron Creek and the Casino-Murwillumbah railway on twin bridges, each about 180 -190 m long, before traversing Tinderbox Creek valley.

The section of the proposed upgrade through Tinderbox Creek valley to the St Helena Tunnel is about 3 km long (**Figure 5.2h**).

About 650 m north of the railway line at Bangalow, twin bridges approximately 145 m long would cross an unnamed tributary of Tinderbox Creek, reducing disturbance to riparian vegetation and the watercourse itself. Tinderbox Road would be realigned and diverted to pass under the twin bridges to maintain local access.

Through this section, there are several large cuttings into the hillside on the western side of the proposed upgrade to avoid any direct impact on Tinderbox Creek. On the eastern side, the proposed upgrade is quite close to the western edge of Tinderbox Creek at two locations. As a result, fill batters that are more steeply engineered are proposed at both locations rather than the normally slope-engineered batters to ensure that the earthworks do not extend into the flood zone of Tinderbox Creek.

The proposed upgrade would diverge to the north, away from Tinderbox Creek, about 1.5 km north of the railway line or about 1.5 km south of the tunnel under St Helena Hill (**Figure 5.2i**). Following a valley northwards and climbing towards the southern portal of the proposed tunnel, it would reach an elevation of about 91 m above sea level, well below the elevation of 183 m above sea level that the existing highway reaches at the top of the St Helena ridge.

The proposed upgrade would pass under St Helena ridge through twin parallel tunnels, each about 340 m long and about 45 m below St Helena Road. The twin tunnels, one for each carriageway, would be separated by a rock pillar. The northbound tunnel would be 11.5 m wide between barriers, providing sufficient width for line marking as 3 lanes in each direction if required in the future. The southbound tunnel would be 12.5 m wide to incorporate the southbound climbing lane while still allowing 1 m wide shoulders on each side. In view of the proposed additional southbound lane, there is no provision for adding an additional lane to the southbound carriageway through the tunnel.

On the north side of St Helena Hill the tunnel would emerge just to the east of the existing highway, allowing the existing highway to be retained as a local road. Through to the Ewingsdale interchange, the proposed upgrade alignment would be as close as possible to the existing highway before merging onto and utilising the existing highway just south of the existing Ewingsdale interchange (**Figure 5.2j**). The grade would be 4.4 percent over a length of approximately 1.4 km. An additional southbound climbing lane would be provided through this section so that slow moving trucks would not be a significant safety hazard to other vehicles, particularly through the tunnel. The southbound lane would be developed on the outside by continuing the southbound on-ramp from the Ewingsdale interchange. The median width would not be reduced and no median barrier would be required, apart from the immediate approach to the tunnel portals. The climbing lane would not merge back to two lanes until about 800 m south of the tunnel. This would remove the need for vehicles to change lanes within the tunnel. South of Ewingsdale, a local access road would be provided on the eastern side of the proposed upgrade to maintain access to two properties.

Where the proposed upgrade passes the Ewingsdale residential area, it would be lower and slightly closer to Ewingsdale than the existing highway. A landscaped mound is proposed between Ewingsdale and the proposed upgrade to provide visual and noise mitigation. The mound would extend over a length of about 1 km, from the southern end of the closest houses in Ewingsdale almost through to the roundabout at Ewingsdale Road.

The existing Ewingsdale interchange would be retained but improved as part of the proposed upgrade. As the proposed upgrade merges onto the existing highway south of the interchange, the existing highway traffic would be diverted to the west onto a new connection road. A new roundabout would connect the existing highway traffic to the western side of the existing interchange. The existing northbound off-ramp, northbound on-ramp and southbound off-ramp would remain with minor modifications. A new direct southbound on-ramp is also proposed.

Figure 5.2d - Proposed upgrade detail

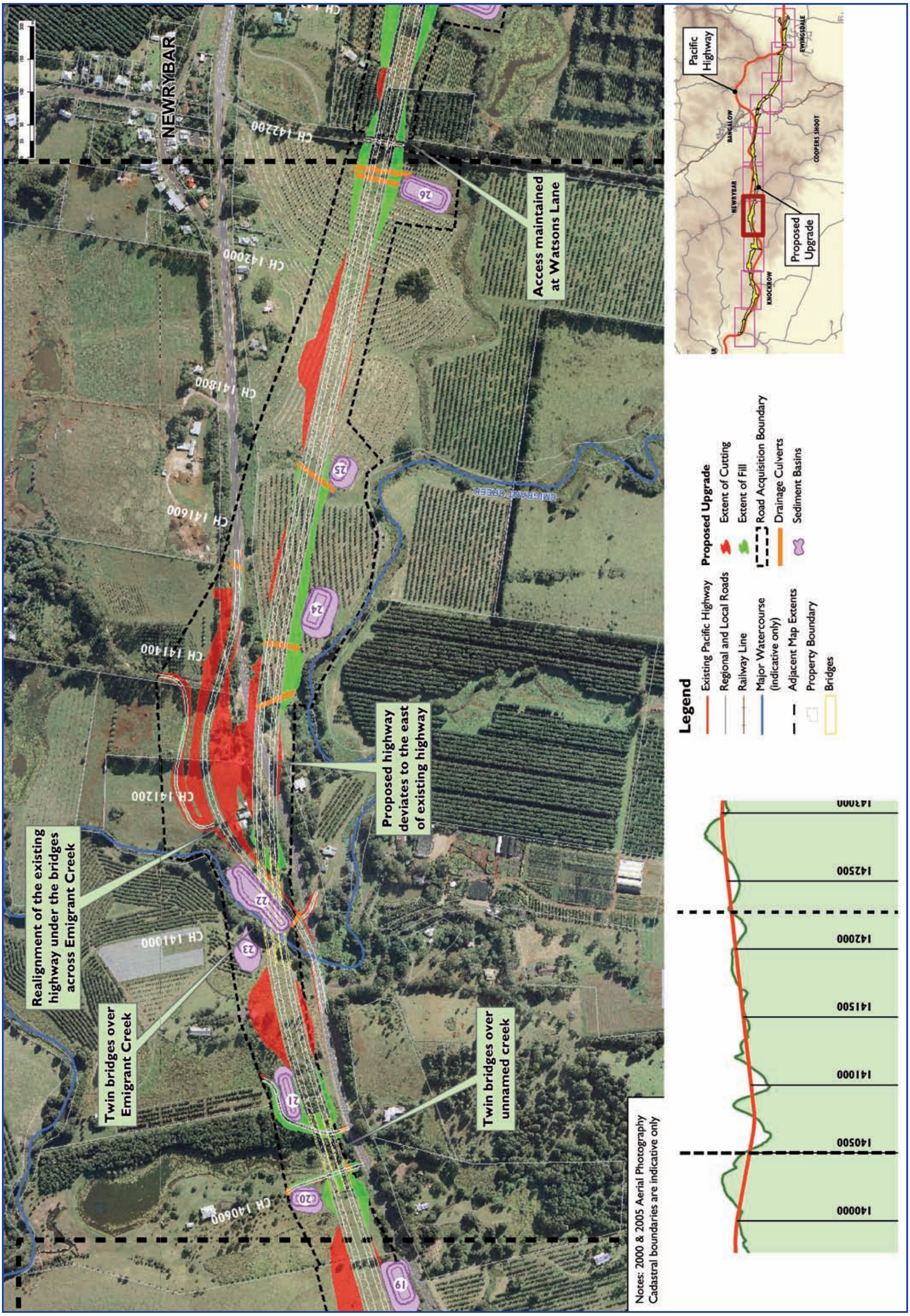


Figure 5.2e - Proposed upgrade detail

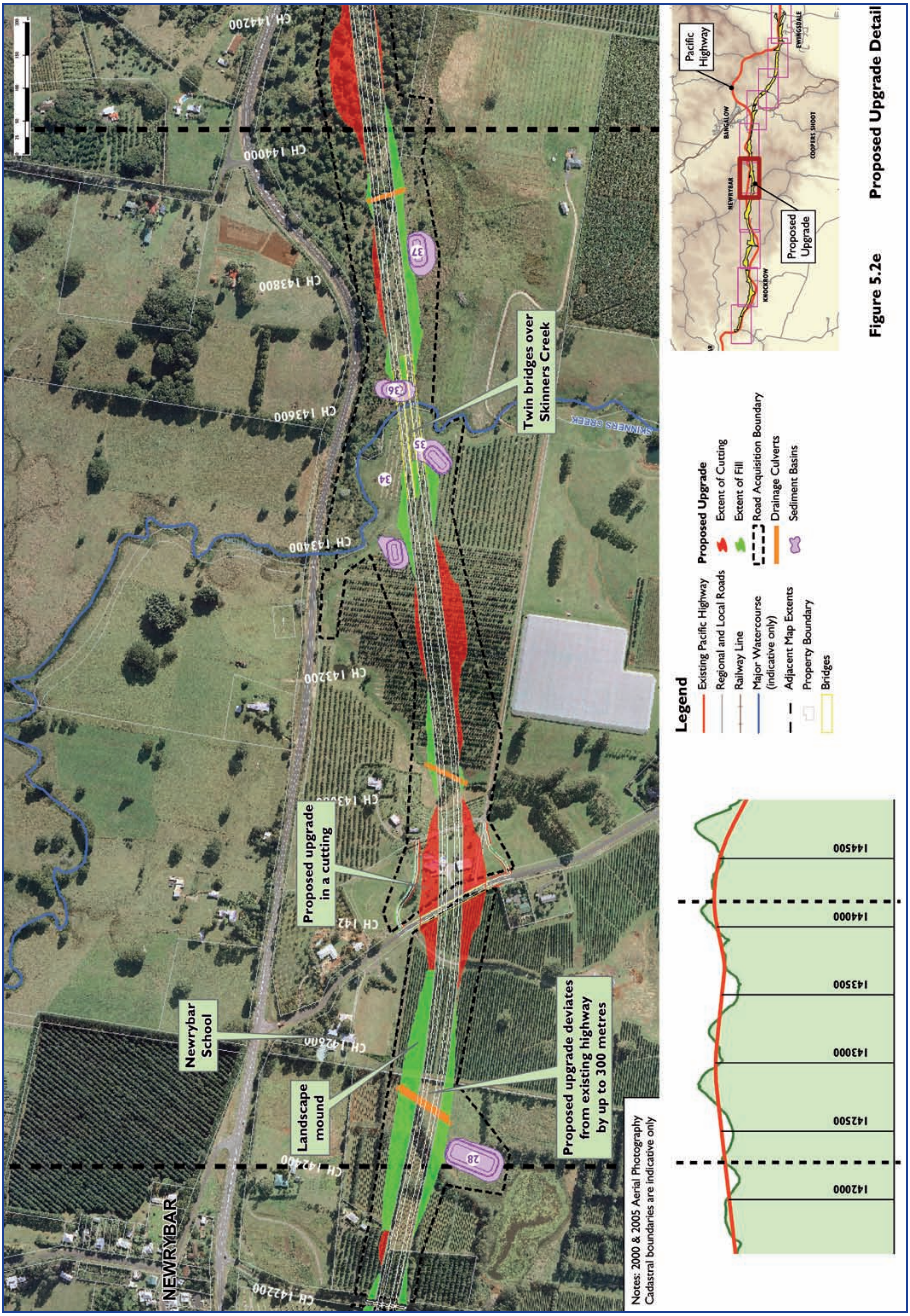


Figure 5.2f - Proposed upgrade detail

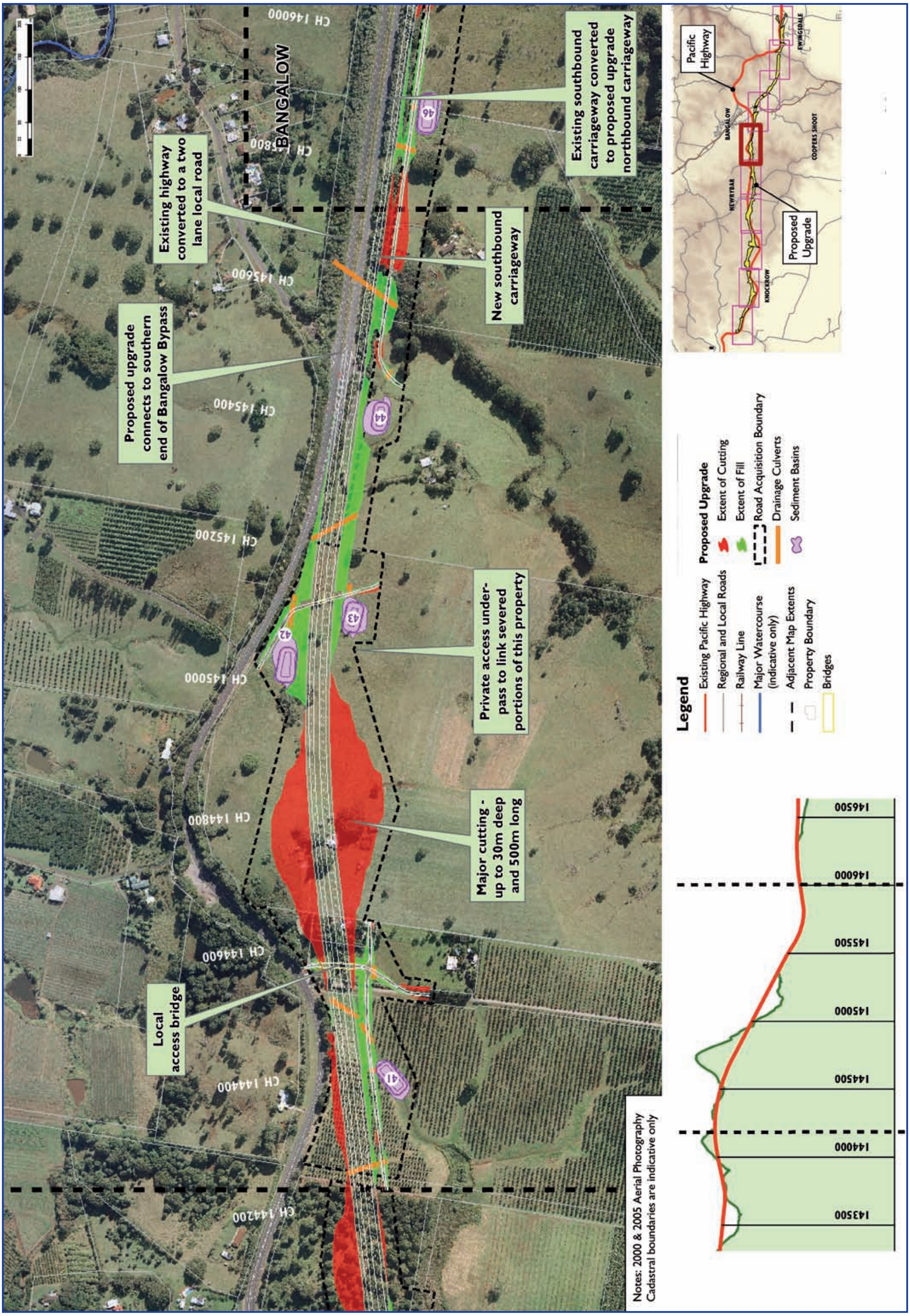


Figure 5.2g - Proposed upgrade detail

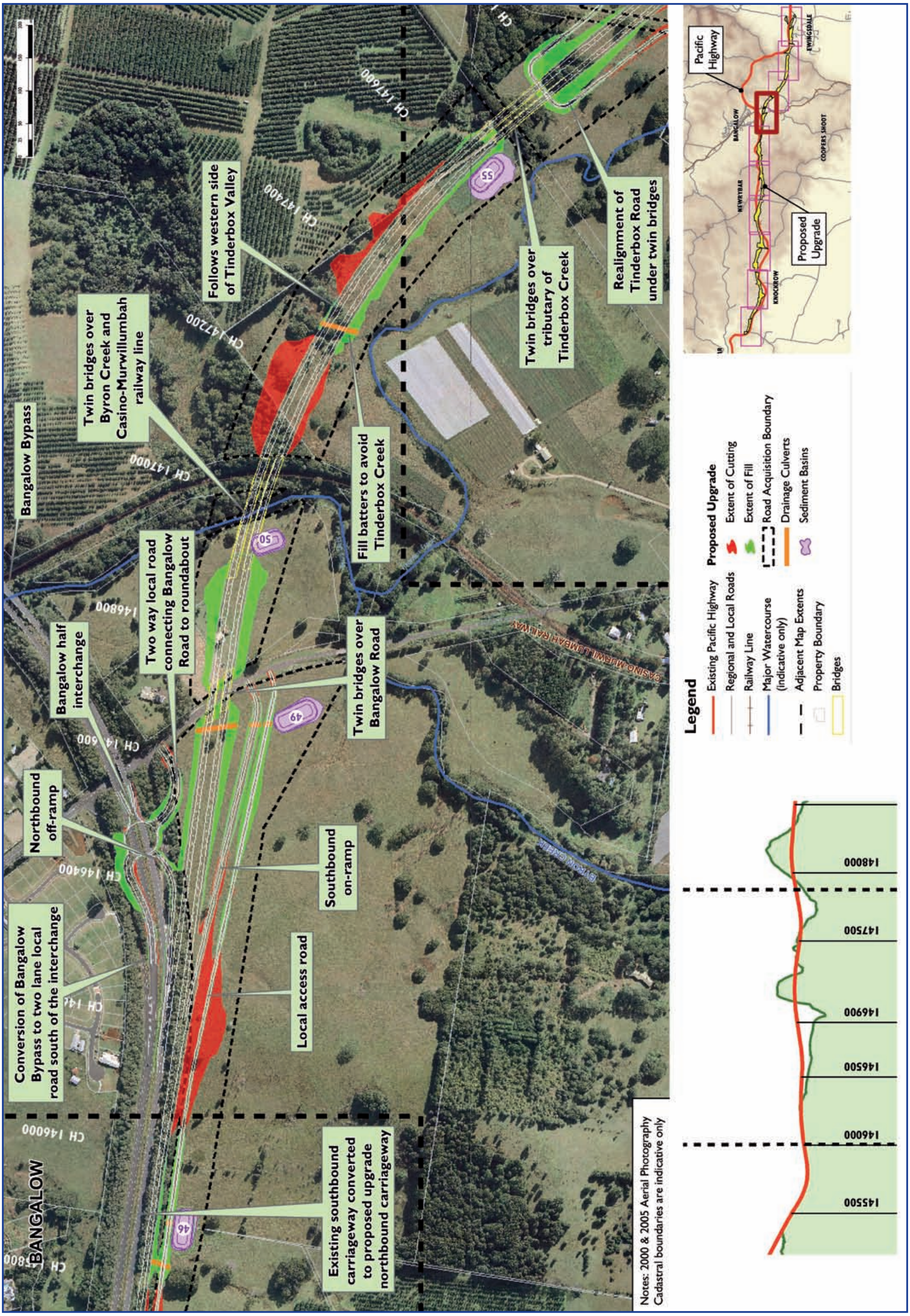


Figure 5.2h - Proposed upgrade detail

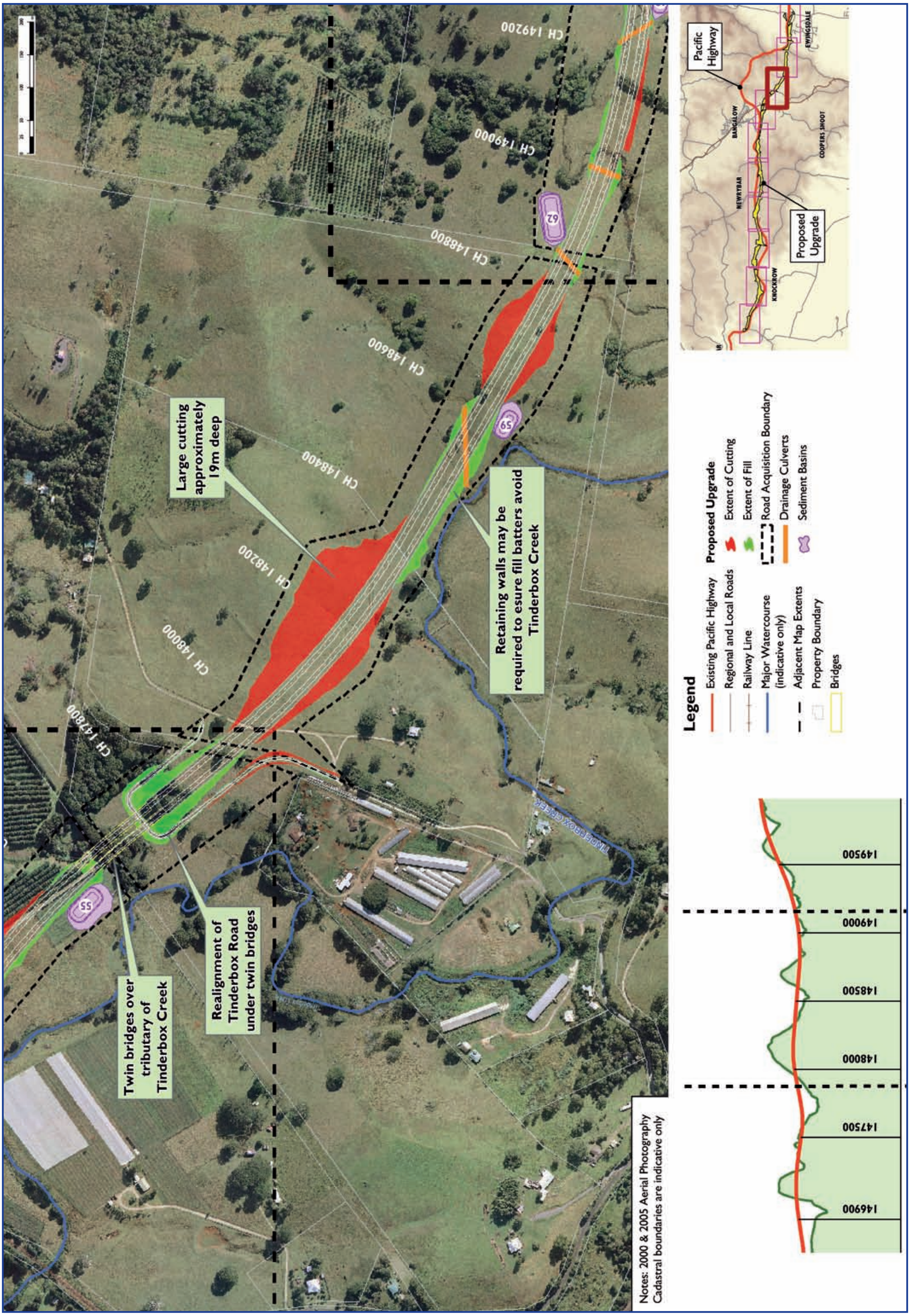


Figure 5.2l - Proposed upgrade detail

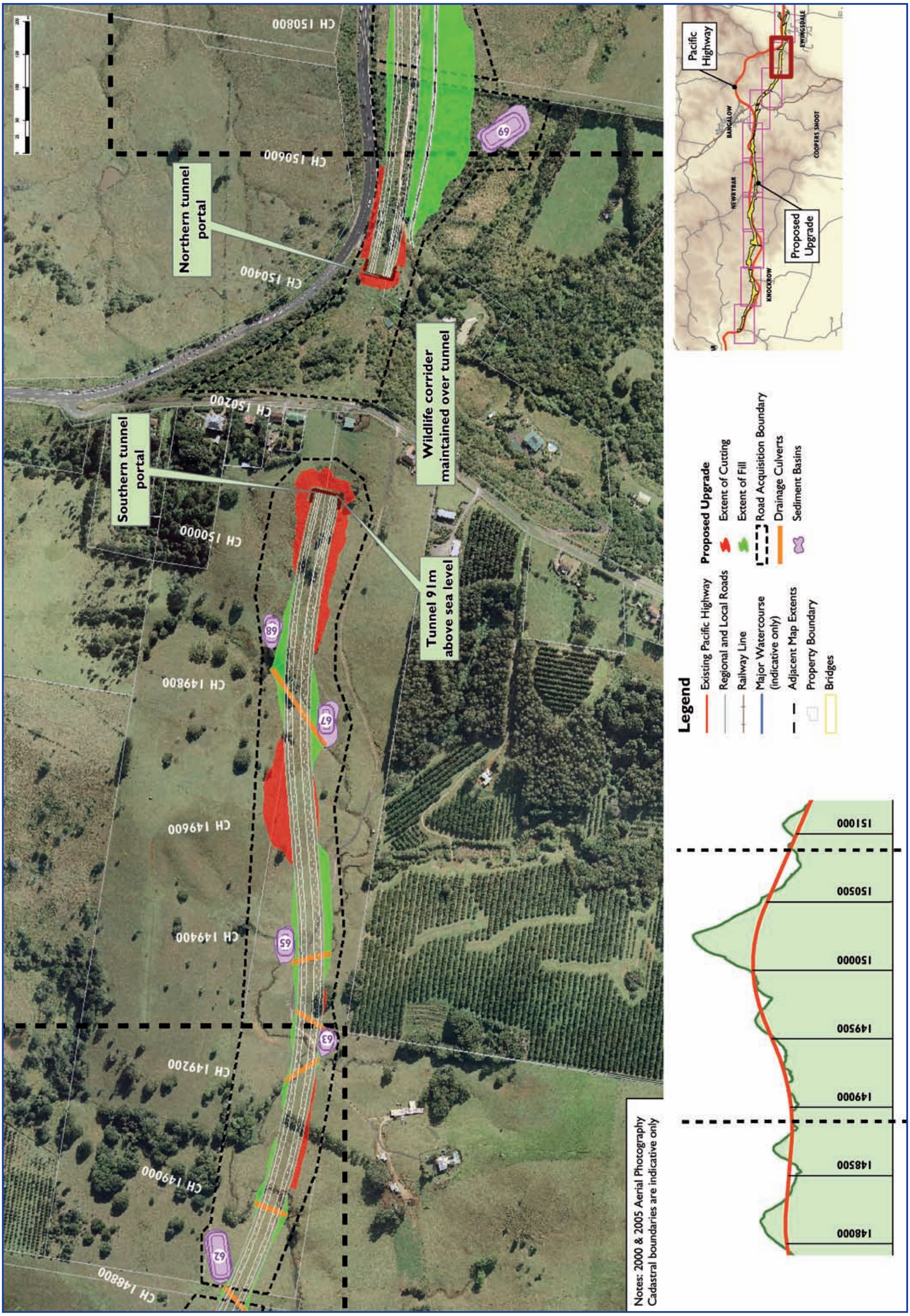
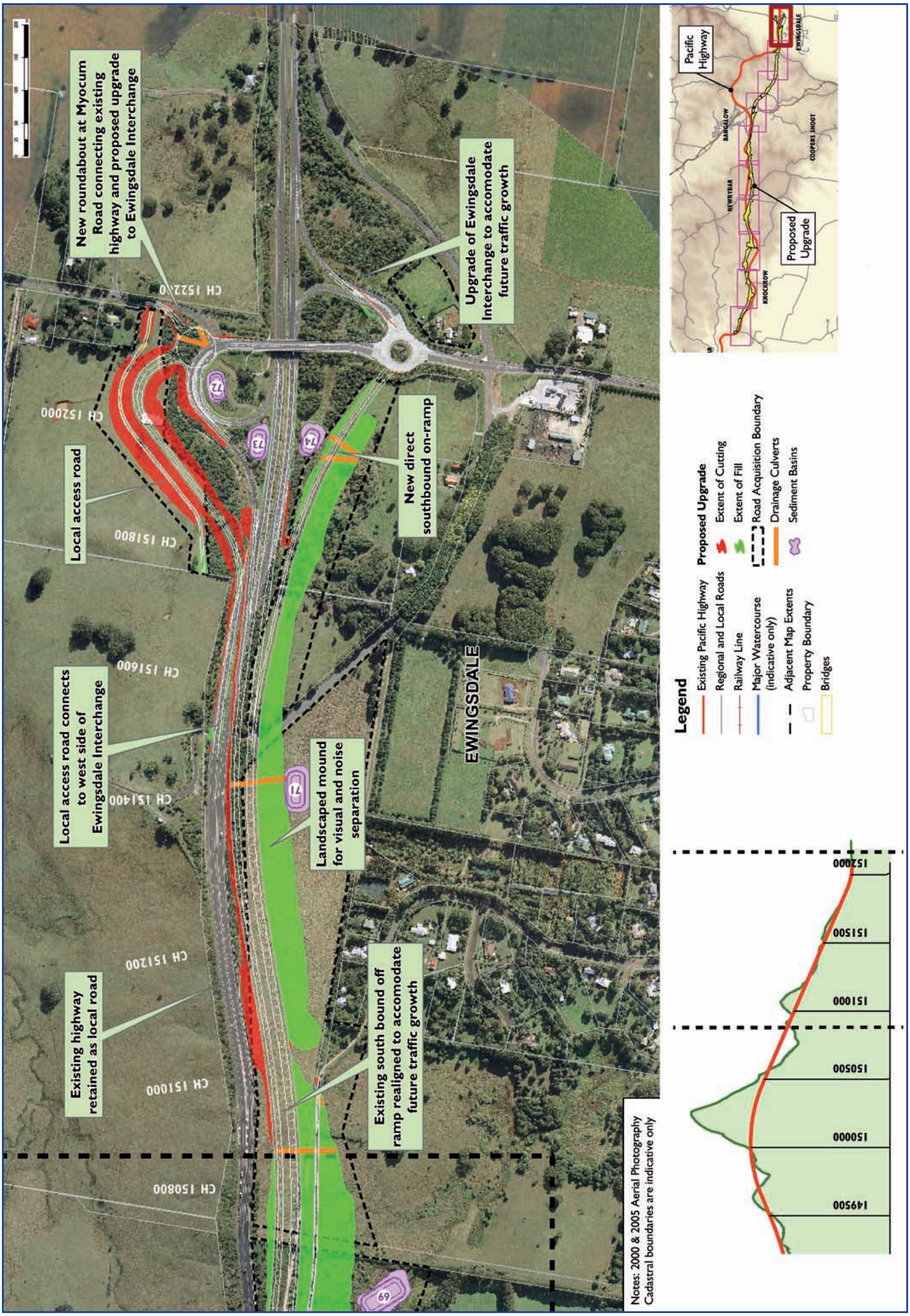


Figure 5.2j - Proposed upgrade detail



5.3 Interchanges and intersections

Full interchanges would be provided at Ross Lane and Ewingsdale and half interchanges would be provided at Ivy Lane (north facing ramps only) and at Bangalow Road (south facing ramps only).

The broader principles associated with access are provided in the *Tintenbar to Ewingsdale Strategic Access Report* (RTA 2008). This report includes a preliminary evaluation of a possible future southern Bangalow bypass that would allow traffic between Lismore/Casino and the Pacific Highway to connect to the highway without travelling through Bangalow. While outside the scope of this project, it would be possible for a southern bypass of Bangalow to be connected to the proposed upgrade should it become justifiable in the future.

Description of the interchanges proposed as part of the upgrade is provided below. The concept designs presented in this section would be subject to refinement during detailed design.

5.3.1 Ross Lane interchange

The majority of the Ross Lane interchange (**Figure 5.3**) would be constructed as part of the Ballina bypass, including the overpass, the south-facing ramps, and temporary north-facing ramps connecting to the existing highway to the north. The Tintenbar to Ewingsdale upgrade would include:

> Refinement to the northbound on-ramp to connect to the proposed upgrade.

> Provision of a new southbound off-ramp. Due to space limitation and a preference to reduce the overall footprint of the combined road corridor, the southbound off-ramp would not connect directly to the roundabout on the east side of the interchange, but rather to the existing highway about 1.1 km north of the roundabout. The existing highway would remain open to local traffic and be two lanes, providing access to Ross Lane and Tintenbar.

5.3.2 Ivy Lane interchange

The layout of the Ivy Lane interchange is shown in **Figure 5.4**. It would allow for traffic movements between the local road network and the proposed upgrade to the north.

The interchange itself comprises a northbound on-ramp and a southbound off-ramp, connected to roundabouts on both sides of the proposed upgrade. The interchange would also be connected to the existing traffic network by a link road from the eastern roundabout back to Ivy Lane. The two roundabouts would be connected by an underpass that would also maintain access to properties on the western side of the proposed upgrade. The roundabout on the eastern side also has a local access road servicing properties on Ivy Lane.

The current Ivy Lane intersection with the existing highway would be retained, but would include a minor intersection upgrade in line with the increased traffic volumes. There is already a right turn deceleration lane for southbound traffic to turn right into Ivy lane. As part of these improvements, a northbound deceleration lane may be required for the existing highway south of the intersection, allowing northbound traffic on the existing highway to turn left at Ivy Lane.

Figure 5.3 - Ross Lane interchange

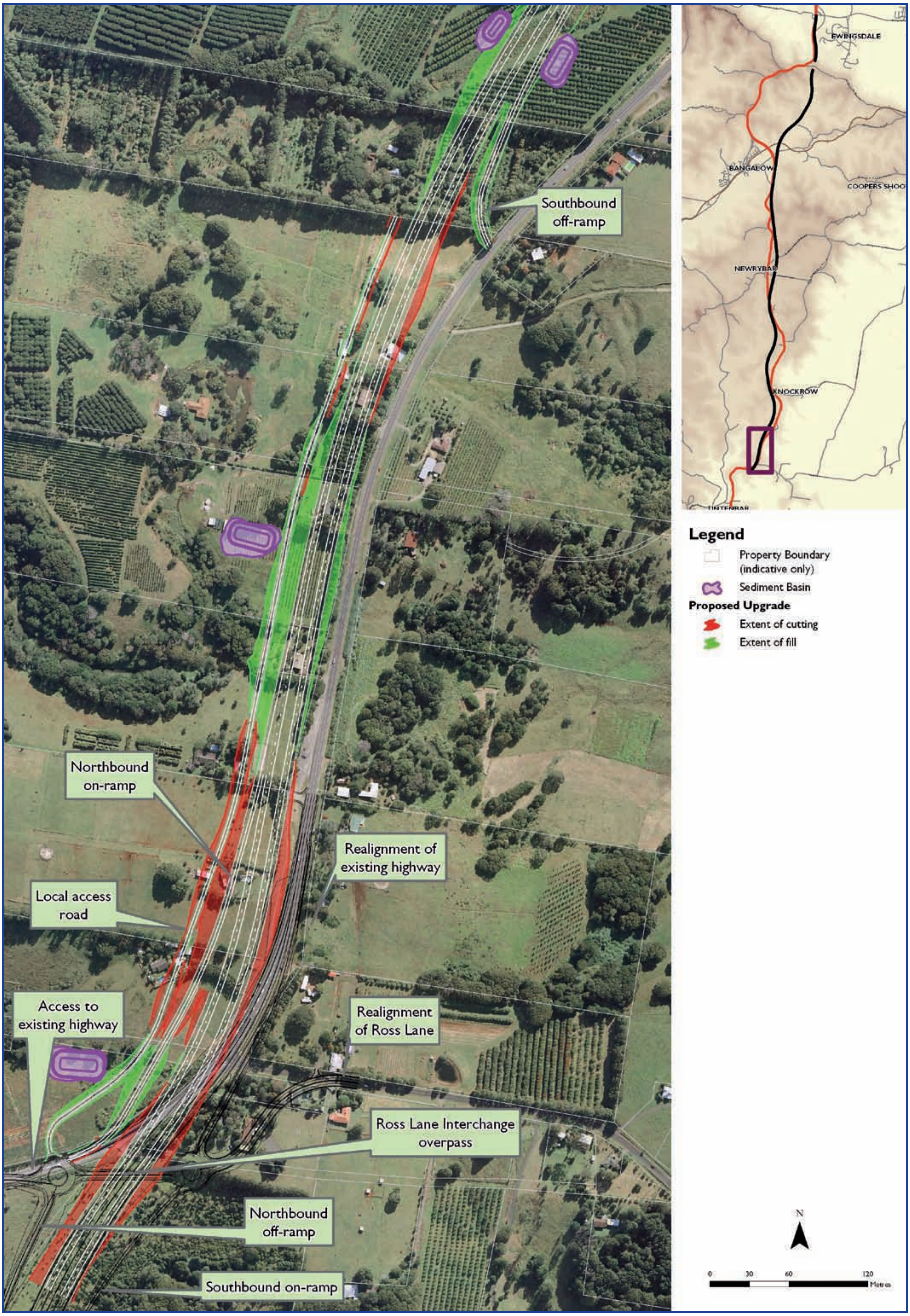
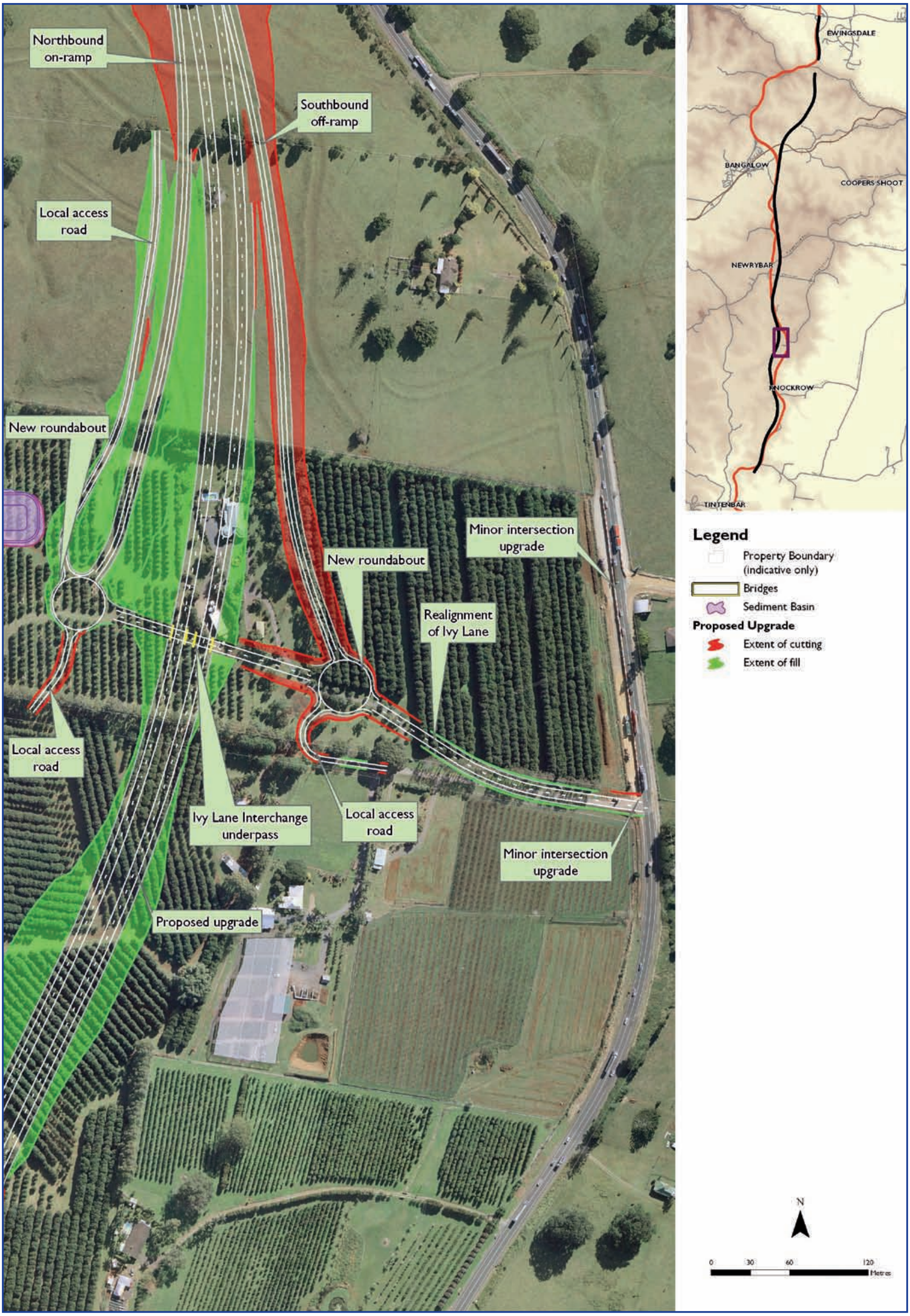


Figure 5.4 - Ivy Lane interchange



5.3.3 Bangalow interchange

The layout of the Bangalow interchange is shown in **Figure 5.5**. It would allow for traffic movements between the local/regional road network at Bangalow and the proposed upgrade to the south. This arrangement would replicate the existing arrangement with the Bangalow bypass at Bangalow Road.

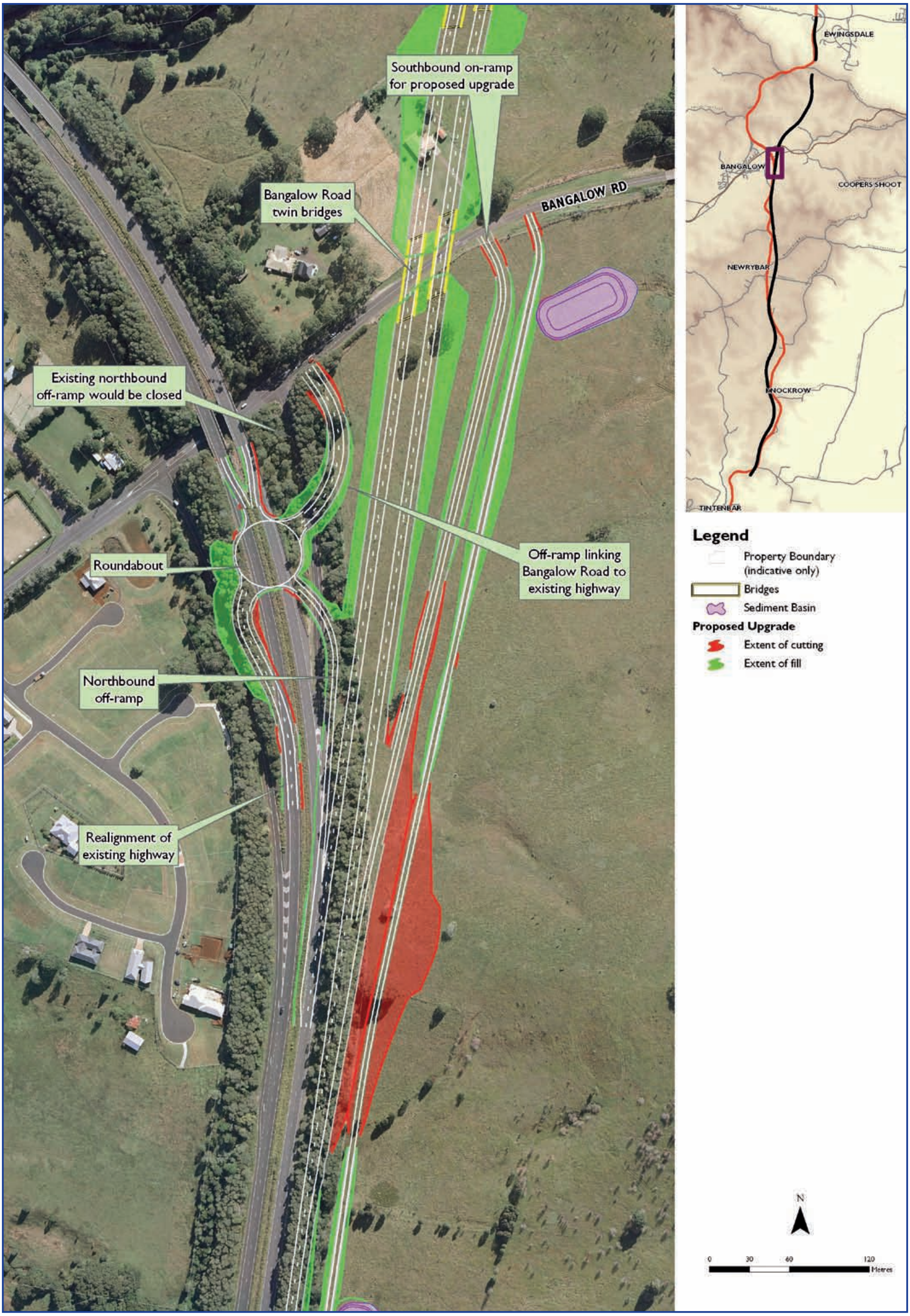
On the eastern side of the proposed upgrade, the interchange would comprise a southbound on-ramp which commences at Bangalow Road. A simple T-junction would be provided at the ramp intersection with Bangalow Road, just east of the proposed upgrade.

On the western side of the upgraded highway, the interchange layout is more complex because of the need to cater for traffic which would continue to use the existing highway to the south and the remaining section of the Bangalow bypass to the north. The northbound off-ramp would connect to a roundabout on the western side of the proposed upgrade, with a two-way road connecting the roundabout back to Bangalow Road. The existing highway, which remains open for local traffic to the south, would also connect to the roundabout, as would the remaining section of the Bangalow bypass to the north. The existing northbound off-ramp from the Bangalow bypass would be closed, this would be replaced by the short two-way road from the roundabout to Bangalow Road.

The proposed interchange layout would retain most of the existing infrastructure including bridges while allowing all traffic movements to and from the proposed upgrade to the south.

Traffic between the local/regional road network and the proposed upgrade to the north would continue to use the existing highway down St Helena Hill, connecting to the proposed upgrade via the Ewingsdale interchange.

Figure 5.5 - Bangalow interchange



5.3.4 Ewingsdale interchange

The existing Ewingsdale interchange would be retained but improved as part of the proposed upgrade. The proposed changes are shown in **Figure 5.6**. The modifications are required to connect the Bangalow/Lismore traffic using the existing highway to the proposed upgrade and the existing highway to the north. At the same time, the opportunity has been taken to incorporate other changes that would address issues with confusion/readability of the current layout and also to address some existing ramp design deficiencies.

The proposed upgrade would include the following changes to the western side of the existing interchange:

> Construction of a new roundabout.

> Relocation of the existing highway further to the west so that it can continue to provide a connection to Bangalow and Lismore. The relocated road would connect to the new roundabout.

> Slight change to the existing northbound off-ramp to diverge from the proposed upgrade rather than from the existing highway. The end of this ramp would also be modified so that it connects to the new roundabout.

> Retention of the existing looped northbound on-ramp. However, it would be modified slightly so that it leaves from the new roundabout on the western side.

> Connection of Myocum Road to the new roundabout.

The roundabout on the western side would also make provision for the addition of a new direct northbound on-ramp from the roundabout heading north-east. This is a future provision only and is not part of the proposed works in this environmental assessment.

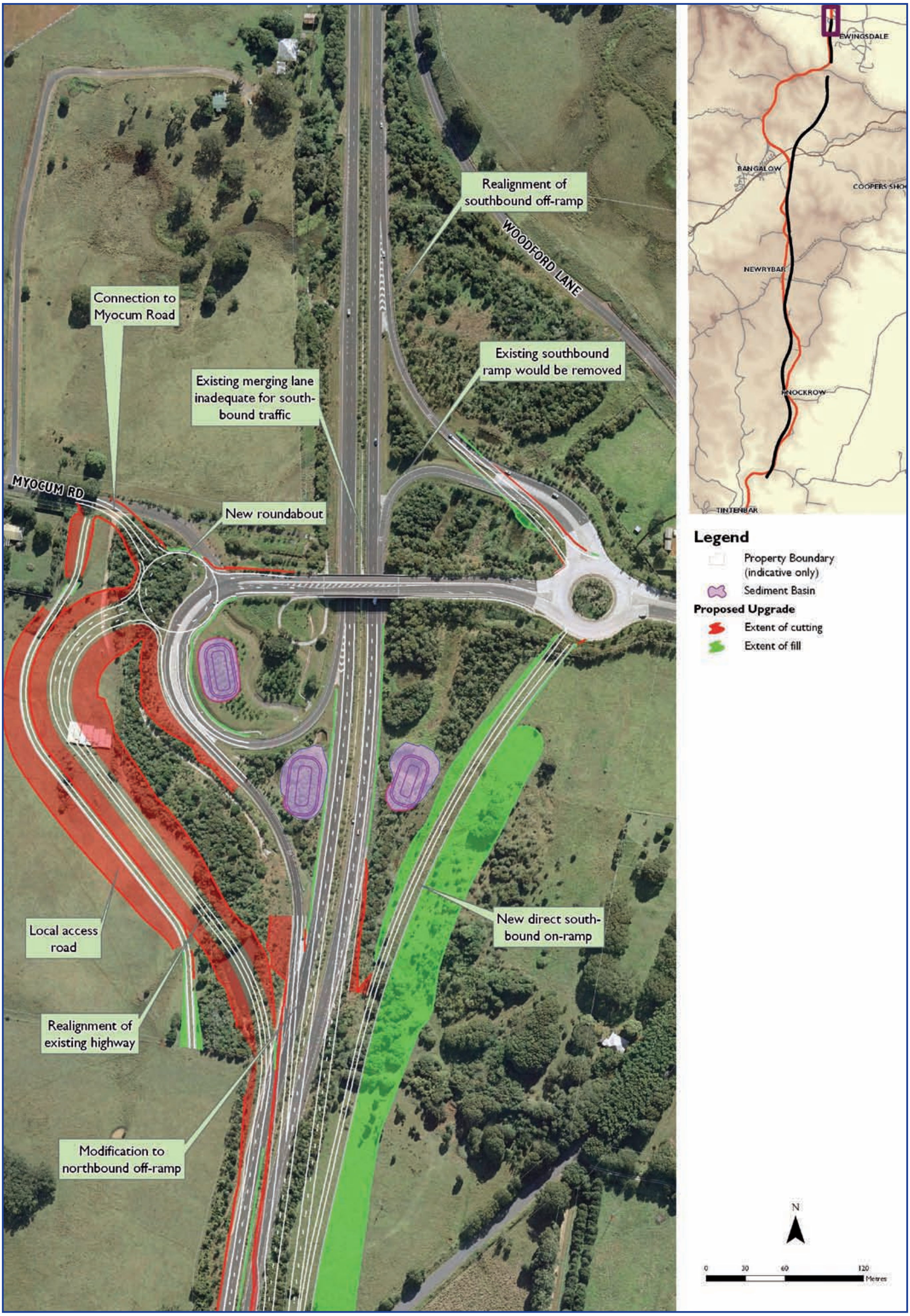
The proposed changes to the eastern side of the existing interchange are summarised below:

> A new direct southbound on-ramp would be provided. The existing loop ramp exits on the northern side of the roundabout to travel south and can be confusing to some users. In addition, the length of the acceleration lane onto the highway is insufficient because of the low speed (40 km/h) of the 40 m radius curve at the entry under the bridge. Removal of this on-ramp and replacement with a new direct ramp connected to the south side of the roundabout is therefore proposed.

> The existing southbound off-ramp would be retained but slightly re-aligned where it connects to the eastern roundabout.

The proposed layout allows for the future realignment of Woodford Lane so that it could be connected to the roundabout. The advantage would be the elimination of the existing at-grade intersection between Woodford Lane and Ewingsdale Road and its replacement with the safer roundabout layout. This is a future provision only and is not part of the proposed works in this environmental assessment.

Figure 5.6 - Ewingsdale interchange



5.4 Bridges and underpasses

5.4.1 Locations and general layouts

Bridge layouts have been developed to demonstrate that specific functional requirements can be achieved and to identify potential environmental impacts. As such, the designs are indicative and would be further refined during the detailed design phase of the project to maximise cost effectiveness, while also considering the proposed urban design principles.

Concept designs for bridge locations, preliminary bridge lengths and width and span arrangements have been developed considering:

> Geometric requirements for each carriageway, including sight distance widening on curved bridges.

> Constructability and construction sequencing.

> The visual impact on the surrounding area.

> Avoidance of piers in watercourse and riparian vegetation.

> Provision of adequate waterway capacity at waterways, with minimal increase to water levels upstream of the structure.

> Provision for fauna access under bridges through consideration of abutment and pier locations.

> The need to incorporate safety screens, hand rails and noise barriers, where required, as integral parts of the bridge balustrade.

> Provision of appropriate horizontal and vertical clearances to roads and railways.

There are six twin bridges and four underpasses carrying the proposed upgrade above roads and creeks. In the detail design phase the larger underpasses proposed could become twin bridges and, conversely, the smaller twin bridges could become underpasses, pending the structural assessments. There are also two bridges carrying local roads above the proposed upgrade. Indicative bridge and underpass details are summarised in **Table 5.1**. These could vary during detailed design.

Table 5.1 Bridge locations and lengths (indicative design)

	Northbound	Southbound
Highway bridges on proposed upgrade	Length (m)	Length (m)
Bridge over minor creek (Yarrenbool Place)	130	115
Bridge over Emigrant Creek	180	165
Bridge over Skinners Creek	195	185
Bridge over Bangalow Road	60	60
Bridge over Byron Creek & Casino- Murwillumbah railway	190	180
Bridge over tributary of Tinderbox Creek	145	145
Local road underpasses under the proposed upgrade	Length (m)	Width (m)
Martins Lane West	70	10.0
Ivy Lane	70	10.5
Watsons Lane	65	10.0
Private access underpass at Ch 145115.	65	11.0
Local road bridges above the proposed upgrade	Length (m)	Width (m)
Broken Head Road	135	10.0
Local access bridge at Ch 144550	60	8.0

Bridges would meet the following performance criteria:

> Meet RTA standards in terms of sight lines, structural performance and maintenance.

> Ensure that maximum flow velocity (in the 1 percent AEP event) does not cause scour.

> Allow future widening in the median with minimal additional ground disturbance.

> Address the *Urban And Landscape Design Strategic Concept* (described in **Chapter 18** and **Working Paper 11**, Landscape, urban design, and visual assessment).

5.4.2 Detailed bridge design

During the design process, the two most likely bridge design options were considered in developing layouts. These two broad options ensured that functional requirements could reasonably be achieved at each bridge location. The two broad bridge design options that were considered for each highway bridge site were:

> Option 1: Precast and prestressed (Super T) concrete superstructures.

> Option 2: Continuous variable span haunched steel trough superstructures.

Both bridge design options would have spill through abutments (with a batter slope of 2:1) and pilecaps below existing ground levels for visual enhancement.

Option 2 offers the potential for longer spans of up to about 57 m where necessary to meet functional requirements. Option 1 bridges would be limited to maximum spans of about 38 m but may have cost savings.

Bridge types would be reviewed during the detail design stage, possibly including bridge options beyond those listed above. The final choice of bridge type would be based on achievement of the above performance criteria and a balance between engineering, urban design, environmental and cost considerations.

5.5 Tunnels

A tunnel for each carriageway is proposed under the St Helena ridgeline. The main features of the tunnels are described below.

5.5.1 Tunnel geometric design

The proposed tunnels have a 4.4 percent approach grade on the north side. They would be approximately 340 m long and with a minimum 5.3 m vertical clearance.

The southbound and northbound tunnels would be similar in shape, except that the southbound tunnel would be 1 m wider.

The carriageway in the northbound tunnel would be 11.5 m wide between barriers, providing sufficient width for 3 lanes if required in the future.

The carriageway in the southbound tunnel would be 12.5 m wide to incorporate the southbound climbing lane while still allowing 1 m wide shoulders on each side.

The two tunnels would be separated by a rock pillar approximately 7.5 m wide.

Concrete barriers would be provided at the edge of the carriageways in each tunnel. Emergency walkways for pedestrians of 1 m wide by 2.1 m high would also be allowed beyond the concrete barriers. Additional headroom would be available above the required 5.3 m vertical clearance at the centre of each tunnel for tunnel services (for example, exhaust fans and wiring).

5.5.2 Tunnel structure and portals

Tunnel support measures along the tunnel were determined by assessment and evaluation of rock quality based on available geotechnical information. Five support classes were developed. Class 1 to 3 would comprise shotcrete and rock bolts of different configurations. Classes 4 and 5 would be likely to require additional support measures such as lattice girders.

The concept design has assumed that the tunnel would be tanked (sealed from groundwater intrusion). The exact nature of the waterproofing will be determined in final design and following further geotechnical investigation.

The tunnel support measures above would be supplemented by concrete lining for long term tunnel support.

The portals would be designed to comply with the RTA guidelines. Final treatment would take into account structural and urban design considerations.

5.5.3 Tunnel safety and servicing

Following a detailed risk assessment it is proposed that vehicles transporting dangerous goods, apart from those carrying Class 1 (explosives) and Class 2.1 (flammable gases), would be permitted to use the tunnel. The risk assessment also identified that appropriate fire control measures such as exhaust fans and a deluge system which should be installed in recognition of the usage by dangerous goods vehicles.

Traffic management and communication systems would be specified in the tunnel design to ensure the safety of tunnel users and personnel employed in tunnel maintenance and operations. A range of electronic equipment would be deployed to monitor and control traffic flows, transmit alarms, alert emergency and breakdown services and maintain contact between RTA traffic control operations, the tunnel control operations and the relevant emergency services.

Ventilation in the tunnel would occur through the piston effect of moving vehicles pushing air toward the respective exiting portals.

To provide appropriate levels of safety over the full range of operating conditions, facilities for traffic management and tunnel communications would be fully integrated into the systems installed to monitor and control the tunnel environment. System design would be related to the layout of the tunnel and its safety facilities i.e. emergency points and escape routes.

Monitoring of traffic and other activities would be achieved by combinations of closed circuit television (CCTV), CCTV alert and incident detection, and emergency telephones. Traffic would be controlled by fixed signs, variable message signs, matrix signals and portal/lane control signs according to specific needs. When hazards arise, variable signals would display appropriate warnings to slow or redirect traffic or warn of lane closures.

The RTA together with the various emergency services would develop controls to cover the operation of the tunnel on a day to day basis, execute planned maintenance, control tunnel traffic and respond to tunnel emergencies. There would be clear procedures and clearly defined responsibilities agreed and laid down between the tunnel stakeholders, with respect to traffic management and tunnel equipment, to ensure rapid and co-ordinated response to emergencies.

In the event of a tunnel closure, the existing highway would form an alternative route,

5.6 Pavements

A low noise wearing course (such as open-graded asphalt, stone mastic asphalt or low noise concrete) is proposed on all bridges as well as in the following sections as part of the noise management measures for the proposed upgrade:

> From about 300 m south of Newrybar (Ch 141750) to Skinners Creek (Ch 143650).

> From south of Bangalow (Ch 145200) to 750 m north of the proposed railway crossing at Bangalow (Ch 147800).

> From the northern portal of the tunnel through to the Ewingsdale interchange.

Further information on noise management is described in **Chapter 15 – Noise**.

In sections where a low noise wearing course is prescribed, the underlying pavement could be conventional flexible pavement, full depth asphalt or continuously reinforced concrete pavement. In other areas, the pavement could be conventional flexible pavement or full depth asphalt with a low noise wearing surface, or plain concrete pavement with a concrete surface.

The final decision on the type of pavement selected would be made during the detailed design phase of the project and would depend on total life costs (which includes construction and on-going maintenance costs), environmental impacts, material sourcing and constructability.

Pavement designs for intersections and local access roads may differ depending on traffic loads, and would be designed for a 20 year life. The pavement type would most likely be flexible pavement. Existing pavements would be used where possible, with minor rehabilitation and resurfacing carried out as required.

5.7 Emergency cross-overs and lay-by areas

The proposed upgrade has been designed to include a proposed outer shoulder width of 2.5 m. In addition, a 1.0 m wide dish gutter is provided adjacent to the outer edge of shoulder in areas of cut and fill. This would allow for vehicles to pull over at any location in the event of a sudden breakdown or other minor incidents, while retaining clearance to through-traffic. Across bridges, the shoulder width would be 2.5 m with no dish gutter. This would still be adequate for most vehicles to be able to stop clear of through traffic.

The only exception to the 2.5 m shoulder would be through the southbound tunnel where the outer shoulder width adjacent to the climbing lane would be 1 m wide. Traffic monitoring systems in the tunnel would allow the outside lane to be closed to traffic in the event of a breakdown in the tunnel.

To enhance clearances and safety, areas with localised shoulder widening (lay-bys) would also be provided at regular intervals of about 2.5 km in each direction, in conjunction with combined median cross-over/u-turn facilities. These facilities allow emergency vehicles to make u-turns and also allow traffic to be directed onto one carriageway if necessary due to accidents or maintenance. Lay-bys and emergency cross-overs would be provided on either side of the tunnel.

A number of additional lay-bys are proposed where maintenance access to sedimentation basins and bridge structures would be required from the proposed upgrade.

Rest area requirements were examined in accordance with the RTA's strategy for regularly spaced rest areas. No rest areas are proposed on the Tintenbar to Ewingsdale upgrade as based on current plans, adequate rest areas are provided and/or proposed to the north and south of this section of the Pacific Highway. Similarly there are currently no proposals for new service centres within the Tintenbar to Ewingsdale upgrade because of the proposed provision of service centres on other upgraded highway sections.

5.8 Lighting, fencing and signage

The proposed upgrade would generally be unlit, with the exception of interchanges, intersections and other areas where lighting is required for safety reasons, such as merging and diverging traffic streams. Lighting would also be provided inside the tunnel.

The lighting at the interchanges and on-off ramps would be designed based on luminance criteria in accordance with Category V3 in AS/NZS 1158.1 – *Lighting for roads and public spaces*. The most energy efficient lighting technology would be favoured. Lighting design would take into account any potential light spill into nearby properties.

Fencing would be provided on both sides of the proposed upgrade to prevent pedestrian, livestock and wildlife access onto the road reserve. Concept design proposals for direction signs have been developed in accordance with standard RTA policy and would seek to direct motorists to the facilities and attractions available in and around the area. Road signage would be confirmed during the detailed design phase and would conform to prevailing RTA practice at the time. Discussions would also be held with the Ballina and Byron Shire councils during the detailed design phase in relation to any particular signage requirements.

5.9 Cuts and fills

Fill slopes are generally proposed to be at a slope of 2:1 (horizontal to vertical). The slope may be reduced during detailed design where space permits and where there are maintenance advantages. Cut slopes would generally be 2H:1V but steeper in some of the deeper cuttings where the geotechnical investigations indicate sound material.

Generally, a minimum separation of about 15 m has been allowed between the edge of earthworks and the proposed acquisition boundary to provide access and some construction flexibility.

5.10 Drainage and water quality management

5.10.1 Drainage

The proposed upgrade would cross Emigrant Creek, Skinners Creek and Byron Creek. Twin bridges are proposed at each of these crossings, as well as over a tributary of Emigrant Creek and a tributary of Tinderbox Creek.

Bridge abutments on both sides of each creek crossing would generally be located to minimise scour velocities, impacts on flood behaviour and other key performance criteria listed in **Section 5.4**.

The impacts of the proposed upgrade on hydrology are discussed in detail in **Section 9 – Hydrology.**

The design of the proposed upgrade would generally allow the natural flow regimes to be maintained. Transverse culverts would be provided beneath the proposed upgrade to convey surface water runoff, and would be designed with sufficient capacity to convey the 1 percent AEP peak flow with minimal impact on highway function and on upstream or downstream flood levels.

Conceptual locations of cross-drainage culverts are indicated in **Figures 5.2a-j**. Culverts have in general been designed to follow the existing waterway alignment to minimise potential for bank erosion, which in some cases results in the culverts being set on a skewed alignment to the proposed upgrade. Appropriate scour protection would be provided on both upstream and downstream ends of all structures where increased velocities have the potential to cause scour. Design of scour protection measures would be undertaken during the detailed design phase based on peak inlet/outlet velocity and is dependent on the characteristics of the culvert flows. Typically, a headwall and apron would be sufficient to protect against scour when the outlet velocities are low. However, watercourses with high velocity flows may require devices to slow the flow at the culvert entry or outlet and protect the stream bed.

Agreed culverts and scour protection would also be designed (during the detailed design phase) to be fish-friendly and fauna-friendly in accordance with relevant Department of Primary Industries Fisheries guidelines.

Runoff from above the proposed upgrade would be collected in a catch drain at the top of cuttings, or a toe drain at the bottom of the batter, and diverted to an existing watercourse or proposed culvert location.

The highway pavement drainage system would be designed during the detailed design stage to cater for run-off from the pavement surface, cut batters and the median of the proposed upgrade.

Bridge deck drainage systems would be devised during the detailed design phase of the project to discharge to the highway pavement drainage system and avoid direct discharge into the watercourse. It is anticipated that piped drainage in the bridge superstructure would provide adequate drainage of surface water from the bridges.

5.10.2 Water quality management

A broad water quality management strategy has been developed for the proposed upgrade. The strategy includes a number of measures to improve water quality running off the proposed upgrade before it enters the local creek system. It also acknowledges differing sensitivities in receiving waters, particularly the high level of sensitivity associated with the close proximity of Emigrant Creek dam, which is part of Rous Water's water supply network.

The most important element of the strategy (both during construction and operation) is a system of sediment basins. Sediment basins work by holding runoff for a period of time to allow suspended solids to be removed from the water and deposited on the floor of the basins. Some sediment basins incorporate additional measures to remove various pollutants. It is proposed to treat virtually all runoff from the proposed upgrade within the Emigrant Creek dam catchment through sediment basins before it is discharged. Outside the Emigrant Creek dam catchment, most runoff would be contained and treated in sediment basins, however runoff from a small proportion of the proposed upgrade would not enter sediment basins. Instead, alternative methods of treatment would be implemented during detailed design. These may include sediment fences (amongst other measures) during construction, while the proposed landscape treatments would be likely to adequately filter this relatively small amount of runoff during operation. Additional details on treatment during construction and operation are provided below.

Construction phase

Erosion and sedimentation controls would be designed in accordance with *Managing Urban Stormwater – Soils and Construction* (Landcom 2004) and the draft DECC document *Managing Urban Stormwater – Soils and Construction Volume 2D – Main Road Construction*. Sediment basins have been sized on the basis that soils likely to be disturbed by the proposed upgrade are generally fine, but non-dispersive (based on geotechnical investigations undertaken to date). Basin sizing allows for capture of runoff from all disturbed areas. During the development of the detail design a specialist soil conservation consultant would be engaged to assist in the development of specific soil and sediment control measures and strategies.

Operational phase

Outside the Emigrant Creek dam drinking water catchment area, construction phase basins would generally be converted to provide an operational water quality function. The basins would serve to treat both day-to-day runoff from the road, and have adequate capacity to contain a major accidental spill from a traffic accident.

Any construction phase basins not retained during the operation phase would be removed once the vegetation in the catchment area has established and water quality has stabilised. Following removal, disturbed areas would be revegetated.

Within the Emigrant Creek dam drinking water catchment area, all construction-phase sediment basins would be converted to water quality basins utilising sand filters for the operation phase. These would also treat day-to-day runoff from the road, and have adequate capacity to contain a major accidental spill from a traffic accident. The basins would be dry basins with treatment achieved through a combination of gross pollutant traps, sand filter media and permeable piping.

Basins in the Emigrant Creek dam catchment would require regular maintenance in the form of cleaning and clearing the gross pollutant traps. The sand filters themselves would require little maintenance, with the sand needing to be replaced only in the event of a spill. The basins outside the Emigrant Creek dam catchment would have a low maintenance requirement consisting of general landscape maintenance and repairs in the case of damage or spills.

5.11 Noise attenuation

As discussed in **Chapter 15 - Noise and vibration,** a traffic noise assessment was undertaken for the proposed upgrade. Based on this assessment, locations requiring noise attenuation have been identified. These are:

> Ewingsdale.
> Clover Hill Estate, Bangalow.
> Newrybar Public School.

The specific method of noise attenuation would be identified during detailed design based on functional, urban design and cost factors. Options would include earth mounds, noise walls, individual architectural treatment of homes, and the use of low noise pavement surfaces.

5.12 Local transport network

A number of regional roads connect with the existing highway between Ross Lane and Ewingsdale, providing east-west access both locally and regionally. These are:

> Ross Lane (regional road 7735) east to Lennox Head and The Coast Road.
> Bangalow Road (main road 65) west to Lismore.
> Ewingsdale Road (main road 545) east to Byron Bay.

In addition to these routes, a number of local roads join the existing highway and provide access to the local communities. These roads carry significantly lower volumes of traffic.

Following the construction of the proposed upgrade, the existing Pacific Highway would fulfil a regional road function, providing a continuous alternative route for local and regional traffic accessing the surrounding local road network. The proposed upgrade would maintain the existing connectivity between houses, villages, towns and community facilities through the provision of local road underpasses or overpasses as well as service roads for properties affected by the proposed upgrade.

It is anticipated that ownership and maintenance of the existing highway would be transferred to the respective councils (Ballina and Byron). This would however be subject to negotiation and agreement. Ownership and maintenance of the proposed upgrade, including associated infrastructure and interchanges within the proposed road reserve, would be the responsibility of the RTA. The precise limits of responsibility between the RTA (for the proposed upgrade) and the councils (for the existing highway) would be defined after project approval and before handover. At this stage the detailed design would be sufficiently developed so that the interface between the new work and the existing road network could be accurately determined.

Further details on the local road network and future traffic conditions can be found in **Chapter 13 – Traffic,** while a strategic overview of access arrangements can be found in the *Strategic Access Report* (RTA 2008). This includes an evaluation of a possible future southern Bangalow bypass (which is outside the scope of this project).

5.13 Pedestrians and cyclists

No specific provision would be made for pedestrians and cyclists on the proposed upgrade. The Broken Head Road overpass would however include a pedestrian/cycle lane or path.

5.14 Services relocations

The following major services relocations would be required:

> Telstra fibre optic cables and coaxial cables, generally following the existing highway and also Tinderbox Creek valley.

> Visionstream fibre optic cables from Bangalow to Ewingsdale, following the Tinderbox Creek valley.

> Optus fibre optic cables from Bangalow to Ewingsdale, following Tinderbox Creek valley and also east along St Helena Road.

> Rous Water 600 mm diameter trunk water supply mains from Emigrant Creek dam to the treatment plant and reservoir at Knockrow, from Rocky Creek dam to the same reservoir at Knockrow, and also east from Bangalow along the Byron Creek valley

There are also smaller distribution water mains owned by Rous Water and the councils which may be affected as follows:

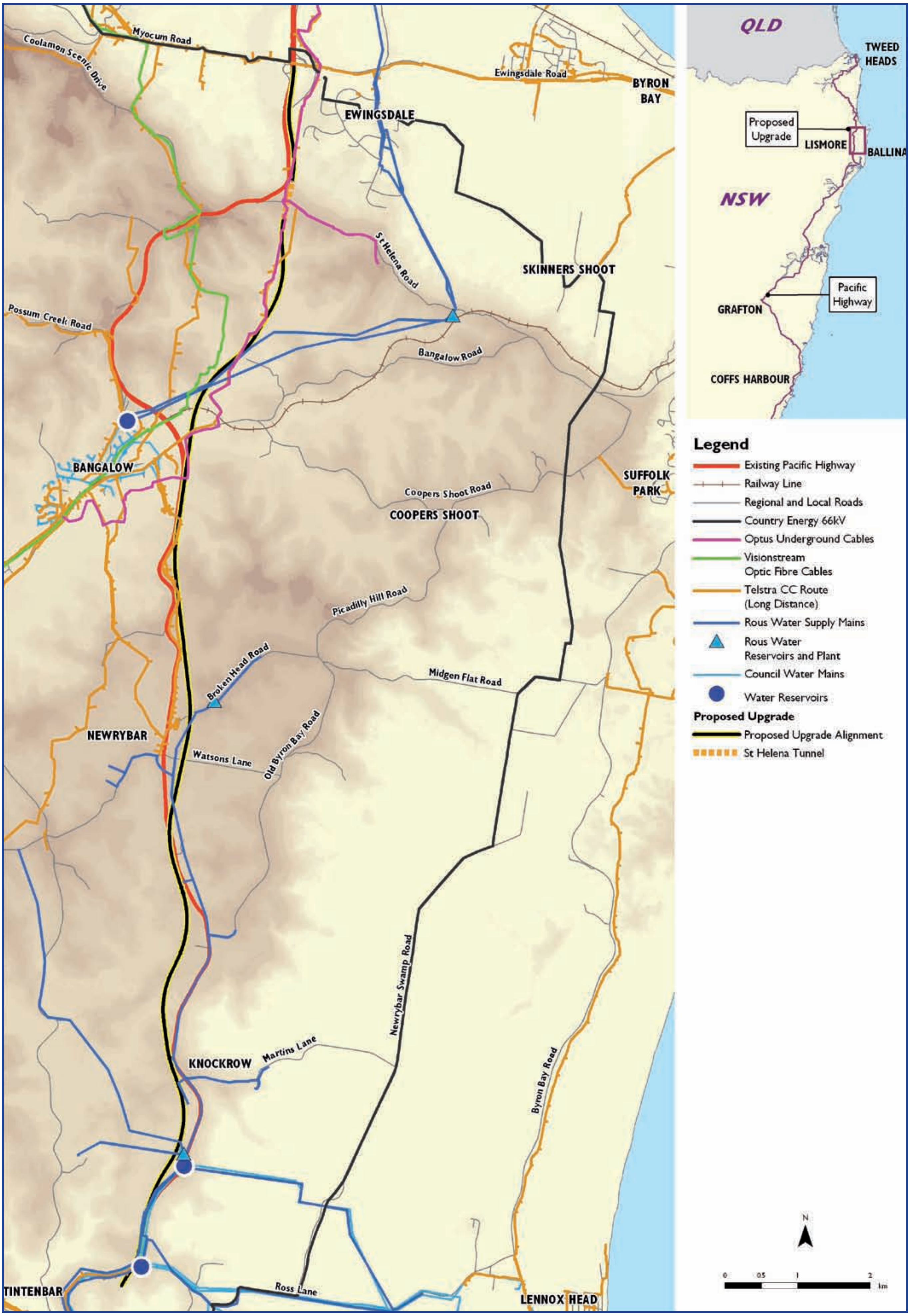
> A 375 mm diameter water main that follows the existing highway south of Knockrow. Ballina Shire Council also has an existing water supply main beside the existing highway south of Knockrow.

> An existing 100 mm diameter distribution main on the eastern side of the existing highway between Knockrow and Broken Head Road.

> An existing 100 mm diameter distribution main along Broken Head Road.

The location of major existing services is shown in **Figure 5.7**. Service would generally be relocated outside the road reserve. Location would be identified in the detailed design in association with the utility provider.

Figure 5.7 Major existing services



5.15 Urban and landscape design

Urban and landscape design have been fundamental to the route selection and engineering design of the proposed upgrade. An urban and landscape concept plan has been prepared for the proposed upgrade (described further in **Chapter 18 - Visual amenity and urban design** and fully detailed in *Working Paper 11 – Urban Design, Landscape and Visual Assessment*). Urban and landscape design principles and the overall response are shown in **Table 5.2** below with reference to the objectives of the Pacific Highway Urban Design Framework. Cross sections indicating typical landscape treatments are shown in **Figure 5.8, Figure 5.9** and **Figure 5.10.**

Table 5.2 - Urban and landscape design principles

Pacific Highway urban design framework objective	Discussion and project response	Key urban and landscape design principles
Objective 1: **Provide a flowing road alignment that is responsive and integrated with the landscape.** Applying to road alignment decisions as well as the road design, the alignment should flow and respond to the shape of the landform and patterns of natural and farmed vegetation cover.	Urban and landscape design objectives and principles to address issues of flowing alignment and responsiveness to the shape of the landform were developed during the route selection process for the proposed upgrade and have influenced the development of the concept design for the proposed upgrade. However, this remains an important issue to address during future detailed design stages.	Shape cuttings to correspond to natural landforms. Revegetate cuttings and embankments to maintain the character of undulating green hills against the horizon line.
	The natural and farmed vegetation cover along the proposed Tintenbar to Ewingsdale upgrade is one of the major features of the study area, as well as a key factor in the area's highly scenic character. Responding to the existing landscape character is an objective of particular importance for the proposed upgrade.	Protect significant stands of roadside vegetation. If retention is not possible reinstate plantings in nearby locations. Design roadside plantings to reflect adjoining landscape and vegetation patterns in order to integrate the road landscape, create a varied sequence of views and enclosure and reduce the linear effect of the upgraded highway. Design landscape plantings to correspond to existing species.

Table 5.2 (cont)

Pacific Highway urban design framework objective	Discussion and project response	Key urban and landscape design principles
Objective 2: **Provide a well vegetated, natural road reserve.** A road corridor in the lush forested landscape of the north east coast of NSW should be well-vegetated in the interest of road user enjoyment, landscape integration and biodiversity protection and recovery.	This objective is similar to Objective 1 with regard to the need to integrate the road corridor with the existing landscape character.	Reduce the visibility of the proposed upgrade from townships, farms and homesteads. Reduce the visibility of the proposed upgrade from the local road system. Ensure that key prominent cuttings are vegetated as much as feasible.
	The revegetation of the road corridor to enhance the natural environment and mitigate against the impacts on existing native stands of vegetation is an important ecological objective.	Undertake ecological restoration in areas of lowland rainforest and riparian areas where they remain within the road reserve. Select plant species to maximise wildlife habitat connectivity, particularly under creek crossings.
Objective 3: **Provide an enjoyable interesting highway with varied views and vistas of the landscape and pleasant restful places to stop.** The Pacific Highway is a long road, it takes a considerable time to drive and there is a tendency for drivers to make long duration journeys. Consequently the drive should be an enjoyable and memorable road user experience. This will help shorten the perception of the journey and keep drivers alert.	The provision of an enjoyable and interesting highway experience with varied views and vistas was considered during the route selection process and formed an integral component of route selection. It has further informed the development of the "Urban and Landscape Design Concept" outlined in ***Working Paper 11 - Urban design, landscape and visual assessment.*** The identified key design principles should guide further design development.	Maintain and protect key vistas and long-distance views and maximise the potential for views to existing landmarks and other prominent features. Vary the degree of enclosure and openness along the upgraded highway, to provide visual interest and enjoyment and reduce the potential for driver fatigue. Maintain a diverse and scenic driving experience along the existing highway alignment.
Objective 4: **Value the communities and towns along the road.** It is important to ensure the road upgrade is considerate of the towns and communities along the route. This can be achieved through sensitive planning of the road alignment to avoid visual and noise impacts. However this is not always possible and in some cases it is of value to have a close relationship between the road and community.	Issues of noise and visual impact on local towns and communities have been considered during the route selection process. The "Urban and Landscape Design Concept" contained in this working paper further addresses theses issues. Detailed design principles for the design of noise barriers are provided in the section called "Urban Design Elements" in ***Working Paper 11 - Urban design, landscape and visual assessment.***	Preserve the small scale character of the existing highway and other local roads. Reduce areas of wide uninterrupted areas of pavement.

Table 5.2 (cont)

Pacific Highway urban design framework objective	Discussion and project response	Key urban and landscape design principles
Objective 4 (cont): It should not be forgotten that the local vernacular of farms, field boundaries, local roads, established businesses and residences is an important cultural aspect of the landscape and the journey.	Reducing the visual impact of the proposed upgrade is an important aspect of valuing towns and communities along the proposed upgrade who value the high visual quality of the study area. As discussed earlier in this working paper, the area's high scenic and lifestyle values are some of the main reasons people chose to live in and visit the area.	Reduce the visual effect of the vertical dimension of infrastructure elements associated with the proposed upgrade including bridges, cuttings, embankments and noise barriers.
Objective 5: **Provide consistency-with-variety in road elements.** Where appropriate consistent road design and road furniture will help unify the highway and reduce the perception of clutter. This will allow the road user to better appreciate the passing landscape. It will also make the driving experience simpler and more comfortable. Conversely, a road, which is inspired by the character and distinctiveness of the local context, will add variety to the journey and help keep drivers interested and aware.	A discussion on appropriate road design and road furniture, including design principles, is provided in the section on "Urban Design Elements" in ***Working Paper 11 - Urban design, landscape and visual assessment.***	
Objective 6 **Provide a simplified and unobtrusive road design.** The road design should be as simple as possible, refined to the basic elements of road and bridge with all other details designed out, simplified or hidden.	Road design formed an integral component of the route selection process for the proposed upgrade. The design of the proposed upgrade represents the result of a collaborative effort of the project team, incorporating engineering and urban design constraints as well as the constraints identified by other specialist consultants on the project team. This objective is further addressed through the recommendations of the "urban and landscape design concept" in ***Working Paper 11 - Urban design, landscape and visual assessment*** which provides detailed design principles for the further development of the road urban design elements to guide the design development stages. Simplifying the road design will also make it easier for the motorist to enjoy the surrounding landscape, to appreciate local landmarks and thereby assist in orientation.	Develop a simple and robust design aesthetic appropriate to highway infrastructure.

