Tintenbar to Ewingsdale

Upgrading the Pacific Highway

ROUTE OPTIONS DEVELOPMENT REPORT
OCTOBER 2005

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Tintenbar to Ewingsdale Pacific Highway Upgrade

Route Options Development Report

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Executive Summary

E1. Completing the Upgrade of the Pacific Highway

The identification of all remaining route options to upgrade the Pacific Highway between the F3 Freeway and Tweed Heads is a key step in moves to complete the upgrade of the highway.

With the $2.2 billion Pacific Highway Upgrade Program in place since 1996 almost 230 kilometres of the highway are now double-lane divided road. A further 225 kilometres of new highway have been approved for construction or have had a preferred upgrade route identified.

Five projects have been announced in October 2005:

- F3 Freeway to Raymond Terrace
- Oxley Highway to Kempsey
- Woolgoolga to Wells Crossing
- Wells Crossing to Iluka Road
- Tintenbar to Ewingsdale.

This is the final group of five projects which are proceeding to the route selection phase in October 2005. These five projects, along with the sections Macksville to Urunga and Woodburn to Ballina, will provide preferred routes for the final 230 kilometres of the highway. This will provide planning certainty for local communities and pave the way for a construction program to complete the upgrade of the Pacific Highway.

Another three projects will involve upgrading the highway along the existing alignment:

- Iluka Road to Woodburn
- Failford Road to Tritton Road
- Herons Creek to Stills Road.

Concept plans are currently being prepared for these projects. The expansion of the existing highway to dual carriageway facility is being discussed with the adjacent communities.

Beyond 2006

The RTA is planning for the long term by providing a high standard road, described as a motorway. A key feature involves being able to separate local traffic from through or long distance traffic.

This means roads that provide a lower speed alternative are located alongside the motorway that is designed for a speed of 110 km/h. Local traffic can get onto the motorway at regular grade separated interchanges.

Figure E1 Typical Cross Section

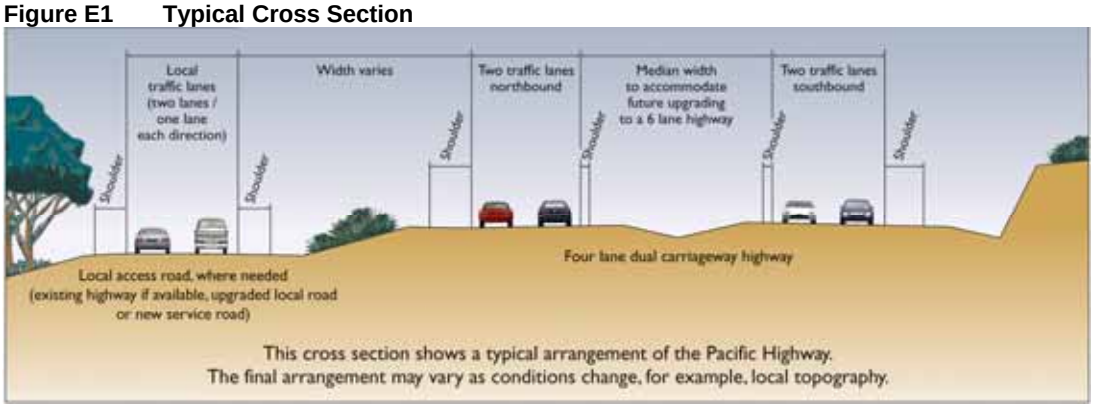
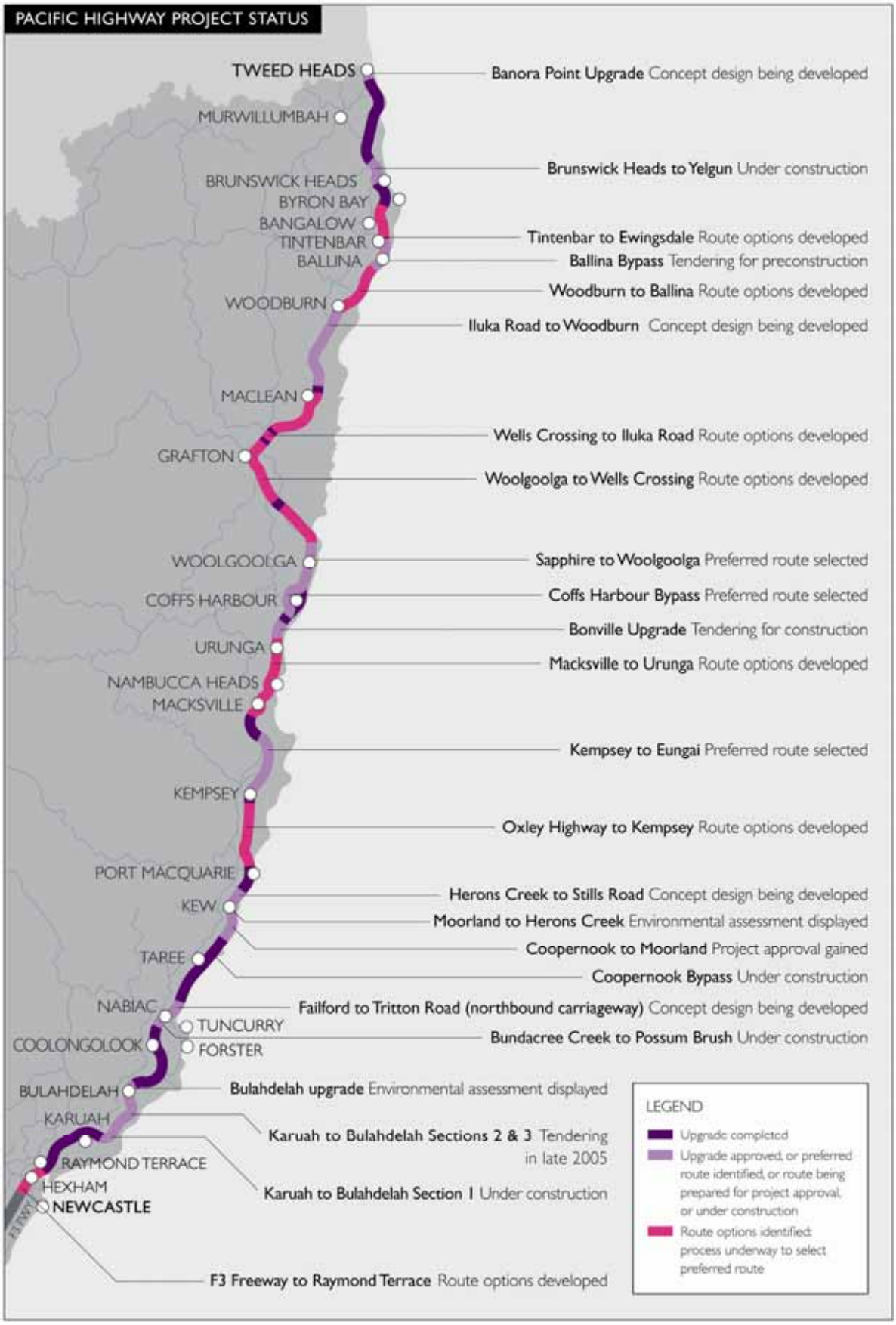


Figure E2 Pacific Highway Project Status



E2. Tintenbar to Ewingsdale

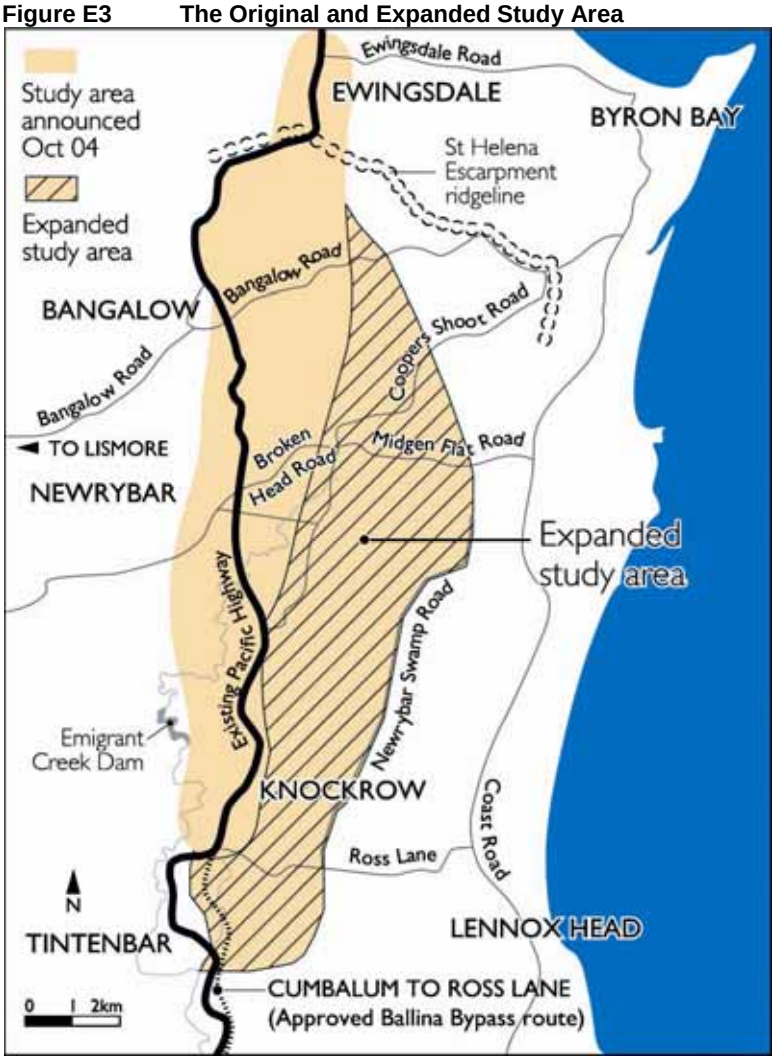
This report addresses the proposed upgrade of the Pacific Highway between Tintenbar and Ewingsdale. This upgrade would link the proposed Ballina Bypass (from Sandy Flat Road) to the existing dual carriageway at Ewingsdale, a distance of approximately 23 km along the existing highway.

In response to concerns raised by individuals, communities, community groups and agencies regarding the extent of the original study area for the project, the RTA initiated a desktop study to identify the feasibility of potential highway corridors outside the original study area. Based on the outcomes of this study, the RTA decided to expand the study area. The expanded study area was publicly announced in April 2005. The boundaries of the expanded study area are:

- South to North: Sandy Flat Creek Road, just south of Tintenbar, north to the Ewingsdale residential area, a distance of approximately 23 km along the existing highway.
- West: generally 0.5 km west of the existing Pacific Highway.
- East: Newrybar Swamp Road in the coastal flats, then up the coastal escarpment.

Both the original study area and the expanded study area are illustrated in **Figure E3**.

Figure E3 The Original and Expanded Study Area



E3. Road Design and Upgrade Strategies

Design standards for the Pacific Highway Upgrade Program require two lanes in each direction, with consideration for the future addition of another lane each way, separated by a median of a desirable width of 12 metres. Traffic volume projections have been prepared for 20 years from 2016.

Two highway upgrade strategies are being considered:

- Class A – two lanes in each direction, 100 km/h posted speed, limited access condition roadway with at grade intersections.
- Class M – two or three lanes in each direction, 110 km/h posted speed, controlled access condition roadway with grade separated interchange access.

The ultimate arrangement of grade separated interchanges and local access roads cannot be accurately determined prior to selection of the preferred route and the preferred upgrade strategy. This may result in further impacts and benefits beyond those considered in this report.

E4. Route Option Development Process

The route option development process involved the following steps:

- Review of existing data.
- Site visits – road and aerial inspections of the study area.
- Preliminary ecological, heritage, traffic, geotechnical and other investigations.
- A variety of community involvement activities to identify community interests, issues and concerns.
- Opportunities and constraints workshops.
- Options workshop to consider possible options.
- Identification and refinement of the feasible route options.
- Preparation of the Route Options Development Report.

The route options display provides the community with an opportunity to comment on the route options.

E5. Community Involvement

A comprehensive community and stakeholder involvement program has been established for this project. Community involvement is undertaken during key stages of the project to ensure that relevant stakeholder views and information can be incorporated into the decision making processes. In particular, community involvement has been sought during the project familiarisation phase and the route options development and assessment phase. To date, the following methods have been used to engage the community:

- Community Information Sessions.
- Establishment of a website, Freecall number, email, and Freepost.
- Community Updates, and progress updates in local media.
- Project Team attendance at community meetings.
- Establishment of a Community Liaison Group and an Agricultural Focus Group.
- Property owner meetings and direct contact.
- Corridor Assessment Workshop.

The community has provided a wealth of local knowledge that has been reviewed and considered by the Project Team. Community submissions were received by email, fax and the Freecall line, as well as through individual property visits and meetings. These submissions were collected and analysed holistically to achieve an understanding of the important issues.

A Community Liaison Group (CLG) was formed with an original group of 30 members, and then re-formed to ensure the group was representative of the expanded study area. The CLG has been committed to providing input to the route development and selection process. The members attended extra meetings, requested and reviewed additional information on a variety of technical topics, and subsequently submitted extensive comments on project objectives, constraints, evaluation criteria, and the development of route options in the study area. Representatives of the CLG attended the Corridor Assessment Workshop. Additionally, Agricultural Focus Group members played a key role in highlighting the issues associated with agriculture and land use.

Government and Other Stakeholder Involvement

Information was also sought from government agency representatives, regional and local organisations and other stakeholders at project commencement and other key stages of the project.

Relevant government agencies/organisations were invited to attend the Planning Focus Meetings in November 2004 and February 2005 and the Corridor Assessment Workshop in August 2005.

All stakeholders were invited to provide input into the assessment process for the project. The Sieve 1 evaluation criteria and performance measures (used to assess the long list of route options) were developed and refined in consultation with agencies and the community through the CLG.

The public display of the short list of route options and related information sessions are integral to the community involvement program for the project. The purpose of the display is to obtain feedback (from the community and other stakeholders) to assist in the selection of a preferred route. As a result of this feedback, further engineering and environmental investigations will be undertaken. Additionally, the Sieve 1 criteria will be refined after the display period is finished. The refined criteria, referred to as Sieve 2 criteria, will be used to evaluate the short list of options.

E6. Study Area Characteristics

Traffic and Transport Issues

With the exception of the Bangalow Bypass and the Ewingsdale Interchange, the Pacific Highway between Tintenbar and Ewingsdale is a single carriageway roadway, generally with one lane in each direction. Overtaking lanes are provided at intermittent locations along the length. The existing posted speed limit on this section of the highway is 100 km/h from Tintenbar to St Helena, followed by an 80 km/h zone traversing St Helena Hill (currently posted 60km/h due to recent accidents). A significant length of this section of the highway has sub-standard geometry and many speed warning signs are posted along its length.

Traffic count data from 2004 indicate that the current two-way Annual Average Daily Vehicle (AADV) volume is in the order of 16,500 vehicles north of Bangalow, and 11,500 vehicles south of Bangalow. The proportion of heavy vehicles that comprise these volumes on a typical day are in the order of 2,100 vehicles (14%) north of Bangalow, and 2,000 vehicles (16%) south of Bangalow. Traffic volumes on the highway are expected to increase due to:

- Population increases regionally, in urban centres (such as Ballina, Bangalow and Byron Bay) and in residential release areas in and around the study area.
- Traffic diverted from other routes as various sections of the Pacific Highway are improved.

- Traffic generated as a result of reduced travel distances, travel times and travel costs (particularly as a result of the opening of new projects towards Queensland).

The consequences of no action or deferral of the highway project would be deteriorating traffic and safety conditions on the existing highway and intersections. With no improvements, predicted traffic growth would increasingly expose the deficiencies of the existing road environment. The following aspects of the highway would be specifically affected:

- The existing accident rate would increase above the current level of 39 reported accidents per 100 Million Vehicle Kilometres (MVK) travelled.
- The number and frequency of serious accidents at the St Helena Hill accident blackspot would increase.
- Capacity and safety problems at the major intersections within the study area would increase.

In addition to the specific area needs identified, the project is required to meet the NSW Government's overall objective of fully upgrading the Pacific Highway to dual carriageway from Hexham to the Queensland border. The upgrade will provide additional capacity in an area with continued traffic growth, and will join other completed and planned projects to form a consistent length of dual carriageway.

Accident History

An accident analysis has been undertaken and is based on accident history for the 5-year period from January 1999 to December 2003 between Ross Lane and the Ewingsdale Interchange. During this period a total of 128 accidents were recorded along this section of the Pacific Highway, excluding the length of the highway between Sandy Flat Road and Ross Lane at the southern end of the study area. The accidents included 10 fatalities, 48 injuries, and 70 accidents not resulting in injury but where a vehicle was towed away.

When compared with the annual average daily traffic volumes within the study area, the accidents represent accident rates of 62 accidents per 100 MVK travelled north of Bangalow, 27 accidents per 100 MVK south of Bangalow, or an average of 39 accidents per 100 MVK for the study area. This rate is above average state-wide accident rates for a rural 2-lane undivided road of 32.8 accidents per 100 MVK, and well above the RTA's Pacific Highway target of 15 accidents per 100 MVK.

E7. Route Options

Planning and Design Process

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 following route options stages:

Preliminary Investigations

The mapping and reporting of environmental and design constraints in the study area was the starting point in the identification of potential corridors for upgrading the highway. The preliminary assessment 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 and Ballina Shire Council Local Environmental Plans (LEPs).
- Site walkover surveys and field investigations.
- Community and agency consultation.
- Technical modelling.

Development of Initial and Long List of Route Options

Using interactive computer modelling and constraints mapping, it was possible to investigate a large number of possible route options. To assist in the development of the initial route options and selection of the long list of options, the study area was divided into three zones as listed below:

- Tintenbar Zone: southern zone from the southern end of the study area to just north of Knockrow.
- Newrybar Zone: central zone of the study area from north of Knockrow to south of Bangalow.
- Bangalow Zone: northern zone of the study area from south of Bangalow to just north of Ewingsdale and the northern end of the study area.

A broad range of route options extending across the study area were investigated. 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 is made up of sections and there are between eight and ten sections in each of the zones. Locations where it is possible to cross from one section to another are referred to as ‘nodes’. Through the multiple combinations of the various sections, it is possible to develop over 200 route options from the long list (see **Figure E4).** The long list of route options selected for assessment included:

- Tintenbar Zone – 9 route options
- Newrybar Zone – 18 route options
- Bangalow Zone – 28 route options, rationalised to 12.

Assessment of Long List of Route Options and Selection of Short List

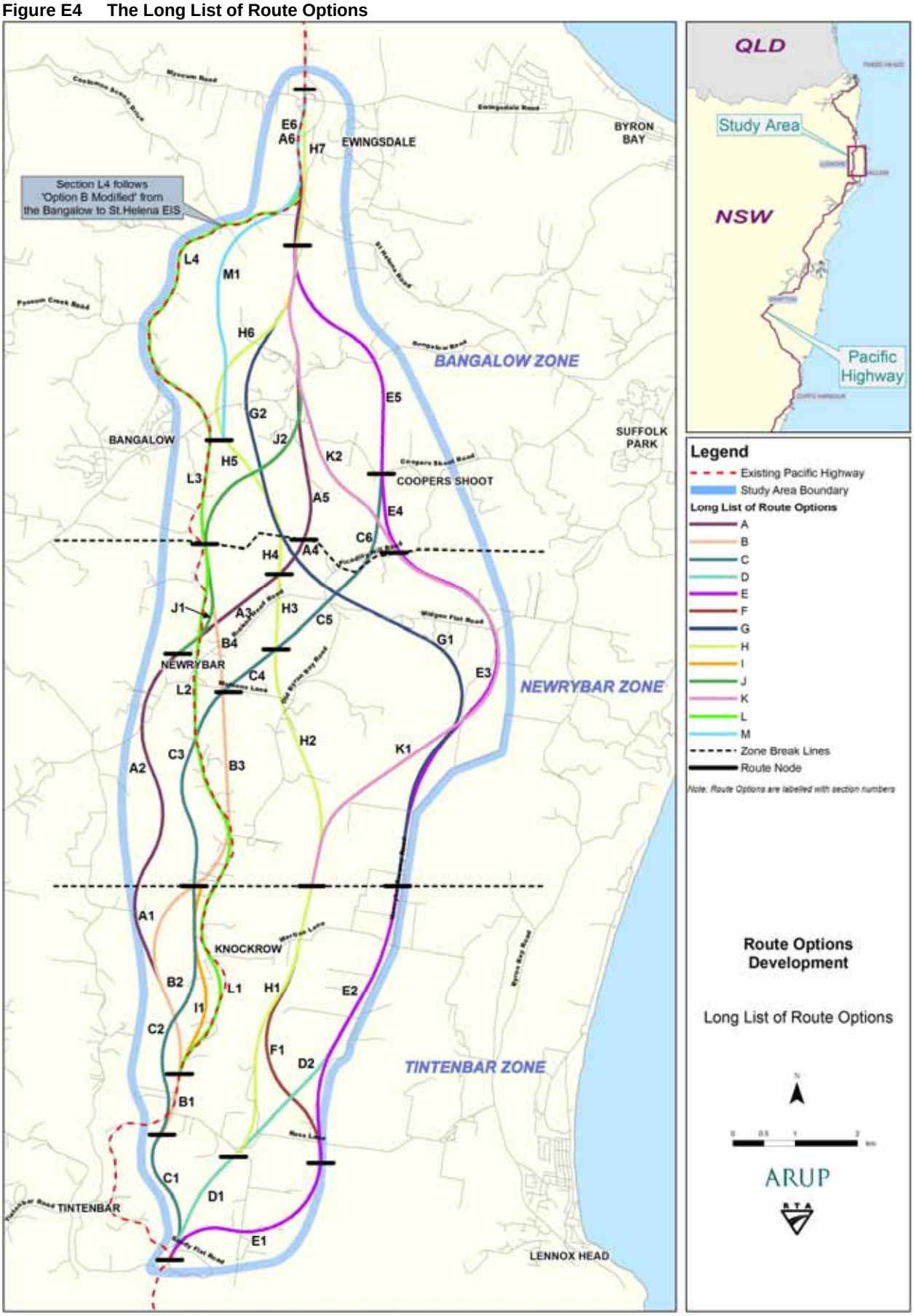
Methodology

The assessment of the long list of options is based on a generic corridor width of 250 m. This corridor width represents the area of investigation at this stage of the study and will be refined in later stages of the study to the actual road reserve width requirements.

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

- Assessment of the performance of each section against Sieve 1 evaluation criteria performance measures with the Project Team’s pairwise weightings used as the base case.
- Application of pairwise weightings from the CLG and government agencies to test sensitivity of performance of each option to the evaluation criteria performance measures. The pairwise process involves taking one evaluation criterion/measure at a time and selecting whether it is of more or less importance than every other criterion/measure.

Figure E4 The Long List of Route Options



By considering the various section combinations within each zone, the application of Sieve 1 evaluation criteria and the pairwise results allowed the long list of route options within each zone to be compared and the best performing route options within each zone to be identified. The better performing options from each zone were assessed both qualitatively and quantitatively to assist in shortlisting the route options. The objectives in the shortlisting process were to facilitate the identification of a short list of route options that achieved the following:

- Performed well overall.
- Resulted in at least two route options through each zone - but limited the number of shortlisted options (for example, by not shortlisting similar options through the same area where one option is clearly better than the other).

Because highly ranked sections from one zone may only connect to a poorly ranked section from an adjacent zone, the process of selection of the short list could not be carried out entirely on a zone-by-zone basis.

As the evaluation process proceeded, it was possible to develop a general grouping of better performing corridor options within each zone made up of the best performing sections. Those section combinations or route options which performed well within each zone were then reviewed to identify the better performing options within each zone that can also connect to a better performing option in an adjacent zone, ensuring that an option was not shortlisted if it could only be connected to a poor performing option in the adjacent zone(s). Similarly, a section combination which performs only moderately well in one zone may be shortlisted if it can be connected to better performing option(s) in the adjacent zone(s). The best performing combinations of sections within each zone were considered as potential components of the short list of options.

Tintenbar Zone

Of the nine options in this zone, five performed well while the remaining four underperformed by comparison. This conclusion can be drawn regardless of the weighting applied. There was little variation in rankings according to pairwise and the five better performers included all section combinations that ranked within the first four in at least one of the pairwise rankings. This approach deleted the worst options, but ensured that any options which performed reasonably well according to at least one of the three applied weightings were given further consideration.

Within the Tintenbar zone, three of the five better performing options have been selected for the short list. They include: Option C1-C2, which connects to good options in the Newrybar zone; Option D1-H1, which connects to options in the Newrybar zone that perform well; and plateau Option C1-B1-B2. Option C1-B1-B2 has the advantage of allowing utilisation of the full length of the approved Ballina Bypass alignment (including the Ross Lane interchange) and also utilises significant portions of the existing highway corridor.

Newrybar Zone

Determination of the short list of options within the Newrybar zone was more difficult because of the number of options (18) and the fact that there were significant variations in ranking depending on the pairwise applied. The selection process was assisted by reference to the shortlisted options in adjacent sections.

Four options in the Newrybar zone were shortlisted. Plateau Option C3-B4 was selected as it performs well and connects to good options in both the Tintenbar and Bangalow zones. It was also considered desirable to carry forward a second plateau option. There were two similar performing possibilities, both of which connected to good options in the Tintenbar and Bangalow zones. The option selected, Option L2, generally follows the existing highway corridor and allows a full assessment of the on-line upgrade option (the option following the existing Pacific Highway where possible).

The decision on which coastal plain option(s) to shortlist was made by referring to the performance of connecting options in adjacent zones. The two options on the coastal plain selected were Option H2-H3-A4 and Option K1. There are some geotechnical issues where Option H2-H3-A4 climbs the side of the escarpment, and inclusion of the other coastal plain option (Option K1) ensures that an alternative coastal plain option is available.

Bangalow Zone

The Bangalow zone long list included three alignments that utilise a tunnel through St Helena Hill. Due to the similarity in selection criteria ratings of these sections, one tunnel option was initially chosen as a typical alignment for the tunnel and tunnel approaches, rationalising the 28 options into the 12 options for assessment purposes. Of the seven better performing options in the Bangalow zone, four have been selected for the short list.

There was remarkable consistency in the ranking of options within this zone with little variation when different weightings were applied. Options A5-E6 and K2-E6 were better performing options and were shortlisted.

The next options assessed were the three which commence at the Newrybar/Bangalow zone boundary where it crosses the existing highway. Option L3-H6-E6 follows the existing Bangalow bypass before diverting east up the Tinderbox Creek valley to the tunnel, Option J2-E6 passes through the Tinderbox Road saddle before connecting to the tunnel approach, while Option L3-M1 connects onto the old Bangalow to St Helena EIS Option F avoiding the need for a tunnel. The first two options ranked higher and performed appreciably better than Option L3-M1, despite having a higher cost than the non-tunnel option. The two tunnel options were therefore shortlisted.

A separate assessment was carried out for the three northern tunnel approach options to determine which option(s) should be shortlisted. Assessment of the three tunnel approaches in the Bangalow zone has been based on Option A5. Using this section as the common approach, the Sieve 1 evaluation process and pairwise were applied to three northern approach options. Of the three northern approach options, Options E6 and A6 retain the 900 m of existing duplication that climbs at a 6% grade south from the Ewingsdale interchange, connecting to the south end of this duplication. At this point the grade can either reduce to 1.8% then increase to 4.4% as it climbs to the tunnel portal (Option E6), or maintain a steady 3% grade from the south end of the existing duplication (Option A6). The third tunnel approach option (Option H7) would involve reconstruction all the way from the Ewingsdale Interchange at a flatter 4.4% grade, on an alignment slightly closer to Ewingsdale.

The result of applying the evaluation criteria and pairwise to the three northern approaches to the tunnel does not identify any major differences between the three options. It is proposed to shortlist Option E6 with the intention of reviewing the vertical geometry during the refinement of the shortlisted options in the next stage of design development.

Even though Option H7 is slightly closer to Ewingsdale, it is proposed that this option also be shortlisted as the flatter grades would have the potential to reduce noise levels from southbound climbing vehicles as well as reducing compression braking for northbound trucks, and it would allow the existing highway to be retained for local traffic.

Option B Modified from Bangalow to St Helena Environmental Impact Statement (EIS)

The Bangalow to St Helena EIS was placed on public exhibition in 1999. The preferred route in the EIS, referred to as Option B, generally followed the existing Pacific Highway. Northern Pacific Highway Noise Taskforce recommendations (RTA 2003a) were the catalyst for further review of Option B. Additionally, *the Bangalow to St Helena Pacific Highway Upgrade Submissions Report*, *Volumes 1 and 2* (RTA 2004) outlined concerns of the preferred route. Thus, Option B Modified has been assessed as part of this report.

The assessment results show that the two option combinations incorporating the section of the Pacific Highway referred to as Option B Modified (Section L4) were rated lowest of the Bangalow zone options regardless of the weighting applied. Particular issues which contributed to the relatively poor ranking of options incorporating Section L4 were:

- It does not meet the highway design criteria established for the upgrade. In particular the design speed of 80 km/h and the sustained 8% grade on the escarpment are considerably below the adopted design standard and would be inconsistent with the standards of adjoining sections of the highway.
- It would force local traffic to share the upgraded highway, as it would not be possible to retain the existing highway as a separate road for local traffic usage. Intermediate interchanges would be required at Possum Creek Road and at Fowlers Lane/Coolamon Scenic Drive, in addition to the existing interchange providing access to Bangalow. The design would also include an at-grade intersection at St Helena Road. The additional interchanges and the greater mixing of local and through traffic with this option would be inconsistent with the standards of adjoining sections of the highway.
- It would be between 1.2 km and 1.8 km longer than other shortlisted route options, adding to travel times for all users.
- It would require acquisition of a greater number of dwellings.
- It performed poorly in terms of noise impacts.
- It crosses more wildlife corridors than other options.

For these reasons neither of the two Bangalow options incorporating Section L4 (Option B Modified) was included in the best performing Bangalow zone options taken forward for further consideration, and neither option made the short list of options.

Summary of Short List of Route Options

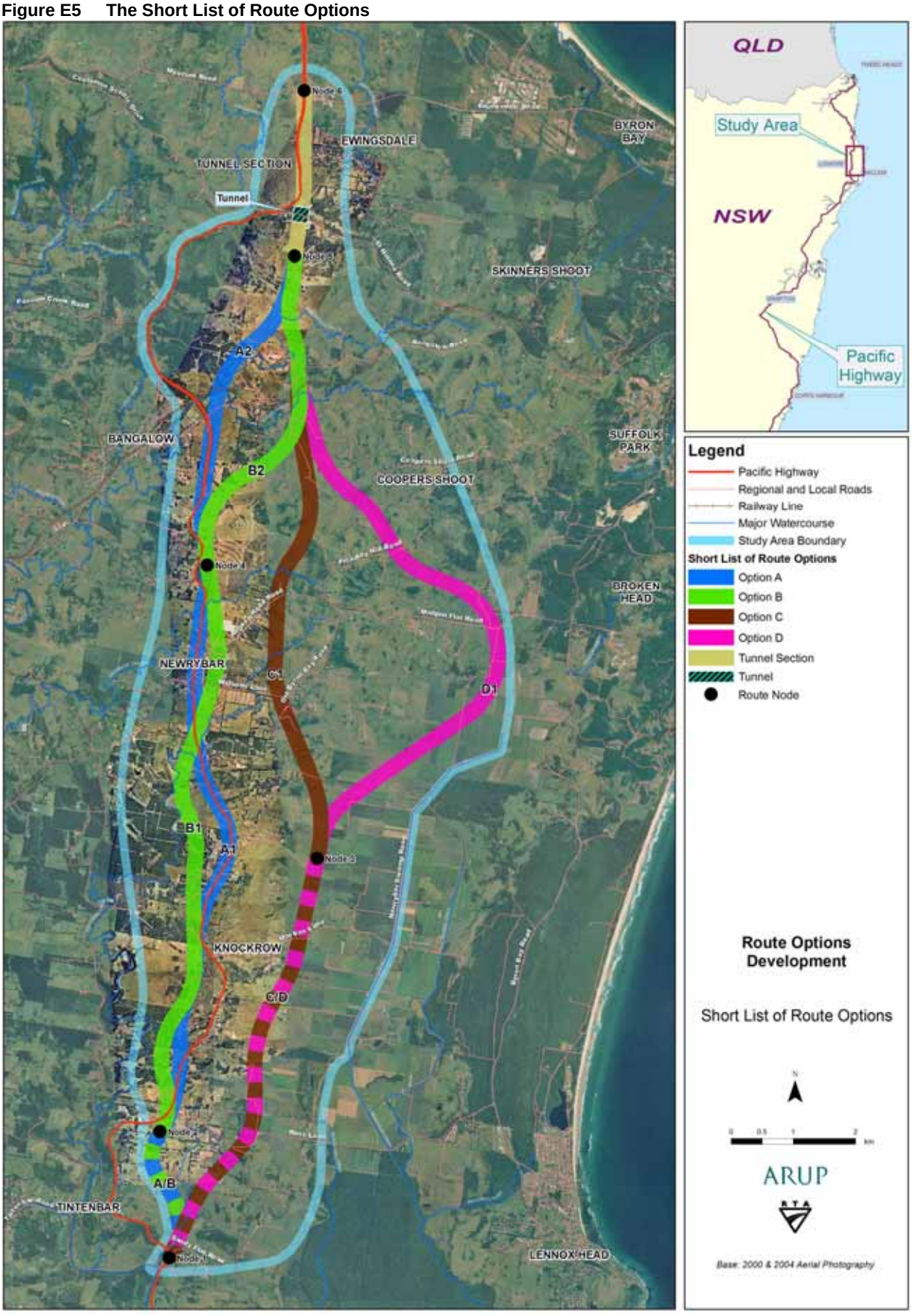
The shortlisted options were renamed Option A, Option B, Option C and Option D to simplify the identification of the options for public display and further assessment. The shortlisted options are shown in **Figure E5**. Option A incorporates an upgrade generally following the existing highway corridor, Option B is a plateau option in an entirely new corridor, and Options C and D are partly located on the eastern coastal plain.