Figure 5.8 Cross section of proposed upgrade showing landscape treatment (at Knockrow - chainage 135600)

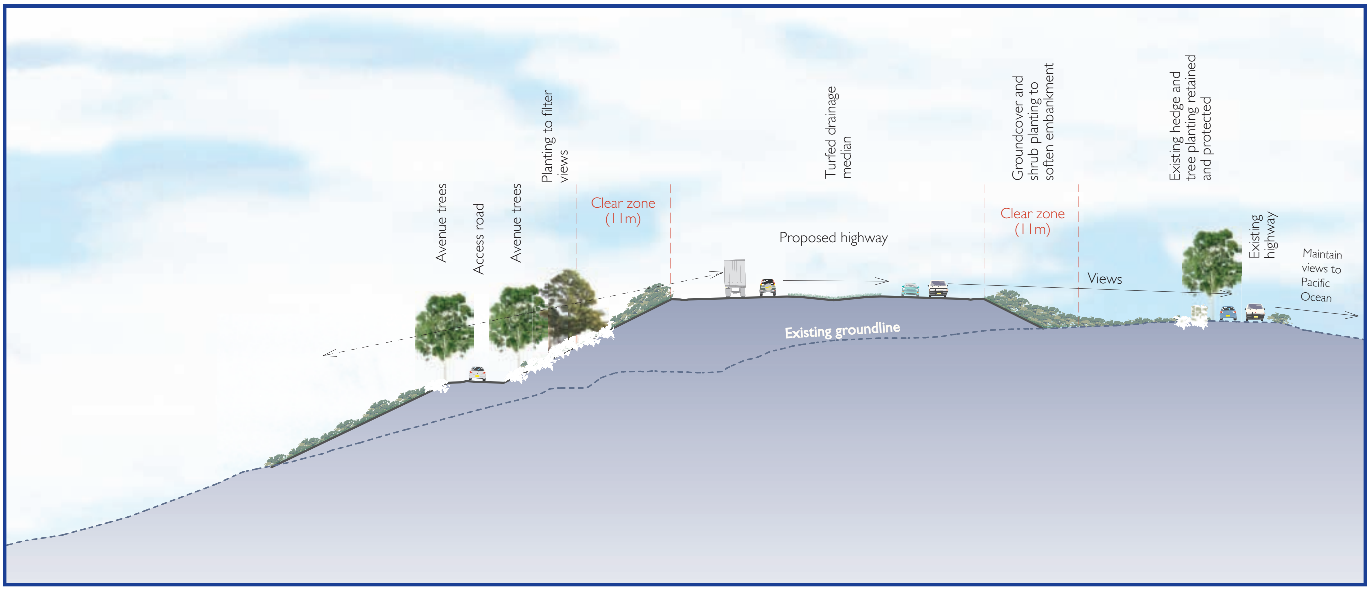


Figure 5.9 Cross section of proposed upgrade showing landscape treatment (at Knockrow – chainage 137100)

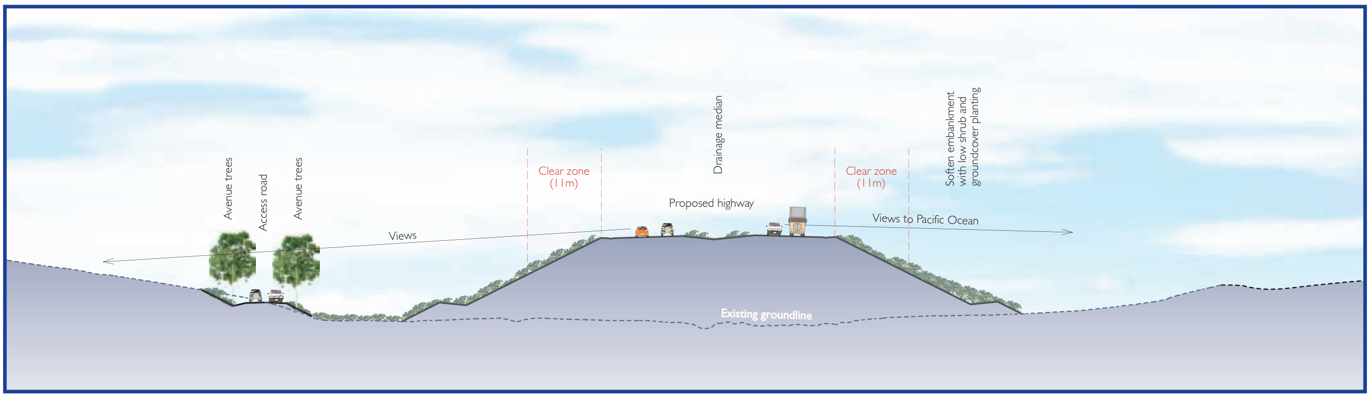
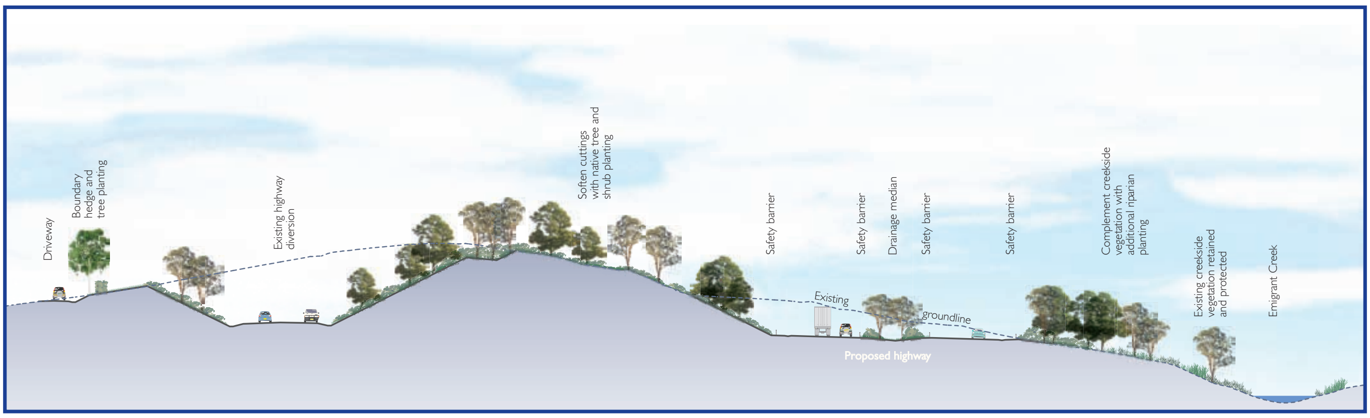


Figure 5.10 Cross section of proposed upgrade showing landscape treatment (south of Newrybar – chainage 141,300)



5.16 Land acquisition

The road corridor width for the proposed upgrade has been determined allowing a minimum of about 15 m between the edge of earthworks and the acquisition boundary. The width of the proposed road reserve is typically about 80 m where there are no cut or fill embankments required. The width increases (up to a maximum of about 250 m) with the scale of associated earthworks and where other elements such as interchanges are required.

The proposed upgrade's dual carriageways would be accommodated within this reserve, together with road embankments, landscaping, noise barriers, water quality control measures, fencing and other environmental mitigation measures.

The proposed road reserve boundary is shown in **Figure 5.2a-j.** Minor adjustments in the road reserve and associated fencing may be made to this boundary during detailed design.

Land within this corridor would be acquired in accordance with the *Land Acquisition* (*Just Terms Compensation*) Act 1991. Each acquisition would be considered on its individual merit. A copy of the RTA's Land Acquisition Policy is provided in **Appendix B**. A remnant land strategy has been developed for allotments incorporating part of the road reserve, but including land excess to the RTA's requirements (refer to *Working Paper 7 – Land use and property)*.

6 Detailed design and construction of the proposed upgrade

6.1 Preparation of detailed design

Detailed design would be undertaken only if the proposal is approved and the Chief Executive of the RTA determines that the project should proceed. In addition, post-approval modifications could occur. Any post-approval modifications that were not consistent with the approved project would require an application for modification in accordance with section 75W of the *Environmental Planning and Assessment Act*, 1979.

To ensure that the design development process adequately incorporates the key principles established during the study and inherent in the concept design, the development of the detailed design would be in accordance with any approval issued by the Minister for Planning. Provided it is consistent with the terms of any approval, detailed design would:

- Be consistent with the design criteria and design principles on which the concept design is based, as described in this environmental assessment and any subsequent submission report.
- Consider opportunities for refinement of the project footprint within the road corridor for safety, engineering and functional reasons, taking into account the presence of environmentally sensitive areas.
- Address any unresolved issues associated with the development of the concept design as described in this environmental assessment and any subsequent submissions report.
- Meet any conditions of approval arising from the environmental assessment approval process, unless changes to the conditions of approval are subsequently approved.
- Incorporate opportunities for innovation.
- Incorporate community and government agency requirements by the implementation of a consultation plan aimed at identifying and resolving issues of concern to agencies, the community and other groups.
- Wherever possible, avoid identified environmentally sensitive areas and significant species.
- Develop and refine impact management measures.
- Appropriately develop and incorporate the urban design strategy and landscape concept developed in the environmental assessment.
- Establish detailed proposals for the construction delivery method and construction staging addressing buildability, traffic capacity and safety during construction, geotechnical issues, all relevant RTA specifications and design requirements, current guidelines and policies and practicality / cost effectiveness.
- Incorporate the construction concepts and environmental management measures presented in this environmental assessment and any subsequent submissions report.
- Address risk management during construction and operation.
- Allow for safe and cost effective maintenance of the proposed upgrade during operation in accordance with occupational health and safety requirements and relevant RTA specifications.
- Be consistent with the principle of ecologically sustainable development.

6.2 Project delivery

6.2.1 Delivery method

If the proposed upgrade proceeds, the RTA would consider the options for project delivery. The preferred method would be selected and implemented in compliance with this environmental assessment, the conditions of approval and the statement of commitments.

6.2.2 Construction hours

Regardless of the delivery method chosen, construction hours would normally be limited to between 7am and 6pm Monday to Friday and between 8am and 1pm Saturday.

Some work may be scheduled outside normal working construction hours so as to reduce impact on residents and road users. These works may include:

> Delivery of materials as requested by police and other authorities for safety reasons.

> Emergency work.

> Work that would significantly delay traffic or cause traffic problems.

> Other works for which a need is demonstrated.

Any work planned outside normal hours or on public holidays would be undertaken only after prior consultation with and/or notification of local residents and the Department of Environment and Climate Change.

6.2.3 Construction duration

It is estimated that a period of about one to one and a half years would be required for land acquisition concurrent with adjustments being made to public utilities, completion of detail design and investigations, and tendering procedures prior to commencement of construction.

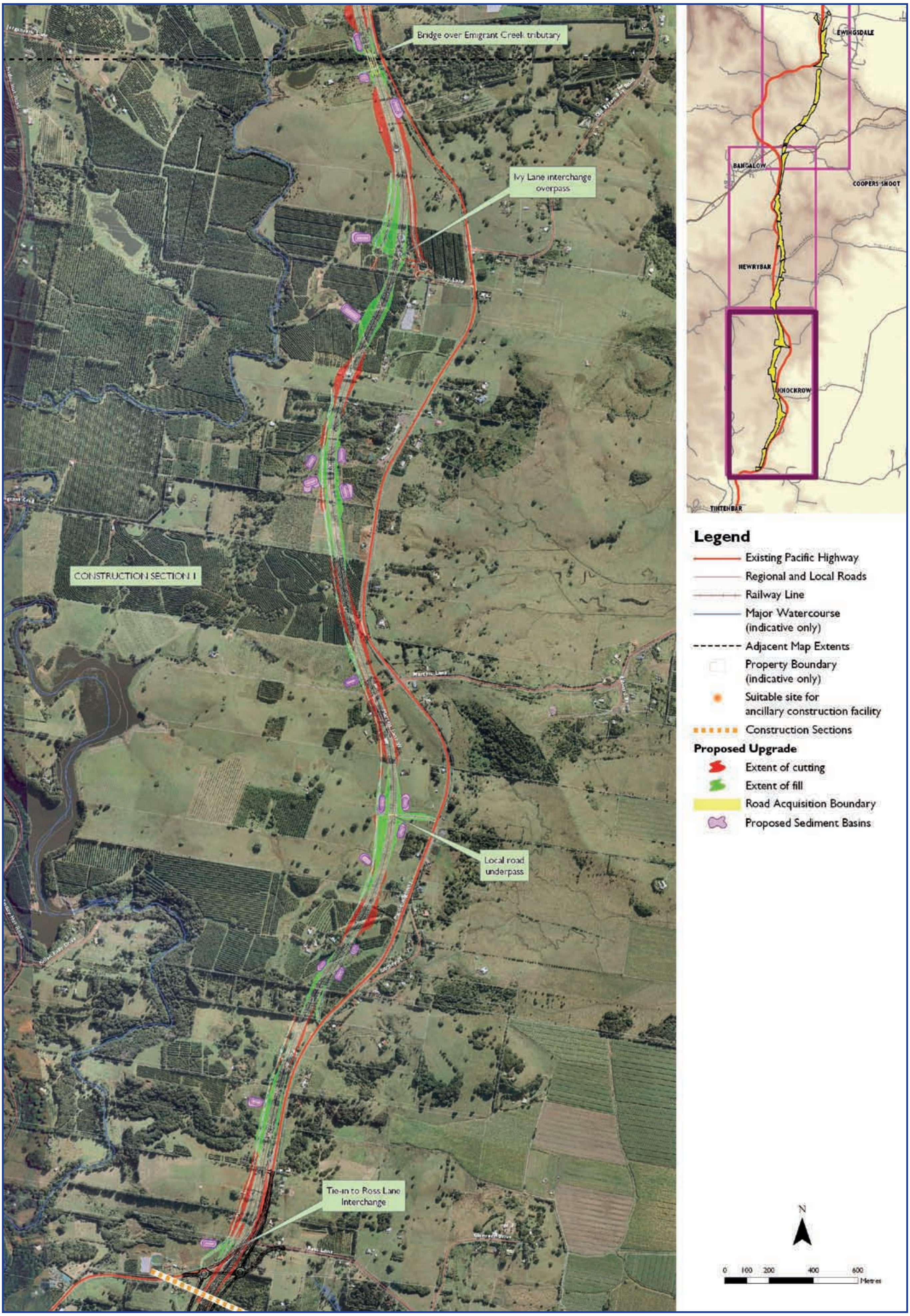
Depending on the chosen delivery method, the construction period would be in the range of 2 to 3 years following the award of contract.

6.3 Proposed construction sections

6.3.1 General

Six construction sections have been defined based on separating sections where significant construction issues or differences in construction methods are likely. This particular sectional approach has mainly been developed as a planning tool and may be altered during construction. The locations and significant features of the six proposed construction sections are given in **Figure 6.1, Figure 6.2** and **Figure 6.3.** Sections 1, 2 and 3 could be opened to traffic independently. Sections 4,5 and 6 could be constructed independently but only opened to traffic as a single section.

Figure 6.1 - Construction section 1



6.3.2 Section 1 - North of Ross Lane Interchange to south of Emigrant Creek bridge

This proposed section runs wholly to the west of the existing highway alignment. The majority of the Ross Lane interchange would be constructed as part of the Ballina bypass, including the overpass and the south-facing ramps providing access to and from the bypass. The Tintenbar to Ewingsdale upgrade would include the addition of north-facing ramps, converting the Ross Lane interchange into a full interchange and thus providing access to and from the upgraded highway in both directions.

Significant features of this construction section are discussed in **Table 6.1** and shown in **Figure 6.1**

Table 6.1 - Construction features – section 1

Significant features	Comments
Length of section	> 6.4 km
Earthworks balance	> Potential excess of material
Tie-in to the Ross Lane interchange	> Connects to north end of Ballina bypass and includes the addition of north facing ramps. > Includes converting the southbound off ramp, that would be constructed as part of the Ballina bypass, to a two-way local road – continuation of the existing highway north of the interchange.
Local road underpass (just south of Martins Lane)	> For provision of local access.
Ivy Lane interchange	> An interchange at Ivy Lane with associated on and off ramp infrastructure.
Bridge over Yarranbool Place	> Bridge over waterway also incorporating private access roads.

6.3.3 Section 2 - South of Emigrant Creek bridge to Bangalow bypass

This proposed section runs wholly to the east of the existing Pacific Highway (**Figure 6.2**). The section includes many separate cut and fill areas and has the largest excess of material of any of the proposed construction sections at 375,000 m³. Significant features of this construction section are discussed **Table 6.2** and shown in **Figure 6.2**.

Table 6.2 - Construction features – section 2

Significant features	Comments
Length of section	> 4.1 km.
Earthworks balance	> Potential excess of material.
Emigrant Creek bridge	> Construction works in the vicinity of the Emigrant Creek bridge would include a realignment of the existing Pacific Highway to the west of the proposed upgrade. The realignment would pass beneath the proposed Emigrant Creek Bridge. > Rehabilitation of the defunct section of the existing highway would be undertaken once the realignment is complete.
Watsons Lane underpass	> Full traffic underpass with 4.8 m clearance.
Proximity to Newrybar Public School	> The vertical alignment of the upgrade is below ground level adjacent to the Newrybar Public School with an earth mound to be introduced between the school and the upgrade
Broken Head road overpass	> Broken Head road intersects the proposed upgrade at the location of a major cut.
Skinners Creek bridge	> Twin bridges approximately 185-195 m long.
Property access bridge at chainage 144,600	
Large cutting at chainage 144,800	> This large cutting would generate a significant excess of material.

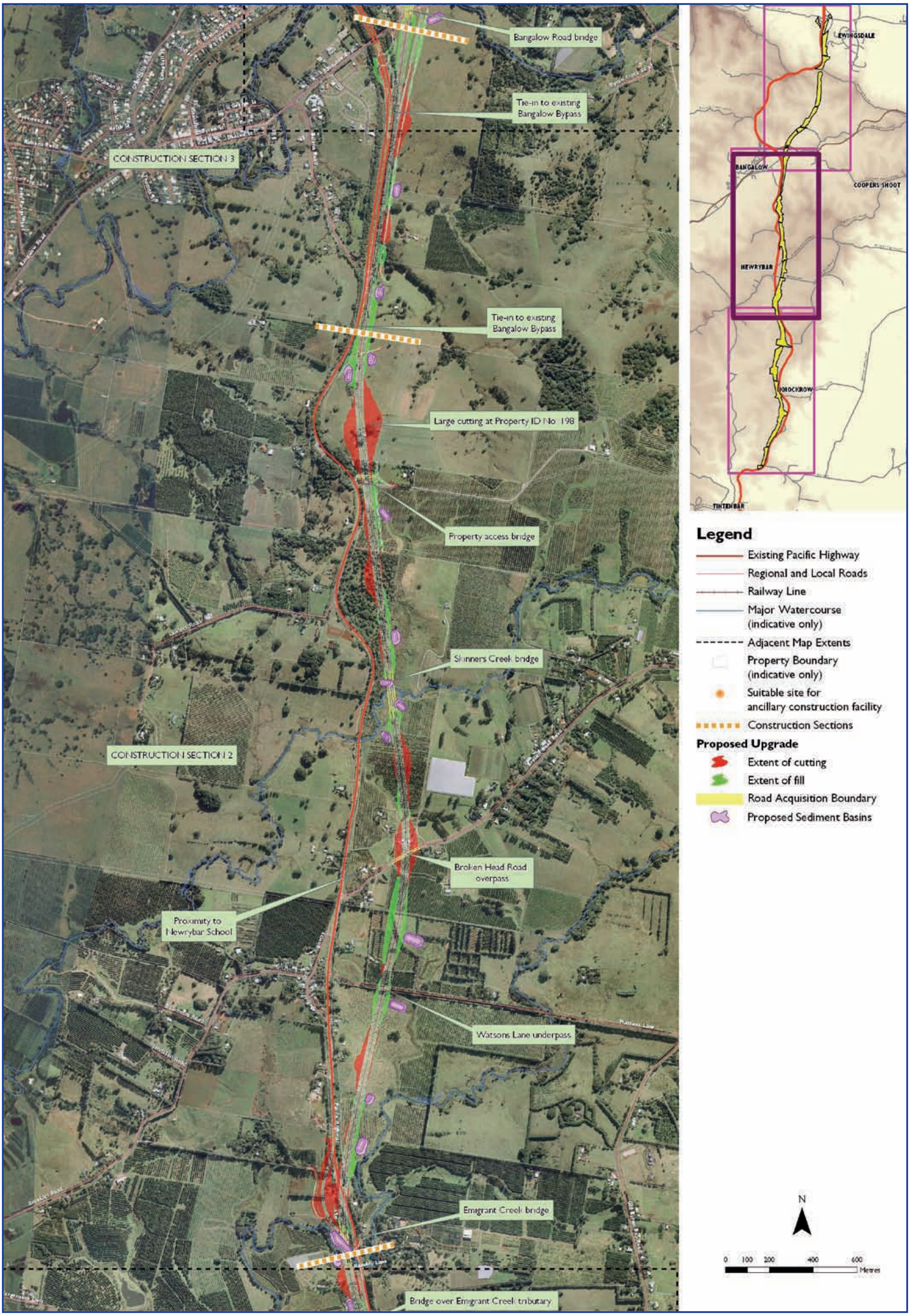
6.3.4 Section 3 - Integration with the existing Bangalow bypass

The proposed upgrade would utilise a section of the existing Bangalow bypass. This would require construction work to be done alongside the existing highway while through traffic is allowed to continue. Traffic delays and changes to traffic conditions would occur during construction works on this section. Significant features of this construction section are discussed in **Table 6.3** and shown in **Figure 6.2**.

Table 6.3 - Construction features – section 3

Significant features	Comments
Length of section	> 5.1 km
Earthworks balance	> Potential deficit of material
Possible mound at Clover Hill	> The strip of land adjoining the Clover Hill estate and the proposed upgrade has been identified as a possible site for the construction of a noise attenuation mound if a mound is determined as the most appropriate means of noise attenuation at this location.

Figure 6.2 - Construction sections 2 and 3



6.3.5 Section 4 - Bangalow bypass to south of tunnel

Access to the proposed upgrade from existing roads in this section is limited. It is expected that construction would proceed sequentially along the acquired land of the upgrade road reserve. Significant features of this construction section are discussed in the following **Table 6.4** and shown in **Figure 6.3**

Table 6.4 - Construction features – section 4

Significant features	Comments
Length of section	> 3 km
Earthworks balance	> Potential excess of material
Bangalow Road bridge	> The bridge would be constructed over the existing Bangalow Road.
Bridge over Byron Creek and rail line	> Significant bridge spanning both Byron Creek and the currently disused Casino-Murwillumbah railway line.
Bridge over tributary of Tinderbox Creek and realignment of Tinderbox Road	> Bridge over tributary of Tinderbox Creek and maintenance of continuity of Tinderbox Road. Tinderbox Road would require realignment.
Major cut in vicinity of Tinderbox Road	> A significant excess of excavated spoil would be generated from the numerous cuts which are required for this section. One cut in particular in the vicinity of Tinderbox Road is estimated to generate approximately 300,000 m^3 of excess material.

6.3.6 Section 5 - Tunnel and portals

Twin tunnels separated by a rock pillar are proposed. They would be approximately 340 m long and 45 m below the existing St Helena Road. Significant features of this construction section are discussed in the following **Table 6.5** and shown in **Figure 6.3.**

Table 6.5 - Construction features – section 5

Significant features	Comments
Length of section	> 0.4 km
Earthworks balance	> Potential deficit of material
Drill and blast construction method	> Conventional drill blast techniques.

6.3.7 Section 6 - North of tunnel to Ewingsdale interchange

This section of the proposed upgrade requires construction in close proximity to the existing Pacific Highway. Where the proposed upgrade passes the Ewingsdale residential area, it is lower and slightly closer to Ewingsdale than the existing highway.

This section is expected to have an approximate cut and fill balance and may have some local geotechnical issues associated with landslips in the vicinity of the northern tunnel portal.

Significant features of this construction section are discussed in the following **Table 6.6** and shown in **Figure 6.3.**

Figure 6.3 - Construction sections 4, 5 and 6

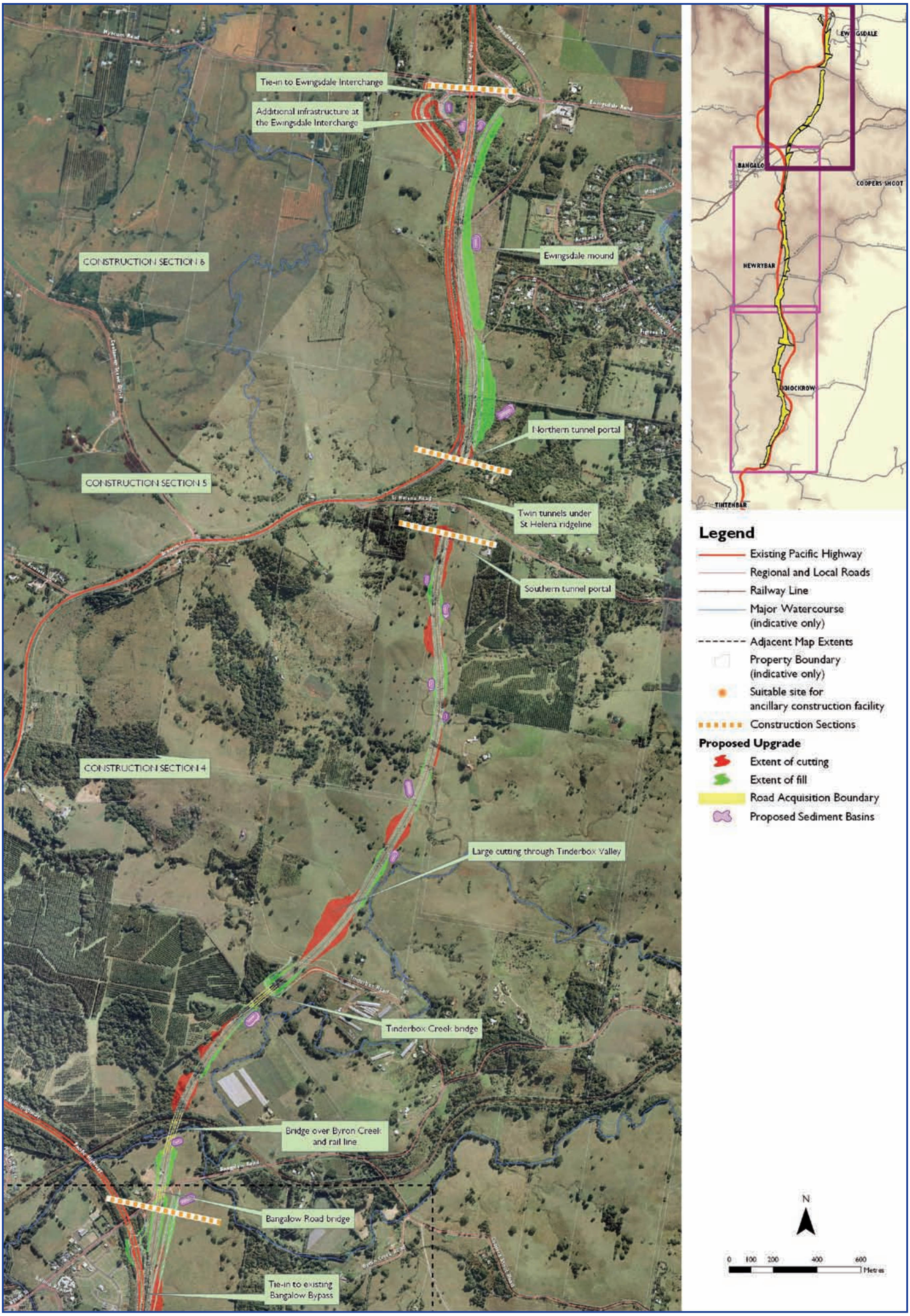


Table 6.6 - Construction features – section 6

Significant features	Comments
Length of section	> 1.6 km.
Earthworks balance	> Potential deficit of material.
Ewingsdale mound	> An earthworks mound to the east of the proposed upgrade in the vicinity of the Ewingsdale interchange.
Additional works and infrastructure at the Ewingsdale interchange	> The new works at the Ewingsdale interchange would include a new roundabout and a new southbound on-ramp. Demolition of part of the existing noise wall would also be undertaken (in partnership with construction of the new mound).
Tie-in to the existing dual carriageway at the Ewingsdale interchange	> Works to proceed in close proximity to operating roadway.

6.3.8 Staging

Construction staging refers to the order in which one or more of the construction sections defined above are constructed, regardless of the delivery method proposed.

Construction staging may alter the number and distribution of ancillary construction facilities and affect the timeframe for completion of the project. Any construction staging arrangements would be made in consideration of the issues associated with each of the construction sections as detailed in Section 6.3.

Appropriate staging of construction would be required to ensure continuity of access along the highway and to and from adjacent properties and intersecting roadways. Staging of construction would consider:

> Continuity of highway, local road and property access.
> The land acquisition process.
> Availability of fill material (earthworks balance of each section).
> Areas where pre-consolidation of embankments would be required.
> The sequence in which completed sections could be opened to traffic.

The final construction staging would be dependant on the availability of construction funding, the concurrent workload in the construction industry and government policy. Staging may not occur and the proposed upgrade may be constructed as a single project.

6.4 Construction activities sequence

A typical sequence of construction activities is show in **Table 6.7**. This is intended to present sufficient detail to allow an assessment of the likely nature and extent of environmental impacts during construction. It is not a full list of all tasks and obligations, and may not occur in the precise order listed.

Table 6.7 - Summary of construction component activities

Component	Activities
Pre construction	> Tendering > Award of contract > Environmental management plans, licences and approvals > Adjustment of existing public utilities > Acquisition of land. > Pre clearing investigations to confirm locations of flora and fauna of conservation significance
Site establishment	> Site set out including survey set-out and establishment of site compounds, access points and access routes > Safety fencing of site > Installation of traffic management measures to control highway and construction traffic during construction > Installation of temporary erosion, sediment and water quality controls including diversion drainage, sedimentation basins and cross-flow culverts > Site compounds, stockpiles and necessary ancillary sites > GPS towers for surveying > Initial environmental safeguards.
Site preparation	> Clearing and grubbing > Mulching > Stripping and stockpiling of topsoil, spoil and unsuitable material > Installation of physical noise mitigation measures (where possible, noise mitigation measures should be installed before any earthworks or major works commence, e.g. in vicinity of Newrybar Public School where timing in regard to school terms is important). > Construction access

Table 6.7 (cont)

Component	Activities
Construction works	> Establishment of batching plants. > Bridges and underpasses, culverts and drains > Bridge construction > Landscaping; progressive as earthworks are finished > Pavement construction > Safety barriers > Lighting, line-marking and signposting
	> Drainage works including: - Cross culverts - Highway drainage - Water quality basins > Earthworks including: - Cuttings - Fill embankments > Tunnel works including drill and blast > Select zones > Batter treatments
	> Batching plants, crushing plants, pug mills, stockpile and storage sites > Upgrade of local roads > Utility adjustments > Property access > Existing highway works
Finishing works	> Remove temporary works > Restore and landscape temporary sites > General site clean up > Topsoil rehabilitation and revegetation of batters and berms

6.5 Resourcing

6.5.1 Equipment

Table 6.8 lists the likely construction plant and equipment that would be used on the proposed upgrade.

Table 6.8 - Predicted plant and equipment requirements for construction

Activities and locations	Plant and equipment
Construction work sites (locations to be determined)	> Fences > Sheds > Fuel storage tanks > Concrete and asphaltic concrete batch plants > Crushing plants
Services relocation at various locations	> Trucks, cranes and excavators > Elevated platform vehicle > Backhoes > Trenchers > Small equipment
Structures	> Piling rigs > Concrete pumps > Cranes > Excavators > Trucks > Barges > Small equipment
Earthworks	> Bulldozers > Trucks > Scrapers > Graders > Watercarts > Compactors > Vibratory rollers > Drilling and blasting equipment for hard rock cuttings
Structural pavement	> Trucks > Concrete paver > Concrete curing equipment > Concrete saws > Asphalt paver > Vibratory rollers > Rubber-tyred rollers

Table 6.8 (cont)

Activities and locations	Plant and equipment
Tunnelling	> Drilling and blasting equipment for hard rock > Trucks > Excavators > Bulldozers > Graders > Small equipment
Other roadworks (including local road improvements)	> Graders > Backhoes > Trucks > Watercarts > Vibratory compactors > Bitumen sprayers. > Vibratory rollers > Rubber-tyred rollers

Note: Plant and equipment requirements are subject to refinement during detailed design

6.5.2 Materials

Construction of the proposed upgrade would require large quantities of various materials such as concrete, fill, asphalt and topsoil. Where possible the materials to be used on the upgrade would be sourced from the local area and from the construction site itself (for example, spoil from cuttings and the tunnel would be used for fill and landscaping purposes).

The total volume of fill required for the proposed upgrade would be sourced from the cuttings along the alignment. Material from the excavations would be varied in quality but it is anticipated that sufficient quantities of the material won from excavations would be available and suitable for use in embankments as general fill and as select fill for the top 0.3 m. Lower quality material could be used for landscape fill and noise mounds and in the lower layers of embankments.

Cement quantities are substantial but would be readily available from industry sources.

The pavement of the proposed upgrade and ramps would require a low noise overlay in some sections to reduce road noise levels where necessary while other associated works such as new local access roads would generally be bitumen sealed. Bitumen sealed roads can have a granular base which would consist of a mixture of recycled and imported gravel road base.

The rigid concrete highway pavement requires a higher quality road base likely to consist of course and fine aggregates of rock, sand, cement and other fine material such as fly ash.

Sand and aggregates would be required for the highway pavement sub-base course and, depending on the choice between rigid or flexible pavement in the detailed design stage, for the overlying pavement asphalt layers or concrete base. Sand, aggregates, and gravel would also be required for other pavements including local roads and ramps, as well as for drainage layers, bedding sand, erosion protection, gabions, and select fill if sufficient material is not available from excavations.

Requirements for materials would also depend on the final design and the extent of the use of pre-cast components for bridges and structures but indicative quantities for major items (excluding pre-cast concrete components) are given in **Table 6.9.**

There are some industrial mineral borrow areas or quarries in the vicinity of the proposed upgrade. These possible local sources for construction materials are heavily favoured due to the reduction in transport, haulage and logistical costs of their use. A list of potential material sources from the local area of the proposed upgrade is given in **Table 6.9.** The possible sites have not been directly approached regarding availability and they should not be assumed to be available at the time of construction.

Table 6.9 - Borrow pits and quarries of the local area

Borrow pits and quarries (sorted by proximity)	
Sandy Quarry x 2	
Location	Newrybar Swamp Road, Knockrow
Operator and status	McGeary Bros
Product/material	Sand
Local Government area	Ballina
Size of pit	-
Proximity to project	3 km E of Knockrow
Boral Teven Quarry	
Location	North Teven and Beacon Roads, Teven
Operator and status	Boral Resources Pty Ltd – in operation.
Product/material	Aggregate road base
Local Government area	Ballina
Size of pit	-
Proximity to project	5 km E of Tintenbar
Airport Pit	
Location	Next to Ballina Airport
Operator and status	Ballina Shire Council (currently inactive)
Product/material	-
Local Government area	Ballina
Size of pit	-
Proximity to project	10 km SE of Tintenbar
Leela Quarry – Lot 1 DP591441	
Location	Dingo Lane off Myocum Road, Tyagarah (adjacent to Myocum landfill)
Operator and status	Byron Shire Council
Product/material	Road base material
Local Government area	Byron
Size of pit	250,000 m^3 or 4.046 ha
Proximity to project	10 km N of Ewingsdale
Batson's Quarry	
Location	West of Broken Head Road, Suffolk Park
Operator and status	Batson's Sand and Gravel Pty Ltd
Product/material	Asphalt sand, concrete and general filling
Local Government area	Byron
Size of pit	-
Proximity to project	10 km E of Bangalow
Mullumbimby Road Quarry	
Location	Located on corner of Pacific Highway and Mullumbimby Road
Operator and status	Batson Sand and Gravel Pty Ltd.
Product/material	Uncrushed gravel and general filling
Local Government area	Byron
Size of pit	-
Proximity to project	15 km N of Ewingsdale

Table 6.9 (cont)

Borrow pits and quarries (sorted by proximity)	
Ocean Shores Quarry	
Location	Off Coolamon Scenic Drive, Ocean Shores
Operator and status	Batson Sand and Gravel Pty Ltd.
Product/material	Road base and general filling
Local Government area	Byron
Size of pit	-
Proximity to project	15 km N of Ewingsdale
Mudges Quarry	
Location	Off Coolamon Scenic Drive, Ocean Shores
Operator and status	Not established
Product/material	-
Local Government area	Byron
Size of pit	-
Proximity to project	15 km N of Ewingsdale
Northern Rivers Quarry	
Location	Off Nimbin Road, West of Lismore
Operator and status	Northern Rivers Asphalt
Product/material	-
Local Government area	Lismore City Council
Size of pit	-
Proximity to project	25 km W of Knockrow
Blakebrook Quarry	
Location	Blakebrook
Operator and status	Lismore City Council
Product/material	Basalt
Local Government area	Lismore City Council
Size of pit	80.9 ha and can extract 200,000 m^3 pa.
Proximity to project	35 km W of Knockrow

The total tonnage of coarse aggregates for on-site batched concrete, asphaltic concrete and pavements required for the full length of the highway upgrade could be up to 350,000 tonnes depending on the type of pavement adopted. It is anticipated that pavement and bridge construction would be spread over approximately two to three years, as such requirements could be up to 150,000 tonnes per year.

Depending again on the pavement type and extent of usage of pre-cast concrete, sand (fine aggregates) would be required for on-site batched concrete, lean mix and asphaltic concrete. Requirements could total up to 180,000 tonnes of clean, durable sand with a low alkali/silica reaction.

6.5.3 Workforce

A peak construction workforce of about 250 to 300 people is anticipated. The average size of the construction workforce on site would be approximately 150 people including management staff and subcontractors. It is expected that employment opportunities would be available for workers in the Ballina Shire and Byron Shire local government areas.

6.5.4 Spoil disposal

The proposed upgrade would result in a surplus of material of approximately 790,000 m^3, consisting predominantly of soil. This figure is based on the concept design. Refinements during detailed design may allow this to be reduced.

Due to this large volume, some impacts may be created from spoil disposal. The following spoil disposal strategy has been developed. Items are listed in priority order to reduce impacts. It is intended that all spoil would be disposed of using one or more of the following methods.

1. **Spoil volume reduction**

   Detailed geotechnical investigations would be carried out as part of the detailed design with possible alignment and profile refinements resulting in a reduced volume of spoil requiring disposal subject to achieving urban design objectives. Refinements might include engineering measures such as stabilisation of cut slopes to reduce the volume of cut material to be removed.

2. **Opportunities for disposal/blending of excess fill within the road reserve**

   Flattening of fill batters and placement of fill would be investigated subject to identified constraints and opportunities (such as landowner consultation, landscape and visual amenity, terrestrial ecology, hydrology and flora and fauna).

3. **Negotiation with adjacent landowners to spoil excess material or identification of other uses outside of the study area**

   Any significant provision of spoil to landowners or other users would be conditional on the recipient providing evidence of having any necessary approvals for receipt of such material (eg council development approval, or section 43 licence under the Protection of the Environment Operations Act) and would also be subject to meeting the requirements of spoil storage and management from the construction environmental management plan (CEMP), including mitigation against environmental impacts of spoil disposal. Key mitigation in the CEMP would include:

- Spoil is not to be deposited in areas where sedimentation of waterways could result.
- Deposition of within drainage lines is to be avoided.
- Spoil is to be kept covered during transportation, and for any extended storage.
- Early development of vegetation/landscaping is required.

4. Use of spoil disposal sites

Any remaining excess material following steps 1, 2 and 3 would be transported to suitable spoil disposal sites, chosen from the potential sites identified both within and external to the proposed upgrade road reserve. Potential sites are discussed below and identified in **Table 6.10.** Nearby sites would be preferred to reduce haulage.

The contractor's CEMP would be required to incorporate the following measures in relation to spoil disposal:

- Air quality and dust suppression.
- Noise requirements of the NSW Environment Protection Authority's "Environmental Criteria for Road Traffic Noise (EPA 1999) and the Road Traffic Authority's "Environmental Noise Management Manual" (RTA 2001).
- Terrestrial ecology. Spoil would not be deposited in areas that could affect ecological values. Sites would be favoured that have potential for revegetation and landscaping following disposal.
- Hydrology and water quality. Spoil would not be deposited in areas where sedimentation of waterways could result.
- Haulage. A traffic management plan would be prepared for haulage of spoil to disposal sites, to address vehicle numbers, preferred haulage routes (in consultation with relevant authorities), hours of operation, and noise, dust and air quality impacts from transportation.

A disused Ballina Shire Council owned quarry at Tintenbar may be useful as a disposal site for spoil. The site has been used as a hard rock quarry and consists of a large open cut pit with vertical basaltic walls which is currently overgrown with weeds (such as camphor laurel). Deposition of excess fill in the pit with appropriate subsequent revegetation with local species may be a good remediation option for the site. The site is estimated at 800 m^2 in area with a possible fill volume of 40,000 m^3.

A preliminary search for possible disposal sites has also been undertaken in the wider local area, and throughout the Northern Rivers region. The most probable locations for suitability such as disused mine sites, landfills and quarries have been investigated with input from the Department of Primary Industries and the Department of Lands.

Table 6.10 - Possible spoil disposal areas

Borrow pits, quarries and mines for possible spoil disposal (sorted by proximity)	
Old Rock Quarry Prop ID No 4	
Location	Crown Public Road off Pacific Highway and Opposite Ross Lane, Tintenbar
Operator and status	Ballina Shire Council, not operated
Product/material	-
Local Government area	Ballina
Size of pit	800 m^2 and approx 40,000 m^3
Proximity to project	Adjacent to T2E
Sand Quarry x 2	
Location	Newrybar Swamp Road, Knockrow
Operator and status	McGeary Bros
Product/material	Sand
Local Government area	Ballina
Size of pit	-
Proximity to project	3 km E of Knockrow
Tyagarah Sand Pit	
Location	Gray's Lane, Tyagarah
Operator and status	Batson Sand and Gravel Pty Ltd.
Product/material	Filling sand
Local Government area	Byron
Size of pit	-
Proximity to project	5 km N of Ewingsdale
Boral Teven Quarry	
Location	North Teven and Beacon Roads, Teven
Operator and status	Boral Resources Pty Ltd – in operation.
Product/material	Aggregate road base
Local Government area	Ballina
Size of pit	-
Proximity to project	5 km E of Tintenbar
Airport Pit	
Location	Next to Ballina Airport
Operator and status	Ballina Shire Council (currently inactive)
Product/material	-
Local Government area	Ballina
Size of pit	-
Proximity to project	10 km SE of Tintenbar
Leela Quarry – Lot 1 DP591441	
Location	Dingo Lane off Myocum Road, Tyagarah (adjacent to Myocum landfill)
Operator and status	Byron Shire Council
Product/material	Road base material
Local Government area	Byron
Size of pit	250,000 m^3 or 4.046 ha
Proximity to project	10 km N of Ewingsdale

Table 6.10 (cont)

Location	The Manse Road, 1 km East of its intersection with Myocum Road, Tyagarah
Operator and status	Byron Shire Council
Product/material	-
Local Government area	Byron
Size of pit	400,000 m³ - with Southern expansion expect another 100,000 m³
Proximity to project	10 km N of Ewingsdale
Broken Head Quarry	
Location	Lot 1 Broken head Road, South of Suffolk Park, Byron Bay
Operator and status	Not operated
Product/material	-
Local Government area	Byron
Size of pit	-
Proximity to project	10 km E of Bangalow
Batson's Quarry	
Location	West of Broken Head Road, Suffolk Park
Operator and status	Batson's Sand and Gravel Pty Ltd
Product/material	Asphalt sand, concrete and general filling
Local Government area	Byron
Size of pit	-
Proximity to project	10 km E of Bangalow
Mullumbimby Road Quarry	
Location	Located on corner of Pacific Highway and Mullumbimby Road
Operator and status	Batson Sand and Gravel Pty Ltd.
Product/material	Uncrushed gravel and general filling
Local Government area	Byron
Size of pit	-
Proximity to project	15 km N of Ewingsdale
Ocean Shores Quarry	
Location	Off Coolamon Scenic Drive, Ocean Shores
Operator and status	Batson Sand and Gravel Pty Ltd.
Product/material	Road base and general filling
Local Government area	Byron
Size of pit	-
Proximity to project	15 km N of Ewingsdale
Mudges Quarry	
Location	Off Coolamon Scenic Drive, Ocean Shores
Operator and status	Not established
Product/material	-
Local Government area	Byron
Size of pit	-
Proximity to project	15 km N of Ewingsdale

Table 6.10 (cont)

Tuckombil Quarry	
Location	Gap Road, Alstonville
Operator and status	Ballina Shire Council - Not operated
Product/material	Basalt, arglite aggregate
Local Government area	Ballina
Size of pit	-
Proximity to project	15 km SW of Tintenbar
Stokers Quarry	
Location	Gap Road, Alstonville
Operator and status	Ballina Shire Council - Not operated
Product/material	Shale
Local Government area	Ballina
Size of pit	-
Proximity to project	15 km SW of Tintenbar
Bora Ridge Landfill	
Location	Myall Creek Road
Operator and status	
Product/material	-
Local Government area	Lismore City Council
Size of pit	-
Proximity to project	30 km
Evans Head Landfill	
Location	Broadwater Road
Operator and status	
Product/material	
Local Government area	Lismore City Council
Size of pit	
Proximity to project	30 km S of Tintenbar
Blakebrook Quarry	
Location	Blakebrook
Operator and status	Lismore City Council
Product/material	Basalt
Local Government area	Lismore City Council
Size of pit	80.9 ha and can extract 200,000 m3 pa.
Proximity to project	35 km W of Knockrow

6.5.5 Energy consumption

Energy required for road construction

Most of the construction work for the proposed upgrade would be undertaken by diesel-powered machinery. However, the range of construction equipment used would be dependent on the contractor selected and the actual conditions encountered during construction. The range of construction equipment is likely to include, but would not be limited to:

- Light transport vehicles.
- Graders and scrapers.
- Bulldozers.
- Front-end loaders and backhoes.
- Excavators.
- Drilling rigs.
- Compactors and compressors.
- Water trucks.
- Materials trucks (road and off-road).
- Backhoes, paving machines and other heavy weight vehicles.
- Pile driving rigs - land-based.
- Cranes - barge-mounted and land-based.
- Concrete pumps and air compressors.
- Concrete and/or asphalt batching plants.
- Crushing plants.

Given the extent and nature of the proposed upgrade, a large quantity of fuel is likely to be used. Fuel consumption would depend on factors including the age and condition of equipment, the speed of operation, haul lengths, and the site conditions encountered. The volume of fuel used would be generally proportional to the earthworks involved. Fuel would also be consumed in other construction activities such as bridge construction, batching plant operation, pavement laying and landscaping. Fuel usage is estimated at approximately 8 million litres of diesel. An estimate of the greenhouse gas implications of the construction and operation of the proposed upgrade is provided in **Section 20.2**

6.5.6 Water consumption

Indicative quantities of water use during construction and potential sources are outlined in **Table 6.11.**

Table 6.11 - Estimated sources and volume of water for construction

Water type	Activities	Source	Quantities
Potable or reclaimed water	Earthworks construction (compaction and pavement stabilisation)	Town water or alternative reclaimed source	18 L/m^3 for compaction 70 L/m^3 for stabilisation
Potable or reclaimed water	Dust suppression	Town water or alternative reclaimed source	As required but average 70,000 L per day
Potable or reclaimed water	Vegetation watering (from vehicle only)	Town water or alternative reclaimed source	120,000 L per day in extreme weather
Potable water only	Concrete and asphalt batching	Town water	200,000 L per day per batching plant

6.6 Ancillary construction facilities

6.6.1 Range of facilities

In addition to the physical footprint of the permanent works for the proposed upgrade, the construction contractor would require temporary access to land to accommodate a range of construction-related facilities and activities. These facilities would include some or all of the following:

> Site compounds for offices and storage of plant and equipment.

> Batching plants - potentially both concrete and asphalt, depending on the type of pavement adopted.

> Crushing plants.

> Stockpile areas.

> Haul roads.

> GPS locational towers.

These facilities are described below in **Sections 6.6.2** to **6.6.8**. The locational criteria that would be followed to identify sites during detailed design are discussed in **Section 6.6.9.** Environmental management of ancillary facilities would be in accordance with the Construction Environmental Management Plan for the proposed upgrade.

6.6.2 Site compounds

The construction contractor would require site compounds for offices, workforce facilities, and storage areas for plant and construction materials. A major construction compound is likely to require an area of at least 100 m by 100 m.

Given that the proposed upgrade may be constructed in several sections or stages (see **Section 6.3**), the construction contractor may require one or more site compounds for each construction stage/package. One potential construction compound site has been identified at this stage, adjacent to the preliminary batching plant location (see **Section 6.6.3**) on the eastern side of the proposed upgrade at Bangalow Road.

The construction compounds would be fenced for security and safety purposes. Initial site works for the compounds would involve site clearing and installation of appropriate environmental controls. Hard-standing areas would be provided for parking, storage, access roads, and site sheds.

6.6.3 Concrete batching plants

Construction of bridge structures (depending on design) may require concrete to be placed in-situ over a period of up to one and a half years. Concrete for road pavements would be required over a period of around two years. This is likely to require one or more concrete batching plants to be constructed on or near the proposed upgrade. Locational criteria that would be used to identify sites suitable for concrete batching plants have been identified in **Table 6.12.** Preliminary general locations for the location of batching plants (either asphalt or concrete) have been identified, including:.

> On the eastern side of the Ewingsdale interchange.
> On Bangalow Road on the eastern side of the proposed upgrade.
> On the north-western side of the proposed Ross Lane interchange.

The final location for batching plants would be determined during detailed design and would be influenced by the specific approach of the construction contractor(s).

It is highly desirable that crushing plants (see **Section 6.6.5**) be located in the vicinity of concrete batching plants, and this would be taken into consideration when choosing the relevant locations for the facilities.

Temporary buildings for staff amenities, offices and quality assurance control would also be required.

6.6.4 Asphalt batching plants

Adoption of a flexible pavement with deep asphalt, or low noise asphalt surfacing for the proposed upgrade would require asphaltic concrete to be placed over a period of about two years. This is likely to require one or more asphalt batching plants to be constructed on or near the proposed upgrade. Locational criteria that would be used to identify sites suitable for asphalt batching plants have been identified below.

The potential concrete batching plant sites listed in **Section 6.6.5** may be equally suitable for asphalt batching plants.

It is highly desirable that crushing plants (see **Section 6.6.5**) be located in the vicinity of asphalt batching plants (particularly if flexible pavement is adopted), and this would be taken into consideration when choosing the relevant locations for the facilities.

Temporary buildings for staff amenities, offices and quality assurance control would also be required.

6.6.5 Crushing plants

Locations which are suited for construction of a crushing plant include the vicinity of the Emigrant Creek bridge site and in the vicinity of the tunnel under the St Helena ridgeline. A crushing plant near the tunnel may be required due to the significant volumes of rock spoil that would be generated at this site.

The crushing plant area would also be expected to include areas for the stockpiling of material. The stockpiling requirements would again depend on the construction staging and contractor's work methods but assuming conservatively that all rock would be crushed, storage would be required for 30 percent of the rock cut volume.

The crushing plant could also potentially produce aggregates for concrete and/or asphalt. Should the construction contractor adopt this option, the crushing plants would be located adjacent or as near as possible to concrete or asphalt batch plants to reduce truck traffic on public roads.

The location of the crushing plant would be determined by the construction staging (if any) and the associated mass haul balance, access, environmental and amenity issues.

6.6.6 Stockpile sites

It is likely that there would be a requirement for stockpiling of general fill material at various locations along the proposed upgrade, and for temporary storage of select material, rock or other imported materials.

Certain cuts and sections of the proposed upgrade would create excess spoil which may require some stockpiling arrangements prior to final disposal. For these areas it is estimated that there could be a requirement for stockpiles of up to 500,000 m^3 of excavated material during the project. In the event of a stockpile of this size being required and assuming a typical maximum height of 3 m, stockpile areas of up to 14 ha would be required.

In addition, areas would be required for the stockpiling of topsoil materials from cut and fill areas prior to placement on medians, embankment slopes, and flatter cut and fill batters.

The potential stockpile areas would also be suitable for the temporary storage of other materials such as unsuitable material, cleared vegetation mulch, rock and excess concrete.

The construction contractor would be required to protect stockpiles of erodible material such as topsoil against erosion by mulching or other means.

6.6.7 Haul roads

Haul roads would be installed inside the road reserve to enable the efficient movement of construction vehicles, plant and equipment. In occasional cases it may be necessary to locate haul roads outside the road reserve for a short distance. This would be carried out in a way that minimises impacts on the surrounding environment. It may be carried out to avoid construction traffic needing to use the public road network.

6.6.8 GPS locational towers

Depending on surveying requirements, a small number of GPS locational towers may be constructed either inside or outside the road reserve. These would typically be small areas (approximately 20 m x 20 m) and be located to avoid impacts on the surrounding environment.

6.6.9 Site identification for ancillary facilities

Identification of suitable areas for ancillary facilities has been based on typical area requirements for projects on a similar scale. Combined with this has been an appreciation of the study area and the environmental issues identified during project development and the preparation of this environmental assessment. Environmental and construction related criteria for each type of construction related facility have been developed and are identified in **Table 6.12**. Selection criteria would be refined during detailed design taking into account specific project characteristics.

Table 6.12 - Locational criteria for ancillary construction facilities

Locational criteria	Site compound	Batching plant	Crushing plant	Stockpile area
Environmental criteria				
100 m or more from waterways and SEPP 14 wetlands	✔✔	✔✔	✔✔	✔✔
150 m or more from Emigrant Creek Dam and/or Emigrant Creek	✔✔	✔✔	✔✔	✔✔
Not in protected conservation areas	✔✔	✔✔	✔✔	✔✔
Low conservation significance for flora, fauna and cultural heritage	✔	✔	✔	✔
No substantial clearing of native vegetation required, or is located where future clearing is required for permanent project works	✔✔	✔✔	✔✔	✔✔
Minimum distance from dwellings or other activities that may be affected by noise or other plant impacts (without additional noise mitigation e.g. bunds / noise shields)	100 m	200 m	300 m	50 to 100 m
Construction requirements				
Easy and safe access to the main road network	✔✔	✔✔	✔✔	✔
Directly adjacent to the upgrade route	✔✔	✔✔	✔✔	✔
Relatively level ground but elevated or sloped to assist drainage and allow containment and treatment of runoff	✔	✔	✔	✔
Minimum area preferred (indicative)	2-3 ha	1 ha	3 ha	3 ha
Electricity and phone services available or can be provided without adverse environmental impacts	✔	✔	✔	Not relevant
Preferably within existing road reservation or within areas to be acquired by the RTA	✔✔	✔✔	✔	✔
At least one site within each likely major construction stage/package	✔✔	✔✔	✔✔	As required
Easily accessible supply of water of appropriate quality	✔	✔✔	✔✔	Not relevant
Adjacent/close to concrete batching plant and/or asphalt batching plant	Not relevant	Not relevant	✔✔	Not relevant

✔✔ Site compliance highly desirable or essential

✔ Site compliance desirable – some flexibility possible depending on particular location and design response

6.6.10 Site rehabilitation

Site rehabilitation works would be undertaken progressively throughout construction, with full rehabilitation of ancillary construction sites once the sites are no longer required. Site rehabilitation measures would include, but not be limited to ripping, reinstatement of topsoil, landscaping and revegetation, and spoil and rubbish removal.

6.7 Construction management

6.7.1 Traffic management during construction

There are no appropriate alternative temporary routes to the existing highway that could be used during construction. Provision for highway traffic would be included in the construction sequencing and construction methodology for all sections of the proposed upgrade, consistent with the RTA's ***Traffic Control at Work Sites*** (RTA 2003).

Much of the proposed upgrade would be able to be constructed with minimal disruption to existing highway traffic (e.g. the Bangalow bypass to south of tunnel section). However, there are a number of locations where construction activities would be required in close proximity to existing highway traffic.

Locations where work would be carried out in close proximity to the existing highway are:

> At the tie-ins at the southern limit of the project to the north of the Ross Lane interchange.

> At the Emigrant Creek bridge and the overpass of the existing highway.

> At the Bangalow Road overpass.

> Along the duplicated section of the existing Bangalow bypass.

> At the tie-in at the northern limit of the project at the Ewingsdale interchange.

The Broken Head Road overpass can be constructed without affecting traffic on the existing highway, but construction would have impacts on road users of Broken Head Road.

In addition to speed restrictions and traffic controls, night work could be required for short periods at the above locations, to allow smooth transitions to occur and traffic diversions to be installed while minimising traffic impacts. Detailed arrangements for works in these areas would be developed during detail design.

Haulage may have an impact on local roads. It would include the transfer of fill material within and beyond the construction corridor as well as the delivery of construction materials. Where significant volumes of fill material need to be transferred within the construction corridor. Haulage would also take into account peak travel hours and times, particularly during school and public holiday periods, to minimise the potential for delays on the existing highway to the travelling public.

6.7.2 Waste management

The selected construction contractor(s) would be required to minimise and manage waste during construction. Guidelines for managing waste, implementing re-use and recycling programs, and disposing appropriately of other non-reusable waste would be developed, consistent with the objectives of the *Waste Avoidance and Resource Recovery Act 2001* and the *Waste Avoidance and Resource Recovery Strategy* (DEC 2006).

Reuse and recycling of materials during construction

Where possible and consistent with other environmental and occupational health and safety requirements, waste materials would be recycled either on-site or through approved off-site recycling programs. Examples of potential opportunities for recycling of materials during construction include:

> Tree and plant material generated during initial site clearing - with the exception of certain weeds and invasive plant species, this material would be mulched and used on-site during construction for erosion and sediment control, and where possible larger logs would be salvaged for reuse.

> Houses to be demolished - recycling of building materials would be optimised.

> Reuse of the existing highway - e.g. depending on agreements reached with the Ballina Shire and Byron Shire councils, reuse of pavement materials from redundant sections of the old highway in the vicinity of the Emigrant Creek bridge.

> Rock and soil material found to be unsuitable for construction purposes - would be reused if possible within the project area in batter extensions, subject to meeting the landscape and urban design objectives described in **Section 5.16**.

> On-site facilities for sorting of paper, plastic, glass and other waste from site compounds - to be recycled through local council recycling programs.

> Topsoil and fill generally.

7 Environmental management

The RTA would require the selected contractor(s) to have an environmental management system (EMS) in accordance with the requirements of the *Environmental Management Systems Guidelines* (NSW Government 1998) and the RTA *Quality Assurance Specification G36 Environment Protection (Management System)*.

A construction environmental management plan (CEMP) would be prepared by the successful contractor(s) to address management measures that need be implemented to ensure compliance with the Minister for Planning's conditions of approval, including the commitments made in this environmental assessment. The CEMP would cover the environmental protection practices, resources and the sequence of activities required.

The contractor(s) would be required to document the following information in the CEMP:

> Roles and responsibilities for planning, approval, implementation, assessment and monitoring of environmental controls.

> Required licences, approvals and permits.

> Potential environmental impacts resulting from construction of the proposed upgrade and the control and mitigation measures to be implemented.

> Objectives and targets for environmental performance.

> Environmental monitoring programs and a mechanism for evaluating environmental performance.

> Communication procedures.

> Document control procedures.

> Emergency response procedures to mitigate potential environmental damage.

> Training, competence and awareness assessment procedures and programs.

> An environmental auditing program and a mechanism for control and management of non-conformances.

> The CEMP would provide specific information in particular areas of environmental management, either by way of direct reference or by environmental management sub-plans.

Tintenbar to Ewingsdale environmental assessment

Part C

Environmental assessment of the proposed upgrade

This part of the environmental assessment document assesses the likely environmental impacts of the proposed upgrade. It also identifies management measures that would be put in place to ensure that environmental impacts are minimised. Extensive background material to support the assessments made in the following chapters is provided in the associated working papers.

8 Environmental risk analysis

This chapter describes an environmental risk analysis that has been undertaken for the proposed upgrade. This risk analysis has been an important part of ensuring that the proposed upgrade is developed in accordance with the principles of ecologically sustainable development.

The environmental assessment requirements (see Appendix A and below) identify environmental risk analysis as a key issue for assessment in the environmental assessment.

Environmental assessment requirement	Where addressed
The environmental assessment must include an environmental risk analysis to identify potential environmental impacts associated with the project (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures.	Section 8.2
Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the environmental assessment.	No additional key impacts identified

8.1 Approach

A wide range of environmental factors were taken into account in the route selection phase of the project. These factors were included in multi-criteria analyses for identification of shortlisted route options and for selection of the preferred route (described in detail in the ***Route Options Development Report*** (RTA 2005) and the ***Preferred Route Report*** (RTA 2006a)).

After the selection of the preferred route, an initial environmental risk analysis was undertaken to identify potential impacts of the proposed upgrade and to assist the Department of Planning in drafting the requirements for the environmental assessment.

A further environmental risk analysis was undertaken during the preparation of this environmental assessment. The analysis:

> Identified environmental issues, including key issues in the environmental assessment requirements and other issues.

> Examined potential impacts and proposed mitigation measures in relation to the identified issues.

> Examined impacts likely to remain after application of mitigation measures.

Based on this analysis, an environmental risk category was assigned to each impact. This enabled the identification of any matters that might be considered as additional key issues and established the basis for an appropriately detailed assessment of those additional key issues to be included in this environmental assessment.

The environmental risk categories are described below.

Category A - May have a high or moderate impacts. Detailed assessment necessary to determine the level of potential impact and to develop appropriate measures to mitigate and manage the impacts.

Category B - May have high or moderate impacts. These can be mitigated by the application of standard environmental management measures.

Category C - Have low impacts. These can be managed by standard environmental management measures.

Impacts that have been assigned a risk category of 'A' are considered in all cases to indicate key issues. The environmental risk analysis has automatically allocated a risk category of 'A' to all key issues identified in the Director General's Requirements.

8.2 Results of environmental risk analysis

The results of the environmental risk analysis are summarised in the following table. The table includes a list of the potential environmental risks, a brief analysis of the nature of impacts and associated management measures, and the identified risk category as described above. The section of the environmental assessment where each risk category is addressed is also included.

Results of environmental risk analysis

Issue	DGRs - Key Issue?	Potential Impacts	Analysis – Proposed mitigation measures and impacts remaining after their application	Risk category	EA Reference
Land use and property	Yes	> Loss of contiguity of settlements and communities > Change in land use within and adjacent to the proposed upgrade > Loss of dwelling entitlements	> Proposed upgrade located to avoid severance of contiguous settlements > Direct loss of 197 ha of agricultural land, including 112 ha of grazing land and 46 ha of macadamia plantations > Remnant land strategy has been prepared to identify the most appropriate use for portions of lots remaining outside the proposed road reserve	A	Chapter 14 and Working Paper 7
Social and economic	Yes	> Relocation of residents due to property acquisition > Impacts to amenity of local residents from noise, visual, traffic > Impacts to road safety > Business opportunities for local contractors during construction > Impact on businesses during operation > Impact on businesses during construction > Loss of agricultural production > Impacts to tourism and regional economy	> 73 lots subject to acquisition requiring a number of residents to be relocated. This has a potential impact on community structure and dynamics > Increased local business revenue and employment opportunities during construction > Potential loss of revenue to Newrybar businesses which would be minimised by the provision of efficient access > Loss of 197 ha of agricultural land > Remnant land strategy has been prepared to maximise agricultural production on remaining land > Improved safety by separating local traffic and highway traffic and higher standard road design > Benefits for the regional economy and tourism through increased accessibility to region	A	Chapter 17 and Working Paper 10

Results of environmental risk analysis (cont)

Issue	DGRs - Key Issue?	Potential Impacts	Analysis – Proposed mitigation measures and impacts remaining after their application	Risk category	EA Reference
Noise and vibration	Yes	> Noise and vibration impacts from construction activities Noise and vibration from highway traffic during operation	> Blasting resulting in ground vibration and airblast > Blasting noise and vibration managed through control of blasting technique > Likely to be some noise impacts from construction equipment, such as earthmoving equipment > Construction noise primarily managed through control of operating hours and provision of respite. Early installation of mitigation measures > Proposed upgrade designed to decrease noise impacts during operational phase > Some operational noise impacts likely > Operational noise impacts managed through noise attenuation in the road reserve and treatment of individual buildings where required	A	Chapter 15 and Working Paper 8
Visual amenity and urban design		> Visual impacts during construction > Visual impacts during operation > Changed experience for highway users	> Some temporary impacts during construction due to earthworks, stockpiles and ancillary facilities. > Proposed upgrade would be a prominent feature in the scenic landscape for residents and other viewers. > An urban design strategy, has been developed to mitigate visual impact for both residents and motorists. > Proposed upgrade designed to maximise driver experience.	A	Chapter 18 and Working Paper 11

Results of environmental risk analysis (cont)

Issue	DGRs - Key Issue?	Potential Impacts	Analysis – Proposed mitigation measures and impacts remaining after their application	Risk category	EA Reference
Traffic	Yes	> Impacts to local road network > Impacts to regional roads	> Increased travel distance for a small number of people. > Improvements in road safety by separating local and regional traffic movements, and improving design of road (straighter and flatter). > Temporary increase of traffic on local roads during construction. > Minimal impact on regional roads.	A	Chapter 13 and Working Paper 6
Soils and geology	No	> Potential for land slips > Erosion potential during construction and operation. > Potential for contamination	> Detailed geotechnical investigations undertaken to identify major risk areas. > Route selection process and design of proposed upgrade to minimise the potential for landslips. > Stability of cut and fill embankments will be ensured through standard design measures. > Standard erosion control measures will be implemented. > Negligible risk of acid sulfate soils.	B	Section 20.1

Results of environmental risk analysis (cont)

Issue	DGRs - Key Issue?	Potential Impacts	Analysis – Proposed mitigation measures and impacts remaining after their application	Risk category	EA Reference
Surface and ground water	Yes	> Impacts on drinking water catchments > Impacts on water quality > Impacts on surface water flows including flooding > Impacts on groundwater flows	> Mitigation measures designed to minimise potential risk of pollution to drinking water during construction and operation. Mitigation measures designed to higher standard than normal and in consultation with Rous Water. Residual risk is low. > Cuttings have the potential to change the flow of groundwater, which may cause some springs to dry up. > Alternative sources of water will be considered where replacement of any disrupted groundwater supply is required. > General flow of groundwater in the vicinity of the tunnel maintained through tanking of the tunnel and through drainage design. Any impacts would be localised. > Bridges and culverts are designed to minimise disruption to surface water flows. > Route selection process resulted in avoidance of major flood prone and acid sulfate soil areas.	A	Chapters 10 and 11 and Working Papers 2 and 3

Results of environmental risk analysis (cont)

Issue	DGRs - Key Issue?	Potential Impacts	Analysis – Proposed mitigation measures and impacts remaining after their application	Risk category	EA Reference
Flora and fauna	Yes	> Potential impacts to threatened species and endangered ecological communities. > Potential impacts to native vegetation and wildlife habitat and corridors. > Potential impacts to aquatic ecosystems and groundwater dependent communities.	> Removal of approximately 2 ha of lowland rainforest (endangered ecological community). Biodiversity offset strategy would be implemented to minimise residual impacts > Removal of approximately 10 ha of terrestrial habitat (including endangered and non-endangered communities) > Riparian rehabilitation program to be undertaken within the road reserve > Limited impacts to groundwater dependent communities > Any significant waterway would be bridged to minimise disturbance to aquatic ecology > Localised disturbance to aquatic habitat at bridge abutments > Proposed upgrade crosses one identified wildlife corridor > Wildlife corridor impacts mitigated through highway tunnel under St Helena ridge	A	Chapter 12 and Working Papers 4 and 5

Results of environmental risk analysis (cont)

Issue	DGRs - Key Issue?	Potential Impacts	Analysis – Proposed mitigation measures and impacts remaining after their application	Risk category	EA Reference
Air quality	Yes	> Impact of dust from construction activities > Impact of road operation on sensitive receivers, including Newrybar School > Impact of tunnel on sensitive receiver > Potential for airborne contaminants to enter drinking water	> Minimal impact from construction activities after standard mitigation measures implemented > Proposed upgrade located and designed to minimise air quality impacts. Modelling of air quality impacts of tunnel suggests minimal impact on surrounding community > Air quality assessment indicates low risk of airborne contaminants affecting drinking water quality	A	Chapter 19 and Working Paper 12
Aboriginal heritage	Yes	> Potential impact to Aboriginal heritage.	> Potential archaeological deposits (PADs) have been identified. > Further investigation of PADs will be undertaken to ensure minimal or no impact on Aboriginal heritage.	A	Chapter 16 and Working Paper 9
Non-Indigenous heritage	No	> Potential impact to non-indigenous heritage	> Likely impact to three non-Aboriginal heritage items of local significance. > Heritage items would be recorded prior to impacts.	C	Section 20.4 and Working Paper 9
Hazards	**No**	> Risks associated with hazardous handling and storage of hazardous materials during construction > Risks associated with the transport of hazardous materials during operation	> Risks associated with spills and fog minimised due to design of proposed upgrade. > Low risk of natural hazards to road.	C	Chapters 10 and 13 and Working Papers 2 and 6

Results of environmental risk analysis (cont)

Issue	DGRs - Key Issue?	Potential Impacts	Analysis – Proposed mitigation measures and impacts remaining after their application	Risk category	EA Reference
Resources and waste	No	> Adequate supply of resources. > Potential impacts from waste during construction. > Energy consumption and greenhouse gas emissions	> Adequate supply available locally. No major competing projects for resources. > Waste during construction managed through standard measures. > Greenhouse gases will be emitted during construction during construction. > Greenhouse gases saved in the operation of the proposed upgrade compared to the do nothing alternative. > Estimated to be an cut/fill surplus of approximately 790,000 m^3	C	Section 20.6.

The risk assessment above has identified no additional key issues (category A issues) to those identified in the Department of Planning environmental assessment requirements. Chapters 9 to 19 address the Department of Planning's key issues. Chapter 20 addresses environmental issues that are allocated a category B or C risk level.

9 Hydrology

This chapter summarises the impact of the proposed upgrade on surface water flows. In particular it assesses whether there would be any potential worsening of the impacts of flooding that may be caused by the obstruction of water flows by bridges and culverts. The chapter is based on a detailed study that is included *Working Paper I - Hydrology assessment*.

Environmental assessment requirement	Where addressed
Flooding impacts, identifying changes to existing flood regimes, in accordance with the *Floodplain Development Manual* (former Department of Natural Resources, 2005) including impacts to existing receivers and infrastructure and the future development potential of affected land	Section 9.5
Impacts to waterways to be modified as a result of the project, including ecological, hydrological and geomorphic impacts (as relevant) and measures to rehabilitate the waterways to pre-construction conditions or better	Sections 9.6 and 9.7 (except for ecological impacts which are addressed in Chapter 12).

9.1 Assessment approach

A study of the hydrologic impacts of the proposed upgrade was undertaken generally in accordance with the Floodplain Development Manual. The study involved.

> Calculation of peak flows for major creeks at key locations.

> Identification of the probable extent of the 1 percent annual exceedance probability (AEP) flood event for each major creek.

> Assessment of the waterway opening required for bridge spans to provide adequate capacity to convey the 1 percent AEP peak flood flow.

> Identification of any residual flooding impacts.

> Identification of impacts to surface water flows and effects of proposed waterway diversions.

The hydrologic studies have been undertaken to a preliminary level for the purposes of the environmental assessment. They are at an adequate level of detail for the concept design of bridges and culverts and to identify likely impacts. Detailed design of the proposed upgrade will require further hydrologic analysis.

9.2 Existing creek network

The following named creeks are crossed by the proposed upgrade:

> Emigrant Creek.

> Skinners Creek.

> Byron Creek (downstream of the confluence with Tinderbox Creek).

A number of unnamed creeks and tributaries are also traversed by the proposed upgrade.

All these creeks originate on the plateau on which the proposed upgrade would be located and flow generally to the southwest. These are described in more detail overleaf.

9.2.1 Emigrant Creek

The source of Emigrant Creek is just south of the junction of Piccadilly Hill Road and Broken Head Road. It has a catchment area of 4.1 km^2 where it is crossed by the proposed upgrade, about 6 km upstream of the Emigrant Creek Dam. The dam and drinking water catchment is discussed in more detail in **Chapter 10 – Water quality.**

The creek passes beneath the existing highway in four 1800 mm wide by 2000 mm high reinforced concrete box culverts, immediately upstream of the proposed upgrade crossing. Beyond this, Emigrant Creek continues flowing southwards where it outfalls to the Richmond River near West Ballina.

The Emigrant Creek catchment upstream and in the vicinity of the proposed crossing is characterised by gentler sloping hills than the Byron and Tinderbox catchments, with numerous small dams and water bodies, both on the creek and its tributaries, and numerous changes of direction. The approximate tidal limit of Emigrant Creek is near the Tintenbar Road bridge.

9.2.2 Skinners Creek

Skinners Creek is the smallest of the named creeks. It has its source near Piccadilly Hill. Where it would be crossed by the proposed upgrade it has a catchment area of 2.3 km^2. Downstream of the crossing, Skinners Creek flows into Pearces Creek, which joins the Wilson River at Booyong. It crosses the existing Pacific Highway approximately 1 km north of Newrybar, where it passes beneath the highway in six 1800 mm circular concrete conduits.

The catchment is less steep than those of Tinderbox and Byron Creeks. Along with Byron and Tinderbox Creeks, this catchment forms part of the drinking water catchment of the proposed Lismore source, discussed in more detail in **Chapter 10 – Water quality.**

9.2.3 Byron Creek

The source of Byron Creek is approximately 1 km northeast of Coopers Shoot. Byron Creek has a catchment of approximately 21.6 km^2 at the point where it is crossed by the proposed upgrade. The catchment includes the Tinderbox Creek catchment as the proposed upgrade crosses downstream of the confluence point of these two creeks. West of the proposed upgrade, Byron Creek joins with the Wilson River, before joining the Richmond River. The catchment forms part of the drinking water catchment of the proposed Lismore source.

The existing Pacific Highway crosses Byron Creek approximately 400 m downstream of the crossing point for the proposed upgrade, on a bridge that also passes over the adjacent Casino – Murwillumbah Railway.

At the upstream end of the Byron Creek catchment, the topography is relatively steep, interspersed with isolated small areas of flatter grade. Downstream of the confluence with Tinderbox Creek, and in the vicinity of the existing Pacific Highway crossing, Byron Creek widens significantly. This is potentially the result of a weir located downstream in Bangalow, which appears to have been constructed to provide a swimming facility. Downstream of the weir, the creek returns to a narrow, natural channel.

9.3 Peak flows

Peak flows were determined using the RAFTS modelling software. **Table 9.1** shows peak flows for the 1 percent AEP event at key locations along each creek.

Table 9.1 - Flow at the 1 percent AEP event at key locations

Creek	Location	1% AEP flow (m3/s)
Byron	Location of existing Pacific Highway creek crossing	532
	Just before Tinderbox/Byron junction	251
	Just after Tinderbox/Byron junction (location of proposed upgrade creek crossing)	506
Skinners	Location of proposed upgrade creek crossing	56
	Location of existing Pacific Highway creek crossing	68
Emigrant	Location of existing Pacific Highway and proposed upgrade creek crossing	146

9.4 Existing flood extent

The existing 1 percent AEP flood extent (**Figure 9.1**) in the vicinity of the proposed upgrade reflects the absence of floodplain and the relatively small catchments of the creeks. The flood extent is generally contained to within several hundred metres of the respective centre line of each creek.

9.5 Impact on flood behaviour

9.5.1 Overview

The proposed upgrade would pass through steeply undulating topography with well-defined creeks and valleys, and cross creek lines close to their source. As a result, the proposed upgrade would not pass through areas constituting a floodplain. It would however, traverse creek overbank areas subject to local flooding during large storm events. This includes the Emigrant, Skinners and Byron creeks – as well as a number of smaller unnamed watercourses.

Potential impacts on flood behaviour potentially include:

> Change in flood levels and extents.

> Change in inundation periods and/or the rate of rise of floodwaters.

> Change in flow velocity.

The hydrologic modeling undertaken to date suggests there would be no changes to flood regimes that impact on existing receivers, infrastructure or development potential of land. Impacts on individual creeks are discussed following.

9.5.2 Tributary of Emigrant Creek

The proposed upgrade crosses an unnamed tributary of Emigrant Creek, approximately 300 m south of the crossing of Emigrant Creek. The existing Pacific Highway runs parallel to the proposed upgrade immediately upstream of the new crossing, and the existing waterway opening consists of 2 x 1500 mm diameter pipes. However, despite the relatively minor upstream catchment area, the proposed upgrade incorporates a bridge at this location, in order to span the upstream end of a private dam, and as a result of the steep topography in the area. Given the small catchment area, this creek has not been subject to hydraulic modelling.

9.5.3 Emigrant Creek

Bridge abutments on both sides of Emigrant Creek would be located in a way that minimises increases in flood levels during flood events. Bridge design would also aim to minimise change to inundation periods and flow velocities.

The existing Pacific Highway, located upstream of the proposed new crossing, would be retained as an access road, and existing waterway openings (four 1800 mm wide by 2000 mm high reinforced concrete box culverts) would be retained.

9.5.4 Skinners Creek

Bridge abutments on both sides of Emigrant Creek would be located in a way that minimises increases in flood levels during flood events. Bridge design would also aim to minimise change to inundation periods and flow velocities.

9.5.5 Byron Creek

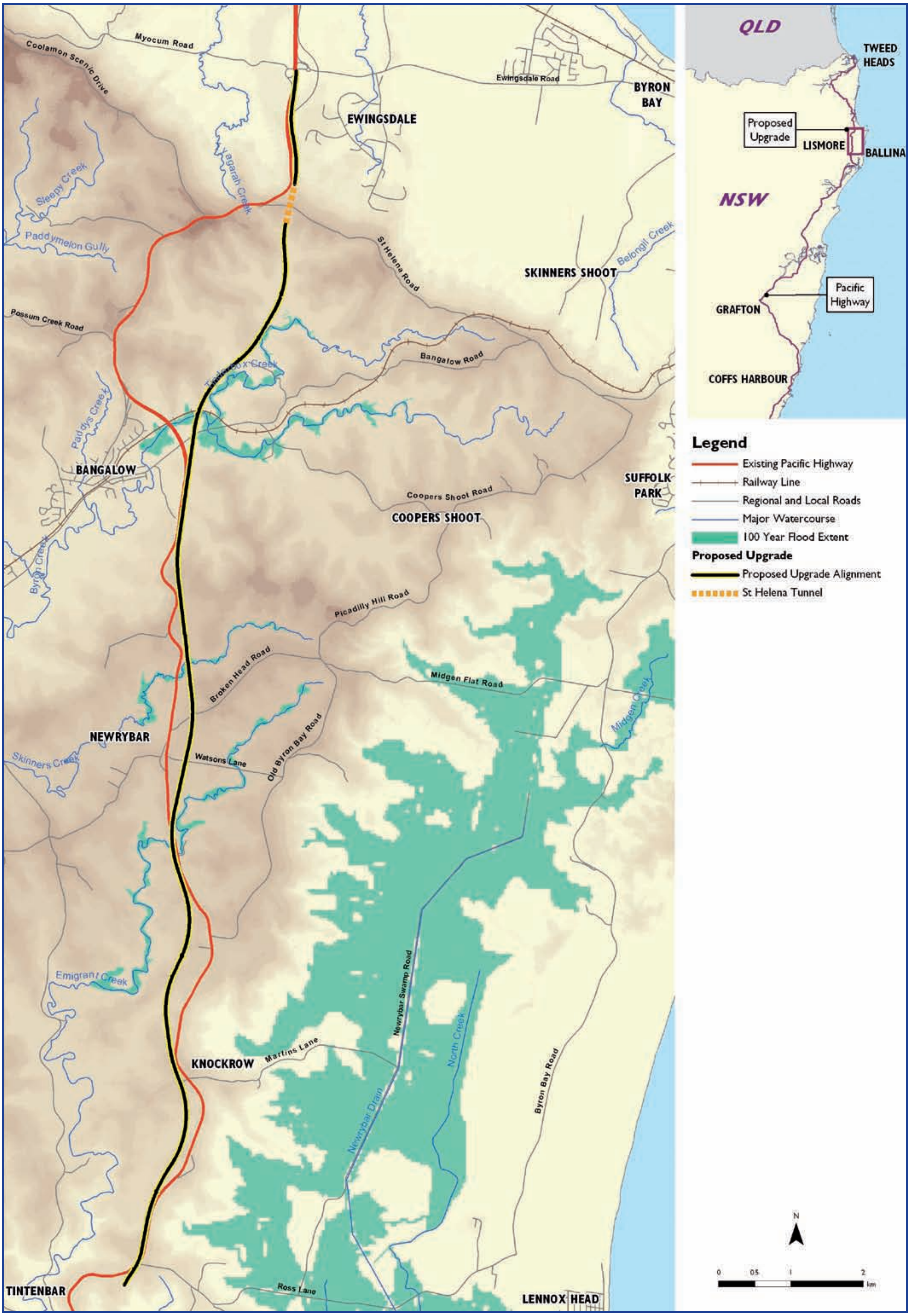
Bridge abutments on both sides of Emigrant Creek would be located in a way that minimises increases in flood levels during flood events. Bridge design would also aim to minimise change to inundation periods and flow velocities.

The position of the northern abutments has been driven by the need to clear the Casino-Murwillumbah railway. The railway is above the 1 percent AEP flood extent, and therefore the abutments are well outside the flood extent. Bridge abutments at the southern end have been angled back where required to reduce impacts on the flood regime.

9.5.6 Minor watercourses

Crossings of minor watercourses have been designed to convey the 1 percent AEP flood event with minimal increase in upstream water levels. There would therefore be minimal impact on the existing flood regime.

Figure 9.1 - 1 percent annual exceedance probability flood extent



9.6 Impacts of waterway modifications

The design of the proposed upgrade would allow the natural flow regimes and existing overland flow paths to be maintained. Accordingly, there would be minimal impact on existing receivers and infrastructure, and on any future development potential.

Culverts would be provided beneath the proposed upgrade to convey surface water runoff, and would be designed with sufficient capacity to convey the 100 year ARI peak flow with:

> No flow on at least one carriageway of the proposed upgrade (predicted performance is well in excess of this requirement).

> Only highly localised increases to water levels upstream of the structure that do not impact on nearby property.

> Minimal disruption to the natural hydrological regime through the diversion of flow onto adjoining catchments.

Waterway diversions have generally been avoided but minor diversions are proposed at a number of situations for one or more of the following reasons:

> Where the proposed upgrade alignment coincides with the existing alignment of a waterway.

> Where the required skew of a culvert would result in a culvert of excessive length.

> Where it would be necessary to direct clean water around a water quality sediment basin.

It is estimated that nine minor waterway diversions would be required, totalling approximately 1.5 km in length. The hydrologic impacts of these diversions would be minimal as they would be specifically designed to maintain the existing hydrologic regime. Similarly, the diversions would be designed to avoid any impacts on downstream morphology of the waterways. Ecological impacts of waterway diversions are discussed in **Chapter 12 - Ecology**. Proposed waterway modifications are shown in **Figures 9.2 a-e.**

9.7 Management of impacts

Because of the minimal nature of impacts on existing waterways, no specific rehabilitation measures are considered necessary. However, the following management measures would be adopted.

9.7.1 Drainage structures

The concept design has incorporated measures such as appropriately sized culverts and diversion drains to limit the extent of changes to the local drainage characteristics so as to maintain existing surface water flow regimes. Drainage structures would be designed to facilitate fish passage in accordance with DPI Fisheries guidelines (Fairfull and Witheridge, 2003)

9.7.2 Scour protection

Appropriate scour protection would be provided on both upstream and downstream ends of all structures where increased velocities have the potential to cause scour. Design of scour protection measures would be undertaken during the detailed design phase based on peak inlet/outlet velocity and applicable fish and fauna friendly requirements. The selection of appropriate scour protection would depend on the characteristics of the culvert flows. Typically, a headwall and apron would be sufficient to protect against scour when the outlet velocities are low. However, watercourses with high velocity flows may require devices to slow the flow prior to entry to the culvert and protect the stream bed.

The topography of the area requires culverts to be laid on a steep grade in a number of locations, to match existing creek alignments. Energy dissipation structures would be provided in these locations to reduce flow velocities and protect against scour.

9.7.3 Modified waterways

Effective hydrologic function and morphological stability would be inherent in the design of diverted waterways. Maximisation of ecological values of these waterways is discussed in **Chapter 12 – Ecology.**

Figure 9.2a - Proposed waterway modifications

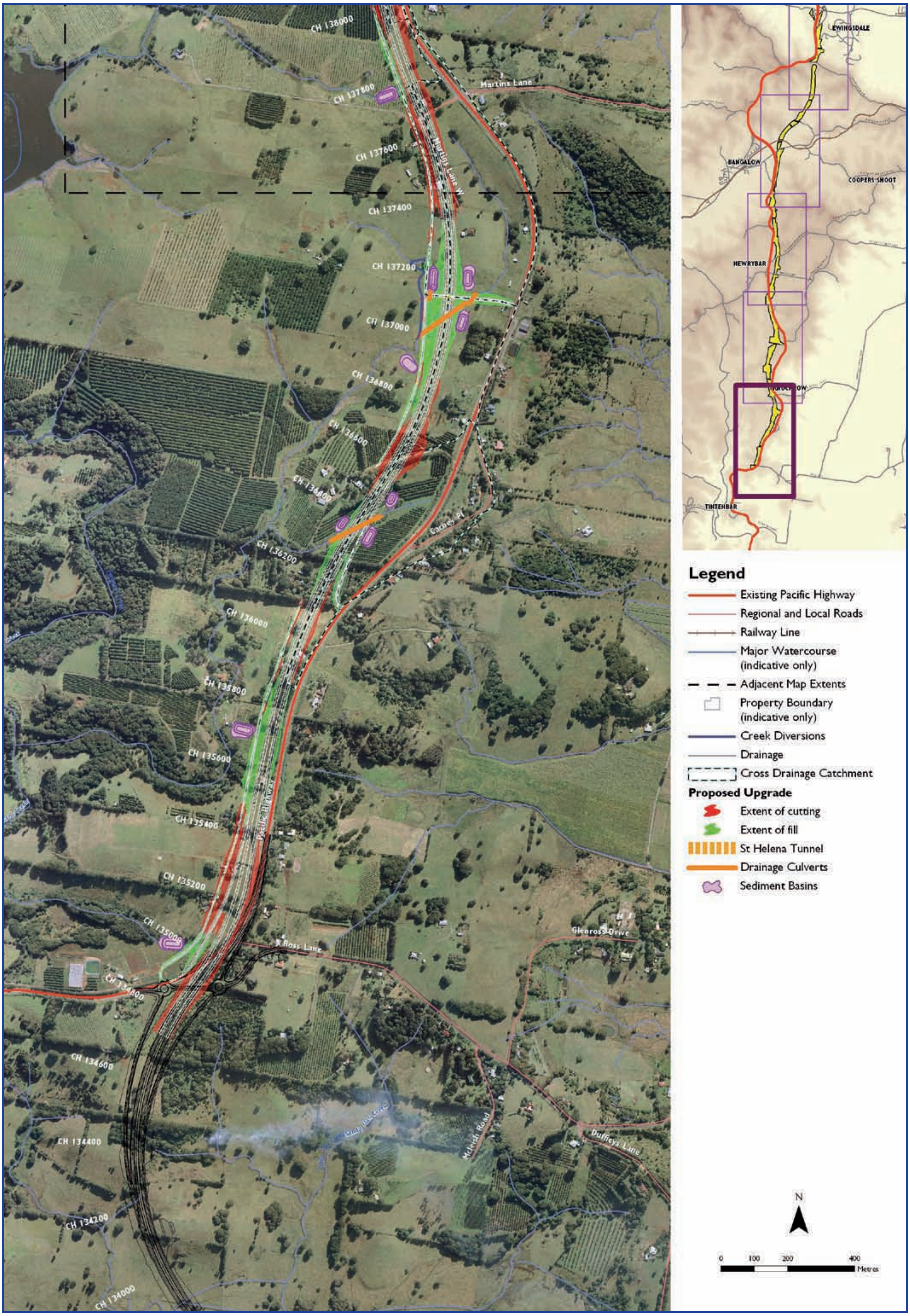


Figure 9.2b - Proposed waterway modifications

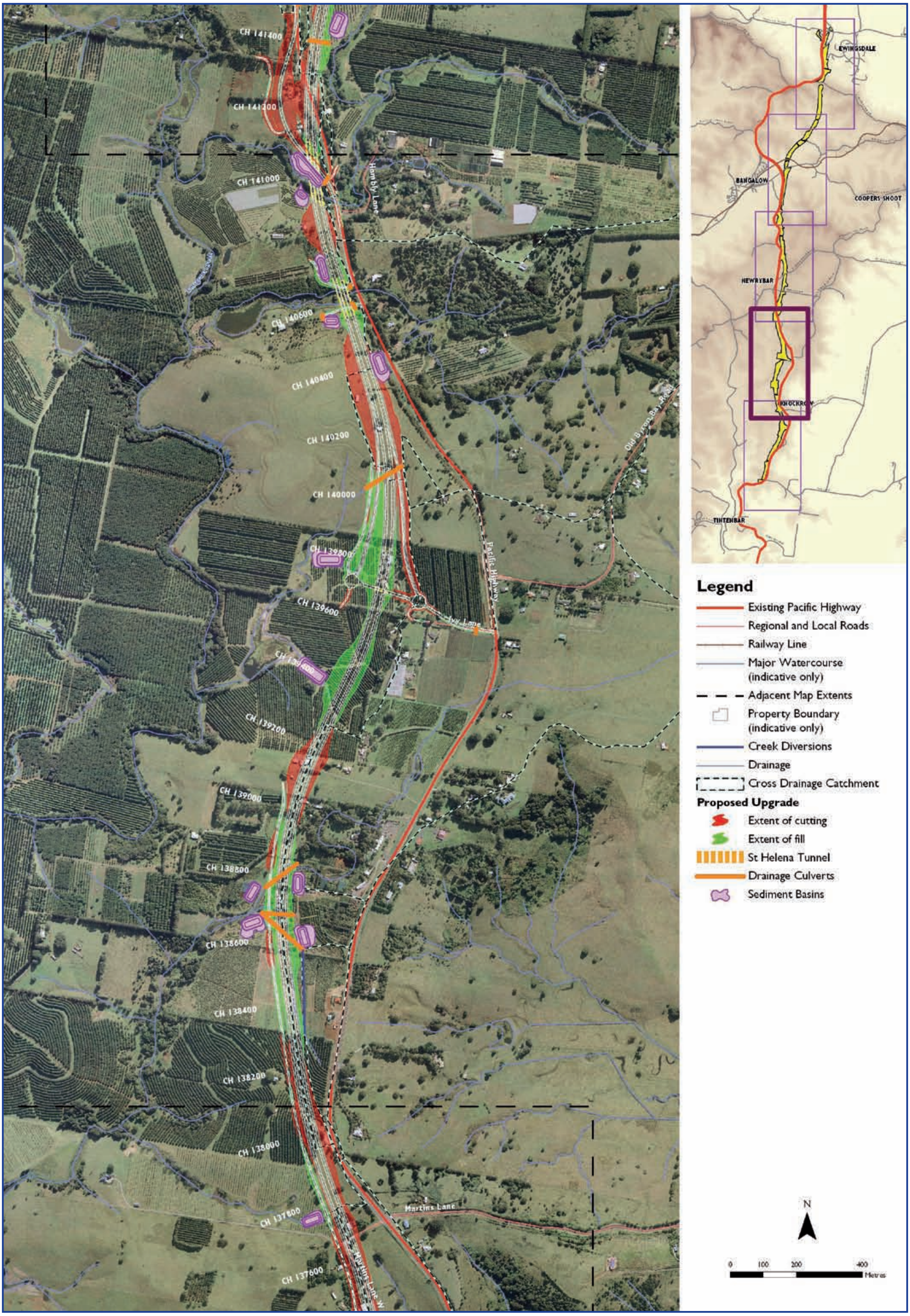


Figure 9.2c - Proposed waterway modifications

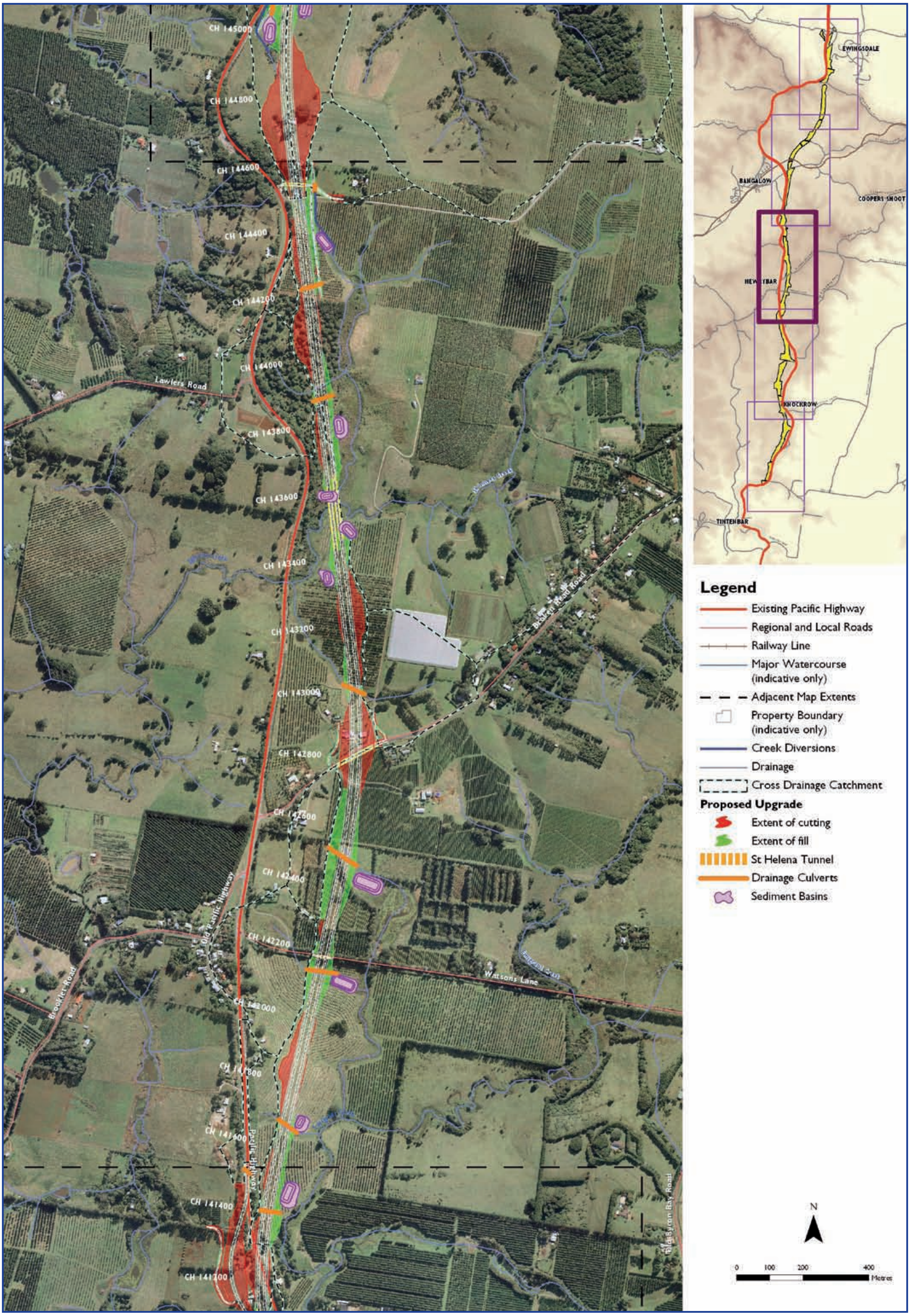


Figure 9.2d - Proposed waterway modifications

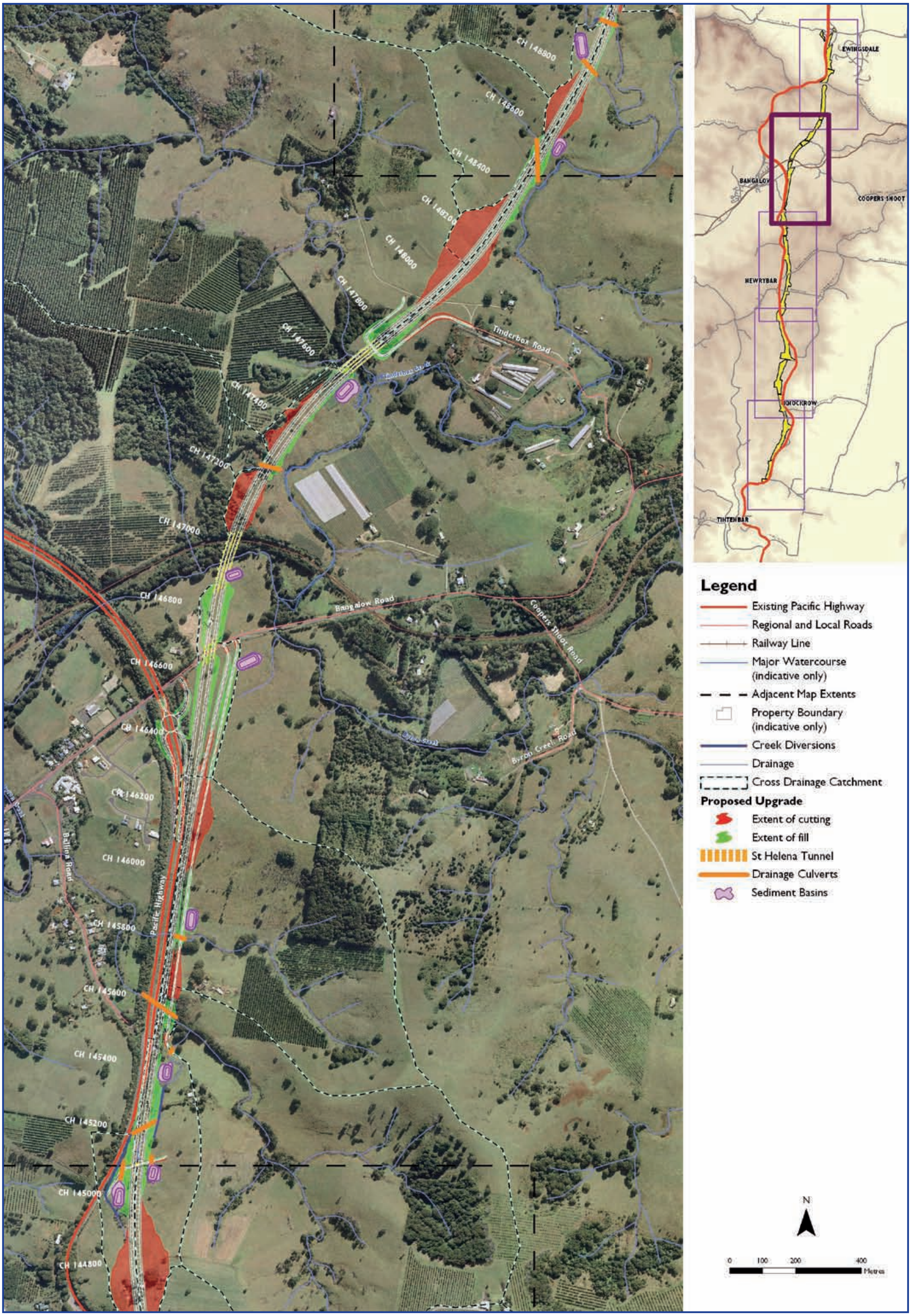
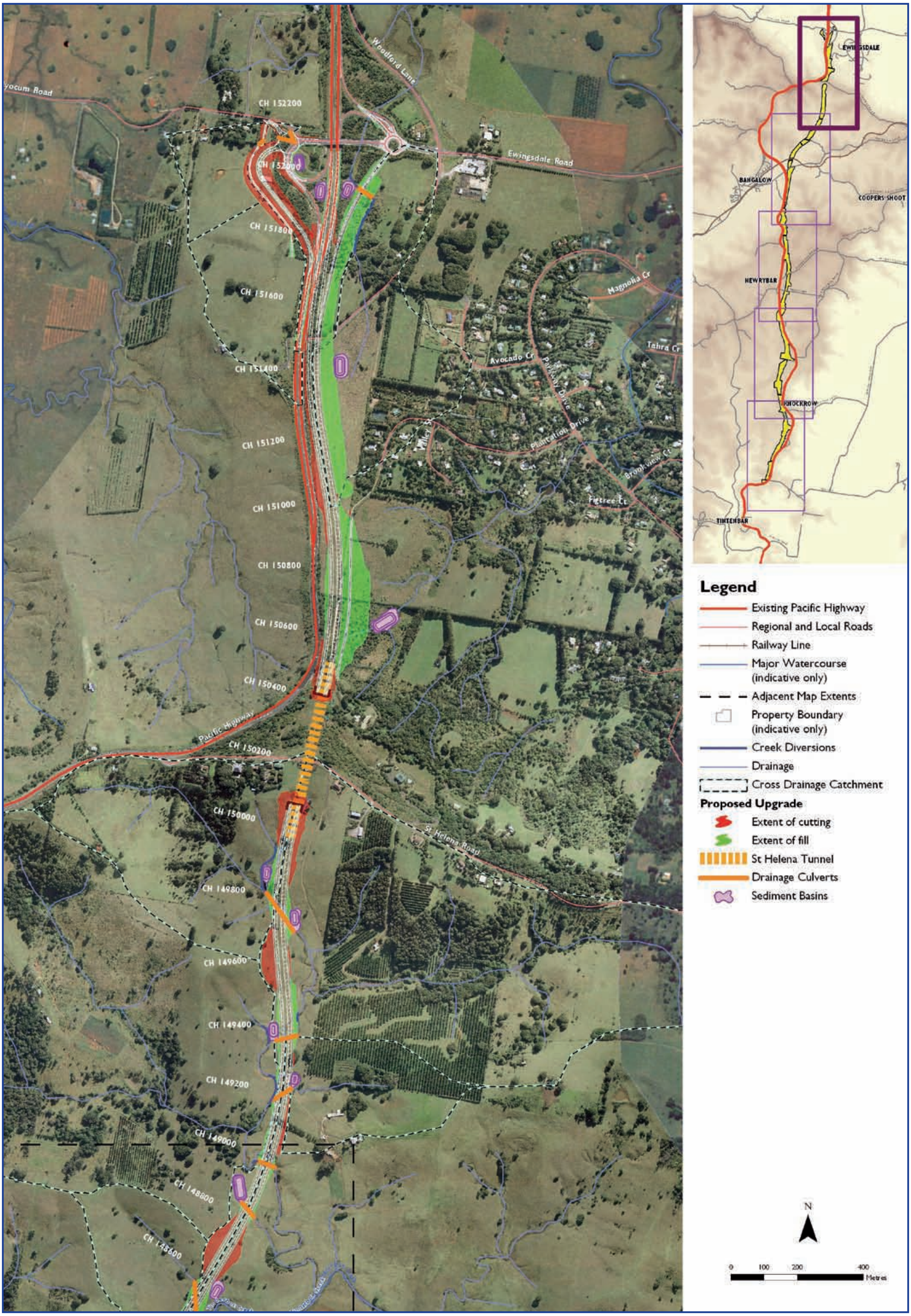


Figure 9.2e - Proposed waterway modifications



10 Water quality

This chapter describes the potential impact of the proposed upgrade on water quality of the area. It summarises the approach described in *Working Paper 2 – Water Quality Assessment.*

Environmental assessment requirement	Where addressed
Consideration of water quality impacts to the catchments of Emigrant Creek and Wilsons River, in consultation with Rous Water	Section 10.8 and 10.9
Consideration of water quality impacts from both accidents and runoff (i.e. acute and chronic impacts) taking into account and considering relevant public health and environmental water quality criteria specified in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000*	Section 10.8 and 10.9

10.1 Assessment approach

The assessment of water quality impacts and the development of mitigation measures for the proposed upgrade involved:

> Review of existing conditions in Emigrant Creek and Wilsons River catchment areas.
> Consultation with Rous Water and local community members.
> Hydrological analysis to determine run-off flows from the proposed upgrade.
> Literature review of potential impacts on water quality associated with highway drainage.
> Defining the proposed treatment approach to be used for the separate catchment areas.
> Development of construction water quality treatment measures based on guidelines in Managing Urban Stormwater – Soils and Construction 4th Edition (Landcom 2004).
> Development of operational water quality treatment measures based on guidelines in AP-R232 – Guidelines for treatment of stormwater runoff from the road infrastructure published by Austroads (2003b), RTA document – Procedure for selecting treatment strategies to control road runoff (2003), and more generally from best-practice measures.
> Development of a MUSIC water quality model to assess the performance of proposed operational treatment measures.
> Review and discuss potential chronic and acute pollution impacts and performance of treatment measures proposed for Pacific Highway upgrade.

10.2 Existing water system

As discussed in **Chapter 9 - Hydrology,** there are four named creeks that would be either crossed by or be in the immediate vicinity of the proposed upgrade. These are

> Emigrant Creek.
> Skinners Creek.
> Byron Creek.
> Tinderbox Creek.

Between Martins Lane at Knockrow and Broken Head Road at Newrybar the proposed upgrade would pass through the drinking water catchment area for the Emigrant Creek dam for a distance of 5.2 km. Thereafter the proposed upgrade would be in the drinking water catchment area for the proposed Lismore source water extraction facility on the Wilsons River until the alignment enters the tunnel under St Helena hill, a distance of 7.2 km. The existing Pacific Highway passes through both of the drinking water catchments detailed above for distances of 4.8 km and 8.4 km respectively. The proposed upgrade and drinking water catchment areas are shown in **Figure 10.1**.

South of the Emigrant Creek dam catchment the proposed upgrade would be within the catchment of the section of Emigrant Creek immediately downstream of the dam. North of St Helena hill, runoff from the proposed upgrade would enter Simpsons Creek and ultimately the Brunswick River to the north.

10.3 Drinking water supply overview

Rous Water is a single purpose County Council with a primary responsibility to supply water in bulk to the local government areas of Lismore, Byron, Ballina and Richmond Valley.

Water presently comes from two main sources Rocky Creek dam and Emigrant Creek dam. Other minor sources include plateau bores and Woodburn bores.

Rocky Creek dam was constructed in 1953 and has a capacity of 14,000 ML and a safe yield of about 11,600 ML per annum. Emigrant Creek dam was originally constructed in 1967-68 to provide a water supply to Lennox Head and Ballina. In the late 1990s Rous Water decommissioned the supply from Emigrant Creek dam due to concerns about the raw water quality. A new water treatment plant at the dam wall was opened in January 2006 and the dam is now used to supplement the drinking water supply from Rocky Creek dam. Its capacity is 820 ML with a safe yield of about 2,600 ML/annum although this will fall to 1,600 ML/annum in the future due to modified environmental flow requirements downstream of the Emigrant Creek dam.

The Rous Water *Regional Water Management Strategy* which was adopted in 1995 (and was amended in 2004) presented a range of options to meet water requirements. Rous Water adopted four actions from the strategy:

> Investigate and develop alternative water sources such as reuse, where appropriate.
> Implement demand management measures.
> Develop the Lismore Source.
> Develop Dunoon dam.

Rous Water plays an active role in catchment management to assist in producing good, clean drinking water. Particular emphasis in the Emigrant Creek dam catchment has been focused on the provision of healthy riparian buffer zones.

Rous Water has also been undertaking demand management to reduce the demand for water, however, with the growth in population in the area, the existing supplies are considered not adequate to meet Rous Water's future needs. They are therefore proceeding with the augmentation of the supply by the development of a new water source near Lismore.

The proposed new water source is referred to as the Lismore source and will consist of a pump station extracting up to 30 ML/day of water from the upper reaches of a tidal pool in the Wilsons River about 5 km upstream of Lismore (Howards Grass). The proposed Lismore source is currently under construction. The extracted water will be pumped as required to the Nightcap water treatment plant, where it will enter the Rous Water distribution network.

10.4 Emigrant Creek dam catchment

10.4.1 Catchment description

Emigrant Creek dam

Emigrant Creek drains a catchment of 1,960 ha, consisting of a variety of land uses including grazing and horticulture (mainly macadamia plantations), which together comprise over 77 percent of the total area. Other landuses include residential, nurseries and other horticulture including orchards and plantations of banana, coffee and stone fruit. Only a small percentage (7.7 percent) of the catchment is bushland, most of which surrounds the bottom half of Emigrant Creek dam (Rous Water 2004 in SKM 2005).

10.4.2 Existing water quality in the Emigrant Creek dam catchment

Egis Consulting conducted a Drinking Water Quality Risk Management Review (2001) which identified the following major risks associated with various land uses in the Emigrant Creek dam catchment:

> Septic tank/infiltration systems – water quality results do not indicate excessive export of coliforms however this remains a risk.

> Macadamia Castle tourist development (due to its small zoo, high level of use and proximity to a small watercourse that drains into Emigrant Creek).

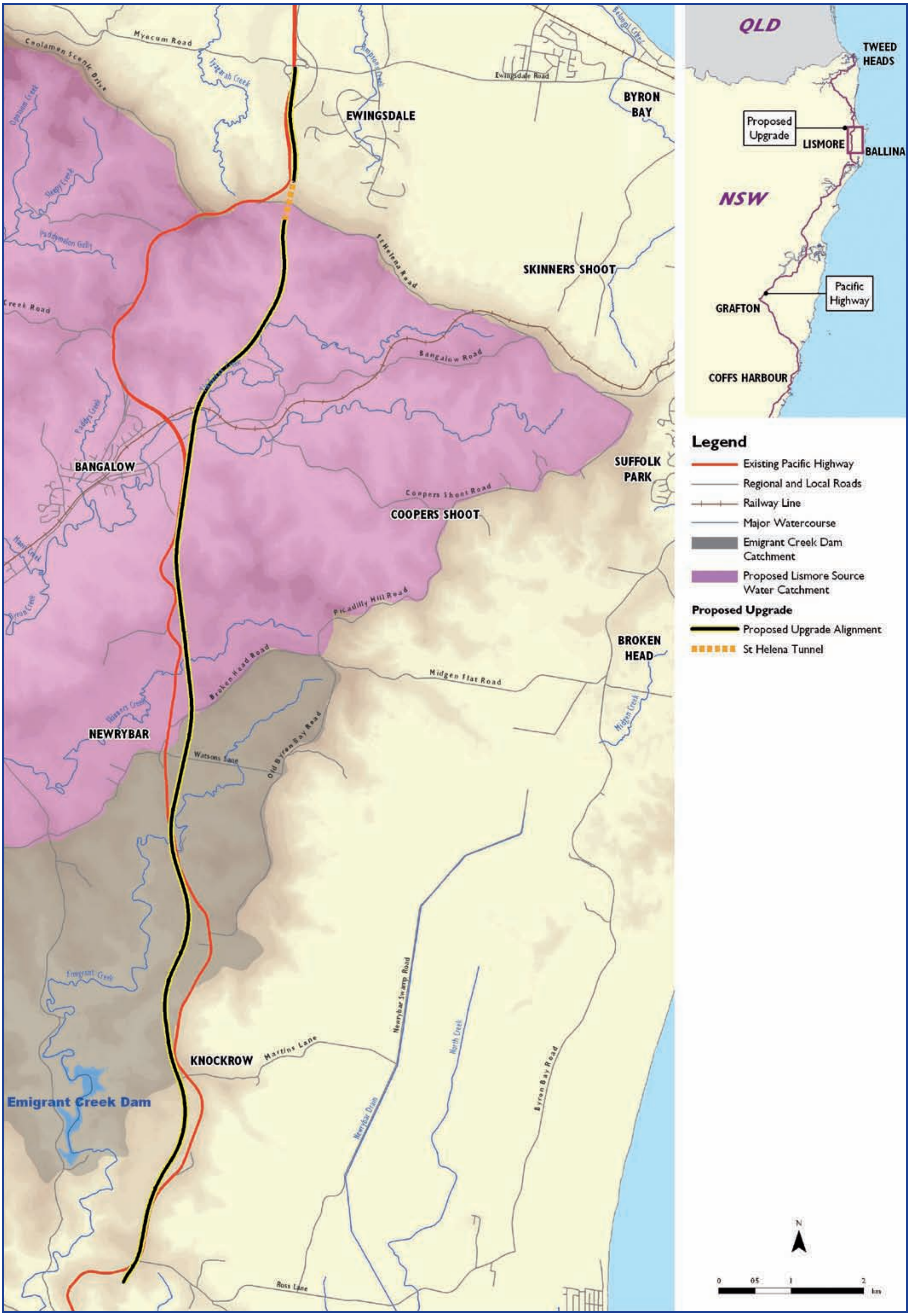
> Creek systems used for cattle watering.

> Pathogens from dairy farms.

> Pesticide spills from farms.

> Contamination from dip sites.

Figure 10.1 - Drinking water catchment areas



Rous Water commissioned SKM Consulting to undertake a review of existing water quality data in Emigrant Creek (SKM 2005). This report suggested that Emigrant Creek suffers from poor water quality, particularly during and following wet weather. The main water quality indicators of concern were nutrients and E.coli.

As part of the assessments for the proposed upgrade, further water quality sampling was undertaken by The Ecology Lab Pty (documented in *Working Paper 5 – Aquatic ecology assessment*). Though based on less robust data, The Ecology Lab formed similar conclusions to SKM in respect of the prevailing water quality.

10.5 Proposed Lismore source catchment

10.5.1 Catchment description

Minor creekline in the upper Wilsons River catchment indicating typical catchment land use.

The proposed upgrade is at the far upstream end of the catchment for the proposed Lismore source. Runoff from the proposed upgrade would enter the Wilsons River via Tinderbox, Byron and Skinners creeks. Tinderbox Creek joins Byron Creek east of Bangalow. Skinners Creek joins Byron Creek west of Bangalow. Byron Creek has its confluence with the Wilsons River near Nashua (about 7.5 km to the south-west of Bangalow). The off-take point for the proposed Lismore source is approximately 61 km downstream of the proposed upgrade.

The catchment area for the Wilsons River at Lismore is approximately 1,400 km^2. The catchment includes the steep and dissected plateau of the Nightcap and Koonyum Ranges, near the coast, running west to the Lofts Pinnacles. The component of the catchment in the vicinity of the proposed upgrade is similar in character to that of the Emigrant Creek dam catchment, being predominantly rural.

10.5.2 Existing water quality in the proposed Lismore source catchment

As stated above The Ecology Lab undertook some water quality sampling on Byron and Skinners creeks which form part of the Wilsons River Catchment. Though the sampling was limited, it indicated water quality in these creeks reflects the rural nature of the catchment and is similar to water quality on the Emigrant Creek dam catchment.

The Environmental Impact Statement for The Lismore Source (Parsons Brinkerhoff 2006) indicates that a water quality monitoring program was undertaken by Rous Water in the vicinity of the off-take point, from 2002 to 2005. The water quality at the proposed Lismore Source was considered to be acceptable as a raw source of drinking water.

Rous Water engaged the NSW Department of Commerce to carry out an assessment of the water quality risks in supplying their customers with drinking water pumped from the proposed Lismore Source and treated at Nightcap water treatment plant.

Their report *Wilsons River Risk Assessment – Risk Assessment and Mitigation Measures Report* (Department of Commerce 2005) identified that the highest risk events that could affect water quality were:

> Runoff from storms washing potentially harmful micro-organisms from sewerage systems into the river.

> Storms washing soils and phosphorus from farmland into the river.

> Pollutants moving upstream with the tide to the extraction point.

> Low river flow and high nutrient concentrations leading to high algal concentrations, and consequently toxicity, taste and odour problems.

Other events that were considered to have high consequences, but were assessed as having a low overall risk included:

> Terrorist attack.

> Chemical spills from traffic accidents.

These low risk events were considered to be best managed through an Emergency Response Plan rather than as part of normal operational procedures.

10.6 Consultation

10.6.1 Stakeholder workshops

Throughout the duration of the project the RTA and Arup have conducted a number of workshop sessions in order to ensure that the interests of all the project stakeholders are correctly defined and addressed appropriately.

As a key stakeholder to the project Rous Water were invited to attend all of these workshop sessions. Representatives of Rous Water did not attend the first planning focus meeting however representatives attended all of the four subsequent workshop sessions.

During the assessment of potential route options and identification of the preferred route for the upgrade, the RTA met with representatives of Rous Water prior to the value management workshop sessions in order to review their key issues and concerns.

10.6.2 Rous Water workshops and meetings

Further to the stakeholder workshops there has been significant additional consultation with Rous Water representatives in respect of the potential water quality impacts arising from the proposed upgrade.

As a result of concerns raised by Rous Water following the value management workshop further meetings and workshops were arranged so that key issues regarding the potential impacts on the drinking water catchment areas are adequately addressed in the development of the project proposals.

The meetings and workshops were supplemented by regular exchange of correspondence with Rous Water. Throughout this process the primary emphasis of Rous Water concerns has been on the potential impacts of the proposed upgrade on the Emigrant Creek dam and its catchment area.

The consultation with Rous Water influenced the scope of the water quality impact assessment, for example detailed risk analyses (both in relation to chronic and acute risks) were carried out as a result of the consultation, to accurately assess likely impacts on the Emigrant Creek dam water supply as well as to help identify the most appropriate water treatment method.

The key meetings and workshops arising from this consultation process are detailed below:

> **Meeting with Rous Water**
May 2006, Lismore.
Meeting to present Storm Consulting to Rous Water and outline proposed water quality modelling work to be undertaken prior to finalisation of preferred route.

> **Meeting with Rous Water**
June 2006, Lismore.
Presentation given by Arup and Storm Consulting detailing the examination of chronic water quality risks associated with proposed upgrade and potential management strategies. Agreement to undertake a water quality impacts risk assessment to include acute risks.

> **Meeting with Rous Water**
October 2006, Lismore.
Meeting to discuss findings of water quality impacts assessment. Agreement to hold risk workshop in December 2006.

> **Visit to Emigrant Creek Dam Water Treatment Plant**
November 2006, Emigrant Creek Dam.
Visit by Arup and Storm Consulting to WTP to assist in understanding and defining the water supply operation and the potential risks of the proposed highway upgrade.

> **Risk Workshop**
December 2006, Ballina.
Risk workshop, independently facilitated by Urbis JHD, to develop a joint risk register for water quality impact risks arising from the proposed highway upgrade. Workshop attended by representatives from Rous Water, RTA, Arup, Storm Consulting and Sydney Catchment Authority.

> **Meeting with Rous Water**
July 2007, Ballina.
Workshop / meeting to present and discuss results of further assessment works of water quality impacts from the proposed upgrade at Emigrant Creek. Review of 21 Management Strategies recommended by Rous Water in their submission of 20 April 2007.

> **Meeting with Rous Water**
  November 2007, Lismore.
  Meeting with Rous Water to provide update on key issues detailed in Rous Water submissions of 20 April 2007 and 24 October 2007. Review of status of chronic and acute water quality impact assessment work undertaken by Arup and Storm Consulting.

> **Meeting with Rous Water**
  March 2008, Lismore.
  Meeting with Rous Water to provide update on status of environmental assessment of proposed upgrade and program for lodging project proposal with NSW Department of Planning. Review of work undertaken and proposed mitigation for proposed upgrade in Emigrant Creek dam and Wilsons River catchments.

10.6.3 Community representations

A number of representations have been made by members of the community during the environmental assessment and concept design phase of the project in relation to the potential impact of the proposed upgrade on water quality.

The submissions have focused on the route selection process and the consideration given to the potential impact of the route options on Emigrant Creek dam and its surrounding catchment area.

10.7 Water quality guidelines

There are several water quality criteria routinely applied in NSW and more broadly in Australia and overseas. In order to assess the potential water quality impacts associated with the proposed Tintenbar to Ewingsdale Pacific Highway upgrade the following water quality performance targets have been reviewed:

> ANZECC Guidelines for Fresh and Marine Water Quality (2000).

> Australian Drinking Water Guidelines (NHMRC 2004).

> NSW Department of Environment and Climate Change (DECC) stormwater quality guidelines – current and proposed.

> Richmond River Water Quality Objectives in conjunction with "Using the ANZECC Guidelines and Water Quality Objectives in NSW" (DEC, undated).

> UK Highways Agency, Design Manual for Roads and Bridges, Volume 11, Section 3 Environmental Assessment Techniques, HA 216/06 Road Drainage and the Water Environment.

The ANZECC guidelines provide a framework tool for catchment managers to assess and manage ambient water quality in a particular resource. The guidelines contain default trigger values for assessing aquatic ecosystem health however these values are not meant to be applied directly to stormwater quality unless the stormwater system is regarded as having conservation value.

In terms of drinking water quality, the ANZECC guidelines refer directly to the Australian Drinking Water Guidelines. These provide general guidance on managing drinking water supplies. They also include guideline values for various drinking water characteristics which are aimed at the quality of water that is drunk by humans. No guidelines values are provided in terms of quality of water entering a water supply catchment or system.

Numerical guidelines included in ANZECC (2000) and the Australian Drinking Water Guidelines are therefore not considered appropriate to assess the water quality impacts of a major road project in isolation. The principles associated with these guidelines were however considered in the route selection process and the development of the concept design for the proposed upgrade.

DECC has water quality criteria which are applicable to any new development in NSW. The specific pollutant retention targets as shown in **Table 10.1** below.

Table 10.1 - DECC current and proposed stormwater pollutant retention criteria

Pollutant	Current guideline Minimum retention (%) of the average annual load	Draft guideline Minimum retention (%) of the average annual load
Total Suspended Solids	80%	85%
Total Nitrogen	45%	45%
Total Phosphorus	45%	65%
Oil and Grease	None visible	None visible

The current guidelines were introduced in the document *Managing Urban Stormwater: Council Handbook - Draft* (EPA 1997) and provide guidance for local government agencies to adopt into their stormwater management plans.

The draft guidelines were issued for consultation in 2007. The changes in minimum retention values represent improvements in best management practices for the treatment of stormwater runoff and the values have subsequently been adopted by a number of NSW council areas in respect of their water quality management guidelines.

The targets are measured by comparing a proposed development without any water quality treatment against a proposed development with treatment.

The DECC criteria have been developed to ensure that receiving waters are afforded suitable levels of protection without imposing a severe burden on developers. These criteria have been widely tested by the DECC and reflect the need to manage the critical water quality parameters of concern in NSW i.e. sediments and nutrients. These criteria however have wider effects because in the context of a stormwater treatment train, retention of soluble nutrients may also result in the retention of other pollutants typically found in stormwater.

The guidelines provided by the DECC requiring specific pollutant retention targets were identified as being appropriate criteria to apply to potential water quality impacts from the proposed upgrade in the Emigrant Creek catchment via the modelling of potential treatment options.

For the remaining sections of the proposed upgrade, including the section in the Wilsons River catchment area, it is proposed that water quality impacts would be managed in accordance with recommended minimum design standards for erosion and sediment control during the construction and operation of main roads. Proposed measures would also provide appropriate spill containment in order to minimise acute water quality impact risks.

In addition to the DECC guideline values discussed above, the guiding principles listed in the Australian Drinking Water Guidelines were considered. **Table 10.2** identifies the project response to each of these guiding principles.

Table 10.2 - Project response to the guiding principles of the Australian Drinking Water Guidelines

Guideline Principle	Project Response
The greatest risks to consumers of drinking water are pathogenic microorganisms. Protection of water sources and treatment are of paramount importance and must never be compromised.	The proposed upgrade would be a potential source of pathogens. The sediment removed as part of the proposed treatment train would play a major role in reducing the concentration of pathogens entering receiving waters.
The drinking water system must have, and continuously maintain, robust multiple barriers appropriate to the level of potential contamination facing the raw water supply.	The Rous Water treatment system contains multiple barriers. Additional barriers would be added as part of the treatment train for the proposed upgrade.
Any sudden or extreme change in water quality, flow or environmental conditions (e.g. extreme rainfall or flooding) should arouse suspicion that drinking water might become contaminated.	Sediment basins are proposed, that would retain runoff from most storm events. Ongoing communication between Rous Water and the RTA would assist in identifying any contamination after extreme events.
System operators must be able to respond quickly and effectively to adverse monitoring signals.	The RTA would work closely with other stakeholders to prepare an emergency response plan for incidents occurring on the road network within the catchment area
System operators must maintain a personal sense of responsibility and dedication to providing consumers with safe water, and should never ignore a consumer complaint about water quality.	The RTA acknowledges Rous Water's commitment to providing safe drinking water.
Ensuring drinking water safety and quality requires the application of a considered risk management approach.	The risks to drinking water quality (both acute and chronic) have been carefully considered in both the route selection and environmental assessment process.

10.8 Construction phase water quality impacts

The construction phase of the proposed upgrade has the potential to generate pollutants which could affect water quality.

The primary potential impact on water quality during construction would be due to increased sediment loads from exposed soil entering receiving waters during wet weather. Increased sedimentation of watercourses can smother aquatic habitats and organisms, and can increase levels of nutrients, metals and other potential toxicants that attach to sediment particles. Other pollutants that may potentially affect water quality during the construction period include:

> Hydrocarbons and chemicals as a result of spills and leakages from construction vehicles or fuel / chemical stores on construction sites.
> Litter and gross pollutants from construction material and activities.

The risks are best managed by the application of *Managing Urban Stormwater – Soils and Construction Volume 2D – Main Road Construction* guidelines together with comprehensive construction management measures.

During the development of the detail design a specialist soil conservation consultant would be engaged by the RTA to assist in the development of the erosion and sediment control measures and strategies.

Water quality impacts are discussed over in terms of chronic (or day to day) impacts and acute impacts (which result from a one-off severe event). Based on the operation and maintenance of the proposed water treatment methods described in **Section 5.10.**

10.8.1 Chronic water quality impacts during construction

Water quality during construction is proposed to be managed primarily through a series of sediment basins. An initial concept for the sediment basin location and size has been developed. This is shown in **Figures 9.2a-e in Chapter 9.**

Outside the Emigrant Creek dam catchment (including in the catchment for the proposed Lismore source) the basins are to be designed to capture and treat the 80th percentile 5 day rainfall event. This design capacity level meets the requirements specified *Managing Urban Stormwater – Soils and Construction Volume 2D – Main Road Construction* (Landcom 2004).

The Emigrant Creek dam catchment is considered more sensitive to water quality impacts due to the proximity of the proposed upgrade to the dam and the water treatment plant off take. The basins in this catchment are therefore proposed to have a higher capacity than those discussed above. These sediment basins are proposed to capture all runoff from the 85th percentile, 5 day rainfall event.

Where space permits basins are proposed to accommodate an additional 5 percent. This method provides a conservative basin volume.

Construction impacts to water quality up to the respective design storm events both within and outside the Emigrant Creek dam catchment would be expected to be minimal.

It should be noted however that a larger storm event could result in overtopping of basins and the potential deposition of sediment and associated pollutants into receiving waters.

Additional measures designed to further minimise impacts are described in **Section 10.10.**

10.8.2 Acute water quality impacts during construction

Risks of acute water quality impacts during construction are primarily in relation to spills or leaks of fuels / oils and other machinery liquids such as radiator coolants which could arise from negligence, accident or deliberate sabotage.

Sediment basins in all catchments would be of a size that would capture a very large spill of this nature. The likelihood of a spill entering waterways is therefore minimal. In addition secondary treatment measures such as sediment fencing, erosion controls within sub-catchments, temporary vegetation and diversion banks would provide some level of protection to nearby waterways.

Additional measures that would further minimise the risk and consequences of an acute event during construction are described in **Section 10.10.**

10.9 Operational phase water quality impacts

The assessment of water quality impacts has identified that the section of upgraded highway that passes through the Emigrant Creek dam catchment has the potential to have a greater consequence on drinking water quality as a result of any pollutants contained in the surface water runoff. A greater level of detail has therefore been undertaken in assessment of water quality impacts for the Emigrant Creek dam catchment.

Water quality impacts are assessed in terms of potential chronic and acute impacts.

Refer to **Section 5.10** for a description of the water treatment train and maintenance requirements of water treatment measures.

10.9.1 Chronic water quality impacts during operation

Water quality outside the Emigrant Creek dam catchment (including in the catchment for the proposed Lismore source) would primarily be managed during operation through conversion of construction sediment basins to operational wet basins in accordance with normal RTA practice. Additional water quality management would occur through the filtering effect of landscape treatments, which would cover the majority of the road reserve beyond the carriageways. The risk to water quality within Byron, Skinners and Tinderbox creeks, as well as Emigrant Creek downstream of the dam, would be reduced as a result of the transfer of the majority of traffic to the proposed upgrade which would have a higher level of treatment than the existing highway.

Impacts to water quality at the proposed Lismore source as a result of the upgrade would be expected to be minimal given the above treatment methods and large distance downstream of the extraction point from the proposed upgrade.

Due to the proximity of Emigrant Creek dam to the proposed upgrade it was identified that a more sophisticated treatment option for stormwater runoff from the proposed upgrade should be provided within the catchment area for the dam. Additionally the stormwater runoff from the section of existing Pacific Highway which is realigned at Emigrant Creek would be passed through the proposed treatment option prior to discharge.

The proposed water quality management option for the Emigrant Creek catchment was to convert the construction sediment basins, sized to capture all runoff from the 85th percentile 5 day rainfall event, to a permanent bioretention basin using sand as a filter medium. In addition a gross pollutant trap would be provided upstream of the sand filter to prevent large debris clogging the filters and adversely affected their performance.

Detailed assessment of the performance of the proposed treatment was carried out in relation to operational water quality impacts within its catchment. Water quality modelling was carried out, using the MUSIC water quality model, for key pollutants to predict the performance of the proposed sediment basins. Two separate models were developed, so that the quality of runoff from the existing highway (pre-upgrade) could be compared with the post-upgrade situation where runoff would occur both from the existing highway (with reduced vehicle use) and the proposed upgrade.

Based on the performance of similar sediment basins, the key pollutants modelled are considered as appropriate indicators of the ability of the basins to remove other pollutants such as heavy metals (refer to *Working Paper 2 – Water Quality Assessment* for more details on the likely relationship between removal of modelled pollutants and other pollutants).

The comparison between pre-development and post-development pollutant loads in the Emigrant Creek dam catchment are shown in **Table 10.3.**

Table 10.3 - Comparison of pre-upgrade and post-upgrade annual pollutant loads for Emigrant Creek catchment

	Pre-upgrade	Post-upgrade	% change
Total Suspended Solids (tonnes/yr)	51.6	24.9	52% reduction
Total Phosphorus (kg/yr)	121	61	50% reduction
Total Nitrogen (kg/yr)	685	590	14% reduction

The modeling results indicate that the proposed upgrade would result in a reduced pollutant load entering the Emigrant Creek dam catchment compared to the current situation. This reduction would be mainly due to the transfer of the majority of traffic from the existing highway onto the proposed upgrade, where there would be high level water quality controls.

The compliance of the proposed water quality treatment with the DECC criteria discussed in **Section 10.7** above is shown in **Table 10.4.** These results are also based on the water quality modelling undertaken and compare the quality of runoff before treatment to the quality of runoff after treatment.

Table 10.4 - Comparison of predicted annual pollutant retention with DECC criteria for Emigrant Creek catchment

	Before treatment	After treatment	Percent retention	Current DECC criteria	Draft DECC criteria
Total Suspended Solids (tonnes/yr)	99	13.9	86%	80	85
Total Phosphorus (kg/yr)	180.6	42	77%	45	65
Total Nitrogen (kg/yr)	846	467	45%	45	45

The results of **Table 10.4** indicate that the proposed upgrade would meet both current and proposed DECC criteria.

In developing the detailed design for the proposal further modelling and design refinement may occur to optimise performance and function of the water quality treatment measures. Through this process other design solutions that also provide compliance with the load reduction and pollution criteria may be considered.

10.9.2 Acute water quality impacts during operation

A chemical spill resulting from a road traffic accident on the proposed upgrade may present a risk to the quality of Emigrant Creek water supply. To identify the magnitude of this risk, a detailed acute risk assessment was undertaken in relation to the Emigrant Creek dam catchment. This assessment included the identification of the likelihood and consequences of a major spill from a vehicle carrying dangerous goods (which are categorised as explosives, flammable gases, flammable liquid, flammable solids, oxidising agents, organic peroxides, toxic and infectious substances, radioactive substances, or corrosives).

The estimated probability of an accident involving a dangerous good vehicle and a spill of greater than 150 kg is shown in **Table 10.5** below. A comparison is made between scenarios with and without the proposed upgrade.

Table 10.5 - Dangerous goods vehicle accident and spill probabilities

Scenario	Probability of dangerous goods vehicle accident	Probability of dangerous goods vehicle accident involving a spill greater than 150 kg
Highway not upgraded	1 in 2.7 years	1 in 63 years
Highway upgraded	1 in 12.8 years	1 in 298 years

The reduction in likelihood of accidents and spills shown in **Table 10.5** can be attributed to the improved design standards of the proposed upgrade compared to the existing highway.

The risk assessment suggests that under dry conditions a large spill (up to 20,000 litres) would be fully contained within the proposed basins. Wet weather would result in an increased risk of pollutants entering the creek system and the main body of the dam however it is estimated that even under wet conditions, less than 1 percent of any given spill is likely to enter the water treatment plant intake. The likelihood of pollutants entering the water supply system if they reach the water treatment plant is further reduced due to:

> The plant process itself, which includes a range of measures for reducing the concentrations of various pollutants that may result from a spill.

> Rous Water's existing procedures that include a spill notification procedure from emergency services and the ability to shut down the Emigrant Creek supply temporarily with no supply interruption to customers.

The acute risk to the proposed Lismore source could be expected to be substantially lower than the risk to Emigrant Creek dam due to the large distance between the proposed upgrade and the extraction point.

10.10 Management of impacts

10.10.1 Management of impacts during construction

Water quality would be primarily managed through the design measures described in **Section 5.10.** A number of other activities would be undertaken during construction however to minimise impacts on the downstream creek system. These include:

> Top soil would be stockpiled and reused during vegetation. Stockpile heights would be minimised to limit wind erosion.
> Disturbed areas would be limited to only those areas which need to be worked on at that point in time and areas will be rehabilitated and sealed as soon as possible following construction.
> Batter slopes would be minimised to ensure that minimum possible area is disturbed.
> Clean run on water would be diverted around all works using diversion drains.
> Construction of sediment basins as early as practical in the construction process.
> Establishment of effective procedures for the recovery of spilt materials.
> The sediment basins would be operated to ensure that sediment is removed when the sediment storage zone has reached 80 percent of capacity.
> Sediment basins would be flocculated with appropriate, approved flocculants to enhance the settling of dispersible and small sediment particles.
> Best practice soil and water management would also put in place. This would include the use of sediment fences, check dams, level spreaders and other devices to mitigate the export of soil from the site.
> Trees would be mulched on site and the mulch used in the revegetation and stabilisation of the site.
> Top soil dressing and revegetation would take place as soon as possible.
> Revegetation would only use native endemic species.
> Temporary sterile grass covers would be used to seal areas whenever practical.
> The use of floating booms shall be made where major crossings and permanent pools are put at risk from construction activities.
> All storages of fuel and chemicals would be bunded and stored in approved storage containers.
> Steep batter slopes would be sealed using jute matt or mesh as appropriate or equivalent erosion control blankets would be employed. These would be biodegradable.
> During the development of the detail design a soil conservation consultant would be engaged by the RTA to assist the design and implementation of best practice measures to ensure that water quality objectives for the project are achieved.

10.10.2 Management of impacts during operation

Management of water quality impacts during operation would focus on the appropriate maintenance of sediment basins and the landscape treatments within the road reserve. Adaptive management measures would be developed to ensure that the performance of the water quality treatment measures remain satisfactory in the event that future rainfall events increase in either frequency or intensity.

Regular maintenance inspections would be conducted, with appropriate recording to identify and rectify general problems, including:

> Areas of erosion, sediment deposition and/or poor vegetative cover.
> Blocked drains and gross pollutant traps.
> Slumped batters.
> Sediment basins or other stormwater treatment measures requiring maintenance or repair.

In addition a detailed emergency response plan would be developed, in consultation with key stakeholders, including NSW Fire Brigade, NSW Police, Rous Water and the RTA, to ensure that the appropriate response is provided to any major incident on the highway which may impact on water quality. Operational measures would include appropriate signage within the catchment areas to ensure that road users alert the appropriate authorities in the event of an incident occurring.

11 Groundwater

This chapter addresses the impacts of the proposed upgrade on groundwater flows and quality. A more detailed assessment is contained in *Working Paper 3 – Groundwater Assessment*

Environmental assessment requirement	Where addressed
Groundwater impacts, considering local impacts at each deep cutting and cumulative impacts on regional hydrology. The assessment must consider: > extent of drawdown > impacts to groundwater quality > discharge requirements; and > implications for groundwater-dependent surface flows (including springs and drinking water catchments) > groundwater-dependent ecological communities > groundwater users including the *Alstonville Basalt Groundwater Source Water Sharing Plan;*	Section 11.3

11.1 Approach

A phased approach was adopted for the groundwater evaluation of the proposed upgrade. The approach involved the following elements:

> Completion of initial ground investigations to characterise the geological and hydrogeological conditions along the proposed upgrade.

> Completion of detailed ground investigations, modelling and analysis at representative locations along the proposed upgrade.

> Extrapolation of the results of the detailed investigations to the remainder of the proposed upgrade.

The initial phases of the hydrogeological investigations were undertaken in conjunction with the geological and geotechnical investigations. The purpose of these investigations was to characterise the geological and hydrogeological conditions along the preferred route. In consideration of the relative complexity of the engineering issues associated with the tunnel beneath St Helena ridgeline, intensive investigations were completed in this area.

The initial investigations identified complex groundwater conditions within the basalt of the Alstonville Plateau. More detailed investigations were then undertaken to assist with the assessment of the impact that the proposed road cuttings would have on the hydrogeological conditions along the route. These additional investigations were completed at two cuttings that were considered to be representative of others along the route. The cuttings investigated comprised:

> Cutting 19 (Type A) at chainage 148000 to 148400. As this cutting penetrates below the underlying groundwater table, the impact would be related to both diversion of rainfall recharge and capture of groundwater flow.

> Cutting 6 (Type B) at chainage 140200 to 140600. As this cutting has limited penetration into the underlying groundwater table, the impact would be related to the diversion of rainfall recharge.

A third type of cutting (Type C) was also identified but not assessed as these cuttings are regarded as having little potential to impact on groundwater flows.

The locations of the different types of cuttings are shown on **Figures 11.1a, b and c.**

Table 11.1 shows details of each cutting. Following analysis and modelling of the results of the detailed investigation, the results were extrapolated along the proposed upgrade on the basis of similarity of geological and hydrogeological conditions

Table 11.1 - Cutting details

Cut No	Cut Depth (m)	Approx. Area Covered (m2)	Approx Penetration into groundwater table (m, max)	Type
0	8	23,010	1 - 2	B
1	12	42,000	2 - 3	B
2	1	16,740	-	C
3	13	19,200	-	C
4a+b	9	32,200	3	A
5	13	19,800	4 - 5	A
6	17	36,000	<1	B
7	14	14,410	-	C
8	9	25,740	<2	B
9	5	24,500	9 - 12	B
10	2	5,320	-	C
11	13	27,950	<3	B
12	7	16,830	-	C
14	10	17,480	-	C
15	28	57,550	<3	B
16	1	15,738	-	C
18a	13	14,900	-	C
18b	4	23,838	-	C

Table 11.1(cont)

Cut No	Cut Depth (m)	Approx. Area Covered (m2)	Approx Penetration into groundwater table (m, max)	Type
19	19	54,890	9	A
20	13	14,000	4	B
St Helena Hill Tunnel Area				
21		1,100	-	C
22	7	11,250	<3	B
23	11	5,795	Yes (portal)	B
Tunnel	N/A	7,500	12 - 19 (tanked)	C
24	15	7,500	Yes (portal)	B
25	13	13,800	-	C
26	4	16,000	-	C

Notes: Cut depth refers to the maximum excavation of the road cut below natural ground surface at the deepest point of penetration;
Area refers to the total area of the cut excavation;
Penetration into the groundwater table refers to the deepest vertical depth the cut excavation penetrates into the prevailing groundwater system/s present at the location in 2007;
A dash (‘‘-‘‘) means not present or not affected; and
‘‘tanked refers to the fact that the tunnel will have a sealed concrete liner (impermeable liner will not permit measurable groundwater flows into the tunnel void).

Figure 11.1a - Cutting locations

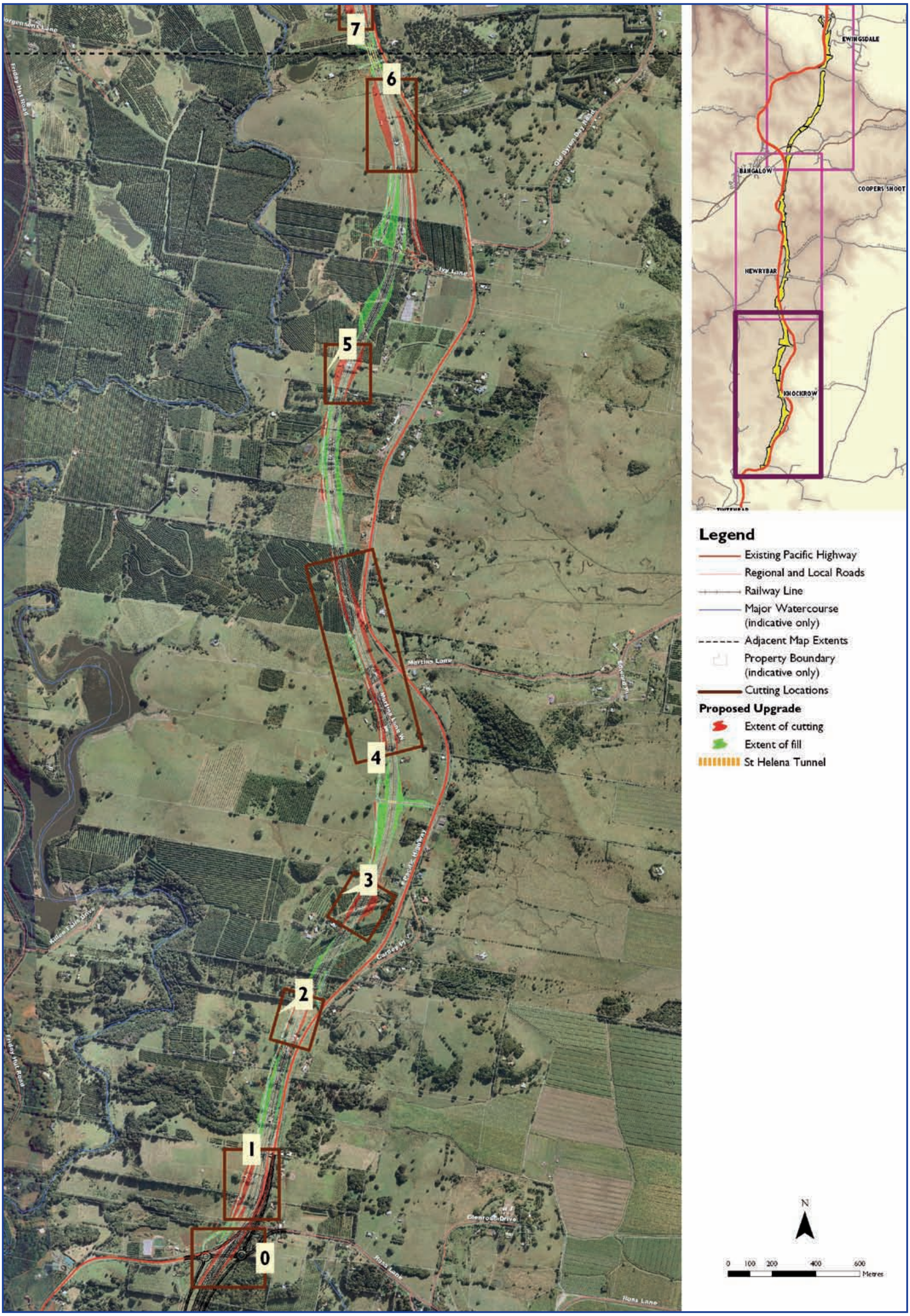


Figure 11.1b - Cutting locations

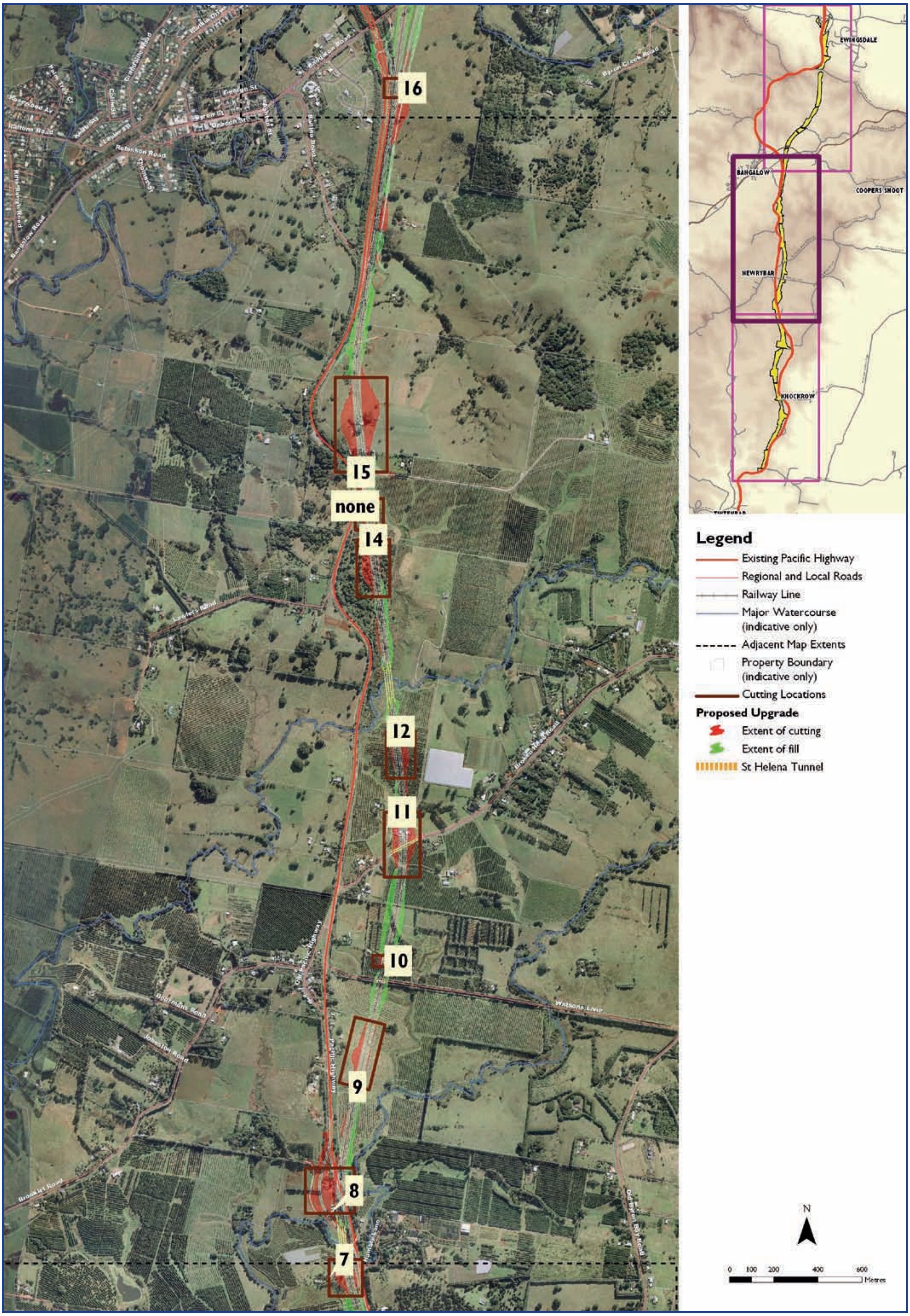
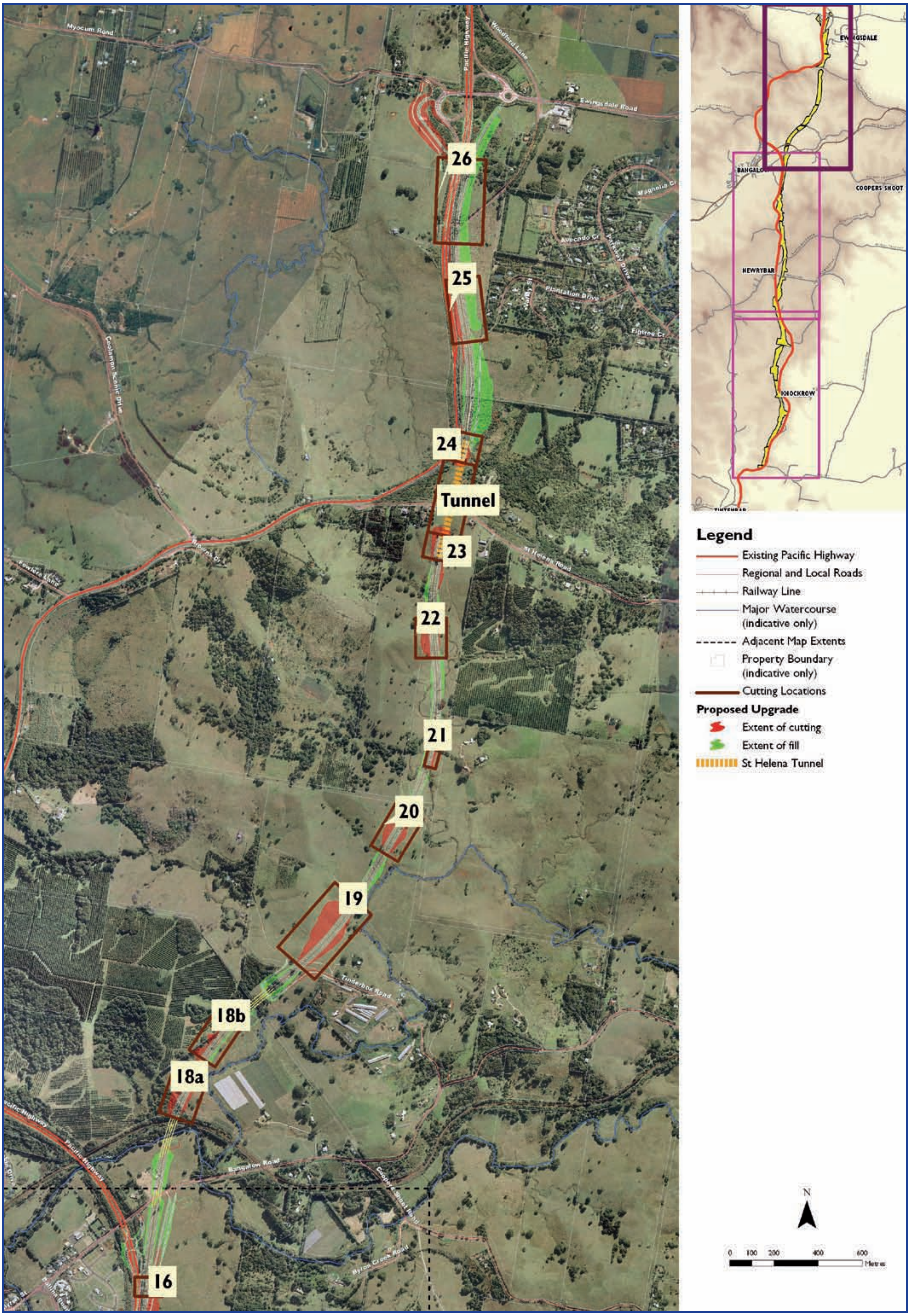


Figure 11.1c - Cutting locations



11.2 Existing groundwater characteristics

11.2.1 Geology

The Alstonville Plateau is made up largely of Lismore Basalt and all of the proposed works would occur in this geological unit.

The Lismore Basalt typically consists of a series of individual lava flows. These lava flows were extruded over a long period of time forming successive layers. Each flow is typically less than 25 m thick. In the periods between lava flows, weathering and deposition took place which allowed thin soil layers to be formed. These layers are now represented within the basalt as poorly lithified sedimentary rocks and as fossil soil horizons.

The hydrological characteristics of each individual basalt lava flow can be quite varied and can change both vertically and horizontally.

Recent exposure and weathering of the Lismore Basalt has resulted in further weathering of the rock.

While the stratigraphy of the plateau is quite complex, it typically comprises:

> Residual soils (derived from the weathering of the Basalt). These can be up to 5 m thick.

> Extremely weathered basalt rock, with essentially soil like properties. These can be up to 15 m thick.

> Discrete layers of basalt rock, generally less weathered but of very variable strength.

11.2.2 Groundwater model

Based upon the results of investigations, a groundwater model was developed to assist with the assessment of impacts. The model comprises an upper groundwater flow system and a deep groundwater flow system.

The upper groundwater flow system is contained within the residual soil and extremely weathered basalt layers. This system is complex, highly variable and likely to comprise numerous localised perched sub-systems. Flow in the system is largely horizontal and is likely to cascade down from one perched sub-system to another, until it reaches the deep groundwater system. For modelling purposes this system is considered to be unconfined.

The deep groundwater flow system is contained largely within the discrete layers of less weathered basaltic rock. Groundwater flow is likely controlled largely by the natural horizontal and vertical fractures within the rock and to a lesser extent by the fossil soil layers between individual flows. For modelling purposes this system is considered to be confined or semi-confined.

Groundwater features pertinent to this study are as follows:

> The local residual weathering profiles and regional layered geological sequences within the Lismore Basalt govern the nature of the 'upper and 'deep' (respectively) groundwater regimes in the area.

> Intermittent and perennial perched groundwater tables can be present within the shallow soil and weathered rock forming a complex, largely layered, cascading groundwater flow system.
> A deeper groundwater systems exist within the more permeable fractured or weathered layers of basalt that can be confined or semi-confined between the relatively massive and less permeable, basalt layers.
> Each of the identified systems has its own unique influence on the way recharge water (rainfall) runs off or infiltrates into the subsurface, thus creating two connected groundwater systems. There is likely to be a zone where the two systems overlap and where groundwater flow will be affected in part by each system. This zone produces a complex groundwater flow pattern, and one which is extremely difficult to interpret, predict and model.
> Regional groundwater flow in the Lismore Basalt generally follows the regional dip of the lava flows, that is, to the north-west. Local flow directions will be largely governed by the local topography, geology, and weathering profile.
> Each groundwater flow regime has the potential to give rise to springs at the surface, typically where zones or layers of lower permeability soil or rock outcrop at the ground surface.

Spring locations identified by the Bureau of Rural Sciences (BRS, Brodie and Green, 2002) are shown on **Figure 11.2.**

11.3 Potential groundwater impacts

The results of the various investigations and groundwater modelling were used to assess the likely impacts on the groundwater systems. The results from the investigation and analysis of two representative cutting types were used to extrapolate along the entire highway upgrade, based on cut area, depth of cut, extent of penetration into the groundwater table and slope shape. Based upon these criteria three types of cutting were identified: Type A, Type B and Type C out of 27 total cuts (not including the proposed tunnel).

Cutting type A is representative of three of the proposed 27 cuts. These cuttings are characterised by a significant depth of excavation, a large length and area and deep penetration into the groundwater table.

Cutting type B is representative of eleven of the 27 proposed cuts. These cuttings are characterised by moderate depth of excavation, small to moderate length and area and limited – less than 4 m – penetration into the groundwater table.

Cutting type C is representative of thirteen of the 27 proposed cuts. These cuttings are characterised by shallow depth of cuts and little or no penetration into the groundwater table. These are considered to have negligible impact on groundwater.

Details of the analysis and modelling carried out are given in *Working Paper 3 - Groundwater Assessment* and the location of these various cutting type are shown in **Figure 11.1.**

11.3.1 Extent of drawdown

Drawdown of the groundwater at Type A cuttings is likely to extend to the same depth as the base of the cutting. This could potentially cause a reduction in recharge to the local groundwater systems of up to 25 percent of their normal recharge. This drawdown is likely to have impacts to a distance of about 200 m from the cutting.

11.3.2 Impacts on groundwater quality

Surface water running off the road surface would generally be intercepted by catch-drains before seeping into cuttings. Some runoff may infiltrate before reaching sediment basins. The small quantity of untreated runoff entering the groundwater system suggests a low likelihood of impact to groundwater quality beyond the immediate road corridor.

11.3.3 Discharge requirements

Measures proposed to mitigate the impacts estimated include options to re-introduce water capture by the road cuttings in the local ground water systems. These measures will require the water quality be polished to ensure it meets background water quality in the local aquifer system.

11.3.4 Impacts on groundwater dependant surface flows, springs, drinking water catchments and groundwater dependent ecosystems

The potential impacts on groundwater dependent surface flows, springs and water catchments and groundwater dependent ecosystems at each cut are summarised in **Table 11.2.** Potential requirements for monitoring and mitigation are also identified. The implementation of the management measures described in **Section 11.4** would be expected to reduce the impacts described in **Table 11.2** to minimal levels. Definitions of groundwater dependent ecosystems are provided in **Section 12.3.9**.

Table 11.2 - Groundwater impact summary

Cut No.	Type	Potential Impact before Mitigation
0	B	Minor reduction of groundwater to creek and potential spring and local water resource within approximately 100 m of cutting. Water course related Groundwater dependent ecosystems present in the vicinity of cut (no groundwater-reliant rainforest or wetlands are present in the area of potential impact).
1	B	Minor reduction of groundwater to creek and potential springs, and local water resource within approximately 100 m of cutting. Potential impact to water course related groundwater dependent ecosystems present in the vicinity of cut (no groundwater-reliant rainforest or wetlands are present in the area of potential impact).
2	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
3	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
4a+b	A	Reduction of groundwater to local creeks and streams, and local water resource in the southern portion of the cut, i.e. within approximately 100 m of cutting. Potential impact to water course related groundwater dependent ecosystems present in the vicinity of cut (no springs or groundwater-reliant rainforest or wetlands are present in the area of potential impact, i.e. within 200 m of cutting).
5	A	Reduction of groundwater to local creeks and streams, and local water resource in the southern portion of the cut, i.e. within approximately 100 m of cutting. Potential impact to water course related groundwater dependent ecosystems present in the vicinity of cut (no springs or groundwater-reliant rainforest or wetlands are present in the area of potential impact, i.e. within 200 m of cutting).
6	B	Minor reduction of groundwater to creek and 4 potential springs, and local water resources within approximately 100 m of cutting. Potential impact to water course related groundwater dependent ecosystems and groundwater-reliant rainforest (north of cutting) present in the vicinity of cut (no groundwater-reliant wetlands are present in the area of potential impact).
7	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
8	B	Minor reduction of groundwater to creek and potential spring and water resource within approximately 100 m of cutting. Potential impact to water course related Groundwater dependent ecosystems present in the vicinity of cut (no groundwater-reliant rainforest or wetlands are present in the area of potential impact).
9	B	Minor reduction of groundwater to creek and potential spring and water resource within approximately 100 m of cutting. Potential impact to water course related groundwater dependent ecosystems present in the vicinity of cut (no groundwater-reliant rainforest or wetlands are present in the area of potential impact).

Table 11.2 (cont)

Cut No.	Type	Potential Impact before Mitigation
10	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
11	B	Minor reduction of groundwater to creek and water resource within approximately 100 m of cutting. Potential impact to water course related groundwater dependent ecosystems present in the vicinity of cut (no groundwater-reliant rainforest or wetlands are present in the area of potential impact).
12	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
14	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
15	B	Minor reduction of groundwater to creek and potentially to springs, and local water resources within approximately 100 m of cutting. Potential impact to water course related Groundwater dependent ecosystems present in the vicinity of cut (no groundwater-reliant rainforest or wetlands are present in the area of potential impact).
16	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
18a	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
18b	C	No measurable impact on local or regional groundwater systems or resources anticipated, there is a groundwater-reliant rainforest cluster (south) nearby but it is unlikely to be impacted. No wetlands are present in the vicinity of the cut.
19	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within approximately 100 m of cutting. Likely impact to water course related groundwater dependent ecosystems present in the vicinity of cut (no groundwater-reliant rainforest or wetlands are present in the area of potential impact).
20	B	Minor reduction of groundwater to creek and potential spring and local water resources within approximately 100 m of road cutting. Potential impact to water course related groundwater dependent ecosystems present in the vicinity of cut (no groundwater-reliant rainforest or wetlands are present in the area of potential impact).
St Helena Hill Tunnel Area		
21	C	No measurable impact on local or regional groundwater systems or resources anticipated. A cluster of groundwater-reliant rainforest may exist of the west and east of the Cut 21 but these are not likely to be impacted. No springs or groundwater-reliant wetlands are present in the vicinity of the cut.
22	B	Minor reduction of groundwater to creek and potential spring and local water resource within approximately 100 m of cutting. Potential impact to water course related Groundwater dependent ecosystems present in the vicinity of cut (no groundwater-reliant rainforest or wetlands are present in the area of potential impact).

Table 11.2 (cont)

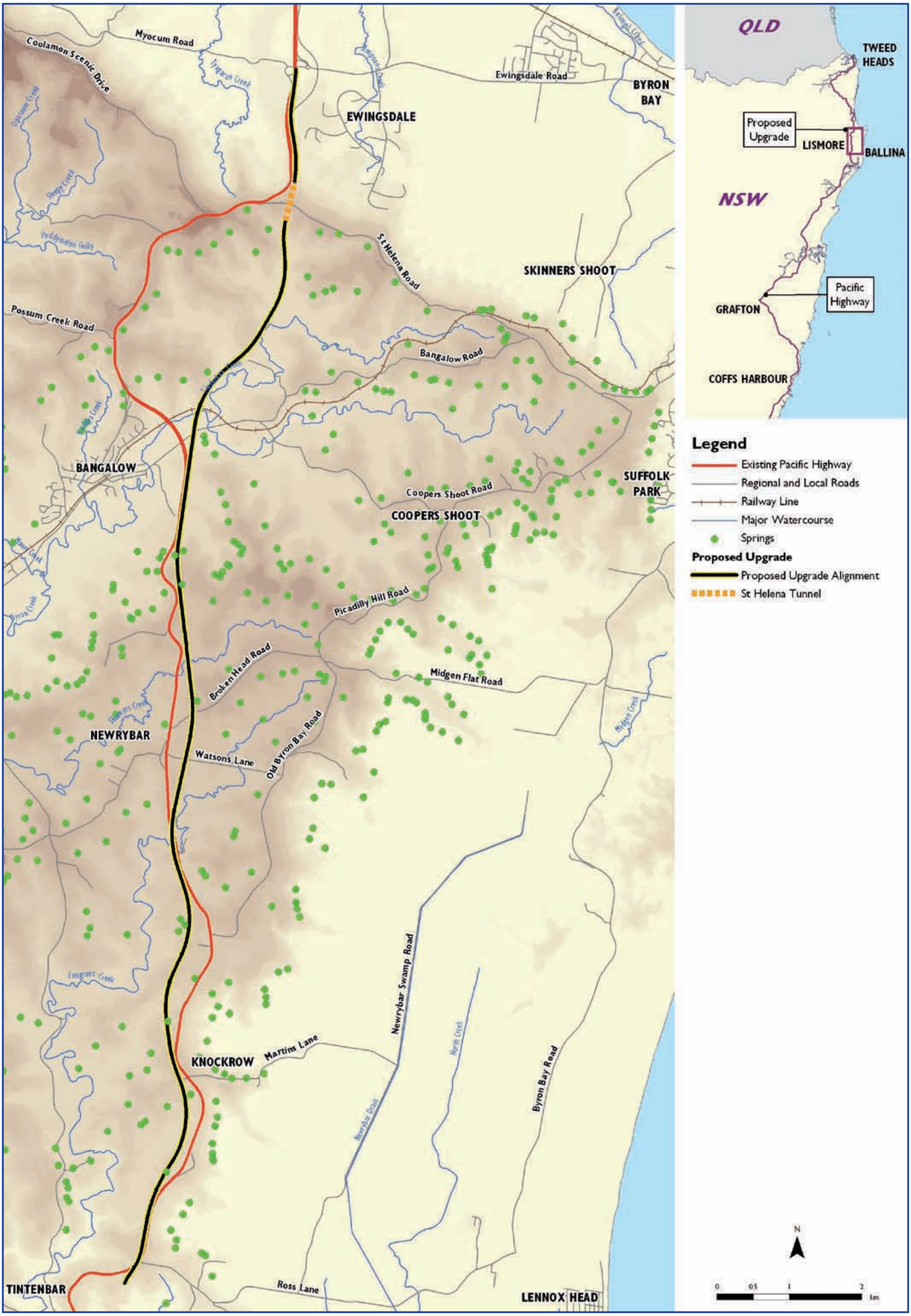
Cut No.	Type	Potential Impact before Mitigation
23	B	Minor reduction of groundwater to spring, creek and local water resource (groundwater well/s and dams) expected within approximately 100 m of portal excavation. Consequentially, minimal impact to water course related Groundwater dependent ecosystems present in the vicinity of cut (no springs, groundwater-reliant wetlands are present in the area of potential impact). Previously mapped (Brodie and Green 2002) groundwater-reliant rainforest in the vicinity of the portal cut appears to no longer exist based on vegetation survey for the environmental assessment.
Tunnel	C	The tunnel is planned to be fully tanked (negligible leakage to tunnel), and therefore no impact anticipated (leakage to tunnel essentially not measurable) within approximately 100 m of excavation. No measurable impact on local or regional groundwater systems or resources anticipated. Groundwater-reliant rainforest clusters may be present in the vicinity of the tunnel (over and east/west) but are unlikely to be impacted. No groundwater-reliant wetlands are present in the vicinity of the tunnel.
24	B	Minor reduction of groundwater to spring and associated creek leading to local water resource dam (and possible groundwater well/s) expected within approximately 100 m of excavation. Minimal local potential impact to water course related groundwater dependent ecosystems present in the vicinity of cut anticipated (no groundwater-reliant wetlands are present in the area of potential impact). Previously mapped (Brodie and Green 2002) groundwater-reliant rainforest in the vicinity of the portal cut appears to no longer exist based on vegetation survey for the environmental assessment.
25	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
26	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.

The results of the analysis summarised in **Table 11.2** suggest that there are potential effects from the proposed upgrade on groundwater dependent surface flows and springs. These impacts would potentially be the greatest at Type A cuts. The management regime identified in **Section 11.4** however would be expected to reduce impacts to negligible levels or in a worst-case scenario, impacts would be highly localised.