The key design features of the short list of options are provided below:

Option A

- Plateau option that incorporates a tunnel under St Helena Hill.
- Alignment uses the approved Ballina Bypass, from Sandy Flat Road to Ross Lane.
- This alignment most closely follows the existing Pacific Highway with almost 10 km of existing road reserves being utilised.
- This alignment also uses the 9(a) zoning near Bangalow and the Bangalow Bypass.
- This option requires the construction of more extensive local access roads and would have high impacts on service relocations and acquisition of buildings.
- This option crosses four major creeks.

Figure E5 The Short List of Route Options



Option B

- Plateau option that incorporates a tunnel under St Helena Hill.
- Alignment uses most of the approved Ballina Bypass, from Sandy Flat Road to Ross Lane.
- This alignment partly utilises the 9(a) zoning near Bangalow.
- This option uses about 5 km of existing road reserve.
- This option is slightly west of the existing Pacific Highway in the south and then switches to be slightly east of the existing highway north of Newrybar.
- This option crosses four major creeks.

Option C

- Coastal plain option that incorporates a tunnel under St Helena Hill.
- This option stays close to the foothills of the escarpment and then gradually climbs the escarpment by traversing the side slope.
- This option traverses an area of geological instability as it climbs the side slope of the escarpment.
- This option crosses some flood prone land and areas.
- This option has a high impact on state significant farmland and severance of currently contiguous settlements, including those along Broken Head Road and Old Byron Bay Road.
- This option crosses four major creeks.

Option D

- Coastal plain option that incorporates a tunnel under St Helena Hill.
- This option stays close to the foothills of the escarpment prior to moving further east and climbing the escarpment via a ridge line.
- This option traverses through flood prone land and areas with potentially deep soft soils.
- This option is a longer route and is also close to the community of Coopers Shoot.
- This option crosses two major creeks.

Northern Tunnel Section

- A tunnel 200 to 300 m long under St Helena Hill.
- Two tunnel approach options were considered for this section of road on the north side of the tunnel. Approach Option T1 follows the existing road and has grades of 6%. Approach Option T2 is located up to 100 m east of the existing highway and has grades of about 4.5%.
- There are no material differences between the tunnels required for these options.
- The tables used in this report are generally based on Option T1 for ease of comparison over the full length.

A summary of the potential impacts of the short list of options is provided in **Table E1**.

Table E1 Summary of Potential Impacts of Short List

	Route Options (Note 1) A	B	C	D
Engineering Characteristics				
Length (m)	19,792	20,152	19,721	22,049
Approximate length of tunnel (m)	200-300	200-300	200-300	200-300
Length of major bridges - highway (m)	660	880	559	0
Length of major bridges - local (m)	345	457	340	268
Length of grades exceeding 4.5% (m)	3,443	2,145	890	890
Comparative travel time for heavy vehicles (minutes)	14.9	14.8	15.1	15.0
Number of horizontal curves with radius less than minimum (750m)	1	1	0	0
Number of horizontal curves with radius less than desirable (750m-1200m)	6	4	1	1
Length (km) of route that utilises existing road reserve	9.9	4.9	2.2	2.2
Length (km) through potentially fog prone areas	7.1	5.9	10.1	14.6
Indicative Strategic Cost Estimate ($million)	400	410	400	385
Socio-Economic Characteristics				
Agriculture and Property				
Regionally Significant (DIPNR) Farmland affected (ha)	459	475	410	492
State Significant (DIPNR) Farmland affected (ha)	3	5	10	0
Agricultural land directly affected (ha)	380	428	403	484
Agricultural land indirectly affected (severance) (ha)	235	300	209	262
Number of dwellings acquired	73	34	25	20
Drinking Water Catchments - approximate length of route (m) through:				
Emigrant Creek Dam Catchment	4800	4000	1900	0
Proposed Lismore Water Source Catchment	7920	7670	6370	5970
Noise				
Absolute CNB (Note 2)	2216	1514	1168	922
Relative CNB (Note 3)	-252	-772	-1107	-1124
Visual				
Visual Sensitivity - approximate length of route (m) through:				
1. Coastal flats	0	0	3900	8400
2. Undulating hills and ridges with limited areas of mature vegetation	5400	6100	5900	5000
3. Enclosed valleys	2500	2400	2200	2300
4. Undulating hills and ridges with extended areas of mature vegetation	8000	8800	2000	600
5. Escarpment	3400	2100	5300	5600
6. Tunnel and approach cuttings	400	400	400	400
Visual Effect: approximate length of route (m) exposed to:				
1. Lower slopes and valleys on plateau	11700	12200	7500	6400
2. Exposed ridge lines with extensive vegetation cover	2700	2500	800	200
3. Coastal flats	0	0	3600	8100
4. Exposed ridge lines with limited vegetation cover	1700	2500	2000	1300
5. Escarpment	3200	2200	5200	5600
6. Tunnel and approach cuttings	400	400	400	400
Environmental Characteristics				
Terrestrial Ecology				
Number of patches of high value vegetation or habitat likely to be affected	16	20	25	25
Approximate area of high constraint vegetation crossed (ha)	16.5	18	23	17
Number of patches of medium value vegetation or habitat likely to be affected	6	6	4	7
Approximate area of medium constraint vegetation impacted (ha)	16	16.5	5.5	6.5
Number of 'edges' created through remnant and regenerated habitat areas	19	22	24	23
Number of times a regional wildlife corridor is crossed	1	1	1	1
Number of times a sub-regional wildlife a corridor is crossed	1	1	3	3
Number of recorded threatened species potentially affected	4	1	0	0
Aquatic Ecology				
Negligible or low constraint waterways crossed	27	37	51	51
Medium constraint waterways crossed	1	2	0	0
Hydrology				
Length through flood prone land (m)	870	870	5060	10230
Cultural Heritage				
Number of medium value non-Indigenous sites directly affected	1	0	0	0
Areas of potential archaeological deposits directly affected (ha)	0.4	3.7	3.6	2.8

Notes:

1. Potential impacts assessment based on tunnel Option T1 at the northern end.
2. Absolute Community Noise Burdon (CNB) is a quantitative evaluation of potential annoyance caused by absolute traffic noise levels on residential receivers up to 300-500 m from a route option. Larger numbers imply a greater potential noise impact.
3. Relative Community Noise Burdon (CNB) is a quantitative evaluation of potential annoyance caused by change in noise levels at residential receivers up to 300-500m from a route option. Larger numbers imply a greater potential noise impact, in this case -252 represents a greater noise impact than -1124.

E8. Next Steps

The project is being developed in a way that is both ecologically sustainable and achieves the best overall outcome for the whole community. The RTA recognises the importance of addressing social, ecological, engineering and cost factors while continuing to provide for future transport needs. Most importantly, dual carriageway roads and fewer highway connections will result in a safer road environment.

A preferred route has not been selected at this stage.

A preferred route will be selected by considering:

- The community's issues and comments on the route options.
- Information on the physical impact of each of these routes, in relation to economic, urban design, ecological, engineering and community issues.
- A value management process which will include a workshop. This workshop will be held with participants from the community, government and technical areas. The workshop will assess the performance of each of the route options against a range of agreed criteria.

Four route options have been identified for further consideration and assessment (see **Figure E5**). Community response to these options is an important part of selecting a preferred route. The route options will be on display for approximately four weeks.

As the route options can be linked together in different ways, there are decisions to be made about a preferred route. The community is being invited to consider each of the options and combinations and provide comments on the reply paid feedback form included with the community update (the feedback form is also available on-line). Community feedback will be integrated into the value management workshop.

Investigation of the four shortlisted route options will continue in preparation for the value management process.

A value management workshop will be held to consider the full range of issues and constraints to locating a highway route. Following refinement of the preferred route, the concept design and environmental assessment phases would commence.

Community involvement will continue. A community liaison group, updates in the local media, newsletters, meetings with individuals and groups, and a project website will continue to keep the community informed and assist community input.

1 Introduction

1.1 About the Project

The NSW Roads and Traffic Authority (RTA) has engaged Arup to undertake route option investigations, environmental assessments, and concept development for the proposed upgrade of the Pacific Highway between Tintenbar and Ewingsdale. This upgrade is part of the overall Pacific Highway Upgrading Program and would link the northern end of the approved Ballina Bypass to the existing dual carriageway at Ewingsdale. The route selection process documented in this report addresses route option investigations and assessments, and identifies a short list of route options.

Previous reports that addressed portions of the Pacific Highway being considered in the Tintenbar to Ewingsdale Upgrade include the Bangalow to St Helena Environmental Impact Statement (EIS) and the Ballina Bypass EIS.

The Bangalow to St Helena EIS was placed on public exhibition in 1999. The preferred route in the EIS, referred to as Option B, generally followed the existing highway. Northern Pacific Highway Noise Taskforce recommendations (RTA 2003a) were the catalyst for further review of Option B. Additionally, *the Bangalow to St Helena Pacific Highway Upgrade Submissions Report, Volumes 1 and 2* (RTA 2004a) outlined concerns of the preferred route. Thus, Option B Modified has been assessed as part of this report.

The Ballina Bypass EIS was placed on public exhibition in 1998. Planning approval has been received for the Ballina Bypass and the project is under development. Preparatory works have commenced on some sections of the Ballina Bypass, further geotechnical investigations and property negotiations are continuing.

The Tintenbar to Ewingsdale Upgrade project is required to meet the NSW Government's overall objective of fully upgrading the Pacific Highway to dual carriageway from Hexham to the Queensland border as shown in **Figure 1.1**.

Figure 1.1 Pacific Highway Upgrade Project

1.2 Study Area

1.2.1 Original Study Area

The Tintenbar to Ewingsdale project commenced in October 2004 with the announcement of the original study area as shown in **Figure 1.2**. Following publication of the original study area and the November 2004 Community Information Sessions, individuals, communities, community groups and agencies raised concerns regarding the extent of the study area. In response to these concerns, the RTA initiated a desktop study to identify the feasibility of potential highway corridors outside of the original study area. Based on the outcomes of this study, the RTA decided to expand the study area. The process that led to the decision to expand the study area is shown in **Figure 1.3**.

1.2.2 Revised Study Area

The expanded study area shown in **Figure 1.2** was publicly announced in April 2005. The boundaries of the expanded study area are:

- South to North: Sandy Flat Creek Road, just south of Tintenbar, north to the Ewingsdale residential area, a distance of approximately 23 km following the existing Pacific Highway.
- West: generally 0.5 km west of the existing Pacific Highway.
- East: Newrybar Swamp Road in the coastal flats, then up the coastal escarpment.

Figure 1.2 Original and Expanded Study Area

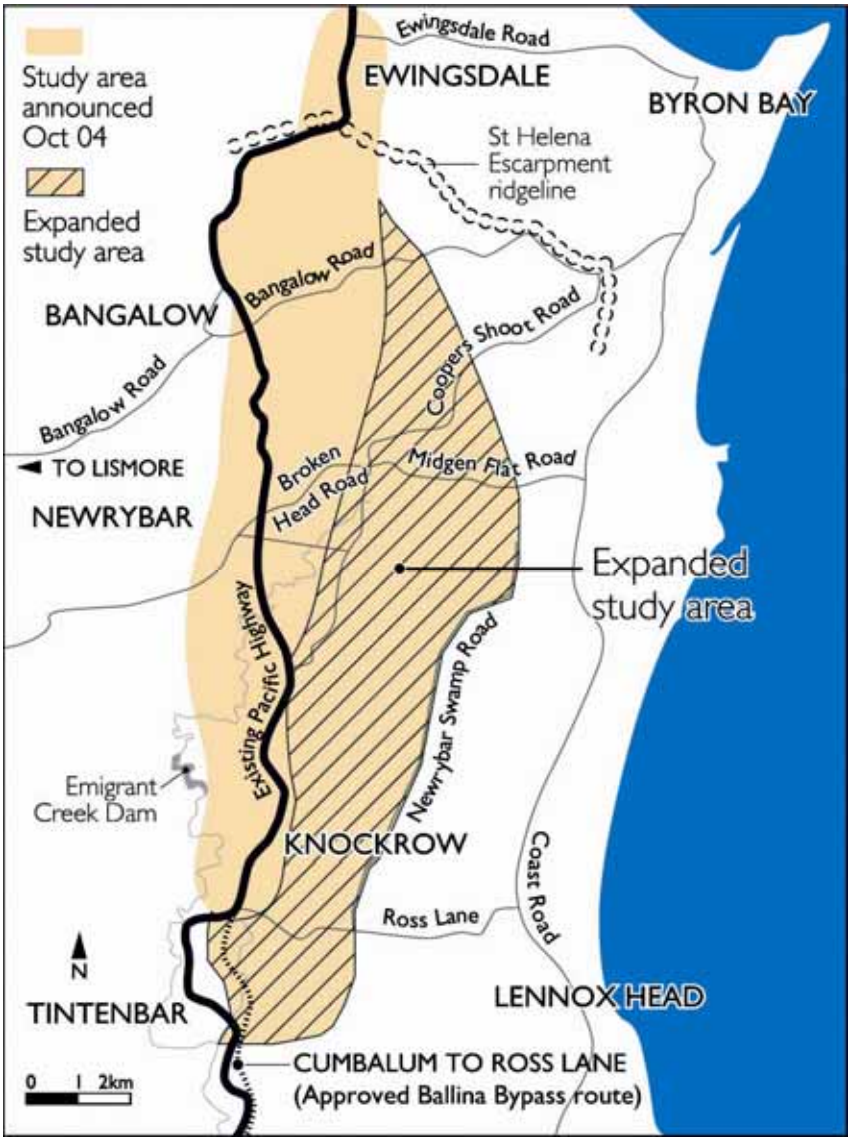


Figure 1.3 Decision Process to Expand Study Area

1.2.3 Existing Pacific Highway

The Pacific Highway is the main road transport corridor serving the North Coast of New South Wales and a major highway link between Sydney and Brisbane. The highway carries significant traffic volumes, especially during the holiday periods.

The Tintenbar to Ewingsdale section of the highway is largely a two-lane, two-way single carriageway with sections of overtaking lanes. In some sections, the highway alignment (both horizontal and vertical) does not meet existing RTA standards (see **Section 3.2.5)**.

1.2.4 Ecologically Sustainable Development (ESD)

Sustainability principles outlined in both NSW and Commonwealth legislation will be considered in the upgrading of the Pacific Highway. The NSW *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) includes the following principles*:*

Schedule 2 of the EP&A Regulation defines the principles of ESD as:

a) the precautionary principle—namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. 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.

b) inter-generational equity—namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

c) conservation of biological diversity and ecological integrity—namely that conservation of biological diversity and ecological integrity should be a fundamental consideration.

d) improved valuation, pricing and incentive mechanisms—namely, that 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 and abatement,

ii) the users of goods and services should pay prices based on the full life cycle 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.

ESD is given further definition and planning impetus through the *Byron Local Environmental Plan* (Byron Shire Council 1988, as amended). The Plan has as its aim to promote sustainable development within Byron Shire.

Application of ESD principles began in the early stages of the project through the identification of highway development constraints in the study area. These constraints guided the development of route options and the selection of the short list of options. Social, environmental and design evaluation criteria used in the project also reflect the ESD principles outlined above. ESD principles will be re-visited during the assessment of the short list of options following the Route Options Display and in any environmental assessments conducted for the preferred route.

2 Approach to Route Selection

2.1 Planning and Design Process

Route options for the Pacific Highway upgrade were developed through an iterative process involving a range of environmental and urban design, engineering, community, safety and cost considerations structured around the following route option stages:

The framework for the assessment of the Tintenbar to Ewingsdale Pacific Highway Upgrade includes the following key elements:

- Program and project objectives.
- Constraints analysis.
- Long list of options.
- Sieve 1 evaluation criteria.
- Corridor Assessment Workshop.
- Pairwise comparison of evaluation criteria.
- Public display of short list of route options.
- Value management assessment of short list of route options.
- Assessment of community submissions from public display.
- Sieve 2 evaluation criteria and recommendation of preferred route.
- Selection of preferred route.
- Refinement and public display of preferred route.
- Preparation of concept design and Environmental Assessment of the preferred route.

The process for the development and assessment of route options as well as the relationship of project phases to key reports and workshops is shown in **Figure 2.1** and described in **Sections 2.1.1** and **2.1.2.** The process incorporates consultation with the community, government agencies, and other stakeholders to provide input into the process and feedback from studies and investigations. Consultation activities associated with the project to date are described in **Section 2.2.**

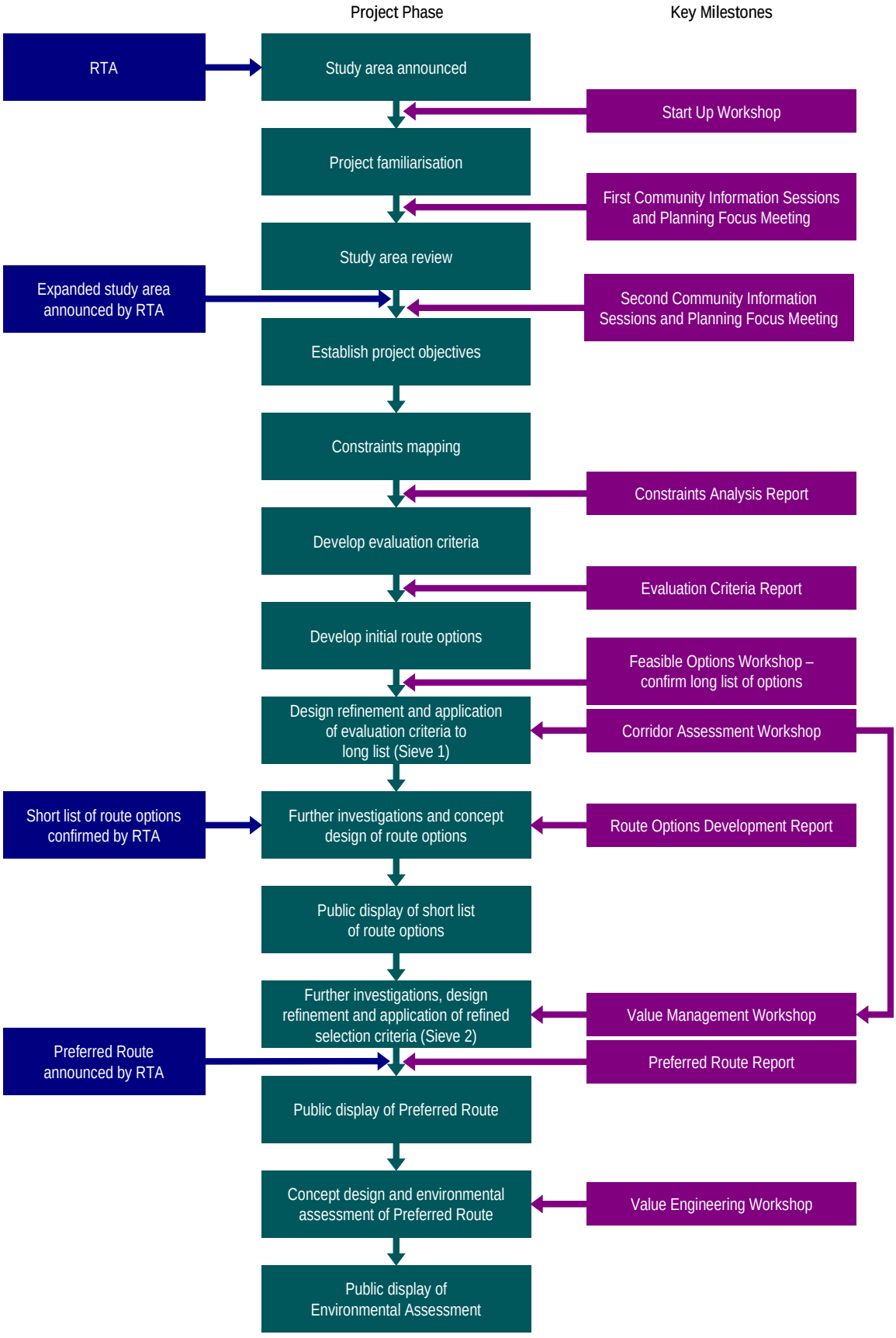
2.1.1 Development of Long List of Route Options

The mapping and reporting of environmental and design constraints in the study area was the starting point in the identification of potential corridors for upgrading the highway (see **Chapter 5** for details). Corridor development began with the modelling of possible alignments. Using interactive computer modelling and constraints mapping, it was possible to investigate a large number of possible corridors.

A broad range of corridor options extending across the study area was investigated. Corridors were progressively adjusted to avoid as many constraints as possible while still achieving the design criteria and maintaining project objectives and functionality.

Following this preliminary development and refinement of route corridors, a Project Team Feasible Options Workshop was held and initial route corridors were reviewed to identify the weaker performing options; for example, those with unacceptable impacts that would be very difficult to build or would not conform to design criteria. These lower performing options were removed from further assessment or consideration and the outcome of the workshop was the establishment of a long list of potential route corridors for further investigation. A detailed explanation of the methodology used to develop and assess the long list of options is contained in **Chapter 7**.

Figure 2.1 Route Selection Process



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

- Step one – assess performance of each section and option against Sieve 1 evaluation criteria performance measures with the Project Team's pairwise weightings used as the base case.
- Step two – apply pairwise weightings from the CLG and government agencies to test sensitivity of project values.

The Sieve 1 evaluation criteria and performance measures are listed in **Appendix A**. The Sieve 1 criteria will be refined after the Display of Route Options is finalised. This refined criteria, referred to as Sieve 2 criteria, will be used to assess the short list of options.

The pairwise process is explained in **Section 7.3.**

2.1.2 Route Options Refinement

Following selection of the short list of options, the next step was a preliminary consideration of environmental impacts of each route option. Information about the short list of route options will be placed on public display in October 2005. The purpose of the display is to obtain feedback (from the community and other stakeholders) to assist in the selection of a preferred route. As a result of this feedback, further engineering and environmental investigations will be undertaken.

2.2 Community and Stakeholder Involvement

2.2.1 Community Involvement

A comprehensive community and stakeholder involvement program has been established for this project. The key objectives of community and stakeholder involvement are to:

- Ensure an open accountable and transparent community involvement process.
- Ensure all potentially affected property owners and interested stakeholders are provided with sufficient information about the project and the likely impacts so that they can provide informed input.
- Ensure appropriate and direct communication with property owners and/or managers in relation to access to and investigations on landholdings within the study area by Project Team members and/or RTA representatives.
- Encourage community support and involvement in the project to facilitate better and more generally accepted outcomes.
- Provide a range of accessible opportunities for stakeholders, interested groups and the wider public to contribute to the project through issues identification, information provision and options evaluation.
- Build an ongoing relationship between the RTA, its contractors, and stakeholders in order to gain long term support for the project, and in particular the Preferred Route.

Community involvement is undertaken during key stages of the project to ensure effective stakeholder involvement. The community involvement process for the project is outlined in **Table 2.1.**

The community provided a wealth of local knowledge that has been reviewed and considered by the Project Team. Community submissions were received by email, fax and the freecall line, as well as through individual property visits and meetings. These submissions were collected and analysed holistically to achieve an understanding of the impacts facing the local community.

A Community Liaison Group (CLG) was formed with an original group of 30 members, and then re-formed to include members of the community to represent the expanded study area. The CLG was committed to providing input to the route development and selection process. The members attended extra meetings, requested and reviewed additional information on a variety of technical topics, and

subsequently submitted extensive comments on both the overall project objectives as well as constraints and the evaluation criteria. Representatives of the CLG attended the Corridor Assessment Workshop.

In addition, Agricultural Focus Group (AFG) members played a key role in highlighting the issues associated with agriculture and land use, in relation to the identification of constraints, evaluation criteria and the development of corridor options in the study area.

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

Table 2.1 Community and Government Involvement Process

Project Stages	Communication Strategy Components
Project familiarisation	• Community Information Sessions. • Freecall number, email, Freepost establishment. • Website development. • Community Update No. 1. • Progress updates in local media. • Project Team attendance at community meetings. • Planning Focus Meeting. • Agency Requirements. • Community Liaison Group and Agricultural Focus Group set-up and initial meetings. • Property owner meetings and direct contact.
Route option assessment	• Community Update No. 2. • Route Options Display and information sessions. • Freecall number. • Planning Focus Meeting. • Community Liaison Group/Agricultural Focus Group meetings. • Progress updates in local media. • Project Team attendance at community meetings. • Corridor Assessment Workshop. • Property owner interviews and direct contact.
Route selection	• Community Update No. 3. • Preferred Route Display. • Community Liaison Group/Agricultural Focus Group meetings. • Property owner interviews and direct contact.

2.2.2 Government and Other Stakeholder Involvement

Information was sought for the project from government agency representatives, regional and local organisations and other stakeholders at project commencement and other key stages of the project.

Planning Focus Meetings were held in November 2004 and February 2005. A Corridor Assessment Workshop was held in August 2005. The following stakeholder groups were invited to attend the meetings and workshop: Ambulance Service of NSW; Australian Heritage Council; Australian Rail Track Corporation; Ballina Shire Council; Bangalow Public School; Bundjalung Elders Council; Burabi Aboriginal Corporation; Byron Shire Council; Byron Tweed Local Aboriginal Land Council; CLG members; Country Energy; Department of Commerce; Department of Education; Department of Environment and Conservation (DEC); Department of Environment and Heritage; Department of

Infrastructure, Planning and Natural Resources (DIPNR)[1]; Department of Primary Industries (DPI); Jali Local Aboriginal Land Council; Kirklands Coaches; National Parks and Wildlife Service (now part of DEC); Newrybar Public School; Northern Rivers Catchment Management Board; Northern Rivers Regional Development Board; NSW Police Force; NSW Rural Fire Service; NSW Sugar Mill Cooperative; Optus; Rail Infrastructure Corporation; Rous Water; Rural Lands Protection Board; State Emergency Service; Telstra; Transgrid; and Tweed Byron Local Aboriginal Council. Several of the groups invited did not attend the meetings and/or the workshop.

Additionally, a meeting with Aboriginal stakeholders took place. Aboriginal heritage constraints and establishment of an Aboriginal Focus Group were discussed. Future meetings of the Aboriginal Focus Group are planned to discuss the short list of options.

2.3 Community Values

Feedback from the community has been received via a range of methods, including community information sessions, the Community Liaison Group and briefings and meetings. This feedback has included general community concern, issues for consideration and recommendations for route option development. From this feedback, a number of key values have been identified as being important to the community. These include:

- The high quality of land for horticultural and agricultural use.
- The scenic quality within and surrounding the study area.
- The environmental quality of the area, including vegetation, wildlife and water quality.
- The proximity to major regional economic centres such as Byron Bay and Ballina.
- The spirit and connectedness of the local community.
- The general rural amenity of the area (i.e. quiet, clean, aesthetic) away from the highway.

These values were also identified at the Corridor Assessment Workshop.

[1] Note that DIPNR has recently separated into the Department of Planning (DoP) and the Department of Natural Resources (DoNR).

3 Planning and Transport Context

3.1 Planning Context

3.1.1 Overview

The NSW North Coast is experiencing rapid growth in population, urbanisation and tourism and has done so for some years. This is due to an attractive climate, the desire to experience a change in life-style opportunities and access to transport (air, rail and road) with links to major cities and regional centres. This growth has promoted increased economic activity and consequently affected the traditional agricultural base of the regional economy.

A similar population expansion is being experienced in south-eastern Queensland in the area between Brisbane and the NSW border. As a consequence of this growth the region is experiencing pressure on transport infrastructure, in particular the movement of freight by road transport, pressure on environmental amenity and quality, pressure on the communities in the region and economic pressures related to employment opportunities and commercial expansion opportunities.

3.1.2 The Sydney-Brisbane Corridor

The Pacific Highway corridor connects Sydney, Newcastle and Brisbane with a number of regional centres, major towns and villages. A number of these regional centres and major towns are located on the coast and inland on a number of major river systems flowing west to east to the Pacific Ocean. The proposal is shown in a regional context in **Figure 3.1.**

Figure 3.1 Regional Context of Proposal

The NSW and Queensland Governments and local government authorities are responsible for land use and transport planning within the corridor in accordance with established planning and environmental legislation, strategies and policies. Documents that have been published that identify the need for improved transport infrastructure within the corridor are:

- *NSW Hunter Regional Environmental Plan* (DoP 1989).
- *NSW North Coast Regional Environmental Plan* (DoP 1988).
- *South-East Queensland Regional Framework for Growth Management* (Queensland Department of Urban Management 1998).

- *Integrated Regional Transport Plan for South-East Queensland* (Queensland Transport 1997).
- *Transport 2007 – An Action Plan for South East Queensland* (Queensland Transport 2001).
- *Upgrading the Pacific Highway: Ten Year Pacific Highway Reconstruction Program Discussion Paper* (RTA 1997).
- *AusLink White Paper* (Australian Department of Transport and Regional Services 2004).

3.1.3 State Environmental Planning Policies

While a large number of the State Environmental Planning Policies (SEPPs) apply to both Ballina and Byron local government areas (LGAs), the SEPPs that are particularly relevant to the route selection and assessment of the proposed upgrading are as follows:

- **State Environmental Planning Policy No. 14 - Coastal Wetlands.** Designated SEPP 14 Coastal Wetlands occur within the two Council areas. SEPP 14 aims to ensure that coastal wetlands are preserved and protected in the environmental and economic interests of the State. Any part of a road proposal affecting a SEPP 14 wetland is classified as designated development and requires Council consent under Part 4 of the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act). The portion of the proposal classified as designated development under SEPP 14 requires the preparation of a Development Application accompanied by environmental assessment under Part 4 of the EP&A Act to be submitted to the relevant Council.
- **State Environmental Planning Policy No. 26 - Littoral Rainforests.** This SEPP protects littoral rainforests and requires that the likely effects of proposed development are considered in an Environmental Impact Statement (EIS). The policy applies to 'core' areas of littoral rainforest as well as a 100 m wide 'buffer' area surrounding these core areas, except for residential land and areas to which SEPP 14 applies.
- **State Environmental Planning Policy Major Projects** (gazetted 1 August 2005). This SEPP defines certain developments that are major projects under Part 3A of the EP&A Act and, as a result, are determined by the Minister for Planning.

3.1.4 North Coast Regional Environmental Plan

The *North Coast Regional Environmental Plan* (NCREP) (DoP 1988) established a regional framework for the development of the NSW North Coast Region. The *North Coast Urban Planning Strategy* (DoP 1995) provides a more detailed implementation framework based on the provisions of the NCREP.