Impacts to the quantity of water entering drinking water sources would be negligible. Any impacted (redirected) groundwater flows within the Emigrant Creek or Wilsons River drinking water catchments would remain within the catchments and would ultimately flow into the surface water system.

Potential impacts to groundwater dependent ecosystems would be restricted to the instream ecology of small creeks and drainage lines in the potential area of impact of Type A and to a lesser extent Type B cuts. No groundwater dependent terrestrial communities (rainforest) would be impacted.

Figure 11.2 - Spring locations



11.3.5 Regional groundwater impacts and impacts on groundwater-dependant ecological communities

A *Water Sharing Plan for the Alstonville Plateau Groundwater Sources* (DIPNR 2004) was prepared in February 2003 in accordance with the *Water Management Act (2000)*. The purpose of the water sharing plan was to sustainably allocate groundwater from the Alstonville Plateau source to environmental flows and other uses. The Alstonville Plateau groundwater source covers an area of about 391 square kilometres (km^2), some of which is located in the study area, and comprises a Tertiary Basalt plateau overlying Clarence Moreton basin sediments.

The annual average recharge of the aquifer was reported to be 44,472 megalitres per year (ML/yr), of which 80 percent or 35,578 ML/yr is allocated to environmental flows. Water allocated to environmental flows is to support river and stream base flows as well as groundwater dependent ecosystems.

The proposed upgrade traverses Bangalow Zone 3 Groundwater Source zone, Alstonville Zone 1 Groundwater Source zone and is slightly overlying Lennox zone 6 Groundwater Source zone as defined by the DWE.

The regional impact on either environmental flows or groundwater users as a result of the proposed upgrade is expected to be minimal given the small area of the resource traversed, and the proposed management of impacts described below, which would reduce local impacts to minimal levels.

11.4 Management of impacts

11.4.1 General mitigation

To effectively manage and mitigate groundwater impacts, and potential uncertainties about the actual impacts, the following approach is proposed:

> **Type A cuts:** There is a high likelihood that Type A cuts would affect groundwater regimes. Engineering measures to be implemented where necessary as part of construction to mitigate groundwater impacts. Long-term monitoring of the groundwater regime in the vicinity of Type A cuts would be commenced well in advance of the road construction. The results of the monitoring, before and during road construction, would determine whether engineering mitigation is required at some or all of the Type A cuts. After road construction, the monitoring should continue to verify the effectiveness of the engineering mitigation, so that modifications can be made, if required.

> **Type B cuts:** It is less likely that Type B cuts would adversely impact on groundwater regimes. Engineering mitigation measures are unlikely to be required at Type B cuts. However, long-term monitoring is proposed, commencing prior to construction, and observation of groundwater behaviour and impact during construction to verify impacts. The results of the monitoring and observations, would determine if engineering mitigation is required at any of the Type B cuts.

> **Type C cuts:** These cuts are expected to have no or negligible groundwater impacts. Monitoring and engineering mitigation measures are not required.

11.4.2 Monitoring

Monitoring of both groundwater level and chemical quality is proposed as an essential measure to mitigate uncertainty in predictions of groundwater behaviour, which have been based largely on groundwater observations over a relatively short period of time. The monitoring would comprise:

> Installation and monitoring of wells.

> Groundwater sampling and analyses for suspended solids and metals.

> Visual observations of surface water flows at springs and creeks.

> An assessment of groundwater dependent ecosystem healthiness.

Long-term monitoring of the existing monitoring wells should be continued up to, during and following construction of the cuts. The monitoring would be initiated prior to construction (background data collection), during construction and during the early years of operation, at a frequency to be determined (potentially quarterly for the first 5 years of operation, with a review of data to determine whether further monitoring is required).

New monitoring wells will need to be installed at Type A and B cuts where there are currently no monitoring wells installed. Additional monitoring wells may also be required at Cuts 6 and 19 where wells were previously installed for the purpose of this study.

The objective of long-term monitoring will be to:

> Obtain baseline groundwater data over a longer period than for this groundwater study and verify the validity of groundwater levels at the two cuts investigated during the study and at the other Type A and B cuts, verify long-term and adverse trends.

> For cuts at which engineering mitigation measures are implemented, permit an early assessment of groundwater behaviour in response to engineering mitigation measures and verify the effective functioning of the mitigation measures.

> At cuts where mitigation measures are not planned (Type B) verify that there are no adverse impacts as a result of the construction.

11.4.3 Potential engineering mitigation measures

Two categories of engineering mitigation measures could be considered at Type A cuts, and at Type B cuts, if monitoring indicates that engineering mitigation is required:

> Engineering mitigation measures that transfer the seepage water downstream. Standard practice would be to collect the seepage from the cut face in the drainage system for the highway, which would be diverted into water quality ponds before being released back into the creek or natural drainage system at some point downstream.

> Engineering mitigation measures that transfer the seepage water (where present) into the groundwater ecosystem immediately down-slope of the cut. These may involve collecting the seepage water from the cut face just above the level of the road, and piping it under the cut/fill platform to the down-slope side of the highway. This collection and piping system would also likely include seepage collected from the drainage blanket under the highway pavement. The collected water could then be returned to the ground through absorption trenches or discharged directly to the surface water system.

From the perspective of risk to local groundwater flow patterns, the second option above, would provide the better solution, although a system combining both may need to be applied in some circumstances. The preferred method and exact form of the mitigation measures would be the subject of ongoing development of the concept design and environmental assessment process.

12 Ecology

This chapter addresses the ecological impacts of the proposed upgrade. Both terrestrial and aquatic ecology are evaluated.

Environmental assessment requirement	Where addressed
> Consideration of threatened terrestrial and aquatic species, populations, ecological communities and/or critical habitat	Sections 12.3.2, 12.3.3, 12.3.4.
> Assessment of the following issues: native vegetation loss; weed infestation; habitat fragmentation; impacts to wildlife corridors including riparian corridors; impacts to groundwater-dependent communities, riparian and aquatic habitat	Sections 12.3.1, 12.3.5, 12.3.6, 12.3.8,12.3.9,
> Consideration of regional scale cumulative impacts and identify the significance of the impacts of the project in the context of the Pacific Highway Upgrade Program	Section 12.3.10

12.1 Assessment approach

The ecological assessment for the proposed upgrade involved terrestrial ecological studies by Biosis Research and aquatic ecological studies by The Ecology Lab. These assessments are documented in detail in *Working Paper 4 – Terrestrial flora and fauna assessment* and *Working Paper 5 – Aquatic ecology assessment.*

Terrestrial ecology

A number of terrestrial ecological investigations were carried out during the project, including:

> Targeted surveys for threatened species in the study area for the proposed upgrade on 14-18 November 2006.

> Verification of constraints mapping within the local area (as part of the route option development process) through site inspections on 1-2 and 14-15 November 2004, on 9-13 May 2005 and on 14-18 November 2005.

The term *study area* in relation to terrestrial ecology refers to the extent of the proposed works (including earthworks) plus 50 m (which allows for the majority of indirect effects on adjacent flora).

The terrestrial ecology study was conducted in accordance with the methodology employed for an assessment under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Part 3A Guidelines for Threatened Species Assessment (DEC & DPI 2005). Additional fauna survey techniques (such as spotlighting and audio recordings of bat calls) were employed to target threatened species thought to occur in the area as well as to gather information on groups of species and to assist in the compilation of species lists.

Some plant species that occur in the local area are annuals (completing their life cycle within a single season) and are present only in the seed bank for much of the year. Other plant species are perennial, but are inconspicuous unless flowering. Similarly, some fauna may be seasonally absent from the study area. Some species that fall into these categories may not have been recorded during the current study.

However, threatened species that fall into these categories are still considered in the impact assessment, as the assessment is based on the presence or absence of suitable habitat for a threatened species, requiring only the presence of habitat, not individual records, for a threatened species to be considered further. The methodology employed for this assessment is sufficient to determine if the proposed upgrade would affect any threatened terrestrial species, populations or ecological communities. More detail on survey and assessment methodology is provided in *Working Paper 4 – Terrestrial flora and fauna report.*

Aquatic ecology

The aquatic ecology investigations included the following:

Habitat assessment of individual waterways on the basis of existing physical and ecological characteristics:

> Sampling and testing of water quality from each waterway.
> Sampling of each waterway for fish and mobile invertebrates (prawns and shrimps).

Field observations and investigations of aquatic habitats and water quality were made on three occasions:

> 30 November and the 2 December, 2004.
> 23 and 26 May 2005.
> 29 November to 1 December 2006.

The habitat value of aquatic habitats within the study area was classified according to NSW Department of Primary Industries' guidelines document, Aquatic Habitat Management and Fish Conservation (DPI 1999).

The term study area in relation to aquatic ecology refers to any watercourse or wetland (natural or artificial) occurring within 500m of the centreline of the proposed upgrade. The potential impact of the proposed upgrade on downstream watercourses and wetlands is also considered.

12.2 Existing ecological characteristics

12.2.1 Terrestrial vegetation communities

Vegetation identified in the study area falls into the following community classifications:

> Lowland rainforest.
> Camphor laurel.
> Plantation.

Community classifications are based on species composition and structure. Lowland rainforest is the only one of these communities that is naturally occurring. The lowland rainforest identified in the study area is regarded as fitting the definition of ***lowland rainforest of the NSW North Coast and Sydney basin bioregions***, which is an endangered ecological community under the *Threatened Species Conservation Act 1995* (TSC Act).

Camphor laurel dominated vegetation was included despite the main species being a declared noxious weed, because it can perform some ecological function as fauna habitat and as a riparian buffer. Plantation refers to plantings of local, non-local native, and exotic species, but excludes macadamia plantations.

Fifteen individual vegetation patches were observed within the study area. These are shown on **Figure 12.1a-c** and described in **Table 12.1** below. The condition descriptions below are based on the level of weed intrusion and the representation of a natural structure and species composition.

Table 12.1 - Vegetation patches in the study area

Patch Number	Community type	Condition
1	Camphor laurel	poor
2	Lowland rainforest	poor
3	Lowland rainforest	poor to moderate
4	Lowland rainforest/Camphor laurel	poor to moderate
5	Lowland rainforest	poor
6	Lowland rainforest	poor
7	Lowland rainforest	poor
8	Plantation	poor
9	Camphor laurel	poor
10	Lowland rainforest	moderate
11	Lowland rainforest	poor
12	Camphor laurel	poor
13	Camphor laurel/Lowland rainforest	poor
14	Camphor laurel	poor
15	Lowland rainforest	poor

12.2.2 Terrestrial flora species

A total of 195 species of vascular plant were recorded from the study area, comprising 139 (71 percent) indigenous species and 56 (29 percent) introduced species.

Forty-nine threatened plant species listed under the TSC Act and/or the Environment *Protection and Biodiversity Conservation Act 1999* (EPBC Act), have been recorded or have potential habitat within 10 km of the study area (*DECC Atlas of NSW Wildlife* and the Federal Department of Environment, Water, Heritage and the Arts EPBC Online Database). Four threatened species listed under the TSC Act and EPBC Act have been previously recorded within the study area with the records confirmed during field surveys for the proposed upgrade, *Diploglottis campbellii, Macadamia tetraphylla, Syzygium moorei and Tinospora tinosporoides*. Two species listed as rare or threatened Australian plants (ROTAP) by Briggs and Leigh (1995), but not listed under the TSC Act or EPBC Act were recorded in the study area (*Archidendron muellerianum and Quassia sp. 'Mt Nardi'*).

12.2.3 Terrestrial fauna habitats

Suitability, size and configuration of vertebrate fauna habitats broadly correlate to the structure, connectivity and quality of local and regional vegetation types. Generally, these habitats can be categorised as:

> Rainforest.

> Camphor laurel.

> Plantations.

> Riparian (including rivers, creeks, drainage lines and wetlands).

> Cleared areas.

Finer scale habitat features in and near the study area include foraging resources, tree hollows, hollow logs, dams, temporary ponds and soaks. The habitat value of each is discussed in the following Figures.

Rainforest

Rainforest habitats provide a wide range of food and shelter for vertebrate fauna. This habitat has been highly disturbed and is restricted to small isolated patches of rainforest remnants within the study area which nonetheless have a refuge and other habitat functions for a range of species. This habitat correlates to lowland rainforest discussed in **Section 12.2.1** above.

Typical tree species in this habitat include figs, palms, silky oak, black bean and brush cherry, and supply food resources for a range of species, particularly birds and mammals. Mature trees which have the potential to support hollows (formed in stags, mature and/or senescent trees) are very limited.

The shrub vegetation and understorey is typically sparse reaching a maximum height of approximately 2 m and 1 m respectively. Abundant habitat is present with a scattered layer of ferns, vines and grasses covering a thick layer of leaf litter, bark and fallen logs. Many invertebrates and amphibians rely on this moisture-retaining habitat to over-winter or as refuge during periods of drought. Similarly, many reptiles rely on ground litter and debris for shelter and foraging.

All examples of this habitat in the study area have been previously disturbed and are subject to ongoing direct and indirect disturbance. The rainforest habitat is considered to have a moderate habitat value based on the ground flora containing a high number of indigenous species; the ground, log and litter layer being largely intact; and a large variety of habitat and resources being available for a range of native fauna.

Examples of threatened fauna that may utilise these habitats include rose-crowned fruit dove *P. regina*, masked owl, grey-headed flying fox and microchiropteran bats.

Camphor laurel

The study area contains a number of isolated patches of vegetation dominated by camphor laurel with *Pittosporum undulatum* and *Lantana camara*. The shrub layer and understorey are also dominated by camphor laurel saplings. Although this habitat is not generally as diverse as native forest, it can provide habitat for a range of fauna. Camphor laurel provides an important winter food source for fruit-eating fauna such as the rose-crowned fruit dove, topknot pigeon *Lopholaimus antarcticus* and white-headed fruit dove *Columba leucomela*. Habitat features such as logs, leaf litter, ferns and vines also provide shelter and foraging habitat for a range of native fauna including birds and reptiles.

Figure 12.1a - Vegetation

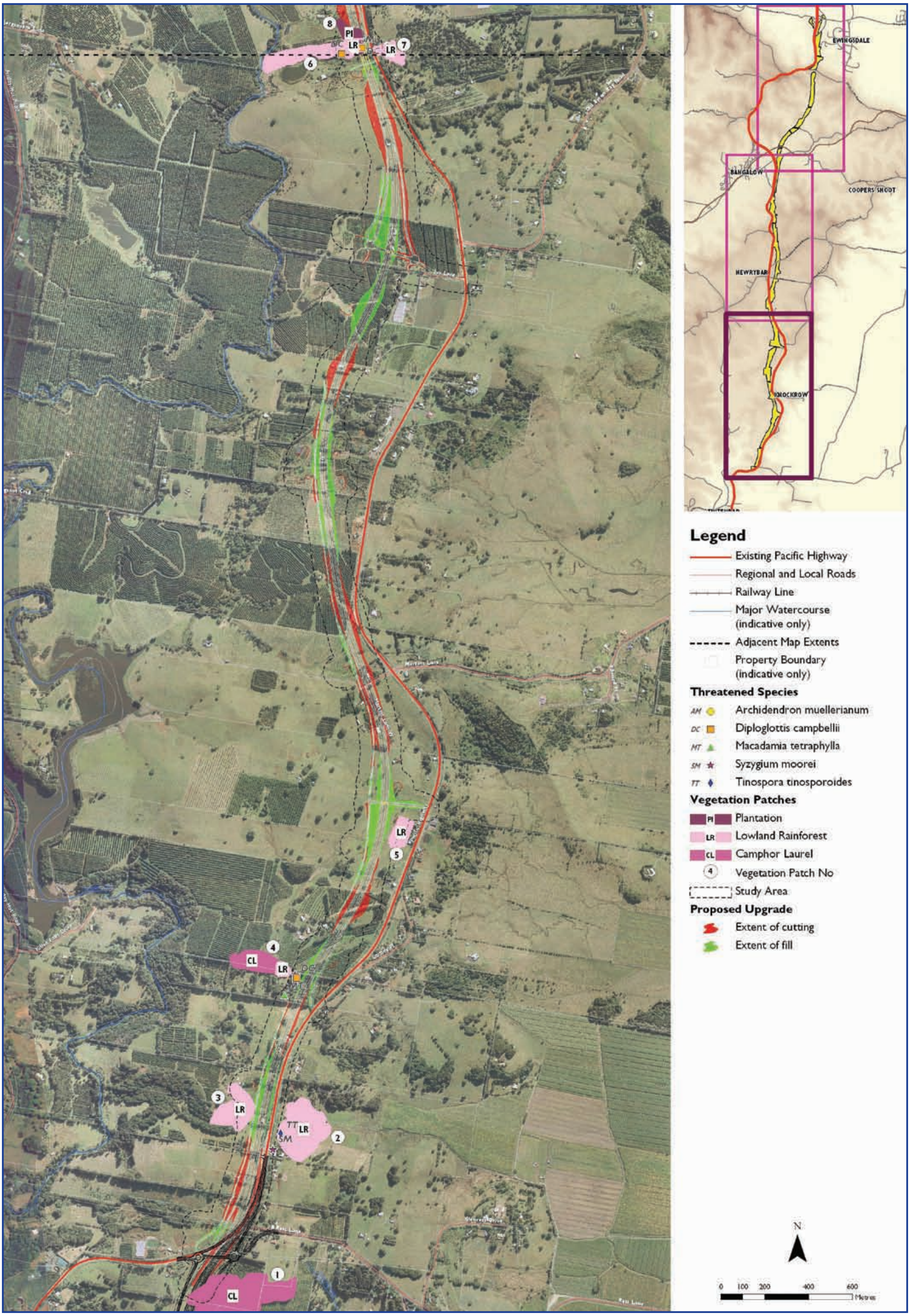


Figure 12.1b - Vegetation

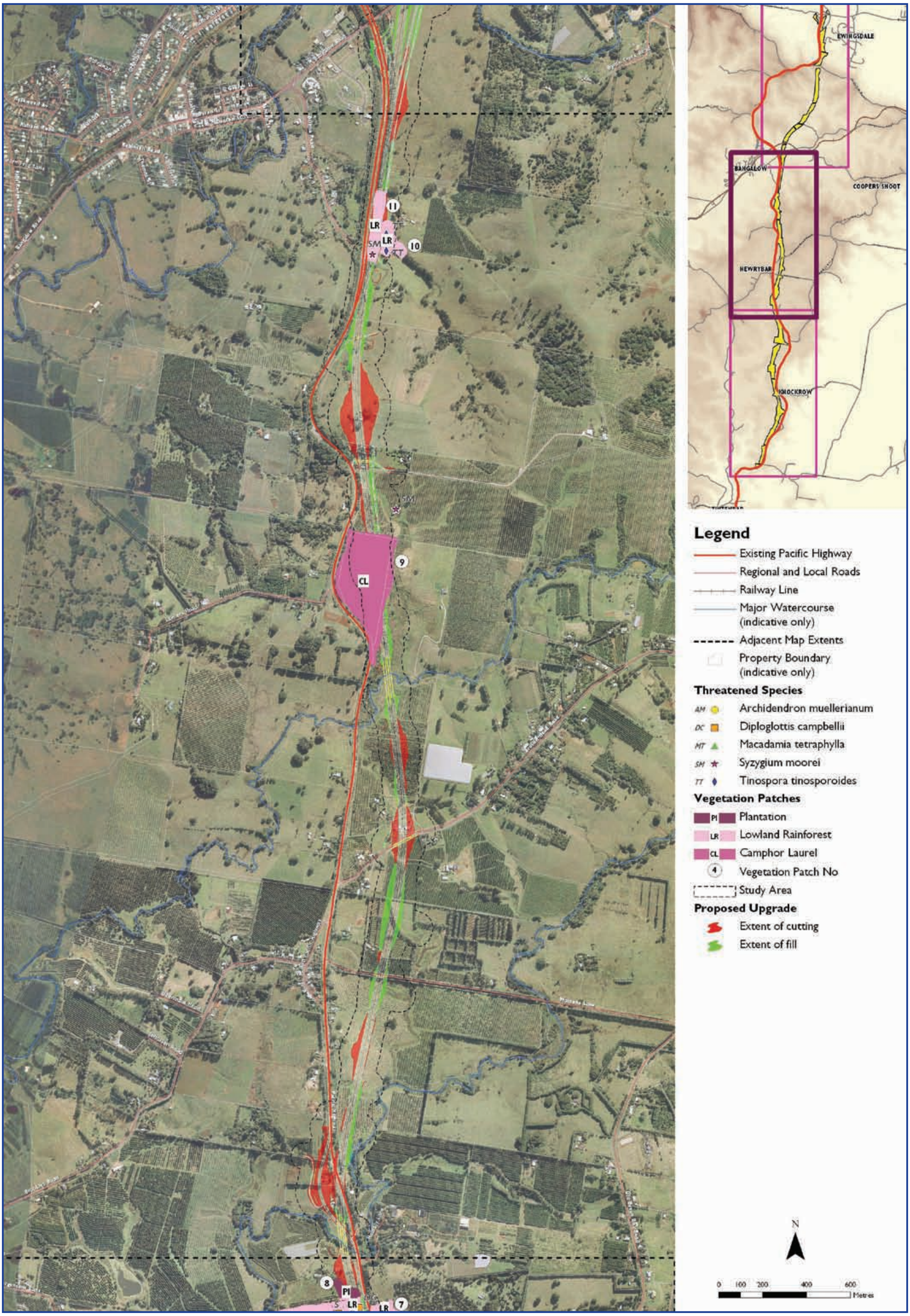
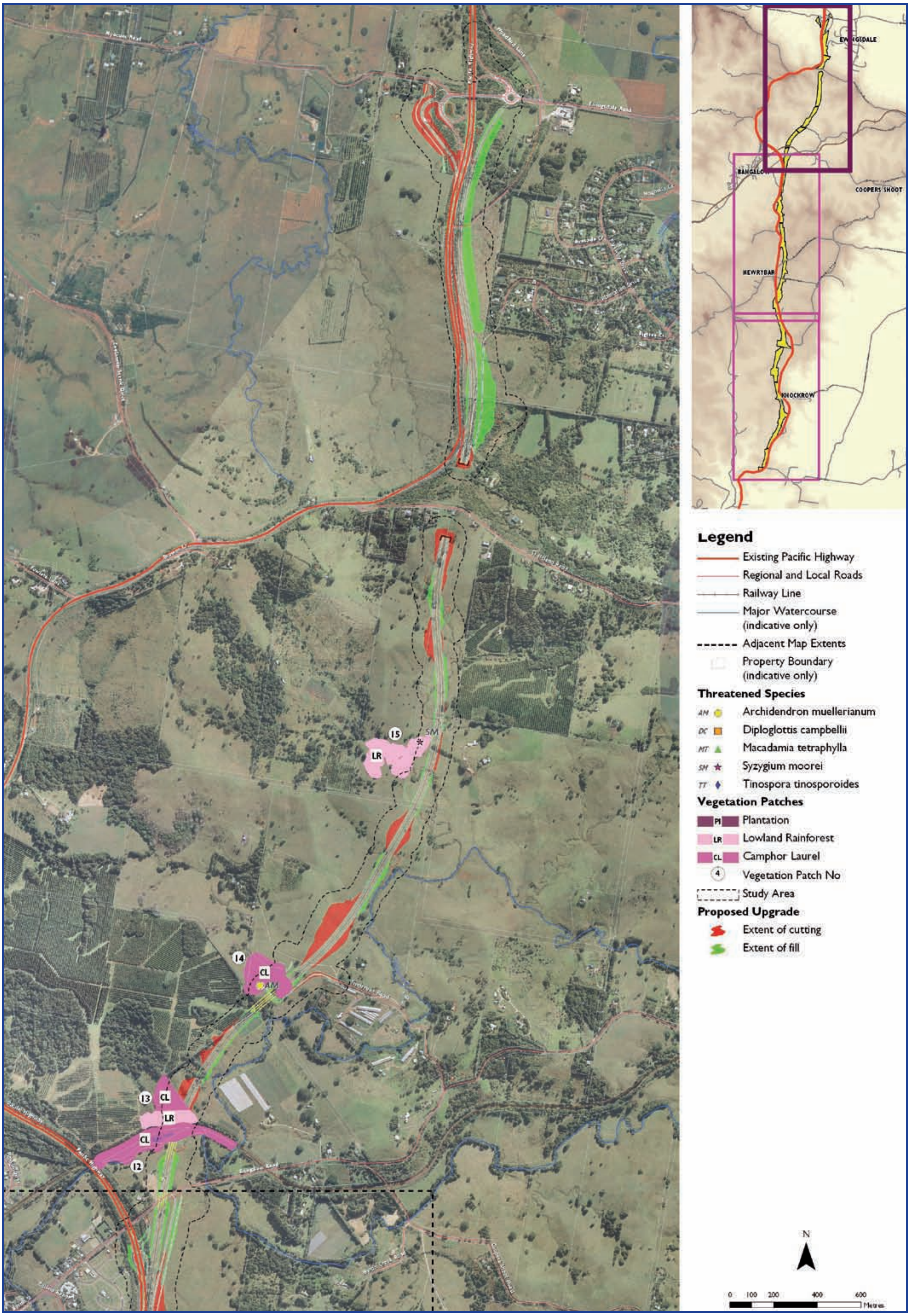


Figure 12.1c - Vegetation



Camphor laurel habitat is considered to have a moderate habitat value, with the ground flora containing a low number of indigenous species; plant communities being fragmented; and ground, log and litter layer being highly disturbed.

This habitat provides potential foraging habitat for the threatened species wompoo fruit dove *Ptilinopus magnificus*, rose-crowned fruit dove *Ptilinopus regina*, superb fruit dove *P.superbus*, and grey-headed flying fox.

Riparian

These riparian habitats are discussed in terms of habitat for terrestrial fauna only. See **Section 12.2.5** for a description of habitat for aquatic fauna.

Wet depressions (heath/sedgeland), creeks, drainage lines and farm dams provide optimal habitat for a range of vertebrate (amphibians, reptiles and small ground-dwelling mammals) and invertebrate species. These areas occur in various forms throughout the study area.

Larger creeks within the study area, such as Emigrant and Byron creeks provide habitat and resources for a range of species. The creek environment includes in-stream habitats, riverbanks, riparian vegetation and associated swamps. These habitats have a range of characteristics making them attractive to fauna such as the common eastern froglet *Crinia signifera* and large-footed myotis.

The creeklines within the study area have been previously disturbed due to agricultural, rural and residential development and associated infrastructure. They generally consist of only a narrow strip (10-20 m) of riparian vegetation through an otherwise agricultural landscape. These habitats within the study area are considered to have moderate habitat value.

Cleared areas

Some sections within and near the study area have been cleared for a range of uses including agriculture, residential properties and infrastructure. Despite these changes, some native species, such as Latham's snipe *Gallinago hardwickii*, may occur within disturbed vegetation and microhabitat components of these areas. However, generally these areas provide few habitat opportunities for native fauna. Species more likely to inhabit these areas include introduced and domestic animals and common native species tolerant of disturbance or favouring edge/ecotone habitat.

Cleared areas are considered to have low habitat value, with the ground flora containing a low number of indigenous species; plant communities being fragmented; the ground, log and litter layer being highly disturbed; and few resources available for native fauna.

Plantations

A number of pine and eucalypt plantations occur within the study area. Although these areas generally provide few opportunities for native fauna, they do provide foraging habitat for birds and bats, including the grey-headed flying fox which is listed as vulnerable on Schedule 2 of the TSC Act.

Plantations are considered to have low habitat value, with the ground flora containing a low number of indigenous species; ground, log and litter layer being highly disturbed; and few resources available for native fauna.

12.2.4 Wildlife corridors and habitat connectivity

A number of wildlife corridors have been identified by Department of Environment and Climate Change (DECC) and Byron Shire Council in the general Byron Bay/Bangalow area (**Figure 12.2**). The identification of these corridors is based on a regional scale representation of potential habitat and linking habitat for species and species assemblages. One of these corridors crosses the study area along the St Helena ridgeline and connects coastal ecosystems south and west of Byron Bay, to upland ecosystems west and north-west of Bangalow. The quality and extent of wildlife habitat within this corridor is relatively low and its designation as a wildlife corridor appears to be more related to its future potential with appropriate management than its current functionality.

On a more local scale, terrestrial wildlife would be expected to move along some of the creek corridors where there is a degree of riparian vegetation occurring. Emigrant Creek and Byron Creek are likely to be the most significant of these.

It should be noted that due to the large amount of clearing that has taken place in the landscape, even small patches of vegetation can be considered to be important habitat value to some fauna species. The isolated patches described in **Section 12.2.1** along with other vegetation patches in close proximity to the proposed upgrade, provide habitat stepping stones for more mobile species.

Terrestrial fauna species

Sixty-eight species of vertebrate were recorded from the study area including five amphibians, two reptiles, seven mammals and fifty-four birds. All species recorded are native apart from the introduced cane toad. Seven species listed under the EPBC Act, the TSC Act or both were recorded. These are listed in **Table 12.2** below.

Table 12.2 - Significant fauna species recorded during surveys of the study area

Latin name	Common name	EPBC Act status	TSC Act status
Ardea ibis	Cattle egret	Migratory	
Monarcha melanopsis	Black-faced monarch	Migratory	
Tyto novaehollandiae	Masked owl		Vulnerable
Pteropus alecto	Black flying fox		Vulnerable
Pteropus poliocephalus	Grey-headed flying fox	Vulnerable	Vulnerable
Miniopterus australis	Little bent-wing bat		Vulnerable
Myotis macropus*	Large-footed myotis		Vulnerable

* This species was previously grouped with Myotis adversus

An additional 58 species listed under the EPBC and TSC Acts have been previously recorded within 10 km of the study area (based on a search of the Atlas of NSW Wildlife (DECC 2008)) and have potential habitat within the study area. These are shown in **Table 12.3.**

Figure 12.2 - Previously identified wildlife corridors

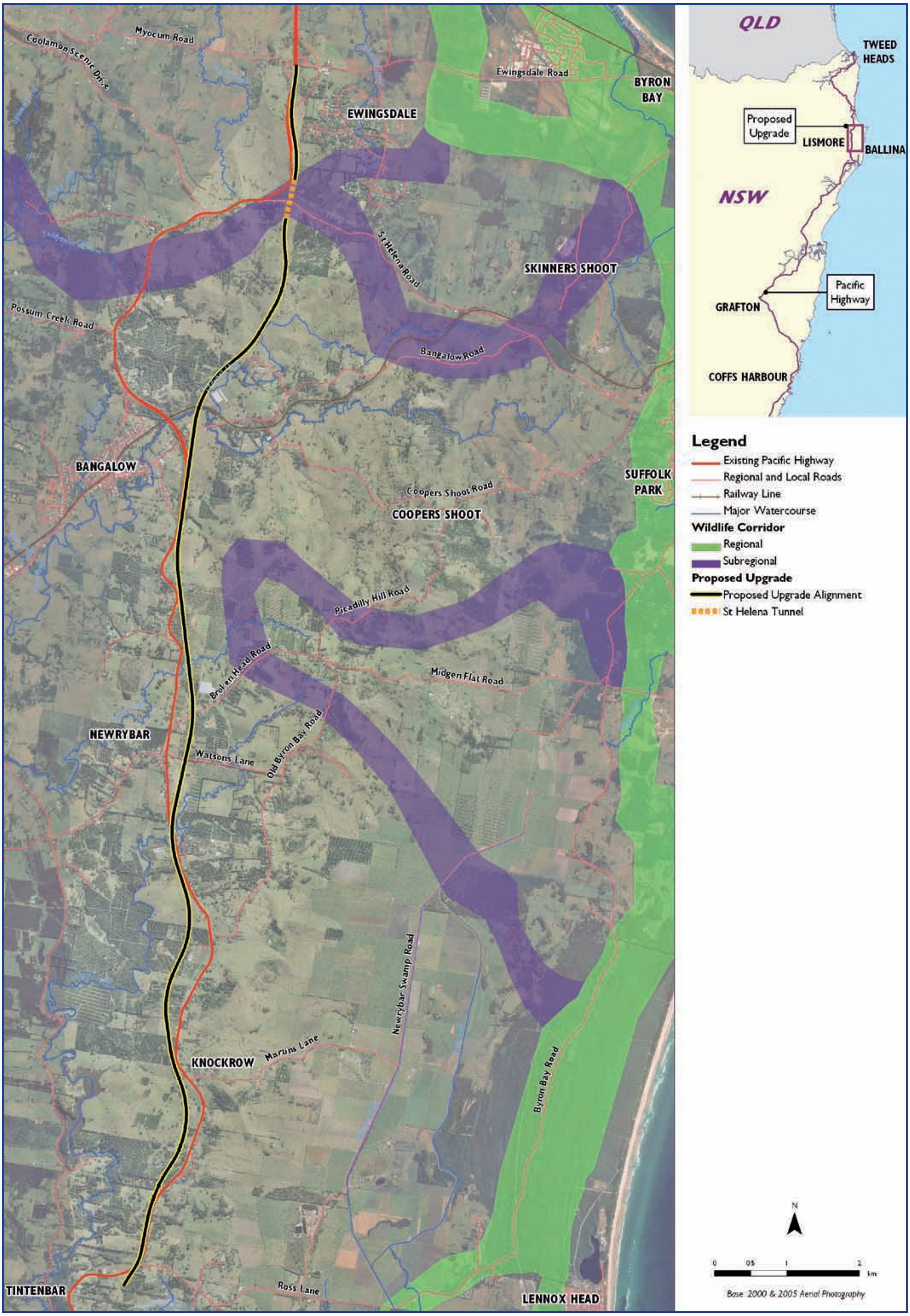


Table 12.3 - Threatened animal species with known/potential habitat likely to be impacted by the proposed upgrade

Scientific Name	Common Name	TSC Act	EPBC Act
Amphibians			
Assa darlingtoni	Pouched Frog	V	-
Crinia tinnula	Wallum Froglet	V	
Litoria aurea	Green and Golden Bell Frog	E1	V
Litoria olongburensis	Olongburra Frog	V	V
Birds			
Amaurornis olivaceus	Bush-hen	V	-
Anseranas semipalmata	Magpie Goose	V	-
Botaurus poiciloptilus	Australasian Bittern	V	-
Burhinus grallarius	Bush Stone-curlew	E1	-
Calyptorhynchus banksii	Red-tailed Black-cockatoo	V	E
Calyptorhynchus lathami	Glossy Black-cockatoo	V	E
Coracina lineata	Barred Cuckoo-shrike	V	-
Cyclopsitta diophthalma	Coxen's (Double-eyed) Fig-Parrot	E1	E
Dromaius novaehollandiae	Emu	E2	-
Ephippiorhynchus asiaticus	Black-necked Stork	E1	-
Erythrotriorchis radiatus	Red Goshawk	E1	VM
Gallinago hardwickii	Latham's Snipe	-	M
Grus rubicunda	Brolga	V	M
Haliaeetus leucogaster	White-bellied Sea-eagle		M
Hirundapus caudacutus	White-throated Needletail		M
Irediparra gallinacean	Comb-crested Jacana	V	-
Ixobrychus flavicollis	Black Bittern	V	-
Lathamus discolor	Swift Parrot	E1	EM
Lichenostomus fasciogularis	Mangrove Honeyeater	V	-
Lophoictinia isura	Square-tailed Kite	V	M
Monarcha leucotis	White-eared Monarch	V	-
Monarcha trivirgatus	Spectacled Monarch	-	M
Myiagra cyanoleuca	Satin Flycatcher	-	M
Pandion haliaetus	Osprey	V	
Pezoporus wallicus	Ground Parrot	V	
Podargus ocellatus	Marbled Frogmouth	V	-
Poephila cincta	Black-throated Finch	E1	V
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V	-
Ptilinopus magnificus	Wompoo Fruit-dove	V	-
Ptilinopus regina	Rose-crowned Fruit-dove	V	-
Ptilinopus superbus	Superb Fruit-dove	V	-
Puffinus carneipes	Flesh-footed Shearwater	V	M
Rhipidura rufifrons	Rufous Fantail	-	M
Rostratula benghalensis	Painted Snipe	V	VM
Stagonopleura guttata	Diamond Firetail	V	

Table 12.3 (cont)

Scientific Name	Common Name	TSC Act	EPBC Act
Stictonetta naevosa	Freckled Duck	V	M
Todiramphus chloris	Collared Kingfisher	V	-
Turnix maculosa	Red-backed Button-quail	V	
Turnix melanogaster	Black-breasted Button-quail	E1	V
Tyto capensis	Grass Owl	V	-
Tyto tenebricosa	Sooty Owl	V	-
Xanthomyza phrygia	Regent Honeyeater	E1	E
Mammals			
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Dasyurus maculatus	Spotted-tailed Quoll	V	E
Miniopterus schreibersii	Eastern Bent-wing Bat	V	-
Nyctimene robinson	Eastern Tube-nosed Bat	V	
Nyctophilus bifax	Eastern Long-eared Bat	V	V
Phascolarctos cinereus	Koala	V	-
Planigale maculata	Common Planigale	V	-
Potorous tridactylus	Long-nosed Potoroo	V	V
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-
Syconycteris australis	Common Blossom-bat	V	-
Reptiles			
Coeranoscincus reticulatus	Three-toed Snake-tooth Skink	V	V
Invertebrates			
Thersites michellae	Mitchell's Rainforest Snail	E1	Z

E = endangered species (EPBC Act)

E1 = endangered species (TSC Act)

E2 = endangered population (TSC Act)

V = vulnerable species (TSC and EPBC Acts)

M = migratory species (EPBC Act)

Z = critically endangered species (EPBC Act)

12.2.5 Aquatic habitats

The habitat value of aquatic habitats within the study area was evaluated on the basis of field investigations of the named creeks. A summary of the habitat value of each of these habitats is shown in **Table 12.4**.

Table 12.4 - Aquatic habitat value

Aquatic Habitat	Habitat Value *
Tributary of Emigrant Creek	Class 3 – minimal fish habitat
Emigrant Creek (downstream of dam)	Class 2 – moderate fish habitat
Emigrant Creek (0-2 km upstream of dam)	Class 1 – major fish habitat
Emigrant Creek (immediately downstream of existing highway crossing)	Class 2 – moderate fish habitat
Emigrant Creek (upper reaches)	Class 3 and 4 - minimal and unlikely fish habitat
Skinners Creek	Class 3 and 4 - minimal and unlikely fish habitat
Byron Creek	Class 2 – moderate fish habitat
Tinderbox Creek and tributaries	Class 2 and 3 - moderate and minimal fish habitat

* Habitat value is based on NSW Department of Primary Industries' guidelines document, ***Aquatic Habitat Management and Fish Conservation.***

Higher fish habitat values are given to those creeks with a relatively high water quality and where the creek morphology is conducive to fish habitat. The Class 1 rating for Emigrant the area immediately upstream of Emigrant Creek dam is largely due to its relatively large volume, which provides good habitat for a range of fish species.

12.2.6 Threatened aquatic species

The *Fisheries Management 1994 (FM Act)* identifies two threatened freshwater species whose ranges potentially include the watercourses traversed by the proposed upgrade. These species are the endangered eastern freshwater cod (*Maccullochella ikei*) and oxleyan pygmy perch (*Nannoperca oxleyana*). A search of the NSW Fisheries *fishfiles* database found records for both of these species within the Richmond River system, however, none of these records were within the Emigrant Creek, Skinners Creek, Tinderbox Creek or Byron Creek catchments.

Given that eastern freshwater cod has only been recorded well downstream and in larger watercourses than exist in the vicinity of the proposed upgrade, it is considered unlikely that suitable habitat occurs.

The oxleyan pygmy perch only occurs in low-lying Banksia dominated ecosystems. This habitat does not occur in the vicinity of the proposed upgrade.

Emigrant Creek downstream of the existing highway crossing. This part of Emigrant Creek has been identified as having moderate fish habitat value.

12.3 Impacts on ecology

12.3.1 Loss of terrestrial vegetation and fauna habitat

Table 12.5 shows the area of each plant community recorded in the study area that would be affected by the proposed upgrade. Direct impact refers to vegetation clearance. Indirect impacts are calculated by buffering the direct impact area by 50 m, based on a 50 m average extent of edge effects described by Biosis Research (2000) and Bali (2005).

Table 12.5 - Area of each plant community affected by the proposed upgrade

Plant community	Affected area (ha)	
	Direct	Indirect
Lowland Rainforest	2.0	3.6
Camphor Laurel	5.7	9.5
Plantation	2.7	0.5
Total	**10.4**	**13.6**

Small fragmented patches of native vegetation would be affected by the proposed upgrade. The condition of the vegetation that would be affected is generally poor, due to previous direct disturbance and the influence of edge effects that results from its fragmentation. This vegetation does have some habitat value however, particularly given the clearance that has previously occurred in the landscape.

A large proportion of the vegetation occurs as the result of planting and does not have the potential to become self-sustaining. The majority of vegetation to be removed is from patches dominated by camphor laurel, which, while performing some wildlife habitat function, is a declared noxious weed in this area.

12.3.2 Loss of threatened ecological communities and critical habitat

There would be a potential direct loss of 2.0 ha of lowland rainforest (listed as an endangered ecological community under the TSC Act). Existing edge effects on adjacent lowland rainforest may also be exacerbated by the proposed upgrade. There is estimated to be 776 ha of lowland rainforest within 10 km of the study area. The proposed upgrade would result in the direct loss of 0.26 percent of this.No critical habitat listed under the TSC Act or the EPBC Act would be affected by the proposed upgrade.

12.3.3 Loss of threatened plant species

Four threatened plant species previously recorded and/or recorded during surveys would be directly or indirectly affected by the proposed upgrade. These are described following and shown in **Figures 12.1a, b and c.**

Diploglottis campbellii

Diploglottis campbellii is listed as endangered under both the TSC and EPBC Acts. The following individual specimens have been recorded in the project area:

> Two (apparently planted) specimens in vegetation patch 6.
> One specimen immediately south-east of vegetation patch 4.

Macadamia tetraphylla

Macadamia tetraphylla is listed as vulnerable under both the TSC and EPBC Acts. Hybrids of the species occurring in commercial plantations are not included in this assessment. The following individual specimen has been recorded in the study area:

> One planted specimen in a garden landscape near vegetation patch 4.

Syzygium moorei

Syzygium moorei is listed as vulnerable under both the TSC and EPBC Acts. The following individual specimens have been recorded in the study area:

> One record in vegetation patch 15, supporting 15 mature trees.
> One specimen in vegetation patch 11.
> One specimen to the north of vegetation patch 9 on the edge of the study area.
> One specimen (likely to have been planted) in vegetation patch 6.
> One planted specimen in a garden landscape south-west of vegetation patch 2.

Tinospora tinosporoides

Tinospora tinosporoides is listed as vulnerable under both the TSC and EPBC Acts. The following individual specimens have been recorded in the study area:

> Two specimens in vegetation patch 10.
> One specimen in vegetation patch 2.

12.3.4 Loss of significant fauna species

A detailed evaluation of potential impact on each of the recorded and potentially occurring significant fauna species is included in *Working Paper 4 – Terrestrial flora and fauna assessment.* The evaluation identifies no significant impacts of the proposed upgrade on any of these species. This is primarily due to the small amount of habitat that would be removed by the project, combined with the relatively low habitat value of the majority of this habitat. Many of the species with actual or potential habitat in the study area (including all of the species recorded in survey undertaken for the proposed upgrade) are highly mobile and not dependent on these small habitat fragments for their survival.

Stand of the threatened species Syzygium moorei in vegetation patch 15.

12.3.5 Habitat fragmentation and barrier effects

The study area has been highly disturbed and contains a number of isolated patches of remnant vegetation. The proposed upgrade generally follows the path of the existing Pacific Highway, thereby minimising further fragmentation of habitats and barrier effects. The proposed upgrade is unlikely to increase the impact of fragmentation on threatened species and endangered ecological communities in the local area given the high degree of fragmentation in the existing landscape.

The proposed upgrade crosses a previously identified sub-regional wildlife corridor in the northern section of the study area. However, the road would be tunnelled through St Helena ridge, thereby minimising fragmentation within the identified corridor and not hindering future efforts to improve the functionality of the corridor.

12.3.6 Edge effects and weed infestation

Edge effects are zones of changed environmental conditions (such as altered light levels, wind speed, temperature) occurring along the edges of habitat fragments. These new environmental conditions along the edges can promote the growth of different vegetation types (including weeds) and allow invasion by pest animals specialising in edge habitats. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators (Berry 2002). This new zone of habitat inside the edge of a fragment can also exacerbate barrier effects.

Using the estimate of edge effects of 50 m proposed by Biosis Research (2000), the proposed upgrade would affect 3.6 ha of native vegetation through edge effects. An additional 10 ha of non-native vegetation would also be affected by edge effects (**Table 12.5**). The proposed upgrade would not create any new edge effects, as the affected patches are small and isolated and already heavily edge affected by other existing uses. It may however increase the magnitude of the existing edge effects.

12.3.7 Mortality

Fauna injury or death can occur as a result of highway construction and operation in two ways:

> *During the break-out phase of construction (when vegetation is removed to expose a natural earth substrate*). Habitat clearance may result in the injury or death of resident or visiting fauna. Some species can more readily evade injury by flying (birds) or 'running' away (such as the larger mammals). Many species, however, are unlikely to move quickly enough to avoid the clearing activities. For example, many nocturnal species (possums, gliders, bats) shelter during the day and smaller ground-dwelling species, such as lizards and snakes, are unable to move rapidly and over large distances.

> *Road kills*. Mortality due to road kill during operation has the potential to affect local fauna species at the sub-population level. In general, rates of road kill mortality are likely to be directly proportional to the distance of native vegetation/fauna habitat crossed by the highway (Forman et al. 2003). However, other factors such as the design of the road (such as height in relation to surrounding ground level, presence of walls and fences, fauna underpasses) also influence road kill mortality. As there is a small amount of habitat for species vulnerable to road kill mortality, roadkill would not be not anticipated to be a major cause of mortality on local populations of wildlife.

12.3.8 Aquatic disturbance, changed hydrology and fish passage

The watercourses along the proposed upgrade are small creeks or drainage lines. Crossing watercourses of this nature would cause little to no impact on aquatic habitats, assuming no in-stream structures are required. New bridges would be installed where the proposed upgrade crosses a tributary of Emigrant Creek, Emigrant Creek, Skinners Creek, Byron Creek and a tributary of Tinderbox Creek.

The proposed upgrade includes the diversion of Tinderbox Creek or its small tributaries in three locations to avoid multiple creek crossings over short distances. The diverted sections of the creek would be created to mimic the creek under the footprint of the proposed upgrade and would not cause significant reductions in habitat availability or water quality.

Potential impacts to aquatic ecology are summarised in **Table 12.6.**

Table 12.6 - Aquatic ecology impact summary

Catchment/Watercourse	Potential Impact
Emigrant Creek/Unnamed tributary of Emigrant Creek	> Highway batter would be located approximately 21 m from the creek, with a distance of 17 m from the edge of the cleared area, potential for run-off into creek.
Emigrant Creek/Drainage Lines between Carney Place and Ivy Lane	> Headwaters of minor creek diverted via box culvert, loss of natural creek habitat (app 160 m).
Emigrant Creek/ Martins Lane to Tributary of Emigrant Creek	> Diversion of altered creek line near Palm Springs Fish Hatchery, reduction in natural and created fish habitat as creek is diverted through culverts.
Emigrant Creek/Tributary of Emigrant Creek	> New bridge crossing would shade approximately 30 m of creek line.
Emigrant Creek/Emigrant Creek	> New bridge crossing to west of existing Pacific Highway bridge would shade 60 m of creek line.
Skinners Creek/ Tributary of Skinners Creek	> New bridge crossing upstream of existing Pacific Highway bridge would shade 35 m of creek line; reduction in natural habitats where creek is diverted beneath upgrade footprint via culverts
Byron Creek/Byron Creek	> Reduction in natural habitats where creek is diverted beneath upgrade footprint via culverts; new bridge crossing upstream east of the existing would shade about 43 m of creek line.
Tinderbox Creek/Tributary of Tinderbox Creek and Tinderbox Creek	> New bridge crossing would shade about 40 m of creek line; reductions in natural creek habitat on the order of 140 m (total) due to multiple diversions of creek line over meandering reach of creek
Simpson Creek/Tributaries of Simpsons Creek	> Reduction in natural creek habitat due to installation of culverts on minor creek lines

12.3.9 Groundwater dependent communities

The Bureau of Rural Sciences Australia (Brodie and Green 2002) identified and mapped the groundwater dependant ecosystems on the Alstonville Plateau, which are described as:

Wetlands – aquatic communities and fringing vegetation dependent on groundwater fed lakes and wetlands. These are lands permanently or temporarily under water or water logged, and include groundwater springs and seepage areas. There are no groundwater dependant wetlands in the study area.

River base flow systems – aquatic and riparian ecosystems that exist in or adjacent to streams that are fed by groundwater base flow. Groundwater may be a significant contributor to flows in coastal streams supporting riparian forests, "sedgelands" and grasslands, as well as in-stream flora and fauna.

Terrestrial vegetation – vegetation communities and dependent fauna that have seasonal or episodic dependence on groundwater. These include trees and shrubs that require the water table to be at least episodically or periodically within their root zone.

Native plant communities recorded within the study area that may be groundwater dependant include rainforest and riparian vegetation.

The outcome of predictive modelling described in *Working Paper 3 – Groundwater assessment*, suggests that impacts to groundwater dependant ecosystems in the hyporheic zone (the zone where groundwater and stream water mixes) are likely in the case of cuts which penetrate into the water table zone upgradient of springs and creeks.

The in-stream ecology of some small drainage lines would potentially be impacted as a result of localised groundwater changes created by some of the larger proposed cuts (as described in **Table 11.2**). Proposed management measures are likely to restrict any impacts to negligible or highly localised levels. None of the identified patches of terrestrial vegetation described in **Section 12.2.1** would be in the area potentially impacted by these cuts.

12.3.10 Regional scale cumulative impacts

The proposed upgrade occurs in a highly developed landscape, dominated by rural development. Consequently, much of the native vegetation of the local area has been cleared and the remnants are small, isolated and fragmented. Accordingly, the proposed upgrade in itself would have a relatively low impact.

The overall biodiversity impacts of the entire Pacific Highway Upgrade Program are greater than those assessed in association with the Tintenbar to Ewingsdale upgrade. Sections of the highway are at different stages of planning and development, with some sections already upgraded and others proposed for upgrade. The cumulative impacts of the entire Pacific Highway Upgrade Program would include a greater extent of clearing of native vegetation and habitats, including endangered ecological communities and threatened species habitat, as well as further fragmentation of habitat.

Table 12.7 details the direct vegetation removal associated with the 13 Pacific Highway Upgrade Program projects that have been declared critical infrastructure by the Minister for Planning under Section 75B(1) of the *Environmental Planning and Assessment Act 1979*. Twelve of the 13 projects (the exception is F3 to Raymond Terrace) are located within the

North Coast bioregion (IBRA 5-1, Thackway & Cresswell 1995). In relation to the Pacific Highway Upgrade Program, the proposed upgrade represents 4.2 percent of the total length of the Pacific Highway to be upgraded, 0.7 percent of the total vegetation to be removed (note: for the proposed upgrade, this includes non-native treed vegetation) and approximately 0.45 percent of the likely extent of endangered ecological communities to be removed. However, it should be noted that the final route of some of these projects have not yet been finalised and the total extent of vegetation clearing may change as the projects develop. For projects at earlier stages of planning, the clearing estimates are more likely to be revised downward as the figures provided reflect the entire corridor width rather than the extent of pavement and earthworks.

Table 12.7 - Regional scale cumulative ecological impacts

Project name	Project status	Project length (km)	Likely vegetation disturbance (ha)	Likely endangered ecological community disturbance (ha)
Banora Point	Environmental assessment submitted for approval	2.5	8	4
Tintenbar to Ewingsdale	Environmental assessment commenced	17	10	2
Woodburn to Ballina	Concept design selected	36	66	52
Iluka Road to Woodburn	Concept design selected	35	117	31
Wells Crossing to Iluka Road	Preferred route selected	71	410	88
Woolgoolga to Wells Crossing	Preferred route selected	27	207	33
Sapphire to Woolgoolga upgrade	Environmental assessment submitted for approval	25	83	18
Coffs Harbour Bypass	Concept design included in LEP	55	Not yet available	Not yet available
Macksville to Urunga	Environmental assessment commenced	3	Not stated	Not stated
Warrell Creek to Urunga	Environmental assessment commenced	45	236	82
Kempsey to Eungai	Environmental assessment submitted for approval	40	258	65
Oxley Highway to Kempsey	Environmental assessment commenced	37	229	66
F3 to Raymond Terrace	Preferred route selected	14	Not yet available	Not yet available

12.4 Management of impacts

12.4.1 Loss of terrestrial vegetation and fauna habitat

Measures proposed to minimise the loss of terrestrial vegetation and fauna habitat include:

- Vegetation clearing would be restricted to those areas where it is absolutely necessary.
- Where clearing does occur, the area would be fenced with highly visible temporary fencing or flagging tape to ensure that clearing does not extend beyond the area necessary.
- Clearing of vegetation would comply with the RTA Pacific Highway Office requirements for fauna rescue associated with roadworks.
- Where suitable, nest boxes would be used to replace any removed tree hollows. Such a program would be developed in consultation with DECC.
- Restoration, regeneration and rehabilitation of areas of native vegetation would occur where it remains within the proposed road reserve. Riparian restoration would be undertaken where creeklines occur on land that is acquired as part of the proposed upgrade, but that would be outside the construction footprint.
- Vegetation management measures would be integrated with the landscape plan for the project.

12.4.2 Loss of threatened ecological communities

The measures listed in **Section 12.4.1** generally apply to the management of impacts on lowland rainforest.

In addition to project specific measures, any compensation over and above (or instead of) that rehabilitation would be negotiated as part of a compensatory habitat package which has been agreed previously with the DECC, covering all Pacific Highway proposals in the area between Ballina and the Queensland border (known as "section 5"). This sectional approach provides for a larger and more effectively manageable area of compensatory habitat, suitable for use as an offset for the Tintenbar to Ewingsdale project and other Pacific Highway upgrade projects including the adjoining Ballina bypass.

The sectional approach ensures an optimal result, as it provides larger areas of land of greater ecological significance, that are better able to be linked to land that is already protected. This approach has also been used successfully on other sections of the Pacific Highway upgrade program. The agreement already reached with the DECC provides for an area of 355 ha to be provided by the RTA as an offset for residual impacts of approximately 51 ha across all projects within section 5 (and includes any project modifications and minor works, which result in small scale variations to areas cleared).

12.4.3 Loss of threatened plant species

Known locations of threatened plants would be avoided where possible and fenced to protect them from direct and indirect impacts, particularly those species that occur on the edge of the study area (*Macadamia tetraphylla, Tinospora tinosporoides, Diploglottis camfieldii and Syzygium moorei*). This may involve fencing to keep out construction vehicles and prevent stockpiling. Contractors would be advised of the presence of the threatened plant species and measures required to protect them. Where threatened plants cannot be protected in-situ, translocation of the plants and collection of propagation material would be considered. A translocation plan would be prepared in consultation with the local council, the Department of Environment and Climate Change (DECC) and the local Botanic Gardens.

12.4.4 Loss of significant fauna species

Given the small amount of habitat available for significant fauna species, no specific management measures are proposed beyond those identified in **Sections 12.4.1, 12.4.5** and **12.4.7.**

12.4.5 Habitat fragmentation and barrier effects

During the design and selection of the preferred route a number of features were included to reduce the effects of habitat fragmentation. For example, the proposed upgrade was located where possible disturbances to one side of an area of vegetation rather than through the middle.

To further mitigate the impacts of fragmentation it is proposed that:

> Only native and locally indigenous plants would be used in the landscaping.

> Detailed bridge design and associated landscape treatment would encourage continuity of habitat along riparian corridors.

12.4.6 Edge effects and weed infestation

Mitigation measures related to edge effects relate generally to reducing impacts outside the direct development zone, controlling possible impacts at their source within the road reserve and reducing the hardness of the edge between the extent of earthworks and native vegetation. Measures to be adopted include:

> Avoiding stockpiling materials adjacent to native vegetation.

> Managing general construction activities to dispose appropriately of waste material and/or contaminants away from adjacent native vegetation.

> Implementing soil erosion and sedimentation control measures.

> Implementing a weed management strategy within the road reserve.

> Using locally indigenous (local provenance) species where possible for landscape plantings and revegetation.

12.4.7 Mortality

Minimisation of mortality of fauna during construction would involve implementation of management measures listed in **Section 12.4.1.**

During operation, a number of additional measures would be implemented to minimise road kill, including:

> Appropriate fencing in the vicinity of bridges to further encourage wildlife into riparian corridors and away from the road carriageways.

> Avoidance of overhanging vegetation that may encourage certain fauna species to enter the road reserve.

> Avoidance of plant species in the median and verge that are likely to encourage fauna vulnerable to road kill.

12.4.8 Aquatic ecology

Management measures to minimise impacts on aquatic ecology would include:

> A range of water quality management measures during construction and operation (refer to **Chapter 10)**.

> Compliance where feasible, in the detailed design of culverts, with NSW Fisheries *Guidelines and Policies for Aquatic Habitat Management and Fish Conservation* (Smith and Pollard 1999) and fish passage requirements for waterway crossings (Fairfull and Witheridge 2003).

> Undertaking restoration of riparian vegetation (as per **Section 12.4.1**).

> Minimisation of ground disturbance on creek banks and in-stream bed disturbance through appropriate detailed design of bridges and culverts and construction procedures.

13 Traffic

This chapter summarises impacts of the proposed upgrade on highway and local traffic, transport and access, and outlines management measures to address any impacts. More detailed assessment of these issues is included in Working Paper 6 – Traffic and Transport.

Environmental assessment requirement	Where addressed
> demonstration of how the project design meets the traffic and transport objectives of the Pacific Highway Upgrade Program;	Section 13.2
> assessment of operational traffic and transport impacts to the local and regional road network, including direct impacts from traffic rerouting and modified access to the upgraded highway, and indirect impacts from the increased accessibility of the Ballina and Byron Shires;	Sections 13.4.1, 13.4.2, 13.4.3 ,13.4.4 and 13.4.5.
> assessment of construction traffic impacts (including spoil haulage).	Section 13.4.6

13.1 Assessment approach

To undertake the assessment, background data was gathered from a number of sources, including:

> Historical and current traffic count data.
> Heavy vehicle facilities and usage.
> Reported accident history.
> Previous relevant traffic studies in the area.
> Existing and proposed pedestrian and bicycle facilities.
> Public transport facilities and operation.

An additional survey to identify the volume and movement patterns of traffic on local roads was undertaken in December 2004. Specific surveys related to Ewingsdale interchange were conducted in December 2006 and January 2007.

The data collected for the traffic study were used to evaluate the overall effect of the proposed upgrade on traffic volumes and patterns on the proposed upgrade and on local roads.

13.2 Project objectives

Objectives for the Tintenbar to Ewingsdale Pacific Highway upgrade have been developed to guide the project's development and related directly to the overall objectives of the Pacific Highway Upgrade Program.

The project objectives relevant to traffic and transport issues are as shown in **Table 13.1.**

Table 13.1 - Project objectives

Pacific Highway Upgrade Program objectives	Specific Tintenbar to Ewingsdale project objectives
Significantly reduce road accidents and injuries	> Develop a project that meets the following design criteria: > Four-lane divided carriageway between Ross Lane and Ewingsdale joining the northern end of the proposed Ballina bypass and the existing dual carriageway roadway at Ewingsdale with potential to expand to six lanes if required with minimal disruption. > Grade separation of local roads and the proposed highway. > Limited access conditions, i.e. no private access points along the proposed highway upgrade. > Design for a 110 km/h design speed > Design that incorporates pedal cyclists requirements. > Develop a project with a target crash rate of a maximum of 15 crashes per 100 million vehicle kilometres over the project length. > Develop a project that retains or replaces existing rest areas within the study area and is consistent with RTA policies on rest areas. > Where possible, improve safety of travel on the existing Pacific Highway (through the study area) until the proposed upgrade is operational.
Reduce travel times	> Develop a project that reduces travel time for Pacific Highway traffic. > Develop intersections and interchanges designed to at least a level of service C, 20 years after opening for the 100th Highest Hourly Volume. > Develop a project that provides adequate flood immunity on at least one carriageway. > Develop a project that minimises disruption and delay during construction.
Reduce freight transport costs	> Develop a project that reduces overall freight transport costs. > Develop a project that meets freight transport vehicle requirements.

13.3 Existing traffic patterns

13.3.1 Traffic volumes

Data from permanent and temporary RTA count stations along the existing highway alignment and surrounding major roads have been used to provide historical traffic volume and composition data.

The most recent annual average daily traffic (AADT) figures and historical counts on the Pacific Highway and surrounding major roads are presented in **Table 13.2, Table 13.3** and **Figure 13.1**. AADT volumes refer to axle pairs rather than vehicles. These indicate that the Pacific Highway to the north of Bangalow carries higher traffic volumes than to the south, with higher volumes again to the north of Ewingsdale Road.

Ewingsdale Road itself carries almost as much traffic as the highway south of the Ewingsdale interchange. It also experiences considerable congestion approaching the Byron Bay town centre during peak periods.

Bangalow Road to the west of the Pacific Highway (to and from Lismore) also carries significant traffic volumes. This traffic accesses and departs the highway through Granuaille Road, with around 75 percent of vehicles travelling to and from the north on the highway. This accounts for the differences in traffic volumes to the north and south of Bangalow. In 2004 there was a difference of around 6000 axle pairs between the RTA count stations at Knockrow and south of the Ewingsdale interchange (see **Table 13.2**).

Table 13.2 - Existing Pacific Highway traffic volumes (AADT) (blank boxes are where no data exists for a particular year)

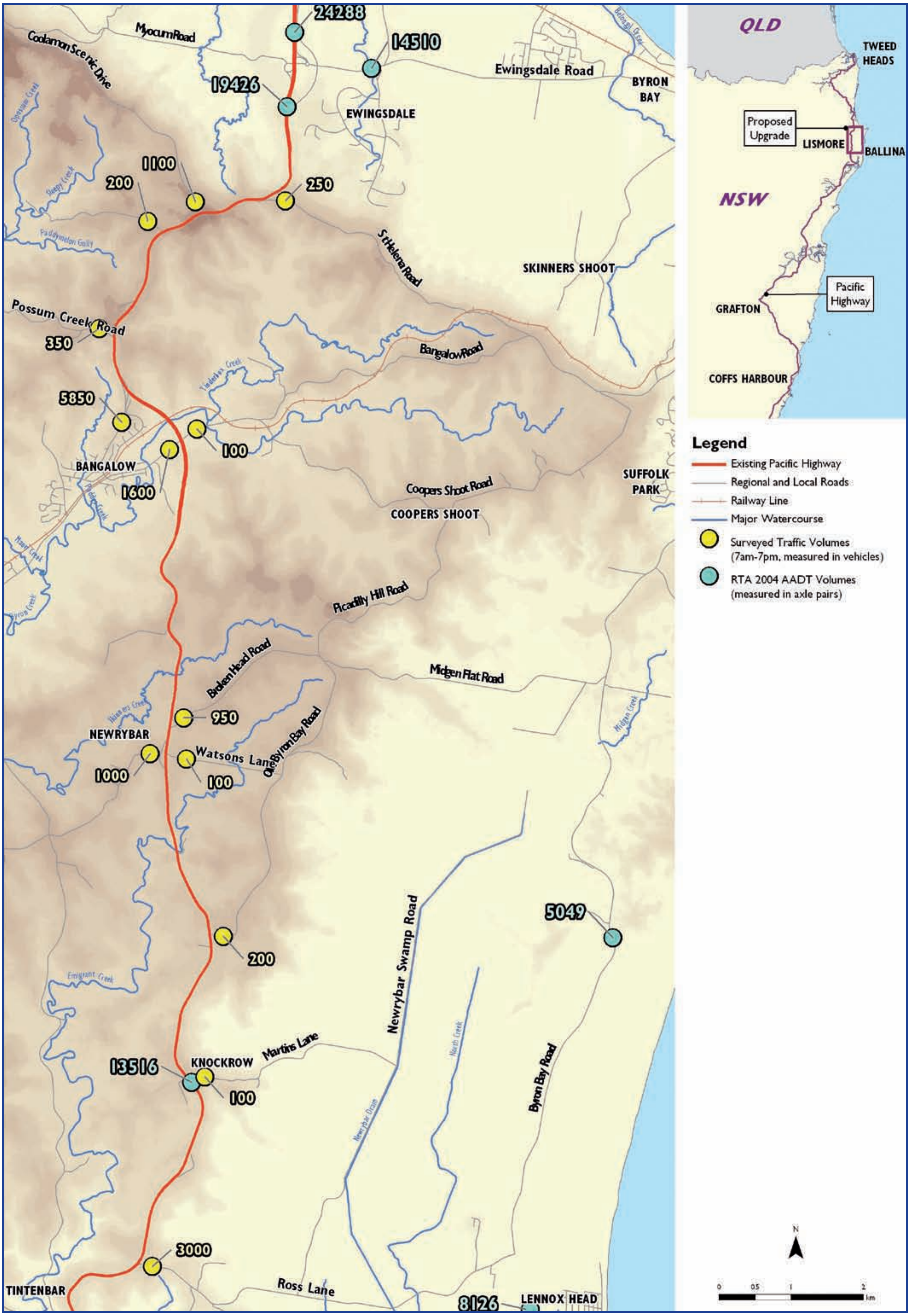
Location	Year						
	1998	2001	2002	2003	2004	2005	2006
Ewingsdale – N of Ewingsdale Rd	-	17,535	-	-	24,288	-	-
Ewingsdale – S of Ewingsdale Rd	13,831	11,188	-	-	19,426	-	-
Knockrow – S of Martins Lane	8,550	9,862	11,420	12,841	13,516	13,665	TBA
E of SH16, Bruxner Highway	19,477	20,922	-	-	23,787	-	-

Table 13.3 - Traffic volumes on surrounding roads (AADT)

Location	Year						
	1998	2001	2002	2003	2004	2005	2006
Ewingsdale Road Ewingsdale – E of SH10, Pacific Highway	11,410	11,876	-	-	14,510	-	-
Bangalow Road Byron Bay – N of Broken Head Road	6,573	7,689	-	-	6,549	-	-
Bangalow Bangalow – 6.4 km W of SH10, Pacific. Highway	5,781	6,366	6,859	7,295	7,457	7,493	TBA
Byron Bay Road At Ballina Shire boundary	4,736	5,690	-	-	5,049	-	-
The Coast Road Lennox Head – 1.5 km S of Ross Lane	6,891	9,366	-	-	8,126	-	-

Since 2001, Byron Bay Road (the road between Lennox Head and Byron Bay, which depending on the section is also known as The Coast Road, Broken Head Road and Bangalow Road) has experienced a reduction in traffic, as indicated in **Table 13.3**. Byron Bay Road is the coast road and tourist route between Ballina and Byron Bay. It also provides local and regional connections for the townships of Lennox Head, Broken Head and Suffolk Park. It is likely the Pacific Highway Upgrade Program and associated improvements in recent years have reduced the attractiveness of this route, transferring some of the traffic to the Pacific Highway.

Figure 13.1 - Traffic Volumes



13.3.2 Existing Pacific Highway – level of service

Level of service is a qualitative measure describing the operational conditions within the traffic stream, based on service measures such as speed and travel time, freedom to manoeuvre, traffic interruptions comfort and convenience. Different level of service categories are described below.

Level of service A describes the highest quality of traffic service for a highway section, when motorists are able to travel at their desired speeds. The highest quality usually results in average speeds of 90 km/h or more on two-lane highways in Class 1 (relatively high speed roads). A maximum flow rate of 490 passenger cars per hour total in both directions may be achieved with base conditions.

Level of service B characterises traffic flow with speeds of 80 km/h or slightly higher on level terrain Class I highways. Service flow rates of 780 passenger cars per hour total in both directions can be achieved under base conditions.

Level of service C describes further increases in flow, resulting in noticeable increases in platoon formation (travelling together in a group, usually involuntarily), platoon size, and frequency of passing impediments. The average speed still exceeds 70 km/h on level terrain Class I highways, and a service flow rate of up to 1,190 passenger cars per hour total in both directions can be accommodated.

Level of service D describes unstable flow conditions. The two opposing traffic streams operate separately at higher traffic volumes and passing becomes extremely difficult. Speeds of 60 km/h can still be maintained under base conditions for a Class I highway, with a maximum service flow rate of 1,830 passenger cars per hour total in both directions.

Level of service E characterises unstable traffic flow. Even under base conditions, speeds may drop below 60 km/h. Passing is virtually impossible at level of service E and platooning becomes intense. The highest volume attainable is generally 3,200 passenger cars per hour total in both directions.

Level of service F represents heavily congested flow with traffic demand exceeding capacity. Volumes are lower than capacity and speeds are highly variable.

Table 13.4 indicates the forecast traffic volumes and resulting level of service on the existing Pacific Highway between Tintenbar and Ewingsdale if no upgrade was to take place.

Table 13.4 - Forecast levels of service for existing highway

Year	AADV	Two-way peak hour volume	Level of service
2003	11,000	1,450	C
2012	15,050	1,750	D
2022	18,900	2,175	E
2032	22,750	2,600	E

This level of service forecast suggests that by 2012 the existing highway will be performing below the proposed upgrade objective level of service C.

13.3.3 Existing highway safety

Accident analysis has been undertaken and is based on accident history for the 5-year period from 1 May 2002 to 30 April 2007. It comprises RTA reported accident data on the Pacific Highway between Ross Lane and the Ewingsdale interchange overpass. During this period a total of 211 accidents were recorded along this section of the existing Pacific Highway.

The accidents included:

> 7 accidents resulting in one or more fatalities.
> 75 accidents resulting in injuries.
> 129 accidents not resulting in injury, but where a vehicle was towed away.

Existing at-grade intersection on the Pacific Highway at Newrybar.

The location of accidents is shown in **Figure 13.2.** The accident rate along this section of the highway during the five years is 36 accidents per 100 million vehicle kilometres travelled (MVKT). This rate is above the state-wide accident rate for a rural 2-lane undivided road of 32.8 accidents per 100 MVKT (RTA, 2004). However, the accident rate differs considerably when separating the study area into the two sections; Ross Lane to Bangalow, and Bangalow to Ewingsdale.

These rates are 23 accidents per 100 MVKT, and 56 accidents per 100 MVKT respectively. Factors influencing this disparity include the tighter horizontal and vertical geometry north of Bangalow and St Helena Hill (steep grades and sharp curve at the base).

13.4 Impacts of the proposed upgrade

13.4.1 Proposed upgrade – level of service

Based on forecast traffic increases (described in detail in *Working Paper 6 – Traffic and Transport*), it is predicted that the proposed upgrade would operate at level of service B in the nominal opening year of 2012 and reach level of service C during 2033 (**Figure 13.3**). As forecast level of service is based on peak volumes, traffic conditions for the majority of the time would be better than the identified level of service.

Figure 13.2 - Location of traffic accidents, May 2002-April 2007

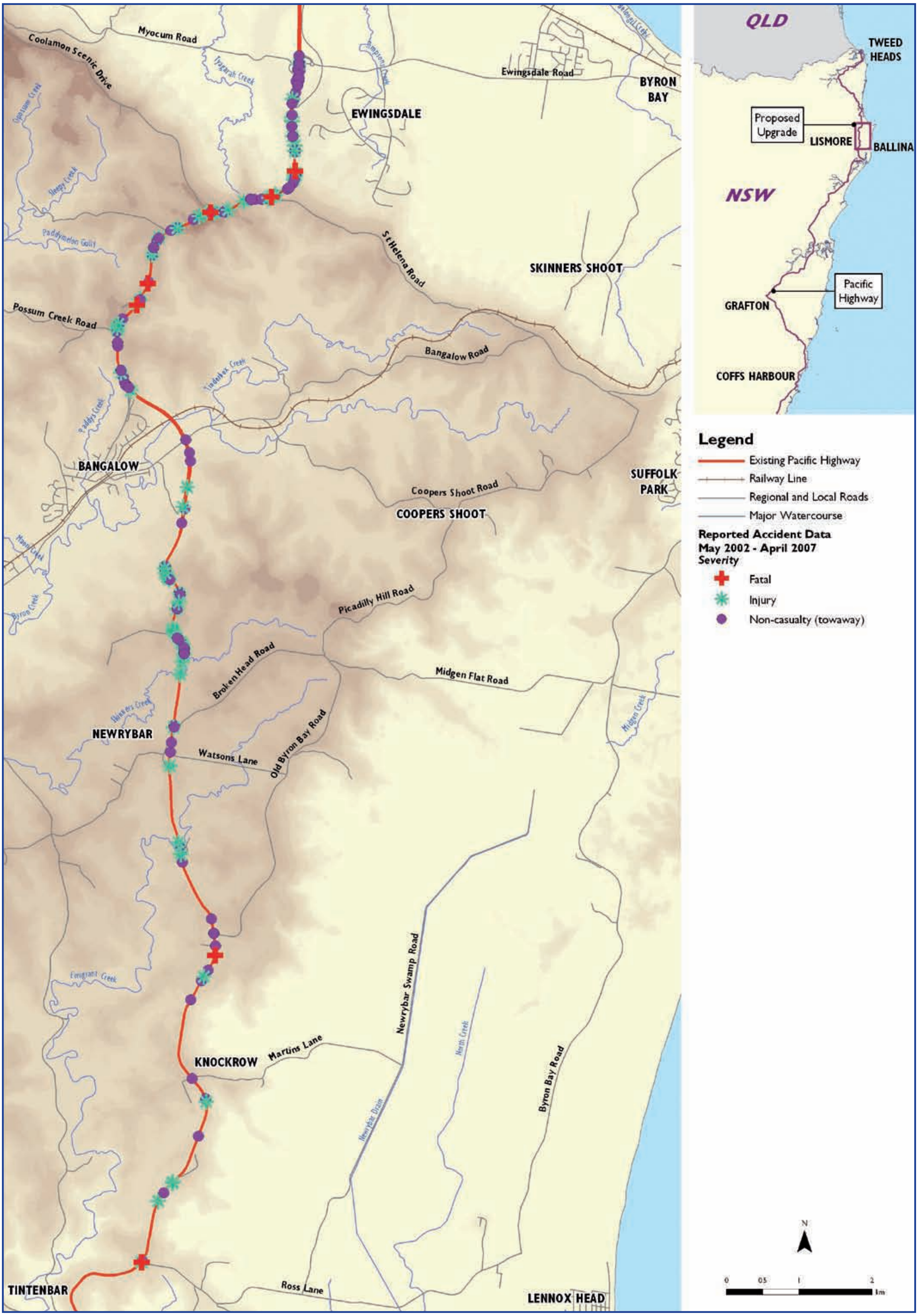
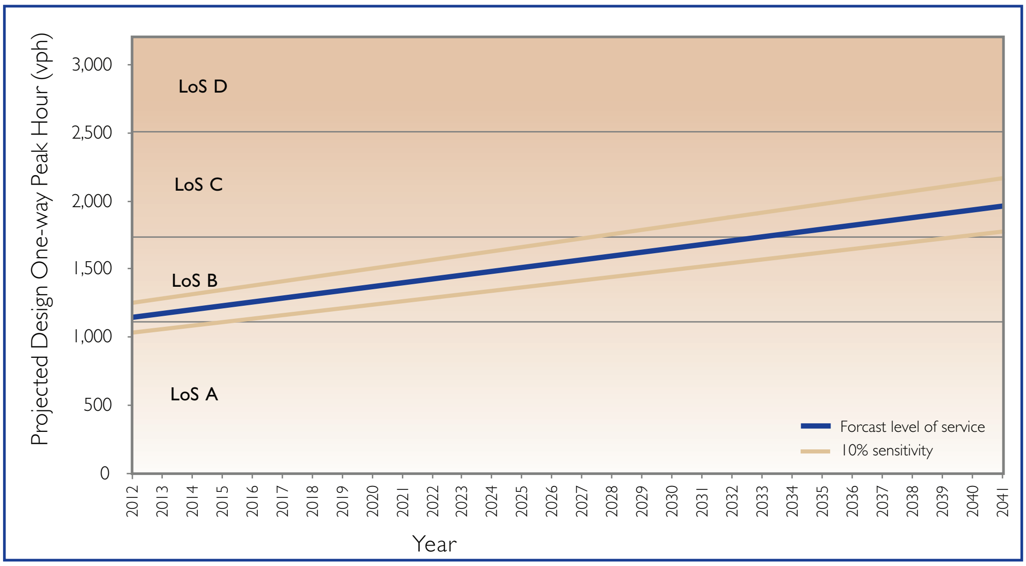


Figure 13.3 - Proposed upgrade – forecast level of service



13.4.2 Impacts on travel times and freight transport costs

The proposed upgrade would result in reduced typical travel times between Tintenbar and Ewingsdale of around two minutes for cars and around two and a half minutes for trucks. This time saving would be expected to be greater when comparing situations of higher traffic volumes where the existing highway conditions result in speed reductions.

Freight transport costs would be expected to reduce because of this distance and time saving. Cost savings for an individual trip would be small, but when considered in terms of the total volume of truck trips, would equate to considerable savings. Freight costs reductions would occur through:

> Time savings.

> Fuel savings.

> Reduced vehicle maintenance costs.

> Increased vehicle life.

13.4.3 Impacts on operation of the existing highway

Following construction of the proposed upgrade, the existing Pacific Highway would become part of the regional road network. To the north of Bangalow, the existing highway would still carry significant traffic volumes. Traffic travelling between areas north of Bangalow and Lismore via Granuaille Road would use the existing highway and travel through the Ewingsdale interchange for access to the Pacific Highway further north. Based on current travel patterns, just under 45 percent of the existing volume would still use the existing Pacific Highway north of Bangalow. With the proposed upgrade in place, the existing highway south of Bangalow is forecast to operate at level of service A until 2032. In 2032, the existing highway north of Bangalow is forecast to operate at level of service C which is considered acceptable.

Despite significant traffic volumes still using the existing highway north of Bangalow, heavy vehicle traffic usage of the existing highway would be significantly reduced. Regional through truck traffic would choose to use the upgraded highway. The reduction of heavy vehicle traffic on the existing highway would be particularly noticeable at night-time when noise is a major concern.

13.4.4 Impacts on operation of other local roads

In accordance with the Pacific Highway Design Guidelines (RTA 2005) local roads intersected by the proposed upgrade would be treated by either providing grade separation in the form of an overpass or underpass, or terminating the local road and providing an access road linking to another nearby local road with grade separation. This treatment would ensure that impacts on local access routes and connectivity are minimal.

Service roads would be provided to connect intersecting roads and property accesses, as well as providing local north/south connections. The concept for individual access for affected properties has been developed in consultation with the relevant property owners.

The proposed access arrangements for the local roads intersected by the upgraded highway is summarised in **Table 13.5 and Figure 13.4.**

Table 13.5 - Local road treatments

Local Road	Treatment
Ross Lane	Full interchange.
Martins Lane West	Access road with underpass connection to existing highway approximately 550 m south of Martins Lane.
Ivy Lane	Half interchange (north-facing ramps) with access maintained to western properties through the interchange to the existing highway.
Existing highway at Emigrant Creek	Localised realignment of existing highway and provision of an underpass of the upgraded highway.
Watsons Lane	Remaining open with an underpass.
Broken Head Road	Overpass of the upgraded highway.
Bangalow Road	Half interchange (north-facing ramps) and underpass of the upgraded highway.
Tinderbox Road	Localised diversion south-west to an underpass location.
St Helena Road	Existing road maintained – passes above tunnel.
Ewingsdale Road	Modification of existing interchange.

Forecast traffic volumes for local roads have been calculated in current terms (2006 traffic volumes) and are presented in **Table 13.6.**

Table 13.6 - Forecast Daily Local Traffic Volumes (2006)

Local road	Base case (no upgrade)	Upgraded highway
Ross Lane	3,680	4,520
Martins Lane	140	140
Old Byron Bay Road	240	240
Watsons Lane	130	130
Old Pacific Hwy, Newrybar	1,170	1010
Broken Head Road	1,050	740
Bangalow Road (east of interchange)	140	140
Bangalow Road (west of interchange)	2,100	2,100
Granuaille Road (on and off-ramps)	7,450	7,450
Possum Creek Road	410	370
Fowlers Lane	240	240
Coolamon Scenic Drive	1,210	890
St Helena Road	290	290
Ewingsdale Road (on and off-ramps)	5,110	2,660

A number of the local roads have low existing volumes and are not likely to be affected by the proposed upgrade. These roads include:

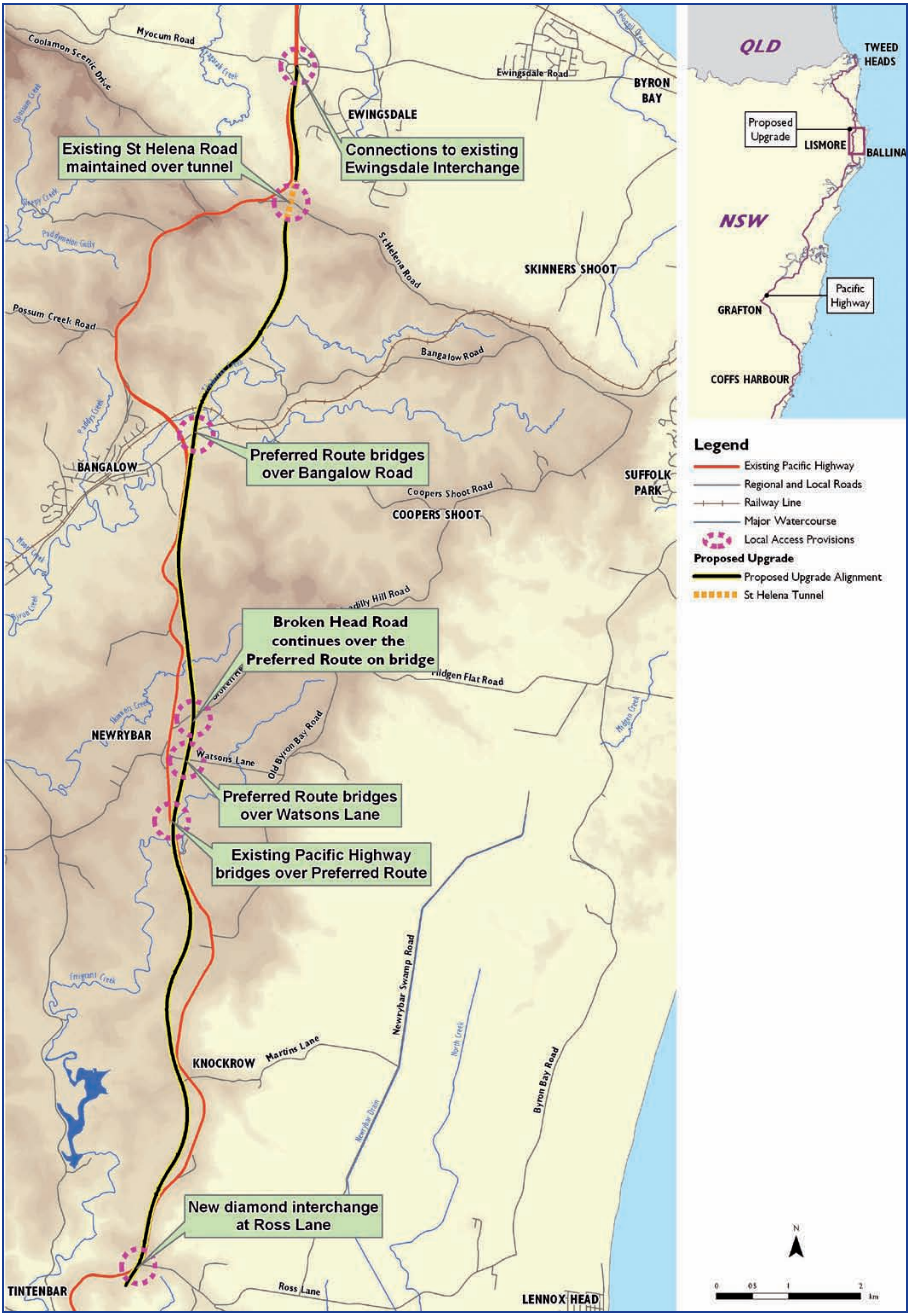
> Martins Lane.
> Old Byron Bay Road.
> Watsons Lane.
> Bangalow Road east.
> Fowlers Lane.
> St Helena Road.

Ross Lane, in conjunction with Tintenbar Road, provides an important east-west regional route. It provides local access to Lennox Head, Broken Head, Suffolk Park and the south of Byron Bay via Byron Bay Road (The Coast Road). As a result of the proposed upgrade and the proposed Ballina bypass, additional traffic is expected on Ross Lane due to the Ross Lane interchange and its function in providing local access for regional traffic movements.

Possum Creek Road and Coolamon Scenic Drive provide east-west connections between the existing highway and Friday Hut Road. The traffic volumes recorded on these roads indicate through traffic use of these connections. The provision of interchanges at Ross Lane, Ivy Lane, Bangalow and Ewingsdale may reduce the attractiveness of these routes causing some road users to adjust their travel patterns. As a result, decreased traffic volumes are forecast on these roads with the provision of the proposed upgrade.

Currently, a significant proportion of the traffic using the south-facing Ewingsdale interchange ramps travels through Bangalow (approximately 35 percent between 7am and 7pm). The proposed upgrade concept design includes the provision of a replacement local service road to connect the existing highway to the Ewingsdale interchange. This would result in a reduced number of vehicles using the south-facing Ewingsdale interchange ramps to and from the upgraded highway.

Figure 13.4 - Proposed local road connections



13.4.5 Indirect impacts from increased accessibility to Byron and Ballina shires

The proposed upgrade would generally improve accessibility to Byron and Ballina shires. Over time this is likely to increase traffic volumes on a range of roads within the area. Forecast Pacific Highway traffic volumes reflect the trend towards more visitation of areas along the coast that become more accessible with the overall upgrade of the Pacific Highway. The individual contribution of the Tintenbar to Ewingsdale upgrade to increased visitation is however difficult to quantify.

13.4.6 Impacts on highway safety

With the improved highway standard and the bypassing of the circuitous section of the highway north of Bangalow, it is forecast that the overall accident rate on the proposed upgrade would be reduced from the current rate of 36 accidents per MVKT travelled and meet the project target of 15 accidents per 100 MVKT. This forecast reduction is based on current accident rates experienced on sections of the Pacific Highway that have already been upgraded to similar standards as those proposed.

The number of accidents and the accident rate on the existing highway is also forecast to decrease, after the proposed upgrade, due to:

- Reduction in traffic volume.
- Predominantly local usage resulting in driver behaviour being consistent with the local road speed environment.
- Reduction in the percentage and size of heavy vehicles.

13.4.7 Construction impacts

There are no appropriate alternative temporary routes to the existing highway that could be used during construction. Provision for highway traffic therefore needs to be considered in the construction staging and construction methodology for all sections of the proposed upgrade.

Management strategies in construction may include provision for traffic use of temporary carriageways, temporary reductions in speed limits through worksites, use of traffic controllers and temporary signage. Control measures to manage traffic would be consistent with the RTA's *Traffic Control at Work Sites* manual (RTA 2003c).

Haulage may have an impact on local roads. It would include the transfer of fill material between sections as well as the delivery of construction materials such as pavement materials, asphalt, and concrete. Haulage would also take into account peak travel hours and times, particularly during school and public holiday periods, to minimise the potential for delays on the highway to the travelling public.

Much of the proposed upgrade would be able to be constructed with minimal disruption to existing highway traffic. However, there are a number of locations where one carriageway would not be clearly separate from the existing highway and construction activities would be required in close proximity to existing highway traffic. For example, construction of the integration with the existing Bangalow bypass section involves duplication alongside and in close vicinity to the existing highway. Once the new carriageway is complete the existing southbound carriageway would be upgraded and some traffic disruption would occur.

Locations where work would be carried out in close proximity to the existing highway are:

> At the tie-ins at the southern limit of the project to the north of the Ross Lane interchange.
> At the Emigrant Creek bridge and the overpass of the existing highway.
> At the Bangalow Road overpass.
> Along the duplicated section of the existing Bangalow bypass.
> At the tie-in at the northern limit of the project at the Ewingsdale interchange.

The Broken Head Road overpass can be completed without affecting traffic on the existing highway, but the overpass construction would have impacts on users of Broken Head Road with the choice of alternative route depending on the trip destination.

Other local roads that cross the proposed upgrade may be subject to short term disruption. The precise nature of this disruption and measures to minimise it would be the subject of traffic management planning during detailed design.

In addition to speed restrictions and traffic controls, night work could be required for short periods at the above locations where the proposed new carriageway conflicts with the existing highway. Night work may be necessary to allow smooth transitions to be constructed and traffic diversions to be installed while minimising traffic impacts.

13.5 Management of impacts

Local traffic impacts during the operation of the proposed upgrade would be managed through the access arrangements that are an inherent part of the project design.

Management measures during construction would include:

> Identification of all public roads to be used by construction traffic.
> Methods to ensure construction traffic uses identified roads.
> Identification of all public roads that may be partially or completely closed during construction and the expected timing and duration of closures.
> Identification and management of impacts on existing traffic (including pedestrians, vehicles, cyclists and disabled persons).
> Temporary traffic arrangements including property access.
> Access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads.
> A response plan for any construction traffic incident.
> Monitoring, review and amendment mechanisms.

14 Land use and property

This chapter outlines the potential impacts of the proposed upgrade on properties and land uses in the vicinity of the proposed upgrade according to the environmental assessment requirements listed below. More detail is provided in *Working Paper 7 – Land use and property assessment.*

Environmental assessment requirement	Where addressed
> Impacts to directly-affected properties and land uses adjacent to the project, including: impacts to land use viability and future development potential, including property title impacts; land sterilisation and severance impacts; and impacts to the connectivity and contiguity of small settlements including Newrybar and Knockrow;	Section 14.2 (note however that issues relating to connectivity and contiguity of small settlements are addressed in Chapter 17 – Social and Economic).
> Consideration of project impacts on the attainment of the objectives of Far North Coast Strategy;	Addressed in Chapter 17 – Social and Economic).
> Development of a mitigation strategy aimed at promoting appropriate final land uses on lands subject to partial or full acquisition as a result of the project, in consultation with Ballina and Byron Shire councils.	Section 14.3

14.1 Assessment approach

Grazing land in the Tinderbox Creek valley.

Impacts on land use were based on an assessment of each affected allotment (allotments requiring full or partial acquisition) by the proposed upgrade. For each allotment, investigations were conducted on both the land within the proposed road reserve and the remnant (severed) portion(s) of the lot that lie outside the proposed road reserve to determine the change to the land use that would be likely to occur.

Land that would be within the road reserve is categorised as *directly affected,* while portions of acquired allotments that would ultimately be outside the road reserve are categorised as *indirectly affected*. Information is presented in **Section 14.3** in a manner that enables the identification of project impacts resulting from the evaluation of individual property impacts. Principles to guide the management of indirectly affected (or remnant) land were also identified.

14.2 Existing land use

The proposed upgrade would traverse predominantly agricultural land uses consisting mostly of grazing and crops such as macadamias and coffee. Land use on properties that would be affected by the proposed upgrade is shown on **Table 14.1.** The land use types used in **Figure 14.1** are described in **Table 14.1.** Each land use type is grouped into a broad category, which is applied in the assessment of land use impacts in subsequent sections.

The proposed upgrade for the most part traverses land classified under the Northern Rivers Farmland Protection Project (DIPNR 2005) as *Regionally Significant Farmland.* In one location (between Newrybar and Bangalow) it coincides with the western extremity of an area identified as *State Significant Farmland* (**Figure 14.2**).

Typical macadamia farm

Table 14.1 - Land use classes and categories

Land use class	Definition	Land use category
Access roads	Includes driveways to house but does not include roads within or between paddocks.	Farm infrastructure
Cleared and cultivated	Land that has been cropped annually or has been prepared for permanent planting, but is not yet planted.	Agricultural land
Coffee immature	Coffee plantations planted in or after 2000.	Agricultural land
Coffee mature	Coffee plantations planted before 2000. (note that no mature coffee occurs on allotments that would be subject to acquisition).	Agricultural land
Floriculture	Land used for cut flower production.	Agricultural land
Grazing	Grazing land.	Agricultural land
House block	House and garden area on larger lots, including pool, tennis courts and garages.	Farm infrastructure
Macadamias immature	Macadamia plantations planted in or after 2000.	Agricultural land
Macadamias mature	Macadamia plantations planted before 2000.	Agricultural land
Nursery	Land used for nursery production, including in-ground nursery plantations and fisheries activities.	Agricultural land
Other fruits	Fruits including avocados, passion fruit, lychees, custard apples, guava, berries, tamarillos, bananas, exotic fruits and pecans. Excludes stone fruits.	Agricultural land
Rural residential	Lots less than 3 hectares with a residence.	Rural residential
Sheds	Sheds including animal shelters, processing facilities, machinery and storage sheds.	Farm infrastructure
Stone fruit	Stone fruits including peaches, nectarines and plums.	Agricultural land
Timber	Remnant native vegetation and planted vegetation.	Natural areas
Timber plantation	Planted timber with harvest guarantee.	Agricultural land
Vegetables	Market gardens including bamboo plantations, excluding home vegetable plots.	Agricultural land
Water course - cleared	Rivers and creeks on grazing land.	Agricultural land
Water course - timbered	Rivers and creeks timbered.	Natural areas
Water supply	Dams.	Farm infrastructure

Land use and property impacts

A total of 73 lots would be affected (subject to acquisition and incorporation into the road reserve) by the proposed highway upgrade. Of the 73 lots, six would be captured entirely within the road reserve, 39 lots would be severed with one parcel of land remaining and 28 lots would be severed into two unjoined parcels of land.

The area of land directly and indirectly affected by the proposed upgrade is presented in **Table 14.2.**

Figure 14.1a - Land use on affected properties

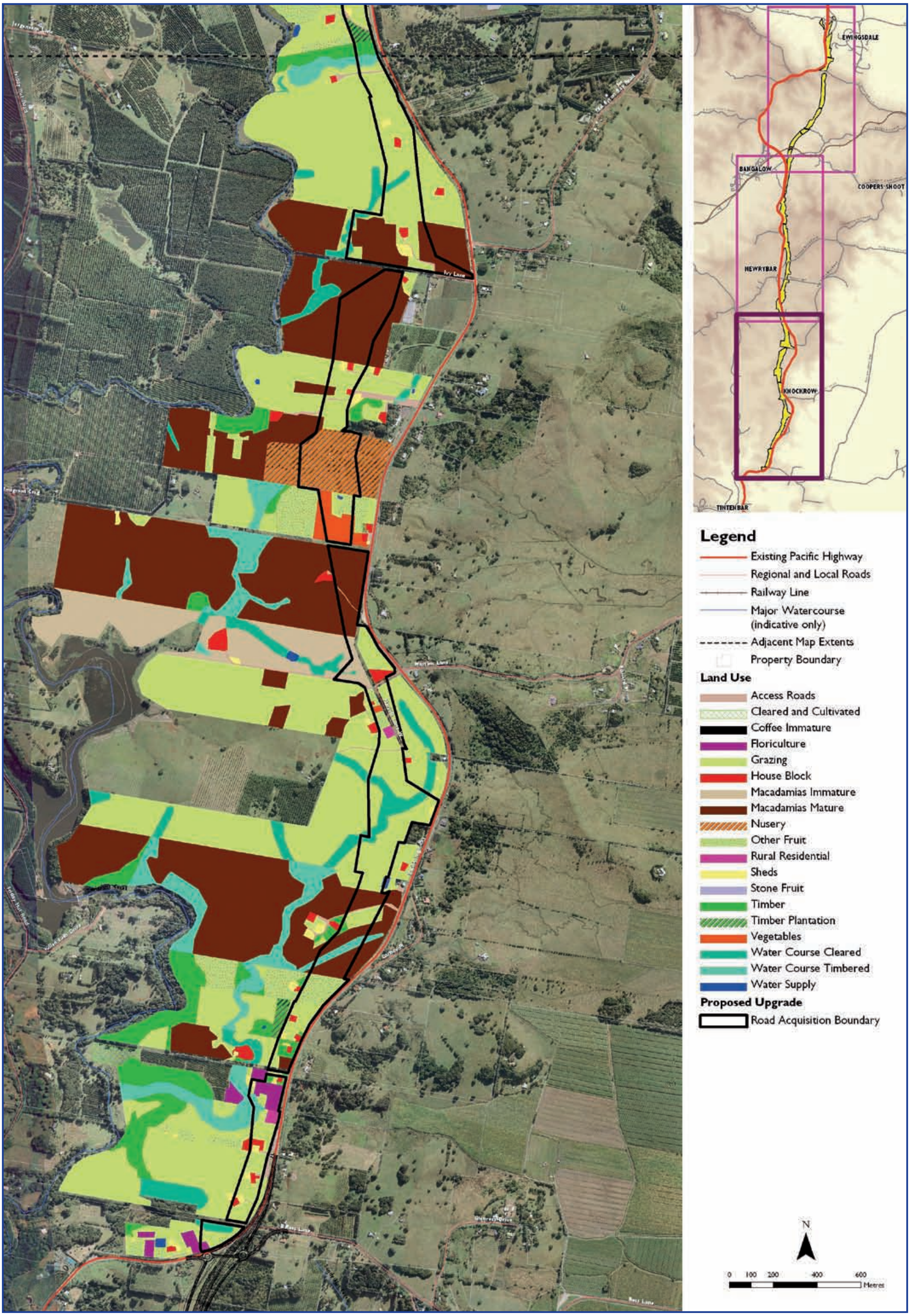


Figure 14.1b - Land use on affected properties

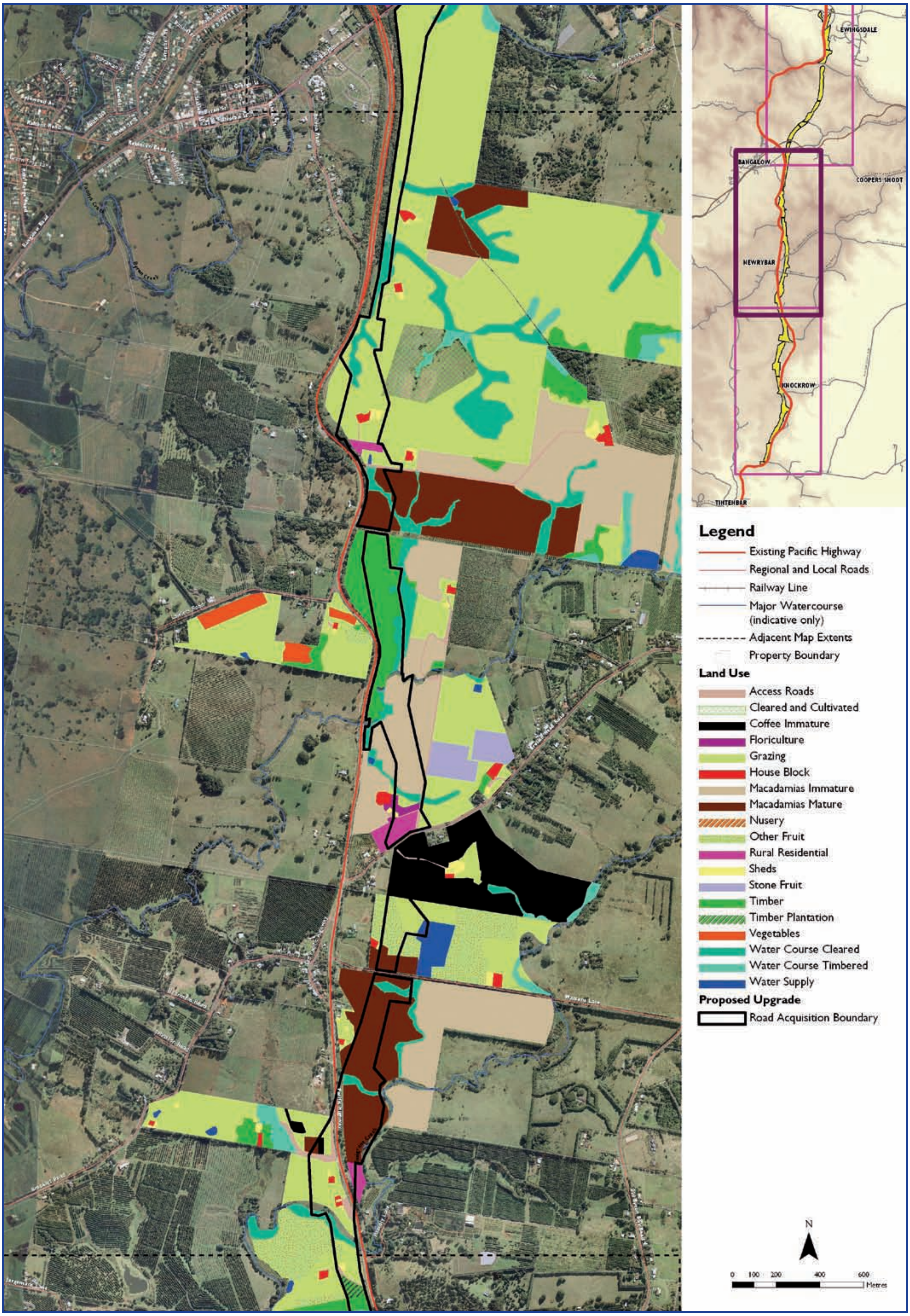


Figure 14.1c - Land use on affected properties

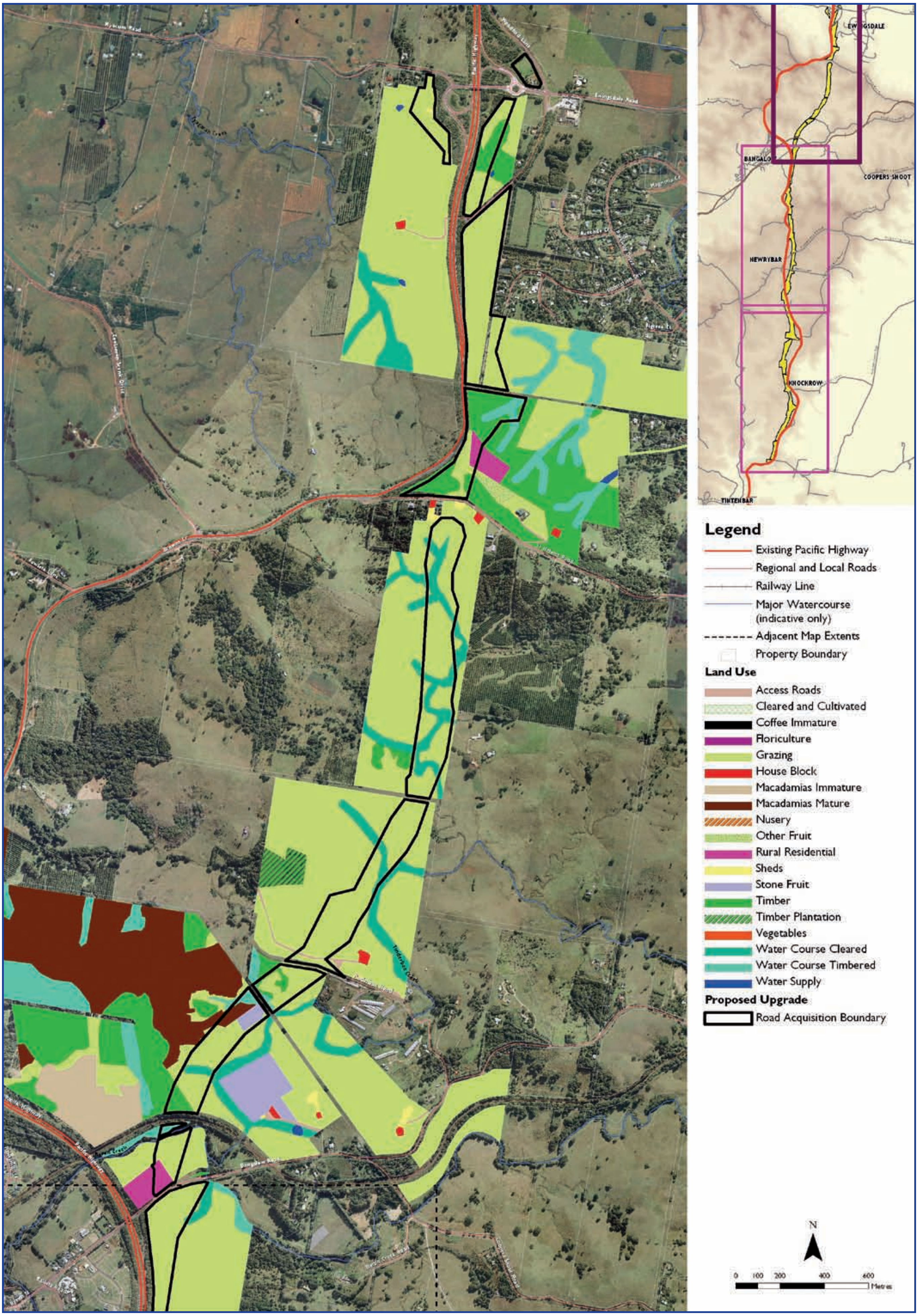


Figure 14.2 State and regionally significant farmland

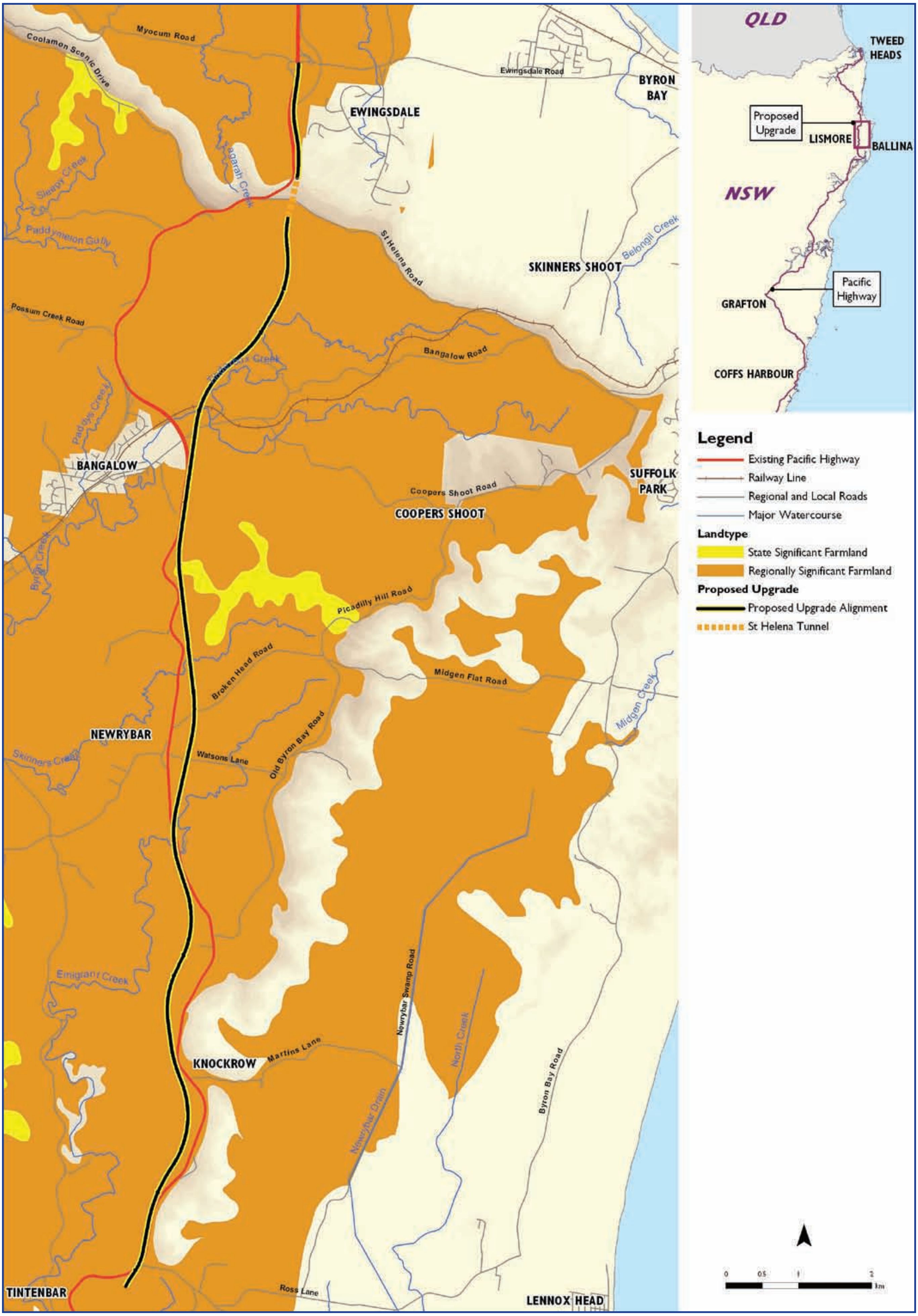


Table 14.2 - Area of land directly and indirectly affected by proposed upgrade (ha)

Description [1]	Directly affected	Indirectly affected	Total affected
Agricultural land	197	998	1195
Natural areas	21	139	160
Farm infrastructure	7	25	32
Rural residential	4	4	8
Total	**229**	**1166**	**1395**

1 Based on 2005 aerial photography, landowner surveys and on-site verification undertaken by Hassall & Associates.

14.3 Land use and property impacts

14.3.1 Impact on agricultural land

The proposed upgrade would affect local agricultural production. One of the determining factors in assessing the value of the impacts is the capability of the land to support particular agricultural activities. The impacts would be greater where land is supporting intensive activities compared to land supporting extensive livestock grazing. The economic value of foregone agricultural production is discussed in **Section 17.3.7.**

It is estimated that less than 1 percent of the total area of identified state significant farmland currently available in the Northern Rivers would be lost to the proposed upgrade. The area of state significant farmland that would be lost to the proposed upgrade is currently used for grazing purposes. The presence of state significant farmland was an important consideration in the route selection process.

As well as direct land loss, agricultural production may be affected by losses in production related infrastructure, altered drainage and access, and forced changes to management.

Table 14.3 shows the areas of agricultural land, by land use class, directly affected by the proposed upgrade.

Table 14.3 - Agricultural activities directly affected by the proposed upgrade (by land use class)

Land use	Area affected (ha)
Grazing	111.7
Macadamias mature	37.6
Water course – cleared	17.2
Macadamias immature	7.9
Nursery	7.1
Other fruit	6.9
Coffee immature	3.1
Vegetables	2.2
Cut flowers	1.9
Stone fruit	0.8
Timber plantation	0.7
Cleared and cultivated	0.1
Total	**197.2**

Each parcel of indirectly affected land (the remnant portion of allotments acquired for the proposed upgrade but not to be included in the road reserve) was evaluated to determine the most likely and appropriate land use after the construction of the proposed land. For the most part, land uses on indirectly affected agricultural land would not be expected to change. Changes in agricultural land use have however been predicted where the size and/or configuration of the remaining portion of land suggests it is impractical to maintain the existing activity after the road reserve has been created. Generally, this manifests in a change to grazing from a more intensive use such as macadamias because the remnant portion of land is too small for the intense use to continue. **Table 14.4** shows the impacts of the proposed upgrade on indirectly affected land.

Table 14.4 - Indirect land use impacts

Description	Area (ha)
Remain in current land use	966.5
Change in agricultural land use	13.5
Potential conversion to revegetation or riparian restoration	17.8
Total	**997.8**

The impacts on existing agricultural activities are likely to be greater along the southern and central portions of the proposed upgrade. In these areas, there is a greater proportion of macadamia plantations, and it is where the majority of the 13.5 ha of land use change identified in **Table 14.4**, would occur.

Direct impacts on farm infrastructure (particularly sheds) would also tend to occur to a greater extent along the southern parts of the proposed upgrade. In this area, the proposed upgrade is in close proximity to the existing highway. Farm infrastructure is often located close to the existing highway due to ease of access and in a number of locations occurs within the proposed road reserve.

Some opportunities have also been identified for conversion of land to create a vegetative buffer or to undertake riparian restoration, primarily in situations where agricultural viability is limited and positive ecological and/or landscape outcomes may be achieved. The ultimate creation of these areas would be subject to agreement between the RTA and local authorities as to the most appropriate ownership and management regime.

14.3.2 Loss of dwelling entitlements

A major concern for the landholders affected by the proposed upgrade is the impact on dwelling entitlements where the proposed upgrade would remove a house on an allotment. Both Ballina Shire and Byron Shire councils have indicated that relocation of dwelling entitlements within the same allotment would be potentially permissible when they are directly affected by the proposed upgrade (pending the availability of a suitable site for relocation). If there is no suitable house relocation site, the dwelling entitlement would be cancelled and the residual parcel of land may be consumed by boundary adjustment either with an adjoining parcel of land or into the road reserve. Landowners subject to cancellation of dwelling entitlements would be entitle to compensation under the *Land Acquisition (Just Terms Compensation) Act 1991*, which reflects the loss of the dwelling entitlement.

For both councils, the application for relocating a dwelling entitlement needs to consider many factors including but not limited to access, land use conflict, on-site effluent management, contamination and noise impact from the adjoining highway.

After consideration of the local environmental plans and remnant land characteristics it is estimated that:

> 15 lots may have their dwelling entitlement cancelled.

> 3 lots may have one of two dwelling entitlements cancelled.

> 8 lots may be eligible to have their dwelling entitlement relocated.

> 1 lot may be eligible to have one of its two dwelling entitlements relocated.

> 46 lots would not have their dwelling entitlements affected.

14.4 Management of impacts

A remnant land strategy has been prepared in consultation with Ballina Shire and Byron Shire Councils, for the proposed upgrade and is included in *Working Paper 7 – Land use and property assessment.* In relation to land acquisition, one of the following two options would generally be adopted (in consultation with landowners) to arrive at a desirable remnant land management outcome:

> Full purchase of the allotment to meet the RTA requirement for the proposed upgrade or where the remnant portion would not be commercially viable.

> Partial purchase of the allotment to meet the RTA requirements that when met leaves remnant land that has commercial use either as an entity or as a desirable addition to a neighbouring lot or has the potential to contribute to revegetation and riparian restoration.

The above principles have formed the basis of the individual lot analysis which is summarised in **Table 14.4.**

The process of acquisition would involve purchase by the RTA in accordance with provisions of the *Land Acquisition (Just Terms Compensation) Act* 1991.

In terms of the final use of land acquired by the RTA but not required for the proposed upgrade, the following range of outcomes would be promoted:

> Amalgamation with adjacent properties to protect existing land use and to provide increased opportunity for enhanced land use.

> Sale where remnant land is capable of being operated in an economically sustainable manner.

> Establishment of vegetative buffers between agricultural land uses and the proposed upgrade in any situations where landscape treatments in the road reserve do not provide adequate buffer.

> Undertaking riparian restoration where properties include a watercourse.

> Promotion of existing environmental programs including Emigrant Creek Healthy Catchment program and Byron Council High Conservation Areas.

> Consult with affected residents to create awareness of Councils' procedures for dwelling entitlement retention, relocation and/or cancellation.

15 Noise and vibration

This chapter summarises the noise and vibration impacts of the proposed upgrade, and outlines management measures proposed to address any impacts. *Working Paper 8 – Noise and Vibration Assessment* provides a more detailed assessment of noise and vibration issues.

Environmental assessment requirement	Where addressed
> an assessment of operational road traffic noise impacts including consideration of local meteorological conditions (as relevant) and any additional reflective noise impacts from proposed noise mitigation barriers;	Section 15.2
> an assessment of construction noise and vibration including construction traffic noise and blasting impacts;	Section 15.3

15.1 Approach and criteria

15.1.1 Noise survey

Ambient noise measurements were conducted over approximately a two-week period in November 2004, and a further two-week period in May 2005. The measurements were undertaken at locations along the existing highway and at other locations within the study area. Unattended noise loggers were used to continuously measure noise at seven different locations. Attended noise measurements were also conducted at a further 32 locations within the study area. A further detailed noise study was undertaken for the Newrybar Public School in February 2007.

15.1.2 Noise modelling

Noise modelling was carried out with noise level predictions made both for daytime (7am - 10pm, 15 hr) and night-time (10pm - 7am, 9 hr) for three base cases;

- 'Future-Existing', i.e. predicted Year 2012 (proposed opening date) traffic flows on the existing road alignment.
- '2012', i.e. predicted Year 2012 traffic flows on the proposed dual carriageway alignment.
- '2022', i.e. predicted Year 2022 traffic flows (10 years after opening) on the proposed dual carriageway alignment.

15.1.3 Road traffic noise criteria

Road traffic noise criteria are provided as guidelines. They provide target noise levels that are desired to be met where it is *feasible and reasonable* to do so.

The basic noise criteria are outlined in the *Environmental Criteria for Road Traffic Noise* (EPA 1999) and shown in **Table 15.1**. The noise criteria are measured at the façade of a building at a height of 1.5 m and are listed in the Noise and Vibration Assessment working paper. In addition, the Environmental Criteria for Road Traffic Noise provides specific criteria for cases with 'extra noise sensitivities', as shown in **Table 15.2**. These criteria are adopted by the RTA in its *Environmental Noise Management Manual (2001)*.

Table 15.1 - Basic noise level criteria for proposed road (from Table 1, EPA Environmental Criteria for Road Traffic Noise

Type of development	Criteria		
	Day (7am -10pm) dB(A)	Night (10pm - 7am) dB(A)	Where criteria are already exceeded
New freeway or arterial road	55 dB$L_{Aeq,15hr}$	50 dB$L_{Aeq,9hr}$	> The new road should be designed so as not to increase existing noise levels by more than 0.5 dB. > Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In some instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.
Redevelopment of existing freeway/arterial road	60 dB$L_{Aeq,15hr}$	55 dB$L_{Aeq,9hr}$	> In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB. > Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.

Table 15.2 - Specific noise level criteria for sensitive land uses

Sensitive land use	Criteria		
	Day (7am -10pm) dB(A)	Night (10pm - 7am) dB(A)	Noise mitigation measures
School classrooms	40 $L_{Aeq,1hr}$	-	> To achieve internal noise criteria in the short term, the most practicable mitigation measures are often related to building or façade treatments. > In the medium to longer term, strategies such as regulation of exhaust noise from in-service vehicles, limitations on exhaust brake use, and restricting access for sensitive areas or during sensitive times to low noise vehicles can be applied to mitigate noise impacts across the road system. Other measures include improved planning, design and construction of sensitive land use developments; reduced new vehicle emission standards; greater use of public transport; and alternative methods of freight haulage. These medium- to long-term strategies apply equally to mitigating internal and external noise levels. > Where existing levels of traffic noise exceed the criteria, all feasible and reasonable noise control measures should be evaluated and applied. Where this has been done and the internal or external criteria (as appropriate) cannot be achieved, the proposed road or land use development should be designed so as not to increase existing road traffic noise levels by more than 0.5 dB(A) for new roads and 2 dB(A) for redeveloped roads or land use development with potential to create additional traffic.

15.1.4 Criteria for construction noise and vibration

The EPA Environmental Noise Control Manual sets out noise criteria for construction projects. The L_{A10} noise parameter is used as the descriptor to assess construction site noise (the noise level that is exceeded for 10 percent of the time, indicative of the *average maximum level*). The relevant criterion depends on the pre-existing L_{A90} noise level (being the noise level that is exceeded for 90 percent of the time, representative of the *background* noise level) and the duration of the construction activity. Construction noise criteria are listed in **Table 15.3.**

Table 15.3 - Summary of construction noise criteria

Construction period	Criteria
4 weeks or less	L_{A10} L_{A90} + 20 dB
4 weeks to 26 weeks	L_{A10} L_{A90} + 10 dB
Greater than 26 weeks	L_{A10} L_{A90} + 5 dB
Tonal or impulsive noise	+5 dB penalty

While the total construction period for the entire project is likely to be greater than 26 weeks, many construction activities would progress along the route during the construction period, and the lowest limit (L_{A10} L_{A90} + 5 dB) would not be appropriate at all locations.

For large construction projects such as the Tintenbar to Ewingsdale upgrade, it is considered appropriate to treat noisy stages of work (such as the earthworks associated with a bridge replacement, for example) as discrete construction periods and assess them against the short and medium term guidelines, provided the cumulative affect of longer-term works is carefully managed.

Where construction noise is audible at residential premises, the EPA guideline recommends that construction should be limited to the following times:

> Monday to Friday, 7am to 6pm, with a maximum of nine hours per day.

> Saturday 7am to 1pm if inaudible on premises, otherwise 8am to 1pm.

> No construction work to occur on Sundays or public holidays.

Due to the nature of highway projects, some construction work may be required to take place outside those preferred hours. The management of these activities would include close liaison with the local community, and the implementation of best practical measures to limit disturbance to the surrounding community.

The Department of Environment and Climate Change has published *Assessing Vibration, a Technical Guideline* (DEC 2006a), which is based on British Standard BS6472 and Chapter 174 of the EPA Environmental Noise Control Manual (ENCM). Australian Standard AS 2670.2-1990 defines limits for both continuous and transient vibration events which are applicable as construction vibration criteria (**Table 15.4**).

Table 15.4 - Multiplying factors to be applied to base curves

Type of building occupancy	Time	Continuous or intermittent vibration	Transient vibration
Critical working areas eg. precision laboratories	Day	1	1
	Night	-	-
Residential	Day	2 to 4	30 to 90
	Night	1.4	1.4 to 20
Office	Day	4	60 to 128
	Night	-	-
Workshop	Day	8	90 to 128
	Night	-	-

Intermittent vibration can be assessed by using vibration dose values calculated according to British Standard BS 6472.1992. **Table 15.5** shows acceptable vibration dose values for intermittent vibration. There is a low probability of adverse comment or disturbance to building occupants at vibration dose values below the preferred values.

Table 15.5 - Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime (0700 – 2200 hrs)		Night-time (2200 – 0700 hrs)	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

With regard to the potential for ground vibration to cause damage to structures, vibration levels may reach much higher values than those applicable to human perception and comfort before the onset of any significant risk. It is proposed to adopt the guidelines and limits in the British Standard BS 7385 as damage criteria for this project, together with a more conservative limit of 5 mm/s in the first instance.

15.1.5 Blasting and vibration exposure

Ground vibration and airblast (also called blast overpressure) are two environmental impacts from blasting. Appendix J of AS2187.2 provides general guidance on appropriate limits for ground vibration and airblast overpressure from blasting.

Recommended limits for the vibration level and blast overpressure from blasting are also found in guidelines from the Australian and New Zealand Environment Conservation Council (ANZECC 1990). These limit blast overpressure to 115 dB (lin, peak) at any residence, and ground vibration to 5 mm/s peak particle velocity. The guidelines also restrict blasting to between 9am and 5pm on weekdays and Saturday, and recommend only one detonation per day.

15.2 Operational road noise assessment

Noise levels have been predicted at over 600 individual residences and other receiver locations along the proposed upgrade. The noise level predictions were made both for daytime (7am - 10pm, 15 hr) and night-time (10pm - 7am, 9 hr) for three base cases described in **Section 15.1.2**.

The 'Future-Existing' noise model assumes a dense graded asphalt (DGA) road surface, while the 'base case' proposed alignment model assumes a concrete road surface with a pavement surface correction of +3 dB(A) relative to DGA. In addition, modelling has also been undertaken for two additional cases with a low-noise pavement (for the purpose of noise modelling stone mastic asphalt has been assumed) in some key sections of the alignment. For this pavement type a correction of -2 dB (relative to DGA) was used. These scenarios are:

> Mitigated situation, '2012', i.e. predicted Year 2012 traffic flows on the proposed dual carriageway alignment.
> Mitigated situation '2022', i.e. predicted Year 2022 traffic flows (10 years after opening) on the proposed dual carriageway alignment.

Noise contour plots for these prediction scenarios are shown in noise contour maps in *Working Paper 8 – Noise and Vibration Assessment.*

For the base case, with a concrete pavement surface and no noise mitigation, 95 residences have predicted noise levels that are above the acute noise level criterion of 60 $dBL_{Aeq,9hr}$ and 65 $dBL_{Aeq,15hr}$ and therefore require noise mitigation. A further 219 residences exceed the base road traffic noise criteria. In total, 314 residences would require noise mitigation.

Noise barriers are not considered reasonable and feasible, except near Clover Hill, since residences near to the route are not typically 'clustered' in close proximity to each other. The low-noise pavement has therefore been examined as a potential noise mitigation measures at key sections of the alignment, including:

> All bridges.
> From about 300 m south of Newrybar (Ch 141750) to Skinners Creek (Ch 143650).
> From south of Bangalow (Ch 145200) to 750 m north of the proposed railway crossing at Bangalow (Ch 147800).
> From the northern portal of the tunnel through to the Ewingsdale interchange.

Noise predictions were also made for the use of a proposed low-noise road surface on these sections of the alignment. In this situation 63 residences are exposed to acute noise levels, and 54 residences exceed the base road traffic noise criteria. In this case, only 117 residences would require noise mitigation when a low-noise pavement is used for the proposed sections of the alignment.

A noise barrier has also been investigated adjacent to Clover Hill (near Bangalow). While the target noise levels are not able to be met with a reasonable and feasible barrier, a 4.5 – 5.5 m high noise barrier may also be considered, since it provides a reasonable level of noise mitigation.

The proposed earthworks adjacent to Ewingsdale generally provide sufficient noise attenuation for the residences at Ewingsdale.

15.3 Construction noise and vibration assessment

15.3.1 Sources of construction noise

General construction activities

The construction of a dual carriageway road generally occurs in three main stages including earthworks, laying of the road-base and final laying of pavement. The duration of the earthworks is likely to be up to six months at some locations and the laying of road base and pavement could also be up to six months at particular locations.

Noise generating activities would include construction of bridges, underpasses, and culverts; earthworks including tunnelling and cutting; paving; and drainage works. These activities would require the occasional use of rock breakers, jackhammers and concrete saws. Bridge and embankment construction could include piling activities. Blasting is likely to be required for the construction of the St. Helena Hill tunnel (see separate discussion following), and possibly some of the large cuttings.

Batching plants

Asphalt and concrete batching plants would be required at several locations along the construction route for a period of up to 2 years. The number of batching plants and final locations would be chosen by the construction contractor and would be dependent on specific requirements and sequencing. Three preliminary general locations have been identified as potentially suitable for either concrete or ashphalt batching plants:

> On the eastern side of the Ewingsdale interchange.
> On the Bangalow Rd on the eastern side of the proposed upgrade.
> On the north-west side of the proposed Ross Lane interchange.

Noise associated with batching plants would primarily be generated from associated vehicle movements and use of plant and equipment.

Site compound

A site compound would be required to be established for offices, facilities and storage of materials, plant and equipment. A preliminary location has been identified on the eastern side of the proposed upgrade on Bangalow Rd, adjacent to the preliminary batching plant location. Depending on the specific needs of the construction contractor and the sequencing of construction, there may potentially be more than one construction compound. Noise associated with a construction compound would primarily be generated from associated vehicle movements.

Crushing plant

A crushing plant may be required near the St Helena tunnel due to the generation of significant amounts of rock spoil. A preliminary location along the southern side of the proposed tunnel works has been identified. The final location of any crushing plant would be determined by the specific needs of the contractor as well as amenity issues. The crushing plant may need to be relocated several times during construction depending on the volumes of rock spoil generated at particular locations. Noise would be generated by the operation of the crushing plant.

Construction traffic

Construction traffic will generate noise over a relatively wide area and beyond the construction site itself. Routes for construction traffic would be determined during detailed design and construction stages. It would be expected however that traffic noise would be greatest where there is a concentration of vehicle movements, such as at construction compounds, batching plant locations and where construction is occurring at a given time.

Tunnel construction

The proposed tunnel construction would include blasting. Blasting may have impacts in terms of noise, overpressure and vibration. These impacts may occur throughout the period of construction of the tunnel (at least six months).

15.3.2 Sensitive receivers

Sensitive receivers have been identified as having high potential to be impacted during construction of the proposed upgrade at three locations:

> Newrybar Public School.
> Residents at Clover Hill Estate, Bangalow.
> Residents at Ewingsdale.

There are also a number of isolated residences located on rural properties at various points along the proposed route.

15.3.3 Construction noise and vibration impacts

Noise impacts from general construction activities

The actual level of impact from construction noise would depend on the type of plant, equipment and construction methodology chosen by the construction contractor and final location of the work sites and batching plants. However, typical L_{A10} sound power levels can be predicted for a number of activities. Bridgeworks would typically generate sound power levels of 115 dB(A) to 120 dB(A), bored piling 115 dB(A), driven piling 120 dB(A), and paving up to 116 dB(A).

Based on a typical average-maximum construction site sound power level of around 113 dBL_{A10} (re 1 pW), and allowing for distance losses and typical atmospheric and environmental noise attenuation, typical construction noise levels are predicted to be around 70 – 75 dBL_{A10} at a distance of 50 m from construction sites, and 45 – 55 dBL_{A10} at a distance of 150 m. This would apply equally to earthworks and paving stages for construction.

There is the potential for construction noise criteria to be exceeded at times during the construction process where sensitive receivers are in close proximity to construction works. The three locations identified above are the most likely to be impacted by any exceedance of noise criteria. Newrybar Primary School is located 100 m from road acquisition boundary, and at both Clover Hill and Ewingsdale there are a number of sensitive receivers within 100 m of the road boundary.

Noise levels would be expected to be generally consistent along the proposed route. Sensitive receivers at a given location are likely to be exposed to noise for up to six months during the earthworks stage and up to six months during the paving stages. In the case of Newrybar Public School, the bridgeworks associated with the Broken Head Road overpass would generate noise for a period of up to nine months, which would occur after earthworks are complete, but may overlap with the paving stage.

Noise impacts from batching plants

Noise from batching or crushing plants also has the potential to impact sensitive receivers within the vicinity of the plant location. Noise emissions from batching plants arise from the use of plant and equipment and from associated vehicle movements. The preliminary plant locations have been identified in part to minimise the number of sensitive receivers. An indicative radius of 200 m has been identified as an area where construction noise criteria may be exceeded at times. Sensitive receivers within 200 m of the preliminary locations would include:

> A maximum of two residences at Ewingsdale.
> A maximum of one residence at Bangalow Road.
> A maximum of two residences at Ross Lane.

Noise would potentially be generated at these locations at least 18 months.

Noise impacts from construction compounds

An indicative radius of 200 m from construction compounds has been identified as an area where construction noise criteria may be exceeded at times. There would be one residence within 200 m of the preliminary construction compound location. Noise from a construction compound would be likely to be generated for the entire construction period.

Noise from crushing plant

A crushing plant would be likely to generate slightly higher noise levels than other construction activities. For this reason, a 300 m radius from the plant location has been identified as an indicative area which may be subject to exceedances of construction noise criteria. There are seven residences (on St Helena Road) within 300 m of the preliminary crushing plant location on the south side of the proposed tunnel. The location of the plant however would be at the base of the portal cuttings, which would provide some level of noise attenuation.

If a crushing plant is needed at other locations, it would generally be located at the base of a cutting, which would limit its potential noise impacts.

Noise from construction traffic

Noise from construction traffic within the road corridor is taken into account in generally qualitative terms in the relevant discussions above. There would be some noise impacts associated with construction vehicle movements outside the corridor, particularly in terms of any off-site disposal of excess fill. There would be a focus during detailed design, of optimising the cut/fill balance and minimising the volume of material disposed of off-site. The number and location of truck movements may be accurately determined at the completion of detailed design.

Impacts from tunnel construction

Impacts from tunnel construction would primarily be related to noise and vibration from blasting activities, which would occur over a tunnel construction period that would be at least six months. Blasting would generally be managed in accordance with the Australian and New Zealand Environment Council's (ANZECC) guidelines to manage vibration and overpressure from blasting. These guidelines recommend that blasting occurs once per day, and between 9am and 5pm on weekdays and Saturday.

The blasting would generate noise (airblast overpressure) that is likely to be audible to nearby residences. The noise would however occur as short, infrequent events and would be associated with ongoing consultation with potentially affected residents.

Based on the airborne propagation distances and the nature of the geology above the proposed tunnel, the Maximum Instantaneous Charge would be need to be limited to around 4 kg to ensure that the ANZECC overpressure and vibration guidelines are met at the nearest sensitive receivers located on the St Helena ridgeline.

Appropriate monitoring would be undertaken during blasting activities to ensure that this is the case, with blasting methods adapted where reasonable and feasible, if criteria are exceeded.

Vibration impacts

Potential vibration impacts associated with the tunnel construction are described above.

The levels of vibration generated from other construction activities would be site specific, and would be dependant on the ground type, the particular equipment used, and the proximity of the construction activity to the receiver location.

Construction activities associated with general road construction are not generally expected to generate perceptible levels of vibration at nearby residences due to the considerable propagation distances. In some cases, where construction is required near to properties, some vibration may be perceptible, but the works are not predicted to generate levels of vibration that would cause damage.

15.4 Management of impacts

15.4.1 Noise management during operation

Noise management during operation may be undertaken in a number of ways, including the construction of noise barriers, architectural treatment of individual houses, and the use of low noise pavement. Noise management measures are discussed below, with estimates of numbers of residences requiring mitigation being based on the noise modeling undertaken for the current concept design.

For 95 residences along the proposed upgrade, the acute noise level criterion of 60 $dBL_{Aeq,9hr}$ at night time and 65 $dBL_{Aeq,15hr}$ during day time is expected to be exceeded. For these houses noise mitigation is recommended. 219 residences exceed the base traffic noise criteria. Therefore, in total 314 residences would require noise mitigation.

Low-noise pavement surfacing is proposed for some sections of the alignment. Noise predictions are also made for this proposed mitigated situation with low-noise pavement on some sections of the alignment. In this situation 63 residences are exposed to acute noise levels. A further 54 residences exceed the base traffic noise criteria. Therefore, in total 117 residences would require noise mitigation when low-noise pavement is applied to these sections of the alignment.

For the residences at Clover Hill in Bangalow the feasibility of noise mitigation was investigated. For a barrier noise to be considered reasonable and feasible, it must provide at least 10 dB(A) of noise attenuation, in accordance with the RTA's Environmental Noise Management Manual. Barriers investigated in this area do not provide sufficient noise attenuation to be considered reasonable and feasible. However, a noise mound 5.5 m high would decrease noise levels at the most affected resident by approximately 9 dB(A), as well as providing noise reductions for a large number of residences. This is still considered reasonable, since it is anticipated that the earthworks for the project as a whole will result in excess material, which could be effectively reused. This noise mitigation would reduce the number of houses that need architectural treatment.

15.4.2 Noise and vibration management during construction

Management measures to reduce construction noise impacts would include:

> Preconstruction noise monitoring to identify background noise levels at representative noise sensitive locations.

> Adhering to the operating time limits and conditions where possible. And where not possible, consult with the community and obtaining advance agreement with the community and the DECC regarding work to be undertaken outside standard operating limits. Possible works outside standard operating times could include emergency works, safety works, delivery of materials or equipment (eg oversize equipment).

> Keeping the location of the stationary plant (air-compressors, generators, etc.) as far away as possible from residential areas.

> Using natural screening by topography wherever possible to reduce noise impacts.

> Using site sheds and other temporary structures or screens to limit noise exposure where possible.

> Installing operational noise barriers as early as possible to provide ongoing screening from construction activities, where possible.

> Choosing appropriate low-noise construction equipment and/or methods.

> Modifying construction equipment or the construction methodology or programme. This may entail programming activities to occur concurrently where a noisy activity will mask a less noisy activity, or, at different times where more than one noisy activity will significantly increase the noise. The programming would also consider the location of the activities due to occur concurrently.

> Choosing appropriate public consultation tools, which may include, but would not be limited to advance notification to local residents of planned activities and expected disruption/effects and effective monitoring of noise levels around potentially affected dwellings.

Environmental management measures to be adopted for construction stages would incorporate a programme of noise monitoring at sensitive receivers, a community information programme and a complaints hotline.

16 Indigenous heritage

This section describes the potential impact of the proposed upgrade on the Indigenous heritage of the area. It summarises the detailed assessment in *Working Paper 9 –Cultural Heritage Assessment.* The chapter addresses the environmental assessment requirements listed below.

Environmental assessment requirement	Where addressed
> Consideration of both artefact and landscape scale mitigation measures, where relevant	Section 16.5
> Consideration of regional scale cumulative impacts and identify the significance of the impacts of the project in the context of the Pacific Highway Upgrade Program	Section 16.4.3

A detailed assessment of impacts of the proposed upgrade on non-Indigenous heritage is also included in *Working Paper 9 –Cultural Heritage*. **Section 20.4** provides a summary of this assessment.

For the purposes of this report, the terms *Indigenous* and *Aboriginal* have the same meaning and are interchangeable. Non-Indigenous refers to occupation by people of any ethnicity other than Aboriginal.

16.1 Assessment approach

A cultural heritage assessment of the proposed upgrade was prepared by Navin Officer Heritage Consultants (***Working Paper 9***), including literature, register and database review, field survey and consultation. Relevant information collated in previous studies (from November 2004 to December 2007) for the proposed upgrade has been incorporated into the working paper.

16.1.1 Previous studies

Previous heritage studies undertaken for the proposed upgrade included input into the *Route Options Development Report* (RTA 2005) and the *Preferred Route Report* (RTA 2006a). This input included:

> Compilation and review of previous cultural heritage assessment in the study area.

> Aboriginal stakeholder consultation including the convening of an Aboriginal focus group meeting.

> Sample archaeological survey and site inspection.

> Feedback from the community liaison group and value management workshops.

> Preliminary assessment of potential impacts on known cultural heritage values (Preferred Route Report (RTA 2006a)).

This input was incorporated into the cultural heritage assessment provided in *Working Paper 9 – Cultural Heritage*.

16.1.2 Literature and database review

A range of archaeological and historical data was reviewed for the study area and the surrounding region. This was used to determine if known Indigenous sites were located within the area under investigation, to facilitate site prediction on the basis of known regional and local site patterns, and to place the area within an archaeological and heritage management context. The review of documentary sources included heritage registers and schedules, local histories, and archaeological reports.

> Indigenous literature sources included the Department of Environment and Climate Change (DECC) Aboriginal Heritage Information Management System (AHIMS), associated files and catalogue of archaeological reports.

16.1.3 Consultation

A variety of consultation has been undertaken since the route options were first developed in 2005. The broader project consultation process is described in **Chapter 4.**

The proposed upgrade would be located within the boundaries of the Jali Local Aboriginal Land Council (LALC), north of Ross Lane to McLeods Shoot, and the Tweed-Byron LALC, McLeods Shoot to Ewingsdale. It also straddles Ballina Shire Council and Byron Shire Council. Throughout the route options phase through to the development of the preferred route (December 2007), the following Aboriginal groups and other relevant organisations were consulted:> Arakwal Aboriginal Corporation.

> Ballina Shire Council.

> Bundjalung Elders.

> Burabi Aboriginal Corporation.

> Byron Shire Council.

> DECC regional office.

> Jali Elders.

> Jali Local Aboriginal Land Council.

> Tweed Byron Local Aboriginal Land Council.

The RTA implemented the DECC *Interim Guidelines for Aboriginal Community Consultation – Requirements for Applicants* (DEC 2005a) for this project. The following consultation was undertaken (full details, including meeting attendance, are provided in Appendix 2 of Working Paper 9):

> Identification of Aboriginal organisations and representatives and initial meetings November 2004 to August 2005.

> An Aboriginal focus group (comprising of representatives of the groups listed above) was established in November 2005 with a view to meet at key milestones of the project.

> The first Aboriginal focus group meeting was held on 24 November 2005 to seek feedback on the route options assessment analysis.

> A value management workshop was held on 15 and 16 December 2005 with members of the focus group invited.

> The preferred route for the proposed upgrade was announced and a media

advertisement was placed for Aboriginal stakeholders to register their interest in September 2006. No responses were received.

> The second Aboriginal focus group was held on 9 February 2007 with limited attendance from Aboriginal stakeholders. To seek input into the cultural heritage assessment, the project team made individual contact with each of the Aboriginal focus group members.

> Representatives of the Aboriginal focus group were invited to assist with the field survey of the proposed upgrade, undertaken in April 2007. A representative from Jali LALC attended and provided extensive information regarding the Indigenous heritage of the area.

> A third focus group meeting was held on 11 December 2007 to present initial findings of the cultural heritage assessment and discuss future fieldwork methodology and focus group participation in that fieldwork.

> Additionally throughout the project there have been specific requests from landowners to review the potential significance of artefacts found on their property. The project team met with the respective landowners and where relevant the findings of those visits have been included in the assessment.

16.1.4 Fieldwork

A field survey of the proposed upgrade was undertaken in April 2007 by Navin Officer Heritage Consultants and a representative from the Jali LALC.

The survey aimed to identify all visible Indigenous and non-indigenous sites and features in the defined study area, and to identify areas of archaeological potential that may require subsurface testing.

For the purposes of the cultural heritage fieldwork the study area comprised a corridor approximately 17 km long and variously 50 to 120 m either side of the alignment centreline.

Survey for Aboriginal sites involved walking through accessible properties within the study area. Traverses were also conducted along adjacent micro-topographic features considered to have archaeological potential. All existing natural ground surface exposures were inspected. All examples of old growth native trees in the survey area were inspected for possible Aboriginal scarring. Where access to private property within the impact area was not available, sections of the preferred route were assessed from nearby access roads and/or accessible properties.

Survey for historic sites was conducted concurrently with the survey for Aboriginal sites. The archaeological survey was aimed at identifying material evidence of Aboriginal occupation as revealed by surface artefacts and areas of archaeological potential un-associated with surface artefacts. Potential recordings fall into three categories: isolated finds, sites and potential archaeological deposits. These are described in *Working Paper 9 – Cultural Heritage Assessment*.

16.2 Existing indigenous heritage conditions

16.2.1 Tribal representation

Aboriginal tribes associated with the area of the proposed upgrade are most likely associated with the Bundjalung group. The Ross Lane to approximately Newrybar section of the proposed upgrade lies within the territory of the Arakwal dialect. The section of the proposed upgrade from about Newrybar to Ewingsdale was inhabited by the Minjangbal tribal group, which extended northwards along the coastal strip past Tweed Heads.

Access routes both along and across the coastal plain would have been important areas of Aboriginal occupation. The coastal plain was regarded as a key area for sites. The area acted as a focus for both economic subsistence and ceremonial gatherings that were supported by an abundance of coastal plain resources. The Big Scrub (the term used to described the extensive rainforest that was occurring in the area at the time of European settlement), the Newrybar Swamp and the beaches and headlands of the coastline would have provided extensive food and material resources.

To date, there has been little evidence to indicate that Aboriginal groups habitually camped within the Big Scrub on the Alstonville Plateau. In contrast, areas on the coastal plain appear to have been preferred as occupation sites and areas of focussed Aboriginal activity.

A native title claim exists over the northern part of the proposed upgrade (**Figure 16.1**). The claim, known as the *Byron Bay Bundjalung People #3* was registered in 2003 and is now in mediation. The claim is made by seven individuals. The claim area includes the northern part of the proposed upgrade.

16.2.2 Cultural values

The Aboriginal community representatives and traditional knowledge holders have identified the importance of the cultural association between a person's tribal affiliation or family grouping, and their corresponding tribal lands and country. Broad landscapes are mentioned in this context, such as the local coastline, estuaries, coastal plain, escarpment, plateau, and the Big Scrub which once occupied the plateau and coastal escarpment.

With regard to the proposed upgrade and the associated plateau landscape, the following points summarise the statements provided by community representatives and elders:

> The escarpment margin of the plateau is a significant and sacred landscape, with the views to and from the escarpment having cultural value.

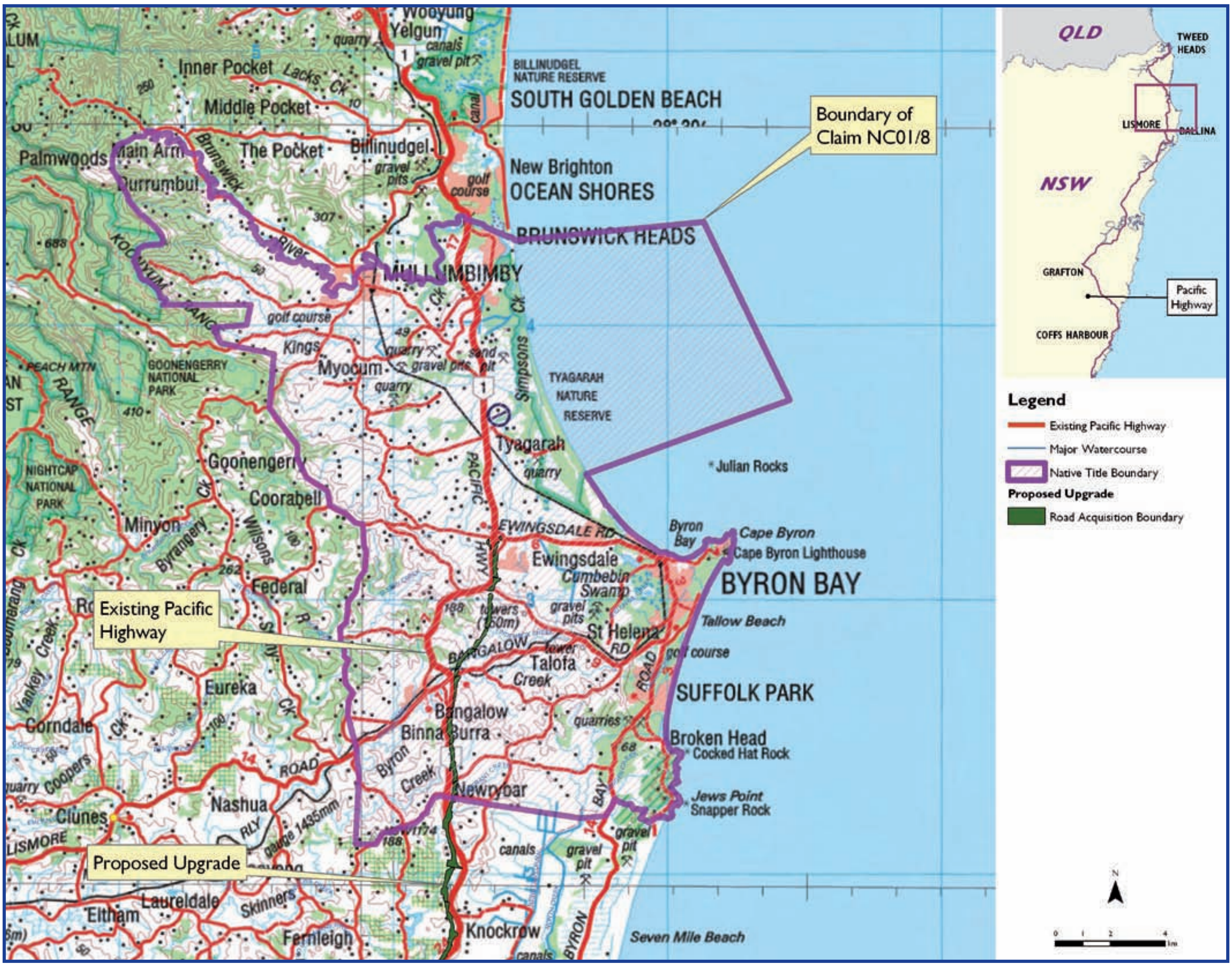
> The existing Pacific Highway across the plateau may approximate the location of an Aboriginal pathway.

> The plateau and its resources (and notably the Big Scrub), was exploited for its food and medicinal resources, but was not an occupation focus.

> Aboriginal through-travel between the hinterland and coastal plain must have involved crossing the plateau. Watershed ridgelines on the plateau may have served as travel routes or pathways.

> Ceremonial activities also occurred on the plateau (as indicated by a stone arrangement site west of Bangalow).

Figure 16.1 - Native title claim no NC01/8 (N6020/01)



> Aboriginal stone artefacts present within the landscape are an important component of the cultural value of that landscape.

16.2.3 Known aboriginal sites

No previously recorded Aboriginal sites are listed on the DECC Aboriginal Heritage Information Management System as occurring within the area of the proposed upgrade.

In the April 2007 survey one small scatter of stone artefacts and two isolated finds were recorded. A description and general location of the recordings is provided below.

T2E A8 – isolated find

This site comprises a single stone artefact visible on a cutting (about three metres high) on the eastern side of the existing highway, near the southern portion of the proposed upgrade.

The Jali LALC sites officer who assisted with the survey noted that this material dominates the artefactual assemblages that he is familiar with on the lowlands (coastal plain).

T2E A9 – isolated find

This site comprises a ground edge hatchet found and collected by a land owner, in the southern portion of the upgrade. This area is now the location of a workshop and shed. The artefact was most likely a ground edge stone hatchet, with possible use as an anvil.

Side view of isolated find T2E A8

Side view of isolated find T2E A9

T2E A10 – artefact scatter

This site comprises two stone artefacts, approximately 60 m apart, located in a macadamia plantation in an upper catchment context in the middle portion of the upgrade. Artefact 1 was visible in the first row of macadamias parallel to a northern boundary fence. Artefact two was visible at the upstream end of a small swamp basin.

16.2.4 Potential aboriginal sites

Given the very limited amount of knowledge about the type and incidence of archaeological deposits within the area of the proposed upgrade, the identification of potential archaeological deposits (PADs) has required a conservative approach whereby most landforms with predicted potential were included. The conservative approach identified 36 PADs. An example of the PADs is shown in the photographic images below with the locations of all PADs shown in **Figure 16.2a-e**

PAD 21 is situated on vegetated creek flats

Looking north towards PADS 26-28 in the western side of Tinderbox Creek. PAD 28 is on the middle distance crest

Figure 16.2a - Location of potential archaeological deposits

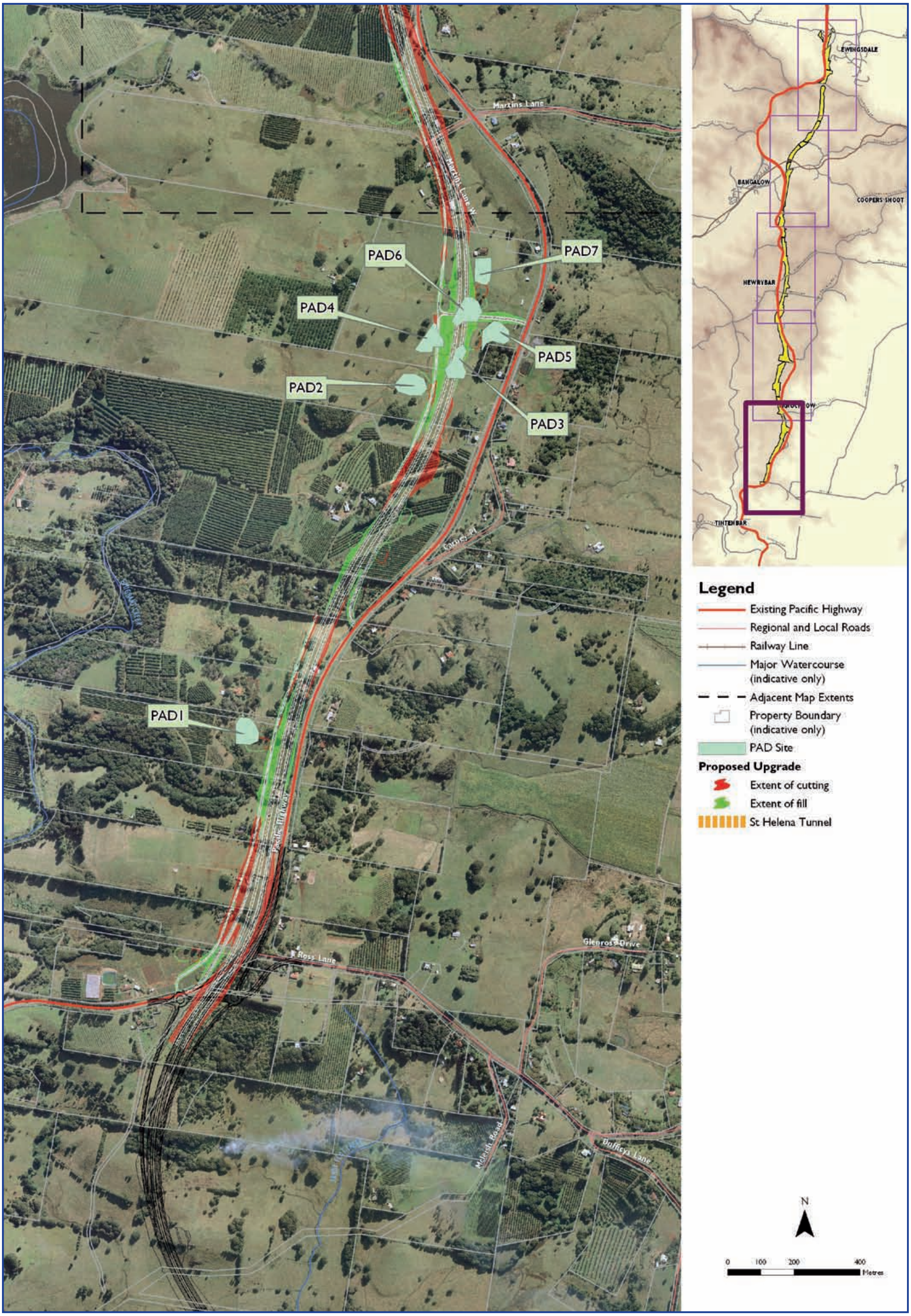


Figure 16.2b - Location of potential archaeological deposits

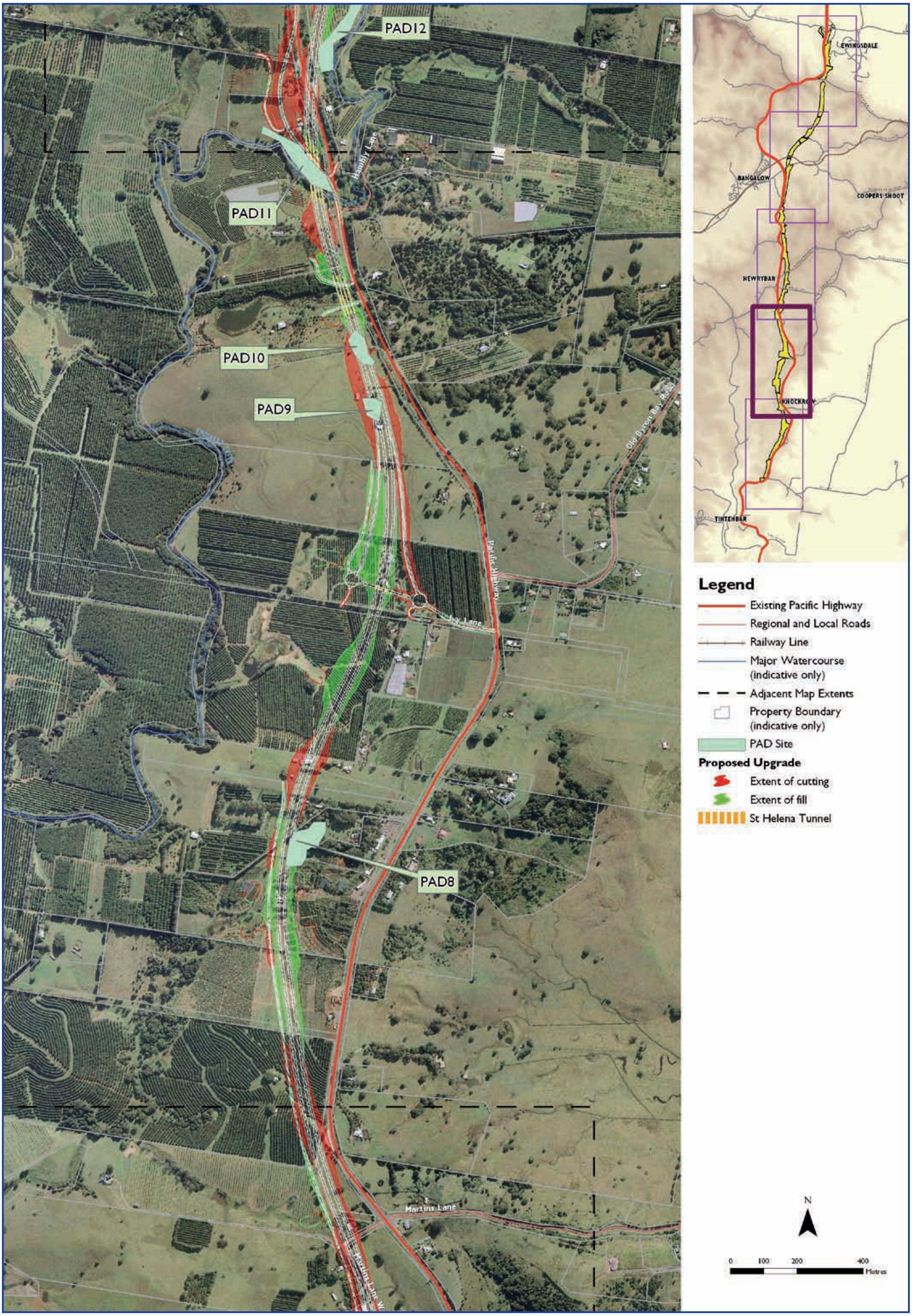


Figure 16.2c - Location of potential archaeological deposits

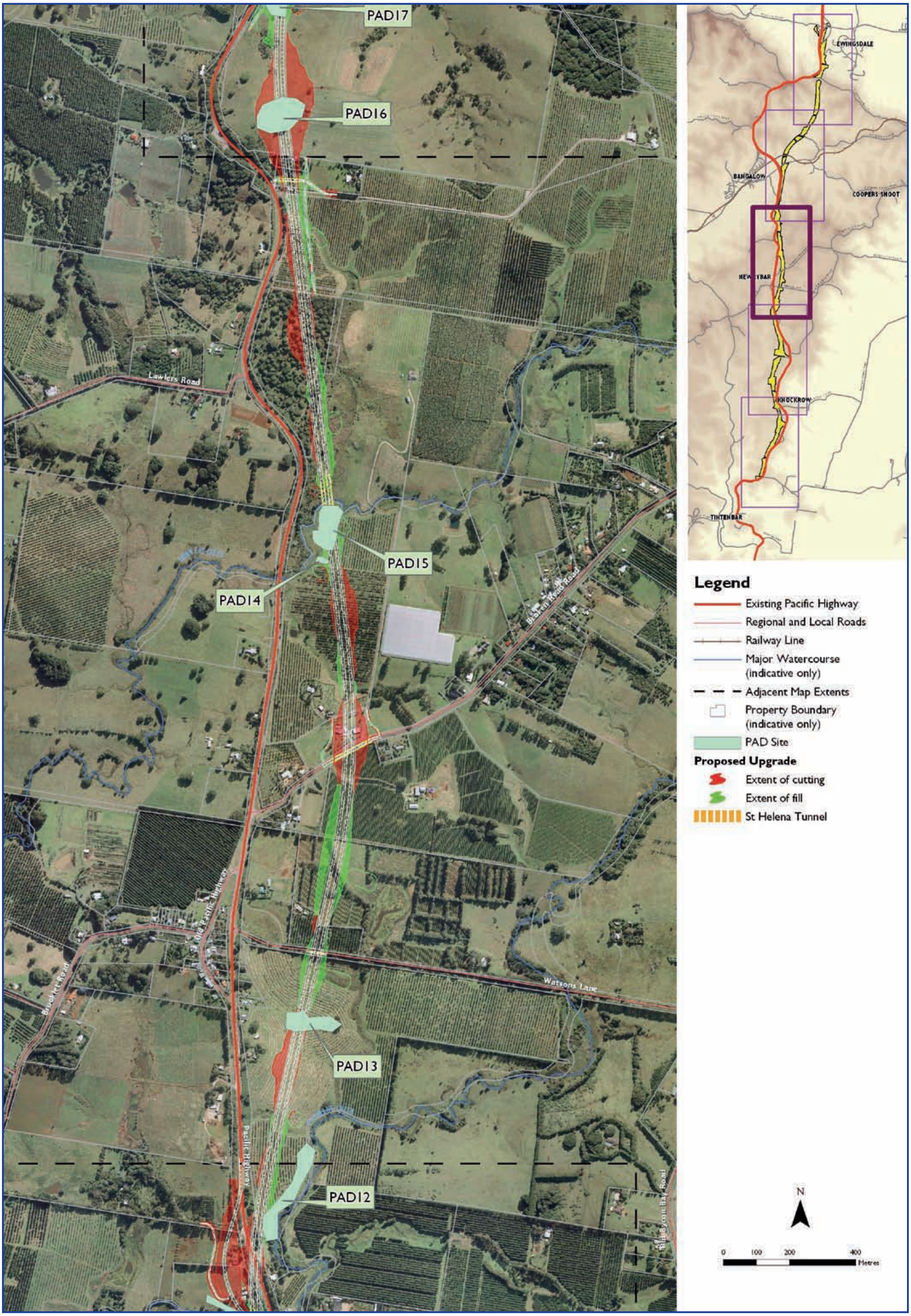


Figure 16.2d - Location of potential archaeological deposits

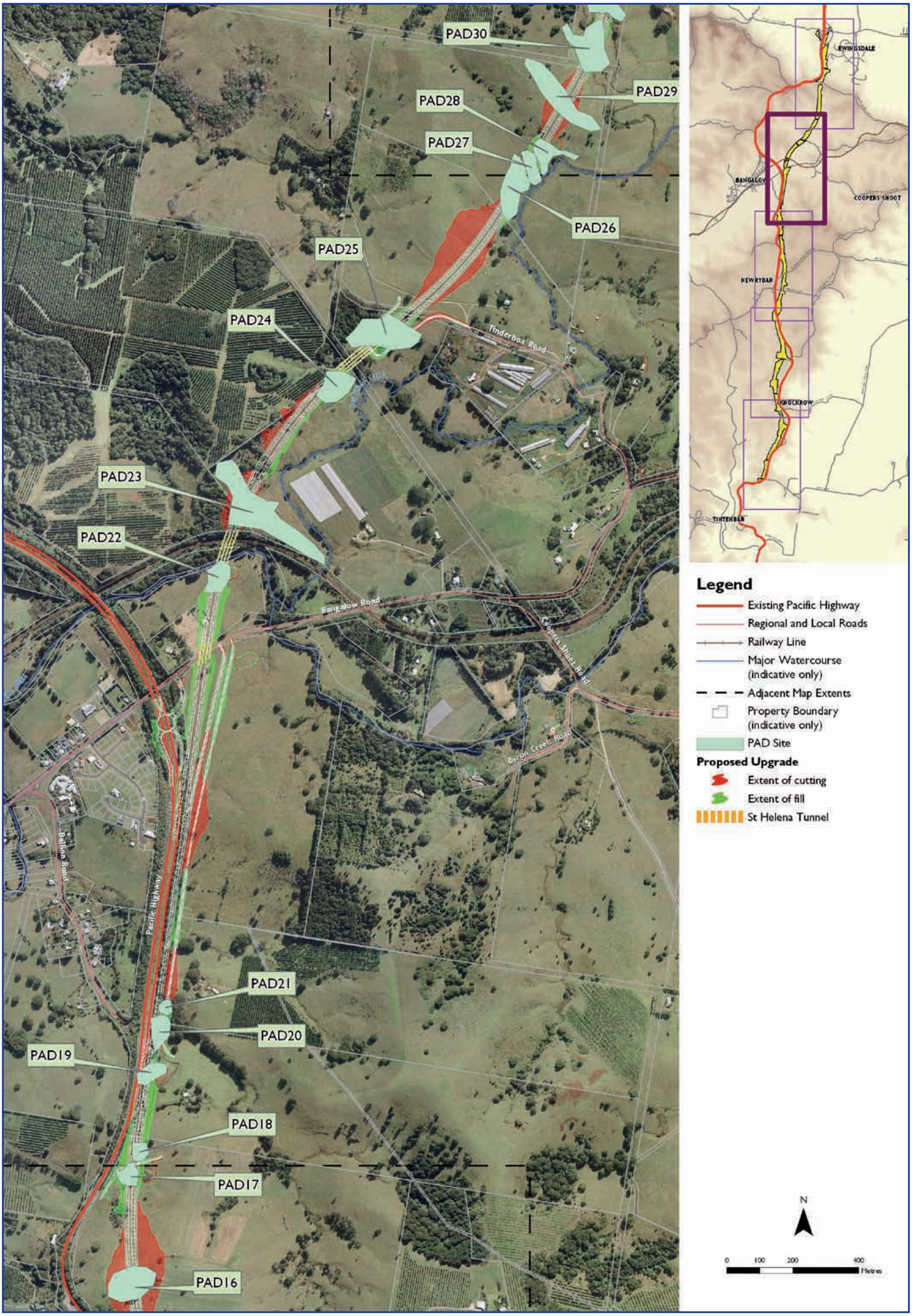
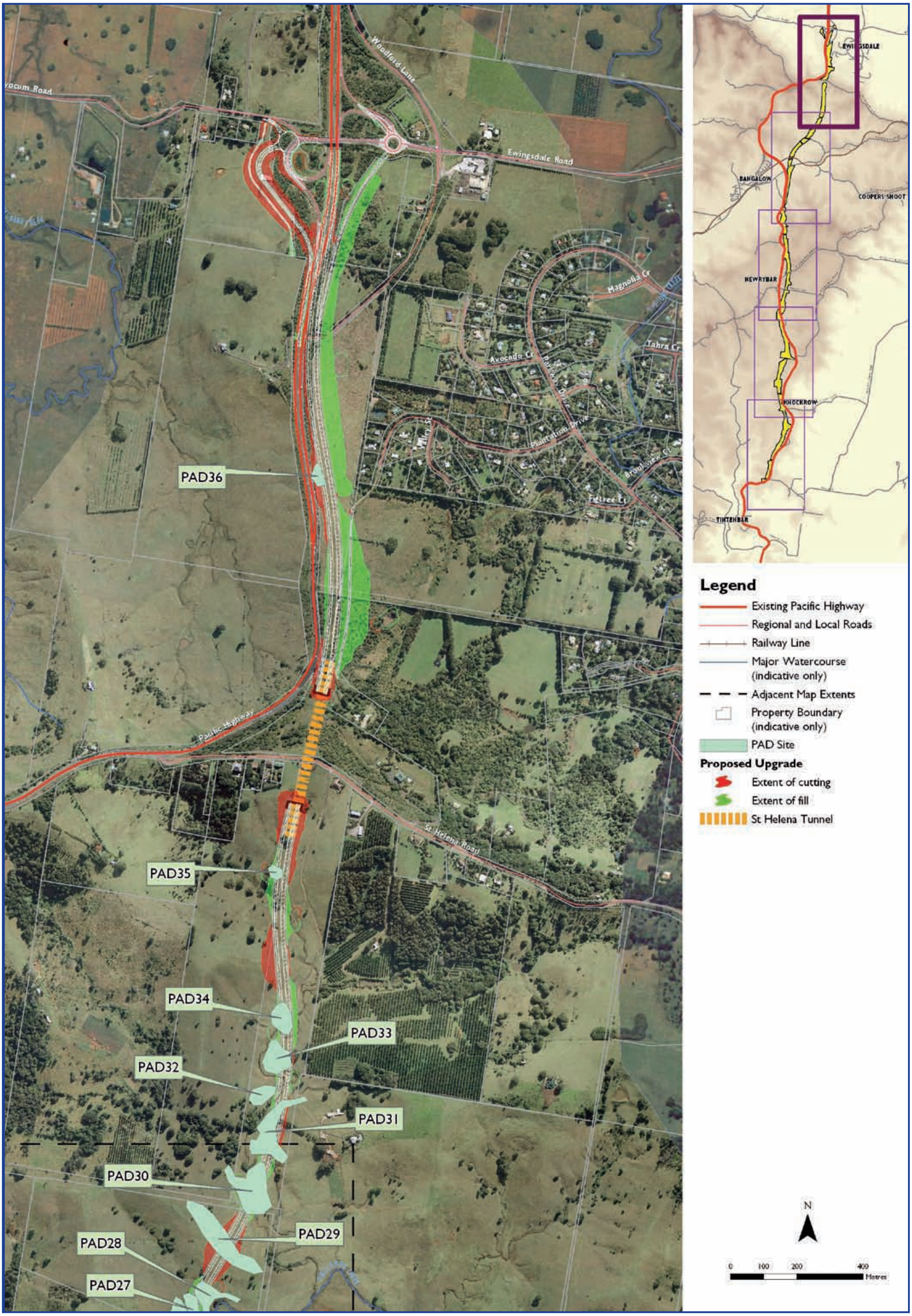


Figure 16.2e - Location of potential archaeological deposits



16.3 Impacts to items of indigenous heritage significance

16.3.1 Impact to known sites and PADs

To assess the significance of impacts on the three known Indigenous heritage sites affected by the proposed upgrade a number of potential categories are used:

> Significance to contemporary Aboriginal people.
> Scientific or archaeological significance.
> Aesthetic value.
> Representativeness.
> Value as an educational and/or recreational resource.