3.1.5 Local Planning Context

3.1.5.1 Ballina Shire Council

The southern portion of the study area for project is located within Ballina Shire Council area. The Ballina Shire Council Local Environment Plan (LEP) is a performance based planning instrument which requires any development proposal to demonstrate that it is consistent with overall aims and objectives as well as any zone objectives.

Relevant zonings within Ballina Shire Council area are shown in **Figure 5.1** (Chapter 5) and listed in **Table 3.1**.

Table 3.1 Ballina LEP 1987 - Land Zoning within the Study Area

Zoning	Comment*
1(a1) Rural (Plateau Lands Agriculture)	Roads are not prohibited but require Council consent*
1(a2) Rural (Coastal Lands Agriculture)	Roads are not prohibited but require Council consent*
1(b) Rural (Secondary Agricultural Land)	Roads are not prohibited but require Council consent*
1(d) Rural (Urban Investigations)	Roads are not prohibited but require Council consent*
6(a) Open Space	Roads are not prohibited but require Council consent*
7(a) Environmental Protection (Wetlands)	Roads are not prohibited but require Council consent*
7(c) Environmental Protection (Water Catchment)	Roads are not prohibited but require Council consent*
7(d1) Environmental Protection (Newrybar Scenic/Escarpment)	Roads are not prohibited but require Council consent*
General – Existing Main and Arterial Roads	Roads are not prohibited and do not require Council consent

*Roads are permissible within all the zones in the study area, with development consent from Council. However, in accordance with SEPP 4 (Development Without Consent), development consent is not required for the carrying out of public infrastructure for 'classified' roads, even where development consent is required in the LEP (see **Figure 5.1**).

Heritage Items

Schedule 1 of Ballina LEP 1987 lists heritage items within the Council area (see **Section 5.11)**.

Urban Settlement Strategy, Cumbalum

An Urban Structure Plan for the Cumbalum Ridge area is currently being prepared by Ballina Shire Council. The purpose of the Structure Plan is to provide the framework for Ballina Shire Council's consideration of future rezoning requests within the broader 'urban investigation' area. It is intended that, once finalised, the Structure Plan will 'set the scene' for the scale of development which will occur, and broadly identify the distribution of neighbourhoods, open spaces, commercial facilities and identify the infrastructure needs of the area. A preliminary draft of this work has been provided to the RTA (see **Section 5.3.2**).

3.1.5.2 Byron Shire

The northern portion of the study area for the Tintenbar to Ewingsdale section of the proposed Pacific Highway upgrade is located within Byron Shire Council area. The Byron Council LEP requires any development proposal to demonstrate that it is consistent with overall aims and objectives as well as any zone objectives.

Relevant zonings within Byron Shire Council area are shown in **Figure 5.1** and listed in **Table 3.2.**

Table 3.2 Byron LEP 1988 – Land Zoning within the Study Area

Zoning	Comment*
1(a) General Rural Zone	Roads are not prohibited and do not require Council consent
1(b1) Agricultural Protection Zone	Roads are not prohibited and do not require Council consent
1(b2) Agricultural Protection Zone	Roads are not prohibited and do not require Council consent
1(c1) Small Holdings Zone	Roads are not prohibited and do not require Council consent
1(c2) Small Holdings Zone	Roads are not prohibited and do not require Council consent
1(d) Investigation Zone	Roads are not prohibited and do not require Council consent
5(a) Special Uses Zone	Roads are not prohibited and do not require Council consent
7(d) Scenic/Escarpment Zone	Roads are not prohibited but require Council consent*
8(a) National Parks and Nature Reserves	Roads are prohibited
9(a) Proposed Road Reserve	Roads are not prohibited and do not require Council consent

* Roads are permissible within all the zones in the study area with the exception of Zone 8A. Under clause 62 of the LEP consent is not required for the construction, reconstruction or relocation of any road by public authority except within zones 7 and 8. Further, in accordance with SEPP 4 (Development without Consent), development consent is not required for the carrying out of public infrastructure such as 'classified' roads; even where development consent is required in the LEP (see **Figure 5.1**)

Heritage Items

Schedule 1 of Byron LEP 1987 lists heritage items within the Council area (see **Section 5.11)**.

Byron Rural Settlement Strategy

In the Byron Rural Settlement Strategy, Byron Shire has identified an area known as Natural Lane for future rural residential development. This area is located to the north of Midgen Flat Road and below the escarpment in the vicinity of Granny Waterhouse Drive. It is currently zoned 1(a) and has the potential for 70 dwellings. Although the strategy is currently under review, the Council has the expectation that this land would be used for rural residential development in the future.

3.1.5.3 Northern Rivers Farmland Land Protection Project

The NSW State Government, through DoP and DoNR (formerly DIPNR) and DPI, has recognised the need to protect agricultural land particularly in those areas facing increasing development pressure. The Northern Rivers Farmland Protection Project has identified areas to be reserved for agricultural land to secure its future growth and development in the Northern Rivers area (see **Section 5.3.2**).

3.1.6 Approvals Process

3.1.6.1 Changes to the Environmental Planning and Assessment Act 1979

The NSW Parliament passed the *Environmental Planning and Assessment Amendment (Infrastructure and Other Planning Reform) Act 2005 No 43* on 16 June 2005. This amendment came into force on 1 August 2005.

The amendment introduces a new Part 3A to the EP&A Act to cover the assessment of major infrastructure development. This type of development was previously assessed under Part 4 and/or Part 5 of the EP&A Act.

3.1.6.2 Application of Part 3A of the EP&A Act to the Tintenbar to Ewingsdale Project

By an order gazetted on 29 July 2005, the Minister for Planning declared that Part 3A applies to all projects for which the proponent is also the determining authority and which otherwise would have required an EIS to be obtained under Part 5.

Within the meaning of Part 5 of the EP&A Act, the RTA is both the proponent and the determining authority for the Tintenbar to Ewingsdale Project. However, the RTA has not yet determined whether an EIS under Part 5 of the Act would be required for this Project, and will not make that decision until a preferred route is selected. It is therefore too early to say whether Part 3A would apply to this project.

If Part 3A does apply, the level of Environmental Assessment (EA) would be determined by the Director-General of Planning, who issues EA requirements after consultation with the relevant public authorities and local Councils. If Part 3A does not apply, the project would be assessed under Parts 4 or 5 of the EP&A Act.

3.1.6.3 Additional Planning Documents

The following additional Regional and Local Settlement Strategies and Policies are relevant to the study area:

- *Ballina Shire Urban Land Release Strategy* (Ballina Shire Council 2000).
- Development Control Plan No. 12: Newrybar Scenic Escarpment (Ballina Shire Council 2003).
- *Byron Bay and Suffolk Park Settlement Strategy* (Byron Shire Council 2002).
- Draft *Place-Based Plan for Ewingsdale* (Byron Shire Council 2003a).
- *Bangalow Settlement Strategy* (Byron Shire Council 2003b).
- *Byron Shire Community Profile* (Byron Shire Council 2003c).
- *Byron Shire Sustainable Agriculture Strategy* (Byron Shire Council 2004).
- EP&A 1979 Direction Under Section 117 (2) Interim Protection for Farmland of State and Regional Significance on the NSW Far North Coast (12 January 2004).

3.2 Transport Context

3.2.1 Regional Road Network

The Pacific Highway is a primary arterial road and the main transport corridor along the east coast of New South Wales (NSW). The Pacific Highway links Sydney with Brisbane via over a thousand kilometres of roadway and is a part of the AusLink network. It caters for interstate travel and transport between NSW and Queensland, as well as intra-state, regional and local travel. Through NSW, the Pacific Highway is approximately 700 km in length.

In a regional context, the highway provides access to Ballina, Byron Bay, and Lismore (via Bangalow Road).

3.2.2 Local Road Network

Locally, the existing highway travels adjacent to the townships of Tintenbar, Knockrow, Newrybar, Bangalow and Ewingsdale; also providing access to the communities of Fernleigh, Brooklet, Coopers Shoot, Skinners Shoot, Possum Creek and Coorabell via approximately 23 kilometres of roads.

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 along the length. The existing posted speed limit on this section of the highway is 100 km/h from Tintenbar to St Helena, followed by an 80 km/h zone traversing St Helena Hill (currently posted 60km/h for northbound traffic due to recent accidents). A significant length of this section of the highway has sub-standard geometry and many speed warning signs are posted along its length.

There are 30 at-grade intersections and 88 property driveways directly accessing the highway along the length of the study area. The highway also provides access to businesses and facilities including:

- Macadamia Castle.
- A café and general store (in Newrybar).
- Coffee and macadamia plantations.
- The village of Bangalow.
- A lookout at Coolamon Scenic Drive.
- A rest area and toilet facilities south of St Helena.

3.2.3 Existing Traffic Conditions

Historical traffic data has been collected from a number of sources. These include:

- Permanent and temporary traffic counting stations, maintained by the RTA.
- Additional traffic counts undertaken specifically for the Project.
- Origin and Destination surveys undertaken for the Project.

Traffic count data from 2004 indicate that the current two-way Annual Average Daily Vehicle (AADV) volume is in the order of 16,500 vehicles north of Bangalow, and 11,500 vehicles south of Bangalow. The proportion of heavy vehicles that comprise these volumes on a typical day are in the order of 2,100 vehicles (14%) north of Bangalow,, and 2,000 vehicles (16%) south of Bangalow.

The permanent traffic counter on the Pacific Highway at Knockrow (south of Bangalow – RTA site 04.060) provides information on the annual, weekly and daily traffic fluctuations on the highway. The 2004 Average Annual Traffic Volume at this location was in the order of 13,500 axle pairs or 11,500 vehicles.

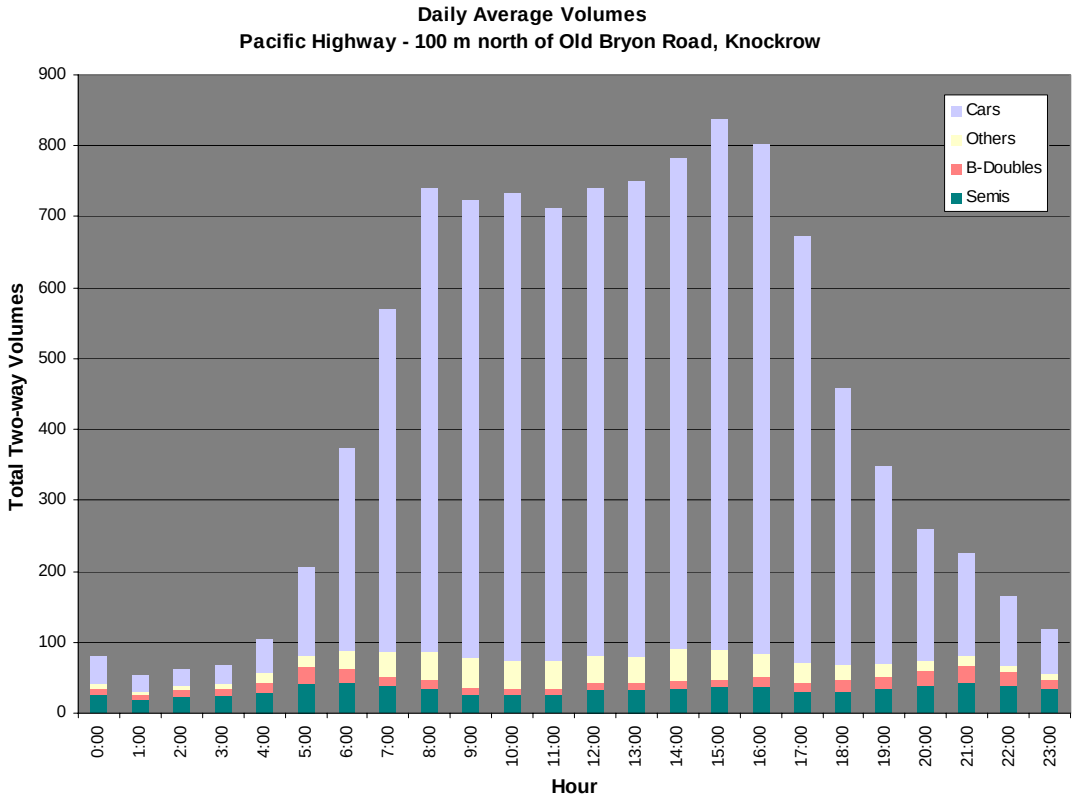
Traffic flows on the highway reach a peak during the major public holiday periods such as Easter, Christmas and school holiday times, with peak traffic volumes 50% to 100% greater than the average weekday volumes. The highest daily volume recorded (to date) was during the 2004 Easter period, on 8 April 2004, when in total 20327 axle pairs were recorded for the two directions. This value is around 50% higher than the Annual Average Daily Traffic and is consistent with other parts of the Pacific Highway affected by holiday traffic.

During the 30th Highest Hourly Volume for 2003 (the design hour), the Pacific Highway operates at Level of Service C between Tintenbar and Ewingsdale, suggesting relatively good traffic conditions for motorists. (Note: safety is not included in the measures that establish service levels).

In terms of vehicles per hour, weekday volumes are relatively consistent throughout the 8am to 5pm period, with minor peaks around 8-9am and 3-4pm, whilst at weekends traffic volumes are relatively consistent for the period 10am to 4pm. During counts on the Pacific Highway in November 2004, south of Bangalow, the average peak hour traffic volume (measured in vehicles) was 8.6% of the daily total for the weekend and 7.8% during the week. The data shows that, for non-holiday weekdays, traffic is relatively evenly spread throughout the day, without a major ‘commuter peak' that is evident in metropolitan regions.

Figure 3.2 shows the fluctuations in average traffic volumes throughout the day. This represents a combination of weekday and weekend traffic.

Figure 3.2 Average Hourly Traffic Volumes on the Pacific Highway



3.2.4 Origin and Destination Surveys

Surveys were conducted to gain an understanding of local traffic movements and connections on the Pacific Highway within the study area. The following key observations made were:

- The high number of vehicles using the highway to travel between Bangalow and Ewingsdale (around 1350 vehicles between 7am and 7pm).
- The number of vehicles travelling between Coolamon Scenic Drive and Ewingsdale (around 300 vehicles between 7am and 7pm).
- The number of vehicles travelling between Newrybar/ Broken Head Road and Bangalow (around 300 vehicles between 7am and 7pm).

Analysis of classified count data south of Bangalow (see **Table 3.3**) indicates that heavy vehicles comprise a significant proportion of the traffic stream; approximately 16% of the average daily traffic volume during typical non-holiday periods. The analysis also shows that this percentage approaches 40% when looking at night traffic only. The fluctuations in average heavy vehicle volumes throughout the day are depicted in **Figure 3.2.**

Table 3.3 Heavy Vehicles on the Pacific Highway

Time Period	Heavy Vehicle Measure	Direction		Total
		Northbound	Southbound	
Average	Heavy vehicles as percentage of daily vehicles	16% (814)	16% (871)	16%
Night only	Night Heavy Vehicles as percentage of total night vehicles	49%	31%	41%
(10pm – 7am)	Night Heavy Vehicles as percentage of total daily Heavy Vehicles	39% (320)	20% (178)	30%
Weekend	Weekend Heavy Vehicles as percentage of weekend total vehicles	9% (444)	8% (433)	9%
	Percentage Heavy Vehicles during weekend peak hour (12pm)	3% (15)	7% (33)	6%

3.2.5 Existing Highway Conditions

The existing Pacific Highway in the study area has numerous sections with sub-standard geometry. The photograph in **Figure 3.3** visually illustrates the geometry of St Helena Hill, which has the steepest grades within the study area, combined with relatively tight horizontal geometry.

Figure 3.4 and **Figure 3.5** graphically display 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 3.5**, combines the vertical and horizontal information from the other three graphs. What it shows is that over 50% 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 at the numerous at-grade intersections and driveways with direct access to the highway.

Figure 3.3 St Helena Hill

3.2.6 Accident History

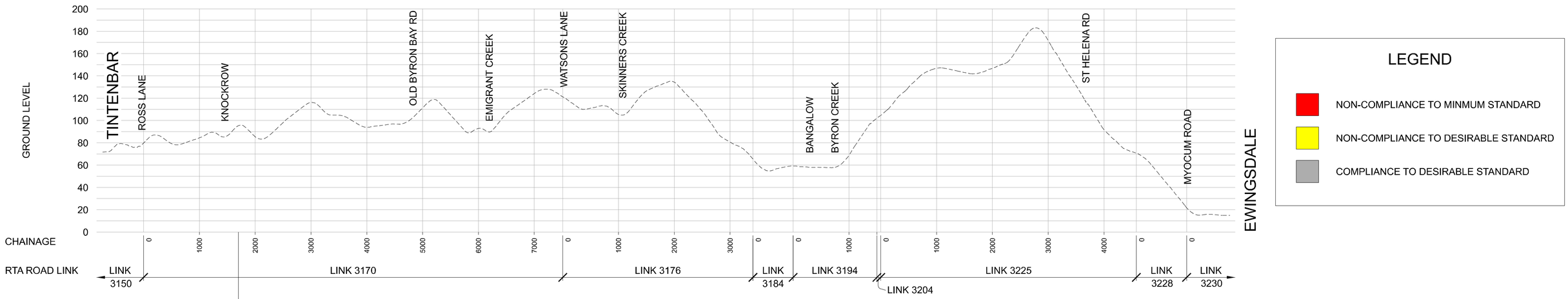
Accident analysis has been undertaken and is based on accident history for the 5-year period from January 1999 to December 2003. It comprises RTA reported accident data between Ross Lane and the Ewingsdale Interchange. During this period a total of 128 accidents were recorded along this section of the existing Pacific Highway (this does not take into account the additional length of the highway between Sandy Flat Road and Ross Lane at the southern end of the study area). The accidents included:

- 8 accidents resulting in 10 fatalities.
- 48 accidents resulting in injuries.
- 70 accidents not resulting in injury, but where a vehicle was towed away.

A summary of the recorded accident data is as follows:

- There were considerably more accidents in the northern part of the study area, to the north of the Bangalow northbound on-ramp. 67 accidents were reported over the 5.3 km section, compared with 59 accidents for the 13.1 km to the south.
- 5 of the 8 fatal accidents were the result of a head-on collision.
- 5 of the 8 fatal accidents occurred north of Bangalow.
- 1 of the 8 fatal accidents involved a heavy vehicle.
- Speed and/or fatigue were contributing factors to the majority of the fatal accidents.
- The most common accident description was vehicles travelling off path on a curve or turning, followed by collision with a vehicle from the opposing direction.

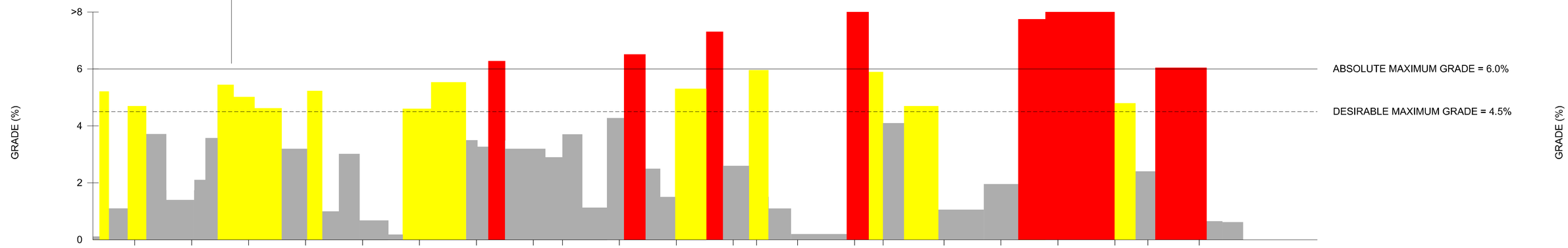
When compared with the annual average daily traffic volumes within the study area, the accidents above represent accident rates of 62 accidents per 100 Million Vehicle Kilometres (MVK) travelled north of Bangalow, 27 accidents per 100 MVK south of Bangalow, or an average of 39 accidents per 100 MVK for the study area. This rate is above the state-wide accident rate for a rural 2-lane undivided road of 32.8 accidents per 100 MVK, as well above the RTA's Pacific Highway target of a maximum of 15 accidents per 100 MVK.



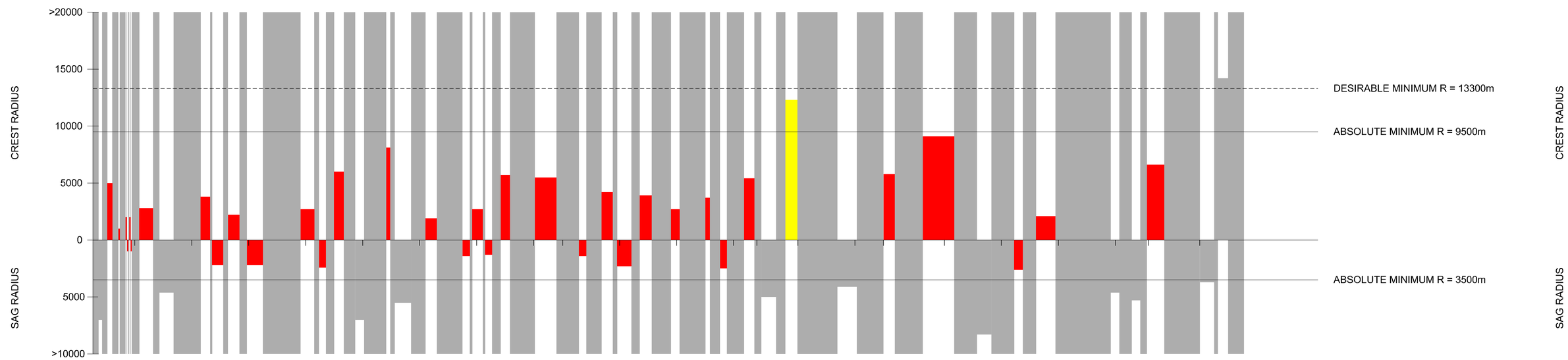
EXISTING PACIFIC HIGHWAY LONGSECTION

LEGEND

- NON-COMPLIANCE TO MINMUM STANDARD
- NON-COMPLIANCE TO DESIRABLE STANDARD
- COMPLIANCE TO DESIRABLE STANDARD



EXISTING GRADES



EXISTING VERTICAL GEOMETRY

Issue	Date	By	Chkd	Appd
01	26/08/05	BK	BM	BM
ORIGINAL ISSUE				

Client

Job Title
PACIFIC HIGHWAY UPGRADE
TINTENBAR TO EWINGSDALE

Scale at A0 N.T.S

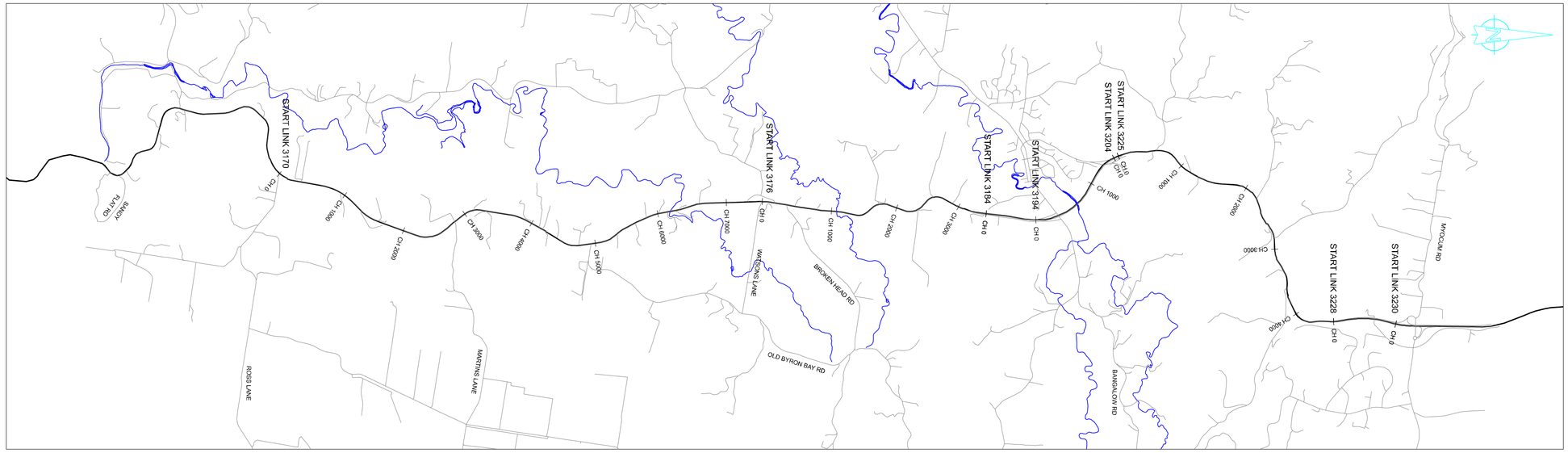
Plot ID

ARUP
Arup, Level 10, 201 Kent St
Sydney, NSW, 2000
Tel +61(0)2)9320 9320 Fax +61(0)2)9320 9321
www.arup.com.au

Drawing Title
EXISTING HIGHWAY GEOMETRY
SHEET 1 OF 2

Drawing Status
FOR INFORMATION ONLY

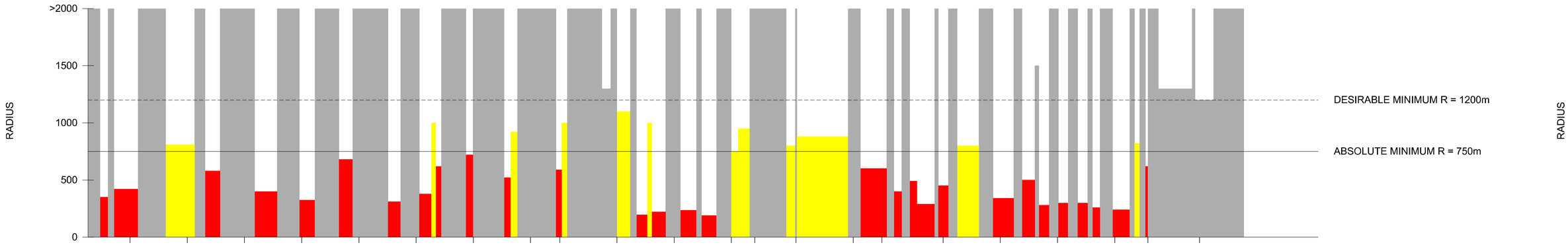
Job No	Drawing No	Issue
84046	**FIGURE 3.4**	**01**



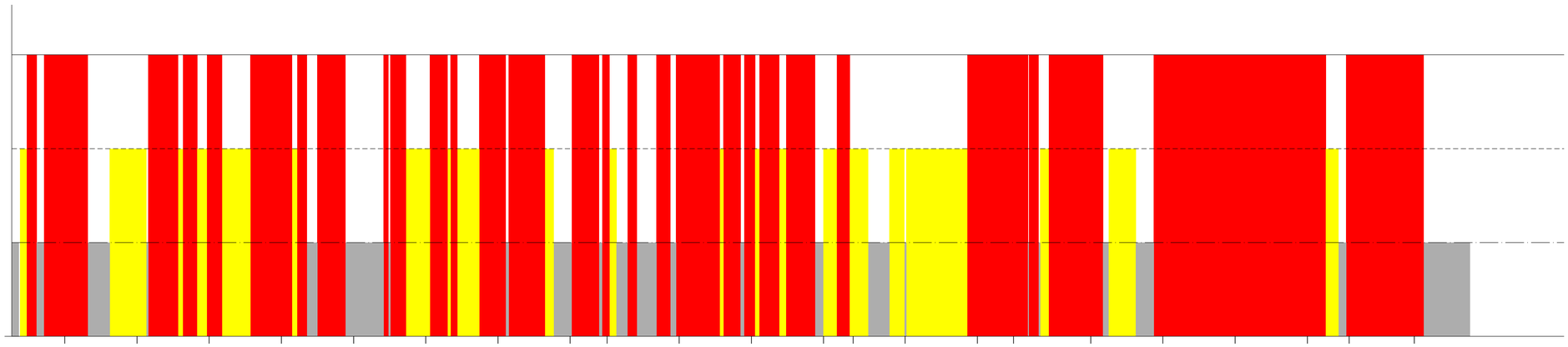
EXISTING PACIFIC HIGHWAY PLAN

LEGEND

- NON-COMPLIANCE TO MINMUM STANDARD
- NON-COMPLIANCE TO DESIRABLE STANDARD
- COMPLIANCE TO DESIRABLE STANDARD



EXISTING HORIZONTAL GEOMETRY



COMBINED GEOMETRY RATING

Issue	Date	By	Chkd	Appd
01	26/08/05	BK	BM	BM

ORIGINAL ISSUE

Client

Job Title: PACIFIC HIGHWAY UPGRADE TINTENBAR TO EWINGSDALE

Scale at A0: N.T.S

Plot ID

ARUP
Arup, Level 10, 201 Kent St
Sydney NSW 2009
Tel +61(0)2)9320 3320 Fax +61(0)2)9320 3321
www.arup.com.au

Drawing Title: EXISTING HIGHWAY GEOMETRY SHEET 2 OF 2

Drawing Status: **FOR INFORMATION ONLY**

Job No	Drawing No	Issue
84046	**FIGURE 3.5**	**01**

3.2.7 Pedestrian, Cyclist and Equestrian Facilities

The Pacific Highway in the study area currently has no specific facilities for pedestrians, cyclists or equestrians. However there are existing and proposed cycle facilities/routes (on and off-road) on Bangalow Road and Ewingsdale Road. The Pacific Highway to the north of the Ewingsdale Interchange is designated as an “inter-town bikeway”, connecting Byron Bay with Mullumbimby and Brunswick Heads.

Pedestrians currently use the highway shoulder and informal verge where available. Pedestrian volumes are low.

3.2.8 Traffic Forecasts

In November 2003, a report entitled *State Highway No 10, Pacific Highway at Ewingsdale - Predictions of Future Traffic Volumes* was prepared for the RTA (RTA 2003b). This report examined historical traffic count data in the vicinity of the Ewingsdale Interchange, as well as additional traffic counts undertaken by the RTA in order to examine the effects of the Yelgun to Chinderah upgrade (at Kankool and Nabiac).

The report concluded that there was a ‘step’ in traffic growth (both light and heavy vehicles) on the Pacific Highway as a result of the opening of the Yelgun to Chinderah upgrade and this should be treated as an instantaneous increase. Furthermore, it recommends that future traffic growth on the highway be treated as linear, based on traffic volumes post Yelgun to Chinderah and historical growth rates.

Therefore traffic forecasts for the Pacific Highway between Tintenbar and Ewingsdale have been undertaken on this basis, using the recommended linear growth rate of 3.2% from 2003 recorded volumes.

For the purposes of analysis, a predicted opening year of 2012 has been used. It should be noted however that this is a planning date and the actual year of opening would be dependent on the availability of funding.

Table 3.4 presents the forecasted Annual Average Daily Traffic (AADT) - in axle pairs - and the Annual Average Daily Vehicles (AADV) for an upgraded dual carriageway, along with the corresponding Levels of Service, for the predicted opening year (2012) through to 2032. The analysis indicates that the upgraded highway would operate at Level of Service B (reasonable freedom for drivers to select desired speed and manoeuvre within traffic stream) upon opening and reach Level of Service C (drivers’ freedom to select desired speed and manoeuvre within traffic stream is reduced) in 2033.

Table 3.4 Forecast Traffic Volumes and Level of Service

Forecast Year	AADT	AADV	Level of Service for upgraded highway
2003 (Base)*	12,841*	10,882*	-
2012	16,539	14,016	B
2022	20,648	17,499	B
2032	24,757	20,981	B
2042	28,867	24,463	C

* Actual recorded data

3.2.9 Other Transport Infrastructure

Public transport operations in the study area consist of long distance coach services and local bus services. With the termination of the Murwillumbah XPT service, there are currently no passenger rail services in the area.