A conservatively high number of PADs have been identified for the purposes of the environmental assessment. This is due to the relative lack of previous studies undertaken on the Alstonville plateau and resulting difficulty to accurately predict the likelihood of archaeological deposits occurring. It is anticipated that this conservative approach to PAD identification would result in a similar number/density of PADs for any given route along the plateau.

For the 36 PADs, insufficient data is available from the survey to make a predictive assessment of their significance and a program of subsurface testing has been developed (refer to **Section 16.4**). Given that the topographic contexts and conditions of all the PADs are well represented elsewhere in the adjacent lands, it is not expected that test results will encounter archaeological material which would warrant, according to rarity or representative value, in situ conservation of the deposits and thus changes to the design and alignment of the upgrade. It is possible however, that other values such as those vested in Aboriginal cultural tradition, may be relevant to the tested PADs and may result in assessments of high or exceptional significance. Examples of sites which could potentially have such value would be a burial ground with multiple burials, a ceremonial site, a large archaeological deposit with extensive stratigraphic complexity and integrity, or a site with major time depth (such as greater than 5000 years).

A summary of the heritage significance and extent of impact to known and potential Indigenous sites is provided in **Table 16.1**.

Table 16.1 - Impact to Indigenous sites

Site ID	Site Type	Heritage Significance	Development Impact
T2E A8	Isolated find	Low to moderate, local	Not directly impacted, occurs within existing highway easement
T2E A9	Isolated find	Moderate, local	Direct impact
T2E A10	Artefact scatter	Low to moderate, local	Direct impact
PADs 1-36	Aboriginal PADs	Undetermined and subject to further sampling.	Of the 36 PADs, 24 would be wholly destroyed and 12 partially

16.3.2 Impact on indigenous cultural values

A number of Aboriginal interviewees have commented on the close association of the existing highway and the corridor for the proposed upgrade. In particular they stated that this would be beneficial in minimising damage to the landscape and potentially occurring sites by concentrating development impact in and near areas of existing disturbance. The considerable European history of forest clearance, dairying, cropping and plantations across the proposed development area has also been noted in this regard.

Additionally, through the methodology applied in identifying the PADs consideration has been given to landscape and in particular the potential for certain landforms to contain items of Aboriginal heritage. Where items of Aboriginal significance are discovered there is potential for that landscape to then have cultural significance within the Aboriginal community.

16.3.3 Cumulative impacts

Cumulative impacts refer to the incremental and combined impacts of past, present and future activities. Cumulative impacts can be measured both through time, and within a particular period of time. For the purposes of this study the local area is defined as the Alstonville Plateau, and the region as the NSW North Coast.

There is no standard methodology for the assessment of cumulative impact on cultural heritage. Ideally an assessment of cumulative impacts can be measured against a baseline of cultural heritage data that characterises the existing environment to be affected, and the cumulative loss already realised. Unfortunately in the case of the local and regional contexts of the proposed upgrade, effective data sets of such information do not exist.

In the absence of an effective baseline for a quantitative evaluation, an assessment must be based on a qualitative review of the main determining factors. These can be defined as the extent and effect of previous impacts on the current resource, the degree to which the current development proposal may affect a resource which is rare or notable, and the effect of other current or planned similar developments.

Heritage items recorded are largely a consequence of the occupation and exploitation of the landscape. The landscape context therefore forms a significant part of the cumulative assessment provided below.

All of the soil landscapes in the area of the proposed upgrade supported sub-tropical rainforest, known locally from the nineteenth century as the Big Scrub. The Big Scrub was notable for its resources which supported the local Aboriginal communities. There are no remnants of the Big Scrub today within the area of the upgrade other than several small patches of lowland rainforest that have been subject to high levels of disturbance.

Agricultural activity can be expected to have had a significant impact on archaeological deposits with potential areas of local concentration being scattered. Disturbance would also have occurred due to construction of road and rail, farm buildings, houses and service easements. In particular there would have been extensive excavation and levelling in the area of the proposed upgrade due to previous highway construction activities. Natural Aboriginal travel routes (such as spur or ridge lines) have been previously affected by the construction of the existing highway and the preferential location of houses, farm buildings, etc on these landforms. This has the effect of reducing the potential incremental impact the proposed upgrade might have.

Recognising the above, it is determined that the level of impact, when combined with the conduct of the proposed cultural heritage management strategies (**Section 16.4**) will not be substantial.

16.3.4 Regional scale cumulative impacts

In the absence of an effective baseline for a quantitative evaluation, an assessment of cumulative impact must be based on a qualitative review of the main determining factors. These can be defined as the extent and effect of previous impacts on the current resource, the degree to which the current development proposal may impact upon a resource which is rare or notable, and the effect of other current or planned similar developments.

Previous Impacts

All of the soil-landscapes traversed by the upgrade, with the exception of the higher gradient slopes of the escarpment (Coolamon), have been subject to extensive clearance of native vegetation for agricultural development. All of the study area soil-landscapes originally supported subtropical rainforest with a closed tall forest structure (Morand 1994). This was known locally from the nineteenth century onward as the Big Scrub. Although this original forest would have secured and stabilized the soils, the zone of biological activity within the upper soil profile would have ensured that any remains of Aboriginal occupation discarded in open soil profile contexts would have been gradually transported and mixed via bioturbation throughout the upper soil zone.

No remnants of the Big Scrub forest remain within the proposed upgrade corridor. Following clearance, agricultural grasslands were developed, first with native species and then with improved pasture techniques, for the grazing of stock animals. Extensive horticulture also occurred with the varied introduction and development of sugar cane, pineapple, banana, and other tropical fruit crops. More recently, the extensive development of plantations has occurred, notably of macadamia nuts.

All of the production methodologies associated with these agricultural industries, starting with vegetation clearance and continuing with repeated soil tillage, and associated downslope movement (erosion) can be expected to have had a significant impact on archaeological deposits. Areas of local artefact concentration are likely to have become more scattered. Larger artefacts will have been damaged by tilling and ploughing and the vertical distribution of all artefacts will have been re-distributed within the plough and ripping zones. Original land surfaces on aggrading landforms are likely to have become overlain by later sediments and conversely degrading landforms may have lost archaeological material through both gradual and rapid downslope erosional transport processes.

Following the change from forest to grasslands, changes in the fluvial regime and sediment loads of the areas drainage lines may have promoted higher sediment loads, more rapid and extreme flooding, and greater erosion and instability in creek banks. All of these processes have adverse implications for the survival and visibility of archaeological deposits in valley floor contexts.

There were no areas observed within the upgrade study area in which these landuse impacts could not have been expected to have operated in the past and/or to continue to be associated with current agricultural production. The study area did not present any peculiarity in this regard when compared to the surrounding land surfaces which have been similarly affected.

More focused and higher levels of disturbance within the proposed upgrade study area are associated with the construction of buildings, vehicle paths, and service easements. The construction of building and road platforms has often involved extensive excavation and leveling of the original ground surface, mostly on locally elevated level ground, and particularly on spur and ridgeline crests. The existing Pacific Highway and other arterial roads across the plateau are frequently positioned along the continuous spur and ridge crests of watershed landforms. As a consequence, these natural through-travel routes (which may also have been favoured by Aboriginal people) have been subject to a disproportionate degree of landsurface disturbance. The preferential placement of residential and farm buildings, together with service easements, in proximity to arterial roads, increases this effect.

The proposed upgrade is notable for the previous impacts associated with the construction of the current Pacific Highway. This means that a significant proportion of the elevated crests traversed by the upgrade alignment have been substantially disturbed either directly or indirectly by the construction of the highway or developments focused around the transport corridor represented by the highway.

By way of contrast some of the valley floor landforms traversed by the upgrade may contain deposits with the least degree of past disturbance. Despite the greater instability of creek banks following forest clearance, the potential for net sedimentation from higher sediment loads, and from downslope transport of cultivated soils, provides for the potential of buried land surfaces with archaeological deposits, some of which may be below the plough zone. This is reflected in the large number of identified potential archaeological deposits within valley floor contexts.

With regard to past impact to European heritage items, the area of the proposed upgrade appears not to have notably different processes of attrition or deterioration relative to surrounding lands. One notable exception however is the economic effect of the highway itself which has probably acted to increase the rate of demolition and renewal of structures through higher property values and commercial potential. This could be expected to lead to fewer surviving heritage items than in more peripheral or marginal areas. Another potential effect of the highway, the promotion and development of towns is substantially sidelined by the deliberate placement of the upgrade so that these areas are avoided. The potential heritage items, values and cumulative impacts associated with townships are also effectively avoided.

The proposed construction of the highway upgrade would result in the removal and obliteration of most heritage items within the proposed upgrade corridor. This level of impact however does not represent a substantially increased cumulative impact because the upgrade area remains largely typical of disturbance levels found elsewhere in the surrounding lands. Any notable differences such as the presence of the existing highway provides a basis for estimating a higher level of disturbance and corresponding loss of heritage value, rather than less.

Rarity and notability

A review of the soil-landscapes present within the upgrade study area shows that the proposed alignment traverses six categories: Bangalow; Ewingsdale; Wollongbar; Wollongbar variant; Coolamon; and Rosebank (in decreasing order of area subject to impact). All of these categories are well represented elsewhere across the Lismore – Ballina map sheet: Bangalow accounts for 151 km^2; Ewingsdale 53 km^2; Wollongbar 178 km^2; Wollongbar variant 18.5 km^2; Coolamon 27.5 km^2; and Rosebank 270 km^2.

In terms of the Aboriginal archaeological resource, the soil landscapes on the plateau are likely to have a similar suite of likely site types, with differentiation provided by the presence of fluvial corridors, watershed ridge and spur lines, exploitable rock exposures, and aggrading landforms with potential for buried deposits. The former presence of closed subtropical rainforest across the whole landform range is likely to have had a stronger determining effect than the more subtle variations of slope, relief and soil type which differentiate the soil-landscape units across the plateau.

16.4 Management of impacts

The following management measures, would be undertaken.

> Comprehensive archaeological survey would be conducted, when access is available and where considered appropriate, on those properties which were excluded from or unavailable for field survey during the time of the environmental assessment.

> Cultural heritage management and Aboriginal cultural appreciation would be incorporated into construction site induction.

> A salvage collection of surface artefacts at sites A9 and 10 would be undertaken.

> A limited program of subsurface archaeological salvage at sites A9 and 10 would be undertaken.

> In the event that there is an assessed risk of disturbance to site A8, then the site would be temporarily fenced and/or the surface artefacts temporarily collected and subsequently re-positioned after the completion of works.

> An initial program of archaeological subsurface testing across a representative sample of the 36 PAD locations would be undertaken, and following a review of the test results, conduct an assessment of whether additional excavation is required, either in additional PADs or as a salvage program within previously tested locations.

> Further PAD investigations would be undertaken if considered necessary according to a review of the initial testing program.

> All recovered artefactual material from the surface collections and subsurface investigations would be the subject of standard archaeological description and analysis.

> In the event that suitable archaeological materials are recovered, age determinations would be made in consultation with local Aboriginal community stakeholders.

> The Aboriginal focus group would continue to be consulted regarding ongoing management of Indigenous cultural heritage.

> Representatives of local Aboriginal stakeholder groups would be offered the opportunity to participate in all fieldwork conducted as part of an Indigenous cultural heritage management program.
> Following the completion of archaeological analysis, all recovered artefactual material (except materials required for age determinations) would be returned to the local Aboriginal community, to be managed according to community and legislative requirements. A secure and local temporary storage location may be required prior to conducting a permanent management strategy. All locations in which salvaged Aboriginal objects are repositioned would be recorded on DECC site cards and provided to the DECC as soon as practicable.
> The RTA would, in consultation with the local Aboriginal community, investigate opportunities to establish nomenclature and the use of public signage associated with the proposed upgrade that promotes local Aboriginal language names and presents Aboriginal interpretations and stories about the landscape and its Aboriginal occupation. The development of landscape treatments and land rehabilitation within the upgrade easement would, where feasible, incorporate components which address Aboriginal cultural landscape values. The Aboriginal Focus Group would be consulted during the development of detailed landscape design.
> Protocols which specify the required actions in the event of the discovery of previously unrecorded Aboriginal objects (including human remains) would be established and followed for the period of construction works.

17 Social and economic

This section addresses the social and economic impacts of the proposed upgrade in accordance with the environmental assessment requirements listed below. More detail is provided in *Working Paper 10 – Social and Economic Assessment.*

Environmental assessment requirement	Where addressed
> Local community socio-economic impacts associated with land use, property and amenity related changes.	Section 17.3.2, 17.3.3, 17.3.4 and 17.3.5.
> Business (including agricultural producers) impacts on a case by case basis including impacts to the overall viability, profitability, productivity and sustainability of businesses	Section 17.3.1
> Regional economic impacts to the agricultural sector taking into account the total loss of regional and State Significant farmland as identified in the Northern Rivers Farmland Protection Project (Department of Planning, February 2005).	Section 17.3.6 (impacts to agricultural activities are discussed in Chapter 14).
> Regional economic impacts to the tourism sector taking into account agri-tourism impacts and impacts to local amenity, character and scenery.	Section 17.3.8

Also addressed in this section are some Director General's Requirements that are under the heading of *land use and property.* These include:

> Impacts to the connectivity and contiguity of small settlements including Newrybar and Knockrow (addressed in **Section 17.3.4**).

> Consideration of project impacts on the attainment of the Far North Coast Strategy (addressed in **Section 17.3.6**).

17.1 Assessment approach

A detailed social and economic assessment *Working Paper 10 – Social and Economic Assessment* was undertaken by Arup and Hassall and Associates as part of the preparation of this environmental assessment. The results of this assessment are discussed in this chapter.

Social impacts have been defined by the NSW Office of Social Policy (1995) as significant events experienced by people as changes in one or all of the following:

> People's way of life – how they live, work, play and interact with one another on a day to day basis.

> Their culture – shared beliefs, customs and values.

> Their community – its cohesion, stability, character, services and facilities.

An analysis of the social impacts and changes likely to occur as a result of the proposed upgrade has been undertaken in regard to the methodology established by the NSW Department of Urban Affairs and Planning's (now Department of Planning) *Environmental Impact Statement guidelines.* No specific guidelines have been developed for Environmental Assessments under Part 3A of the *Environmental Planning and Assessment Act.*

Economic impacts on the agricultural sector and adjacent businesses were measured in terms of the change in regional income (or gross regional product). Qualitative assessment has also been made as to the nature of impacts on different types of businesses and the broader effect of the proposed upgrade on the tourism industry in the area.

17.2 Existing social and economic profile

The local community includes the townships of Bangalow, Newrybar, Ewingsdale and Knockrow, and people living on surrounding rural properties. It is a diverse mix of people including families who have been in the area for generations as well as more recent arrivals that have come to the area for commercial and/or lifestyle reasons. There is a strong interest in both environmental and development issues in the region. The interface between the two areas of interest, coupled with increasing property prices and a desire to protect and enhance the existing high levels of amenity, has resulted in a local population that is very involved in local matters.

The main street of Newrybar

Ballina and Byron shires are both experiencing population growth. For the period 1991 to 2001, Ballina and Byron shires respectively experienced 2.14 percent and 2.86 percent annual compound population growth respectively. Between the 1996 and 2001 censuses, Ballina and Byron shires' population growth was 7.3 percent and 9.7 percent respectively. Major economic activities in the immediate vicinity of the proposed upgrade are agricultural and agricultural related processing. They include:

> Beef cattle.
> Macadamias.
> Coffee.
> Stone fruit.
> Sugar.

Approximately 1 in 8 working people on the North Coast are employed in primary production (NSW Department of Primary Industries 2006). The North Coast region is defined by NSW Department of Primary Industries as all of the Tweed, Brunswick, Richmond, Bellinger, and Nambucca catchments, most of the Hastings catchment and large parts of Clarence and Macleay catchments. It also comprises the eastern half of the Northern Rivers Catchment Management Area, which extends westward across the New England Tableland to the Great Divide. Farm gate value of agricultural production on the North Coast is in excess of $1 billion per annum, rising to about $2 billion when processing is included, particularly in the agricultural and forest industries (NSW Department of Primary Industries 2006).

Tourism is a major industry in a regional sense with the local area playing a role in terms of its contribution to the scenic landscape, provision of access, and provision of some specific tourist related businesses. According to data produced by Tourism NSW (2007) for the Northern Rivers region, for the year ending December 2007 the total number of visitors to the area was 4.7 million. Total expenditure from tourism for this time period was more than $1 billion. The Northern Rivers Tourism Plan identified that 85 percent of visitors to the region are domestic, and 86 percent of visitors travel to the region by car. The region also attracts the second highest number of international visitors in NSW. There are a range of accommodation options including resorts, bed and breakfasts, hotels, hostels and camping grounds.

17.3 Social and economic impacts

17.3.1 Impacts on local businesses

Impacts of the upgrade on the viability, profitability, productivity and sustainability of directly affected non-agricultural businesses would reflect the change in the physical operating environment (accessibility, visibility and operating amenity) and disruption of patronage (be it from through traffic on the existing highway, local patronage or whether the town or village is a 'destination' in its own right). Furthermore, those impacts would vary between the short term (during construction and adjustment within the local community) and the long term (as accessibility, visibility and operating amenity impacts become fully embedded).

The types of impacts on local non-agricultural businesses include:

> Accessibility.

> Visibility.

> Operating amenity.

These different impacts are discussed below in terms of impacts on businesses at Newrybar, Knockrow and Ballina.

The Macadamia Castle currently has direct access onto the existing Pacific Highway.

Accessibility

Accessibility to business enterprises relates to the ease that potential patrons can gain access to the businesses within the proposed upgrade area.

Some disruption to local and through traffic would be expected during the construction period. Traffic disruptions would potentially affect businesses at either Newrybar, Knockrow or Bangalow, however the overall impact on businesses would be expected to be minor due to the anticipated short duration of disruptions.

During operation, business enterprises with links to passing highway trade would be potentially subject to adverse effects as a result of the relocation of the highway and more restricted access that would result. The main potential impact in this regard is at Knockrow, where a proportion of the business received by the Macadamia Castle is related to its easy accessibility from the highway. Passing highway traffic is less important to businesses in Newrybar and Bangalow (although it is acknowledged that some business activity occurs in these locations from highway users stopping for a rest and/or refreshment). Access arrangements for patrons of these businesses (other than passing highway traffic) would change due to local road reconfiguration, however it would be expected that access for local patrons would generally be easier.

Visibility

Visibility to passing traffic is important to some businesses, particularly any that are reliant on passing trade (as discussed above). Businesses in Newrybar and Bangalow currently have very limited visibility from the highway, other than signs indicating the presence of each town. The Macadamia Castle at Knockrow however, is highly visible from the existing highway. The facility would not be visible from the proposed upgrade, which may have some impact on patronage, but may be able to be mitigated through appropriate signage.

Construction would not be expected to impact on the visibility of businesses in the area.

Operating amenity

The proposed upgrade may affect the amenity of the townships by having an influence on the noise environment, air and visual quality.

The amenity of Newrybar is expected to be improved during the operational phase of the proposed upgrade. Reduced noise and improved safety associated with the lower traffic volumes on the existing highway are likely to enhance Newrybar's role as a destination village for tourists and to complement the types of businesses that currently occur in the town.

Amenity in Knockrow (at the Macadamia Castle) would also be improved, both in terms of noise and safety. This improved amenity would be beneficial to many of the components of this business, which has both outdoor and indoor activities and facilities.

The impact on Bangalow businesses' operating amenity would be likely to be minimal as it is currently bypassed by the existing highway and this would continue for the proposed upgrade.

Amenity may be reduced when construction is occurring in close proximity to businesses, particularly in terms of noise. Businesses in Newrybar are the most likely to experience amenity related impacts during construction. Construction activities would be approximately 500 metres from the centre of Newrybar when construction is at its closest point potentially resulting in minor impacts on business activities that are dependent on amenity.

An additional short term influence on businesses in the area would be revenue generated directly by construction workers. Businesses (particularly food outlets) in Newrybar and Bangalow are likely to benefit from this expenditure during the construction period, with the greatest benefit occurring when construction is occurring in close proximity to the respective town centres.

An overall assessment of the above factors is shown in **Table 17.1**.

Table 17.1 - Summary of business impacts in adjacent towns and villages

Town or Village	Businesses	Short Term Impacts	Long Term Impacts
Bangalow	> Gift Shop > Mixed emporium > Service Station > Patisserie > Cafés > Hotel > Guest House and other accommodation > Various other general retail businesses	> Neutral > Some potential minor accessibility impacts. Some businesses would benefit from likely expenditure by construction workers.	> Neutral > No long term impacts anticipated.
Newrybar	> General Store > Harvest Café > Newrybar Gallery > Camphor Cottage > Newrybar Saddlery and Produce > Country House Antiques	> Negative > Business is evenly mixed between local and tourism expenditure. Reduced connectivity is expected during construction.	> Positive > Ultimately improved amenity for a 'destination' village should offset connectivity impacts.
Knockrow	> Macadamia Castle	> Negative > Business is dominated by existing highway related trade. Potential amenity and access impacts during construction.	> Neutral > Although less exposure, positive impacts are expected owing to improved amenity and safer access.

The proposed upgrade would be expected to have some short term negative impacts on businesses located in Newrybar and Knockrow (Macadamia Castle) but should be neutral or positive over the long term.

Short term negative impacts in Newrybar and Knockrow would affect profitability of businesses and, if they are highly leveraged or otherwise financially vulnerable, their short term viability. However, over the long term, the net impacts of the highway upgrade are expected to be neutral to positive for the local trading environment in all three centres. This should, on balance, benefit the value of affected businesses by increasing profitability and productivity, and therefore their viability and sustainability.

17.3.2 Social impacts of land acquisition

During the route selection process, there was a great deal of concern in the community over the uncertainty of which alignment would ultimately be chosen, particularly amongst those residents who were not already in proximity to the existing highway (identified as newly affected dwellings and included a number on the plateau and coastal plains). As the proposed upgrade would follow the existing highway relatively closely, the number of newly affected dwellings is minimised.

There are, however, a total of 73 lots that would be directly affected by the proposed upgrade (in some cases the landholder owns more than one allotment), with a total of 22 houses within the proposed upgrade footprint. Consultation has been undertaken by the RTA with all directly affected landowners. The acquisition negotiation process and determination of compensation, is governed by the RTA's *Land Acquisition Policy* (Appendix B) and the *Land Acquisition (Just Terms Compensation) Act 1991* respectively.

Throughout the options development and route selection process, and more recently during discussions with landowners, the RTA has developed an understanding of the typical concerns of landowners directly affected by the proposed upgrade in relation to property acquisition. The socio-economic impacts of property acquisition expressed by the community are listed as follows with a commentary on the likely impact.

Limited number of properties to choose from in the area

Owing to the low density form of residential accommodation, there are limited numbers of properties within the proposed upgraded area. The expected decline in housing stock (22 dwellings are within the proposed upgrade footprint) would affect the ability of residents to find a suitable (and perhaps similar) property in the area, particularly with net migration growth pressures.

Loss of local connections and community cohesion

Community involvement is a defining characteristic of many of the residents in the Ballina and Byron local government areas. Loss of connections and community cohesion would be a particular issue for those who relocate outside of the area. It is presently unknown what proportion of those who would have their dwelling acquired would stay within the locale or relocate elsewhere. For those who retain their building entitlement and construct away from the proposed upgrade on the remainder of the allotment, social networks would be sustained.

Impacts on health and wellbeing owing to the possible upheaval of roots.

For many residents within the proposed upgrade area, impacts on health and wellbeing were associated with the uncertainty of which route would become the preferred option and the potential for it to result in the acquisition of their property. Negative impacts on health and wellbeing could potentially be experienced by those facing property acquisition.

17.3.3 Impacts on community services and facilities

The proposed upgrade would not result in the loss of any existing community services or facilities. The only existing community facility that may be adversely affected is the Newrybar Public School, which is located approximately 300 metres north east of the village.

The proposed upgrade runs adjacent to the school's eastern boundary. At this location, however, the proposed upgrade would be much lower than the school. Although there is a perception amongst some members of the community that the school would be isolated between the new alignment and the old highway, it is unlikely the proposed upgrade would impede the access of staff and students. As the proposed upgrade would run below Broken Head Road (which would form an overpass), current accessibility along its primary frontage would be maintained.

The school's connection to Newrybar village is likely to be improved after the highway is upgraded as the existing highway would have:

> A significant reduction in traffic volumes.

> Greater consistency in driver behaviour with the separation of high speed through highway traffic and lower speed local traffic.

> A reduction in the percentage and size of heavy vehicles.

It is anticipated that access would be improved to other community facilities, such as Newrybar Hall and facilities in Bangalow through improved efficiencies and safety in the local road network.

More generally, throughout the upgraded highway area it is likely that during construction, access to the towns and villages in which other community facilities are located may be hindered during specific periods.

17.3.4 Impacts on connectivity and contiguity

With any linear infrastructure project, there is the potential to create severance and impede the ability of residents to traverse through an area, by the creation of a physical and /or psychological barrier. The existing Pacific Highway forms an edge in some instances to settlement areas and concentrates movement in a north – south direction.

Connectivity and contiguity would be largely maintained throughout the area through the various access arrangements described in **Chapter 13**. Where access to the existing highway would be altered as a result of the proposed upgrade, new local roads would provide a connection to the existing highway and then the interchanges. In some cases, this may slightly result in slightly longer travel times for drivers who would have to follow the modified local road network to reach interchanges or crossing points of the proposed upgrade. Some residents on the western side of the proposed upgrade in the vicinity of Knockrow for example would have longer distances to travel to access the existing highway as they would need to travel on a new service road to reach a proposed underpass that would connect them to the existing highway.

In some areas road access would be improved. Access to Newrybar for local road users for example, would generally be easier with crossings of the proposed upgrade at Broken Head Road and Watsons Lane, and significantly reduced traffic volumes on the existing highway.

Community severance would be limited as the proposed upgrade avoids the settlements (that is, the villages and towns with relatively closely settled rural properties on the fringes). The settlement areas of both Knockrow and Newrybar are not directly affected. The addition of the proposed upgrade into the rural landscape is likely however, to create some perception of severance among rural residents. While physical access would be maintained, rural residents on one side of the proposed upgrade may feel less connected to settlements or rural residents on the opposite side. Integration of the highway into the landscape (refer to **Chapter 18**), as well as appropriate access arrangements, would assist in minimising this perception.

Travel on the proposed upgrade would be faster and safer than the existing highway and changes to the local road network would create safer local travel conditions.

Disruptions to access on the local road network and the existing Pacific Highway would occur at times during the construction period. This is most likely to occur where the proposed upgrade would cross the existing highway or other local roads such as Broken Head Road, Watsons Lane and Bangalow Road. Alternative access would always be provided for any lengthy access restrictions. Traffic impacts during construction are also discussed in **Section 13.4.7**.

17.3.5 Impacts on amenity and safety

Impacts on amenity generally relate to noise, visual impacts and air quality of the proposed upgrade. These are discussed separately in **Chapters 15, 18 and 19** respectively. The effect of the proposed upgrade on road safety is discussed in **Chapter 13.**

17.3.6 Impacts on local and regional growth

Potential impacts on the region's future growth (with reference to the Department of Planning's *Far North Coast Regional Strategy*) are examined in consideration of the impacts of the proposed upgrade not proceeding and socio-economic impacts of the upgraded highway on growth targets.

An efficient, safe and reliable transport system is one of the key elements in the encouragement and support of regional population growth and economic development. The Pacific Highway is the most significant transport infrastructure element between Newcastle and Brisbane and it is an important contributor to the continued economic development of the NSW North Coast region. If the highway is not upgraded to provide an appropriate level of service for existing and forecast traffic volumes, it is likely that:

> Inefficiencies and cost increases would be experienced by existing businesses, agriculture, tourism and residents.

> The attractiveness of these regions for new economic development would reduce in response to diminishing road transport services.

Upgrading the Pacific Highway to a dual carriageway standard is an integral part of, and would assist in the attainment of the Far North Coast Regional Strategy. Improvements to the road corridor will provide greater transport efficiency and safety for residents, and for intra-regional and interstate movements. The proposed upgrade would continue the role of the Pacific Highway Upgrade Program in increasing the accessibility of the region, which would in turn provide benefits for tourism as described in **Section 17.3.8**.

Implementation of the proposed upgrade, along with the Ballina bypass, would also improve the safety and efficiency of the connection between Ballina's regional airport and Byron Bay and surrounds. These areas are major tourist attractions that are served in part by Ballina's regional airport.

As illustrated within the Far North Coast Regional Strategy, the existing Pacific Highway demarcates the coastal areas in the east with the environmental assets, rural land, national parks and state forests in the west in the local government areas of Ballina and Byron. The proposed upgrade maintains this general alignment. It would avoid existing urban footprints as well as proposed future urban release areas and therefore not act as a physical barrier to urban growth. Indeed, the provision of the proposed upgrade, cumulatively with other sections of the Pacific Highway Upgrade Program, would be likely to contribute to further urban growth through improvements in accessibility.

17.3.7 Impacts on agricultural production

The agricultural sector is subject to negative impacts arising from foregone production on land resumed or isolated by the proposed upgrade. Regional economic impacts to the agricultural sector, taking into account the total loss of regional and state significant farmland as identified in the Northern Rivers Farmland Protection Project (DIPNR and DPI), are considered in this section.

Total gross regional product in Byron-Ballina is expected to fall by less than 0.5 percent as a result of foregone agricultural production land. The impact of the proposed upgrade on the availability on state significant farmland (as identified by the DIPNR and DPI (2005)) would be minor (**Figure 14.2**). It is estimated that less than 1 percent of the total area of identified state significant farmland currently available in the Northern Rivers would be lost to the proposed upgrade. The area of state significant farmland that would be lost to the proposed upgrade is currently used for grazing purposes. Indirect impacts are unlikely as it would be the western edge that is lost, with no resulting severance/sterilisation effects.

In determining the foregone production of agricultural land due to direct and indirect (severance) impacts of the upgraded highway, each affected lot was assessed on an individual basis. It was assumed that pre-construction conditions would be restored for drainage and services, however, access to the lot may be altered. The foregone gross margin was calculated for those land uses classified as agricultural land. That is, the annual value of farm gate production less any variable costs incurred in the process of production.

Foregone annual production from agricultural land directly and indirectly affected by the proposed upgrade is shown in **Table 17.2**. The net present value of a stream of foregone production over 30 years is also presented using three discount rates. The levels of foregone production assume that there would not be any beneficial development of low intensity land use following the construction of the upgrade.

Table 17.2 - Foregone agricultural production

Impact	Foregone value of annual agricultural gross margin[1] ($'000)	Net Present Values (over 30 years) ($'000)		
		4 %	7 %	10 %
Directly affected	$454	$8,200	$6,000	$4,700
Indirectly affected	$241	$4,300	$3,300	$2,500
Total	$695	$12,500	$9,200	$7,200

1 A 'gross margin' can be defined as the gross income from an enterprise less the variable costs incurred in achieving it. Variable costs are those costs directly attributable to an enterprise and which vary in proportion to the size of an enterprise. A gross margin is not profit because it does not include fixed or overhead costs such as depreciation, interest payments, rates and permanent labour, which have to be met regardless of enterprise size (NSW Department of Primary Industries - **http://www.dpi.nsw.gov.au/agriculture/farm-business/budgets/about/intro**).

A flow-on effect from the loss of agricultural land is the potential loss of associated processing activity that is, the value of processing and adapting the raw produce for consumption/further processing. A local coffee processor has stated that the loss of prime land has the potential to affect future export orders through disrupted supply and potential loss of the clean green image. This was raised in discussions with three local business owners who stated that buyers visited the local farms to view local product. When visiting, the buyers stated that the image was very important in the selection of the product for market and this was a key differentiator of the Ballina / Byron area to other areas nationally and internationally.

17.3.8 Impacts on tourism

At a regional scale, the proposed upgrade would continue the role of the Pacific Highway Upgrade Program in increasing the accessibility of the region. The proposed upgrade would complete a continuous dual carriageway link between Brisbane and Ballina, which would be expected to continue the trend of increased visitation to the area from south-east Queensland. The Ballina area is likely to be the main beneficiary of this increased accessibility.

The proposed upgrade is expected to benefit the expanding self drive (touring by car) tourist market. In addition to the improved regional accessibility noted above, it would contribute to a more unified and coherent local road network by removing through traffic from the existing highway. The existing highway would become instead an important element in the local network, enabling the touring by car across the area without the current impediment of the need to cross a busy major highway.

Interchanges on the proposed upgrade would provide ease of access to the local road system, while cross accesses would improve connectivity for touring between areas to the east and west of the proposed upgrade.

Together, these features of the proposed upgrade would enhance the self drive experience throughout the local area and scenic hinterland.

Opportunities would be provided for local authorities to introduce or expand tourist sign posting and tourist routes, utilising the improved local road network and connectivity, The opportunity for local villages (particularly Newrybar and Bangalow) to fulfil more of a tourist destination function would also be strengthened.

As noted in **Chapter 18**, the proposed upgrade would have substantial visual impacts. While these would be managed through an urban and landscape strategic concept, the introduction of a new large item of road infrastructure into the landscape would of itself affect the visual experience of the self drive tourist. However, given the design features of the proposed upgrade and the substantial benefits to self drive tourism likely to result from the more unified and coherent local road network, these negative impacts are expected to be minimal in relation to the overall positive impact on tourism.

Benefits are expected to occur both as a direct result of improvements and opportunities attending the introduction of the proposed upgrade; and in a cumulative, regional sense in conjunction with overall improvements in access arising from the Pacific Highway Upgrade Program.

The proposed upgrade may cause interruptions to traffic during construction, especially during peak holiday times. Traffic management would focus on avoidance of disruption at these times in particular. The impact on tourism is likely to be minimal, with decisions on visiting the area and region being made in response to its positive attractions rather than concerns about short term interruptions to through travel.

17.4 Management of impacts

Social impacts of the proposed upgrade have been minimised through the route selection for the project and in the concept design. Road access would be maintained to all residents through a system of access roads, interchanges, underpasses and overpasses. During construction, access would be managed through a traffic management measures which would be aimed at minimising disruption to local traffic. Management of noise, visual and air quality amenity impacts are discussed in **Chapters 15, 18 and 19.**

During construction, access and signage requirements for businesses would be taken into account in construction traffic management. Detailed design of the proposed upgrade would consider the signage and visibility requirements for individual businesses and groups of businesses. Refer to **Chapter 14** for more information on the management if impacts on agricultural activities.

18 Visual amenity and urban design

The visual impact of the project is assessed in this chapter. Additional assessment was deemed necessary to the environmental assessment requirements listed below, because of the potentially high visual impact of the proposed upgrade on the rural landscape of the area. A detailed study was prepared as part of this environmental assessment and is included as *Working Paper 11 - Urban design, landscape and visual assessment.*

Environmental assessment requirement	Where addressed
> Consideration of project and urban design (including noise barriers, retaining walls and landscaping) consistent with overall design of the Pacific Highway Upgrade Program and the existing (and desired) character of affected localities	Section 18.4 and Part C Section 5.15
> Consideration of the *Noise Wall Design Guideline* (RTA, 2006).	Section 18.4 and Part C Section 5.15

18.1 Assessment approach

The visual impact of the proposed upgrade was determined by considering both the visual effect of the proposed works and the visual sensitivity of surrounding areas, as determined by surrounding land use areas from which the upgrade would be visible and by the viewers likely to see the upgrade. **Figure 18.1** illustrates how various combinations of visual effect and visual sensitivity are combined to identify high, moderate or low visual impact levels.

Figure 18.1 - Identification of visual impact

VISUAL EFFECT LEVEL

VISUAL SENSITIVITY LEVEL	HIGH	HIGH TO MOD-ERATE	MODERATE	MODERATE TO LOW	LOW
HIGH	High Impact	High Impact	High to Moderate	High to Moderate	Moderate Impact
HIGH TO MOD-ERATE	High Impact	High to Moderate	High to Moderate	Moderate Impact	Moderate Impact
MODERATE	High to Moderate	High to Moderate	Moderate Impact	Moderate Impact	Moderate to Low
MODERATE TO LOW	High to Moderate	Moderate Impact	Moderate Impact	Moderate to Low	Moderate to Low
LOW	Moderate Impact	Moderate Impact	Moderate to Low	Moderate to Low	Low Impact

Visual effect is the expression of the visual interaction between a proposed development and the existing visual environment surrounding it. The visual effect can also be expressed as the level of visual contrast between the proposed upgrade and the visual setting within which it would be placed. It considers the relationship of factors such as form, line, colour and texture between a proposed development and the surrounding environment.

Visual sensitivity is a measure of how critically a change to the existing landscape would be viewed from various areas and users. The visual sensitivity of a proposed development therefore depends on the type of viewers and surrounding land uses likely to see the proposed development, as well as on the visual characteristics of the existing environment. Tourists or people using recreational areas, for example, would use the surrounding landscape as part of their leisure experience and will view change to the landscape more critically than for example industrial or agricultural workers. Similarly, viewers are likely to be highly sensitive to development in natural or previously undeveloped areas and less sensitive to developments in areas which are already highly developed or widely considered to be of lesser scenic quality, such as industrialised areas.

Refer to *Working Paper 11 – Urban Design, Landscape and Visual Assessment* for a detailed description of how values were identified for visual effect and visual sensitivity.

For the purposes of the visual impact assessment, the proposed upgrade was divided into five precincts (**Figure 18.2**). The visual impact is assessed for each precinct.

18.2 Existing visual character

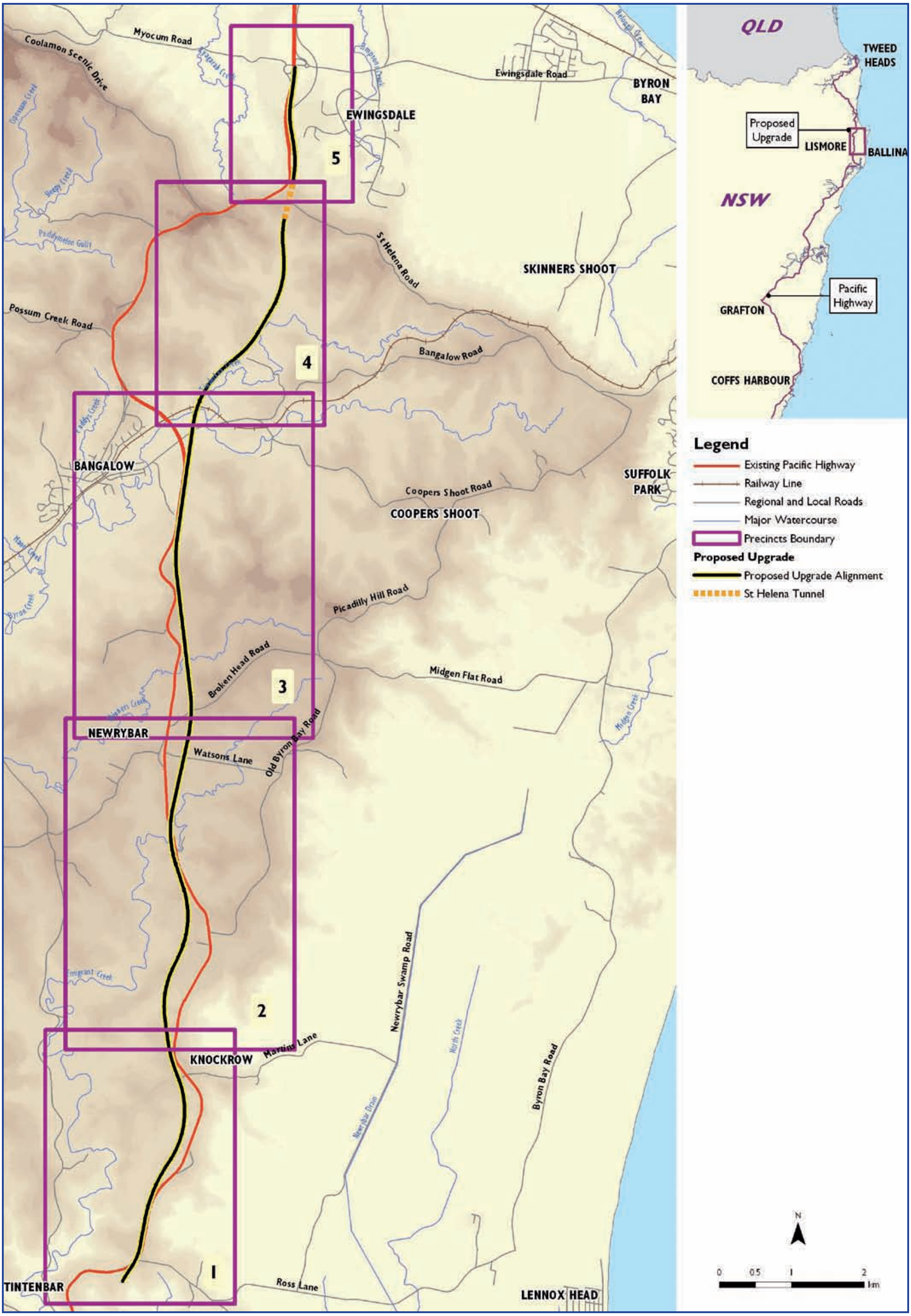
18.2.1 Landform

The site for the proposed upgrade is on the elevated Alstonville Plateau which is defined by a steep escarpment on its northern and eastern edges, falling to a relatively flat coastal plain.

The escarpment that separates the plateau areas and the coastal flats is aligned roughly parallel to the coast, running in a north-easterly to south-westerly direction. The escarpment rises above the coastal plain, generally increasing in height from about 80 m above sea level in the south of the study area to over 180 m above sea level at Granuaille Hill, above McLeods Shoot Lookout in the north of the study area. It provides a dominant landform feature in the locality, accounting for much of the area's scenic quality.

The landscape of the elevated plateau is characterised by a steeply undulating landform dissected by numerous watercourses. As a result of this, the escarpment itself as well as the ridges and higher slopes on the plateau are exposed to many viewpoints. Conversely, the lower slopes and valleys of the plateau are often concealed from many viewpoints in the locality. The elevated areas within the study area also provide expansive regional views towards the Pacific Ocean and inland. Many properties situated on the upper slopes of the escarpment in particular, enjoy spectacular and uninterrupted views towards the Pacific Ocean and across the coastal flats, headlands and ridges.

Figure 18.2 - Visual assessment precincts



18.2.2 Vegetation

On the elevated plateau, the combination of a subtropical climate and highly rich and productive soils produces a lush cover of both indigenous and exotic vegetation, interspersed by more open areas of paddocks or plantations. A recurring feature along the current highway is the significant number of macadamia tree plantations whose grid arrangements provide a unique character to the local agricultural landscape. The types and degree of vegetation cover combined with the steeply undulating landform results in a highly diverse and scenic landscape.

The escarpment slopes are generally steeper and less suitable for agriculture, resulting in a combination of open grassed paddocks with clumps of exotic and native trees, the latter primarily on the steeper slopes.

18.2.3 Settlement patterns

The settlement pattern within and adjacent to the study area is a mixture of small towns and villages with relatively closely settled rural properties in the surrounding areas. Bangalow is the largest town in the study area and located on its western edge. Newrybar is a small village on the Pacific Highway which services the local area. Ewingsdale in the north is a relatively recent subdivision on the lower escarpment slopes overlooking Byron Bay.

Residential properties outside these towns concentrate along the local roads through the study area, creating small hamlets close to the roads' edges which often follow the ridge lines of the high plateau.

A number of recent residential subdivisions are evident in the area, complementing more traditional rural housing and taking advantage of the spectacular rural and coastal views.

18.3 Visual impacts

18.3.1 Precinct 1 – Knockrow (Ross Lane to Martins Lane)

Visual effect

The proposed upgrade would result in a notable increase in road infrastructure in this precinct, in particular in the area immediately north of the Ross Lane interchange where there would be a large number of parallel roadways, including the local access road, northbound on-ramp, the upgraded highway and the existing highway alignment. The provision of individual cuttings for some of these would assist in reducing the overall visual effect of the large number of roadways in close proximity to one another and associated expanse of pavement.

While there would be a large amount of road infrastructure at the Ross Lane interchange, the majority of this would be in place prior to construction works for the upgraded highway, including the two roundabouts, and the changes to the existing highway alignment, crossing over the upgraded highway on a new bridge structure. The new local access roads on the western side of the upgrade further increase the amount of road infrastructure in the precinct.

Another area where the increase in road infrastructure would be highly visible would be in areas where both the new local access road and the upgraded highway would be located on fill embankments so that they would be relatively exposed to views from the existing highway alignment.

The intersection of the proposed local access road and the existing highway alignment approximately half way between Carney Place and Martins Lane would be a noticeable new element, but would be of relatively small scale.

The construction of the upgraded highway would further affect the visual character of the precinct through the severance of agricultural properties. Apart from the introduction of a new infrastructure element in the landscape, specific effects would be the loss of some macadamia plantations, as well as the prominence of cuttings and fill embankments associated with the upgrade. These would be highly noticeable when seen from both affected properties and beyond, but especially in the area between Carney Place and Martins Lane West. This section of the proposed upgrade would be located on large fill embankments through relatively open countryside. It would therefore be widely exposed to views, in particular from the existing highway alignment which in this area features only limited roadside vegetation.

Visual assessment precinct 1 looking north. The Ross Lane interchange is at the bottom of the photograph.

In other sections within the precinct, the proposed upgrade would be located in cuttings which would make it less visually prominent from the surrounding landscape. However, the cuttings themselves would have a potentially significant visual effect, especially large cuttings or where soil conditions and poor slope stability would require engineered stabilisation measures such as benching, retaining walls, rock netting or shotcreting.

In terms of effects on individual properties, local access driveways are currently small in scale. They are terminated by the existing highway alignment and property owners are able to enjoy views into the landscape beyond the existing Pacific Highway. As a result of the proposed upgrade and associated earthworks, the views along many access driveways would be blocked instead by fill embankments. This would affect the vistas along these driveways and the respective experience of affected property owners.

Another effect of the proposed upgrade would be the loss of property boundary plantations along the edge of the existing highway alignment, which currently make an important contribution to the landscape character of the precinct.

Visual sensitivity

The proposed upgrade would be visible from the existing highway alignment and from new local access roads. Viewers would include local residents and tourists both of whom are likely to be highly sensitive to visual changes in the landscape. However, the overall number of potential viewers is limited by the comparatively few roads and buildings which would be within close proximity of the proposed upgrade. The visual sensitivity of this precinct is therefore likely to be low to moderate.

Visual impact

The visual impact of the proposed upgrade in this precinct would be likely to be moderate due to the moderate to high visual effect and the low to moderate visual sensitivity of viewers in the precinct.

18.3.2 Precinct 2 – Emigrant Creek (Martins Lane to Broken Head Road)

Visual effect

Major visual changes specific to the precinct would result from the construction of the creek crossings and associated works including the realignment of the existing highway near Emigrant Creek, the construction of the Ivy Lane interchange, the removal of vegetation, including agricultural plantations, and the large cuttings and fill embankments required to achieve a satisfactory vertical road alignment. Road infrastructure beyond the proposed upgrade itself would be limited compared to other precincts, with this precinct requiring relatively few new or amended local access arrangements.

Visual assessment precinct 2 looking south. Newrybar is on the bottom right of the photograph.

Works at Emigrant Creek would be of significant scale. They would include the realignment of the existing highway, including lowering of the alignment to allow the upgrade to pass over it, and the construction of fill embankments leading up to the creek crossing. The twin bridges in the proposed upgrade, spanning both the realigned existing highway and Emigrant Creek would be significant new structures. Further, a major cutting would be required on the southern approach to Emigrant Creek and would be clearly visible from the existing highway alignment. The overall visual effect of the Emigrant Creek crossing itself would be somewhat reduced by the location of the works in the Emigrant Creek valley. While the valley is visually well contained, much of the existing heavy vegetation cover is closely aligned with the existing highway and would need to be removed. While visibility of the Emigrant Creek crossing is currently limited as a result, following the proposed upgrade the crossing would be more widely exposed to views, in particular from the west, unless vegetation is reinstated in this area.

The twin underpasses and bridge over the Emigrant Creek tributary near 'Yarrenbool Place' would represent another highly noticeable visual change, being located immediately alongside the existing highway alignment.

The construction of the Ivy Lane interchange, associated roundabouts, underpass and local access roads on the western side of the proposed upgrade would introduce a significant amount of road infrastructure in this part of the precinct, representing a notable visual change. With the exception of the off-ramp, these are all located on fill embankments, adding to the visual prominence of the infrastructure. However, the location of the interchange just offset from the ridge line and the irregular pattern of vegetation in the area would conceal it to a degree, lessening its visual effect.

The construction of the proposed upgrade would result in a reduction in the area covered by macadamia plantations between Martins Lane and Old Byron Road, on the western side of the existing highway. This would be highly noticeable, as plantations currently abut the existing highway alignment and provide a pleasant visual experience with their highly textured foliage and strict grid arrangement that provides a constantly changing pattern to the passing viewer. Following the proposed upgrade, plantations in this area would be confined to the western side of the proposed upgrade. In addition to losing the experience of driving along the edge of the plantations, the plantations currently restrict views and their removal would expose the proposed upgrade more widely to views from the existing highway alignment. In particular when approaching the Macadamia Castle from the south, both the proposed upgrade and local access road would be highly visible as they cut through the rural landscape below the ridge line along which the existing highway is located.

North of Emigrant Creek, the proposed upgrade would sever existing macadamia and coffee plantations. This would be noticeable from a number of locations within the precinct, including the existing highway and the proposed upgrade, from Old Byron Road, Watsons Lane and from within the affected properties themselves. The effect would be exaggerated by the changing angles created between the wide sweeping curves of the proposed upgrade and the strong grid pattern of the plantations. The resulting conflicting geometries would make it obvious that the proposed upgrade was imposed on the pre-existing agricultural landscape.

With regard to earthworks, the proposed upgrade in this precinct would traverse a series of valleys and ridge lines and as a result would require significant earthworks along much of the route to achieve a satisfactory vertical alignment. In particular, a number of large cuttings are required around the Macadamia Castle and the Ivy Lane interchange, near the Emigrant Creek crossing and north up to Watsons Lane. The construction of a noise barrier near Newrybar Public School (likely to be a landscaped earth mound) would represent a further noticeable modification to the natural landscape. Provided the mound is successfully vegetated and well designed to integrate with the natural landform and the cutting under Broken Head Road, its visual effect may be able to be reduced over time and as vegetation matures.

The size of the cuttings and fill embankments together with the severing of properties throughout much of the precinct would result in a notable visual effect, in particular on the affected land holders. The proposed upgrade would feature prominently when seen from their properties. This would be exacerbated by the fact that additional trips would be needed to be made by these land holders who would need to use the new local access road and the existing highway alignment to travel between the severed halves of their properties.

Cuttings and fill embankments would also be noticeable from parts of the local road system.

Visual sensitivity

The visual sensitivity of this precinct is likely to be moderate, as sections of the proposed upgrade within this precinct would be exposed to a potentially large number of viewers who would be able to see the proposed upgrade from the existing highway alignment, local access roads, local residences and properties and possibly from Newrybar Public School. Limited glimpses may also be possible from the Harvest Café terrace in Newrybar, where a large number of people currently enjoy the outlook beyond the existing highway and into the agricultural landscape to the east. Viewers would include local residents and tourists who are likely to be highly sensitive to visual changes in the landscape.

Visual impact

The visual impact of the proposal in this precinct would likely be moderate due to the moderate visual effect of the proposed upgrade and the moderate visual sensitivity of viewers in the precinct.

18.3.3 Precinct 3 – Bangalow (Broken Head Road to Byron Creek)

Visual effect

The major visual changes in the Bangalow precinct would be associated with the significant amount of earthworks in the precinct, specifically the major cutting through 'Arundel', the works around the existing Bangalow bypass, the crossing of Broken Head Road and the severing of agricultural plantations.

Visual assessment precinct 3 looking north. Bangalow is on the left of the photograph.

The proposed upgrade in this precinct would traverse a series of valleys and ridge lines, requiring significant earthworks along much of the route to achieve a satisfactory vertical alignment. In particular, large cuttings would be required near Broken Head Road and to the north. A particularly large cutting would be required near 'Arundel', and would also represent a significant visual change in the landscape, slicing through a natural hill top. Being set against the skyline, it is widely exposed to views, especially from the north. Areas from which the cutting would be able to be seen include elevated parts of the Bangalow township, such as areas from Rankin Drive or other areas north of the railway line, and parts of the St Helena ridge. In addition to the significant vertical size of these cuttings, cutting angles of repose would need to be relatively flat, therefore occupying a large footprint. Substantial fill embankments would also be required in the Byron Creek floodplain. Similarly, the large cuttings near Broken Head Road and the bridge itself would result in notable visual changes that would be highly visible from Broken Head Road and the residences and other properties located along it.

The proposed works around the Bangalow interchange would be significant due to the large increase in road infrastructure, including the pavement surfaces of the four parallel roadways (the north- and southbound carriageway of the proposed upgrade, the realigned existing highway on the current northbound carriageway of the Bangalow bypass and the proposed new local access road), on- and off-ramps, roundabout and additional bridges over Bangalow Road and Byron Creek.

Further increasing the degree of visual change in this area would be the removal of roadside vegetation lining the eastern side of the existing highway alignment and Bangalow bypass, in what would be the median strip of the proposed upgrade. This vegetation is particularly dense and well established and its removal would alter the outlook from the existing highway alignment, opening up views towards the east. These views would be largely dominated by the hard pavements associated with the proposed upgrade and the new local access road. In addition to representing a highly noticeable loss, it would also expose the upgrade works and existing highway alignment to views from a larger area than is currently the case. The narrow distance between the different road and carriageways limits the potential for landscaping or other measures that would provide visual separation or screening.

Visual effects around the Bangalow interchange would be further increased by the potential construction of a noise barrier on the western side of the existing highway, required to provide noise amelioration to residents of outlying residential areas in Bangalow, including the 'Clover Hill' estate. If a noise barrier was constructed at this location, it would be likely to require the removal of significant established vegetation on the western side of the existing highway. The cumulative effect of these works would be the complete removal of vegetation along what is currently a densely vegetated road and visually pleasant road corridor. Revegetation would eventually resemble the current situation.

The twin bridges over Byron Creek and the railway line would constitute a significant infrastructure element. The relatively open and exposed location of the bridge and associated large fill embankments in the floodplain of Byron Creek would exacerbate the visual effect, with little screening provided by either the landform or vegetation cover. In this naturally flat landscape, the large fill embankments in particular would be highly noticeable as a 'foreign' object in the landscape. The height of the bridge would also readily reveal the construction method of the bridge, including the numerous piles that are likely to be required. Initial design investigations have indicated that piles are likely to be staggered which will result in a more solid appearance of the two bridges when seen from surrounding areas.

While the bridge over Bangalow Road would be significantly shorter, its visual effect would be similar as it is equally raised above the natural floodplain level, and readily exposed to viewers driving along Bangalow Road, which is important as one of the main entry and arrival points at the township.

A second instance of major twin bridges would need to be constructed over Skinners Creek. They would be almost parallel to the existing highway alignment and within close proximity to it. Its significant elevation above the natural valley floor, together with the earthworks associated with the structure, would make it a visually noticeable and therefore important infrastructure element in the precinct. Because of this, the detailed design resolution of the bridge would have a significant bearing on its visual effect when seen from surrounding areas or the existing highway.

Another visual effect of the proposed upgrade results from the severing of a number agricultural crop areas on the eastern side of the existing highway alignment. Affected crops would include macadamia plantations, as well as coffee plantations south of Broken Head Road. The visual effect of severed plantations, in particular of severed macadamia plantations, would be highly noticeable from the proposed upgrade, from Broken Head Road and from within the affected properties themselves. North of Broken Head Road where macadamia plantations are largely set out in fairly straight rows either perpendicular or parallel to existing roads, the visual effect of severed plantations would be exaggerated by the changing angles between the proposed upgrade alignment and the strong grid pattern of the plantations. The resulting conflicting geometries would make it obvious that the proposed upgrade was imposed on the pre-existing agricultural landscape.

Visual sensitivity

The visual sensitivity of this precinct is likely to be high, as much of the proposed upgrade would be exposed to viewing by a potentially large number of local residents and tourists, both of whom would be highly sensitive to changes in the landscape. The proposed upgrade would be highly visible from local roads such as the existing highway alignment (including the Bangalow bypass), the new local access road, Bangalow Road and Broken Head Road. A potentially large number of viewers would also be able to see the works associated with the proposed upgrade from parts of Bangalow, in particular from areas in close proximity to the upgrade such as around Ballina Road, and from higher lying areas north of the railway line. Other potential viewers would include farm workers and local residents on properties east of the proposed upgrade and along Broken Head Road.

Visual impact

The visual impact of the proposed upgrade in this precinct would likely be moderate to high due to the moderate visual effect and the high visual sensitivity of viewers in the precinct.

18.3.4 Precinct 4 – Tinderbox Creek Valley (Byron Creek to St Helena Ridge)

Visual effect

Major visual changes in the Tinderbox Creek valley precinct result from the large size of cuttings, from the construction of the tunnel portals and the construction of the bridge over the Tinderbox Creek tributary and associated Tinderbox Road diversion.

Visual assessment precinct 4 looking north. St Helena Road is at the bottom of the photograph.

Significant earthworks would be required for much of the precinct, with major cuttings needed north of Tinderbox Road and around the tunnel portal. The cutting on the tunnel approach would result in a major visual change to the character of the existing hillside, due to its significant height, the extent of excavation of the natural hillside, the steep nature of the cutting faces and the need for benching to improve stability. The steep cutting faces are likely to present challenges to revegetation, and are therefore likely to require 'hard' engineering stabilisation measures which would result in a stark contrast to the existing grazing landscape.

While the magnitude of cuttings associated with the portal construction provides an indication of the potential visual effect of the portal in quantitative terms, the actual visual effect on the surrounding landscape may be greater. It would be determined to a significant degree by the final design and detail treatment of the tunnel approach and portals. Recommendations on the design of the tunnel portals are provided in the "Urban and Landscape Design Concept Plan" section of *Working Paper 11 – Urban design, landscape and visual assessment.*

In addition, the landscape of the precinct is fairly open and would readily expose the upgrade and associated works to viewers on surrounding properties and local ridge line roads.

While road infrastructure in this precinct would be minimal beyond the upgraded highway itself, the diversion of Tinderbox Road and the construction of the bridge over the Tinderbox Creek tributary would result in a notable visual change. While the design of the bridge has the potential to reduce the visual effect of the structure, its visibility would generally be limited to immediately surrounding areas, due to the landform and vegetation cover along the creeks in the vicinity of the proposed bridge and road diversion.

Visual sensitivity

The proposed upgrade in this precinct would be able to be viewed mainly by local residents and farm workers in the Tinderbox Creek valley. In general farm workers may be less sensitive to visual changes than residents whose view from private properties would be affected. While the remote nature of the Tinderbox Creek valley is likely to further increase the sensitivity to changes in the level of development, the overall number of viewers is comparatively low, due to the sparse level of settlement and associated road systems. Tourists may also be able to obtain glimpses of the proposed upgrade, when travelling along the ridgeline roads that surround the valley, in particular St Helena Road and Bangalow Road. However, most of these views would be fairly distant.

The overall visual sensitivity of this precinct is likely to be low to moderate.

Visual impact

The visual impact of the proposed upgrade in Precinct 4 would likely be moderate to high due to the high visual effect and the low to moderate visual sensitivity of viewers in the precinct.

18.3.5 Precinct 5 – Ewingsdale

Visual effect

Major visual changes specific to the fifth precinct result from the large increase in road infrastructure on the Ewingsdale spur, the associated large fill embankments and the construction of the tunnel portals and associated excavation works.

The construction of the proposed upgrade adjacent to the alignment of the existing highway would approximately double the amount of road infrastructure on the Ewingsdale spur. Similarly, roadway infrastructure would increase noticeably around the Ewingsdale interchange, as a result of the diversion of the existing highway alignment and the provision of the additional access road. However, the scale of the infrastructure around the interchange is already significant, helping to reduce the degree to which the changes would be perceived as modifying the existing landscape.

The works on the Ewingsdale spur on the other hand would result in a more significant visual change, in particular the tunnel portals and associated cuttings, and the large fill embankments located along the eastern side of much of the proposed upgrade. Construction of the latter would also require the removal of roadside vegetation on the eastern side of the existing highway which currently provides visual screening from Ewingsdale. A stand of vegetation immediately north of the tunnel portal would also need to be removed and the loss of vegetation on the prominent spur would be highly noticeable.

In addition, the cutting on the tunnel approach would represent a major visual change to the character of the St Helena ridge, due to its significant height, the steep nature of the cutting face and the need for benching and other stabilisation measures. The engineering works required around the tunnel portal would be in stark contrast to the existing vegetated landscape character. These works would also be highly visible, being exposed to views from the St Helena ridge and from the coastal lowlands below.

Visual sensitivity

The proposed upgrade and associated works would be readily visible from sections of local roads including the existing highway alignment, St Helena Road, Myocum Road and Coolamon Scenic Drive, as well as from the proposed upgrade itself. Potential viewers would include local residents and tourists. The works would also be visible from McLeods Shoot Lookout, a popular tourist destination and rest stop which offers spectacular panoramic views over the coastal lowlands, the Pacific Ocean and mountain ranges in the background.

Visual assessment precinct 5 looking south-east. Ewingsdale interchange is in the centre of the photograph.

Cape Byron is the other major lookout and tourist destination in the area, however, its distance from the proposed upgrade is so large (greater than 8 km) that it would be difficult to see the proposed upgrade.

The residential area of Ewingsdale is in relatively close proximity to the proposed upgrade, as reflected in the number of buildings in the middleground distance. However, overall building numbers in the precinct are comparatively low and views from Ewingsdale to the proposed upgrade are limited by the topography of the area as well as the existing vegetation cover.

The overall visual sensitivity of Precinct 5 is therefore likely to be low to moderate.

Visual impact

The visual impact of the proposed upgrade in Precinct 5 would be likely to be moderate due to the moderate to high visual effect and the low to moderate visual sensitivity of viewers in the precinct.

18.3.6 Visual impact overview

The predicted visual impacts for each precinct reflect the corresponding local conditions. They further reflect the scale of the road infrastructure within each precinct's setting and the extent of visibility from surrounding viewpoints. However, the partially quantitative precinct assessment does not fully reflect the total visual impact of the proposed upgrade.

The scenic qualities of the landscape within and surrounding the study area are well recognised by residents and visitors alike. The growing popularity of the region as a place to live and to take a holiday is testament to the accepted beauty of the area's landscape and resulting lifestyle.

The combination of steep rolling topography and lush stands of vegetation encompassing areas of open and green paddocks creates an appealing natural setting. Layered over this setting is a relatively small scale pattern of rural development which conforms to the varied form of the natural features of the area. This layering of rural and natural elements produces an intricate cultural landscape pattern where neither element dominates the other. Settlements nestle into valleys and hillsides. Roads wind along ridge lines and around hills, through dense stands of vegetation and over watercourses. As a consequence, the landscape varies continuously and reveals changing characteristics to the traveller passing through the area.

The overall visual effect of the proposed upgrade on this kind of landscape is considered to be quite profound. The standard design requirements for a modern four lane dual carriageway motorway, with relatively gentle gradients and wide sweeping curves, introduces an entirely new form of infrastructure into the area. Where the existing road and rail infrastructure and pattern of subdivision respond to the constraints of the local topography and therefore become an integrated part of the overall composition of the landscape, the proposed upgrade would by necessity, override these constraints. As a result, the upgraded highway would become the dominant element cutting a relatively straight path through this varied landscape, overriding its existing patterns of development.

The proposed upgrade would be a piece of infrastructure of a scale which would be perceived as visually dominant across the length of the majority of the study area. Although the long term benefits of landscape plantings would modify the visual effects of the proposed upgrade to a degree, the overall width and comparatively straight alignment would not enable it to integrate into the landscape as the existing roads have done. The steepness and geotechnical composition of many cuttings would further limit the potential for and likely success of benefits of landscape design treatments.

Over time the visual impacts of the upgraded highway would be partially mitigated by the treatments proposed along its length. However, the scale of the road in this landscape would remain a visually dominant feature. It would therefore substantially and irrevocably change the visual character of the areas through which it passes.

Photographic simulations of the proposed upgrade have been prepared from four representative viewpoints to illustrate its visual effect in a range of situations. The four viewpoints are:

Viewpoint 1 – Robinson Road, Bangalow

Viewpoint 2 – Tinderbox Road, east of Bangalow

Viewpoint 3 – St Helena Road, St Helena Ridge (directly above proposed tunnel)

Viewpoint 4 – Existing Pacific Highway at Ewingsdale.

The viewpoint locations are shown in **Figure 18.3**, while the photographic simulations are shown in **Figure 18.4 - Figure 18.11**. Note that these views represent the proposed upgrade without landscape treatment. Over time the establishment of plantings would help to integrate the propsed upgrade into the landscape.

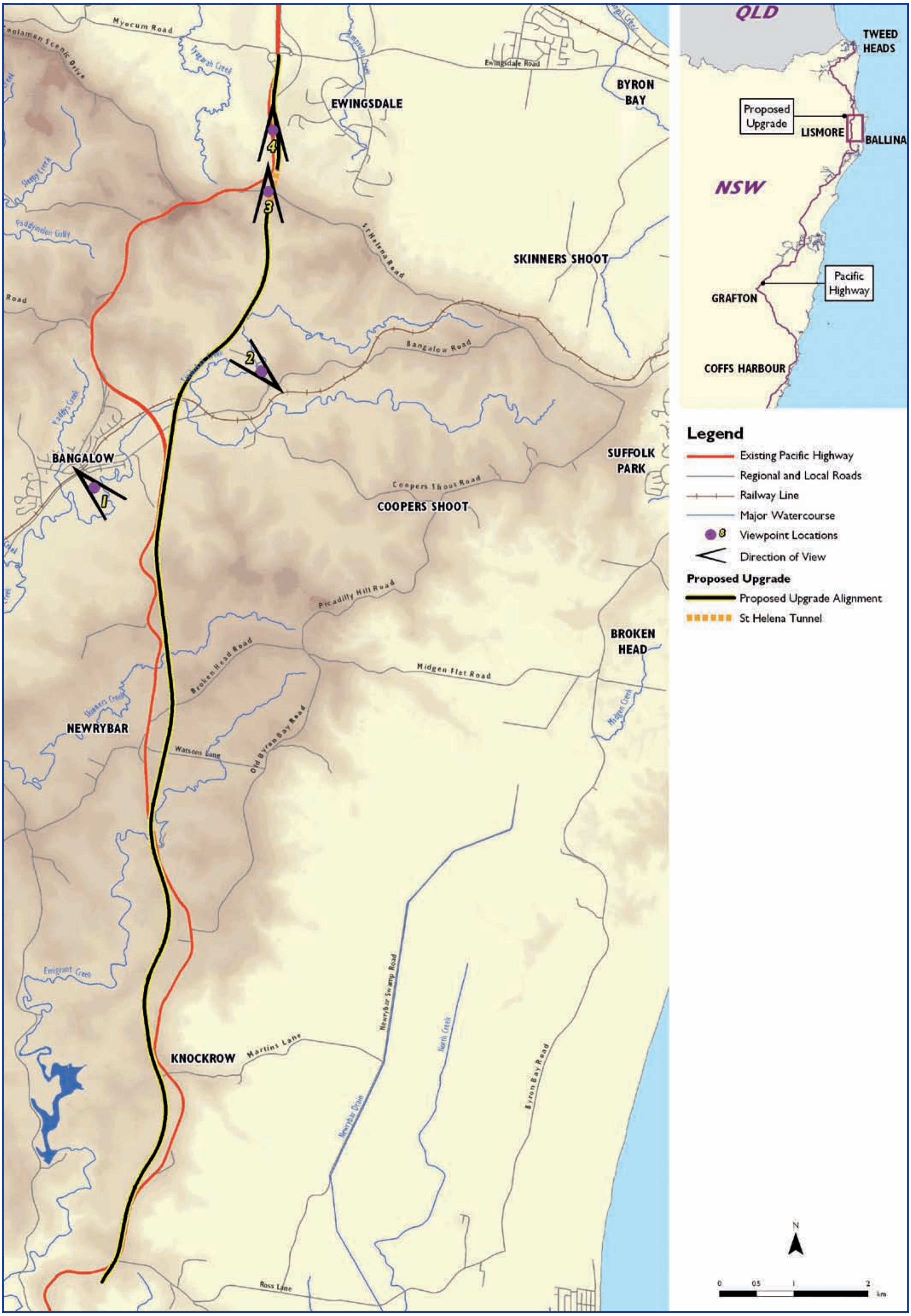
18.4 Management of impacts

Working Paper 11 – Urban design, landscape and visual assessment includes an 'urban and landscape strategic concept'. This strategic concept is intended to form the basis of detailed urban and landscape design. It is aimed at minimising the visual impact of the proposed upgrade and integrating it into the surrounding landscape.

The urban and landscape strategic concept (detailed in *Working Paper 11 – Urban Design, Landscape and Visual Assessment*) has been developed around three main components:

- Major landmarks.
- Road infrastructure elements.
- Corridor landscape strategy.

Figure 18.3 - Viewpoint locations



18.4.1 Major landmarks

Landmarks (**Figure 18.12**) will be key natural features along the route, which are likely to be the particularly memorable moments on the journey. They include major topographic features such as prominent ridge lines or floodplains, as well as areas that offer panoramic views of the surrounding countryside. Major landmarks also include features which will be important to local road users, residents and other viewers who would see them from beyond the road reservation. An example would be the Emigrant Creek crossing where the upgraded highway would pass over the existing highway alignment, which would be retained as the main local road link and tourist route.

As memorable key points along the route, the design of structures and elements associated with the upgraded highway around those landmarks will be important in influencing the experience and perception of the visual character of the proposed upgrade. They therefore would receive a high level of attention and design resolution in the detail design stages of the proposed upgrade, to achieve an outcome of high visual and urban design quality consistent with the importance of the landmark. More detailed information on landmarks is provided in the relevant precinct concept plans.

18.4.2 Road infrastructure elements

Road infrastructure elements are the major items of road infrastructure associated with the proposed upgrade, both along the upgraded highway and in connection with the local road system. They include elements such as interchanges, major cuttings, bridges, tunnel portals, noise barriers and local access roads (**Figure 18.13**).

Generally, it is these elements that will form the more highly visible components of the upgraded highway, being exposed to both motorists and to viewers in surrounding areas. Design resolution of the road infrastructure elements is important as, they define the junction points between the upgraded highway and the landscape beyond the immediate road corridor. Further, a number of these elements coincide with major landmarks along the route and are therefore likely to be particularly memorable.

In contrast, detailed design components such as safety barriers would not be perceptible by viewers from surrounding areas, being generally small in scale. While their design resolution would be important from the point of view of the motorists experience of the upgrade, it would have less influence on the way the upgrade would be perceived by viewers in surrounding areas.

The urban and landscape design strategic concept has identified a hierarchy of road infrastructure elements, based on their location and the relative importance of that location, as determined by the number of viewers likely to see the works, the visual and landscape setting, the identified visual effect and associated visual impact, and the potential for landscape planting or other mitigation measures to reduce the potential visual impact of the road infrastructure element. In addition, the proposed hierarchy emphasises the balance between the key considerations of design aesthetic and upfront costs.

Figure 18.4 - Viewpoint 1, existing view – Robinson Road Bangalow looking south-east

Figure 18.5 - Viewpoint 1, photographic simulation of proposed upgrade– Robinson Road Bangalow looking south-east

Figure 18.6 - Viewpoint 2, existing view – Tinderbox Road looking north-west

Figure 18.7 - Viewpoint 2, Tinderbox Road looking north-west - photographic simulation of proposed upgrade

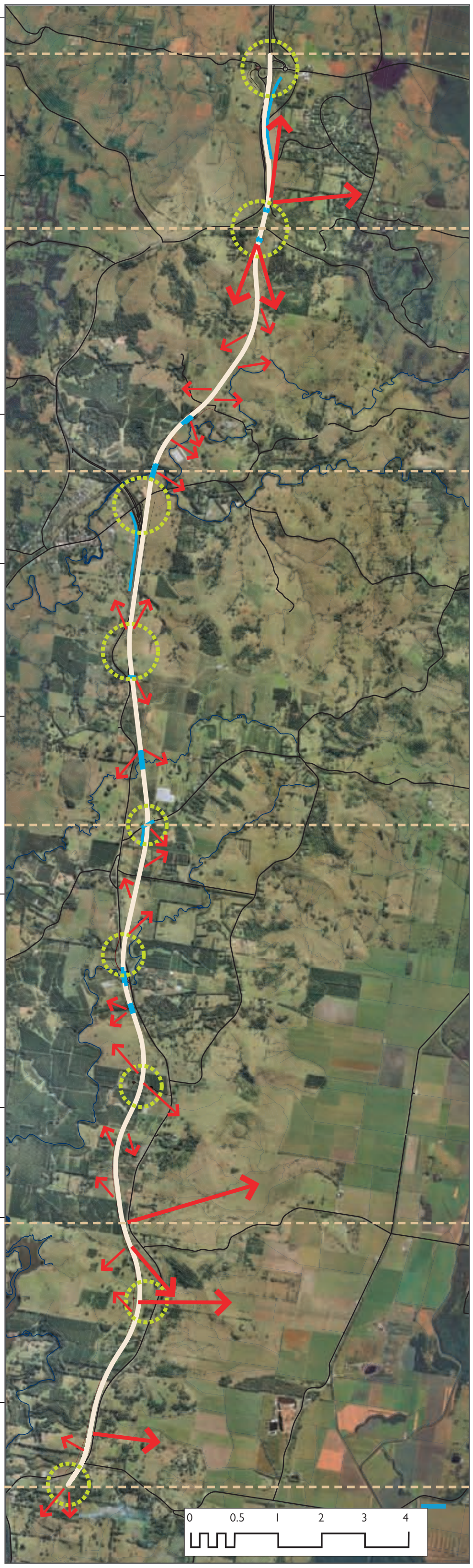
Figure 18.8 - Viewpoint 3, St Helena Road looking south – existing view

Figure 18.9 - Viewpoint 3, St Helena Road looking south – photographic simulation of proposed upgrade

Figure 18.10 - Viewpoint 4, existing highway at Ewingsdale, existing view

Figure 18.11 - Viewpoint 4, existing highway at Ewingsdale, photographic simulation of proposed upgrade

Figure 18.12 - Urban and landscape design strategic concept – major landmarks



Landmark	Importance	Design Response / Strategy
EWINGSDALE COASTAL VALLEY	Entry/ arrival to Byron Bay and approach to Bangalow tablelands.	Reflect and heighten the sense of arrival through enhanced landscape treatment of the interchange. Maintain open views between the Ewingsdale spur, Coolamon Scenic Drive and the coastal lowland.
ST HELENA RIDGE	The ridge forms the threshold between two distinct landscapes: Byron/ the coastal hinterland and the elevated plateau/ tablelands. The prominent scenic escarpment, combined with valley and rare ocean and Cape Byron views provides an important landmark experience.	Design road infrastructure elements to remain subservient to the natural landscape. Enhance the sense of drama afforded by sudden extensive views to the ocean and into the Tinderbox valley when emerging from the tunnel. Design landscape treatments to maintain views.
BYRON CREEK CROSSING AND FLOODPLAIN	Arrival to Bangalow - the major township along the route. Road, rail and creek junction point.	Design road infrastructure elements such as bridges to enhance awareness of this important junction point. Design interchange landscape treatments to reflect the importance of the township.
ARUNDEL RIDGE	Major local high point - the proposed large cutting will create a landmark against the skyline. Important valley views mark the approach to Bangalow.	Treat cutting faces to soften the cutting outline against the skyline. Retain the open views to the north and associated sense of arrival on the approach to Bangalow.
BROKEN HEAD RIDGE	Major local ridge line. Its significant elevation permits extensive views both to the north and south. The proposed deep cutting and associated overbridge will be important elements against the skyline.	Design the overbridge to reflect the importance of the ridge in terms of the experience of both motorists on the proposed upgrade and local road users and residents. Treat cutting faces to soften the cutting outline against the skyline.
EMIGRANT CREEK VALLEY AND CROSSING	Crossing point of the existing highway, the proposed upgrade and Emigrant Creek - the major watercourse. The enclosed and vegetated valley provides a major point of contrast to the gently rolling open countryside of the plateau.	Maintain the enclosed character of the valley around the creek crossing. Reflect the importance and high degree of visibility of the crossing point through attention to detail in bridge design and aesthetic.
IVY LANE INTERCHANGE	The Ivy Lane interchange is the gateway to the macadamia "heartland".	Design interchange landscape treatments to reflect the arrival in the heartland of macadamia production and the productive agricultural lands on the elevated plateau.
KNOCKROW ESCARPMENT	Route exposed along the high point of the ridge. Open views across valleys and towards the Pacific Ocean - one of the few sections of the Pacific Highway where the ocean can be seen.	Maximise the potential to experience ocean views.
ROSS LANE ESCARPMENT	Entry point/ threshold between Ballina/ the coastal hinterland and the elevated plateau.	Landscape treatment to the Ross Lane interchange to reflect its "gateway" effect in the ascent/ descent of the elevated plateau.

Legend

- Upgraded highway alignment
- Minor views from the proposed upgrade
- Major views from the proposed upgrade
- Major landmark/ natural feature
- Proposed urban design elements: bridges, tunnel portals, noise barriers

Figure 18.13 - Urban and landscape design strategic concept – road infrastructure elements

EWINGSDALE INTERCHANGE

Design landscape treatments to reduce the visual effect of the road infrastructure and to create a sense of arrival at the famous destination of Byron Bay.

TUNNEL PORTALS

'Priority One' elements. Carefully design tunnel portals and approaches to integrate the structure with the natural landform.

Utilise materials and treatments of high aesthetic standard and proven performance over time.

BYRON CREEK BRIDGE

'Priority One' bridge.

'CLOVER HILL NOISE BARRIER

'Priority One' element. Design the barrier to be visually unobtrusive and concealed by landscape planting on both sides to maintain the rural landscape character.

MAJOR CUTTING THROUGH 'ARUNDEL'

'Priority One' element. Design cutting angles, benches and landscape treatments to reduce the effect of the cutting against the skyline.