Two bus companies, Blanch's Bus Company and Kirklands Buslines, provide a total of 3 local route services within the study area. There are two main corridors for bus services between Ballina and Byron Bay, either through the inland route on the Pacific Highway, or along the coast through the townships of Lennox Head and Suffolk Park. The scheduled travel time between Bangalow and Byron Bay is approximately 20 minutes. In addition to the scheduled route services, four bus companies (Blanch's, Kirklands, Summerland and Campbell's) operate school runs in the morning and afternoon.

Two bus companies, Kirklands Buslines and Sunstate Charter, provide long distance bus services in the study area, with a general local travel restriction of over 40 km not being permitted. These services are in addition to the through services such as Sydney-Brisbane routes. The scheduled travel time between Bangalow and Brisbane is approximately 3 hours and 20 minutes.

Ballina Airport is located within 5 km of the Ballina CBD and is approximately 20 minutes from Byron Bay and 30 minutes from Lismore. Last year the Ballina Shire Council owned airport catered for over 120,000 passengers. Ballina Airport caters for all types of air traffic, including domestic flights, air freight/courier services and general aviation.

Coach transfers between Ballina Airport and destinations to the north, south and west are available.

In addition, the Casino-Murwillumbah railway passes through the study area. While the railway has not operated since early 2004, it is a requirement that provision should be made for the possible future re-opening of the railway. Grade separation would therefore be required where any options cross the railway.

3.3 Government Transport Initiatives

The need for the highway upgrade should be considered in relation to broader transport and road network planning carried out by the State and Commonwealth Governments. This strategic planning has resulted in publication of a number of planning studies and the establishment of Commonwealth and NSW Government strategies and initiatives which relate to that section of the Pacific Highway within NSW. The Pacific Highway is a State Highway and the principal financial responsibility of the NSW Government in NSW and of the Queensland Government in Queensland, however there are some Commonwealth and NSW Government initiatives involving joint funding between the State and Commonwealth Governments on some projects, including the Pacific Highway Upgrading Program, and *AusLink: Building our National Transport Future*.

These initiatives provide the strategic planning context for the upgrading of the Pacific Highway between Tintenbar and Ewingsdale and are described in more detail below.

3.3.1 The Pacific Highway Upgrading Program (PHUP)

Upgrading the Pacific Highway: Ten Year Pacific Highway Reconstruction Program (RTA 1997) provides a ten-year commitment to develop the existing highway between Hexham and the Queensland border. The initial funding commitment in NSW was $2.2 billion over 10 years. The objective was to significantly improve the standard of the Pacific Highway and provide a safer and more efficient transport link, with the result that accident 'blackspots' be eliminated and travel times reduced. The agreed Program ends in June 2006, however the State and Australian Governments have both committed to extending the program.

3.3.2 AusLink: Building Our National Transport Future

AusLink is the Australian Government's policy (Australian Department of Transport and Regional Services 2004) for improved planning and accelerated development of Australia's land transport infrastructure. It addresses the planning and funding of Australia's national roads, railways and inter-modal terminals by taking a long-term, strategic approach to future needs. The objectives of the plan are to provide transport benefits for businesses, local communities, exporters and farmers. In addition, there would be environmental benefits from reduced congestion, pollution and more efficient transport.

The AusLink National Network is based on national, regional and urban transport corridors, links to ports, airports, and intermodal connections between road and rail. The AusLink National Network incorporates the former National Highway system and many Roads of National Importance, including the Pacific Highway between Newcastle and Brisbane.

3.3.3 Other Relevant Transport Strategies

In addition, there have been a number of other recent studies and documents addressing the upgrading of the Pacific Highway, including:

- *North Coast Road Strategy* (RTA 1992).
- *North Coast Urban Planning Strategy* (DoP 1995).
- *Pacific Highway: Managing the Impact of Delay* (RTA 1999b).
- *Northern Pacific Highway Noise Taskforce Report* (RTA 2003a).
- *Pacific Highway Safety Review* (RTA 2004b).
- *Pacific Highway Urban Design Framework* (RTA 2005a).

3.4 Need for the Project

The existing Pacific Highway is a vital link for various forms of traffic and types of journey. It serves as the through highway route for north-south regional and interstate traffic, but also as a local access thoroughfare for private and commercial traffic in the area.

Establishing the need for the project is crucial to the identification and selection of appropriate project objectives and evaluation criteria for the options assessment process and the selection of corridor options.

3.4.1 Background

The need to upgrade the Pacific Highway between Tintenbar and Ewingsdale is based on a combination of factors including regional growth, economic issues, and road safety issues. Each of these factors is discussed below.

Regional Growth

The sustained recent population growth and forecasts for continued growth both in the Ballina Shire Council and the Byron Shire Council and the entire North Coast Region indicate an increasing pressure on the existing transport system. It is necessary that transport infrastructure improvements occur to ensure that community expectations for safe and efficient road transport are met and accommodate the current and projected growth trends without significant increases in delays, travel times or congestion. Highway improvements are necessary to provide safe, efficient access for social activity, trade, tourism, and emergency services.

It is expected that traffic volumes on the highway and adjoining roads would continue to increase due to:

- Population increases regionally and in urban and rural residential release areas in the vicinity of this section of the highway.
- Traffic diverted from other routes as various sections of the Pacific Highway are improved.
- Traffic generated as a result of reduced travel costs.

Economic Issues

Levels of economic development are closely tied to population growth and related investment. A high standard, reliable road network linking regional areas with larger urban and metropolitan areas is essential to provide access to both markets and sources of goods and services. Transport costs can be a major input to production costs so road improvements have a direct and positive impact on regional and national economic efficiency.

In the Tintenbar and Ewingsdale context, the highway is significant in is its facilitation of transport movements associated with local agriculture as well as providing a road network to support the local tourism industry.

Road Safety Issues

The need for the upgrade can be argued in road safety terms, both at the local and regional level. Based on the nature and type of recent traffic accidents occurring on the highway between Tintenbar and Ewingsdale, the difficulties local residents experience in safely accessing the highway and the issue of pedestrians and cyclists safely crossing the highway in the Newrybar area and at other smaller settlements, there is a demonstrated need to provide a higher standard of road.

In regional terms, it is desirable that motorists have a uniform standard of safe roads for as much of their journey as possible. Continuity of high quality road conditions directly correlates with lower levels of accidents, especially fatalities. Also, predictability of uniform road conditions reduces driver fatigue and frustration, both of which are contributing factors to accidents. The Pacific Highway both north and south of the Tintenbar to Ewingsdale project is already duplicated or duplication is planned.

The Tintenbar to Ewingsdale upgrade should be considered in the context of the overall highway upgrade so it does not cause safety concerns by being the only unimproved section

3.4.2 Consequences of No Action

The consequences of no action being taken to develop the upgrade would include adverse implications for local and regional growth patterns; for the overall efficiency and safety of the Pacific Highway system; and for local environmental amenity and road safety.

Road Safety Issues

As a result of the lower Level of Service for traffic and the continued use of a lower standard road for major long distance traffic flows with a high proportion of heavy vehicles, there would be implications for road safety if the upgrade did not proceed or is delayed for a long period. Specific road safety implications would include increases in:

- The number and severity of accidents, especially where road conditions are currently sub-standard.
- The number and severity of accidents at the numerous at-grade intersections, especially where the layout or sight distance is currently sub-standard.
- The level of risk for pedestrians when crossing the highway, particularly in the villages of Knockrow and Newrybar.
- The difficultly for residents adjacent to the highway to gain access to and from the highway.
- The level of risk for cyclists using the highway.

Local and Regional Growth

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. As the Pacific Highway is the most significant transport infrastructure element between Newcastle and Brisbane, 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 standard of service for existing and forecast levels, 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 service.

The Pacific Highway System

If the upgrade does not proceed or is deferred for a long period, current levels of service would deteriorate. Without the upgrade, specific implications for Pacific Highway operations would be:

- Increasing congestion along the highway - traffic volumes now experienced only during peak holiday periods would become daily occurrences and at holiday times the road system would become severely congested.
- Commercial traffic would experience delays which would adversely affect productivity and economic performance.
- The mobility of people in the sub-region would be reduced - those affected would include commuters to and from Tweed Heads and the Gold Coast to the north and Ballina, commercial operators, tourists, shoppers, and the local workforce.
- An increase in road user costs through increased congestion and decreased road safety levels.

In order to meet the Level of Service targets set for the upgrade, duplication of the highway would be necessary to accommodate projected traffic growth over a 20 year period.

3.4.3 Conclusions

The conclusions that can be drawn from this analysis are that the upgrade is needed:

- To improve safety and prevent an increase in the number and severity of accidents on the highway that could be expected as traffic volumes and congestion increase and as the discontinuity with the improved standard of the highway to the north and south of the project becomes more apparent.
- To contribute to the significant local, regional and interstate transport role of the Pacific Highway.
- To ensure that the current configuration and condition of the Pacific Highway between Tintenbar and Ewingsdale is consistent with the highway's strategic role, especially its ability to appropriately accommodate projected traffic growth.
- To ensure that there would not be a decrease in the Level of Service and related increases in travel times on the days on which unacceptable traffic congestion occurs.
- To support continued regional growth and economic development, including growth of population, growth of urban areas, commercial development, growth of tourism and growth of employment opportunities within the North Coast Region of NSW and in adjoining areas in southern Queensland, through improved efficiencies in transport.

The need for the project has been established by identifying planning, transport and environmental needs which supports the commitment of both Commonwealth and NSW Governments to upgrading the Pacific Highway under the PHUP and AusLink initiatives.

4 Project Objectives, Design Principles and Assessment Criteria

4.1 Program Objectives

The Pacific Highway Upgrading Program aims to:

- Significantly reduce road accidents and injuries.
- Reduce travel times.
- Reduce freight transport costs.
- Develop a route that involves the community and considers their interests.
- Provide a route that supports economic development.
- Manage the upgrading of the route in accordance with Ecologically Sustainable Development (ESD) Principles.
- Provide the best value for money.

4.2 Project Objectives

Following early consultation with the community (three Community Information Sessions held in the study area between 12 and 16 November 2004) and the CLG, it was considered necessary to amend the generic RTA project objectives to better reflect the unique needs of this particular study and community concerns.

Project-specific objectives (grouped by program objectives) are listed in **Table 4.1**. These objectives have been reviewed by the original and re-formed CLG established for the study.

Table 4.1 Project Objectives

RTA Program Objectives	Project Objective
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 MVK 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.

RTA Program Objectives	Project Objective
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 (LOS) 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.
Develop a route that involves the community and considers their interests	• Meet the objectives of the Community Involvement Plan and the CLG. • 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. • 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 EPA 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. • Develop a project that minimises the impacts on heritage (indigenous and non-indigenous) places.
Provide a route that supports economic development	• Develop a project that minimises the impacts on prime agricultural lands. • Develop a project that improves accessibility for local industries, utilities and emergency services. • Develop a project that minimises the impacts on businesses dependent on Pacific Highway traffic.
Manage the upgrading of the route in accordance with Ecologically Sustainable Development (ESD) principles	• 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 DEC Guidelines for managing environmental issues (biodiversity, water quality, Acid Sulfate Soils). • Assess and address cumulative environmental impacts. • Develop a project that addresses environmental safeguards and measures necessary to mitigate environmental impacts.
Provide the best value for money	• Minimise the Whole of Life Costs of the project. • Maximise the use of the existing road reserve and other road assets for duplicated sections of the project where possible.

4.3 Design Principles and Standards

4.3.1 Urban Design Approach

The urban design outcome must be an integrated cohesive best practice design in accordance with the *Pacific Highway Urban Design Framework* (RTA 2005a) and incorporating guidelines from the following RTA documents:

- *Beyond the Pavement - Urban and Regional Design Practice Notes* (RTA 1999a).
- *Noise Wall Design Guidelines* (RTA 2003c).
- *Bridge Aesthetics - Design guidelines to improve the appearance of bridges in NSW* (RTA 2003d).
- *Shotcrete Design Guidelines - Design guidelines to avoid, minimise and improve the appearance of shotcrete* (RTA 2005c).
- *Roadscape Guidelines* (RTA 1998).

The urban design approach to the project and all the upgrades of the Pacific Highway is defined in the Framework as:

> *The upgrade should be a sweeping, green highway providing panoramic views to the Great Dividing Range and the forests farmlands and coastline of the Pacific Ocean; sensitively designed to fit into the landscape and be unobtrusive; and characterised by simple and refined road infrastructure.*

4.3.2 Urban Design Objectives and Principles

The following design objectives and principles are based upon the objectives and principles in the Framework and seek to integrate the road infrastructure into the landscape as much as possible, whilst providing an attractive driving experience for the motorist. They are a series of broad principles that would also influence road design decisions and potentially mitigate some of the visual impacts of a new highway alignment. They include, but are not limited to, the following:

- **Selection of an alignment which conforms to the prevailing landform:**
  - Follow the existing land formation to create a flowing alignment which is responsive to the landscape.
  - Avoid crossing steep and exposed ridges and spurs to minimise deep cuttings.
  - Avoid deep valley crossings where large embankments or viaduct structures are required.
  - Independently grade (horizontally and vertically) the north and southbound carriageways to limit the extent of cuttings and embankments and thereby reduce the footprint of the highway.
  - Where steep cuttings or embankments are necessary, align the road on a sweeping curve to reduce the extent of the cutting or fill embankment being visible from any one point.
  - Arrange the alignment as a series of reverse curves and avoid long straight sections of road.
- **Selection of an alignment which responds to the landscape character:**
  - Follow landscape edges such as boundaries between crops, plantations, forested areas and open paddocks.
  - Avoid dissecting formal landscapes such as orchards and plantations.
  - Avoid large stands of trees which are prominent features in the landscape.
  - Avoid prominent features in the landscape including landmarks or culturally significant elements/structures.

  - Avoid crossing large water bodies.
  - Minimise the number of intersections with existing roads to reduce the highway and local road footprint.

- **Selection of an alignment which minimises the visual impact of the highway:**
  - Avoid the visual catchments of key public places e.g. lookouts (where possible).
  - Avoid the immediate visual catchments of towns and villages (where possible).
  - Minimise the visibility of the highway from farms and homesteads (where possible).
  - Align the cuttings to avoid them being silhouetted against the skyline.
  - Utilise landforms to screen sections of the highway from key viewpoints.
- **Selection of an alignment which provides an attractive driving experience and easy orientation for the motorist:**
  - Select an alignment which provides a sequence of road characters (topography, land uses, etc) varying from regional views to total enclosure for enjoyment and reduced driver fatigue.
  - Select an alignment where the motorist can see landmarks and features, such as ocean views, for orientation.
  - Horizontally and vertically split the north and southbound carriageways to limit the extent of cuttings and embankments to reduce headlight glare and a 'motorway' appearance of the road.
  - Select an alignment which is separate from the local road system to preserve the small scale character of the local roads.
- **Selection of an alignment which improves local access and connectivity between settlements separate from the highway:**
  - Minimise the number of intersections to improve highway efficiency and improve local road traffic flow.
  - Utilise landform to provide efficient grade separated intersections.

4.3.3 Highway Design Standards

The design standards for the Tintenbar to Ewingsdale upgrade of the Pacific Highway are comprehensive and incorporate the standards/guidelines required to achieve the program goals and project objectives, particularly in relation to road safety and overall performance in terms of design life, level of access, level of service and flood immunity. They are based on the design standards that have been adopted for the Pacific Highway Upgrading Program and accommodate other influences including environmental issues, land management requirements, and service provision. The overall objective is the development of a 'value for money' project from a broad community perspective.

The primary design criteria for the upgrading of the Pacific Highway from Tintenbar to Ewingsdale are defined in the following documents:

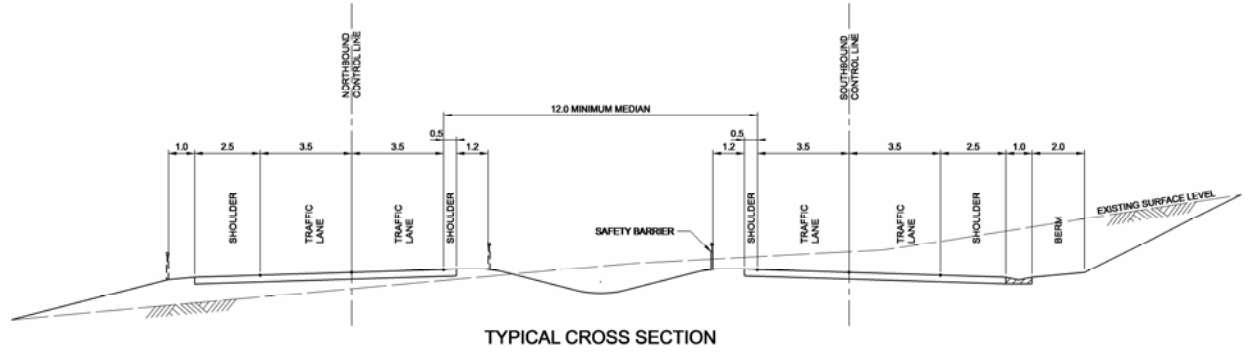
- *Upgrading the Pacific Highway, Upgrading Program beyond 2006, Design Guidelines Issue 1.2* (UPH Design Guidelines) (RTA 2005b).
- Austroads standards, including *Rural Road Design – A Guide to the Geometric Design of Rural Roads* (Austroads 2003).
- *Road Design Guide* (RTA 1996) including various updates.
- Grade Separated Interchanges (A Design Guide) (NAASRA 1984).

Key standards applying to this project are summarised in **Table 4.2** and a typical cross-section for the upgraded highway is shown in **Figure 4.1.**

Table 4.2 Road Design Standards

Feature	Upgraded Highway	Other Roads including Existing Pacific Highway
Design speed	110 km/h horizontal and vertical. Absolute minimum vertical design speed of 100 km/h may be considered at certain locations and subject to Pacific Highway Office approval.	100, 80 and 60 km/h dependent on function.
Cross section	Dual carriageway with two 3.5 m wide lanes, inner shoulders 0.5 m, outer shoulders 2.5 m, minimum median width varies from 2.6 m to 12 m depending on median barrier type.	Two lane single carriageway with maximum 2 m shoulders dependent on road function.
Vertical grades	Desirable maximum grade 4.5%. Absolute maximum grade 6% (desirable maximum length 500 m). Climbing lanes may be required depending on length of sustained grades above 4.5%.	Not specified, refer *Road Design Guide* (RTA 1996).
Flood immunity	1 in 100 year desirable or 1 in 20 year absolute minimum across floodplain. Effects of Probable Maximum Flood to be assessed.	No change to existing conditions.
Intersections	Grade separated, no at-grade intersections permitted.	At-grade.
Access to highway	Restricted.	Unrestricted.
Local access	Alternative routes to be provided.	Service roads or local arterial road networks to provide an alternative routes for local traffic.
Clearances above highway	5.3 m for the full road width including shoulders (5.3 m for any pedestrian bridges). 7.5 m above railway.	5.3 m desirable, 4.6 m minimum.

Figure 4.1 Typical Cross-Section of Upgraded Highway



Further details of the proposed design criteria are described below:

- Development of the highway must include a strategy for the future upgrade from 2 to 3 lanes in each direction. The preferred strategy is to widen within the median; and median widths are set accordingly. Bridges minimum width of 11.5 m is required where additional width cannot be added later and provided there is off-road provision for cyclists (30 years, whole of life analysis). A strategy must be developed and approved by Pacific Highway Office if there is no off road provision for cyclists.
- Grade separation where the upgraded highway crosses local roads or the existing highway, and the elimination of direct access to provide freeway type conditions. The preferred standard for the highway upgrade is 'M Class' as designated in the UPH Design Guidelines. The project should therefore be designed to 110 km/h Freeway standard, and requires alternative routes to be available for local traffic through the provision of service roads or local arterial road networks. As an absolute minimum, if an 'M Class' project cannot be provided then the 'A Class' project requirements would apply. 'A Class' projects are to be designed as Controlled Access Roads, and must be developed with a strategy for conversion to 'M Class' standard in the future. Future conversion should not require changes to the alignments, although 'A Class' projects would generally be signposted at 100 km/h.
- Median widths dependant on assessed requirement for future widening as well as type of median barrier/fencing. Generally, desirable minimum median width 12 m to accommodate future widening to three lanes in each direction. Minimum median width of 5 m with wire rope barrier or 2.6 m with a Type F or VCB barrier subject to provision for widening on nearside (outside). Wider medians and/or independent carriageways should be considered where appropriate for example to preserve vegetation or provide a visual feature.
- Meet or exceed B-Double vehicle requirements as a through route, and, where appropriate, design interchanges and intersections for B-Double usage. However, there are currently no designated B-Double routes in the study area apart from the existing Pacific Highway and, assuming the upgraded highway is on a new alignment, it is expected that the old highway would lose its status as a B-Double route on opening of the upgrade.
- Interchanges and intersections with the highway are to achieve Level of Service C or better in accordance with Austroads Traffic Engineering Practice Series Part 2 for the 100th Highest Hourly Volume, 20 years after opening.
- Desirable flood protection from Q20 in the floodplain and Q100 elsewhere.
- On-road provision for cyclists (an alternative route must be provided if on road provision is not available).
- Lighting where safety standards require, such as at intersections and interchanges.

It should be noted that while desirable and minimum requirements have been proposed, they should not be regarded as absolutes. Where conditions are encountered such that the suggested design criteria cannot be fully implemented because of significant construction or financial constraints, a relaxation of the requirements may be appropriate while still maintaining the intended concepts of safety and design.

4.4 Assessment Process

The assessment process for the Tintenbar to Ewingsdale upgrade is outlined in **Section 2.1**. Criteria for the assessment of route options were developed by the Project Team in conjunction with the CLG and various agencies. Selection criteria, based on the Programme and Project Objectives, are listed in **Appendix A.** Application of the criteria is explained in **Sections 7.2 and 7.3**.

5 Existing Conditions and Constraints within the Study Area

5.1 Defining Constraints

The mapping and reporting of environmental, urban design, social and engineering constraints is the starting point in the identification of potential corridors for upgrading the highway. It also allows the Project Team to gain an understanding of the characteristics of the study area early in the process.

The process of classifying constraints involves their ranking into three categories which define their significance; these categories are low, medium and high. As a guide, high-level constraints include areas that are designated or equate to having national or state level significance, medium equates to areas or features of regional level significance or equivalent and low equates to locally significant areas or features.

Certain project constraints are not able to be mapped but can be described in words whilst other features within the study area would not be able to be classified in the manner mentioned above. For example, certain engineering constraints do not fall neatly into constraints categories. While still important issues for highway location, they would be mapped and or described in an appropriate manner to enable the team to take them into consideration in the option development process.

Constraints were identified from a combination of desk based assessment, consultation with relevant agencies and stakeholders, use of aerial photographs and topographic maps and fieldwork. The constraints mapping influenced the development of route options as described in **Chapter 6** and **Chapter 7**.

5.2 Methodology for Identifying Existing Conditions and Constraints

The methodology for identifying existing conditions and constraints included a review of:

- Maps (for example topographical and soil landscape maps).
- Previous investigations in the study area (for example the Ballina Bypass EIS, and the 1998 Richmond River Floodplain Study).
- Aerial photography.
- Technical databases (for example for threatened species).
- Various technical and academic papers.
- Byron and Ballina Shire Council LEPs.

In addition the following activities were undertaken:

- Site walkover surveys.
- Field investigations (for example geotechnical, ecology, heritage and land use).
- Community consultation (for example Community Information Sessions).
- Agency consultation.
- Technical modelling (for example potential noise impacts).

5.3 Socio-Economic and Land Use

5.3.1 Demographic Characteristics

Growth within the Local Government Areas

The study area lies partly within both the local government areas of Ballina (southern half) and Byron (northern half). These LGAs are experiencing substantial social and economic change along with other areas of the Northern Rivers (defined by Northern Rivers Regional Development Board as stretching from the southern end of the Clarence Valley to the Queensland border and west to the Great Dividing Range).

For the period 1991 to 2001, Ballina and Byron Shires respectively experienced 2.14% and 2.86% annual compound population growth. Between the 1996 and 2001 censuses, Ballina and Byron Shires' population growth was 7.3% and 9.7% respectively.

Review of 2001 Census Data

Data from the 2001 Census of Population and Housing (Australian Bureau of Statistics) was analysed to provide an overview of the demographic structure of the study area. Eight Census Collection Districts (CCDs) cover and, in most cases, extend beyond the boundary of the study area. As a result, the analysis is generalized for this larger area and compared.

The key demographic characteristics of the study area CCDs relevant to this proposal are:

- Total population in 2001 of 4,134 persons.
- The age structure is more closely aligned with the younger age structure of Byron shire than to the older age structure of Ballina.
- Within the study area, less than 1% of the population identified themselves as indigenous.
- Approximately 54% of the employed labour force worked full time and 43% part time. There is a high level of unemployment and underemployment in both LGAs.
- The largest industry occupational category was the retail sector (14.2%) followed by agriculture (10.8%), accommodation and cafes (10.5%), manufacturing (9.3%) and health and community services (9.2%).
- There were generally lower proportions in weekly household income levels at the lower levels ($0 to $499) than was the case for the Ballina and Byron Shires and similar or slightly higher proportions (especially compared to Byron) in the higher household income levels ($1,000 and above).
- The population had marginally higher levels of educational attainment in the Bachelor degree and above categories than in the Richmond Tweed region or in the state overall.
- Car ownership levels (especially more than one car per dwelling) in the study area CCDs are generally higher than the rates recorded at the LGA, regional and state levels.

5.3.2 Planning Strategies

Ballina Shire

A draft *Urban Structure Plan* for the Cumbalum Ridge is currently being developed by Ballina Shire Council for the rest of the Ridge, which would determine the 'carrying capacity' of the Ridge and the style of development. The Plan provides a broad analysis of the Cumbalum Ridge identifying:

- Potential environmental hazards which might affect the urban development potential of the area.
- Natural resources such as habitat values, agricultural land and extractive resources and the potential visual impact of development on the landscape.

- The potential for future urban-rural land use conflict.
- The likely future needs of the population, in relation to commercial, recreation and community facilities and housing form.

Ballina Council's preliminary Cumbalum Structure Plan work identifies three 'planning precincts' within the broader 'urban investigation' area. Precincts B and C are located within the study area (see **Figure 5.4** in **Section 5.3.4**). The draft Concept Land Use Plan for Precinct B identifies the area as having potential to accommodate a population of 3,500 to 4,000 people under a conventional subdivision pattern and between 5,000 to 6,000 people under a village style development pattern. It is proposed that concept planning for Precinct C be deferred for a period of 10 years.

The Cumbalum Ridge area forms part of Ballina Council's Urban Land Release Strategy, which has the purpose of fulfilling Council's responsibility to provide a variety of housing opportunities, adequate to meet the future likely needs of the Shire population. The Cumbalum Ridge area is identified by Ballina Council as being of strategic importance to meeting these future housing needs.

Byron Shire

In the *Byron Rural Settlement Strategy*, Byron Shire has identified an area known as Natural Lane for future rural residential development. This area is located to the north of Midgen Flat Road and below the escarpment in the vicinity of Granny Waterhouse Drive. It is currently zoned 1(a) and has the potential for 70 dwellings. Although the strategy is currently under review, the Council has the expectation that this land would be used for future rural residential development in the future. LEP zoning for both Byron Shire and Ballina Shire is provided as **Figure 5.1.**

Northern Rivers Farmland Land Protection Project

The Northern Rivers Farmland Protection Project has identified areas to be reserved for agricultural land and to secure its future growth and development in the Northern Rivers area.

The DIPNR map has identified land in the study area as predominately regionally significant land with an area of state significant land just north of Broken Head Road (see **Figure 5.2**). Accordingly, these areas cannot be rezoned for urban or residential development in the future unless already identified in Council's existing settlement strategies as of December 2004. For the purpose of the Farmland Protection Project, state and regionally significant land have the same status in the study area.

Figure 5.1 LEP Zoning

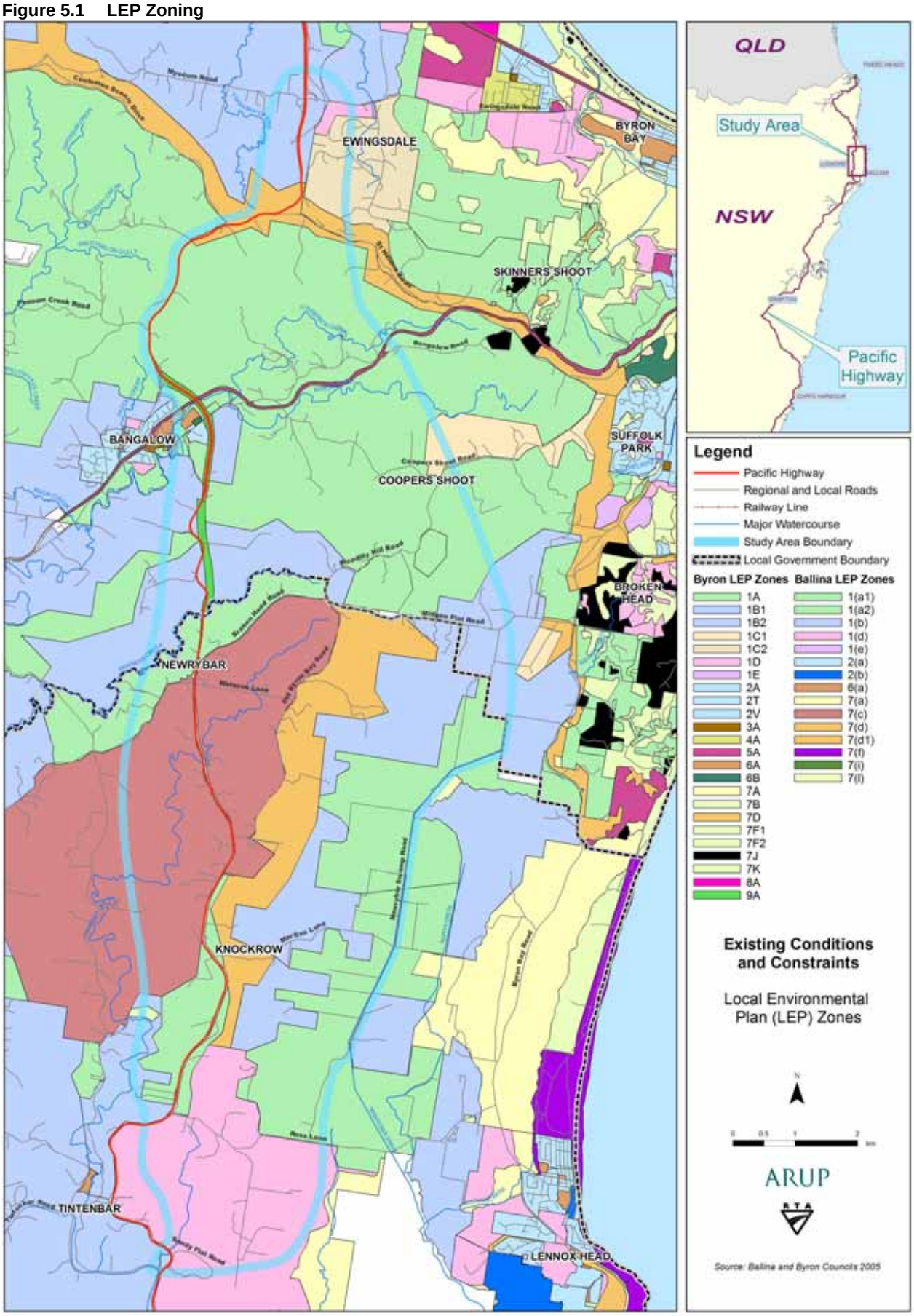
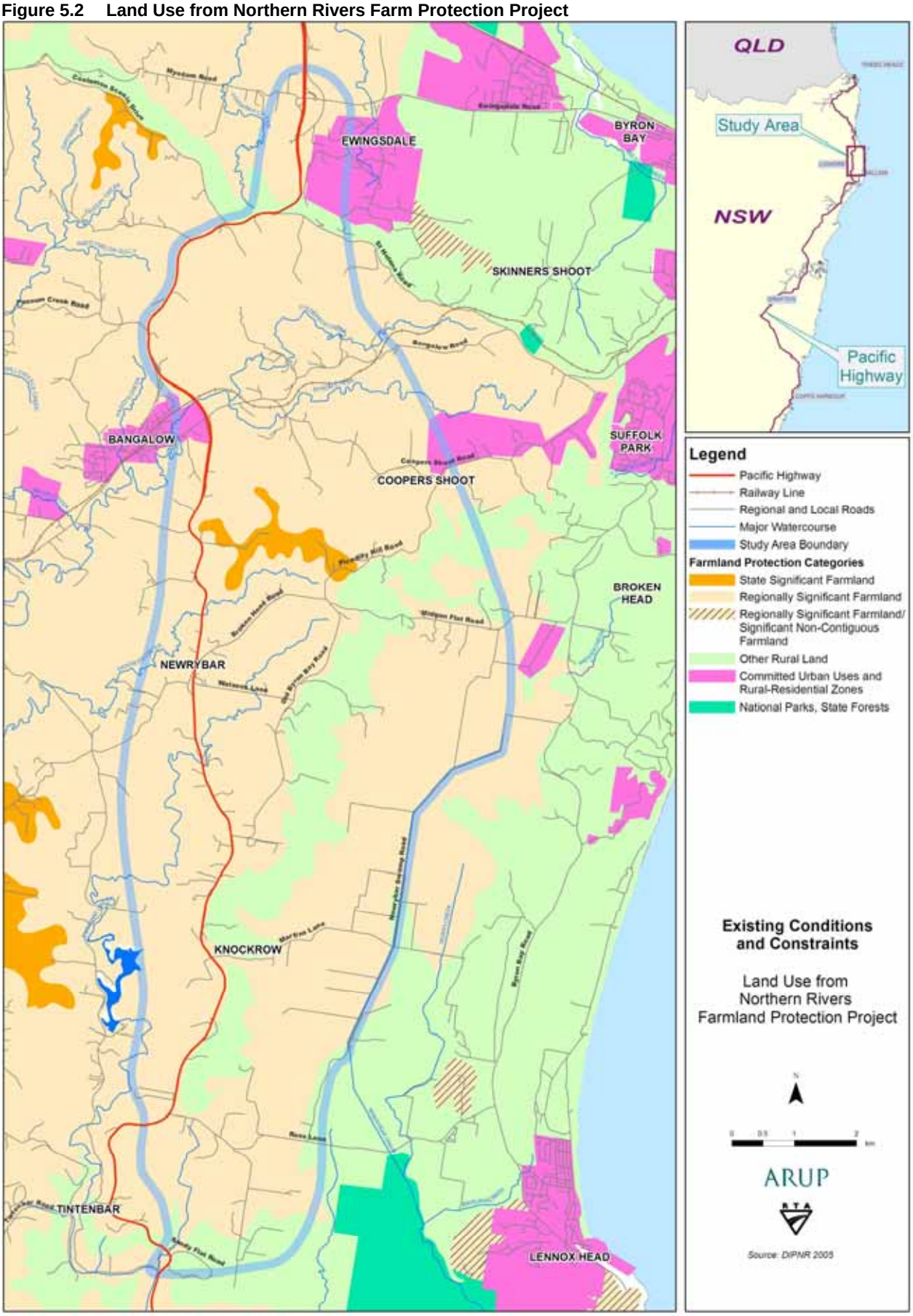


Figure 5.2 Land Use from Northern Rivers Farm Protection Project



5.3.3 Land Use

Land Use Categories

Land use has been identified in the following broad categories:

- Townships, villages and precincts (and associated infrastructure such as halls, churches, sporting fields, schools, cemeteries).
- Land identified for future or possible future residential development.
- Rural residential and rural residential clusters.
- Agriculture including cattle grazing, bananas, macadamia, stone fruit, coffee, sugar cane.
- Tourist accommodation.
- Other agriculture enterprises including plant nurseries and mixed enterprises.
- Other business such as Macadamia Castle, Ready Mix Cement, and Abel Sand.