SKINNERS CREEK BRIDGE

'Priority Three' bridge.

NEWRYBAR PUBLIC SCHOOL NOISE MOUND

'Priority Two' element. Design the mound to integrate with the natural land form,
vegetation patterns and the cutting under Broken Head Road.

'YARRENBOOL PLACE' BRIDGE & ACCESS ROADS

'Priority Two' bridge.

OFF-RAMP T-INTERSECTION

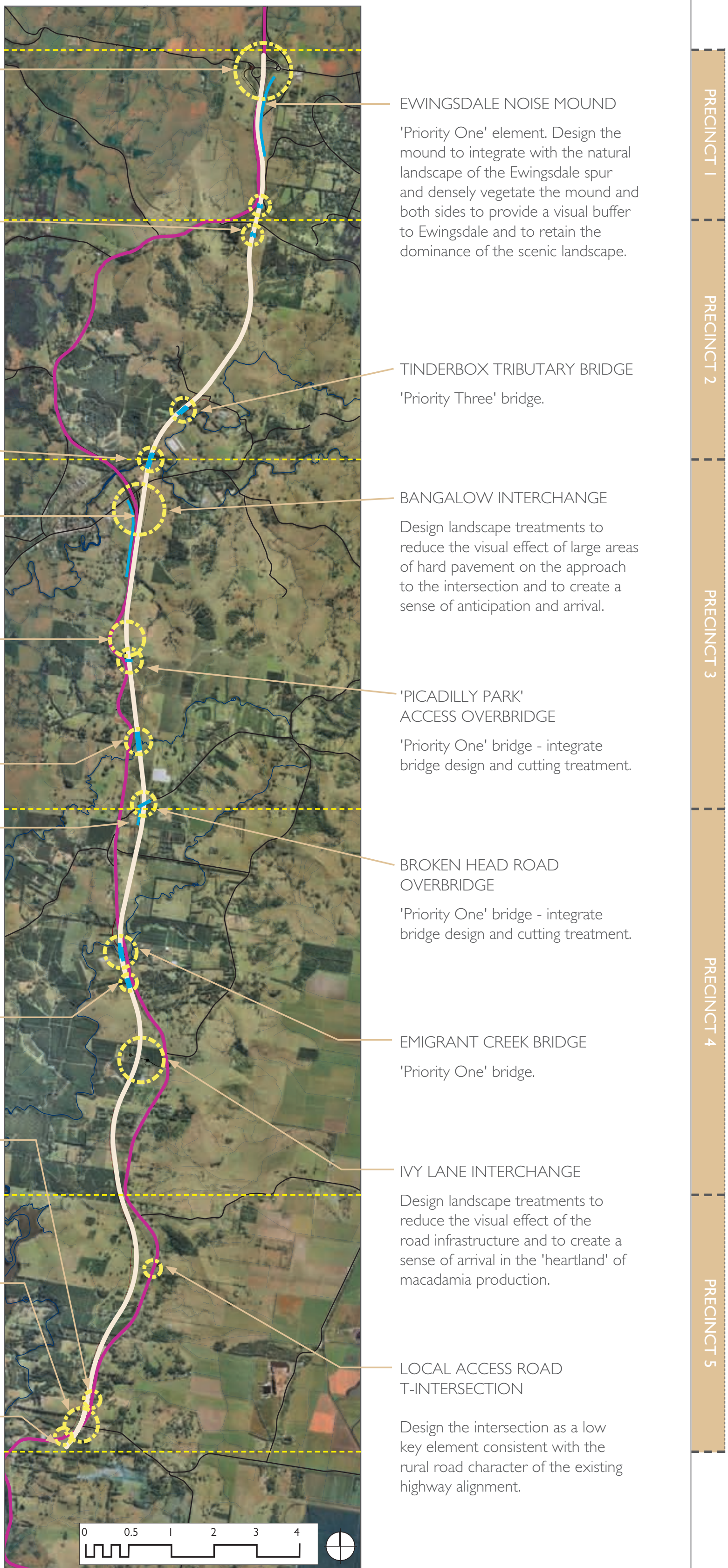
Design the intersection as a low key element consistent with the rural road character of the existing highway alignment, while maximising the sense of arrival.

ROSS LANE INTERCHANGE

Design landscape treatments to reduce the visual effect of the road infrastructure and to create a sense of arrival on the elevated plateau.

LOCAL ROAD INTERSECTION

Design the intersection as a low key element consistent with the rural road character of the existing highway alignment.



EWINGSDALE NOISE MOUND

'Priority One' element. Design the mound to integrate with the natural landscape of the Ewingsdale spur and densely vegetate the mound and both sides to provide a visual buffer to Ewingsdale and to retain the dominance of the scenic landscape.

TINDERBOX TRIBUTARY BRIDGE

'Priority Three' bridge.

BANGALOW INTERCHANGE

Design landscape treatments to reduce the visual effect of large areas of hard pavement on the approach to the intersection and to create a sense of anticipation and arrival.

'PICADILLY PARK' ACCESS OVERBRIDGE

'Priority One' bridge - integrate bridge design and cutting treatment.

BROKEN HEAD ROAD OVERBRIDGE

'Priority One' bridge - integrate bridge design and cutting treatment.

EMIGRANT CREEK BRIDGE

'Priority One' bridge.

IVY LANE INTERCHANGE

Design landscape treatments to reduce the visual effect of the road infrastructure and to create a sense of arrival in the 'heartland' of macadamia production.

LOCAL ACCESS ROAD T-INTERSECTION

Design the intersection as a low key element consistent with the rural road character of the existing highway alignment.

Legend

Alignment of the proposed upgrade

Existing highway alignment

Proposed urban design elements: noise barriers, bridges, tunnel portals

Important design element along the proposed upgrade: interchanges, intersections, major cuttings

Design 'Priority One' element

The combination of a landmark location, the large size of the structure, the high degree of visual exposure and limited potential for screening or landscaping to reduce the visual effect, warrant an approach whereby the design aesthetic and integration of the structure with the surrounding landscape is the key consideration.

Design 'Priority Two' element

The size of the structure, the moderate degree of visual exposure and the limited potential for screening, combine to warrant a moderate level of design detail, with an even balance between design aesthetic and cost effectiveness.

Design 'Priority Three' element

The relatively low number of viewers and the potential to mitigate the visual effect of the structure with landscape planting permit a more purely functional design, giving priority to cost-effective design.

Working Paper 11 – Urban design, landscape and visual assessment includes a section called urban design elements, that provides specific guidelines for the various elements that would comprise the proposed upgrade.

18.4.3 Corridor landscape strategy

The corridor landscape strategy provides an approach to the planting and other landscape treatments within the road corridor (**Figure 18.14**). The strategy has been developed based on the existing pattern of planting/ vegetation and open landscapes in the area. Consistent with the *Pacific Highway urban design framework*, the corridor landscape strategy aims to augment existing vegetation patterns to provide an interesting and varied road user experience consisting of opening and enclosed views, as well as to minimise the visual contrast between the upgraded highway corridor and the surrounding rural landscape. However, it is important to note that the corridor landscape strategy was developed at a large-scale, strategic level and therefore provides a general guide or principle to be followed in highway landscaping works. Future design development and associated detail site investigation may determine that exceptions to the strategy are warranted in certain locations along the route, such as to emphasise (or conceal) particular features, views or conditions in areas along the proposed upgrade.

Figure 18.14 - Urban and landscape design strategic concept – corridor landscape strategy

CHAINAGE 150,200 - 150,600

Protect and complement the vegetated character of the St Helena ridge line, in particular maximise planting around the tunnel portals to reduce their visibility.

CHAINAGE 147,000 - 147, 900

Restrict major planting to the western side of the road reservation. Design all plantings to maximise opportunities for views into the Byron and Tinderbox Creek floodplain.

CHAINAGE 145,700 - 146,500

Restrict large plantings to the western side and to the softening of the noise barrier. Design plantings to allow views towards the east.

CHAINAGE 144,900 - 145,400

Design plantings to be consistent with the open landscape character along the Highway and to maximise opportunities for views into the surrounding countryside.

CHAINAGE 143,400 - 144,100

Design plantings to complement existing vegetation on the western side and to maintain views to the east.

CHAINAGE 139,900 - 140,600

Design plantings to be consistent with the open landscape character along the Highway and maximise opportunities for views into the surrounding countryside.

CHAINAGE 138,500 - 139,000

Design landscape plantings to complement surrounding agricultural plantations and to enhance the experience of travelling through an enclosed/ heavily vegetated landscape.

CHAINAGE 138,300 - 138,500

Limit the height of roadside landscaping to maximise views.

CHAINAGE 136,800 - 137,900

Limit the height of roadside landscaping to maximise views, in particular ocean views.

CHAINAGE 136,100 - 136,800

Design landscape planting to complement surrounding agricultural plantations and to enhance the experience of travelling through an enclosed/ heavily vegetated landscape.

CHAINAGE 135,200 - 136,100

Design landscape planting to complement existing vegetation on the western side and to maximise views towards the east/ the Pacific Ocean.

CHAINAGE 134,400 - 135,200

Design landscape planting to complement existing vegetation and to reduce the visual effect of the cutting through the ridge.

CHAINAGE 150,600 - 152,250

Design plantings to maximise opportunities for views, restricting large plantings to soften the appearance of the noise mound and to provide a visual buffer to Ewingsdale.

CHAINAGE 147, 900 - 150,200

Design plantings to be consistent with the open landscape character along the Highway and maximise opportunities for views into the surrounding countryside.

CHAINAGE 146,500 - 147,000

Design Highway landscaping works to maximise views across the open floodplain.

CHAINAGE 145,400 - 145,700

Use landscape planting to reinforce the heavily vegetated and enclosed character of the creek crossing.

CHAINAGE 144,100 - 144,900

Complement existing vegetation to provide an enclosed experience along the upgraded highway and to soften the impact of the cutting against the skyline.

CHAINAGE 140,600 - 143,400

Design landscape plantings to complement surrounding agricultural plantations, while allowing views across the productive landscape where landform permits. Reinforce the dense planted character around the Emigrant Creek crossing.

CHAINAGE 139,200 - 139,900

Design landscape plantings to complement surrounding agricultural plantations and to enhance the experience of travelling through an enclosed/ heavily vegetated landscape.

CHAINAGE 139,000 - 139,200

Limit the height of roadside landscaping to maximise views.

CHAINAGE 137,900 - 138,300

Provide landscape planting along the upgraded highway to complement surrounding agricultural plantations, while allowing views across the productive landscape where landform permits.

PRECINCT 1

PRECINCT 2

PRECINCT 3

PRECINCT 4

PRECINCT 5

Legend

Heavily vegetated, visually enclosed areas

Corridor planting works to correspond to the existing pattern of vegetation/open and enclosed landscapes:

Sections of proposed upgrade characterised by vegetated landscapes to one side and open landscapes to the other

Sections of proposed upgrade through heavily vegetated landscapes

Sections of proposed upgrade through predominantly open landscapes/ areas with little vegetation cover

19 Air quality

This chapter assesses the impacts of the proposed upgrade on air quality. More detail is provided in *Working Paper 12 –Air Quality*.

Environmental assessment requirement	Where addressed
> Impacts to sensitive receivers (e.g. Newrybar school);	Section 19.4.2
> Consideration of local meteorological conditions;	Section 19.2
> Impacts to road users and other receivers at the tunnel section;	Section 19.4.3
> Consideration of airborne pollutant impacts on drinking water catchments.	Section 19.4.4

19.1 Assessment approach

The air quality assessment is based on the use of a computer-based dispersion model to predict air pollutant concentrations near selected sections of the road. The assessment considers the major air pollutants arising from motor vehicles (carbon monoxide, nitrogen dioxide and particulate matter) and the likely effect of the proposed upgrade on local air quality.

The assessment included consideration of predicted concentrations of the air pollutants compared to relevant regulatory air quality criteria at the following locations:

> Near surface roads.

> At Newrybar Public School playing fields.

> In the vicinity of the tunnel portals.

> Near sections of road at grade.

The assessment also included qualitative consideration of the potential impacts of:

> Air pollutants upon the drinking water quality.

> Particulate matter pollution on vegetation (including agricultural vegetation).

19.2 Existing environment

19.2.1 Dispersion meteorology

Dispersion models typically require information on temperature, wind speed, wind direction, atmospheric stability class and mixing height. These factors are important for determining the direction and rate at which pollutants will disperse.

There are no known weather stations near the proposed upgrade which can be used to characterise the local wind patterns. The nearest automatic weather station with wind data that could be used for air dispersion modelling is at Ballina Airport, approximately 10 km to the south of the proposed upgrade.

Meteorological conditions in the hills above the escarpment are likely to differ from those experienced at Ballina due to differences in topography. Nevertheless, the Ballina data is likely to contain some broader scale wind patterns of north coast NSW that are common to both areas.

The Ballina wind data shows that, annually, the predominant winds are from the north although winds from the west-southwest are also common. The northerly winds are observed in the summer months, while winds from the west-southwest are in winter. Autumn and spring show a combination of the summer and winter patterns. Calm conditions (winds less than or equal to 0.5 m/s) occur for 12.5 percent of the time at the Ballina site and the annual average wind speed is 3.9 m/s.

In response to community concerns regarding specific conditions in Tinderbox Creek valley, additional site-specific meteorological data for the Tinderbox Creek valley was created using the Commonwealth Scientific and Industrial Research Organisation (CSIRO) prognostic model – The Air Pollution Model (TAPM). The TAPM generated data for Tinderbox Creek valley show some similarities in wind directions to the Ballina Airport data although the wind speeds are higher. Also, the TAPM data show a much lower frequency of calm conditions.

19.2.2 Local climatic conditions

The Bureau of Meteorology collects climatic information from Byron Bay, to the northeast of the proposed upgrade. Temperature data show that February is typically the warmest month with a mean daily maximum of 27.6°C. July is the coldest month with a mean daily minimum of 11.7°C.

Rainfall data collected at Byron Bay show that January is the wettest month with a mean rainfall of 208 mm over 13 rain days. Byron Bay experiences an average of 1,721 mm of rain annually.

19.2.3 Existing air quality

Air quality monitoring has not been carried out along the proposed upgrade. However, monitoring data have been collected by the RTA at the Pacific Highway near Coffs Harbour, These data have been used to provide an estimate of background levels of pollutants, as they represent a similar environment to the area of the proposed upgrade (**Table 19.1**).

Table 19.1 - Background levels of pollutants (Pacific Highway at Coffs Harbour)

Pollutant	Averaging time	Background level	Criteria
Carbon monoxide (CO)	1 hour	1.2 mg/m^3	30 mg/m^3*
	8 hour	0.3 mg/m^3	10 mg/m^3*
Nitrogen dioxide (NO_2)	1 hour	73.8 µg/m^3	246 µg/m^3*
Particulate matter less than 10 µm (PM_{10})	24 hour	37.8 µg/m^3	50 µg/m^3*
Particulate matter less than 10 µm ($PM_{2.5}$)	24 hour	15.4 µg/m^3	25 µg/m^3**

* NSW Department of Environment and Climate Change (DECC) Impact Assessment Criteria

** National Environment Protection (Ambient Air Quality) Measure goal (there are no project goals for $PM_{2.5}$ in NSW)

In summary, all measured levels of pollutants were below their respective air quality goals. These measured values will include emissions from the traffic on the Pacific Highway which will be the major contributor to carbon monoxide and nitrogen dioxide. Particulate matter will have contributions from other sources.

19.3 Air quality impacts during construction

Dust would be generated from earthworks associated with the proposed upgrade. The total amount of dust would depend on the silt and moisture content in the soil and the types of activities being carried out.

The equipment likely to be used on site is described in **Chapter 6**. The major sources of dust would be bulldozers, excavators and wind erosion from the exposed surfaces.

19.4 Air quality impacts during operation

Emission rate estimates were calculated with consideration of predicted traffic flows for 2012 and 2022 and were based on emission rates for passenger cars using petrol, passenger cars using diesel and heavy goods vehicles using diesel. Emissions from traffic on both the proposed upgrade and the existing highway (with no upgrade) were calculated.

19.4.1 Near surface roads

The maximum predicted concentrations of pollutants occur at the kerbside with concentrations declining with distance from the road. Predictions have been made for both the proposed upgrade and the existing highway without the proposed upgrade. The proposed upgrade splits the traffic between two carriageways and therefore results in lower concentrations close to the existing highway. The predicted maximum concentration for kerbside locations along the existing and proposed routes for 2012 and 2022 emission predictions are shown in **Table 19.2** below. These represent the maximum ground level concentrations as a result of the vehicle traffic. The modelled figures indicate the contribution of emissions by vehicles. Total pollutant concentrations at kerbside can be identified by adding the modelled concentrations with the maximum background concentrations (which are also listed in **Table 19.2** and derived from **Table 19.1**.

Table 19.2 - Predicted concentrations of pollutants at kerbside

Pollutant	Maximum ground level concentrations at kerbside					
	2012		2022		Maximum background concentration	Criterion
	Proposed upgrade	Existing highway with no upgrade	Proposed upgrade	Existing highway with no upgrade		
CO (mg/m³, 1 hour)	1.1	2.1		2.6	1.2	30
NO2 (µg/m³, 1 hour)	41.3	81.4	45.4	89.8	73.8	246
PM10 (µg/m³, 24 hour)	8.9*	17.4*	8.9*	17.5*	37.8	50
PM2.5 (µg/m³, 24 hour)	8.9**	17.4**	8.9**	17.5**	15.4	25

* Adjusted using time adjustment factor of approximately 0.47 to convert 1-hour predictions to 24-hour averages.

** Assuming 100 percent of PM_{10} emissions are $PM_{2.5}$ fraction

All ground level concentrations predicted for the proposed upgrade are less than the existing highway with no upgrade and also less than the relevant criteria. There are some exceedances for the existing highway with no upgrade for PM10 and PM2.5 when added to the maximum background concentrations.

The predicted maximum concentration for locations 10 m from the kerb along the existing and proposed routes for 2012 and 2022 emission predictions are shown in **Table 19.3.**

Table 19.3 - Predicted concentrations of pollutants 10 m from kerbside

Pollutant	Maximum ground level concentrations at 10 m from kerbside					
	2012		2022		Maximum background concentration	Criterion
	Upgrade	No upgrade	Upgrade	No upgrade		
CO (mg/m³, 1 hour)	0.5	0.8	0.6	0.7	1.2	30
NO2 (µg/m³, 1 hour)	31.5	46.7	34.1	50.4	73.8	246
PM10 (µg/m³, 24 hour)	4.5*	6.6*	4.5*	6.6*	37.8	50
PM2.5 (µg/m³, 24 hour)	4.5**	6.6**	4.5**	6.6**	15.4	25

* Adjusted using time adjustment factor of approximately 0.47 to convert 1-hour predictions to 24-hour averages.

** Assuming 100% of PM10 emissions are PM2.5 fraction

All ground level concentrations predicted for the proposed upgrade at 10 m from the kerb are less than for the existing highway with no upgrade and also less than the DECC criteria when added to the maximum background concentrations.

The above assessment is based on emission rates assuming that the roadway is flat. However, there will be some sections of the route with steeper grade.

There is a substantial increase of carbon monoxide emissions with grade, with up to a ten-fold increase from zero to 6 percent grade. However the predicted concentrations of carbon monoxide are so far below the goal, that even an increase of this size would not cause any exceedances of air quality goals.

The effect of grade on nitrogen dioxide and particulate matter is not as great with two to threefold increase from zero to 6 percent. Again, the predicted concentrations for these pollutants are low and at 10 m from the kerb, there would only be a slight exceedance for particulate matter in the unlikely event that maximum grade coincides with the location for maximum predicted (flat road based) emissions.

19.4.2 Newrybar Public School

The proposed upgrade would approach to within 30 m of the Newrybar Public School playing fields. The school could therefore be regarded as being a worst case in terms of sensitivity of receivers. Based on the results of the modelling of pollutant levels at 10 m from the kerb, anticipated worst-case concentrations of pollutants would not cause significant deterioration of air quality. Air quality criteria would not be exceeded. The low level of impact at Newrybar Public School suggests that no other sensitive receivers would be subject to emissions that exceed criteria.

19.4.3 In the tunnel and near tunnel portals

As was the case with the roadside concentrations, the predicted concentrations near the proposed tunnel portals are substantially below the relevant criteria. The maximum predicted concentrations in the vicinity of the portals are shown in **Table 19.4.**

Table 19.4 - Predicted concentrations of pollutants in the vicinity of the tunnel portals

Pollutant	Maximum ground level concentration	Maximum background concentration	Criterion
CO (mg/m^3, 1 hour)	0.3	1.2	30
NO2 ($\mu g/m^3$, 1 hour)	25	73.8	246
PM10 ($\mu g/m^3$, 24 hour)	2.4*	2.4*	50

* Adjusted using time adjustment factor of approximately 0.47 to convert 1-hour predictions to 24-hour averages

Under normal operating conditions the 'piston effect' of vehicle induced air flow in each of the unidirectional tunnel bores would provide satisfactory natural ventilation within the tunnel. With a steady natural air flow through a one way tunnel, in the direction of traffic flow, the exhaust emission concentration increase from the tunnel entrance (ambient air or background value) up to a maximum value near the tunnel portal. The highest value inside the tunnel is therefore likely to be close the maximum values shown in **Table 19.4**.

As there is no certain control of air direction or velocity, it is possible that the movement of air in the tunnel could change direction and result in the maximum exhaust concentrations occurring nearer the centre of the tunnel. Natural ventilation cannot be fully relied upon to prevent the build up of unhealthy fumes, obscuration or contamination within the tunnel during still, adverse wind or slow moving traffic conditions.

Consideration of the risk of fires occurring in the tunnel, particularly in respect of smoke control, has identified the need for a number of fire control systems including mechanical ventilation. Longitudinal mechanical ventilation would be provided by jet fans mounted within the tunnel at a limited number of points to create a longitudinal flow of air along the length of the tunnel. The strategy for ventilation within the St Helena tunnel would be to make as much use of natural longitudinal ventilation as possible and supplement this for short periods by jet fans in the event of adverse conditions applying within the tunnel.

19.4.4 Potential effects on drinking water

One of the issues that is sometimes raised as a concern near roadways is the potential impacts of airborne pollution on drinking water. While airborne pollutants can enter water systems directly through deposition from the air or through runoff from soil contaminated with fallout, the levels associated with roadways are generally low.

Australian Drinking Water Guidelines (ADWG) are published by the National Health and Medical Research Council (NHMRC) / Natural Resource Management Ministerial Council (NRMMC) to provide the water supply industry with guidance on what constitutes good quality drinking water. Water suppliers are guided by these criteria in implementing treatment systems. Refer to **Section 5.10.2** and **Chapter 10** for details on water quality treatment for the proposed upgrade.

Lead deposition in the vicinity of roadways has been a potential issue in the past, however lead is no longer in petrol. Polycyclic aromatic hydrocarbons are the other significant motor vehicle emissions (present predominantly in particulate diesel emissions) with the potential to be deposited in the vicinity of roadways. The proposed upgrade is predicted to result a general improvement in air quality due to improved grades and traffic flow and therefore would be very unlikely to result in any deterioration in drinking water quality.

19.4.5 Particulate matter effects on vegetation (including agriculture)

Particulate matter can have a physical and chemical impact on vegetation (including agricultural vegetation). The effect of dust deposited on vegetation depends on the characteristics of the dust, plant species and environmental conditions. Factors important to the deposition rate of particulate matter include ambient concentration, atmospheric condition, aerosol properties, surface roughness and vegetation condition. Impacts on vegetation can include physically smothering the leaves, physically blocking the stomata and an increase in leaf temperature. Critical loads vary with plant function and it is not possible to predict the precise nature of one plant's response from the known response of another.

Doley (2006) examined the physical effects of dust on vegetation and suggested that the most sensitive plant functions may be altered with dust loads of about 8 g/m^2 for dust with medium diameters of 50 μm. The DECC air quality criterion for total dust deposition is 4 g/m^2/month which suggests that compliance with this level would provide protection for the most sensitive plant functions. Compliance with the particulate matter concentration criteria for PM_{10} would typically relate to compliance with the dust deposition criteria, so based on the relatively low PM_{10} concentrations predicted, no adverse air quality impacts on vegetation would be expected.

19.5 Management of impacts

As vehicle emission impacts are effectively managed at source via vehicle fuel standards, vehicle maintenance and emissions testing, no specific operation mitigation measures are proposed.

Air quality management would be incorporated in the overall construction environmental management plan with requirements that include:

> All disturbed areas would be stabilised as soon as practicable to prevent or minimise wind blown dust.

> All unsealed trafficable areas would be kept sufficiently damp during working hours to minimise wind blown or traffic generated dust emissions.

> Water sprays, sprinklers and water carts would be employed if needed to adequately dampen stockpiles, work areas and exposed soils to prevent the emission of dust from the site.

> Stockpiles and handling areas would be maintained in a condition that minimises wind blown or traffic generated dust. Areas that may be inaccessible by water carts would be kept in a condition which minimised wind blown or traffic generated dust using other means.

> All equipment for dust control would be kept in good operating condition. The equipment would be operable at all times with the exception of shutdowns required for maintenance. Construction equipment would be properly maintained to ensure exhaust emissions comply with the *Protection of the Environment Operations Act 1997*.

> Silt would be removed from behind filter fences and other erosion control structures on a regular basis, so that collected silt did not become a source of dust.

> Any dust, soil or mud deposited on public roads associated with construction activities and would be removed immediately and disposed of appropriately.

> Dust monitoring would be carried out during construction to determine the compliance with the Department of Environment and Climate Change dust deposition goals.

> No dust sensitive industries have been identified along the route at this stage, however this would be reviewed prior to construction.

20 Other environmental impacts

20.1 Geology and soils

Geotechnical investigations have been carried out based upon the developing concept design of the proposed upgrade. The purpose of these investigations was to provide technical information on the prevailing ground conditions in the area to assist with route selection and concept design. The investigations were also used to identify geotechnical and soils issues for this environmental assessment.

The geotechnical investigations carried out were undertaken between 2005 and 2007. These investigations comprised a review of existing information, geological and geomorphological mapping, drilling boreholes, excavating test pits, cone penetration testing, seismic surveys, in situ testing, measurement of ground water levels, sampling of soils, rock and ground water and geotechnical laboratory testing on the samples recovered.

20.1.1 Overview of existing geology and soils

Topography

The proposed upgrade crosses the Alstonville Plateau, an area higher than the surrounding regions. The plateau is characterised by low rolling hills which are cut by a number of gullies and valleys. The northern and eastern edges of the plateau are marked by steep hillsides that descend to the coastal plane below.

The proposed upgrade would need to cross a number of creeks. The larger creeks to be crossed include: Emigrant Creek, south of Newrybar; Skinners Creek just north of Broken Head Road; Byron Creek, north of Bangalow Road; and a tributary of Tinderbox Creek, north of Bangalow Road.

Geology and soils

The geological materials that make up the Alstonville Plateau comprise largely basalt rock and soils derived from the basalt. The basalt is known as the Lismore Basalt. It was formed from a series of lava flows from the now extinct Mt Warning volcano about 20 million years ago during the Tertiary Period.

The individual lava flows that make up the Lismore Basalt were formed progressively over a long period of time. Weathering of each new lava flow took place before the next lava flow was formed. This has resulted in each lava flow having different characteristics from those above and below and in some instances has resulted in individual lava flows being separated by soil layers.

Ongoing weathering of the Lismore Basalt since its formation has created a mantle of soils at the ground surface. The character of the soils formed varies depending on the composition of the basalt from which it was derived and the geomorphological processes to which is has been exposed. The published soil landscape map for the area (DNR 1994) indicates three types of soil: residual soils on valley floors and at the base of the northern slopes of the plateau; erosional soils on the rolling hills of the plateau; and colluvial soils on the steep northern and eastern facing slopes at the edge of the plateau. These colluvial soils have been identified as having a mass movement (landslide) hazard.

Below the Lismore Basalt lie a series of sedimentary and metamorphic rocks which are collectively known as the Neranleigh-Fernvale Group. This group of rocks is generally only encountered in deep boreholes and is not known to be exposed at the ground surface of the Alstonville Plateau.

20.1.2 Impact of changes to surface and subsurface conditions

Soft soils

Soft soils are largely absent from the proposed upgrade. However, small areas of soft soil may exist locally, particularly near creeks. The construction of embankments would increase the stress on the soil below. As soft soils are highly compressible, this increased stress would, if not properly managed, lead to significant compression of the soil, settlement of an embankment above and possibly additional loads being imposed on adjacent structure foundations.

Hillsides

The proposed upgrade would need to cross many hillsides. The construction of embankments on hillsides can, if not properly managed, cause changes in the subsurface soil conditions which may lead to instability in an embankment and the soil below. These changes result from the increased stress imposed by the embankment and can lead to the disturbance of the natural drainage pattern within the soil. These changes can be particularly problematic where natural springs or potentially unstable colluvial soils exist.

Cut slopes

The proposed upgrade would require a number of cut slopes to be excavated into hillsides and ridges. Additional cuttings would be required to form the proposed tunnel portals. The deepest of the cut slopes would be about 36 m (subject to detailed design refinements). These would be excavated into a number of different materials including a range of soils and rocks which have been weathered to varying degrees.

Excavating the ground to form cuttings can lead to instability of the ground. This instability could occur both on the hillside immediately above a cutting and within the cutting its self.

The excavation of cuttings below the ground water table may affect the existing groundwater regime by drawing down the water table. These impacts are discussed in greater detail in **Chapter 11 - Groundwater.**

Tunnel

The proposed upgrade includes a section of tunnel beneath St Helena Hill. The tunnel would be excavated within a series of variably weathered and fractured basaltic lava flows of the Lismore Basalt. The maximum cover of soils and rock above the tunnel would be approximately 40 m (subject to detailed design refinements). .

The risk of settlement of the ground surface in response to the excavation of a tunnel below was investigated and found to be low.

The excavation of a tunnel below the groundwater table may affect the existing groundwater regime. Drawdown of the groundwater table could occur if water is allowed to drain into the tunnel. These impacts are discussed in greater detail in **Chapter 11 - Groundwater.**

Contaminated land

An investigation into the potential for contaminated land along or adjacent to the proposed upgrade was carried out. The investigation focussed primarily on agricultural sources of contamination as this was considered the most likely, given the land use in the area.

The proposed upgrade passes near a number of disused cattle tick dip sites. These sites have all been filled and capped. However, if disturbed, these sites could become sources of contamination.

The results of testing for soil contamination resulting from the use of agricultural pesticides and fertilisers were below the existing adopted assessment criteria. It is therefore considered unlikely contaminants are present along the proposed upgrade at levels that could pose a risk to construction workers, road users or the general public.

Acid sulfate soil

Soils that contain sulfate minerals such as pyrite can, when exposed to the air, cause the production of weak acid solutions. These acids may impact on the surrounding environment. Typically, potentially acid sulfate soils are found in low lying areas made up of young estuarine soils. Road construction can cause these materials to be exposed to the air if either the ground water table is lowered or if soils are excavated from below the ground water table and placed above it.

The proposed upgrade does not cross the type of countryside that is normally associated with acid sulfate soils. Consequently the potential for acid sulfate soils is considered to be low. Field and laboratory testing encountered only one location, at Byron Creek, where acid sulfate soil was identified.

The proposed works at Byron Creek comprise the construction of embankments and piling for a bridge across the creek and a railway line. These activities would be unlikely to cause large enough quantities of soil to be exposed to the air for acid to be generated.

Acid sulfate rock

Like soils, some rocks contain sulfate minerals that when exposed to the air can cause the generation of weak acid solutions, which can impact on the surrounding environment. For significant acid generation to occur sufficient quantities of sulfate minerals must exist in the rock and the sulfate minerals must be exposed to the air. The rate of acid generation from a rock is usually considerably slower than that from an acid sulfate soil. The rate of acid generation plays a very significant part in determining whether any significant impact would result.

The vast majority of tests carried out during the investigations indicate that the rock sampled had an acid consuming potential. This means that the rock contains minerals that could actually neutralise acids that they come in contact with. Only one sample identified potentially acid forming rock.

Erosion

Soils and weak weathered rocks may be at risk of erosion if not protected, particularly from concentrated flowing water. Erosion, if not prevented, may in time lead to instability of cut or fill slopes. The eroded material may impair or block drains or, if allowed to escape into the wider environment, cause sedimentation and turbidity in nearby creeks and rivers.

Testing of the clay soils that dominate the proposed upgrade indicate that the soils have a low potential for dispersion (a form of erosion).

20.1.3 Management of impacts

Soft soils

The impact of local areas of soft soils can be successfully managed. The management technique adopted would depend upon the local ground conditions, construction scheduling, and the availability of materials. Where the extent and depth of soft soil is small, it could be partially or totally removed and replaced with a bridging layer of more competent material.

Other techniques exist which could, if necessary, be considered if the soft soil is more extensive or thicker than is currently anticipated. These other techniques typically involve accelerating the consolidation of the soft soil, so that the majority of any expected movement takes place before the road is completed and hence damage is avoided. This outcome can be achieved by surcharging with additional temporary fill and / or the installation of wick drains.

Where unsuitable materials such as compressible top soil or wet softened soil exist beneath a pavement or embankment, they would be removed and where necessary replaced with engineered fill prior to any construction taking place. Excavated top soil would be stockpiled during construction and reused for landscaping.

The expected subgrade materials would generally be suitable subgrade for embankments once unsuitable materials are removed. However, consideration would be given to stability, drainage, moisture content and pavement design.

Bridges, underpasses and culverts would be required at a number of locations along the proposed upgrade.

The settlement of bridge approach embankments in most cases is not expected to be a major issue. However, embankment settlement at the crossing of Tinderbox Creek would be checked as deeper firm soils are anticipated.

Foundations for structures would depend on local ground conditions but at most locations bored cast-in-place piles founded on weathered rock are likely to be feasible. Shallow spread footing may also be feasible where rock is shallow – Emigrant Creek and Watson's Lane. Driven piles may however be more suitable where saturated soils would required the casing of pile bores or where disturbance of soil is to be minimised due to other constraints, like acid sulfate soil – Byron Creek.

Drainage culverts are likely to be feasibly founded on shallow spread footings in stiff soils. Where deep softer soils exist, piled support may be required.

Hillsides

Construction of embankments on hillsides can cause unstable slopes by disturbing the natural soil drainage and by imposing additional stress on soils which may only be marginally stable in the natural state.

These impacts would be managed by the provision of sub-surface drainage and by excavating benches into the soil beneath embankments. Sub-surface drainage would be designed to suit the local conditions and could be provided by a rock fill drainage blanket where springs are found, or by trench or pipe drains.

Cut slopes

Stable cut slopes can generally be formed by designing batters to existing RTA engineering criteria and by taking into account the prevailing sub-surface conditions during the detailed design. Typically, cuts in soils and more highly weathered rock would be cut to 2 m horizontal (2H):1 m vertical (1V). Cuts in material suspected to be derived from old landslides would be excavated to 4H:1V. Cuts in more competent rock would be cut to 1.5H:1V to 0.75H:V depending on local conditions. Cut slopes would be refined in detailed design.

Individual batter heights would be restricted to up to 10 metres in slopes cut to 2H:1V or shallower and 7 metres or less in slopes steeper than 2H:1V. Cuttings which require more than one batter to achieve the design depth would be provided with benches between the batters, these would typically be 4 m wide. The purpose of limiting batter angles and heights is to ensure long term stability of the cutting, reduce the risks of failure and minimise maintenance requirements.

In some locations where sub-surface conditions are adverse, this cut slope geometry design alone may not be sufficient to achieve a stable slope and additional stabilisation measures may be required locally. These additional measures may take the form of rock bolts, wire mesh or shotcrete.

Retaining structures may be required where corridor widths are restricted or where other constraints dictate that the width of the proposed upgrade needs to be reduced. This is most likely at interchanges, bridges and at the proposed tunnel portal. The selection of the type of retaining structure would depend largely on the local ground conditions and space constraints. Reinforced earth walls, gabion walls, crib walls, reinforced concrete gravity walls, soldier pile walls and soil nailed walls are all considered feasible.

At the tunnel portals the cut slope geometry would need to be varied from that used at other cut slopes. A steep angle and increased batter height are likely to be required to maintain the equivalent of at least one tunnel diameter of cover above the tunnel.

Structural support of these portal cuts would be required. Depending on the material in the cut, this support is likely to comprise rock bolts or dowels installed in a regular triangular pattern grid. Areas of lower strength rock would also need to be protected with reinforced shotcrete and the installation of drains.

Tunnel

The rock surrounding the tunnel would need to be supported to prevent collapse. The type and amount of support required would be determined during the detailed design and would depend on the quality of the rock and the method chosen for the construction of the tunnel.

Contaminated land

If cattle tick dip sites are disturbed by construction, further investigation, remediation or disposal to an appropriately licensed landfill of potentially contaminated materials may be required. No cattle dip sites have been recorded within the proposed acquisition boundary. There is however, a small possibility that previously unrecorded cattle tick dip sites may occur. Appropriate induction and management procedures would be implemented as part of the construction environmental management plan, to minimise the risk from disturbance of a site during construction.

If soils are disposed off-site, then routine testing would be undertaken to assess the appropriate waste classification of the soils according to DECC guidelines.

Acid sulfate materials

Potential acid sulfate soils were identified in only one sample at one location - Byron Creek, along the proposed upgrade. They are not anticipated at other locations.

Further testing at this location during the detailed design stage would be carried out to confirm the lateral extent of any potentially acid sulfate soils. An assessment would then be carried out, considering the proposed construction activities, whether an acid sulfate soil management plan is required.

Erosion

The potential for erosion to take place during the construction of the proposed upgrade can be reasonably mitigated by following the guidance given in documents such as Landcom's *Managing Urban Stormwater: Soils and Construction* (2004).

In the longer term soil erosion would be managed by providing vegetation cover to exposed soils.

20.2 Climate change - effect of the proposed upgrade

An assessment of the greenhouse gas emissions associated with proposed upgrade has been carried out to identify the impact of the proposed upgrade on processes affecting climate change.

20.2.1 Assessment approach

Greenhouse gases (GHG) attributable to the proposed upgrade may be assigned as either Scope 1, Scope 2 or Scope 3 emissions depending on their sources. These categories and the likely sources of a result of the upgrade are described in **Table 20.1**.

Table 20.1 - GHG emissions categories

Emission	Definition	Likely sources
Scope 1 emissions	> Direct emissions generated on site	> Construction plant and equipment > Road maintenance plant and equipment > Land clearing
Scope 2 emissions	> Use of steam, heat or power on site where emissions are generated off site (usually in a power plant)	> Electricity use on site office > Electricity use in mechanical and electrical systems including lighting
Scope 3 emissions	> Downstream emissions from supply chain > Upstream emissions from use of product	> Embodied energy in construction materials > Transport of materials to and from site > Embodied energy in maintenance materials > Vehicles travelling on road > Emissions associated with wider development generated by road upgrade

The RTA is likely to be obliged under the National Greenhouse and Energy Reporting Act 2007 to report emissions over which it has operational control (i.e. Scope 1 and Scope 2 emissions). However for the purposes of this development assessment, Scope 3 emissions are also considered where there is a proximate link between the development and the emission source *(Gray v The Minister for Planning,* LEC 2006). The GHG assessment for the proposed upgrade therefore considers the following emission sources for the construction and operational phases of the proposed upgrade.

Construction:

Scope 1 – Fuel use in construction plant and equipment; land clearing.

Scope 2 – Electricity use on site office.

Scope 3 - Embodied energy in construction materials.

Operation:

Scope 1 - Fuel use in road maintenance plant and equipment.

Scope 2 - Electricity use in mechanical and electrical systems including lighting.

Scope 3 - Embodied energy in maintenance materials, vehicles travelling on road.

20.2.2 Greenhouse gas emissions during construction

Scope 1

Fuel use by construction plant and equipment, including consumption and extraction

Fuel use was estimated based the average fuel consumption per kilometre of road constructed on other Pacific Highway Upgrade Program projects. An average fuel consumption of 481 kilolitres of diesel fuel per kilometre was determined (RTA 2007b).

Therefore, fuel consumption for the proposed 17 km upgrade is estimated at 8,177 kL. Direct greenhouse gas emissions based on the calculated fuel consumption would be 22,078 t CO_2-e (carbon dioxide equivalent).

Land clearing

In addition to vehicle emissions, the project would generate emissions associated with land clearing. There are two types of emissions associated with this process. Firstly, the carbon which is currently stored in soil and vegetation is released into the atmosphere. The mechanism for this process would depend upon the ultimate disposal methodology and is essentially a waste related emission. Secondly, the potential of the vegetation to sequester carbon in the future would be affected.

For the purposes of this assessment the waste related emissions have been determined using the Australian Greenhouse Office's (AGO) FullCAM model and the AGO Factors and Methods Workbook (2006). The FullCAM model was used to calculate the quantity of stored carbon based upon the vegetation type and age, the soil type, and land use practices that have been applied. It was also assumed that all vegetation is disposed of to landfill and ultimately vented to the atmosphere as methane which has a global warming potential 25 times that of carbon dioxide. In reality, a proportion of the vegetation would be mulched and used in landscaping. Mulching would increase the aerobic conversion of carbon to carbon dioxide rather than the anaerobic conversion to methane. Furthermore, the fate of methane at landfill sites is dependant on the type of management. Flaring, combusting or composting management techniques would result in conversion of methane to carbon dioxide and a reduction in the equivalent t CO_2-e emitted. For the purposes of this assessment is has been assumed that no flaring or combustion would occur and that all methane is emitted which is considered the worst case scenario.

In addition to the equivalent emissions generated during land clearing, the potential of the cleared vegetation to sequester carbon in the future is also diminished. However, as part of the upgrade, revegetation works would occur within the median strips and road reserve as well as significant environmental enhancement works in strategic locations as part of the remnant land strategy. It is therefore considered that the revegetation works proposed would result in an overall insignificant change and possible improvement in the ongoing carbon sequestration potential within the construction footprint.

Scope 2 and 3

Indirect emissions were also estimated for the construction of the proposed upgrade, in particular emissions associated with the previously estimated diesel use and those embodied in the demand for on-site materials, in particular steel and concrete.

Indirect emissions associated with diesel extraction and supply

Indirect emissions associated with diesel extraction and supply were assessed at a rate of 0.2 kilograms CO2-e per litre (AGO, 2006). This would result in an additional 1,635 t CO_2-e, with a total emission (full fuel cycle) of 23,713 t CO_2-e.

Electricity use

Electricity use is anticipated to be a minor source of emissions and would be associated with lighting and appliance use within site offices. For the purposes of this assessment, it was assumed that two site offices equipped with computers, air conditioning, refrigeration, kitchen appliances, fluorescent and security lighting would be operating over a 150 week construction period purchasing electricity from the grid. This gives total GHG emissions of 32 t CO_2-e (using a full fuel cycle emission factor incorporating including emissions associated with transmission and distribution, fuel extraction and production).

Embodied energy in material

Greenhouse gas emissions associated with embodied energy in concrete, steel, asphalt, bitumen and steel were calculated using the RTA's *Carbon Estimation Tool for Road Construction Projects*.

Construction quantity estimates and associated embodied greenhouse gas emissions are shown in **Table 20.2** below.

Table 20.2 - GHG emissions from embodied energy in materials

Material	Quantity (tonnes)	GHG emissions (tCO2e-)
Cement	81,553	76,660
Fly ash	27,169	270
Aggregate	217,625	1,740
Sand	113,994	910
Steel (reinforcement)	12,090	28,170
Asphalt	53,653	2,150
Bitumen	1,191	60
	TOTAL	**109,960**

Transport to and from site

Fuel use for the transportation of materials to site was estimated based on the construction quantity estimates above, the likely trip length, the number of loads and rate of fuel combustion of trucks. This resulting GHG emissions were then calculated using the RTA's *Carbon Estimation Tool for Road Construction Projects* using a full fuel cycle emission factor. This results in 885 t CO_2-e.

Transport of construction and demolition waste from site to landfill would be minimised to the extent possible by maximising re-use on site and recycling. Emissions associated with this transportation have therefore been excluded from the assessment.

Summary of construction emissions

A summary of the GHG emissions associated with the construction period is presented in **Table 20.3.**

Table 20.3 - GHG emissions during construction period

Source	GHG emissions (t CO2-e).
Fuel use (including diesel extraction)	23,713
Land clearing	58,300
Electricity	32
Embodied energy	109,960
Transport to site	885
TOTAL	**192,890**

20.2.3 Greenhouse gas emissions during operation

Scope 1

Fuel use in road maintenance plant and equipment

While road maintenance activities constitute direct emissions, such emissions are considered to be very minor compared with the high traffic volumes expected. Furthermore, as a result of the upgrade, ongoing maintenance is anticipated to decrease compared to the base case (no build) scenario. These emissions have therefore been excluded from the assessment.

Scope 2 and 3

Embodied energy in maintenance materials

Similarly, embodied energy in maintenance materials would constitute a relatively small source of operational emissions compared with the high traffic volumes. The quantity of material required for ongoing maintenance of the highway is also likely to decrease as a result of the upgrade compared to the base case (no build) scenario. These emissions have therefore been excluded from the assessment.

Electricity use in lighting and other mechanical and electrical systems

The upgrade would require the installation of lighting systems including street lighting, tunnel lighting and variable message signs. It is assumed that all of these systems would be powered from mains electricity. In reality, there are likely to be opportunities for some of these systems to be solar powered. Solar powered devices would have zero associated greenhouse gas emissions and would be adopted where possible.

The upgrade would require the operation of a new street lighting system. For the purposes of this assessment, the GHG emissions associated with street lighting were calculated using the AGO's Public Lighting Calculator and the AGO Factors and Methods Workbook. It was assumed that the upgrade would require the installation of approximately 210 street lights at interchanges (Ivy lane interchange, Bangalow interchange, Ewingsdale interchange and parts of Ross Lane interchange) at the on / off ramps, local roads in the vicinity of the interchanges only and on the main carriageway for a length of 300 m past the connection point at 50 m spacings. For the purposes of this assessment the lights were assumed to be 400 W High Pressure Sodium lights.

The tunnel lighting requirements would be determined during detailed design to meet the International Commission on Illumination (CIE) guidance for the lighting of roads, tunnels and underpasses (CIE 88-1990) This requires detailed consideration of the level of light outside and on the point inside the tunnel at which visual adaptation of drivers must occur as they pass through the various lighting zones (threshold zone transition zone, interior zone and exit zone). For the purposes of this assessment lighting requirements were estimated based on typical lighting requirements for similar length tunnels including:

> 94 × 400 W lamps within the threshold zones.
> 44 × 250 W lamps within the transition zones.
> 271 × 100 W lamps within the interior zone.

Two 1 kW variable message signs would also be installed at either end of the tunnel and would operate for 24 hours a day.

The combined GHG emissions from lighting sources are presented in **Table 20.4**. This assumes that the electricity is purchased from the grid.

Table 20.4 - GHG emissions associated with lighting systems

Item	Annual energy consumption (GJ/year)	GHG emissions (t CO2-e/year)[1].
Street lighting	1,444	425.9
Tunnel lighting	256	75
Variable Message Signs	63	18.6
Total	**1,251**	**519.5**

[1]. Full fuel cycle emissions including transmission and distribution, fuel extraction and production

There are a number of other mechanical and electrical systems whose operation would result in GHG emissions including CCTV, communication systems and ventilation systems in the tunnel for emergencies. The energy and GHG emissions associated with these systems is anticipated to be minor compared to other emission sources and have not been included in the quantitative assessment.

Vehicles travelling on road

To assess the GHG emissions as a result of the use of the road by vehicles a comparison of the base case (no build) was made against the operation of the proposed upgrade.

GHG emissions were calculated for both cases over a 30 year period from 2012 to 2041 (30 years from opening) using RTA's REVS software. This software predicts the overall diesel and petrol consumption taking into account urban conditions, road conditions and fleet growth predictions. The overall fuel consumption estimate for diesel and petrol was then used to determine an estimate of greenhouse gas emissions. An analysis of the traffic model shows that the proposed upgrade is anticipated to reduce travel times through a reduction in highway length, as well as by bypassing steep grades and circuitous sections of the existing highway and therefore reduced GHG emissions associated with vehicles travelling on the road.

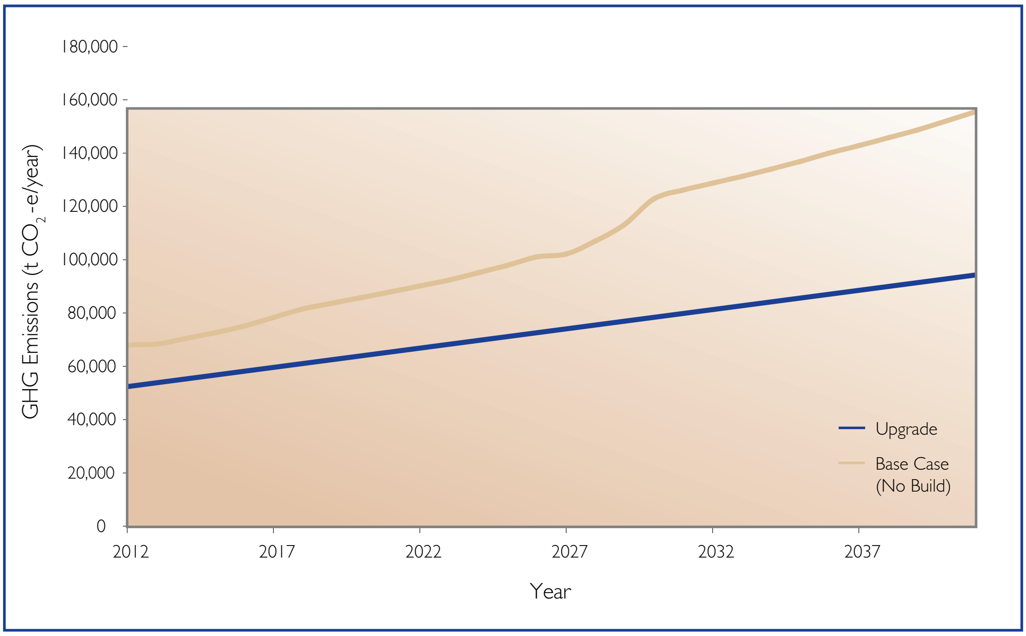
The results of the GHG savings are shown in **Table 20.5** and **Figure 20.1**.

Table 20.5 - GHG emissions attributed to vehicles travelling on road

GHG emissions (t CO_2-e)				
	2012	2041	Total (30 yr period)	Annual Average
Base Camp (no build)	68,100	155,600	3,235,500	107,900
Proposed upgrade	52,300	94,000	2,185,700	72,900
Saving	15,800	61,600	1,049,800	35,000

[1]. Full fuel cycle emissions including transmission and distribution, fuel extraction and production

Figure 20.1 - GHG emissions for vehicles travelling on the road network



The proposed upgrade is anticipated to reduce greenhouse gas emissions by around 15,800 t CO_2-e in 2012, rising to a reduction of 61,600 t CO_2-e in 2041.

The traffic model considers vehicle travel for the network based on historical trends and expected fleet growth as well as an additional growth factor for directed and induced travel from as a result of the entire PHUP.

The model does not account for changes to travel patterns for such varied reasons as other road network upgrades or issues, provision of public transport alternatives and cycleway, changes to road user behaviour (for example, those resulting from fuel prices), changes to technology, or the introduction of different vehicle types. Furthermore the conversion of fuel to GHG emissions assumed that there would be no change in fuel types or greenhouse intensity over the 30 year period and hence did not take into account increased uptake of renewable fuels, or improvements in vehicle efficiency. These would affect the absolute GHG emission savings but since such changes would occur regardless of whether the proposed upgrade goes ahead, the relative fuel savings would not be affected.

Emissions associated with wider development

The improvement in travel time along the proposed upgrade itself is not considered significant enough so as to promote development within its immediate vicinity. However the Pacific Highway Upgrade Programme (PHUP) cumulative improvement in travel time may result in increased residential, commercial and/or industrial development accessing the highway. Therefore GHG emissions associated with the construction and operation of such developments may be in some part attributable to the PHUP. However, the drivers for such developments incorporate many different factors not related to the PHUP. Therefore associated emissions are extremely difficult to quantify and have not further been considered in this assessment.

Notwithstanding, the directed and induced traffic along the highway as a result of the entire PHUP has been incorporated into the assessment of emissions associated with vehicles travelling along the road.

20.2.4 Cumulative impacts

Cumulative greenhouse gas emissions for the project were calculated for each year over the 30 year period as follows

$$E_i = E_{c_t} + i x E_{L_i} - \sum_{1}^{i} E_{s_i}$$

E_i - Cumulative GHG emissions at year i

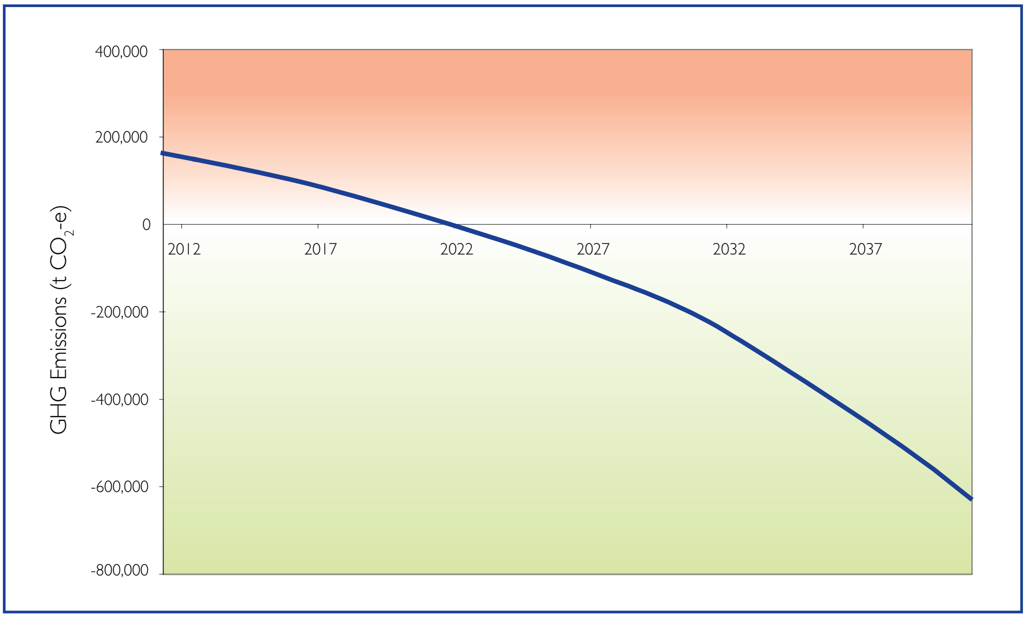
E_{c_t} - Total construction GHG emissions

E_{L_i} - GHG emissions attributable to lighting for year i

$\sum_{1}^{i} E_{s_i}$ - Sum of GHG emission savings from year 1 (2012) to year i.

The overall impact can therefore be established as shown in **Figure 20.2**

Figure 20.2 - Cumulative GHG emission impact and payback period



Based on the method applied, the proposed upgrade would result in annual greenhouse savings, with a net saving or break-even reached in 2022 when the emissions generated during construction would be offset by the operational savings. Over the project life, (i.e. by 2041), cumulative savings are expected to be in the order of 800,000 t CO_2-e.

20.2.5 Management measures

Greenhouse gas emissions can be reduced at both the construction and operational stages of the proposed upgrade. At the construction stage, the following management measures would apply:

> Assess energy (fuel/electrical) efficiency when selecting equipment.
> Maintain equipment to retain high levels of energy efficiency.
> Where feasible, use biofuels (biodiesel, ethanol, or blends such as e10 and b80), to reduce greenhouse gas emissions from construction plant and equipment.
> Minimise vegetation clearance as far as possible and replant vegetation where feasible.
> Where feasible, mulch cleared vegetation for re-use on site.
> Revegetate cleared areas to the extent feasible.
> Use local materials and local staff wherever possible, to reduce transport-related emissions.
> Use recycled materials, for example replacing cement with fly ash, using recycled aggregate, and recycled content in steel, to minimise the lifespan impact of greenhouse gas emissions in production. This would be undertaken where feasible and reasonable, in line with the RTA's specifications, particularly 'design, construct, maintain' requirements.

During the operational phase, fuel consumption of motor vehicles is directly proportional to emissions of carbon dioxide and other greenhouse gases from motor vehicles. Emissions cannot be reduced by control technologies, except where they result in improved fuel consumption. RTA programs that encourage better vehicle maintenance and, therefore, improved fuel economy, would be beneficial in reducing fuel usage and greenhouse gas emissions. Any programs that otherwise reduce fuel use would also be encouraged, such as clear signage, provision of facilities that encourage public transport use, solar powered telephones and lighting and maintenance of a quality road surface.

In addition, an energy audit for the street lighting system would be conducted in accordance with AS/NZS 1158.1.1:2005. The purpose of the audit would be to demonstrate that the design of the lighting scheme has minimised the life cycle energy of the scheme, commensurate with reliability and cost.

20.3 Climate change - effect on the proposed upgrade

The effects of climate change on the proposed upgrade can be assessed in terms of:

> Sea level rise and storm surges.
> Weather changes.
> Storm intensity and flooding.

Sea level rise and storm surges are not relevant to the proposed upgrade due to its elevation above seal level. The remaining two factors are however discussed below.

Climate change has the potential to change weather patterns for the study area. This could be in the form of temperature increases and higher winds. The Commonwealth Scientific and Industrial Research Organisation (CSIRO), in conjunction with the Bureau of Meteorology, has published a technical report titled *Climate change in Australia: technical report 2007*.

In this report, the best estimate for temperature change in Australia is warming of between 0.7 and 1.2 degrees Celsius by 2030, depending on the location. Coastal regions are not expected to warm to the same degree as inland areas. An increase of extreme temperatures (hot days and warm nights) is predicted (CSIRO and BoM 2007).

Climate change could also lead to an increase in the intensity of rainfall events. Essentially, this would mean that the rainfall expected to occur in a 1 percent annual exceedance probability (AEP) flood event would occur more frequently. Rainfall projections and intensity have also been included in the CSIRO report and a number of scenarios can be accessed at the climate change website (http://www.climatechangeinaustralia.gov.au/index.php) with variable emission levels and for different future years. By selecting annual changes for 2030 and assuming low emission levels, the changes in rainfall pattern for the area of the proposed upgrade could vary from -10 to +5 percent relative to the 1990 baseline (CSIRO and BoM 2007).

There is still a large fluctuation in data, which makes it difficult to provide any solid conclusions on the expected increases in rainfall intensity. However, in terms of the impact on the proposed upgrade, it could mean that the design immunity of the road (currently beyond 1 percent AEP) would reduce as a consequence. It is not possible to quantify this potential effect.

Given the high level of flood immunity associated with the proposed upgrade, any disruption to the proposed upgrade in terms of flooding is likely to remain highly infrequent.

The uncertainty surrounding climate change impacts and the likelihood that current management measures would be adequate for a considerable period of time, suggests that an adaptive management strategy would be appropriate to ensure that the proposed upgrade is not unexpectedly affected by climate change. Ongoing monitoring of storm frequency and intensity, and other weather changes would allow changes to the hydrologic and water quality management to occur in the future as needed. This would have the added benefit of utilising the best available technology at the time it is needed.

20.4 Non-indigenous heritage

Non-Indigenous consultation

In response to the publication of the *Route Options Development Report* (RTA 2005) and *Preferred Route Report* (RTA 2006a), a number of submissions were received from individual landowners who drew attention to items that they felt had local heritage significance. The project team reviewed these submissions and on occasion Navin Officer Heritage Consultants visited the respective landowners to confirm the significance of the items. In some cases this allowed the project team to include items of low local significance in the assessment of the proposed upgrade.

Additionally, information relating to the presence and location of non-Indigenous sites and heritage values was collected during the community consultation program and incorporated as applicable into this assessment. Inputs were provided through:

> Contributions from the corridor assessment workshop (July 2005) and value management workshop (December 2005).
> Landowner meetings following the Route Option Development Report (October 2005) as noted above.
> Phone consultation and on-site liaison with land-owners prior to and during the archaeological field survey of the preferred upgrade route.
> Representatives from the Ballina and Byron Shire councils attending various community and stakeholder consultation forums.

Recording parameters – Non-Indigenous heritage

Non-Indigenous heritage relates to a period during and following contact between Aboriginal and European or Southeast Asian peoples. The identification and assessment of non-indigenous cultural heritage in Australia is primarily an exercise that draws upon historical archaeology, documentary and data records, and oral history.

In the context of the proposed upgrade an historical archaeological site may fall into domestic, agricultural, transport, commercial and industrial categories.

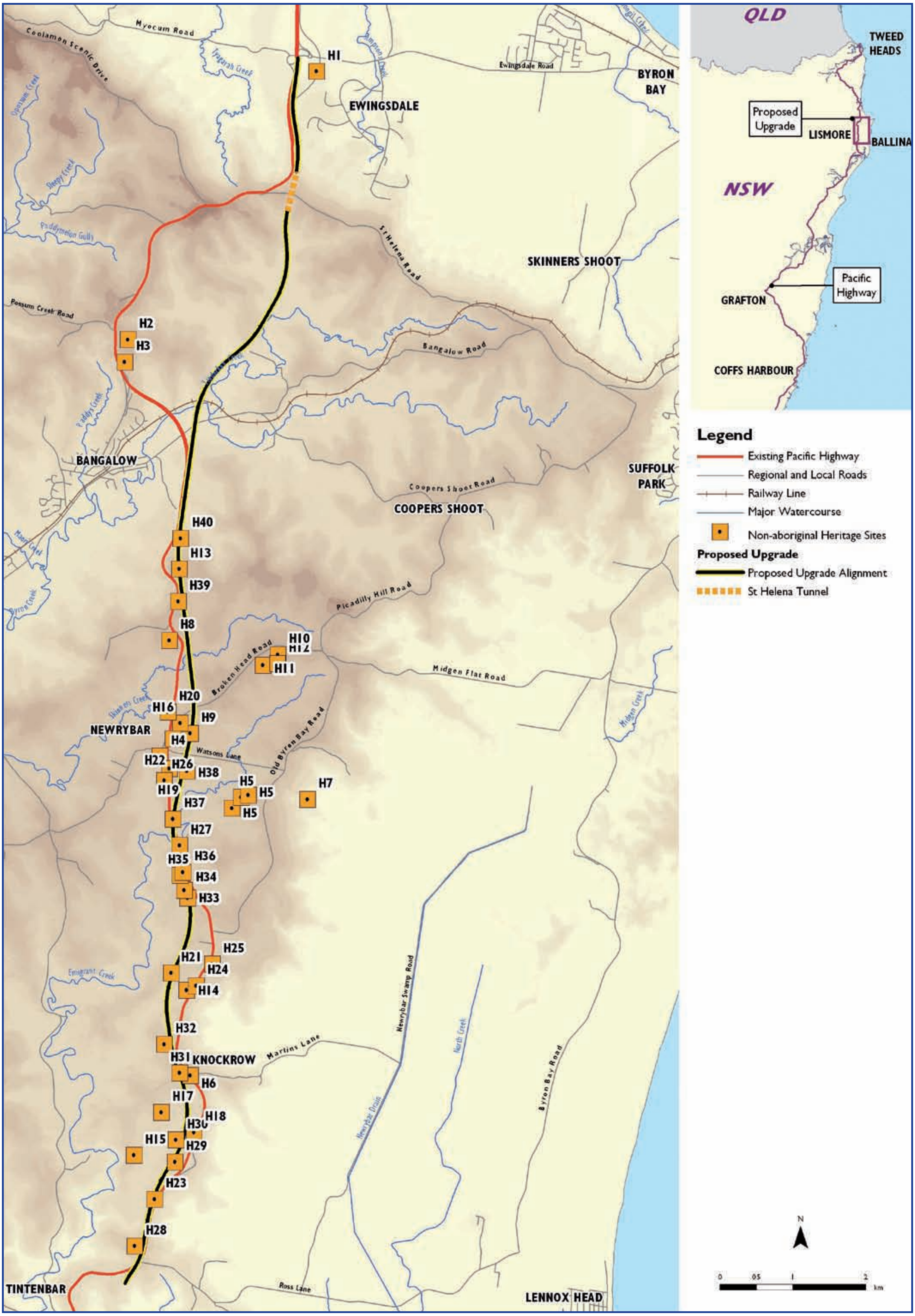
20.4.1 Existing non-Indigenous heritage conditions

None of the heritage recordings within the area of the proposed upgrade appear on Commonwealth government heritage registers, the NSW State Heritage Register, the current heritage schedules on the Ballina or Byron Local Environmental Plans, or the North Coast Regional Environmental Plan 1988. During April 2007 and previous surveys for the project 18 non-indigenous sites were recorded. A brief description of the sites is provided in **Figure 20.3** while their location is shown**.** A full description of the sites is provided in *Working Paper 9 - Cultural Heritage Assessment.*

Table 20.6 - Non-Indigenous cultural heritage recordings

Site ID	Site description
T2E H9	Cricket pitch and ground.
T2E H13	Arundel farm complex and plantings.
T2E H18	Former Knockrow School site and teachers residence.
T2E H21	Corn-Brae Lodge.
T2E H23	Weatherboard house.
T2E H28	Fig tree.
T2E H29	Forestry stump.
T2E H30	Derelict farm building – possible former dairy.
T2E H31	Remnant yards and two rail fencing.
T2E H32	Weatherboard cottage.
T2E H33	Weatherboard cottage.
T2E H34	Site of former dairy.
T2E H35	Family memorial.
T2E H36	Property entrance.
T2E H37	Car remnants.
T2E H38	Tree plantings.
T2E H39	Scatter of glass and ceramic fragments.
T2E H40	Concrete floor and footings.

Figure 20.3 - Non-Indigenous cultural heritage recordings



The methodology used to assess the cultural significance of non-Indigenous items and places follows that defined by the NSW Heritage Office. The heritage assessment criteria are those set out for listing on the State Heritage Register. A full description of the methodology and assessment criteria and how they apply to each site is provided in *Working Paper 9 - Cultural Heritage Assessment.*

20.4.2 Impacts to non-Indigenous heritage

A summary of the heritage significance and extent of impact to non-Indigenous sites is provided in **Table 20.7** below.

Table 20.7 - Impact to non-Indigenous heritage sites

Site ID	Site type	Heritage significance	Development impact
T2E H9	cricket pitch and ground	Below threshold	Direct impact on the pitch and roller location, the fig tree is located 40 west of a proposed fill embankment and there is potential for the retention of the fig tree, alive and in situ within the highway easement
T2E H13	Arundel farm complex and plantings	Moderate, local	Direct impact on whole complex
T2E H18	Former Knockrow School site and teachers residence	Moderate, local	Not affected, either directly or by property acquisition
T2E H21	Corn-Brae Lodge	Below threshold	The western cottage will be directly affected, the eastern and older cottage will not be directly affected or subject to property acquisition
T2E H23	Weatherboard house	Moderate, local	Direct impact
T2E H28	Fig tree and reported location of milk bottlery	Below threshold	Direct impact to most of reported site area, there is potential for fig tree to be retained, live and in situ within highway easement
T2E H29	Forestry stump	Below threshold	Cut and fill would occur in close proximity to tree, there may be potential for tree to be retained, live and in situ within highway easement
T2E H30	Derelict farm building	Moderate, local	Structure occurs 18 m west of a proposed service road, and would be affected by property acquisition, there is potential to retain structure within highway easement
T2E H31	Remnant yards and fencing	Below threshold	Direct impact
T2E H32	Weatherboard house	Moderate, local	Not directly affected or subject to property acquisition
T2E H33	Weatherboard cottage	Below threshold	Direct impact
T2E H34	Site of former dairy	Below threshold	Direct impact
T2E H35	Family memorial	Below threshold	Direct impact on memorial and all but the far western end of tree plantings
T2E H36	Property entrance	Below threshold	Direct impact
T2E H37	Car remnants	Below threshold	Direct impact
T2E H38	Tree plantings	Below threshold	Not directly affected or subject to property acquisition
T2E H39	Scatter of glass and ceramic fragments	Below threshold	Not directly affected, but in close proximity to construction zone, and subject to property acquisition
T2E H40	Concrete floor and footings	Below threshold	Direct impact

Only two sites above the heritage significance threshold will be directly affected (that is destroyed) by the construction of the proposed upgrade. These sites are The ***Arundel*** farm complex (T2E H13) and a weatherboard house (T2E H23).

Cumulative impacts

With regard to non-Indigenous heritage items, the agricultural lands affected by the proposed upgrade do not display any degree of rarity or representativeness which are of higher value than the majority of the adjacent plateau lands.

Relative to surrounding lands the attrition or deterioration of heritage items does not appear different The economic effect of the existing highway may have acted to increase the rate of demolition and renewal of structures through higher property values and commercial potential, which may lead to fewer surviving heritage items than in areas with lesser access. The surviving resource is typified by early twentieth century pastoral and horticultural site types and dominated by dairying residential infrastructure. All of these site profiles can be expected to be well represented elsewhere across the plateau lands.

The proposed upgrade would directly affect on two sites classified as having heritage significance (moderate significance in the local context). Recognising this and aspects outlined above, it is determined that the level of impact, when combined with the conduct of the proposed cultural heritage management strategies (Section 16.5) will not be substantial.

20.4.3 Management of impacts

The following management measures would be undertaken in relation to non-Indigenous heritage.

> An archival recording of sites H13, 23 and 30 would be conducted, consistent with the standards and guidelines published by the NSW Heritage Office prior to the commencement of any demolition and construction works.

> An assessment of the viability of a conservation management strategy for site H30 would be conducted and a decision made and followed regarding an appropriate management strategy.

> Provision would be made for the potential salvage of timbers and other architectural elements for adaptive reuse, during and following the demolition of sites H13 & 23, (and from H30 in the event that conservation is considered to be unviable).

> An archival record of limited scope would be conducted at sites H9, 21, 31, 33 & 40 prior to the commencement of any demolition and construction works. Such a record may consist of annotated photographs and descriptive notes where necessary.

> Where feasible, consideration would be given to retaining the trees alive and *in situ* at sites H28 and 29.

> The concrete grass roller at the former Newrybar cricket ground (H9) would be recovered and placed with an appropriate local institution, historical society, or repositioned in an appropriate local public space.

> The remnants of old agricultural machinery around the western *Corn Brae* cottage (H21) would be recovered and repositioned.

> If still present at the time of acquisition, the private family memorial (H35) and iron fencing within the property entrance at H36 would be carefully recovered and returned to the current property owners.

- In the event that there is an assessed risk of accidental damage from construction works to sites H18 and 32, then a temporary fence would be erected between the site and area of construction for the course of the construction period.
- Protocols which specify the required actions in the event of the discovery of previously unrecorded non-indigenous relics (including human remains) would be established and followed for the period of construction works.

20.5 Hazards

The environmental risk assessment summarised in **Chapter 8 - Environmental risk analysis** regarded hazards as environmental risks associated with transport or storage of dangerous goods, as well as broader traffic safety issues. It can also refer to risks to the operation or construction of the proposed upgrade due to natural events such as floods.

These hazards are addressed in a number of different chapters within the environmental assessment. The risk of spills associated with transport and storage of dangerous goods is discussed in **Chapter 10 – Water quality**. Flooding risk is discussed in **Chapter 9 – Hydrology**. Traffic safety issues are discussed in **Chapter 13 – Traffic**.

20.6 Resources and waste

The environmental risk assessment summarised in **Chapter 8** identified a number of issues under the heading of resources and waste. These included adequacy of the supply of construction resources, waste produced during construction (including excess fill material), and greenhouse gas emissions during construction and operation.

The supply of construction resources and disposal of excess material are discussed in **Section 6.5**. Greenhouse gas emissions during construction and operation are discussed in **Section 20.2.**

Tintenbar to Ewingsdale environmental assessment

Part D

Justifications and conclusions

21 Strategic and project justification

This chapter addresses the strategic need for the proposed upgrade, including how the proposed upgrade would meet the identified project needs and that of the Pacific Highway Upgrade Program. The table below identifies the key issues for the assessment in the environmental assessment requirements. Note that some of these issues are addressed in earlier chapters.

Environmental assessment requirements	Where addressed
Strategic Justification	
Outline the strategic outcomes for the Pacific Highway Upgrade Program, including with respect to strategic need and justification:	Section 2.1
> The aims and objectives of relevant State planning policies	Section 2.2
> The principles of ecologically sustainable development	Section 21.3
> Cumulative and synergistic impacts associated with the program as a whole	Section 21.2
Identify how the project fits within these strategic outcomes and how impacts associated with the project would be considered and managed to achieve acceptable environmental outcomes across the Pacific Highway Upgrade Program. Describe:	
> The need for and objectives of the project	Sections 2.4 and 2.6
> Alternatives considered (including an assessment of the environmental costs and benefits of the project relative to alternatives)	Section 2.4
> Provide justification for the preferred project taking into consideration the objects of the Environmental Planning and Assessment Act 1979	Sections 21.1 and 21.4

21.1 Benefits and impacts of the Pacific Highway Upgrade Program and the proposed upgrade

The *strategic and project need* for the Pacific Highway Upgrade Program (PHUP) and the proposed upgrade are discussed in Chapter 2.

The *strategic and project justification* for the PHUP and the proposed upgrade are outlined below in terms of their expected benefits and 'cumulative' and 'synergistic impacts' relative to the strategic objectives and desired outcomes of the program.

Expected benefits

Transport desired outcome: improved safety and travel times.

The program is expected to have significant benefits for transport and public safety.

The total reduction in the number of vehicle accidents as a result of the PHUP in the 30 years from 2006 are estimated to be 3,200 and 3,800, with a corresponding reduction in fatalities of between 130 and 155 (RTA 2005), relative to the base case of no upgrade.

The proposed upgrade would have a corresponding decrease in accidents, injuries and fatalities. The target for the proposed upgrade is a reduction in accident rates from 36 accidents per million vehicle kilometres travelled (MVKT) to 15 per MVKT.

Travel time savings for a highway user travelling in a car between the F3 Freeway and the NSW-Queensland border are estimated at approximately 90 minutes, relative to the base case of no upgrade (beyond what had already been completed by 2006) (RTA 2005). It follows that these travel time savings would also be achieved by commercial vehicles, thereby leading to significantly reduced freight costs.

The contribution of the proposed upgrade to this total travel time saving is approximately 2 minutes for cars and 2.5 minutes for commercial vehicles during normal operation. This time saving would be greater in busy periods.

Economic desired outcome: improved opportunities for regional economic development

The overall program would generate substantial regional economic development benefits in terms of the additional economic activity and employment induced by construction expenditure and the anticipated reduction in road transport costs. It is estimated that the present value of the increases in annual regional output by the program is $3.1 billion. An estimated creation of between 85,000 and 110,000 jobs (directly and indirectly) would occur during construction which would result in the generation of household income of approximately $2.5 billion to $3.3 billion. A large proportion of these would be associated with induced tourism and existing regional businesses expanding their output.

The proposed upgrade would ensure that the transport and economic benefits achieved by the other projects in the overall program are able to be capitalised on by the residents and businesses within the region. More specifically the tourism industry would experience growth from improved accessibility to the region. Freight transport costs would also be expected to reduce due to reduced travel time and improved fuel efficiency. Importantly, the proposed upgrade would also support the targeted future levels of population and housing growth on the North Coast as identified in the *Far North Coast Regional Strategy* (NSW Department of Planning 2006).

Social desired outcome: improved access to employment and community services

Substantial direct benefits of the program would accrue to road users, through improved safety, reduced crashes and reductions in the costs of travel. Reduced travel times would also improve access to employment opportunities and community services and facilities for resident populations. The flow-on effects would produce further social benefits in the form of reductions in costs for public transport users and increased economic activity and employment. Public transport users would, however, need to rely on possible cost reductions and beneficial flow-on effects for public transport availability to gain accessibility benefits.

The key social benefits gained from the proposed upgrade would relate to accessibility and public safety, including the separation of local and through traffic.

Environmental desired outcome: protection and enhancement of the natural and built environment

There are a range of cumulative environmental impacts associated with the PHUP. Some of the cumulative impacts are discussed earlier in the environmental assessment (ecology in **Chapter 12** and heritage in **Chapter 16**). There are also a range of amenity and other social impacts on some residents and communities that would occur as a result of the PHUP including impacts relating to visual amenity, noise and community severance. As an important part of the PHUP these impacts have been minimised through route selection and project design, and would continue to be minimised in the procedures associated with construction.

There are also a number of cumulative environmental benefits of the PHUP. These include (in general terms) improved air quality, lower resource use and reduced greenhouse gas emissions, and in the case of many communities improved amenity through the relocation of the Pacific Highway away from sensitive areas such as town centres and residential areas.

The proposed upgrade would have some environmental impacts which are discussed in detail in this environmental assessment, along with management measures to minimise these impacts. It is predicted to have benefits for regional air quality and greenhouse gas emissions. Other significant environmental benefits would be realised at the local level. Residents on the existing Pacific Highway, where this would become a local access road, would experience some amenity benefits. The proposal also includes a program of riparian restoration in which would provide environmental enhancement and improve local amenity.

Financial desired outcome: effective and efficient way of investment financial resources

Quantifiable monetary benefits of the program, such as savings in vehicle operating costs, travel time and avoided crashes, would be substantial. The program is estimated to result in net savings (after construction costs have been taken into account) with a present value of between approximately $540 million and $1.3 billion.

No separate cost-benefit analysis has been carried out for the proposed upgrade, however it could be expected that the proposed upgrade would contribute to the totals above in a way that is generally proportional to its length. Economic and ‘value-for-money’ considerations have been integrated into the development of alternative routes for the proposed upgrade and in the selection process for the preferred route.

21.2 Cumulative and synergistic impacts

The upgrade of the Pacific Highway is integral in meeting the needs of regional and state transportation demands as growth pressures along coastal towns increase. Furthermore important transport, economic, social and environmental benefits would be achieved through the overall program and the proposed upgrade. While the program and proposed upgrade both seek to achieve the greatest benefits with the least negative effects, a range of negative impacts, some of which may be cumulative, would also result (**Table 21.1**).

Table 21.1 - Potential cumulative and synergistic impacts of the program and proposed upgrade

Desired Outcome	Program	Project (proposed upgrade)
Transport: improved safety and travel times	> Improved travel times would result in a potentially significant transfer of freight from rail to road due to reduced road transport costs, leading to an increase in heavy vehicles on the road (and associated safety and amenity implications).	> Minor travel time improvement expected; therefore, minimal rail to road transfer expected as result of proposed upgrade itself, relative to overall program.
	> Congestion and slower travel times during roadworks for the various upgrade projects.	> Minor disruption with proposed highway offline to the existing highway allowing existing road network to be maintained for most of the construction period. Some temporary access changes during construction of bridges however relatively small impact in context of overall program due to small scale of project.
Economic: improved opportunities for regional economic development	> Some economic activities may be affected in towns that are bypassed. These could be positive or negative effects, depending on then nature of the activities within the context of the town.	> No towns bypassed. > Small number of businesses potentially affected by changes in access.
	> Lack of availability of road materials for other projects.	> Relatively large material quantities needed for scale of project, due to need for large structures, but relatively small impact in context of overall program due to short upgrade length.
Social: improved access to employment and community services	> The primary beneficiaries would be road users. Others in the community, including disadvantaged groups, would benefit to the extent that cost reductions and other flow-on effects are passed onto public transport users and consumers.	> Minor impact relative to overall program as interchange improvements and local road connections would benefit many in the community. Upgrade would improve local road network by removing through traffic.

Table 21.1 (cont)

Desired Outcome	Program	Project (proposed upgrade)
	> Increased severance and amenity impacts on farms or towns not bypassed or areas not upgraded.	> No towns bypassed. > Farms located between the proposed upgrade and the existing Pacific Highway would experience some severance impacts. A remnant land strategy has been developed to minimise impacts. Proposed highway for the most part follows the existing highway alignment closely and as such the impacts are minor in context of the overall program.
	> Changes in the character and lifestyle of communities from induced development.	> The proposed highway traverses a rural area where development controls and local environmental plans within the local government areas restrict the level of development. The proposed upgrade is considered to have a minor role in induced development and in context to overall program.
	> Impacts on Indigenous culture due to interference or disturbance to cultural sites of heritage.	> Minor impact expected relative to overall program due to small footprint of upgrade in a highly disturbed agricultural area and avoidance of significant impacts on potential areas of Indigenous heritage.
Environmental: protection and enhancement of the natural and built environment	> Loss of habitat and severing of wildlife corridors where new route alignments are constructed. > Compensatory programs would offset impacts to some extent.	> Minor impact relative to overall program due to land already cleared for agriculture, small area of vegetation removal, replanting of riparian vegetation and disturbed nature of existing vegetation.
	> Increases in fuel use and greenhouse emissions from growth in vehicle use and population levels in the region associated with increased accessibility arising from the program.	> No noticeable impact expected (benefits for fuel use and greenhouse gas emissions expected with a positive outcome in terms of operation versus construction reached around 2022).

Table 21.1 (cont)

Desired Outcome	Program	Project (proposed upgrade)
	> Impacts on landscape by the construction of new roads.	> Substantial element in a scenic landscape. High impact relative to size of project, due to large structures proposed and location on escarpment. Urban and landscape design measures to be a high priority.
	> Some loss of agricultural land to the highway and to new induced development.	> No land expect to be lost to new induced development however loss of agricultural land due to location in a rural area.
	> Potential reduction in water quality and impacts on flooding managed through best practice methods.	> Minor impact relative to overall program due to poor existing water quality. Some potential benefits for water quality in Emigrant Creek catchment. Some localised minor negative impacts. > Location of proposed highway on plateau and escarpment avoids flood prone areas. Bridge structures designed for major flooding events.
	> General improvement in townscape and heritage values (with the exception of isolated locations) due primarily to highway bypasses.	> Minimal impact on townscapes. Significant heritage items have been avoided. Minor impact in context of overall program.
Financial: effective and efficient way of investing financial resources	> Net economic benefit from the PHUP.	> A range of immediate local economic benefits with isolated small negative impacts.

Managing the cumulative impacts of the Program and the proposed upgrade

Table 21.2 summarises the actions, strategies and policies that have or are being implemented in response to these issues, including integration with the principles of ecologically sustainable development. As identified, the proposed upgrade has a synergistic relationship with the program and as such management of the cumulative impacts of the proposed upgrade itself is also discussed.