Land uses are shown in **Figure 5.3.**

Land Use Data Assumptions

There are limitations to the land use data, namely:

- For agricultural production, the mapping identifies the likely land use per cadastre but does not delineate the actual production areas. For example, for an individual property identified as a macadamia plantation, the actual plantation area is not delineated.
- Not all production units and or activities on a particular holding have been identified, e.g. rural residential may have a small cropping enterprise or tourist accommodation, grazing property may have homestay/cabins.
- There are a number of home-based businesses in the study area but they have not been identified.
- Land use changes over time – this analysis is current as at September 2005.

Townships and Villages

Within or adjacent to the study area, the main urban settlements are Bangalow and Newrybar and the Ewingsdale residential area.

- Bangalow - The built-up area of Bangalow is located just to the west of the western boundary of the study area. The existing Pacific Highway was diverted away from the main street of Bangalow some years ago to the current alignment about 1km east of the township.

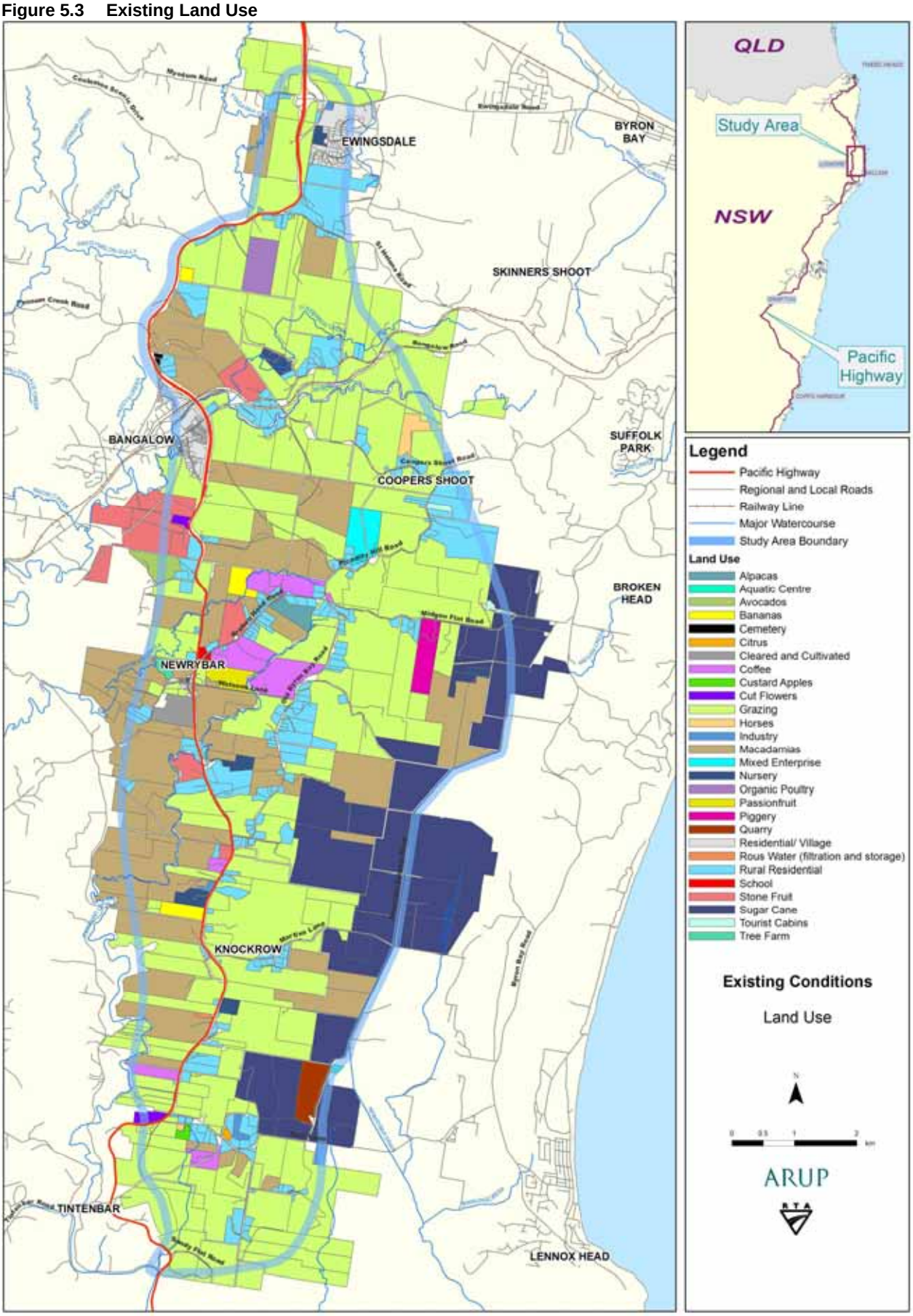
  The Pacific Highway bypass of Bangalow has created new business opportunities for the village, enhanced its sense of place, community and historical values. Bangalow has a population of approximately 1,200 people and serves as a local service and community centre for the northern part of the study area and surrounding rural areas. The township also provides service centre functions for the surrounding farms (Byron Shire 2004).

  Bangalow has a range of local community facilities and services including Bangalow Primary School, Bangalow Community Health Centre, Bangalow Community Childrens Centre and NSW Police.

- Newrybar - The village centre of Newrybar which includes houses, general store, café, hall, nursery, and an agriculture supply store, is located immediately to the west of, but not directly fronting, the existing Pacific Highway. The Newrybar Primary School is located to the east of the highway on Broken Head Road.

- Ewingsdale - The residential community of Ewingsdale is located at the northern end of the study area and is a separate residential area 6 km inland from Byron Bay, surrounded by farmland to the east, the escarpment to the south, the existing highway to the west and Ewingsdale Road to the north. Ewingsdale has a community hall and church, and a Steiner School is also located there.

Figure 5.3 Existing Land Use



In addition there are a number of rural residential clusters across the study area as well as individual rural residential allotments which have created neighbourhoods beyond the township of Bangalow and the village of Newrybar. There are rural residential clusters along St Helena Road, Tinderbox Lane, Broken Head Road, Coopers Shoot Road, Piccadilly Hill Road, Old Byron Bay Road, Martins Lane East, Carney Place, Ross Lane, McLeish Road, Glenross Drive, and Dufficys Lane.

Agriculture in the Region

Eight percent (8%) of Northern Rivers (NR) residents are employed in agriculture, fishing and forestry, with 7.5% in Ballina Shire and 5.8% in Byron Shire (Northern Rivers Regional Development Board [NRRDB] 2003). NRRDB defines the Northern Rivers as the catchment areas of the Clarence, Richmond and Tweed Rivers. In Byron Shire, for example, agriculture provides the third largest source of income to the Shire, after tourism and Centrelink payments. Agricultural enterprises in the Northern Rivers region include:

- Beef cattle production, which is the greatest land use and the Northern Rivers region's biggest single income earner ($140 million annually, DPI 2000).
- Bananas, dairying, vegetables and sugar cane, which generally have been established for many years. There is decline or consolidation and change in focus in some of these industries such as a change in the variety of bananas grown.
- Macadamias, which are now well established, and low chill stone fruit, which has been grown commercially for 20 years.
- New and emerging industries such as coffee, native foods and herbs (culinary and medicinal).
- Organic production which also continues to be established across the range of enterprises.

Agriculture in the Study Area

The most extensive agricultural land uses in the study area (in terms of land occupied) are beef cattle grazing and macadamias, followed by sugar cane and then a range of other horticultural enterprises.

Agricultural enterprises in the study area are shown in **Table 5.1**.

Table 5.1 Agricultural Enterprises in the Study Area

Enterprise	Approx. Amount in Study Area	Approx. Percentage of Study Area
Grazing (beef cattle)	3310 ha	50%
Macadamias	1350 ha	19%
Sugar cane (some of which is being converted to macadamias)	700 ha	10%
Coffee	150 ha	2%
Stone fruit	100 ha	1%
Nurseries and tree farms	50 ha	<1%
Bananas	40 ha	<1%
Others (e.g. cut flowers, poultry, avocados, citrus, alpaca, passionfruit)	200 ha	3%

Business and Tourism

The proposed highway upgrade through the study area would not involve any town bypasses. However, in the study area, there is a small number of businesses which have a varying degree of reliance on trade generated directly from passing long distance highway traffic (as opposed to local traffic which, by necessity, uses the highway in the study area for local trips). In addition, given the close proximity (less than 1 km) of the township of Bangalow to the highway, there are a number of businesses there that have some reliance on highway-related trade.

Highway-related Businesses

Discussions were held with some business owners/operators in the study area to gauge the extent of reliance on highway-related trade.

The most directly affected business is Macadamia Castle at Knockrow. This business currently attracts approximately 350,000 visitors annually and approximately 80% of its overall trade from highway traffic, i.e. 280,000 visitors per year.

There are two businesses in Newrybar located close to, but just off, the existing highway – the general store and the Harvest Café – that attract some trade from highway traffic. These businesses provide a number of locally based employment opportunities – many of which are part-time or casual – and also purchase a proportion of their supplies locally. Both of these business operators estimate that highway-related trade accounts for 30% of their trade with a further 20% of customers drawn from the wider regional area.

The operators of all three businesses consider that relocation of the highway away from its current alignment would have a varying, but significant, effect on the viability of these businesses.

Businesses in Bangalow

Bangalow is a tourist destination as well as a local service centre for the closely settled rural hinterland. Currently there is easy and direct access between Bangalow and the highway which involves a detour of approximately 2 km.

A wide of range of businesses operate within Bangalow, including service stations, coffee shops, restaurants, cafés, antique stores, specialty shops, a hotel, and a bowling and recreation club.

Based on discussions with selected Bangalow business operators, highway-related business ranges from 15-25% of trade (see **Table 5.2**). The Project Team estimates that approximately 14 Bangalow businesses would have some reliance on highway-related traffic.

Tourism

Tourist facilities are not a major land use in the study area but many of the businesses in Bangalow benefit from tourism activity. The following tourism land uses are located in or near the study area:

- Macadamia Castle.
- Byron County Cottages on Bangalow/Byron Road.
- Four Winds Villa and Plantation Lorna on Old Byron Bay Road.
- Byron Country Cottages/Talofa Lodge.
- Anna's Cabins on Piccadilly Hill Road.
- Warrawillah Cottages on Midgen Flat Road.
- Coopers Shoot Guest House.
- Murojum Farmstay.

Table 5.2 Sample Bangalow Businesses with a Reliance on Highway-Related Trade

Business Name	Proportion of Trade
Mobil Service Station, 16 Granuaille Road	30% local, 50% regional, 20% other including highway
Choux Choux Patisserie	50% local, 35% regional, 15% highway
Urban Café	Weekend: 35% locals, 40% tourists staying locally, 25% highway Weekdays: 80% locals, 20% tourists and highway
Bangalow Hotel	50% locals, 50% tourists (25% staying; 25% highway)

Source: Discussions with business owners and operators, September 2005

Other land uses

Other land uses include:

- Aquatic Centre, Newrybar Swamp Road.
- Cemetery, Bangalow.
- Electricity substations and other Country Energy plant at various locations.
- Rous Water infrastructure and facilities at various locations.
- Sand Quarry, Newrybar Swamp Road.
- Meat-e-vites Pet Food, Ross Lane, Lennox Head.

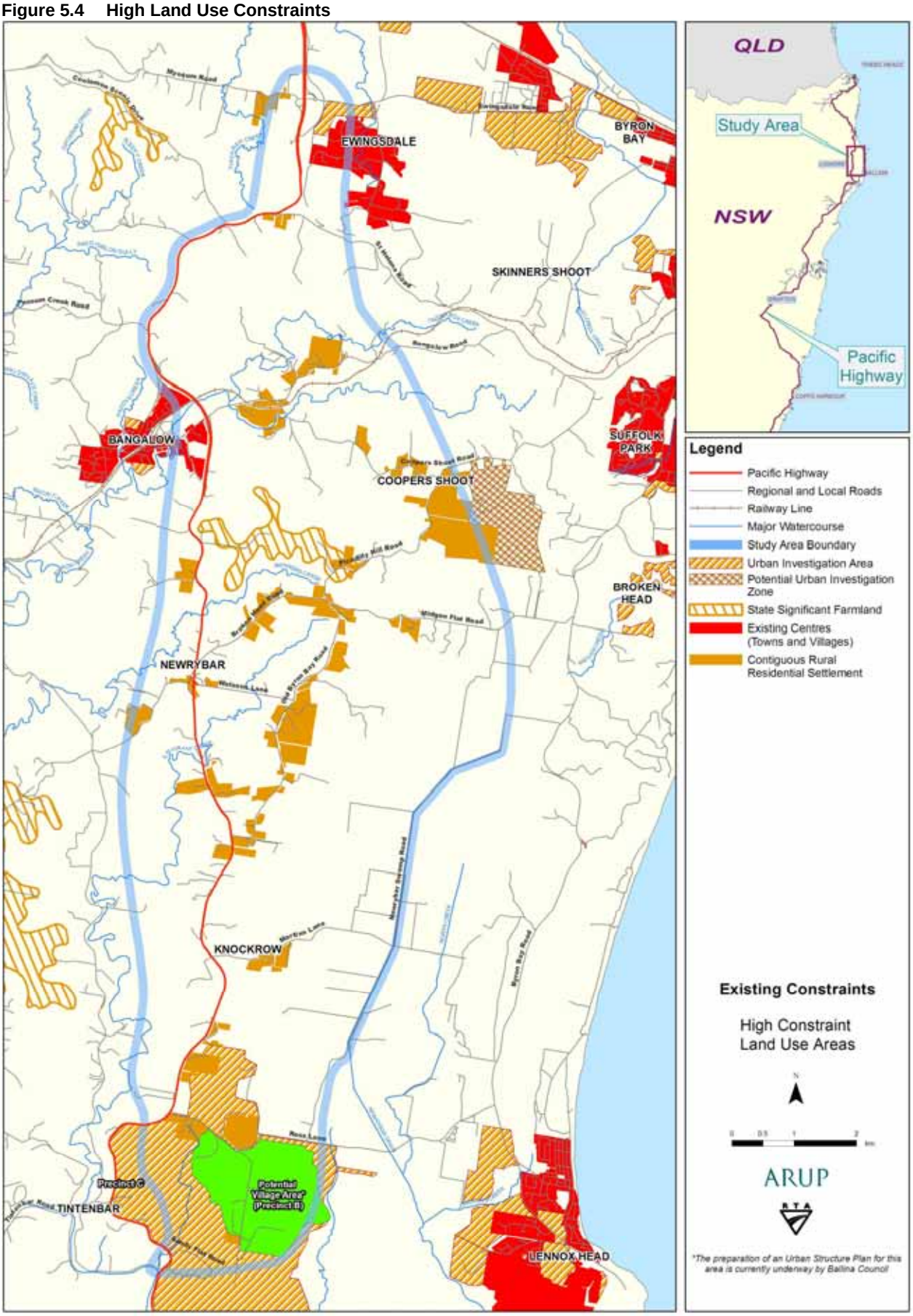
5.3.4 Land Use Constraints

The land uses described above have been reviewed and given a constraints classification. The land use constraints classifications are provided in **Table 5.3.** Agricultural and other existing rural land use constraints are mapped in **Figure 5.2** and **Figure 5.3**. Residential and urban high constraints are mapped in **Figure 5.4**.

Table 5.3 Land Use Constraints

Constraints Classification	Description
No-go areas	Townships and villages and associated infrastructure, e.g. schools, cemeteries, halls, churches and other religious buildings (such as temples) or nursing homes.
High constraint	Rural residential clusters and areas designated for future urban and rural residential. These areas include the rural residential clusters on St Helena Rd, Tinderbox Lane, Broken Head Road, Coopers Shoot Road, Piccadilly Hill Road, Old Byron Bay Road, Martins Lane East, Carney Place, Ross Lane, McLeish Road, Glenross Drive, Dufficys Lane. Areas designated for future residential development as identified in Ballina and Byron LEPs and/or relevant Shire Strategies. These include the areas known as Natural Lane in Byron Shire and the Cumbalum Ridge in Ballina Shire. State Significant Land as identified in DoP's Farmland Protection Project.
Medium constraint	Agriculture production enterprises, other business and rural residential properties.

Figure 5.4 High Land Use Constraints



5.4 Topography, Geology and Soils

5.4.1 Geological and Soil Condition

The geological and soil conditions in the study area are described below in **Table 5.4** and mapped in **Figure 5.5** and **Figure 5.7.**

Table 5.4 Geological and Soil Condition

Terrain Unit	Topography	Geology	Soils
Floodplain	Low-lying floodplain east of the escarpment foothills.	Quaternary alluvial sediments overlaying Quaternary estuarine sediments and Quaternary marine and barrier sediments	Alluvial, estuarine and marine soils; organic and non-organic clay, sand, indurated sand (weakly cemented with humic ferrous oxide), and stiff to hard clay and silt. Potential Acid Sulfate Soils.
Escarpment	Distinctive steep slopes, punctuated by spurs and gullies.	Argillites/greywackes of the Neranleigh-Fernvale Group present within 20 m beneath the lower slopes and spurs. Sandstone of the Ripley Road Sandstone and Raceview Formations form outcrops. Some basalt outcrops as well.	Residual soils, colluvium or landslide debris.
Plateau	Elevated plateau characterised by low rolling hills dissected by moderately deeply incised gullies and valleys, with some elevated ridges and hills. Topographic relief generally increases from south to north.	Basaltic rock of the Lismore basalt.	Residual soils.

5.4.2 Route Option Constraints

Within the study area the following issues impose a constraint on route selection:

- Landslides and mass movement – both existing and potential. Areas of instability, indicating susceptibility to landslides, are shown in **Figure 5.6**.
- Low strength and compressible soils ('soft soils') on the floodplains. The geology of the study area is shown in **Figure 5.7**.
- Acid Sulfate Soils (ASS) on the coastal plains. Areas of potential ASS are shown in **Figure 5.7.**

Figure 5.5 Soil Landscape

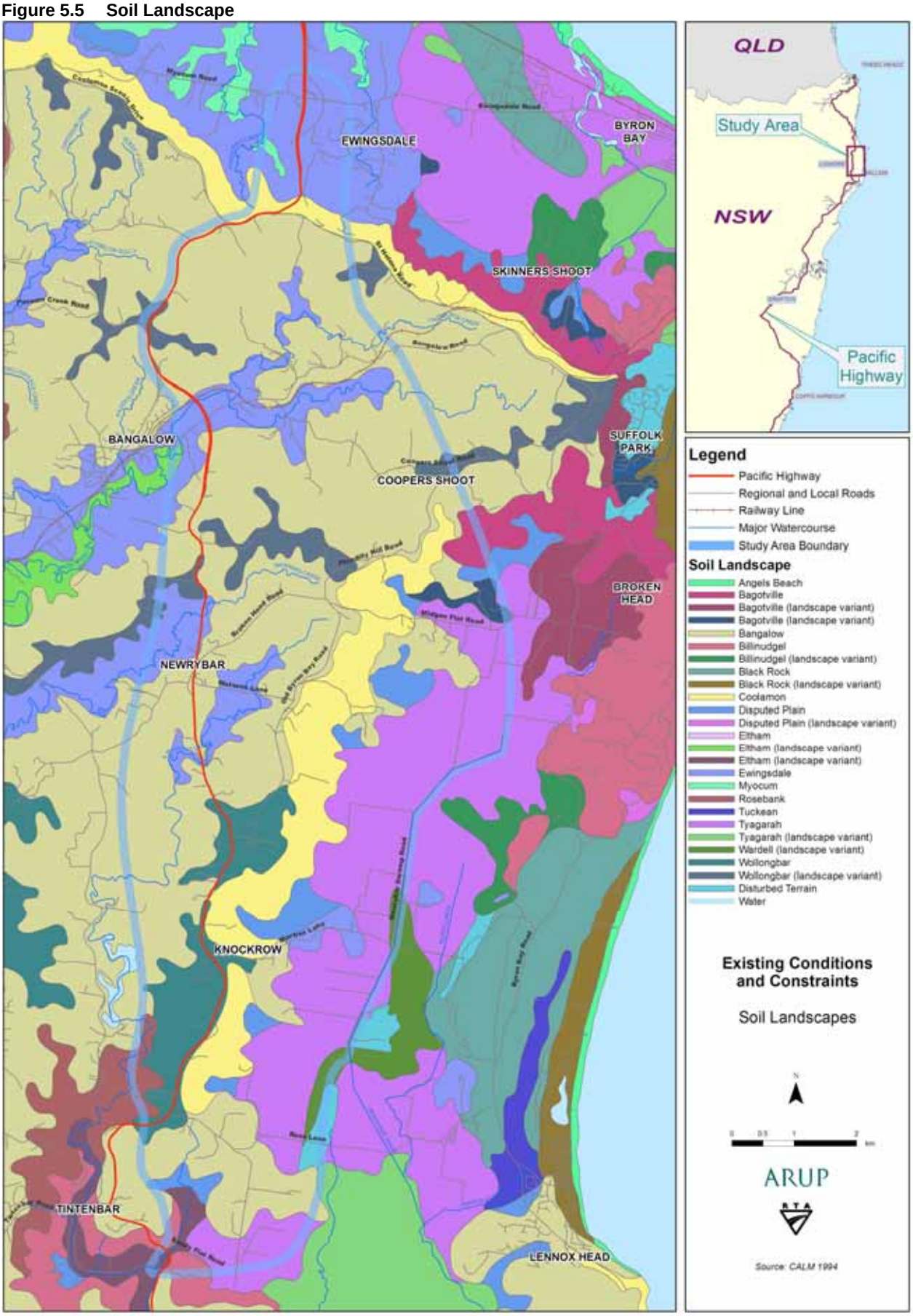


Figure 5.6 Geotechnical Features

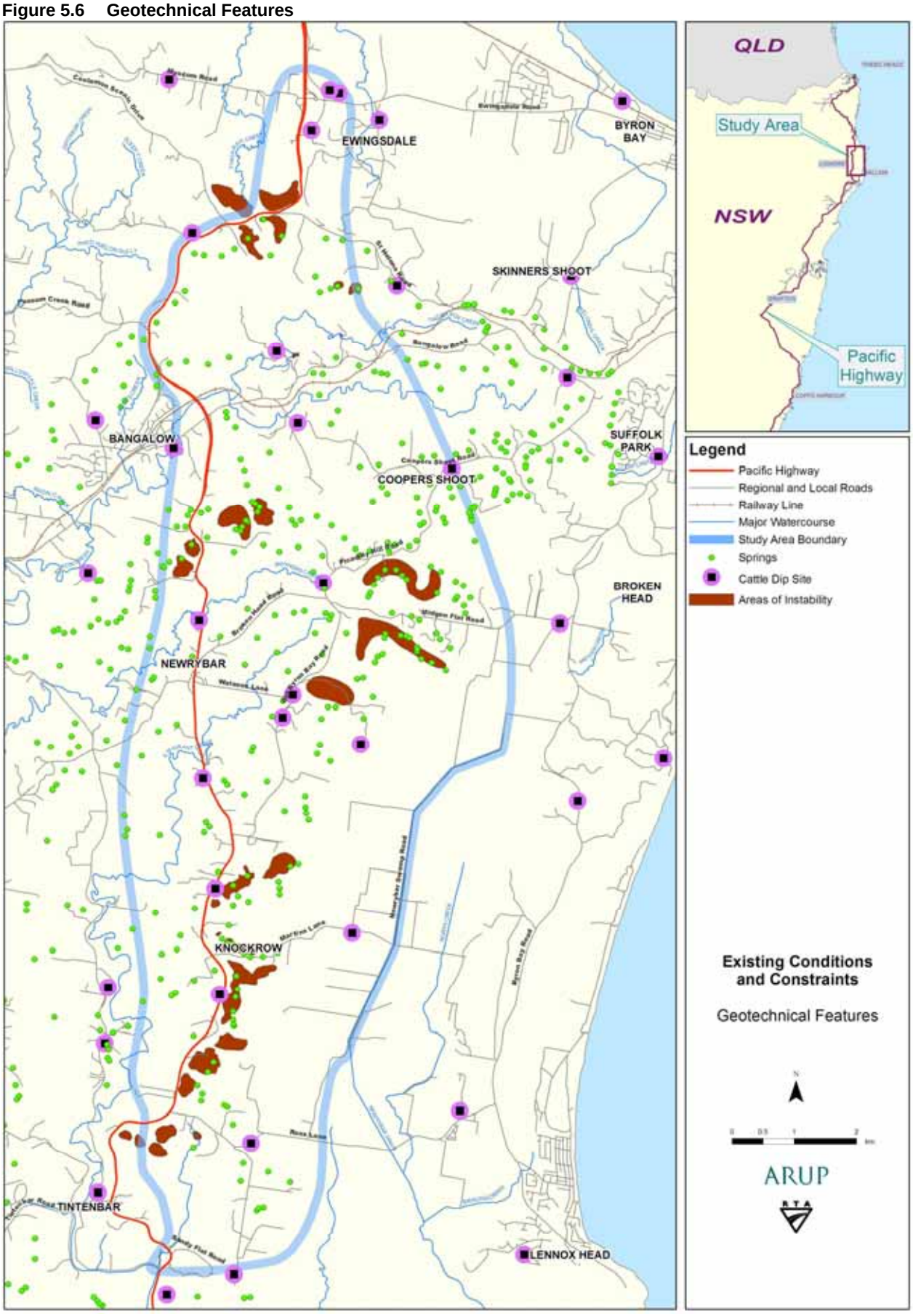
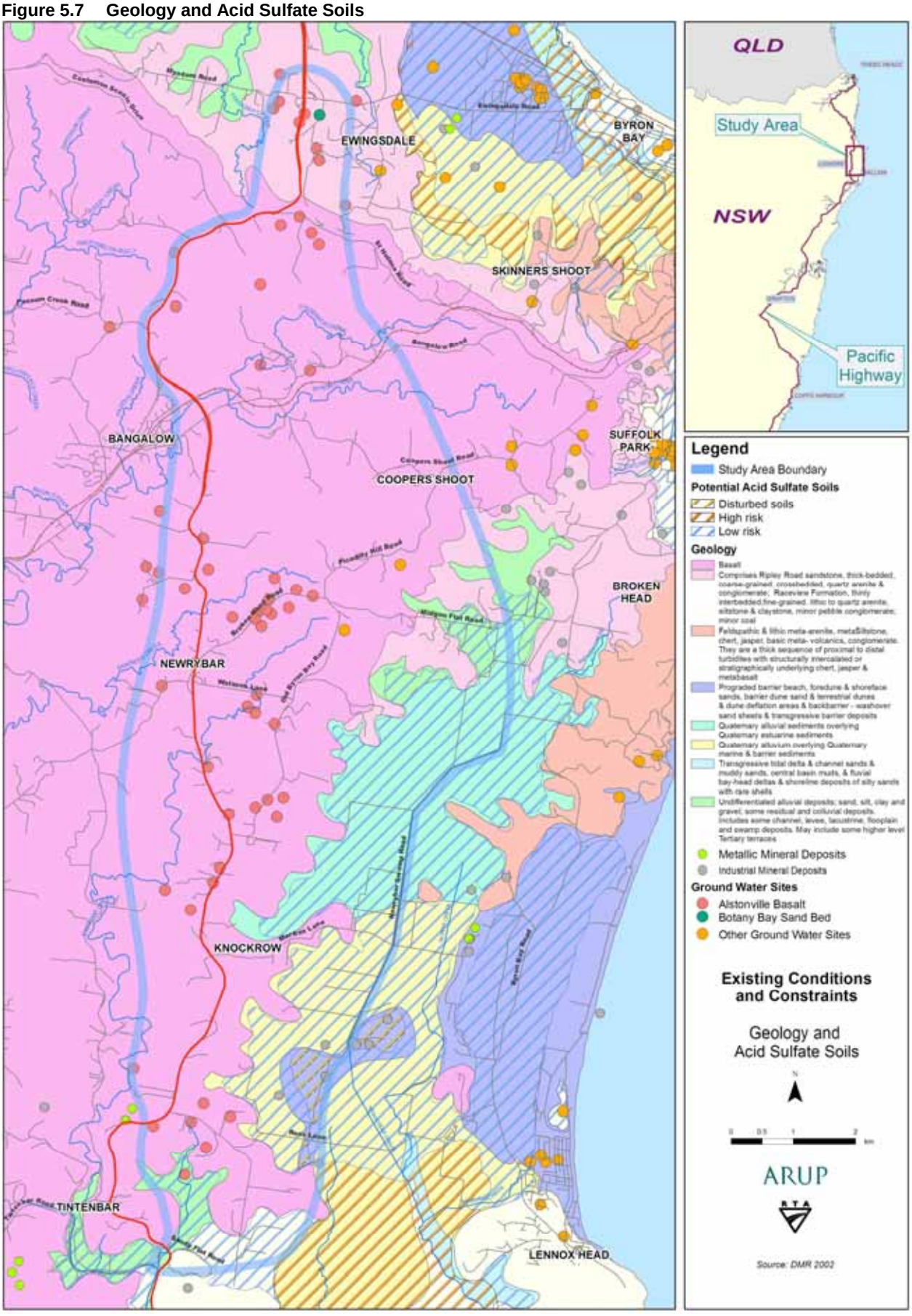


Figure 5.7 Geology and Acid Sulfate Soils



5.4.3 Engineering Issues Associated with Geotechnical Constraints

The following engineering constraints relate to issues that require consideration in route design:

- Variability of the Lismore Basalts – variable weathering profile and the presence of boulders. Inter-bedding of layers of high and low strength rock and relict soil horizons.
- Alteration of complex groundwater regimes within the variable rock profile.
- Amorphous clay content of residual basaltic soils.
- Intersection of relict, possibly saturated soil horizons creating mechanisms for mass movement.
- Contaminated soils – related to old cattle dips and historic use of pesticides.

Cuts and Construction Material Sources

Cut batter profiles and depths have the potential to impact on visual and aesthetic compatibility (urban design and scenic value), the width of corridor required to construct the road and the balance of cut and fill materials for earthworks. There is also the potential requirement for drill and blast in high and very high strength rock, which may have a noise and vibration impact during the construction phase.

The variable rock conditions mean that different cut batter profiles and excavations techniques would be required depending on the actual conditions at each cut.

There is a high likelihood that drill and blast would be required to excavate competent rock, such as typically occurs in the more elevated parts of the study area. This rock can be excavated to form relatively steep batters (resulting in a narrower road footprint) but would likely require localised structural support, such as rock bolts, to maintain stability. Where competent basalt overlies poorer quality weathered rock and/or soil horizons, there is a higher risk of instability. This would need to be considered at the design stage. With some processing and crushing, most of the excavated high strength basalt is expected to be suitable for the production of select materials. In addition, there are some existing operational quarries in or near the investigation area that could supply high quality construction materials.

The relatively low strength rock and residual soil can be excavated using conventional rippers and excavators, with assistance from rock breakers in higher strength layers. The excavated material would be suitable for general embankment fill. Cut batter slopes in low strength rock and residual soils would need to be relatively shallow (max. 2H:1V) and this would result in a relatively wide road corridor.

Tunnel

Geotechnical risks and issues associated with a potential tunnel include tunnel support requirements, potential to impact on the groundwater regime (including local groundwater bores and springs) and excavation methods, which may include drill and blast.

A tunnel beneath St Helena Hill would likely be through the Lismore Basalt generally comprising relatively competent high strength basalt separated by more weathered and fractured basalt layers.

The tunnel construction is feasible, using tunnelling techniques that have been used previously in NSW and overseas. Twin tunnels with an arched roof profile and rock pillar separating the tunnels are expected to be suitable for the anticipated ground conditions, similar in profile to the recently constructed Cudgen Road Tunnel. Tunnel excavation would use drill and blast techniques, which offer the greatest flexibility in the anticipated variable conditions.

Aligning the tunnel to avoid poorer rock conditions and locate the arched roof within the competent rock layers would reduce tunnelling risks.

The tunnel is not expected to significantly impact on the existing groundwater regime, and for this reason a drained tunnel option (unlined) is considered feasible. This is because limited groundwater inflows into the tunnel are expected. A tunnel mainly within weathered and fractured rock (roof in

competent rock) could be designed so that groundwater inflows are collected and used to supply existing springs in the vicinity of the tunnel portals.

Floodplain

In the floodplain area the road would probably be carried on fill embankments. The key geotechnical issues are the risks associated with the construction of the road over low strength and compressible soils ('soft soils'); which may impact on the road construction duration, long-term pavement performance, and costs, for construction and long-term pavement maintenance.

The embankments would cause settlement of the compressible foundation soils during construction and also later following completion to design height. The bearing capacity (strength) of the foundation soils would improve as the settlement occurs. The rate of embankment construction (by adding successive fill layers) would need to be carefully balanced so that the strength of the foundation soils is not exceeded and does not result in instability of the embankments during construction. Methods are available for increasing the rate of settlement and strength improvement, such as improving the soil drainage and surcharging (temporarily adding a greater height of fill than required).

The construction of the pavement on the top of the embankment would need to be programmed to limit the risk of future settlement of the foundation soils causing damage to the pavement. This may mean that additional time of several months is needed after completing construction of the embankment to wait for additional foundation settlement to occur (preloading period).

Road construction is not expected to impact on the existing groundwater regime beneath Newrybar Floodplain.

Fill embankments on highly compressible soils on the floodplains would settle more than the pile supported bridges. Bridge approach treatment would be needed to smooth the transition from pile supported bridges to embankments on floodplains so that a stepped pavement surface does not develop between the bridge and embankment. These treatments may include pile supported geosynthetic reinforced embankments.

Acid Sulfate Soils

Road construction over the floodplain is not expected to result in the release of Acid Sulfate Soils into the environment or changes to the groundwater regime that would result in exposure of potential acid sulfate soils above the water table. Where localised disturbance of acid sulfate soils is required, the works would be carried out in accordance with relatively standard procedures for managing Acid Sulfate Soils, which would be described in an Acid Sulfate Soils Management Plan.

Other Geotechnical Issues

These include:

- Limitations of the existing geotechnical data and engineering models developed to assess each of the key geotechnical issues and provide a robust comparison of the feasible route options.
- Halloysitic mineralogy of the residual basaltic clay, which impacts the management of earthworks. These soils are considered suitable for use as general fill material during roadworks provided suitable construction techniques and compaction controls are employed.
- The presence of basalt boulders/corestones in the weathered rock profile, which impacts on excavation techniques.
- Contamination – the nature of potential contamination in the study area is typical of a rural agricultural environment with low concentrations of diffuse contamination and some known cattle dip sites (point sources). The cost of remediating cattle dip sites would be relatively low in comparison to other cost drivers. For these reasons, contamination is not considered to be a criterion for route selection.

5.5 Hydrology

The study area lies predominantly within the catchment of the Richmond River, with the exception of a small section in the far north which forms part of the Brunswick River Catchment. The Richmond River Catchment covers an area of approximately 7,000 square kilometres, from Cape Byron in the north to the coastal plain adjacent to Evans Head in the south and the Border Ranges National Park and the Richmond Range in the west.

The following named creeks pass through the study area:

- Tyagarah Creek
- Tinderbox Creek
- Byron Creek
- Skinners Creek
- Emigrant Creek
- Newrybar Drain
- Sandy Flat Creek.

Tyagarah, Tinderbox, Byron, Skinners and Emigrant Creeks originate in the highlands west of the Main Coast Range, and flow generally to the southwest, with the exception of Tyagarah Creek, which flows north to the Brunswick River. The remaining creeks are located in the 'flats' to the east of the Main Coast Range. The area falls wholly within the region overseen by the Northern Rivers Catchment Management Authority.

Although not directly passing through the study area, the following watercourses are relevant to characterising the local hydrologic and hydraulic system.

- Simpsons Creek
- Flood Mitigation Drain
- North Creek
- Deadmans Creek.

Figure 5.8 shows the major catchment areas and surface water features in the study area.

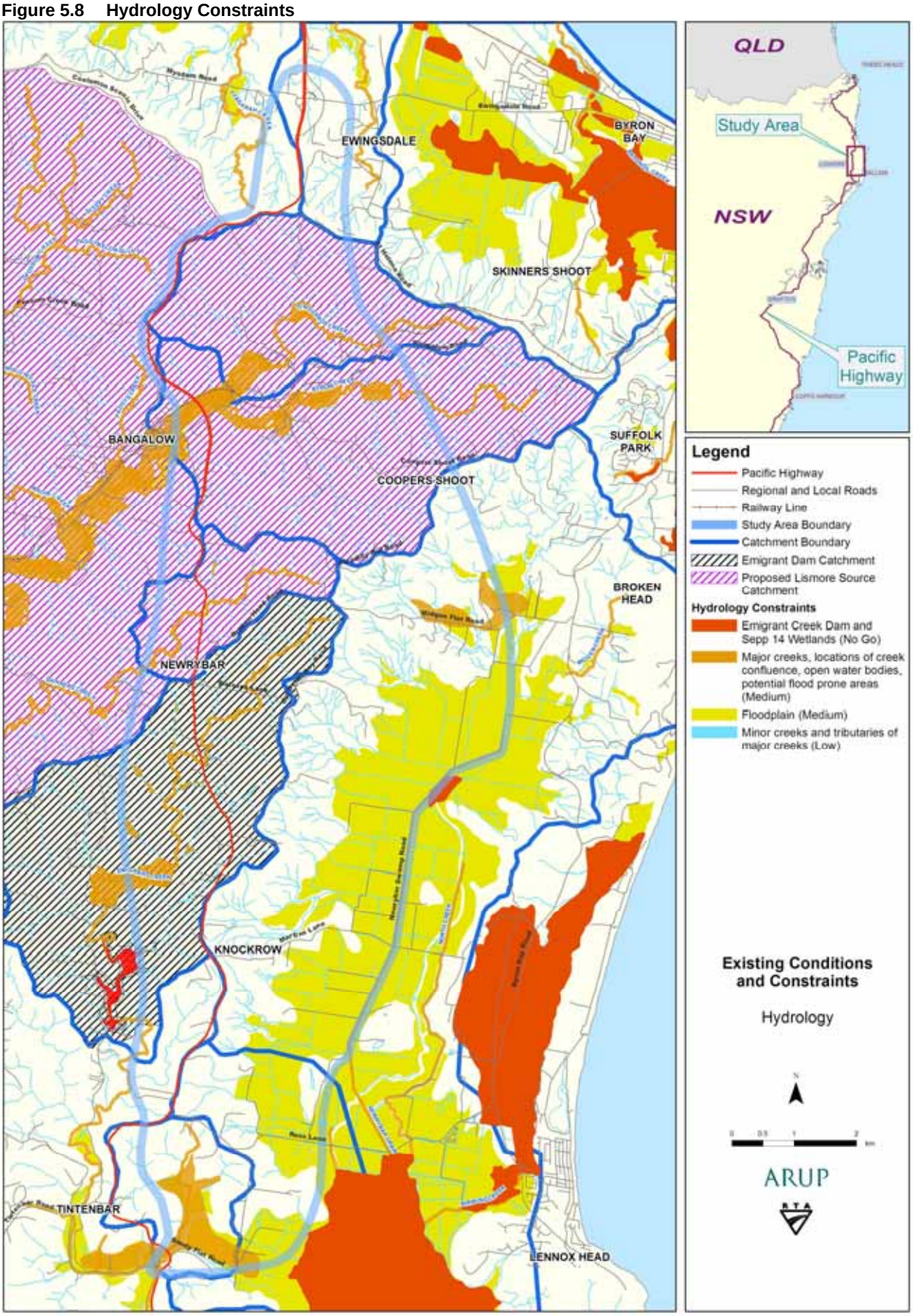
The constraint levels of hydrological issues mapped in **Figure 5.8** are defined below in **Table 5.5**.

Table 5.5 Hydrology Constraint Classification

Constraint Classification	Description
No-go area	Areas to avoid, e.g. SEPP 14 Wetlands.
High	There are no high hydrologic constraints.
Medium	Major creeks, locations of creek confluence, open water bodies, potential flood prone areas.
Low	Minor creeks and tributaries of major creeks.

For the purpose of this study, major creeks have been defined as all named creeks identified on topographic mapping, with the remaining watercourses categorised as minor creeks. All creeks within the area of investigation are relatively small in real terms.

Figure 5.8 Hydrology Constraints



Flooding Characteristics

Flooding characteristics for the study area have been identified based on review of available contour information, input from the community, site walkover observations, and existing flood mapping held by the Councils and DoNR.

Hydrologic and hydraulic computer modelling will be carried out once a detailed topographical survey is available.

Key past reports and plans used to compile hydrologic and hydraulic constraints include:

- *Flood Study of Richmond River Floodplain* (WBM on behalf of Ballina Shire Council 1998).
- Ballina Shire Council Minimum Fill Level Plans.
- Hydrologic and Hydraulic Studies, *Ballina Bypass EIS* (WBM).
- Byron Shire Council DCP Part K: Flood Liable Lands.
- DIPNR (DoNR) floodplain mapping.

The *Ballina Floodplain Management Study* was carried out by WBM on behalf of Ballina Shire Council in 1996-97. As part of the study, numerical models were created for the lower Richmond River. On the Newrybar Plain, the modelling extended as far north as Ross Lane, and for the Emigrant Creek network the model extends to Sandy Flat. This study identified and modelled design floods comprising combinations of the three primary sources of flooding in Ballina Shire:

- Rainfall over the Richmond River Catchment (total catchment area 7,000 km²) causing the river to swell and break its banks.
- Rainfall on the local catchments and floodplains (Maguires Creek, Emigrant Creek, North Creek etc).
- Elevated ocean levels and storm wave conditions.

A one-dimensional hydraulic model was developed, from which flood levels for various storm return periods were estimated. The 1% Annual Exceedance Probability (AEP) flood levels from this model, outlined in **Table 5.6,** were used to create the Ballina Minimum Fill Level Plan. The fill levels are therefore an approximate representation of the 1% AEP event for the purpose of planning floor levels for new developments. Mapping of fill levels extends as far north as Martins Lane, which runs perpendicular to the Newrybar Drain.

Table 5.6 Key 1% AEP Planning Levels for the Study Area

Location	Approximate 1% AEP level (m AHD)
Martins Lane East	3.2 m
Ross Lane	2.0 m
Deadmans Creek, south of Ross Lane and east of the Ballina Nature Reserve	1.8 m
Confluence of Sandy Flat Creek and Emigrant Creek	4.0 m

A hydraulic and hydrologic study was carried out by WBM for the effects of the Ballina Bypass on the flooding regime. The base model used in this assessment was an upgraded version of that used in the 1997 *Ballina Floodplain Management Study*. The model was extended to include the Sandy Flat Area.

It was found that in large flood events Sandy Flat Creek acts as a conveyor of floodwaters backing up from Emigrant Creek. Floodwaters inundate the Sandy Flat Creek Basin and overflow to the North Creek Floodplain.

The study was undertaken with limited survey information in the Sandy Flat area, and hence the hydraulic model is rough in this area. However, it was estimated that for the proposed crossing of Sandy Flat Creek as part of the Ballina Bypass, a minimum total opening width of 10 m is required to maintain existing flood inundation patterns for a 100 year flood.

WBM has since been commissioned by Ballina Shire Council to carry out two-dimensional modelling for the Richmond River floodplain. This model would have the same extent as the existing one-dimensional model.

Tidal Effects

Tidal effect within the study area is contained to Emigrant Creek, North Creek and Newrybar drain. The tidal limit for the North Creek extends to just to the south of Martins Lane East. Emigrant Creek's tidal limit is defined by the Tintenbar Road Bridge.

5.6 Water Quality

Preliminary water quality sampling was undertaken at representative sites in all catchments throughout the study area. Water was sampled *in situ* for temperature, salinity, dissolved oxygen and pH. Additionally, water samples were taken for analytical testing for organochlorine pesticides, trace elements, oil and grease, nitrogen, phosphorus and chloride. The results of water quality analysis were used to assess water quality within the study area in terms of the health of aquatic ecosystems by comparison with ANZECC (2000) *Guidelines for Fresh and Marine Waters*.

Water quality results for all watercourses sampled were typical of aquatic ecosystems that, historically, have been highly disturbed by agricultural and grazing practices. The results of the sampling are presented in **Table 5.7** in relation to the ANZECC (2000) Guidelines.

Table 5.7 Water Quality in the Study Area (in comparison with ANZECC (2000) Guidelines)

	ANZECC Trigger Values	Emigrant Creek	Skinners Creek	Byron Creek	Sandy Flat Creek	North Creek (slopes)	North Creek (plains)
pH	6.5-8.0	↓	↓	✓	↓	V	↓
Dissolved Oxygen (% saturation)	8.5-110	V	↓	V	↓	↓	V
Salinity (µS/cm)	125-2200	↓	↓	V	✓	V	✓
Total Phosphorus (µgP/l)	<50	↑	↑	↑	V	↑	✓
Total Nitrogen (µgN/l)	<500	✓	V	✓	✓	V	✓
Oxides of Nitrogen (µgN/l)	<40	↑	↑	V	↑	V	V

↓ - below guidelines, ↑ - above guidelines, **V** - variable (inside and outside of guidelines), ✓ - within guidelines

Rous Water is currently documenting the results of a two-year water quality monitoring programme for some watercourses in the study area. Once available the data would be used to update and supplement the project information within the study area.

Parts of the study area lie within two catchment areas for drinking water, namely the Emigrants Creek Dam Catchment and the proposed Lismore Water Source.

These areas are shown in **Figure 5.8**. Emigrants Creek Dam itself is a high constraint but is not within the study area.

5.7 Aquatic Ecology

5.7.1 Aquatic Habitats

The study area contains, or could possibly impact on, a number of watercourses with varying aquatic ecological significance as shown in **Figure 5.9.** Field investigations of these watercourses were undertaken between May and December 2005.

5.7.2 Threatened Species

In addition to a survey of habitats, databases were searched for the possible presence of threatened or endangered species. The following species were identified as requiring consideration.

- Eastern freshwater cod (*Maccullochella ikei*)
- Oxleyan pygmy perch (*Nannoperca oxleyana*)
- Olive perchlet (*Ambassis agassizii*)
- Freshwater catfish (*Tandanus tandanus*)

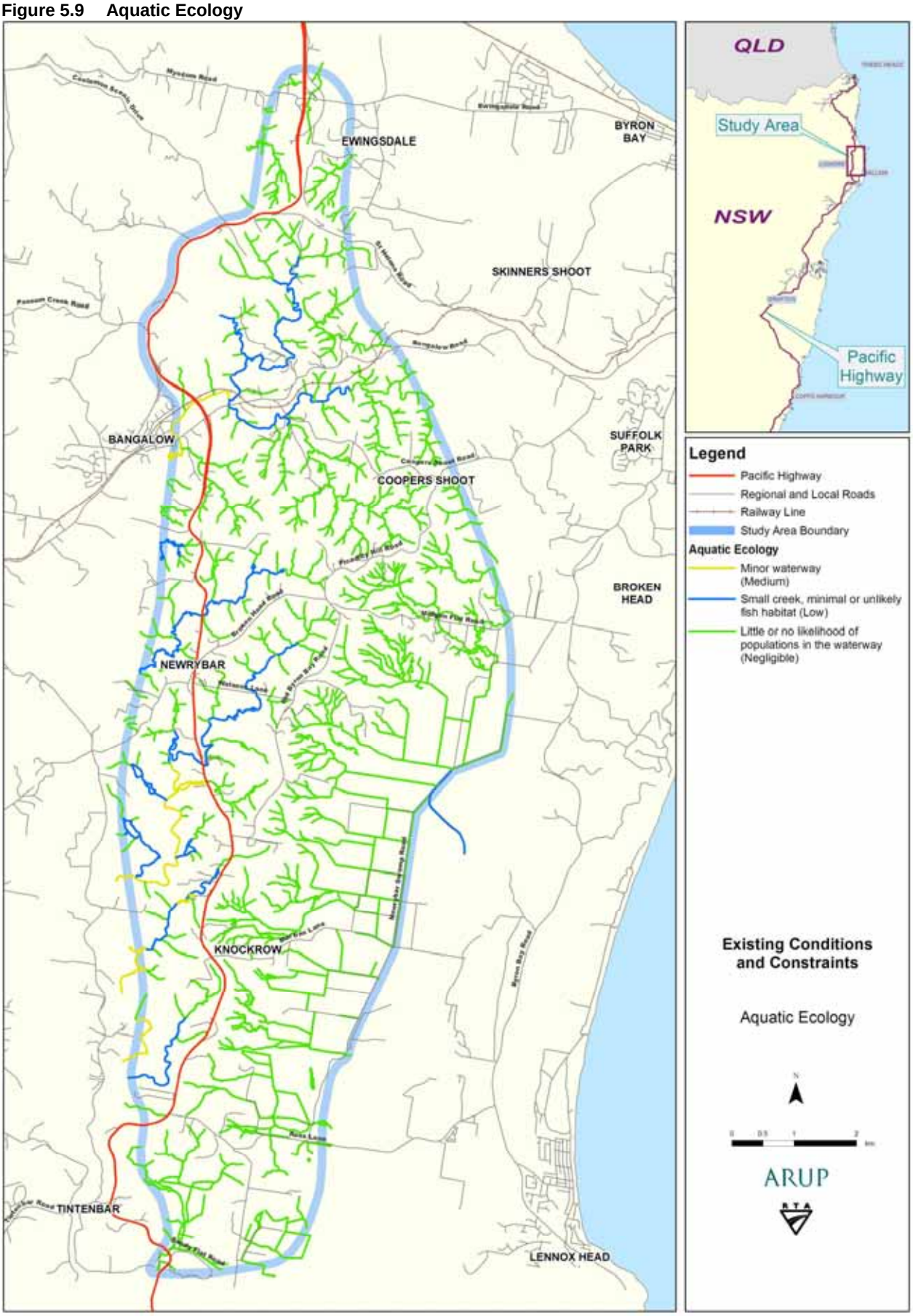
In order to describe the relative significance of each waterway in relation to the project, a constraints classification has been adopted as shown in **Table 5.8**.

Figure 5.9 illustrates the classification of the respective watercourses study area. Notably no watercourses are allocated a 'high' classification. A few water courses have a classification of 'medium' (including Emigrants Creek and Byron Creek) but most are 'low' to 'negligible'.

Table 5.8 Aquatic Ecology Constraints

Constraint Classification	Definition
High	Permanent or major waterway with clearly defined creek bed and banks, considered moderate or major fish habitat. Potential for alteration to minimal fish habitat, fish passage, fish abundance, diversity or water quality that can be at least partially mitigated at design and construction phases. Potential for presence of threatened species, or threatened species known to be present. High level of recreational and/or commercial fishing activities occur in the waterway that may be affected.
Medium	Minor waterway that connects with wetlands and provides potential refuge, breeding or feeding area for aquatic fauna. Potential for minor alteration to minimal fish habitat, fish passage, fish abundance, diversity or water quality that can be effectively mitigated at design and construction phases. Potential for presence of threatened species. Some recreational and commercial activities occur in the waterway and require consideration.
Negligible to Low	Waterway is ephemeral, a drainage line or small creek with minimal or unlikely fish habitat. Waterway could be crossed without instream structures and set back from creek banks with no to negligible effects on fish habitat, fish passage, fish abundance, diversity or water quality. Little to no likelihood of threatened aquatic species or populations in the waterway. Little or no recreational or commercial fishing activities that would be affected by a waterway crossing.

Figure 5.9 Aquatic Ecology



5.8 Terrestrial Ecology

5.8.1 Threatened Species

The NSW Threatened Species Conservation Act 1995 (TSC Act) protects all threatened plants and animals native to NSW (with the exception of fish and marine plants). It provides for the identification, conservation and recovery of threatened species and their populations and communities. It also aims to reduce the threats faced by those species.

The Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act) provides for the identification and listing of Threatened Species and Threatened Ecological Communities.

Threatened species recorded in the study area are shown in **Figure 5.10**.

A total of 48 threatened plant species listed on the TSC Act and/or EPBC Act have previously been recorded within a 10 km radius of the study area.

A total of 58 threatened animal species and/or migratory species listed on the TSC Act and/or EPBC Act have previously been recorded within 10 km of the study area.

Platypuses have been previously recorded by local residents on the unnamed creekline leading south from the St Helena Road ridgeline, from the unnamed creek running through “Clovelly Grove” south of Knockrow and from the dam on “Yarrenbool” within the study area. Although the Platypus is not listed as a threatened species on either the TSC Act or the EPBC Act, its presence has the potential to be a significant issue due to public concern for this well known and iconic Australian species.

Swamp Sclerophyll Forest, which is an Endangered Ecological Community (EEC) listed on the TSC Act, was recorded in the study area. Additionally, the EECs of Byron Bay Dwarf Graminoid Clay Heath Community, Freshwater Wetlands on Coastal Floodplains and Subtropical Coastal Floodplain Forest are known to exist within Byron and Ballina Shire Council Areas, but do not occur within the study area.

5.8.2 Key Habitats and Wildlife Corridors

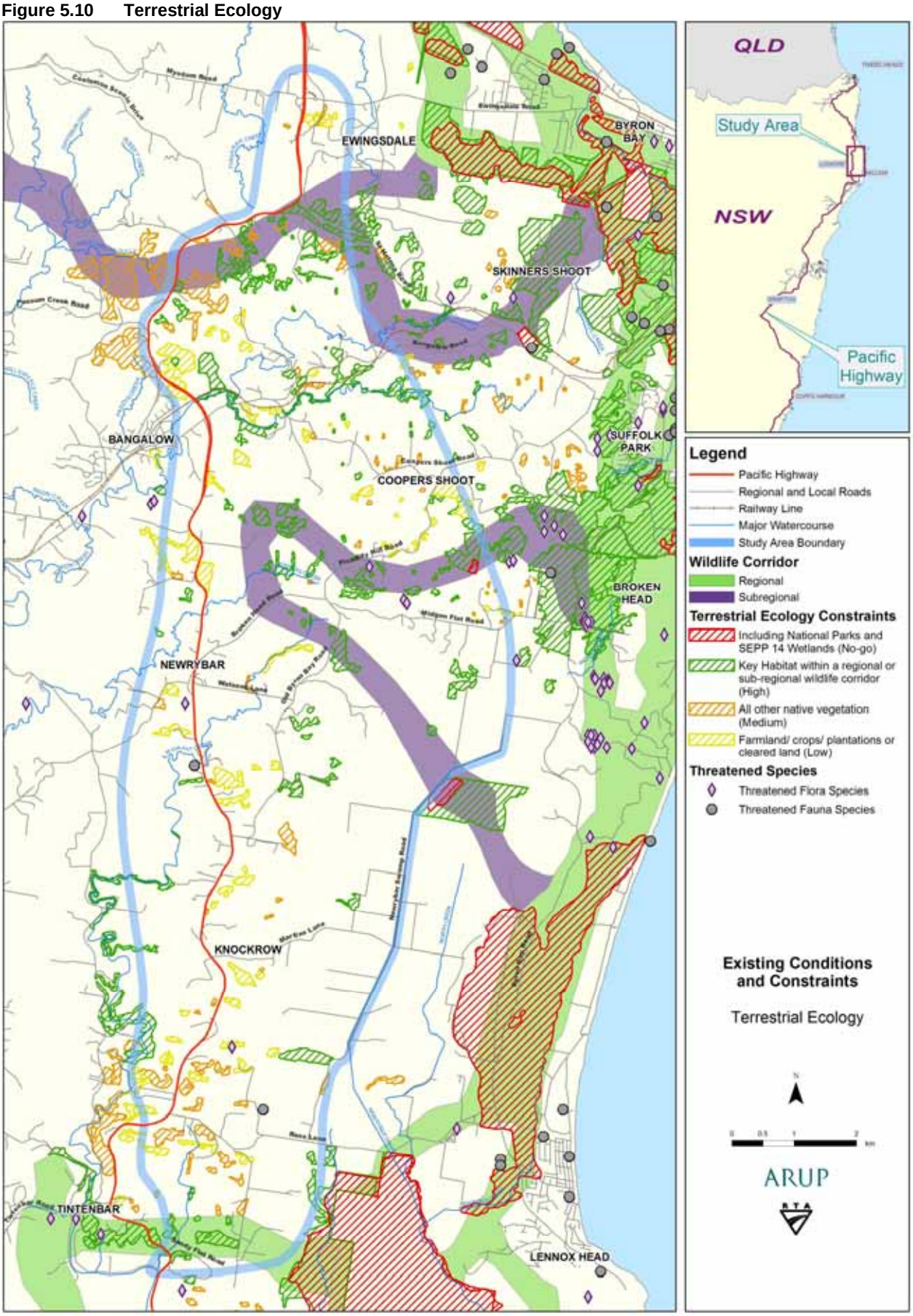
Key habitat and corridors have been proposed by the NSW Department of Environment and Conservation (DEC) and mapped to provide an indicative representation and consolidation of areas of potential high conservation value for priority forest fauna and habitat corridors that link these across the landscape. These areas of vegetation form part of a large network of vegetation patches and represent potential habitat and linking habitat for species. At the regional scale, three major corridor linkages cross the study area. One major corridor runs down the eastern boundary of the study area.

Byron Shire Council also provides mapping of wildlife corridors in the Byron *Draft Biodiversity Conservation Strategy*. These corridors show a close correlation to the corridors identified by DEC, although they also include additional areas outside the DEC corridors.

Although the study area contains numerous patches of vegetation, many of these patches consist predominantly of Camphor Laurel and, as such, are of low conservation value. However, throughout the study area there are a number of areas of significant vegetation in both the east and west. It should be noted that due to the large amount of clearing that has taken place in this landscape that even small patches of vegetation are considered to be of high conservation value.

The corridors identified by Byron Shire Council and DEC are detailed below and shown in **Figure 5.10**. For ease of describing the varying ecological habitats the study area has been split into sections.

Figure 5.10 Terrestrial Ecology



Northern Section (Ewingsdale to Bangalow)

In the northern section, lying along the St Helena Road ridgeline and then down to the coastal floodplains, is a string of rainforest with minimal Camphor and Camphor Laurel patches within two east-west DEC sub-regional wildlife corridors. The northern corridor links Goonengerry National Park to the northwest with Tyagarah Nature Reserve to the northeast while the southern corridor links Skinners Shoot with St Helena and the Goonengerry-Tyagarah corridor. Cleared areas, patches of Camphor Laurel and the existing Pacific Highway already fragment these corridors.

Middle Section (Bangalow to Newrybar)

To the southeast of Bangalow a U-shaped sub-regional corridor enters the east of the study area and links Newrybar Swamp with Piccadilly Hill. This corridor contains a number of patches of high quality rainforest. However, cleared areas and Broken Head Road heavily fragment these patches.

Lower Section (Newrybar to Tintenbar)

Immediately south of Tintenbar an east-west DEC regional corridor crosses the study area from Ballina Nature Reserve in the east to Emigrant Creek near Tintenbar in the west and then south to Uralba Nature Reserve. This corridor is highly fragmented by cleared areas and the existing Pacific Highway.

Eastern Coastal Section (Ewingsdale to Ballina Nature Reserve)

Lying just outside the entire eastern boundary of the study area is a series of north-south DEC regional corridors. From north to south they link Tyagarah Nature Reserve, Cumbebin Swamp Nature Reserve, Arakwal National Park, Seven Mile Beach and Ballina Nature Reserve. All the east-west corridors discussed above link these north-south corridors with vegetation patches to the west of the study area. Although these north-south corridors are better vegetated than those discussed above, they are still fragmented by numerous roads, two railway lines, cleared farming land and the townships of Ewingsdale, Bryon Bay, Suffolk Park and Lennox Head.

Ballina Shire Council is presently finalising a Biodiversity Conservation Strategy, which would identify wildlife corridors and patches of vegetation of high conservation value. The corridor is likely to cross the study area from Ballina Nature Reserve in the east along Sandy Flat Road to Emigrant Creek near Tintenbar in the west and then north along Emigrant Creek to Killen Falls and Emigrant Creek Dam. The exact location of this corridor has not been finalised, but is likely to be similar to the DEC corridor discussed above for the Lower Section.

Constraints Classification

Assessment of the conservation significance of each habitat within the study area was based on a combination of the following factors:

- Size.
- Connectivity.
- Occurrence of significant plant and/or animal species.
- Occurrence of significant vegetation communities and/or habitats.
- Formal conservation/reserve status.
- Ecological integrity.