Table 21.2 - Managing the cumulative impacts of the Pacific Highway Upgrade Program and the proposed upgrade

Cumulative impact	Required management/action/response	Implementation and responsibility
Improved travel times would result in transfer of freight from rail to road	> Investigate policies to improve the efficiency of rail operations and manage impacts of increased heavy vehicles on the road network.	> Australian Rail Track Corporation (ARTC) and RailCorp are implementing strategies to improve efficiency of rail operations. > RTA is implementing a Stopping Area Strategy – Driver Reviver Strategy. > RTA is increasing road maintenance funding commensurate with increased truck numbers.
Congestion and slower travel times due to the effects of roadworks for the various upgrade projects	> Investigate strategies for traffic management and safety improvements on these sections, particularly with respect to trucks and buses.	> RTA has developed a roadwork coordination scheme that offers ways to minimise the adverse impact of roadwork delays on road users. A key component of this strategy is the dissemination of regular information to Pacific Highway road users and local communities about delays due to highway construction and maintenance activities. This allows road users to plan their journeys and make decisions when scheduling activities. The RTA produces weekly and urgent traffic reports about potential delays. These reports are distributed to service stations along the highway, NRMA branches, RTA motor registries, local councils, tourist centres and the media. > Detailed traffic management measures (including work shutdowns during peak holiday periods) are prepared and implemented for individual projects, including the proposed upgrade.
Some businesses may be detrimentally affected by being bypassed (although the majority would benefit).	> Investigate measures to enhance visibility and access to bypassed towns and retail areas and promote local development. No bypasses associated with the proposed upgrade.	> Department of Planning (DoP) and RTA are implementing a retail commercial policy, incorporating a highway service centre policy. > RTA identifies towns by signage and ensures provision of consistent signage. > RTA provides good town access. > Local government, tourism agencies, and regional economic development agencies identify and promote town industries for development. > Local government and regional economic development agencies evaluate long-term socio-economic effects on small towns and rural communities.

Table 21.2 (cont)

Cumulative impact	Required management/action/response	Implementation and responsibility
Lack of availability of road materials for other projects	> Investigate and develop strategies for sourcing road materials.	> RTA, Department of Primary Industries, local government and quarry/development industries are undertaking further studies to ensure provision of pavement materials.
Accessibility benefits not shared equitably	> Investigate means to improve public transport, including provision of infrastructure for bus depots, bus stops, cycleways, etc.	> AusLink has provided significant funding for upgrading the passenger and freight rail networks. The ARTC is currently upgrading the track and signalling on the North Coast Line. > The RTA is incorporating bus, cycle and pedestrian access improvements into Pacific Highway Upgrade Program projects. > The Ministry of Transport and local government are investigating means to improve public transport services. > The proposed upgrade provides improved safety for buses and cyclists on the existing highway.
Increased severance in towns not bypassed	> Develop strategies to reduce severance impacts, early consultation, crossings, tunnels, overpasses.	> The RTA has developed a Stopping Area Strategy, which is a means of coordinating vehicle stopping opportunities as part of the Pacific Highway Upgrade Program. Advantage is taken of facilities provided by major towns in convenient locations. > The concept design for the proposed upgrade includes a number of aspects to reduce severance, including maintaining the current local road network for motorists, cyclists and pedestrians.
Changes in the character and lifestyle of communities (social and environmental effects of induced development)	> Implement planning policies to mitigate inappropriate development types. > Monitor cost of living and social justice changes in areas of rapid growth and target policies to disadvantaged groups.	> This is inherently controlled through local and state planning instruments and development application reviews as well as the Department of Planning for any major development. > The cost of living and housing affordability are typical indicators collected intermittently by a variety of measures at a local, state and federal level.

Table 21.2 (cont)

Cumulative impact	Required management/action/ response	Implementation and responsibility
Impacts on Indigenous culture	> Strategic assessment of potential impacts. > Route planning based on longer sections of highway to provide greater flexibility to avoid culturally significant areas. > Detailed assessment of local impacts during environmental assessment. > Involve Aboriginal communities in the road planning process. > Monitor cumulative impacts.	> Extensive consultation with relevant Aboriginal groups has been undertaken for the proposed upgrade in accordance with Department of Environment and Climate Change (DECC) interim guidelines. > The commitments to environmental protection by the RTA in the environmental assessment include ongoing vigilance of construction and RTA personnel during the construction phase of the proposed upgrade, identification of any potential item of Indigenous archaeological value and appropriate action taken should any such item or area be uncovered. > Impacts are also monitored by the DECC and Aboriginal land councils.
Reduction in biodiversity	> Extensive consultation with relevant Aboriginal groups has been undertaken for the proposed upgrade in accordance with Department of Environment and Climate Change (DECC) interim guidelines. > The commitments to environmental protection by the RTA in the environmental assessment include ongoing vigilance of construction and RTA personnel during the construction phase of the proposed upgrade, identification of any potential item of Indigenous archaeological value and appropriate action taken should any such item or area be uncovered. > Impacts are also monitored by the DECC and Aboriginal land councils.	> The baseline monitoring information conducted for every upgrade project is public information contained within the environmental assessments for the project. These documents are provided to government, as are the results of longer-term monitoring during construction and operations. > The RTA is adopting a broader sectional approach to compensatory habitat for the Pacific Highway Upgrade Program on consultation with DECC. > Biodiversity impact predictions were undertaken as part of the options assessment process, which was commented on by the government and the public. > The DoP has released its Far North Coast Regional Strategy 2006-31, which identifies a balance between providing sustainable growth for the region while promoting protection of the 'areas key environmental assets. > The commitments to environmental protection by the RTA in the Environmental Assessment include monitoring during the construction phase of the project. > As part of the project riparian restoration would be undertaken in consultation with local authorities.

Table 21.2 (cont)

Cumulative impact	Required management/action/ response	Implementation and responsibility
Increases in fuel use and greenhouse gases	> Support improved road design, vehicle design and maintenance. > Implement RTA policy on greenhouse reduction. > Encourage retention of freight on rail.	> The RTA has a strategy to develop road design principles to minimise fuel consumption and the improvement of vehicle engine design to maximise fuel efficiency and minimise emissions. It also has a role on the Advisory Committee on Vehicle Emissions and the State's Motor Vehicle Maintenance Program. > The RTA has prepared a Greenhouse Reduction Plan to address and provide policy in relation to greenhouse gas emissions resulting from its activities. The aim of the plan is the minimising of emissions. > AusLink has provided significant funding for upgrading the passenger and freight rail networks. The ARTC is currently upgrading the track and signalling on the North Coast Line. > BASIX and other energy and resource conservation mechanisms introduced.
Impacts on landscape	> Minimise new area clearance and earthworks through road design and route selection. > Implement or develop landscape strategies, particularly north of Ballina. > Develop urban design strategies.	> *The Far North Coast Regional Strategy 2006-31* requires the protection of the scenic quality of the region including natural areas, attractive rural areas and areas adjacent to water bodies, headlands, skylines and escarpments. > The RTA has an overall urban design strategy for its projects, which are implemented for the proposed upgrade. > Impacts on natural or rural landscape values were assessed as part of the project. Impact assessments and management measures would be implemented to reduce impacts.
Loss of agricultural land	> Avoidance of prime land through route selection and design. Develop strategies at project level that minimise impacts on rural land viability. > Investigate planning controls that minimise effects on prime agricultural land.	> The options processes for individual RTA projects typically adopt indicators associated with prime agricultural land loss. Depending on the severity of impacts, management measures are devised and implemented as part of project assessments. > Controls incorporated at local government level as well by DoP through the *Far North Coast Regional Strategy 2006-31*.

Table 21.2 (cont)

Cumulative impact	Required management/action/ response	Implementation and responsibility
Reduction in water quality and impacts on flooding (including effects of climate change on highway upgrades)	> Implementation of RTA Acid Sulfate Soil management guidelines and RTA Water Policy. > Implement water monitoring programs in support of other such measures. > Implement erosion and sedimentation control plans at project level. > Ensure provision of flood passage structures in design. > Implement residential development strategies which minimise effects of land clearing and runoff and limit water extraction.	> Implementation of guidelines and policy are RTA standard procedures. > Water monitoring programs and erosion and sediment control are typical environmental management commitments made by the RTA at the project level where relevant (and have been implemented for the proposed upgrade). > Flood passage is a standard RTA design procedure. Flooding assessment was completed for proposed upgrade. > Residential impacts are controlled through local planning instruments and development application reviews, as well as by the DoP for any major development.
Reduction in townscape and heritage values	> Implement controls to maintain townscape and heritage values.	> The options processes for individual RTA projects typically adopt indicators associated with heritage areas. > Planning agencies are responsible for other development controls. > Proposed upgrade has a high level of flood immunity and would not be expected to be affected by climate change.
Increased costs for provision of services due to induced development	> Investigate options for assistance to local government, service and utility providers to bring forward provision of services.	> The master planning process at the NSW Government level has included wide consultation and publication to ensure all relevant parties are informed. The specific requirements are to be determined by each utility provider in accordance with current business planning practices. > The RTA is managing this issue through consultation with other government departments and utility providers.

21.3 Integration of the program and proposed upgrade with principles of ecologically sustainable development

Ecologically sustainable development aims to sustain and conserve natural resources through 'using, conserving and enhancing the communities' resources so that the ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased (Commonwealth Government of Australia, 1990).

The principles of ecologically sustainable development have been an integral consideration throughout the process of developing the proposed upgrade and assessing its benefits and impacts. In addition, the preparation and exhibition of the environmental assessment in itself contributes to the consideration of the principles of ecologically sustainable development. It makes detailed information about the proposed upgrade publicly available and assists in the decision on whether the proposed upgrade should proceed.

Definitions of the four principles of ecologically sustainable development quoted below are from the *Protection of the Environment Administration Act 1991*. The definitions from this act are cross referenced in the *Environmental Planning and Assessment Act 1979*.

Precautionary principle

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.

In the application of the precautionary principle, public and private decisions should be guided by:

(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and:

(ii) an assessment of the risk-weighted consequences of various options.

Intergenerational equity

The present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations

Conservation of biological diversity

Conservation of biological diversity and ecological integrity should be a fundamental consideration.

Improved valuation, pricing and incentive mechanisms

Environmental factors should be included in the valuation of assets and services, such as:

(i) *polluter pays* - that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,

(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,

(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

The ways in which the Pacific Highway Upgrade Program as a whole, and the proposed upgrade respond to the principles of ecologically sustainable development are summarised in **Table 21.3** below.

Table 21.3 - Application of ecologically sustainable development principles to the program and proposed project

Relevant ecologically sustainable development principles	Program approach	Project approach
Precautionary principle	Early strategic assessment. Use of best available technical information and adoption of best practice environmental standards, goals and measures to minimise environmental risks.	Environmental risk analysis prepared at project application phase and updated in this environmental assessment. Conservative, "worst case" scenarios addressed in impact assessment. Best practice measures are included in the management measures proposed in Part C of this environmental assessment and incorporated into the draft Statement of Commitments in Appendix C.
Inter-generational equity	The decision to upgrade the Pacific Highway has integrated long and short-term economic, environmental, land use and social (including social equity) considerations, so that any foreseeable impacts are not left to be addressed by further generations.	Issues that have potential long-term implications, such as consumption of non-renewable resources, waste disposal, greenhouse emissions, removal of vegetation and impacts on visual amenity and water quality, have been avoided and minimised as much as possible through route/concept selection and application of management measures such as best practice water quality management and a comprehensive urban and landscape design strategy (see Part C and Appendix C).
Conservation of biological diversity	Recognition in the program of the rich biological environment of the North Coast of NSW and the need to avoid and control potential impacts throughout the length of the upgrade (e.g. through selection of which sections to upgrade).	The route/concept selection and design development have sought to avoid and minimise biodiversity impacts as much as possible. Riparian restoration would be undertaken as part of the proposed upgrade, while the landscape strategy includes biodiversity objectives.
Improved valuation, pricing and incentive mechanisms	Environmental and social costs/ benefits considered alongside economic and financial costs/ benefits in the decision to upgrade the Pacific Highway and in the selection of the highway sections to upgrade.	Environmental and social issues were considered in the strategic planning and establishment of the need for the project, and in the consideration of options. The value placed on these resources is evident in the extent of the planning, environmental investigations and design of management measures.

21.4 Relationship between the proposed upgrade and the objects of the Environmental Planning and Assessment Act 1979

The ways that the proposed upgrade would meet the objects of the *Environmental Planning and Assessment Act 1979* (EP&A Act) are outlined in **Table 21.4** below.

Table 21.4 - Performance of the proposed upgrade against the objects of the EP&A Act.

EP&A Act objectives	Performance of Proposed Upgrade
(a) To encourage	
(i) the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment,	The proposed upgrade and associated mitigation and management measures detailed in the Environmental Assessment allow for the proper management of these issues. For discussion of: > Agricultural land, see Chapter 14. > Natural areas, see Chapter 12. > Forests, see Chapter 12 for natural forests; no forestry industry would be affected. > Minerals – no active mineral extraction would be affected. > Water, see Chapters 9 and 10. > Cities, towns and villages, see Chapters 14 and 17).
(ii) the promotion and co-ordination of the orderly and economic use and development of land,	The development of the proposed upgrade is anticipated to have significant economic benefits for the region, and for the movement of freight. No substantial adverse impacts on local businesses are expected (see Chapter 17).
(iii) the protection, provision and co-ordination of communication and utility services,	Utilities affected by the proposed upgrade would be relocated and/or protected as described in Section 5.14.
(iv) the provision of land for public purposes,	The proposed upgrade itself is proposed for a public purpose. No land reserved for public recreation would be affected.
(v) the provision and co-ordination of community services and facilities,	No community facilities occur within the proposed road reserve. Access to community facilities would be maintained, but altered in certain cases.
(vi) the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats,	Protection of threatened species, populations and ecological communities, and their habitats is described in Chapter 12.
(vii) ecologically sustainable development, and	Achievement of the principles of ESD was a key design principle for the proposed upgrade. This is described in Table 21.3.
(viii) the provision and maintenance of affordable housing.	The proposed upgrade is unlikely to influence the provision and maintenance of affordable housing in the area.

Table 21.4 (cont)

EP&A Act objectives	Performance of Proposed Upgrade
(b) To promote the sharing of the responsibility for environmental planning between the different levels of government in the State.	This is a high level objective that does not apply specifically to individual projects. While the Minister for Planning would determine the project application under Part 3A, Ballina and Byron shires have been consulted extensively throughout the route selection and environmental assessment process.
(c) To provide increased opportunity for public involvement and participation in environmental planning and assessment.	Community involvement in the planning and assessment of the proposed upgrade is described in Chapter 4.

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Glossary

Term	Definition
Aboriginal Heritage Information Management System (AHIMS)	A list of known Aboriginal sites held by the DEC.
Acid Sulfate Soils (ASS)	Naturally acid clays, mud and other sediments usually found in swamps and estuaries. They may become extremely acidic when drained and exposed to oxygen, and may produce acidic leachate and runoff, which can pollute receiving waters and liberate toxins. ASS is classified as material, which is above the groundwater, is undergoing oxidation and has a pH of less than 4.0.
Acute noise levels	Road traffic noise levels received at private dwellings, that are predicted to be greater than 65dB(A) Leq(15hr) (day) and 60dB(A) Leq(9hr) (night), as presented in Practice Note IV, Step 3, part (2) of the RTA's (2001) Environmental Noise Management Manual.
Alignment	A detailed geometric layout, in plan and profile, following a general route.
Amenity	Natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence and cultural and recreational attributes.
Annual Exceedance Probability (AEP)	The chance of a flood of a given size (or larger) occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (i.e. a 1 in 20 chance) of a peak discharge of 500 m^3/s (or larger) occurring in any one year.
Archaeological Site	A site is defined as any material evidence of past Aboriginal activity that remains within a context or place that can be reliably related to that activity. Usually a site classification requires a minimum of two detected artefacts.
Annual Average Daily Traffic (AADT)	Volume representing the total traffic in both directions at each location, calculated from mechanically obtained axle counts.
Annual Average Daily Vehicles (AADV)	Represents the average number of vehicles passing in both directions during a 24-hour period estimated over a period of one year.
Batter	The side slope of walls, embankments and cuttings or the degree of such slope.
Carriageway	Portion of a road or bridge used by vehicles (inclusive of shoulders and auxiliary lanes).
Census	The enumeration of an entire population, usually with details being recorded on residence, age, sex, occupation, ethnic group, marital status, birth history, and relationship to head of household.
Culvert	An enclosed channel used for the passage of surface water under a road or other embankment.
Cut (batter)	The material removed (excavated) from the existing ground surface.
Decibel (dB)	A unit used in the comparison of powers and levels of sound energy. A comprehensive glossary of noise terms can be found in Section 1 of the RTA's Environmental Noise Management Manual (2001), which can be obtained from RTA's website at www.rta.nsw.gov.au/environment/noise/.

Term	Definition
dB(A)	Decibels using the 'A' weighted scale, measured according to the frequency of the human ear.
Design speed	A nominal speed used for the design of geometric features of the road, such as curves.
Dispersion	The spatial property of being scattered about over an area or volume.
Dual carriageway	A road with separated carriageways for traffic travelling in each direction.
Earthworks	The process of extracting, moving and depositing earth during construction.
Ecologically Sustainable Development (ESD)	Development that maintains and improves the total quality of life. Development both now and in the future in a way that maintains the ecological processes on which life depends. Key components of ESD are intergenerational equity, maintenance of biodiversity, improved economic evaluation of environmental costs and benefits and the precautionary principle.
Evaluation Criteria	A list of criteria and measurables used to evaluate the route options. Sieve 1 criteria were used to evaluate the long list of options. Sieve 2 criteria were used to evaluate the shortlist of options.
Fill (batter)	The material placed in an embankment.
Floodplain	Valley floor flat adjacent to a stream that is flooded by the 'annual' flood (often considered to be the flood with a recurrence interval of about 1.6 years).
Footprint	The footprint is indicative of the likely actual road reserve width requirements and includes the land that would be required for the physical roadway (highway and service roads), public utility plant (if required), earthworks, and maintenance clearances. The footprint also includes a margin for drainage or other works that may be required beyond the extent of earthworks.
Geotechnical	Work relating to soil mechanics, foundation engineering, rock mechanics, engineering geology, hydrogeology and materials testing.
Grade Separation	The separation of traffic so that crossing movements that would otherwise conflict are at different levels.
Groundwater	Water beneath the surface of the earth which saturates the pores and fractures of sand, gravel, and rock formations.
Habitat	The place where an organism lives, habitats are measurable and can be described by their flora and physical components.
Horizontal Alignment	The geometric form of the centreline of a roadway in the horizontal plane.
Hydrogeology	The branch of geology that studies the movement of subsurface water through rocks and the effect of moving water on rocks, including their erosion.
Hydrology	The study of the properties, distribution, use, and circulation of the water on Earth and in the atmosphere in all of its forms.
Interchange	A grade separation of two or more roads with one or more interconnecting carriageways or ramps.
Intersection	A meeting of two or more roads.

Term	Definition
Level of Service	A qualitative analysis providing a means of determining the traffic-carrying performance of a road or any element of it under the prevailing roadway and traffic control conditions.
Median	A strip of land which separates carriageways for traffic in opposite directions.
Noise Wall	A wall or barrier (noise barrier) erected to block or deflect noise.
Pairwise	A tool used to assess the relative importance of the evaluation criteria. It allows stakeholders the opportunity to weight the evaluation criteria in order of importance to them. This allows the study team to gain an understanding of which evaluation criteria are viewed as more important.
PM10	Usually airborne particulate matter less than 10 m (microns or one millionth of a metre) in diameter, a measure of dust.
PM2.5	Usually airborne particulate matter less than 2.5 m (microns or one millionth of a metre) in diameter, a measure of dust.
Portal	Entry and/or exit of a tunnel.
Potential Acid Sulfate Soil (PASS)	Defined as material below the groundwater which has not been oxidised and generally has a pH of greater than 4.0. The pH has the potential to become much lower when the soil is exposed to oxygen as a result of activities such as excavation and drainage.
Service Road	A subsidiary carriageway constructed between the principal carriageway and the property line, connected only at selected points with the principal carriageway. It reduces the number of access points to a major road, with a consequent improvement in safety.
Shoulder	The strip of pavement bordering the carriageway beyond the traffic lanes and constructed at the same level as the pavement surface. Used by traffic in emergencies and provides clearance to batter slopes.
Terrestrial	Living or growing on land; not aquatic.
Tributaries	Rivers or streams flowing into a larger river or lake.
Vertical Alignment	The geometric form of the centreline of a carriageway in the vertical plane.
Wetland	Land either permanently or temporarily covered by water. These areas are usually characterised by vegetation of a moist-soil or aquatic type.

Abbreviations

Term	Definition
AADT	Annual average daily traffic
ADWG	Australian Drinking Water Guidelines
AEP	Annual exceedence probability
AGO	Australian Greenhouse Office
AHD	Australian height datum
AHIMS	Aboriginal heritage information management system
ANZECC	Australian and New Zealand Conservation Council
ARTC	Australian Rail Track Corporation
BRS	Bureau of Rural Science
CCTV	Closed circuit television
CEMP	Construction environmental management plan
CSIRO	Commonwealth Scientific and Industrial Research Organisation
dB(A)	A-weighted decibels
DET	Department of Education and Training
Department of Environment and Conservation (DEC)	Former name for part of the current NSW Department of Environment and Climate Change
DECC	NSW Department of Environment and Climate Change (formerly DEC, EPA and NPWS)
DGA	Dense graded asphalt
DIPNR	NSW Department of Infrastructure Planning and Natural Resources
Department of Natural Resources (DNR)	Former name for part of the current NSW Department of Water and Energy
DPI	Department of Primary Industry
DoP	Department of Planning
DWE	NSW Department of Water and Energy
ECRTN	The former Environment Protection Authority's (EPA 1999) Environmental Criteria for Road Traffic Noise
EIS	Environmental Impact Statement
ENCM	The former EPA's (1994) Environmental Noise Control Manual

Term	Definition
ENMM	The RTA's (2001) Environmental Noise Management Manual
Environment Protection Authority (EPA)	Part of the current NSW Department of Environment and Climate Change (DECC)
EP&A Act	NSW Environmental Planning and Assessment Act 1979
EPBC	Act Commonwealth Environment Protection and Biodiversity Conservation Act 1999
ESD	Ecologically sustainable development
FM Act	Fisheries Management Act
GDEs	Groundwater dependant ecosystems
GHG	Greenhouse Gas
LAeq noise levels	Constant sound pressure level which exhibits the equivalent acoustic energy of a fluctuating noise level, otherwise known as the 'energy-average' sound level
LALC	Local Aboriginal land council
LEP	Local Environmental Plan
LGA	Local government area
MVKT	Million vehicle kilometres travelled
NCREP	North Coast Regional Environmental Plan
NHMRC	National Health and Medical Research Council
NNTT	National native title claim
NRMMC	Natural Resource Management Ministerial Council
NSW	New South Wales
OH&S	Occupational Health and Safety
PAD	Potential archaeological deposit: any location considered to have a moderate to high potential for subsurface archaeological material
PHUP	Pacific Highway Upgrade Program
Probable maximum flood (PMF)	Largest flood that could conceivably occur at a particular location, which defines the extent of flood-prone land (the floodplain)
PPV	Peak particle velocity
QLD	Queensland
ROTAP	Rare or threatened Australian plants
RTA	NSW Roads and Traffic Authority

Term	Definition
SC	Shire Council
SEPP	State environmental planning policy
TAPM	The air pollution model
t CO2-e	Tonnes of carbon dioxide equivalent
TSC Act	Threatened Species and Conservation Act
VDV	Vibration dose valve
WSP	Water Sharing Plan
WP	Working Paper

Appendix A

Director General's requirements

NSW GOVERNMENT
Department of Planning

Contact: Dinuka McKenzie
Phone: (02) 9228 6348
Fax: (02) 9228 6355
Email: Dinuka.McKenzie@planning.nsw.gov.au

Our ref: 9037893

Mr Bob Higgins
General Manager, Pacific Highway
NSW Roads and Traffic Authority
PO Box 576
GRAFTON NSW 2460

Dear Mr Higgins

Director General's Requirements for the Environmental Assessment of Proposed Pacific Highway Upgrade between Tintenbar and Ewingsdale

The Department has received your application for the proposed Pacific Highway Upgrade between Tintenbar and Ewingsdale Project (Application Number: 07_0051).

I have attached a copy of the Director-General's requirements (DGRs) for the environmental assessment of the Project. These requirements have been prepared following the Planning Focus Meeting held on Monday, 16 April 2007 and in consultation with the relevant government agencies.

It should be noted that the Director-General's requirements have been prepared based on the information provided to date. Under section 75F(3) of the Act, the Director-General may alter or supplement these requirements if necessary and in light of any additional information that may be provided prior to the proponent seeking approval for the Project.

I would appreciate it if you could contact the Department at least two weeks before you propose to submit the Environmental Assessment for the Project to determine:

- the fees applicable to the application;
- relevant land owner notification requirements;
- consultation and public exhibition arrangements that will apply;
- options available in publishing the Environmental Assessment via the Internet; and
- number and format (hard-copy or CD-ROM) of the Environmental Assessment that will be required.

Prior to exhibiting the Environmental Assessment, the Department will review the document to determine if it adequately addresses the DGRs. The Department may consult with other relevant government agencies in making this decision. If the Director-General considers that the Environmental Assessment does not adequately address the DGRs, the Director-General may require the proponent to revise the Environmental Assessment to address the matters notified to the proponent. Following this review period the Environmental Assessment will be made publicly available for a minimum period of 30 days.

If your proposal includes any actions that could have a significant impact on matters of National Environmental Significance, it will require an additional approval under the Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act). This approval would be in addition to any approvals required under NSW legislation and it is your responsibility to contact the Department of Environment and Water Resources to determine if an approval under the EPBC Act is required for your proposal (6274 1111 or http://www.environment.gov.au).

Please note that the Commonwealth Government has accredited the NSW environmental assessment process for assessing impacts on matters of National Environmental Significance. As a result, if it is determined that an approval is required under the EPBC Act, please contact the Department immediately as supplementary Director-General's requirements will need to be issued.

If you have any enquiries about these requirements, please contact Dinuka McKenzie, A/Senior Environmental Planning Officer, Major Infrastructure Assessments on 02 9228 6348 or via email (dinuka.mckenzie@planning.nsw.gov.au).

Yours sincerely

Chris Wilson
Executive Director
As delegate for the Director-General

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Application number	07_0051
Project	Pacific Highway Upgrade – Tintenbar to Ewingsdale
Location	Between the Ross Lane and the Ewingsdale Road interchanges of the Pacific Highway within the Byron Shire and Ballina Shire Local Government Areas.
Proponent	NSW Roads and Traffic Authority
Date issued	22 May 2007
Expiry date	22 May 2009
General requirements	The Environmental Assessment (EA) must include the following: 1. an **executive summary**. 2. a **detailed description** of the Project including: ▪ route alignment and corridor width; ▪ design elements (e.g. requirements for LOS, pedestrian and cyclists, rest areas and service centres etc); ▪ differentiate the limits of the Project with respect to the existing Pacific Highway including operational/ maintenance responsibilities; ▪ potential staging; ▪ ancillary facilities (e.g. compound site, batching plants etc); and ▪ resourceing (e.g. construction material needs, spoil disposal, natural resource consumption including water). 3. an **assessment of the key issues**, with the following aspects addressed for each key issue (where relevant): ▪ describe the existing environment; ▪ assess the potential impacts of the proposal at both construction and operation stages, in accordance with relevant policies and guidelines. Both direct and indirect impacts must be considered including potential interactions with the existing Pacific Highway (as relevant); ▪ identify how relevant planning, land use and development matters, (including relevant strategic and statutory matters), have been considered in the impact assessment and/ or in developing management/ mitigation measures; and ▪ describe measures to be implemented to avoid, minimise, manage, mitigate, offset and/or monitor the impacts of the Project and the residual impacts. 4. a **draft Statement of Commitments (SoC)**. The SoC must incorporate or otherwise capture all measures to avoid, minimise, manage, mitigate, offset and/or monitor impacts identified in the impact assessment sections of the EA and ensure that the wording of the SoC clearly articulates the desired environmental outcome of the commitment. The SoC must be achievable, measurable (with respect to compliance), and time specific, where relevant. 5. **certification** by the author of the Environment Assessment that the information contained in the Assessment is neither false nor misleading.
Key issues	▪ **Strategic Justification and Project –** outline the strategic outcomes for the Pacific Highway Upgrade Program (PHUP), including with respect to strategic need and justification, the aims and objectives of relevant State planning policies, the principles of Ecologically Sustainable Development, and cumulative and synergistic impacts associated with the Program as a whole. Identify how the project fits within these strategic outcomes and how impacts associated with the project will be considered and managed to achieve acceptable environmental planning outcomes across the PHUP. ▪ **Project Justification –** describe the need for and objectives of the project; alternatives considered (including an assessment of the environmental costs and benefits of the project relative to alternatives), and provide justification for the preferred project taking into consideration the objects of the *Environmental*

	Planning and Assessment Act 1979.
	▪ **Land Use and Property -** including but not limited to:
	  ▪ impacts to directly-affected properties and landuses adjacent to the project, including: impacts to landuse viability and future development potential, including property title impacts; land sterilisation and severance impacts; and impacts to the connectivity and contiguity of small settlements including Newrybar and Knockrow;
	  ▪ consideration of project impacts on the attainment of the objectives of *Far North Coast Strategy*; and
	  ▪ development of a mitigation strategy aimed at promoting appropriate final land uses on lands subject to partial or full acquisition as a result of the project, in consultation with Ballina and Byron Shire Councils.
	▪ **Social and Economic -** including but not limited to:
	  ▪ local community socio-economic impacts associated with landuse, property and amenity related changes;
	  ▪ business (including agricultural producers) impacts on a case by case basis including impacts to the overall viability, profitability, productivity and sustainability of businesses;
	  ▪ regional economic impacts to the agricultural sector taking into account the total loss of regional and State Significant farmland as identified in the *Northern Rivers Farmland Protection Project* (Department of Planning, February 2005); and
	  ▪ regional economic impacts to the tourism sector taking into account agri-tourism impacts and impacts to local amenity, character and scenery.
	▪ **Surface and Ground Water -** including but not limited to:
	  ▪ water quality impacts to the catchments of Emigrant Creek and Wilson River, in consultation with Rous Water, taking into account impacts from both accidents and runoff (i.e. acute and chronic impacts) and considering relevant public health and environmental water quality criteria specified in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000*;
	  ▪ groundwater impacts, considering local impacts at each deep cutting and cumulative impacts on regional hydrology. The assessment must consider: extent of drawdown; impacts to groundwater quality; discharge requirements; and implications for groundwater-dependent surface flows (including springs and drinking water catchments), groundwater-dependent ecological communities, and groundwater users including the *Alstonville Basalt Groundwater Source Water Sharing Plan*;
	  ▪ flooding impacts, identifying changes to existing flood regimes, in accordance with the *Floodplain Development Manual* (former Department of Natural Resources, 2005) including impacts to existing receivers and infrastructure and the future development potential of affected land; and
	  ▪ impacts to waterways to be modified as a result of the project, including ecological, hydrological and geomorphic impacts (as relevant) and measures to rehabilitate the waterways to pre-construction conditions or better.
	▪ **Flora and Fauna -** including but not limited to:
	  ▪ consideration of threatened terrestrial and aquatic species, populations, ecological communities and/or critical habitat; and
	  ▪ assessment of the following issues: native vegetation loss; weed infestation; habitat fragmentation; impacts to wildlife corridors including riparian corridors; impacts to groundwater-dependent communities, riparian and aquatic habitat; and
	  ▪ consideration of regional scale cumulative impacts and identify the significance of the impacts of the project in the context of the PHUP.
	▪ **Noise and Vibration -** including but not limited to:
	  ▪ an assessment of operational road traffic noise impacts including consideration of local meteorological conditions (as relevant) and any additional reflective noise impacts from proposed noise mitigation barriers;
	  ▪ an assessment of construction noise and vibration including construction traffic noise and blasting impacts; and
	  ▪ the assessment(s) must take into account the following guidelines as

	relevant: *Environmental Criteria for Road Traffic Noise* (EPA 1999), *Environmental Noise Management Manual* (RTA, 2001), *Environmental Noise Control Manual* (EPA, 1994), *Assessing Vibration: A Technical Guideline* (DEC, 2006); and *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZECC, 1990).
	▪ **Visual Amenity and Urban Design -** including but not limited to:
	  ▪ consideration of project and urban design (including noise barriers, retaining walls and landscaping) consistent with overall design of the PHUP and the existing (and desired) character of affected localities; and
	  ▪ consideration of the *Noise Wall Design Guideline* (RTA, 2006).
	▪ **Traffic** - including but not limited to:
	  ▪ demonstration of how the project design meets the traffic and transport objectives of the PHUP;
	  ▪ assessment of operational traffic and transport impacts to the local and regional road network, including direct impacts from traffic rerouting and modified access to the upgraded highway, and indirect impacts from the increased accessibility of the Ballina and Byron Shires; and
	  ▪ assessment of construction traffic impacts (including spoil haulage).
	▪ **Air Quality** - including but not limited to:
	  ▪ impacts to sensitive receivers (e.g. Newrybar School); consideration of local meteorological conditions; impacts to road users and other receivers at the tunnel section; and consideration of airborne pollutant impacts on drinking water catchments.
	▪ **Indigenous Heritage** – including but not limited to:
	  ▪ the consideration of both artefact and landscape scale mitigation measures, where relevant; and
	  ▪ consideration of regional scale cumulative impacts and identify the significance of the impacts of the project in the context of the PHUP.
	▪ **Environmental Risk Analysis –** notwithstanding the above key assessment requirements, the EA must include an environmental risk analysis to identify potential environmental impacts associated with the project (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the EA.

Consultation	You should undertake an appropriate and justified level of consultation with relevant parties during the preparation of the EA, including: ▪ local, State or Commonwealth government authorities and service providers such as Rous Water, the Department of Environment and Climate Change, the Department of Primary Industries, the Department of Water and Energy, the Department of State and Regional Development, Byron Shire Council and Ballina Shire Council; ▪ Specialist Interest Groups including Local Aboriginal Councils; and ▪ the public, including affected landowners. The EA must describe the consultation process, document all community consultation undertaken to date and identify the issues raised (including where these have been addressed in the EA).

Appendix B

RTA land acquisition policy

Land Acquisitions

Roads and Traffic Authority
New South Wales
www.rta.nsw.gov.au

2nd Edition
3 February 1999

Policy Statement

LAND ACQUISITIONS

The Road and Traffic Authority (RTA) is responsible for providing a safe and efficient road transport system in NSW.

Often it is necessary to acquire land to upgrade existing roads or construct new roads.

This document is a general guide to the procedures that are followed when the RTA acquires land and while it provides a comprehensive overview of the essential elements of the RTA's acquisition policy is not intended as a complete statement on the subject.

Throughout this document the term "affected" means affected by the acquisition or proposed acquisition of land. Payment of compensation only takes place where land is acquired.

Owners of property, that is affected by the acquisition of land required for roadworks, are generally aware of roads proposals either through enquiries made when purchasing the property, from proposals shown on Local Planning Schemes or through the RTA's community consultation for new projects.

(New road proposals are made public as soon as possible. It should be noted that the RTA is not required to acquire more land than is necessary for roadworks).

The Roads Act 1993 authorises the RTA to acquire land and payment for land is assessed in accordance with the provisions of the Land Acquisition (Just Terms Compensation) Act 1991.

The Roads Act 1993 and other legislation allows the RTA to enter land to carry out investigations. Consideration of those powers is outside the scope of this document.

One objective of the Land Acquisition (Just Terms Compensation) Act 1991 , referred to throughout this document as the Act, is to encourage the acquisition of land by negotiated purchase in preference to compulsory process. The RTA fully supports this objective.

The RTA generally purchases property as an owner initiated acquisition either under the "hardship" provisions of the Act or its "preferred option" policy (explained on page 2) or as an RTA initiated acquisition in preparation for immediate roadworks. When agreement is reached the purchase is completed by contract and transfer takes place similar to a sale in the open market, however it should be noted that the RTA's solicitor will prepare contracts.

Owner Initiated Acquisition under the provisions of the Act

Owners may experience difficulty in selling their property if part or the whole is designated for acquisition for roadworks. If an owner is unsuccessful in attempting to sell a designated property and is experiencing hardship, then a written application can be made to the RTA requesting acquisition under the “hardship” provisions of the Act. To be eligible for consideration for “hardship” acquisition a property must be designated for acquisition within the meaning of the Act. Land is designated for acquisition if:

(a) the RTA has, in connection with an application for development consent or building approval, given written notice that the land has been designated for road and future acquisition by the RTA ; or
(b) the land is reserved for a public purpose (road) indicated in an environmental planning instrument and the RTA is specified as the body responsible for acquiring the property.

To meet the Act’s criteria for “hardship” acquisition an owner must demonstrate that it has become necessary to sell for pressing personal, domestic or social reasons or to avoid a loss in income and that attempts to sell the property have been unsuccessful because of the designation for acquisition by the RTA. If an owner meets the hardship criteria to the RTA’s satisfaction, the RTA will agree to purchase the property and in effect becomes the purchaser that cannot be found in the market place. While it is the RTA’s preference to complete hardship acquisitions by negotiated agreement, the compulsory process is alsoavailable to the land owner if preferred.

The RTA’s basis of assessing payment in hardship matters is market value unaffected by road proposals. No other payments in addition to the unaffected market value are made as the owner’s willingness to sell the property in the market place is taken as a preparedness to accept the normal costs associated with selling a property. It should be noted that in most circumstances an owner will not be responsible for a sales commission that would otherwise be payable if the property had been successfully marketed and sold through a real estate agent.

Owner Initiated Acquisition under the “Preferred Option” Policy

In the process of considering the location of a new road the RTA may examine several possible routes and a preferred option may be selected from those routes for further environmental impact study. As a result of community consultation the location of the preferred option will become known. This public knowledge could frustrate attempts by owners to sell properties potentially affected by the taking of land. Properties potentially affected by a preferred option proposal are not designated land because the actual route has not been finalised. Consequently the owners of such properties are not eligible for consideration to have their property acquired under the owner initiated acquisition provisions of the Act. The RTA is however prepared to consider the acquisition of such property outside the provisions of the Act.

The RTA will consider a request for acquisition if an owner can demonstrate hardship using the criteria specified in the Act. The acquisition will be at the discretion of the

RTA and subject to the availability of funds with each party being responsible for all their own costs. The basis of the purchase price will be the assessment of market value unaffected by the road proposal.

Where an acquisition is proceeding on this basis, compulsory acquisition is not an option. Where an agreement cannot be reached on the purchase price, the following procedure is available:

- The offer is withdrawn

- The owner to choose a valuer from a panel of independent valuers nominated by the Australian Property Institute and referred to the owner by the RTA for selection. In this way the valuer chosen is mutually acceptable to both the owner and the RTA.

- The selected valuer will act as an independent expert and will be commissioned by the RTA to carry out a valuation of the subject property.

- Each party is to be responsible for the payment of 50% of the valuation fee.

- The owner or the RTA may make written submissions to the valuer within the first seven (7) calendar days after the valuer is instructed.

- The independent expert's determination will be binding on both parties if the owner wishes to proceed.

- No further valuations will be obtained and the offer to acquire at the determined value will remain open for a period of three (3) months, after which time the offer will lapse.

If the offer lapses and a subsequent decision is made to proceed with the preferred option and the property remains affected, the RTA will recommence negotiations to acquire that part of the property required for roadworks when road construction is imminent.

Programmed Acquisition (RTA initiated)

When land is required for road construction the RTA will initiate acquisition by way of a letter to owners of property affected by the taking of land. The letter will advise the owner that a valuer representing the RTA will make arrangements to inspect the property and carry out a valuation for the purpose of submitting a formal offer for the owner's consideration. The letter invites land owners to submit an asking price, if that is desired, and also advises, that if the owner engages a registered valuer to value the property, the RTA will reimburse fees to the maximum amount specified in the letter.

Reimbursement of valuation fees is subject to the conditions contained in Appendix "A". The valuation report is to be in accordance with the "Basic Content of Valuation

Reports" contained in Appendix "B". It is expected that the valuer will act as an expert and not an advocate.

Division 3 of Part 4 of the Act, in particular Section 55, details the relevant matters to be considered when assessing payment and can be summarised as follows:

- Market Value. (unaffected by road proposals)
- Special Value.
- Severance.
- Disturbance.
- Solatium, and
- Any increase or decrease in the value of adjoining or severed land.

For a fuller understanding, refer to Sections 55 - 62 of the Act which are reproduced in Appendix "C". The heads of compensation to be considered are the same whether the acquisition is a negotiated purchase or is completed by compulsory process.

Following assessment, the RTA will submit written conditions of acquisition
to owners for their consideration. One of those conditions will specify the maximum amount that the RTA is prepared to reimburse in respect to conveyancing costs. If the conditions of acquisition are acceptable, the matter will proceed to exchange of contracts and settlement. If the RTA's offer is not acceptable, it is suggested that the services of a registered valuer be engaged to carry out an assessment on the owner's behalf. If there is a difference between valuations, negotiations will take place in an attempt to resolve the matter. Every effort will be made to negotiate a mutually acceptable agreement.

Depending on the RTA's requirements it may be necessary to acquire the whole of a property or only part of a property. The terms "total" or "partial" are used to describe these situations.

Total Acquisition

There are additional considerations peculiar to total acquisitions:

It is strongly recommended to the property owner, that no commitment be made to purchase a replacement property until contracts are exchanged on the sale to the RTA.

If a deposit on a replacement property is required, the RTA will make an advance payment of up to 10% of the value of the property being acquired by the RTA. The advance payment will be made at the time of or after the exchange of contracts and will be subject to conditions required by the RTA's solicitor.

The market value of the property will be assessed having regard to the prime cost items and inclusions at the time of inspection. If it is the owner's intention to retain any item, it is necessary to indicate to the valuer at the time of inspection that an item is to be excluded so that a correct assessment can be made. Requests made after the valuation inspection may be refused or the valuation reduced by the value of the item.

The property must be left in a clean and tidy condition. In accordance with standard real estate transactions, vacant possession will be required on the date of settlement. The RTA will carry out an inspection on the date of settlement to ensure compliance and that all inclusions are intact.

Swimming pools should be clean on the day of settlement and should comply with any relevant statutory or Council requirements including fencing and signage.

Partial Acquisition

If only part of a property is required by the RTA, the letter opening negotiations will include a plan showing the new road boundary and the area and dimensions of that part of the property to be acquired.

The method of assessing the amount to be paid for the land is the “Before and After” method which requires two valuations to be carried out. The first valuation is of the property unaffected by road proposals. The second valuation, as at the same date, is of the residue land on the basis that the new road construction has been completed and the road in use. The difference between the two valuations is the payment for the land to be acquired.

The RTA will, at its own cost prior to or during roadworks, adjust services and public utilities as required, relocate fencing and reinstate access to the new road boundary. It should be noted that fencing will be relocated to the new road boundary to a standard similar to that existing. If considered necessary, the RTA will prepare a plan detailing property adjustments for consideration by the land owner and if acceptable that plan may form part of the contract for sale.

On occasion, the RTA may acquire the whole of a property if the effect of roadworks on the residue land is considered to warrant total acquisition. This applies if the owner purchased the property prior to the RTA formally indicating that the property is to be affected by the acquisition of land, or if the already affected property is to be further adversely affected by the acquisition of additional land. All relevant elements of compensation within section 55 of the Act will be considered.

Where an owner purchased the property in knowledge of the RTA’s requirement, the RTA may acquire only that part required for road. If an owner purchased in knowledge of a road affectation and has requested the RTA to acquire the whole property the RTA may agree to total acquisition. However, if a decision is made to acquire the whole property compensation will be limited to market value unaffected by road proposals together with reasonable conveyancing and valuation costs. If an agreement cannot be reached on conditions of total acquisition, the RTA may elect to proceed with only the acquisition of the land required for road.

Entry for Roadworks

Once an acquisition has been settled, entry for roadworks can take place. On occasion, the RTA's road construction program requires entry prior to completion of the acquisition and in such matters the RTA relies on the owner's cooperation. If required and the owner is agreeable, the RTA may arrange formal right of entry on exchange of contracts or, entry by way of lease.

If an agreement cannot be reached to ensure the RTA's timely entry onto the required land for roadworks, the Minister may approve the issue of a written Proposed Acquisition Notice to compulsorily acquire the land.

COMPULSORY ACQUISITION

Compulsory Acquisition is a statutory process under the Act available to the RTA to acquire land. It also provides the means for resolving disputes about the amount of compensation payable if an agreement cannot be reached in a negotiated purchase. Generally the process is as follows:

The RTA seeks the Minister's approval to compulsorily acquire land.

- If the Minister approves, the RTA issues a Proposed Acquisition Notice to each party with a known legal or equitable interest in the land, (eg a registered proprietor, mortgagee, lessee, trustee) or with a right or privilege over the land, or in connection with it (eg, easement beneficiary, occupant, licensee, etc). The Notice advises of the RTA's intention to acquire the land after 90 days. However, a shorter period can be agreed by the owner and RTA, or can be approved by the Minister. A Proposed Acquisition Notice is accompanied by a Compensation Claim Form.

- The issue of a Proposed Acquisition Notice is recorded on the relevant Title registers at the Land Titles Office.

- During the 90 day (or shortened) period after the issue of the Proposed Acquisition Notice, negotiations may continue in an effort to purchase the land.

- During the 90 day (or shortened) period after the issue of the Proposed Acquisition Notice, the RTA seeks the Governor's approval to compulsorily acquire the land.

- If contracts for purchase have not been exchanged within the minimum Notice period and if the Governor approves, an Acquisition Notice is published in the Government Gazette within 120 days of the issue of the Proposed Acquisition Notice unless a longer period is agreed to in writing by the owner and the RTA.

- An extract of the Acquisition Notice is also published in a local newspaper.

- The RTA owns the land from the date of publication of the Acquisition Notice in the Gazette. The former owner's legal and equitable interests in the land are converted to an entitlement to compensation.

Advance Payment

Following the publication of the Acquisition Notice the RTA advises affected owners of the acquisition. It is generally prepared to offer to pay 90% of the RTA's purchase offer, in return for vacant possession of the land.

Terms of Continued Occupation

The RTA is entitled to charge rent for the land from the date of notification in the Gazette until possession is obtained. The terms of rental are, in the absence of an agreement, such reasonable terms as the RTA may determine. Unpaid rent may be deducted from compensation payable. Parties entitled to compensation are paid statutory interest on the amount of compensation such interest being calculated from the date of gazettal up until the date of payment.

Compensation

Each recipient of a Proposed Acquisition Notice is entitled to lodge a claim for compensation with the RTA. Also, anyone else who considers that they are entitled to compensation but did not receive a Proposed Acquisition Notice may lodge a claim. Claims must be on the prescribed form. Compensation is not paid until a properly completed claim has been lodged. If agreed, compensation may comprise land or works in whole or part settlement of a claim.

The Valuer General determines the amount of compensation (including legal and valuation costs) to be offered by the RTA in a Compensation Notice.

A Compensation Notice is issued within 30 days after notification of the compulsory acquisition in the Gazette. This Notice is issued whether or not a claim for compensation has been lodged. However, the Minister may approve delay in the issue of a Compensation Notice by up to an extra 60 days. In the case of competing claims the RTA may not issue a Compensation Notice until entitlement is resolved.

If the amount of compensation is accepted, and the necessary settlement papers and claim form are returned to the RTA properly completed, the RTA will pay the compensation within 28 days of receipt of those papers. Interest is paid on the compensation from the date of acquisition to the date of payment.

If the amount of compensation is not accepted, the claimant may lodge an objection with the Land and Environment Court. The objection should be lodged within 90 days of receiving the Compensation Notice. This ensures that the Court will hear the objection and determine the amount of compensation to be paid. Within 28 days after it is given notice of the institution of proceedings, the RTA will pay the claimant 90% of the compensation offered in the Compensation Notice as an advance on account of compensation, if that is acceptable to the claimant. Interest is also paid on the advance for the period from gazettal to the date that the advance is made. If it is not accepted, the advance and interest will be deposited into a trust account pending the Court decision.

If, within 90 days of a Compensation Notice issuing, the amount offered in that Notice has not been accepted and an objection has not been lodged with the Land and Environment Court, the offer is deemed to have been accepted. The RTA then deposits the amount offered plus interest into the trust account where it is held until it is accepted or until an objection is lodged with the Court. Money earned by the trust account deposit becomes part of the compensation.

If compensation is in the trust account six years after the date of acquisition and a claim has not been received, the compensation is paid to the State Treasurer and held in the Treasury until paid to an entitled claimant. Interest is not paid on the compensation for the time that it is held in the Treasury.

Occupation

People in lawful occupation of land compulsorily acquired and to whom compensation is payable are entitled to remain in occupation as tenants of the RTA until:

(a) the compensation is paid; or

(b) an advance payment of not less than 90% of the amount offered in the Compensation Notice is paid; or

(c) not less than 90% of the amount offered in the Compensation Notice is deposited into the trust account due to a deemed acceptance, Court action, or competing claims;

whichever occurs first.

Furthermore, people lawfully occupying any building which is their principal place of residence or place of business are entitled to remain in occupation as tenants of the RTA for three months after it is compulsorily acquired, regardless of whether any of the abovementioned payments have been made. However, the Minister may shorten that period.

The terms of occupancy, including rent, in the absence of an agreement with the claimant are determined by the RTA on reasonable terms and any unpaid rent can be offset against any compensation payable by the RTA.

Once the RTA is entitled to vacant possession, it may request the Sheriff to deliver possession of the land to the RTA. The Sheriff's costs may be recovered as a debt or deducted from any compensation payable.

APPENDIX "A"

REIMBURSEMENT OF VALUATION FEES – CONDITIONS OF PAYMENT

The purpose of the reimbursement of valuation fees is to provide the owner with the opportunity to obtain an independent valuation report from a Registered Valuer. The role of the Valuer is to provide a valuation report as to the owner's entitlement to compensation in accordance with the Land Acquisition (Just Terms Compensation) Act 1991. In some cases the valuation will form the owners claim to the Roads and Traffic Authority (RTA) and in other cases the valuation report may act to verify that the compensation offered by the RTA is fair and reasonable. The Valuer is to act as an expert not as an advocate for the owner. The valuation must comply with professional standards.

The RTA is prepared to reimburse a fee incurred in obtaining a valuation report up to the maximum amount specified in the letter opening negotiations and subject to the following conditions:-

1. The Valuer engaged must be registered to carry out valuations for that particular type of property and preferably be a current member of the Australian Property Institute.

2. The Valuation Report shall be in accordance with Appendix "B" Basic Contents of Valuation Reports. The Valuer should be prepared to support the valuation in discussions with the RTA's Valuers.

3. A copy of the report in its final form signed by the valuer is to be supplied with and in support of the asking price.

4. Reimbursement will take place upon settlement of the acquisition, however the RTA will, under direction from the land owner, make a payment of 50% of the fee directly to the valuer following the valuation report being made available to the RTA.

Owners are advised to ensure that the Valuer is prepared to provide the valuation in accordance with the conditions outlined above and is also prepared to accept a fee to the maximum amount specified in the letter opening negotiations.

In the event that it is considered necessary to engage some other consultants such as Accountants, Town Planners, Surveyors, etc., prior approval in writing must be obtained if it is intended to seek reimbursement of these fees from the RTA.

APPENDIX ‘B’

BASIC CONTENT OF VALUATION REPORTS

1. Evidence that the valuation was undertaken by the valuer who signed the report and disclosed his/her registration number together with a statement that he/she is registered to value the subject class of property.

2. Date of valuation and date of inspection.

3. Areas/dimensions and legal particulars of the land. Any legal constraints which would restrict development should be noted.

4. A description of the improvements.

5. A site plan showing position of improvements in relation to boundaries.

6. A floor plan showing accurate areas, date and the north point.

7. Specific list of inclusions

8. An outline of permitted land use under current relevant environmental planning instrument and/or local government codes.

9. A description of the class of land valued and the current or potential use of the land together with its location.

10. Details of the sales/rental information relied upon to arrive at the valuation, together with analysis and calculations.

11. Photographs of sales evidence.

12. Valuation rationale

13. Assessment of all individual Heads of Compensation as detailed in Land Acquisition (Just Terms Compensation) Act 1991.

14. The rental value of the property

APPENDIX "C"

EXTRACT FROM THE LAND ACQUISITION (JUST TERMS COMPENSATION) ACT 1991

Relevant matters to be considered in determining amount of compensation.

55

In determining the amount of compensation to which a person is entitled, regard must be had to the following matters only (as assessed in accordance with this Division):

(a) the market value of the land on the date of its acquisition;
(b) any special value of the land to the person on the date of its acquisition;
(c) any loss attributable to severance;
(d) any loss attributable to disturbance;
(e) solatium;
(f) any increase or decrease in the value of any other land of the person at the date of acquisition which adjoins or is severed from the acquired land by reason of the carrying out of, or the proposal to carry out, the public purpose for which the land was acquired.

Market value

56. (1) In this Act:

"**market value"** of land at any time means the amount that would have been paid for the land if it had been sold at that time by a willing but not anxious seller to a willing but not anxious buyer, disregarding (for the purpose of determining the amount that would have been paid):

(a) any increase or decrease in the value of the land caused by the carrying out of, or the proposal to carry out, the public purpose for which the land was acquired; and
(b) any increase in the value of the land caused by the carrying out by the authority of the State, before the land is acquired, of improvements for the public purpose for which the land is to be acquired; and
(c) any increase in the value of the land caused by its use in a manner or for a purpose contrary to law.

(2) When assessing the market value of land for the purpose of paying compensation to a number of former owners of the land, the sum of the market values of each interest in the land must not (except with the approval of the Minister responsible for the authority of the State) exceed the market value of the land at the date of acquisition.

Special value

57. In this Act:

"special value" of land means the financial value of any advantage, in addition to market value, to the person entitled to compensation which is incidental to the person's use of the land.

Loss attributable to severance

58. In this Act:

"**Loss attributable to severance"** of land means the amount of any reduction in the market value of any other land of the person entitled to compensation which is caused by that other land being severed from other land of that person.

Loss attributable to disturbance

59. In this Act:

"loss attributable to disturbance" of land means any of the following:

(a) legal costs reasonably incurred by the persons entitled to compensation in connection with the compulsory acquisition of the land;

(b) valuation fees reasonably incurred by those persons in connection with the compulsory acquisition of the land;

(c) financial costs reasonably incurred in connection with the relocation of those persons (including legal costs but not including stamp duty or mortgage costs);

(d) stamp duty costs reasonably incurred (or that might reasonably be incurred) by those persons in connection with the purchase of land for relocation (but not exceeding the amount that would be incurred for the purchase of land of equivalent value to the land compulsorily acquired);

(e) financial costs reasonably incurred (or that might reasonably be incurred) by those persons in connection with the discharge of a mortgage and the execution of a new mortgage resulting from the relocation (but not exceeding the amount that would be incurred if the new mortgage secured the repayment of the balance owing in respect of the discharged mortgage);

(f) any other financial costs reasonably incurred (or that might reasonably be incurred), relating to the actual use of the land, as a direct and natural consequence of the acquisition.

Solatium

60. **(1)** In this Act:
"**solatium"** means compensation to a person for non-financial disadvantage resulting from the necessity of the person to relocate his or her principal place of residence as a result of the acquisition.

(2) The maximum amount of compensation in respect of solatium is:

(a) except as provided by paragraph (b)-$15,000; *(see note at end of Extract)* or

(b) such higher amount as may be notified by the Minister by notice published in the Gazette.

(3) In assessing the amount of compensation in respect of solatium, all relevant circumstances are to be taken into account, including:

(a) the interest in the land of the person entitled to compensation; and

(b) the length of time the person has resided on the land (and in particular whether the person is residing on the land temporarily or indefinitely); and

(c) the inconvenience likely to be suffered by the person because of his or her removal from the land; and

(d) the period after the acquisition of the land during which the person has been (or will be) allowed to remain in possession of the land.

(4) Compensation is payable in respect of solatium if the whole of the land is acquired or if any part of the land on which the residence is situated is acquired.

(5) Only one payment of compensation in respect of solatium is payable for land in separate occupation.

(6) However, if more than one family resides on the same land, a separate payment may be made in respect of each family if:

(a) the family resides in a separate dwelling-house; or
(b) the Minister responsible for the authority of the State approves of the payment

(7) If separate payments of compensation are made, the maximum amount under subsection (2) applies to each payment, and not to the total payments.

Special provision relating to market value assessed on potential of land

61. If the market value of land is assessed on the basis that the land had potential to be used for a purpose other than that for which it is currently used, compensation is not payable in respect of:

(a) any financial advantage that would necessarily have been forgone in realising that potential; and

(b) any financial loss that would necessarily have been incurred in realising that potential.

Special provision relating to acquisition of easements or rights, tunnels etc.

62. **(1)** If the land compulsorily acquired under this Act consists only of an easement, or right to use land, under the surface for the construction and maintenance of works (such as a tunnel, pipe or conduit for the conveyance of water, sewage or electrical cables), compensation is not payable except for actual damage done in the construction of the work or caused by the work.

(2) If land under the surface is compulsorily acquired under this Act for the purpose of constructing a tunnel, compensation is not payable (subject to subsection (1)) unless:

- (a) the surface of the overlying soil is disturbed; or
- (b) the support of that surface is destroyed or injuriously affected by the construction of the tunnel; or
- (c) any mines or underground working in or adjacent to the land are thereby rendered unworkable or are injuriously affected.

(3) If the land compulsorily acquired under this Act consists of or includes an easement or right to use the surface of any land for the construction and maintenance of works (such as canals, drainage, stormwater channels, electrical cables, openings or ventilators), the easement or right is (unless the acquisition notice otherwise provides) taken to include a power, from time to time, to enter the land for the purpose of inspection and for carrying out of any additions, renewals or repairs. Compensation under this Part is payable accordingly.

Note in respect to Solatium

In accordance with Section 60(2)(b) the maximum amount of Solatium was increased to $16,821 effective from the 1 July 1998. There may be further increases in the maximum amount of Solatium from time to time and it is suggested that you speak with the RTA's Property Acquisition staff for the latest information.

Appendix C

Draft statement of commitments

Draft statement of commitments

The Environmental Assessment for the proposed upgrade has identified a range of environmental outcomes and management measures that would be required to avoid or reduce its environmental impacts. These have been converted to specific commitments, which are described in this Appendix.

Overview

Chapters 9 to 20 of the Environmental Assessment identify a number of mitigation and management measures with the aim of minimising and/or mitigating, as far as practical, the adverse impacts associated with the proposed upgrade. These measures have informed the development of the draft Statement of Commitments that the RTA will implement as part of the construction and operation of the proposed upgrade.

The draft Statement of Commitments may be revised in response to public submissions to the Environmental Assessment and/or design changes made before final submissions to the Department of Planning. The final Statement of Commitments would be considered by the Department of Planning in assessing the proposed upgrade. Should approval be granted by the Minister for Planning, approval conditions would pay regard to the final Statement of Commitments. Any consortium or contractor selected to undertake further planning, design, construction and/or operation phases of the proposed upgrade will be required to undertake all works in accordance with the final Statement of Commitments.

Draft commitments

The draft Statement of Commitments includes for each commitment:

- An objective.
- Details of the commitment.
- Reference to the applicable timing of the commitment (pre-construction, construction and/or post construction).
- Reference documents influencing the objectives and implementation of the commitment.

Should approval be granted by the Minister for Planning, approval conditions would pay regard to the final Statement of Commitments. The following definitions apply in relation to this draft Statement of Commitments:

- Pre-construction: Work in respect of the proposed upgrade that includes design, survey, acquisitions, fencing, investigative drilling or excavation, building/road dilapidation surveys, minor clearing (except where threatened species, populations or ecological communities would be affected), establishing ancillary facilities such as site compounds (in locations meeting the criteria identified in Section 7.5.1 of the Environmental Assessment), or other relevant activities determined to have minimal environmental impact (e.g. minor access roads).
- Construction: All work in respect of the proposed upgrade other than that defined as a pre-construction activity/work.
- Operation: The operation of the activity, but not including commissioning trials of equipment, or temporary use of parts of the proposed upgrade during construction.

Objective	Ref No.	Commitment	Timing	Reference Document
General environmental management				
Ensure the potential impacts of the project are managed	EM1	A construction environmental management plan (CEMP) will be prepared and implemented to guide project delivery.	Pre-construction and construction	> Department of Planning Guideline for the Preparation of Environmental Management Plans. > RTA QA Specification G36, Section 4.1.1
	EM2	Operational environmental management measures will be implemented, as appropriate, to manage impacts during operation of the project (see commitments below).	Operation	
Communication and consultation				
Ensure effective consultation with the community	C1	The community will be informed through various media as to the proposed works schedules, areas in which these works are proposed and construction hours. Contact names and phone numbers of relevant staff will be provided.	Pre-construction and construction	> RTA Community Involvement Practice Notes and Resource Manual (RTA 1998)
	C2	The existing project website will be maintained, including periodic updates of work progress, consultation activities and proposed work schedules. The website will provide a description of relevant approval authorities and their area of responsibilities, and contact names and phone numbers of relevant staff.	Pre-construction and construction	> RTA Community Involvement Practice Notes and Resource Manual (RTA 1998)
Ensure effective management of complaints	C3	The existing 24-hour toll free project phone line will be maintained and advertised.	Pre-construction and construction	> RTA Community Involvement Practice Notes and Resource Manual (RTA 1998) > AS 4269 Complaints Handling

Objective	Ref No.	Commitment	Timing	Reference Document
Communication and consultation				
	C4	A system to receive, record, track and respond to complaints within a specified timeframe will be established, including procedures for non-compliance.	Pre-construction and construction	> RTA Community Involvement Practice Notes and Resource Manual (RTA 1998) > AS 4269 Complaints Handling
Maintain pro-active consultation with directly affected property owners.	C5	Property owners will be consulted about the implementation of mitigation measures that affect their property and any issues raised will be considered where reasonable and feasible.	Pre-construction and construction	> RTA Community Involvement Practice Notes and Resource Manual (RTA 1998)
Land use and property				
Provide appropriate level of compensation in relation to property acquisitions	L1	All property acquisitions will be negotiated with affected landholders in accordance with relevant legislation and RTA policy.	Pre-construction	> Land Acquisition (Just Terms Compensation) Act 1991 > RTA Land Acquisition Policy (RTA 1999)
Manage potential impacts on structures or properties due to construction or operation of the project	L2	Subject to land owner agreement and following appropriate notification, building and property condition surveys will be conducted on those structures or properties that may be affected. Owners of structures or properties will be given a copy of the inspection report prior to the commencement of construction. Where liable, any property damage caused directly or indirectly by the project's construction or operation will be rectified at no cost to the property owner(s). Alternatively, the RTA may negotiate compensation for the property damage with the property owner.	Pre-construction and construction	> RTA QA Specification G36AS 4349.1 Inspection of Buildings > ISO 4866 Mechanical Vibration and Shock – Vibration of Buildings – Guidelines for the Management of Vibrations and Evaluation of their Effects on Buildings

Objective	Ref No.	Commitment	Timing	Reference Document
Land use and property				
Promote appropriate final land uses on land subject to partial or full acquisition	L3	A remnant land strategy to minimise land use severance and sterilisation, and a mitigation strategy for final land uses will be implemented in consultation with Ballina and Byron Councils and in general accordance with the principles described in Section 14.4 of the Environmental Assessment.	Pre-construction and construction	> Land Acquisition (Just Terms Compensation) Act 1991 > RTA Land Acquisition Policy (RTA 1999)
Construction noise and vibration				
Limit construction noise impacts on sensitive receivers, and where reasonable and feasible, comply with relevant standards to reduce noise to an acceptable level.	CN1	Reasonable and feasible mitigation that seeks to achieve the construction noise objectives detailed in the Environmental Noise Control Manual (EPA 1994) will be developed and implemented during construction and will include measures in Commitments CN2 to CN8.	Pre-construction and construction	> Environmental Noise Control Manual (EPA 1994) > AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites
	CN2	Construction hours will normally be limited to between 7am and 6pm Monday to Friday and between 7am and 1pm Saturday. These works will only be undertaken after informing affected residents and consulting with the DECC and relevant local council(s).	Construction	> Protection of the Environment Operations Act 1997 > RTA Environmental Noise Management Manual (RTA 2001)
	CN3	Consultation with potentially affected residents will be undertaken with regard to the timing of noise generating activities.	Pre-construction and construction	> RTA Community Involvement Practice Notes and Resource Handling (RTA 1998)
	CN4	Operational noise controls will be installed early in the construction phase, where reasonable and feasible, to assist in the management of construction noise.	Construction	

Objective	Ref No.	Commitment	Timing	Reference Document
Construction noise and vibration				
	CN5	All mechanical equipment and silencing equipment (where installed) will be well maintained.	Construction	> AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites
	CN6	Equipment not in use will be switched off to avoid unnecessary noise emissions.	Construction	
	CN7	Concurrent operation of noisy equipment will be avoided, as far as reasonable and feasible.	Construction	
	CN8	Construction noise will be monitored at sensitive receivers including during potentially high risk noise activities. The monitoring data will be analysed to determine compliance with the construction noise objectives and approval and/or licence requirements. Any necessary adaptive management requirements will be identified and implemented where reasonable and feasible.	Construction	> RTA Environmental Noise Management Manual (2001) > NSW Industrial Noise Policy (EPA 1999)
Limit construction vibration impacts on sensitive receivers and, where reasonable and feasible, comply with relevant standards to reduce vibration levels to an acceptable level.	CN9	Reasonable and feasible mitigation that seeks to achieve construction vibration criteria will be developed and implemented and will include measures in Commitments CN10 and CN11.	Pre-construction and construction	> Assessing vibration: A Technical Guideline (DEC 2006) > Environmental Assessment - Section 15.1.4
	CN10	Vibration monitoring and construction equipment testing will be undertaken at representative locations to ensure that vibration levels do not exceed applicable criteria. Any necessary adaptive management requirements will be identified and implemented where reasonable and feasible.	Construction	> Assessing vibration: A Technical Guideline (DEC 2006) > Working Paper 8 – Noise and Vibration Assessment

Objective	Ref No.	Commitment	Timing	Reference Document
Construction noise and vibration				
	CN11	Consultation with potentially affected residents will be undertaken with regard to activities that are likely to produce high levels of vibration.	Pre-construction and construction	> RTA Community Involvement Practice Notes and Resource Handling (RTA 1998)
Limit impacts on sensitive receivers associated with blasting activities during construction and, where reasonable and feasible, comply with relevant standard to reduce airblast overpressure and vibration levels to an acceptable level.	CN12	Air blast overpressure and vibration will be measured from test blasts to establish appropriate propagation characteristics for the site and increase the accuracy of blasting predictions.	Construction	> Assessing vibration: A Technical Guideline (DEC 2006) > Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC 1990)
	CN13	Reasonable and feasible mitigation that seeks to achieve airblast overpressure and vibration criteria will be developed and implemented.	Pre-construction and construction	> Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC 1990) > Working Paper 8 – Noise and Vibration Assessment
	CN14	Blasting vibrations and air blast overpressure will be monitored during construction. Any necessary adaptive management requirements will be identified and implemented where reasonable and feasible.	Construction	

Objective	Ref No.	Commitment	Timing	Reference Document
Operation noise and vibration				
Limit operational noise impacts experienced at sensitive receivers and, where reasonable and feasible, comply with relevant standards to reduce noise levels to an acceptable level.	ON1	Operational noise mitigation measures will be designed and implemented to achieve applicable road traffic noise criteria where reasonable and feasible.	Pre-construction, construction and operation	> RTA Environmental Noise Management Manual (RTA 2001) > Environmental Criteria for Road Traffic Noise (EPA 1999)
Determine effectiveness of operational noise control measures	ON2	The design and implementation of operational noise mitigation measures will be undertaken in consultation with potentially affected residents	Pre-construction, construction and operation	> RTA Environmental Noise Management Manual (RTA 2001) > Environmental Criteria for Road Traffic Noise (EPA 1999)
	ON3	Monitoring of operational noise will be undertaken within one year of the opening of the proposed upgrade. Should the monitoring indicate that traffic noise levels exceed those predicted for the proposed upgrade, additional measures will be investigated and implemented where reasonable and feasible.	Operation	> RTA Environmental Noise Management Manual (RTA 2001) > Environmental Criteria for Road Traffic Noise (EPA 1999)
Traffic, transport and access				
Manage construction traffic impacts on local roads	T1	Pre- and post-operation road condition reports will be undertaken for local roads likely to be used during construction. Any damage, beyond normal wear and tear, will be repaired at no cost to relevant road authorities unless an alternative arrangement is agreed between the RTA and the relevant road authority.	Pre-construction operation	

Objective	Ref No.	Commitment	Timing	Reference Document
Traffic, transport and access				
	T2	> Construction vehicle movements, work programs and traffic control measures will be planned to maintain a balanced traffic flow. This will be achieved by: > avoiding or minimising traffic impacts during peak periods, long weekends and holiday periods. > considering other road works in the area and local traffic movements. > consulting with relevant road authorities. > providing prior communication of changes to traffic conditions to the affected community.	Pre-construction and construction	
Manage and limit disruption of property access during construction and operation	T3	Access to properties will be maintained during construction, and where necessary temporary alternative arrangements will be provided in consultation with the property owner.	Construction	> RTA Traffic Control at Work Sites > RTA QA Specification G10 Control of Traffic
	T4	Where any legal access would be permanently affected by the project, alternative access to an appropriate standard will be provided where feasible and reasonable in consultation with the property owner. Where alternative access arrangements are not feasible or reasonable and a property is left with no access, negotiations will be undertaken with the property owner for the acquisition of the property.	Pre-construction	> RTA Traffic Control at Work Sites > RTA QA Specification G10 Control of Traffic > Land Acquisition (Just Terms Compensation) Act 1991 > RTA Land Acquisition Policy (RTA 1999)

Objective	Ref No.	Commitment	Timing	Reference Document
Visual amenity				
Integrate the proposed upgrade into the surrounding landscape, minimise impacts from sensitive viewpoints, and maximise the quality of vehicle user experience.	V1	Undertake detailed design and construction to be consistent with the landscape and urban design strategy described in Section 5.15 and 18.4 of the Environmental Assessment.	Pre-construction and construction	> Urban and Regional Design Practice Notes, Beyond the Pavement (RTA 1999) > Pacific Highway Urban Design Framework (RTA 2005) > Working paper 11 – Urban Design, Landscape and Visual Assessment.
Integrate the proposed upgrade into the surrounding landscape, minimise impacts from sensitive viewpoints, and maximise the quality of vehicle user experience.	V1	Undertake detailed design and construction to be consistent with the landscape and urban design strategy described in Section 5.15 and 18.4 of the Environmental Assessment.	Pre-construction and construction	> Urban and Regional Design Practice Notes, Beyond the Pavement (RTA 1999) > Pacific Highway Urban Design Framework (RTA 2005) > Working paper 11 – Urban Design, Landscape and Visual Assessment.
Heritage				
Minimise impacts to Indigenous heritage	H1	Detailed design will minimise impact to the identified Aboriginal heritage items wherever reasonable and feasible.	Pre-construction	
	H2	Construction plans will show all identified Aboriginal heritage items within the construction corridor that will not be directly impacted by construction.	Pre-construction and construction	
	H3	Any identified Aboriginal heritage items in the construction corridor not directly impacted by construction will be fenced prior to any adjacent works and where appropriate, will be signposted.	Pre-construction and construction	

Objective	Ref No.	Commitment	Timing	Reference Document
Heritage				
	H4	Construction personnel will be educated on their obligations for Aboriginal cultural materials under the National Parks and Wildlife Act 1979.	Construction	> Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC 2005) > RTA Aboriginal Liaison Protocol Aboriginal cultural heritage: standards and guidelines kit (DECC) > Protecting Aboriginal objects and places - interim guidelines for community consultation (DECC) National Parks & Wildlife Act 1979
	H5	In the event that human remains are encountered during construction, management measures referred to in Section 16.4 of the Environmental Assessment will be followed. The need for and function of this protocol will be included in site induction programs.	Construction	> Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC 2005) > RTA Aboriginal Liaison Protocol Aboriginal cultural heritage: standards and guidelines kit (DECC) > Protecting Aboriginal objects and places - interim guidelines for community consultation (DECC) National Parks & Wildlife Act 1979 > Working Paper 9 - Cultural heritage assessment

Objective	Ref No.	Commitment	Timing	Reference Document
Heritage				
	H6	In the event that Aboriginal objects (other than human remains) are encountered during construction in areas outside of previously recorded Aboriginal sites or potential archaeological deposits, the protocol referred to in Section 16.4 will be followed. The need for and function of this protocol will be included within site induction programs.	Construction	> Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC 2005) > RTA Aboriginal Liaison Protocol Aboriginal cultural heritage: standards and guidelines kit (DECC) > Protecting Aboriginal objects and places - interim guidelines for community consultation (DECC) National Parks & Wildlife Act 1979
Ensure ongoing Aboriginal stakeholder input to address potential impacts on Indigenous heritage items, areas, object and landscapes	H7	The registered Aboriginal stakeholders and the DECC will be consulted in the management and mitigation of impact to Aboriginal heritage including: > mitigation of impact to identified Aboriginal heritage items > the procedures to be followed if unknown Aboriginal heritage items are encountered during construction; and > the inclusion of identified Aboriginal heritage items in maintenance documents for use during operation.	Pre-construction and construction	> Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC 2005) > RTA Aboriginal Liaison Protocol Aboriginal cultural heritage: standards and guidelines kit (DECC) > Protecting Aboriginal objects and places - interim guidelines for community consultation (DECC) National Parks & Wildlife Act 1979
Minimise impacts to non-Indigenous heritage	H8	Detailed design will minimise impact to the identified non-Aboriginal heritage items wherever reasonable and feasible.	Pre-construction	

Objective	Ref No.	Commitment	Timing	Reference Document
Heritage				
	H9	If any previously unidentified non-Aboriginal heritage are encountered, all works that would potentially impact the item and/or its curtilage will cease immediately. The DECC and the RTA Senior Environmental Officer will be notified immediately and specialist advice will be sought if required. Works will not recommence until appropriate clearance has been received.	Pre-construction and construction	
Social and economic				
Minimise social impacts during construction and operation of the proposed upgrade.	S1	In addition to the commitments identified in this table under noise, air quality and visual which relate to social impacts, the following specific commitment will also be met: The location of ancillary construction facilities will take into account the proximity of residences.	Pre-construction	
Minimise economic impacts during construction and operation	S2	Ongoing consultation with potentially affected businesses will occur prior to and during construction to address individual concerns and issues and to identify any adaptive management requirements.	Pre-construction and construction	
	S3	Adequate signage will be implemented during construction and operation to ensure businesses and their patrons are aware of new access routes and/or potential disruptions.	Construction and operation	> Guidelines for Tourist Signage (RTA 2005)

Objective	Ref No.	Commitment	Timing	Reference Document
Surface water quality				
Minimise impacts to downstream surface water quality.	W1	Development and implement water quality control measures during construction including (but not limited to): Minimising disturbed areas. Construction of sediment basins as early as practical and feasible. Using sediment fences, check dams, level spreaders and other devices to supplement sediment basins. Implementing landscape treatments (or temporary cover crops) as early as practical and feasible.	Pre-construction and construction	> RTA QA Specification G38 Soil and Water Management. > RTA Code of Practice for Water Management (1999) > RTA Stockpile Management Procedures 2001 > Soils and Construction: Managing Urban Stormwater (Landcom 2004) > Managing Urban Stormwater – Soils and Construction Volume 2D – Main Road Construction (DECC – draft)
	W2	A specialist soil conservation consultant will be engaged during detailed design to assist in the development of erosion and sediment control measures and during construction to implement and improve measures.	Pre-construction	> Managing Urban Stormwater – Soils and Construction Volume 2D – Main Road Construction (DECC – draft)
	W3	A water quality monitoring program will be developed and implemented during construction.	Pre-construction and construction	> Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000
	W4	Ongoing communication will be maintained with Rous Water, with water quality monitoring results being made available.	Pre-construction, construction and operation	

Objective	Ref No.	Commitment	Timing	Reference Document
Surface water quality				
	W5	The water quality of discharges from the road reserve into the Emigrant Creek dam catchment will be monitored during operation to ensure that water quality meets the criteria discussed in Chapter 10 of the Environmental Assessment. Reasonable and feasible adjustments to water quality management during operation will be made if water quality management measures do not perform to these criteria	Operation	> Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 > Soils and Construction: Managing Urban Stormwater (Landcom 2004) > Managing Urban Stormwater – Soils and Construction Volume 2D – Main Road Construction (DECC – draft)
Groundwater				
Minimise impacts to groundwater flows during construction and operation	G1	Groundwater monitoring bores will be installed at an appropriate location downstream of cuttings predicted to impact on groundwater flows. Monitoring will be undertaken during construction and for one year of operation.	Pre-construction, Construction and operation	
	G2	If any essential water supply to any properties is affected, reasonable and feasible mitigation will be implemented in consultation with the relevant property owner(s).	Construction and operation	
Flora and fauna				
Minimise the impacts of vegetation clearance and habitat loss	F1	Detailed design will minimise the area of native vegetation to be cleared wherever reasonable and feasible.	Pre-construction	

Objective	Ref No.	Commitment	Timing	Reference Document
Flora and fauna				
	F2	Construction plans will show ecologically sensitive areas within the construction corridor that will not be impacted by construction. Where clearing is required, the area will be fenced with highly visible temporary fencing or flagging tape to ensure that clearing does not extend beyond the area necessary.	Pre-construction and construction	
	F3	Known locations of threatened plants will be avoided where possible and fenced to protect them from direct and indirect impact.	Construction	
	F4	Clearing of vegetation will comply with appropriate RTA guidelines in relation to fauna rescues.	Construction	> RTA Pacific Highway Office guidelines for fauna rescue associated with roadworks.
	F5	Where alternative locations exist, nest boxes will be used to replace any removed tree hollows. Such a program will be developed in consultation with DECC.	Construction	
	F6	Riparian restoration will be undertaken where creeklines occur on land that is acquired as part of the proposed upgrade, but that would be outside the construction footprint.	Pre-construction and construction	
Minimise edge effects on adjacent vegetation	F7	Ancillary construction facilities will be sited away from areas of adjacent native vegetation.	Construction	
	F8	Waste material during construction will be stored away from adjacent native vegetation	Construction	
	F9	Weeds will be managed in the road reserve both during construction and operation.	Construction and operation	
	F10	Locally indigenous species will be used in landscape treatments.	Construction	

Objective	Ref No.	Commitment	Timing	Reference Document
Flora and fauna				
Minimise habitat fragmentation, barrier effects, and road mortality	F11	Detailed bridge design and associated landscape treatment and revegetation will take into account terrestrial fauna movement opportunities along riparian corridors.	Pre-construction and construction	
	F12	The road reserve will be fenced at strategic points (primarily near creek crossings), to encourage wildlife movement beneath the highway.	Construction and operation	
Minimise impacts on aquatic habitat	F13	Waterway crossings will be designed and constructed to maintain fish passage in accordance with the fish habitat classification of each waterway and in consultation with the Department of Primary Industries (Fisheries).	Pre-construction and construction	> Fishnote: Policy and Guidelines for Fish Friendly Waterway Crossings (NSW Fisheries). > Policy and Guidelines for Design and Construction of Bridges, Roads, Causeways, Culverts and Similar Structures (NSW Fisheries 1999). > Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge 2003).

Objective	Ref No.	Commitment	Timing	Reference Document
Air quality				
Minimise air quality impacts during construction	A1	Dust suppression and avoidance during construction will include the following measures: Minimise exposure of soils Where needed, stockpiles, work areas and exposed soils will be dampened to prevent the emission of dust from the site or areas kept in a condition which minimises wind blown or traffic generated dust using other means. All equipment for dust control will be kept in good operating condition. Silt will be removed from behind filter fences and other erosion control structures on a regular basis, so that collected silt did not become a source of dust; and Remove construction dirt from adjacent roads.	Pre-construction and construction	> Department of Environment and Climate Change Guideline Approved Methods for Sampling and Analysis of Air Pollutants in New South Wales.
	A2	Dust generating activities will cease during high wind and when existing dust suppression methods are ineffective.	Construction	
	A3	Dust deposition and particulate monitoring will be undertaken during construction at sensitive receivers. Adaptive management measures will be undertaken where necessary and where reasonable and feasible.	Construction	> AS 3580.10.1-1991 Methods of Sampling Analysis of Ambient Air. > DECC Guideline Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales. > AS 2922 Ambient Air Guide for Siting of Sampling Equipment.

Objective	Ref No.	Commitment	Timing	Reference Document
Greenhouse gases and energy use				
Minimise greenhouse gas emissions during construction and operation	G1	During detailed design, opportunities will be identified to reduce operational greenhouse gas emissions and energy consumption wherever reasonable and feasible. Opportunities may include improvements to grade and road alignment, use of renewable energy technologies, use of energy efficient pavements and use of energy efficient street lights.	Pre-construction	
	G2	Energy efficient vehicles, plant and equipment (including office equipment) will be selected wherever reasonable and feasible.	Pre-construction and construction	
	G3	All vehicles and equipment will be maintained and serviced to meet the manufacturers' specifications.	Construction	
	G4	Low emission fuels will be used wherever reasonable and feasible.	Construction	
	G5	Where available, a renewable energy source accredited by the Green Power Accreditation Program and/or photovoltaic panels will be used for on-site electrical energy.	Construction	

Objective	Ref No.	Commitment	Timing	Reference Document
Waste				
Minimise and manage the production and impacts of waste during construction	WS1	The waste hierarchy (avoid/resource recovery/disposal) will be maximised during construction and will be incorporated into work programs and site inductions.	Pre-construction and construction	> Waste Avoidance and Resource Recovery Act 2001 Waste Avoidance and Resource Recovery Strategy (Department of Environment and Conservation 2006) > NSW Government's Waste Reduction and Purchasing Policy Environmental Guidelines > Assessment, Classification and Management of Liquid and Non Liquid Waste (EPA 1999)
	WS2	A waste register will be maintained, detailing types of waste collected, amounts, date/time and details of disposal.		
	WS3	Regular visual inspections to ensure work sites are kept tidy and to identify opportunities for reuse/ recycling.		
	WS4	Disposal of chemical, fuel and lubricant containers and solid and liquid wastes will occur in accordance with the requirements of the DECC.		> Assessment, Classification and Management of Liquid and Non Liquid Waste (EPA 1999)
	WS5	The reuse of materials will be maximised.		