The significance of vegetation patches within the study area is evaluated on a geographical scale with four levels: National, State, Regional and Local. Due to the depletion and destruction of native vegetation across NSW, all native vegetation is considered to have at least Local significance. For the purposes of this report constraint levels for terrestrial ecology have been defined in **Table 5.9.**

Table 5.9 Terrestrial Ecology Classification

Constraint Classification	Description
No-go area	National Park Estates (i.e. National Parks and Nature Reserves) and SEPP 14 Wetlands.
High	Any native vegetation mapped by DEC as occurring within a regional or sub-regional wildlife corridor and/or being key habitat, and large patches of native vegetation and smaller patches that are connected to contiguous native vegetation, as they have high connectivity and/or intrinsic habitat value. Additionally, any vegetation patches on properties that are participating in the Land for Wildlife program or revegetation programs coordinated by the Big Scrub Rainforest Landcare Group (BSRLG) and patches of Camphor Laurel that are known to contain threatened species are mapped as 'high'.
Medium	All other native vegetation is mapped as 'medium' as it is of local significance. Additionally, Camphor Laurel mapped as occurring within DEC regional or sub-regional wildlife corridors is mapped as 'medium'.
Low	Cleared land, farmland and crops or plantations as they have little conservation value.

5.9 Climate and Air Quality

The study area lies on the coast with a local climate heavily influenced by offshore meteorological activity. The study area has a warm to subtropical climate and high rainfall, which provides an ideal situation for a great variety of agricultural and horticultural pursuits.

5.9.1 Climate Data

The information in **Table 5.10** was observed from meteorological data recorded at Byron Bay weather Station for 2004 supplied by the Bureau of Meteorology.

5.9.2 Dispersion Characteristics

The dispersion characteristics of the area are affected by wind speed, wind direction, atmospheric stability class and mixing height. Meteorological data was obtained from the Bureau of Meteorology recorded at the Ballina automated weather station from December 2003 to November 2004. Cloud cover data is recorded at the Byron Bay Lighthouse.

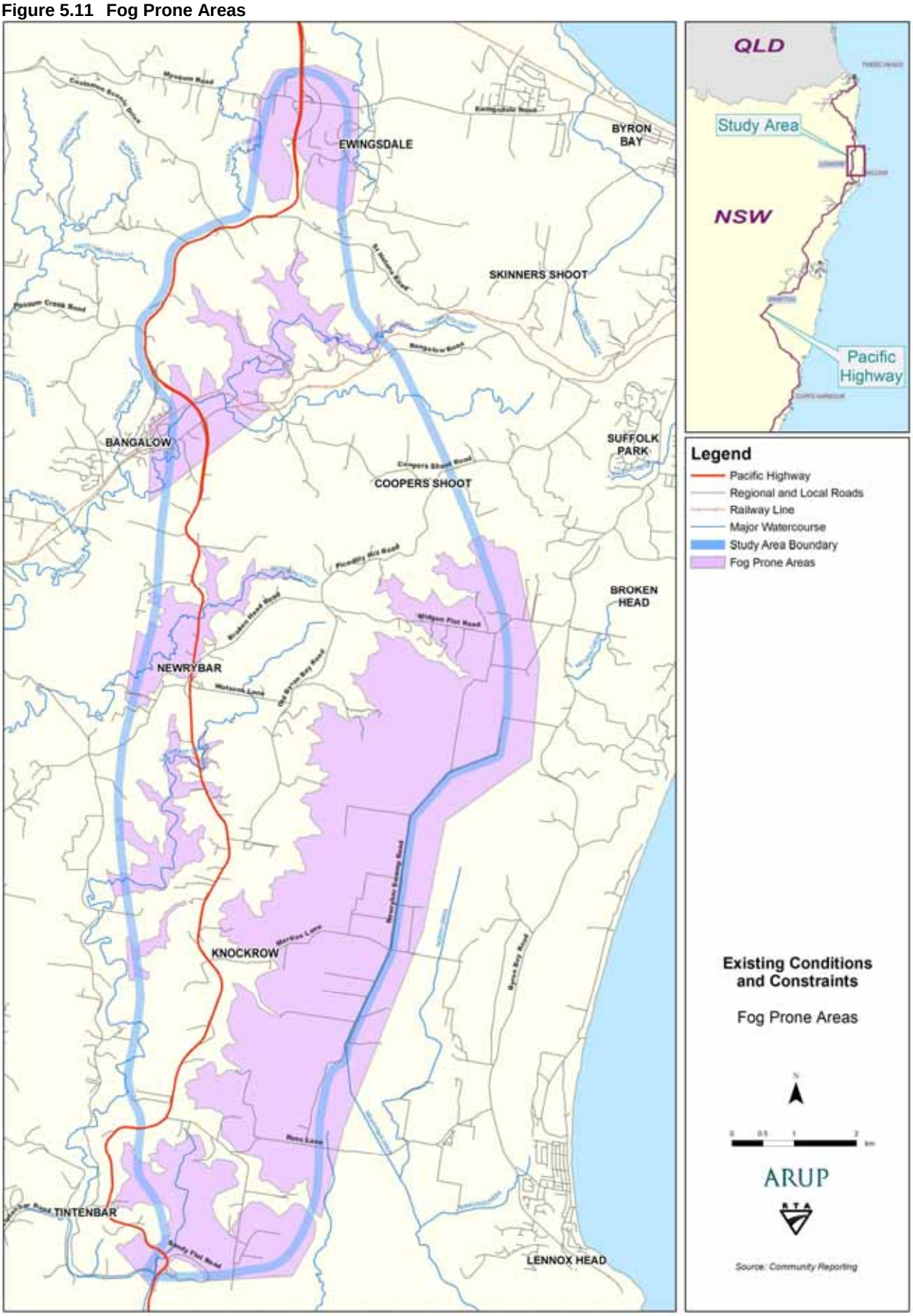
On an annual basis the data indicates that winds are predominantly from the north and west. In spring and summer the wind is mainly from the north, while in autumn and winter the wind is predominantly from the west. The annual average wind speed over the period was 3.9 m/s.

Atmospheric Stability is usually assigned according to six classes. These classes range from Class A which relates to unstable conditions in which plumes would spread rapidly, while Class F relates to stable conditions, in which a plume would spread slowly. The Classes B to E relate to intermediate dispersion conditions. The frequency of occurrence of each the different stability class was identified by data from the Byron Bay lighthouse. The high frequency of intermediate class stabilities (predominantly Class D for 38.6% of the time) indicates that atmospheric conditions would favour relatively quick dispersion for a significant proportion of the time.

Table 5.10 Meteorological Data, Byron Bay 2004

Temperature	• The annual average maximum and minimum temperatures experienced are 23.7°C and 16.5°C respectively. • On average January and February are the hottest months with an average maximum temperature of 27.5°C. • July is the coldest month, with average minimum temperature of 11.7°C. • Average minimum and maximum temperatures during summer range between 19.5°C and 27.5°C. • Average minimum and maximum temperatures during winter range between 11.7°C and 20.3°C.
Humidity	• The annual average humidity reading is 76% at 9am and 71% at 3pm. • The annual average humidity is 71%. • The month with the highest humidity on average is February with a 9am average of 83%. • The month with the lowest humidity on average is August with a 3pm average of 64%.
Rainfall	• Rainfall data shows that March is the wettest month, with an average rainfall of 212.1 mm over 17.0 days. • The average annual rainfall is 1707.6 mm with an average of 153 rain days. • There is a seasonal variation in average monthly rainfall, with most rain falling in autumn and the least rain falling in spring. The number of rain days is also highest in autumn and lowest at the end of winter and in spring.
Fogs and Frosts	• 15 fog and 14 frost observations have been recorded from 1963 to present. Fogs have been observed in the months of February, March, April, May, July, November and December, while frosts have been observed from June to September (source: Alstonville Tropical Fruit Research Station, located approximately 10 km to the WNW of Ballina). • A map of fog prone areas has been compiled from local community observations, and is presented in **Figure 5.11**. This map shows that areas of land at lower elevations and confined in valleys are prone to fog formation. To the east of the escarpment, fog is likely to occur up to an elevation of 30 m above sea level, while on the plateau to the west of the escarpment, fog is likely to occur adjacent to streams and is confined by valleys. This is consistent with the relatively low frequency of fogs recorded at Alstonville.

Figure 5.11 Fog Prone Areas



5.9.3 Air Quality

Pollutants

Air pollutants emitted from traffic include:

- Carbon monoxide (CO).
- Nitrogen oxides (NOx) comprising mainly a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2).
- Particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}) and less than 2.5 microns ($PM_{2.5}$) including polycyclic aromatic hydrocarbons (PAHs).
- Hydrocarbons including benzene, xylene, toluene, 1,3-butadiene and odours.

Diesel engines are a major contributor to air pollution and while heavy duty diesel vehicles make up less than 10% of the total Australian fleet and approximately 13% of vehicle kilometres travelled, they contribute approximately 40% of oxides of nitrogen and 60 to 80% of the particulate emissions by the road transport sector.

There is limited information regarding existing air quality within the study area. Areas located away from larger regional centres generally do not have air quality monitoring stations. The main reason for this is that in predominantly rural areas, pollutants do not exist in high enough concentrations to cause adverse environmental or health impacts or concerns. As such, monitoring for such pollutants on a long term basis is not usually undertaken outside metropolitan and/or industrial areas.

A number of environmental impact assessments, which have been undertaken for the upgrade of the Pacific Highway have included short-term air quality monitoring of CO adjacent to the highway. These results show that CO concentrations measured along the Pacific Highway are well below the relevant DEC 8 hour criteria of 9 ppm (EPA 2001).

Constraints

The DEC has air quality goals for nitrogen dioxide, carbon monoxide and particulate matter. **Table 5.11** lists the relevant DEC air quality goals for New South Wales. These goals are used for assessing roadway projects and impose a constraint on the location and design of a highway.

Table 5.11 DEC Air Quality Goals

Pollutant	Goal*	Averaging period
Carbon monoxide	25 ppm or 30 mg/m³	1-hour
	9 ppm or 10 mg/m³	8-hour
Nitrogen dioxide	0.12 ppm or 246 μg/m³	1-hour
	0.03 ppm or 62 μg/m³	Annual
Particulate matter	50 μg/m³	24-hour
< 10 microns(PM10)	30 μg/m³	Annual

* mg/m³ – milligrams per cubic metre, ppm – parts per million, μg/m³ – micrograms per cubic metre

5.10 Public Utilities

The following utilities have been identified in the study area:

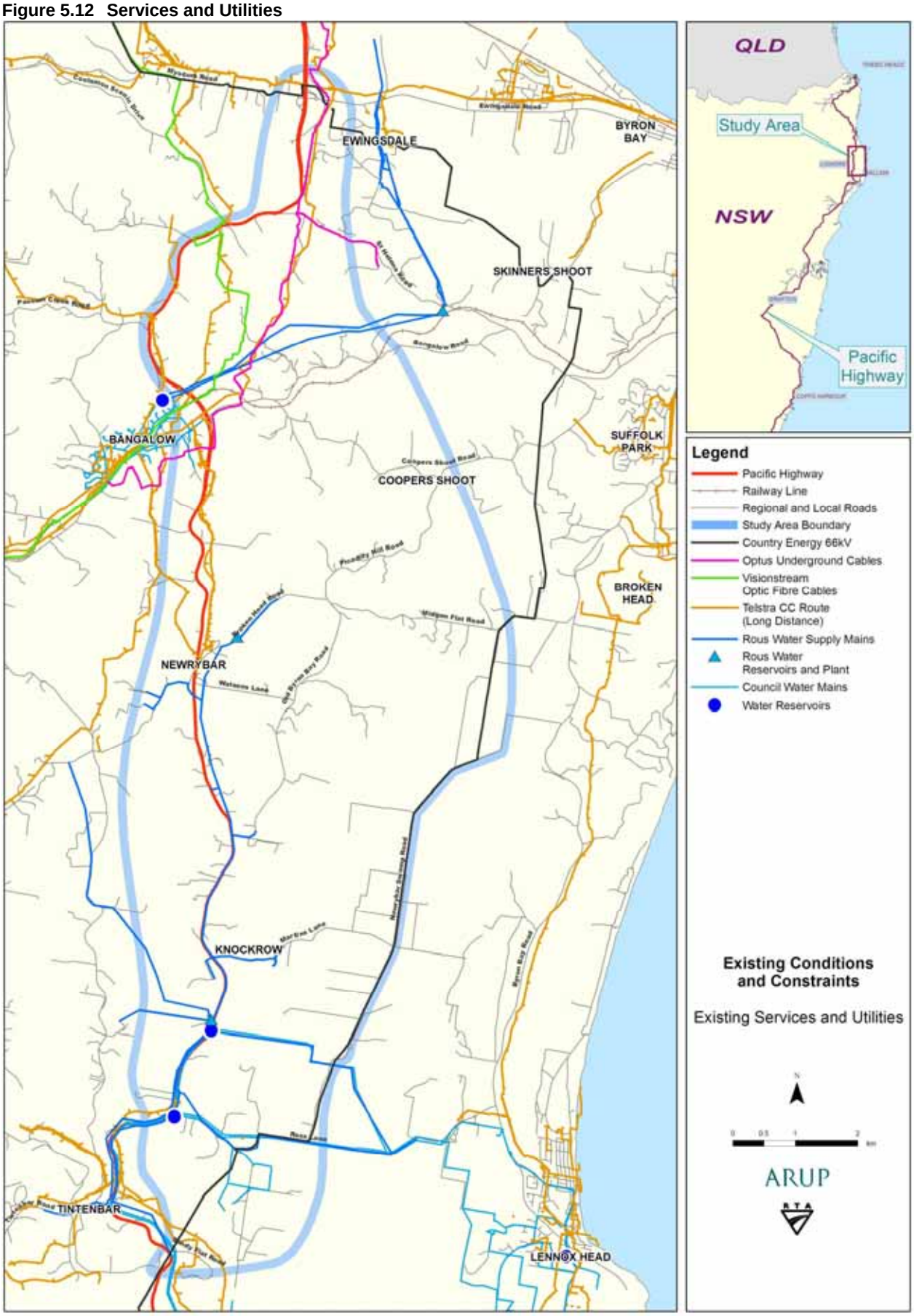
- **Telstra** fibre optic cables beside the existing highway. Telstra copper cabling of varying sizes can be found throughout the study area, servicing residences and commercial facilities.
- **Visionstream** fibre optic cables from Bangalow to Ewingsdale. These follow Bangalow Road from the west, then through the north of Bangalow crossing the existing highway in the vicinity of Byron Creek before heading north primarily along property boundaries, east of the existing highway corridor. The cables then approach the existing highway opposite Coolamon Scenic Drive and travel parallel to the highway before crossing at Fowlers Lane and travelling parallel to the highway back to Coolamon Scenic Drive before heading west along Coolamon Scenic Drive.
- **Optus** fibre optic cables along St Helena Road and from Ewingsdale to Bangalow, east of the existing highway corridor. These cables extend north from Ewingsdale towards Tyagarah on the eastern side of the highway as well as west towards Lismore on the southern side of Bangalow Road.
- **Rous Water** 600 mm diameter truck water supply mains from Emigrant Creek Dam and Rocky Creek Dam to Bangalow and to a treatment plant and reservoir at Knockrow, and distribution watermains to the north and south. The components of these distribution mains can be described as follows:
  - Following the existing highway south to Tintenbar.
  - Heading east from Knockrow along property boundaries then south along Newrybar Swamp Road, before heading west along Ross Lane and connecting with the southern highway main (above).
  - Heading north along the existing highway, then to the east of the highway until Broken Head Road where it heads east to a reservoir and continuing a short distance east along Broken Head Road.

  Rous Water also has distribution mains connecting to a Council reservoir on the northern side of Bangalow, heading east and crossing the existing highway, travelling approximately parallel to Bangalow Road, to a reservoir on St Helena Road before heading north-west to Ewingsdale.
- **Ballina Shire Council** water supply mains beside the existing highway south of Knockrow, as well as Ross Lane and Newrybar in the vicinity of the Rous Water supply mains described above.
- **Country Energy** power supply infrastructure, including a 66 kV supply line which crosses the existing highway at Sandy Flat Road before heading north-east to Ross Lane near the intersection with Sandy Flat Road. From this point the supply line follows Ross Lane before heading north along Newrybar Swamp Road on the eastern edge of the study area, then further north outside the study area to Skinner Shoot and north-west to Ewingsdale.

The above utilities are shown in **Figure 5.12.**

In addition, the Casino-Murwillumbah railway passes through the study area. While the railway is no longer operating it is a requirement that provision should be made for the future re-opening of the railway. Grade separation would therefore be required where any options cross the railway. The ease of providing the necessary clearances could vary depending on the alignment of the option/railway and the relative levels of the option/railway at each crossing location.

Figure 5.12 Services and Utilities



5.11 Cultural Heritage

5.11.1 Aboriginal Heritage

Consultation

Contact was made with known Aboriginal community groups prior to fieldwork proceeding. These included the Jali Local Aboriginal Land Corporation (LALC), based near Ballina for the southern section of the study area from Ross Lane to McLeods Shoot. The Tweed-Byron LALC was contacted but did not participate, as no Aboriginal heritage survey was conducted in the small portion of study area within their boundaries (McLeods Shoot to Ewingsdale). The Bundjulung Elders were represented in the field. They are a Native Title claimant group.

During the initial week of fieldwork, the Project Team became aware of another Aboriginal group, the Burabi Aboriginal Corporation. They were contacted and also participated in the fieldwork.

Planning is under way to establish an Aboriginal Focus Group in the near future.

Review of Legislative Framework

The National Parks and Wildlife Act 1974 (as amended) provides the primary basis for the legal protection and management of Aboriginal sites within NSW. The implementation of the Aboriginal heritage provisions of the Act is the responsibility of DEC.

With the exception of some artefacts in collections, or those specifically made for sale, the National Parks and Wildlife Act generally defines all Aboriginal artefacts or relics to be ‘Aboriginal Objects’ and to be the property of the Crown. An Aboriginal Object has a broad definition and is inclusive of most archaeological evidence. It should be noted that even single and isolated artefacts are protected as Aboriginal Objects under the Act.

Literature and Database Review

A range of documentation was used in assessing archaeological knowledge for the Tintenbar to Ewingsdale study area and the surrounding region.

Aboriginal literature sources included the NSW Department of Environment and Conservation (DEC) Aboriginal Heritage Information Management System, associated files and catalogue of archaeological reports. The local knowledge of Aboriginal representatives present during the field investigations was also utilised. This background research was used to determine if known Aboriginal 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 research management context.

There had been little previous archaeological survey within the study area and only a few Aboriginal sites had previously been recorded. No Aboriginal sites had previously been recorded along the coastal range to the west of the coastal plain and there has only been one archaeological survey carried out previously within this topographic unit (Craib 1997 for the Bangalow to St Helena project). Most of the archaeological studies had been conducted either on the coastal plain or on the immediate coastline, as well as a survey for the Ballina Bypass (Collins 1998). A number of site types have been identified from these studies, including artefact scatters, middens, burials, ceremonial grounds and areas of potential archaeological deposits (PADs).

Field Surveys

The surveys attempted to sample the full range of environments where Aboriginal sites might be expected to be located based on the information obtained from the background research, and the information supplied by the Aboriginal representatives. The survey strategy was therefore aimed at investigation of the major ridge and spurlines that traversed the study area, the margins of the former Newrybar Swamp, the sandy deposits within the coastal plain, and the major drainage lines. Additional topographies such as upper, mid and lower slopes were sampled when available.

Existing Conditions and Constraints

Almost the entire area has been subject to total clearance of native vegetation enabling farming activities to take place. Cattle grazing, and plantations of Macadamia trees, sugar cane, coffee and fruit trees have contributed to large-scale disturbance of the landscape. There are also many examples of ground disturbance in the form of contour banks, irrigation and rock removal that have caused considerable ground disturbance. Rock removal in particular, where paddocks have been cleared of the natural surface rocks and the rocks placed in piles, may have had a significant impact on any archaeological sites that may be present.

Aboriginal Sites

Fifteen Aboriginal sites have been identified in the study area, including nine previously recorded sites and six sites identified during the Project Team fieldwork (see **Figure 5.13**). The Aboriginal sites identified during the survey included three artefact scatters and three isolated artefacts. The significance of these sites was assessed as low with the following exceptions:

- The artefact scatter (site T2EA3) which was assessed to be of 'moderate' local heritage significance.
- The artefact scatter (site T2EA5) where rare artefact types (grindstones) were assessed to be of 'high' local heritage significance.

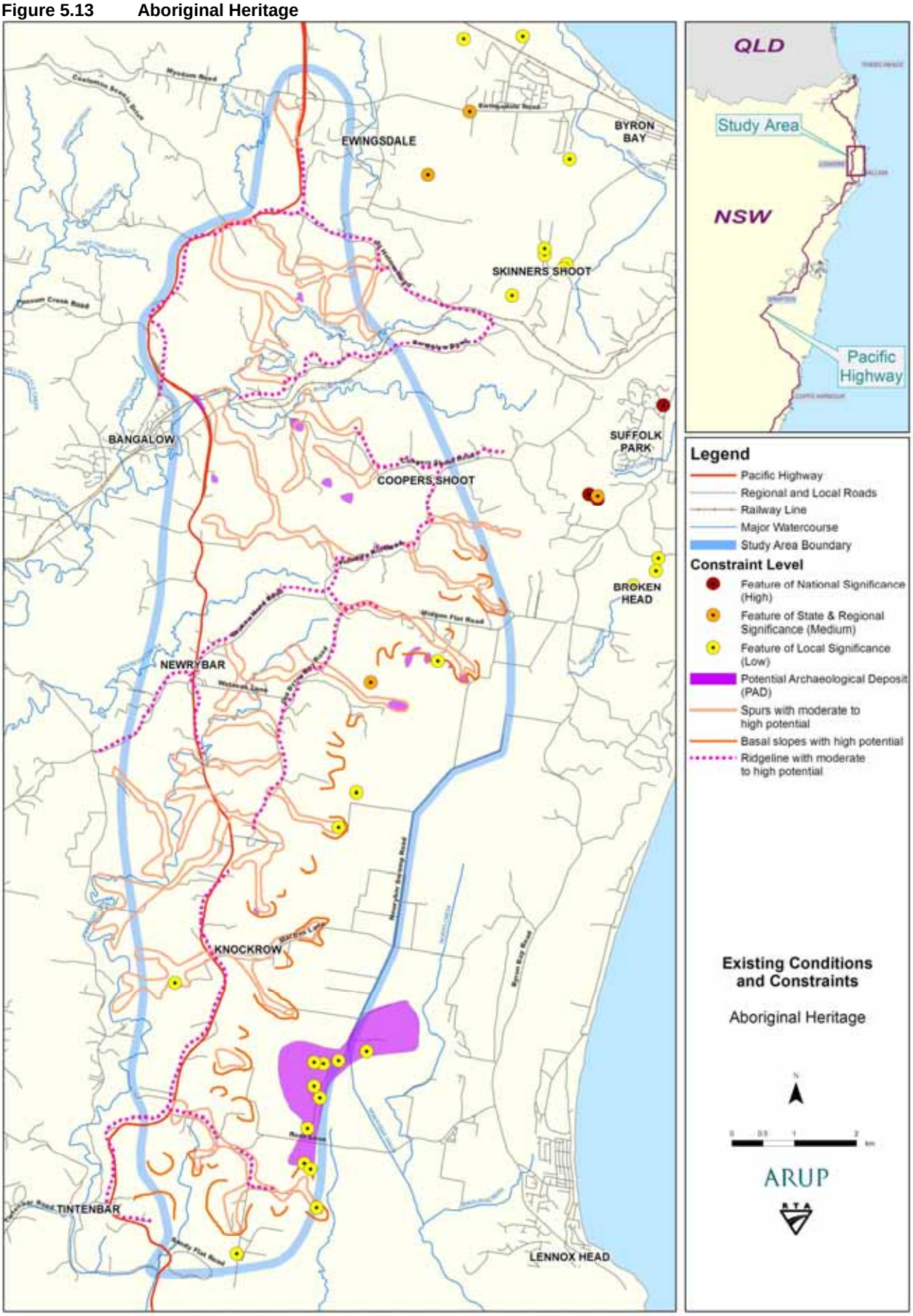
The previously recorded Aboriginal sites are identified as artefact scatters.

Classification of constraints shown in **Figure 5.13** are listed in **Table 5.12**.

Table 5.12 Cultural Heritage Constraints Classification

Constraint Classification	Description
High	Cultural heritage features of national significance.
Medium	Cultural heritage features of state and regional significance.
Low	Cultural heritage features of local significance.

Figure 5.13 Aboriginal Heritage



Potential Archaeological Deposits (PADs)

The field surveys were restricted by ground surface visibility constraints and in order to offset these difficulties, areas of Potential Archaeological Deposit (PAD) have been identified. These areas may not have any surface evidence of cultural activity, but based on models and environmental considerations, are deemed to have potential for sites to exist (usually artefact scatters). Such locations need to be considered in the planning and route selection process but they cannot have any significance assigned to them until they are confirmed or rejected as sites.

Based on micro topographic features identified in the field, twelve locations within the surveyed properties were identified as having archaeological potential. The PADs include elevated terraces above creeklines and the crests of prominent spurs that could have been used as access routes from the high ridges to the creeks. Other PADs include microtopographic features such as basal slopes of spurs that were elevated above the former Newrybar Swamp or other permanent water.

Native Title Claims and Aboriginal-owned Land

A Native Title Claim exists over the northern part of the study area. The claim area is north of Newrybar, from the coast inland, and includes the northern part of the study area. The National Native Title Tribunal has determined that there is a *prima facie* case for the establishment of some rights and interests. These include the right to occupy, use and make decisions about the use and enjoyment of the area (non-exclusive). The claimants also have a *prima facie* right to protect and maintain places of importance and to speak for the determination area. The claim, registered in 2003, is now in mediation and has not been granted to date.

5.11.2 Non-Aboriginal Heritage

Review of Legislative Framework

The NSW Heritage Act 1977 provides the primary basis for the legal protection and management of non-Aboriginal heritage sites within NSW. The purpose of the Act is to ensure that the heritage of New South Wales is adequately identified and conserved and it is concerned with all aspects of conservation ranging from the most basic protection against damage and demolition, to restoration and enhancement. It recognises two levels of heritage significance - State significance and Local significance - across a broad range of values.

Literature and Database Review

Sources of historic information for the assessment included parish maps and portion plans and heritage listings held by the Australian Heritage Commission, the NSW Heritage Council, the National Trust of Australia (NSW) and the heritage schedules attached to the Ballina and Byron Shire Councils' Local Environmental Plans (LEPs). A review of local histories and other literature available for the general study area was also undertaken.

Community Information Sessions

Additional information regarding cultural heritage within the study area has been provided to the Project Team by the local community. Information was volunteered through Community Information Sessions (CIS) and shopfronts identifying the following additional heritage sites with potential heritage value.

5.11.3 Existing Conditions and Constraints

The heritage items identified by the literature review are listed in **Table 5.13.**

Table 5.13 Heritage Items

Label	Description
T2E H1	Ewingsdale Anglican Church and Community Hall The Ewingsdale Anglican Church (1915) and Community Hall (1908) are approximately 250 m east of Pacific Highway and 175 m south of Ewingsdale Road. Both buildings are protected as relics under Section 139 of the NSW Heritage Act 1977, being greater than 50 years old and are considered to be locally significant features.
T2E H2	Jelbon Leigh The private residence of Jelbon Leigh, located approximately 1 km north of Bangalow and 150 m east of Pacific Highway, is listed as a heritage item on Schedule 2 of the *Byron Local Environmental Plan* (Byron Shire Council 1988). It is considered to be a locally significant feature.
T2E H3	Bangalow Cemetery The cemetery, located on the eastern side of the Pacific Highway and approximately 750 m north of Bangalow, was identified as being greater than 50 years old and is therefore protected as a relic under Section 139 of the NSW Heritage Act 1977. It is considered to be a locally significant feature.
T2E H4	Village of Newrybar The village of Newrybar is located approximately 4 km south of Bangalow and 150 m west of Pacific Highway and was settled in 1881. The village includes a number of historic buildings which still stand and are currently in use, such as the Community Hall (1899), an old cottage (c.1899), the Historic Bakery (c.1900) and the Old Church (1911) in the village. The buildings were identified as being greater than 50 years old and are therefore protected as relics under Section 139 of the NSW Heritage Act 1977. They are considered to be locally significant features.
T2E H5	Three Fig Trees on 'The Orchard' (*Ficus macrophylla* – Moreton Bay Figs) The Three Fig Trees are located approximately 200 m west of Old Byron Bay Road and 500 m south of Watsons Lane and one kilometre east of Pacific Highway with access via Old Byron Bay Road. The Three Fig Trees were identified as being greater than 50 years old and are therefore protected as relics under Section 139 of the NSW Heritage Act 1977. They are considered to be locally significant features.
T2E H6	Historic Monument and Monument Plaque The historic monument consists of a white painted besser brick and concrete plinth and is located at the southeast corner of Martins Lane East and Pacific Highway and was erected in memory of four members of the R.A.A.F. who died in a plane crash in the vicinity in 1944. The monument was identified as being greater than 50 years old and is therefore protected as a relic under Section 139 of the NSW Heritage Act 1977. It is considered to be a locally significant feature.

Community Information Sessions

Community Information Sessions (CIS) identified a number of additional sites with potential heritage value. These sites are listed in **Table 5.14.**

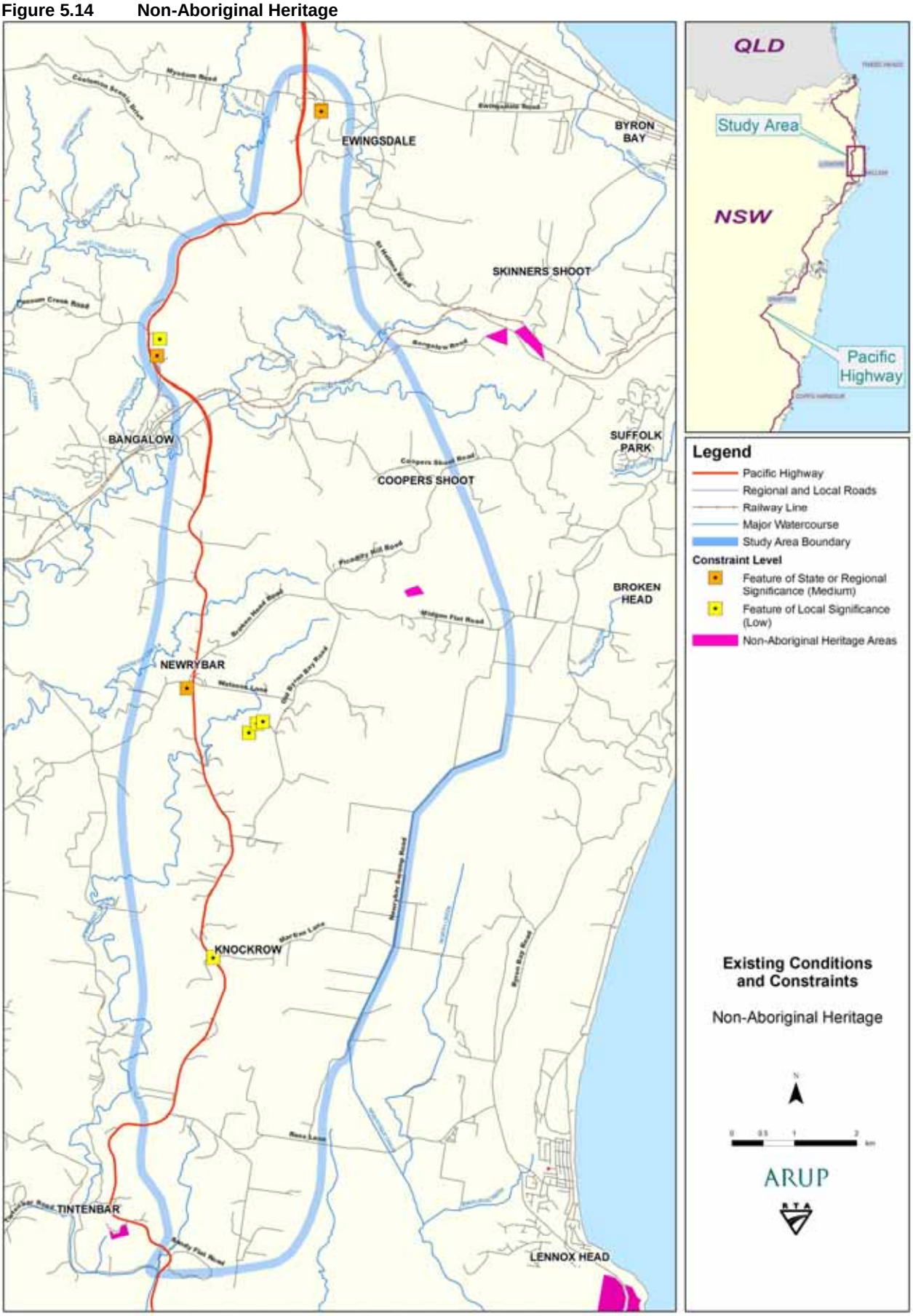
Table 5.14 CIS Potential Sites with Heritage Value

Site type	Unique ID	Location	Potential Heritage Value	Comments
Fig trees	PO 12	Knockrow-Newrybar	Low Local	Scattered over district, Alan Craig of The Orchard has applied for heritage listing of three very large trees (T2E H5).
Cricket pitch	PT 159	Newrybar	Low Local	Examined part of this property (or nearby), pitch not identified, not likely to have survived plantations and dam construction. Not identified from aerial photos.
Stone fences	PT 160	Broken Head Road	Low Local	One stone line found but was result of rock clearing of paddocks.
Turn-of-century well and farmhouse		Broomans Road, Newrybar	Low-Moderate Local	Requires verification.
House	PT 102	Coopers Shoot Road	Moderate Local	On Draft Byron LEP. More information required.
Residence and farming property	AR 31	Ewingsdale	Unknown	Potentially outside study area Requires verification

Constraints

The constraints shown in **Figure 5.14** have been classified as for Aboriginal heritage (**Table 5.12**).

Figure 5.14 Non-Aboriginal Heritage



5.12 Landscape and Visual Amenity

Every region has its own unique attributes that make that place special and valued by the community. In simple terms there is the landscape setting, the settlement form and architecture, and the way the community operates or functions. Road development can have an effect on all three aspects and it is important to develop a road which fits well into its setting.

This region contains a wide array of natural and built features appreciated by locals and visitors alike. These include:

- Scenic escarpment zones
- Coastal flats
- Bangalow township
- Tintenbar township
- Cumbebin Swamp Nature Reserve
- Hayters Hill Nature Reserve
- Broken Head Road
- Newrybar Swamp
- Plateau
- McLeods Shoot Lookout
- Ewingsdale township
- Coolamon Scenic Drive/Possum Shoot
- St Helena Hill ridge
- Hayters Hill ridge
- Main Coast Range
- Ballina Nature Reserve

The majority of the study area is located on an elevated plateau which is defined by a steep escarpment on its northern and eastern ridges, falling to a relatively flat coastal plain. Within this area these natural features coupled with the coastal landscapes of beaches and rocky headlands form major landscape features responsible for developing the growing eco-tourism industry and the relaxed country lifestyle. The coastal plain provides a primary area for agricultural farming activities including sugar cane, tropical fruits and nuts, coffee and tea.

Vegetation

Vegetation within the study area is dominated by the terrain and the rich and productive soils. Exotic and indigenous vegetation spans much of the plateau, interspersed by open areas of paddocks or plantations. Steeper slopes on the escarpment are less suitable for agriculture, resulting in a combination of open grassed paddocks with clumps of exotic and native trees. By contrast, the coastal flats are characterised by the flourishing agricultural industry. Outside the study area the coastal flats form part of a wetland system within the Ballina Nature Reserve.

Settlement Patterns

Within the study area there are several small towns and villages – Newrybar, Ewingsdale, Bangalow and Knockrow. Residential properties outside these areas concentrate along local roads through the study area, creating small hamlets. These hamlets usually follow the ridge lines of the high plateau where the elevation offers panoramic views of the surrounding landscape and in some cases the ocean.

Constraints

The whole region including the study area is considered to have high scenic (visual) and landscape values. While certain landscape features are more prominent than others, it is the diversity of landscape types and characters and the relationships between them that contribute to the overall landscape and visual experience of the area.

In terms of the highway upgrade, much of the visual and landscape impact of the final proposal would depend not only on the form and alignment of the highway, but also on the view points from where it would be able to be seen and the character of the landscape between the viewer and the highway. In addition, the perceived visual impact of the highway would also be influenced by the expectations of the viewers and the type of activity that they are engaged in (such as local resident, motorist, etc).

Visual constraints are presented and described in three categories which take into consideration the relationship between the physical features of the landscape, land use patterns and the degree to which people and place in different areas are likely to be sensitive to changes introduced by the road upgrade. These categories are:

- **Landform Sensitivity** (**Figure 5.15**) defines areas of exposed hills and ridges that are visually sensitive to road development.
- **Landcover Sensitivity (Figure 5.16)** describes the variety and character of the landcover of the study area, and the effect of road development on that character.
- **Settlement Sensitivity (Figure 5.17)** identifies the settlement patterns in the study area and the likely sensitivities of the settlement form to an upgraded highway.

Given the complexity of the visual and landscape assessment, **Table 5.15** provides guidance in terms of significance criteria to be applied when assessing any proposed road upgrades or new road corridors for their potential impacts.

Table 5.15 Visual Amenity Constraints Classification

Issue	High	Medium	Low
Proximity to the highway alignment	Highway visible from within 2 km.	Highway visible from between 2 km and 5 km.	Highway visible from greater than 5 km.
Visual sensitivity of the land-uses from which the highway is viewed	Highway visible from a regionally significant viewpoint or township, tourist destination, recognised lookout or roads used as tourist routes.	Highway visible from a locally significant viewpoint e.g. local roads, residences on rural properties.	Highway visible from a locally insignificant viewpoint e.g. low traffic volume roads/lanes, industrial sites, farmland.
Visual quality of the landscape through which the highway passes	Highway impacts on high quality landscape e.g. steeply undulating landforms including escarpments, substantial stands of mature trees, attractive cultural features or landmarks.	Highway impacts on medium quality landscape e.g. rolling landforms, isolated stands of mature trees, cultural features.	Highway impacts on low quality landscape e.g. flat landforms, minimal stands of mature trees, unattractive cultural features.
Scale of the highway infrastructure	The scale/size of highway infrastructure is prominent in the landscape setting e.g. >10 m cuttings and/or fill embankments, (depending on local landform i.e. in flat open areas smaller embankments may be high) substantial viaducts/structures, carriageways exposed.	The scale/size of highway infrastructure is apparent in the landscape setting e.g. 0 to 10 m cuttings and/or fill embankments, moderate to small viaducts/structures, carriageways visible.	The scale/size of highway infrastructure is not apparent in the landscape setting e.g. no cuttings and/or fill embankments, no viaducts/structure, carriageways mostly screened.
Effectiveness of mitigation measures	Mitigation measures would have little success in reducing the impact of the road on the landscape.	Mitigation measures can partially contribute to visual absorption of the road into the landscape.	Mitigation measures contribute to the absorption of the road into the landscape.

Figure 5.15 Landform Sensitivity

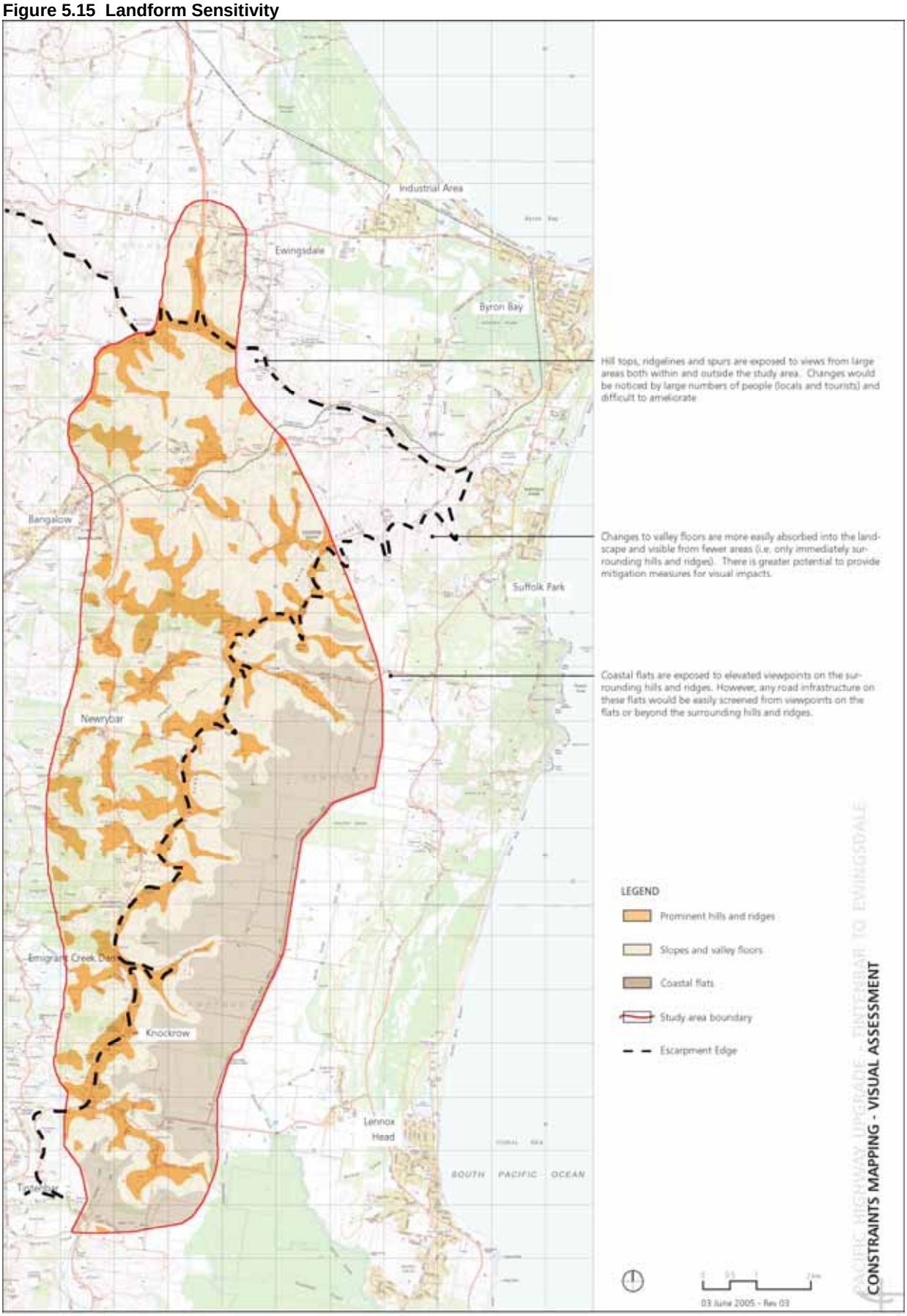


Figure 5.16 Landcover Sensitivity

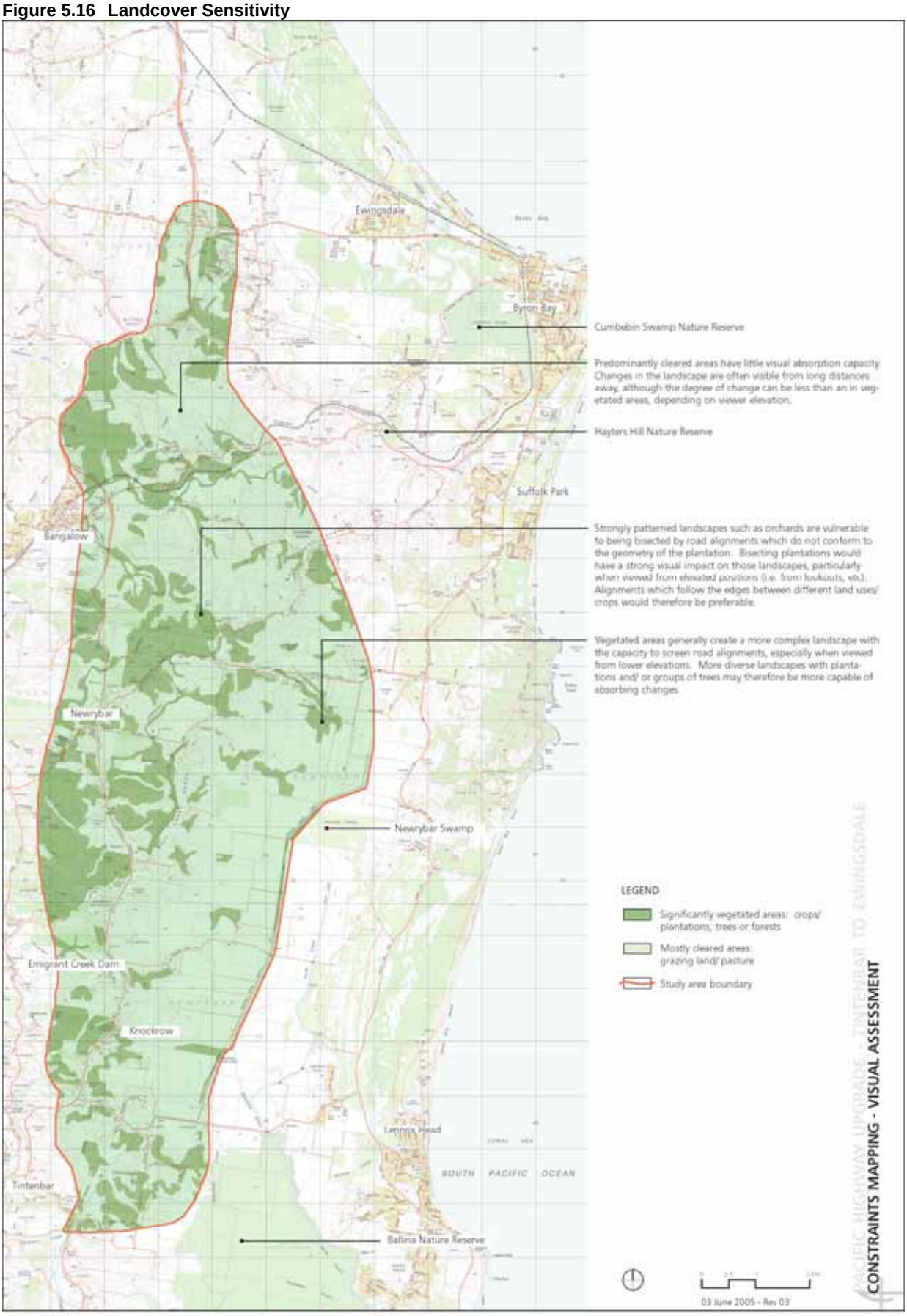
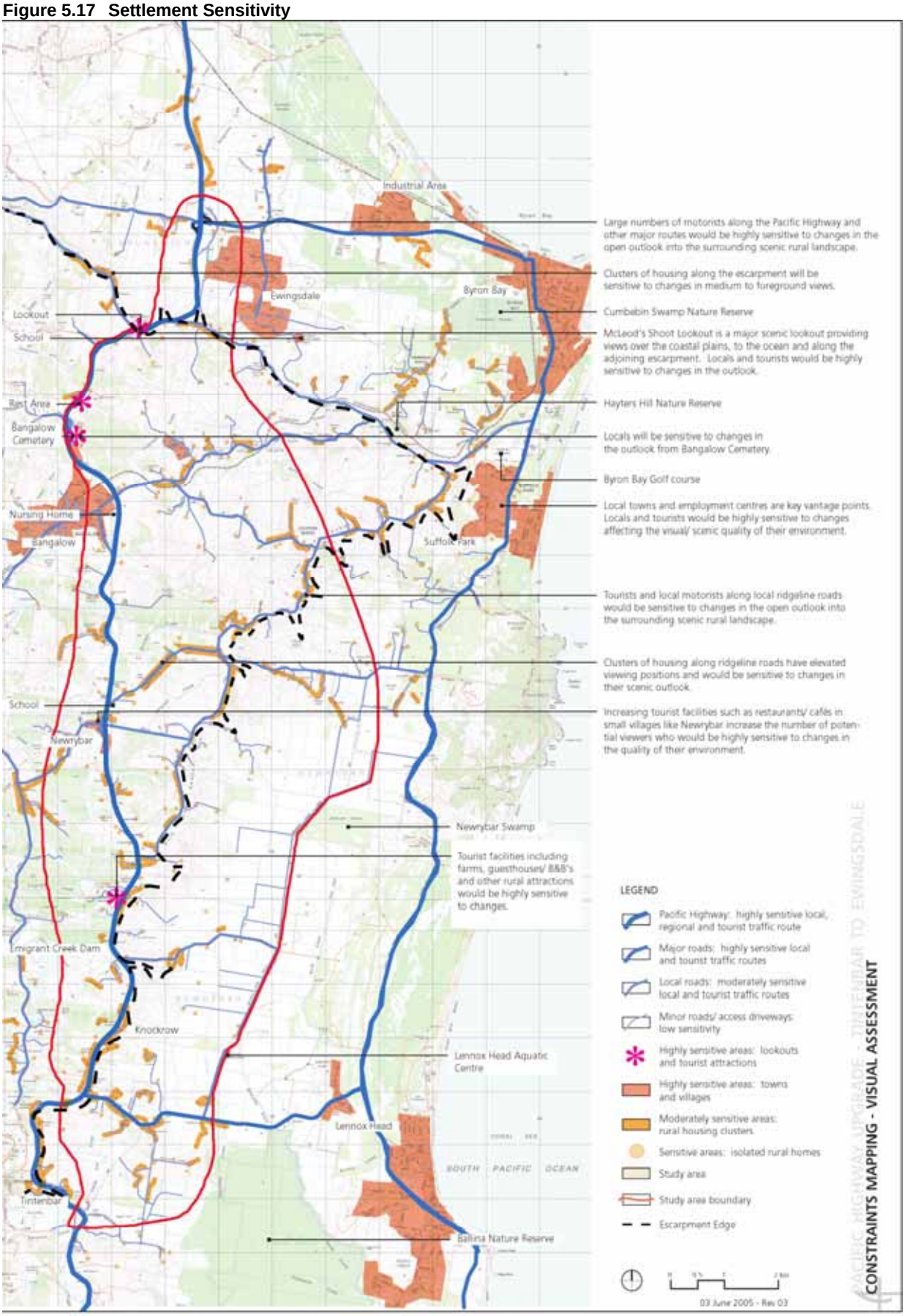


Figure 5.17 Settlement Sensitivity



5.13 Noise Environment

5.13.1 Methodology

Initial highway noise levels have been estimated using the *Calculation of Road Traffic Noise* (CoRTN) methodology, which predicts the daytime and night-time traffic noise levels. Initial predictions are based on preliminary predicted traffic flow rates and heavy vehicle percentages for 2025.

The noise modelling was used to calculate the horizontal distance from the highway at which critical noise levels corresponding to EPA criteria and RTA 'acute' noise levels. This information was used to map buffer zones around all buildings in the area of investigation, which represent the limits within which noise criteria would be exceeded at the buildings.

In addition to the traffic noise predictions and analysis, actual traffic noise levels from the existing highway have been measured during two noise surveys undertaken in the study area over a period of four weeks. Hundreds of noise measurements were undertaken at around 35 representative locations. Noise loggers were also installed at five locations within the study area for longer-term noise measurements.

5.13.2 Existing Noise Environment

Noise from the existing highway currently affects properties up to 300-500 m from the existing highway alignment, although traffic noise is audible further from the highway particularly during the night-time.

The main noise constraints are the large number of residential properties in the study area, particularly adjacent to the existing highway alignment, and along the many minor roads in area, such as Ross Lane, Martins Lane, Old Byron Bay Road, Broken Head Road, Piccadilly Hill Road, Coopers Shoot Road, Byron Bay to Bangalow Road and St Helena Road.

The township of Bangalow, and the larger settlements of Newrybar and Ewingsdale are also significant noise sensitive constraints. There is an existing noise barrier adjacent to the highway at Ewingsdale to mitigate noise. Additionally, there is a current proposal to provide a noise barrier in Newrybar adjacent to the western side of the existing highway and to extend the noise barrier just south of Ewingsdale.

Both Bangalow and Ewingsdale, and properties adjacent to the existing highway on St Helena Hill are affected by noise from truck engine braking from the steep gradients on St Helena Hill. Newrybar School, located on Broken Head Road, is also a noise sensitive constraint.

5.13.3 Constraints

Noise modelling was used to calculate the horizontal distance at which various noise levels would be achieved. The target noise levels were 65 and 60 dB(A) daytime and 60 and 55 dB(A) night-time. These correspond to the 'acute' noise levels according to the RTA and 'redevelopment of existing' traffic noise criteria from the NSW EPA Environmental Criteria for Road Traffic Noise (ECRTN) respectively.

For the purposes of the noise assessment, constraints have been classified in four levels of buffer zones according to the criteria shown in **Table 5.16** which correspond to the critical noise levels.

Table 5.16 Noise Constraints Classification

Criterion	Horizontal distance
65dB(A) daytime	40 metres
60dB(A) night-time	60 metres
60dB(A) daytime	100 metres
55dB(A) night-time	140 metres

These buffer zones are illustrated in **Figure 5.18.** At this time, noise level impacts associated with all the options would be considered to be locally significant. **Figure 5.18** identifies locations of houses based on aerial photo assessment - these locations have not been site verified.

5.14 Engineering Constraints

Engineering constraints have not been mapped as low, medium, high, no-go because in many cases the constraint can be overcome by appropriate engineering design. However, engineering constraints, particularly topography, can have a significant influence on grades, cost and buildability, and are therefore an important influence on the development of route options. The major engineering constraints are described below.

5.14.1 Topographical Constraints

The main topographical constraints (presented in **Figure 5.19**) are:

- Significant level differences at the escarpments at the edges of the Alstonville plateau where the terrain falls to the coastal plain. The height of the escarpment varies within the study area from about 75 m at the southern escarpment near Ross Lane, 75 to 150 m on the eastern side and 100 to 150 m at the northern escarpment at St Helena. Even at the locations where the escarpment is lowest, a sustained climb over about 1.5 km would be required at the desirable maximum grade of 4.5%. The major difficulty from an engineering perspective is to develop alignment options which achieve the desirable maximum grade while limiting the cut and fill depths. For geotechnical reasons related to stability and maintenance it is generally preferable for the depths of cuttings to be no more than about 30 m and the height of fills to be no more than about 10 to 15 m. For alignments where cutting depths would have to exceed 30 m a tunnel might be required, and a viaduct might be required where fill depths on an alignment would exceed 10 to 15 m. Extensive earthworks as well as tunnels and viaducts can add significantly to costs as well as visual impacts and thus provide a significant constraint.
- The Alstonville plateau is incised by a number of streams which generally flow across the plateau from the north-east towards the south-west forming a series of valleys and ridges. The general direction of the highway is north-south, which means that the highway must cross these valleys and ridges. As with the escarpment, the major difficulty is to develop alignment options which achieve the desirable maximum grade while limiting the cut and fill depths. The adjacent valleys of Tinderbox Creek and Byron Creek at the north end of the study area are the most pronounced. The valley floors are 80 to 100 m lower than the ridge south of Bangalow and 70 to 120 m lower than the St Helena ridge. The ridges and valleys associated with Skinners Creek and Emigrant Creek to the south also cross the plateau from the north-east towards the south-west but are less incised and provide a lesser constraint to alignments.

Figure 5.18 Noise Buffer Zones

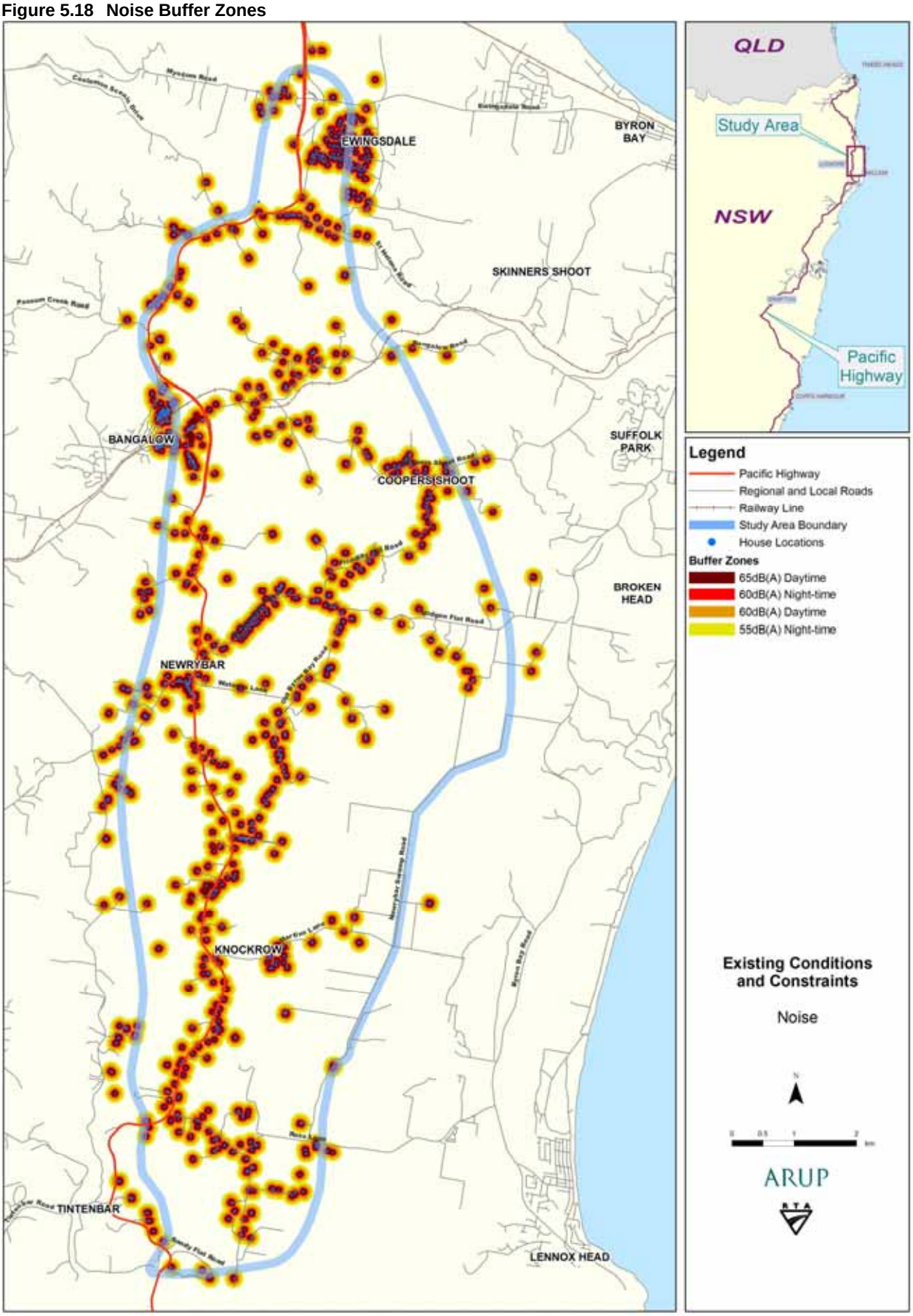
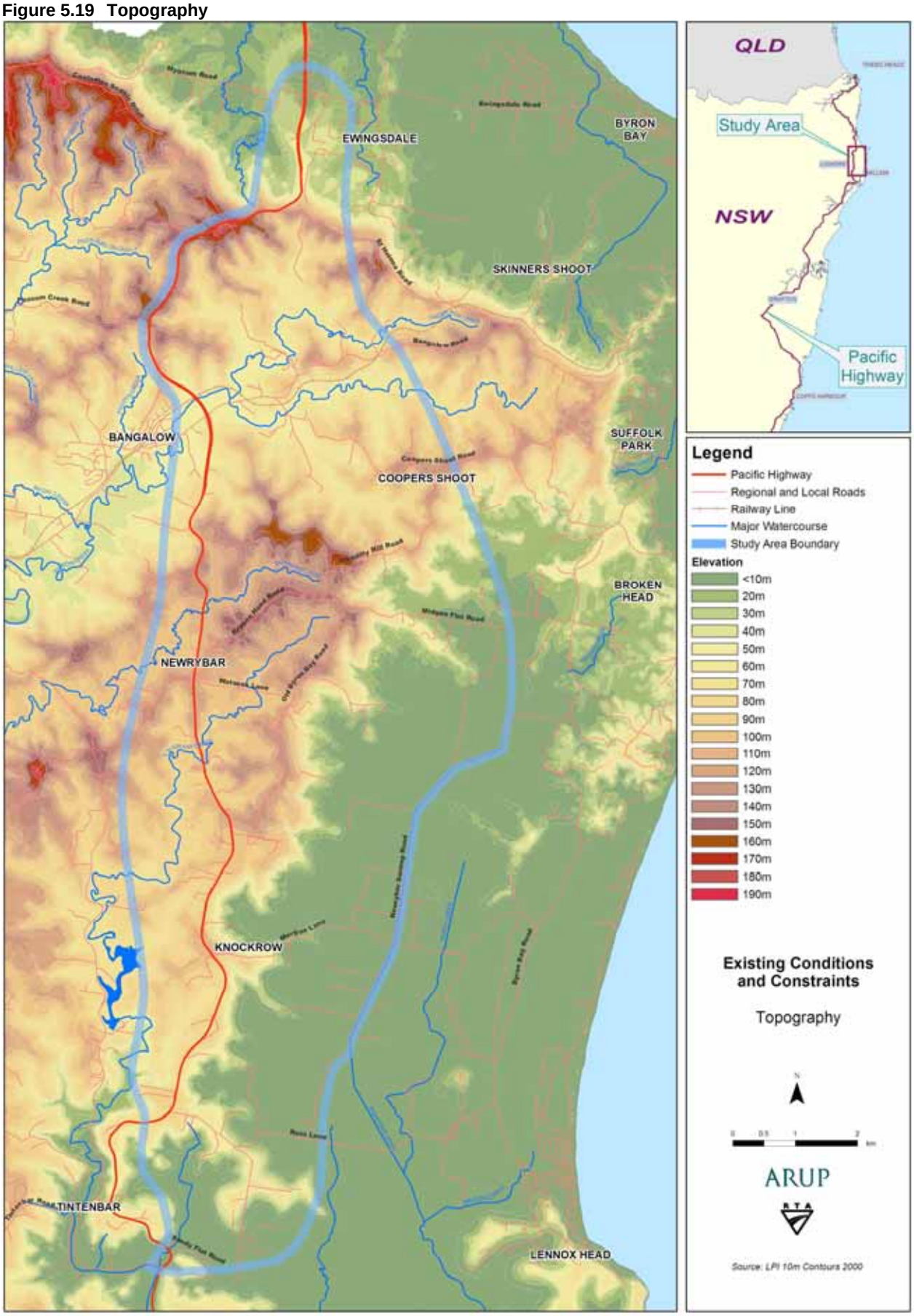


Figure 5.19 Topography



- The engineering constraints presented by the significant level differences at the escarpment and on the valleys and ridges crossing the plateau are compounded by the steep slopes on most sections of the escarpment as well as on the sides of the Tinderbox Creek and Byron Creek valleys, generally exceeding 20% and exceeding 33% in some isolated pockets. High cuts and fills in these steep areas, especially where the cuts and fills are across the sides of these slopes, are difficult from a geotechnical perspective and can result in long term stability and maintenance issues.

5.14.2 Constraints to Upgrading Existing Highway

Upgrading the existing highway would be possible, however the following engineering constraints would have to be addressed in order to achieve the desired design criteria (see **Section 4.3.3)**:

- With the exception of the dual carriageway Bangalow Bypass (a length of about 2.5 km) and the duplication constructed as part of the Ewingsdale interchange upgrade, a second carriageway would be required adjacent to the existing highway.
- There are many substandard horizontal and vertical curves suitable for 70-90 km/h only, with typical operating speeds around 75 km/h. Over 50% of the existing highway does not comply with at least one minimum design standard. Other examples of substandard design include inadequate sight distances, particularly at the numerous at-grade intersections and driveways with direct access to the highway.
- In order to meet the design criteria and eliminate safety black-spots, these sections of the existing highway would require local realignment, involving acquisition of land and dwellings, disturbance of vegetation within the existing road reserve, and also affecting access to adjacent properties.
- To meet the design criteria, local traffic should not be required to use the upgraded highway for short trips. If the existing highway is upgraded then a separate local arterial road for local traffic would be required adjacent to the upgraded highway for the full length. Construction of the local road as well as the additional carriageway would add to the cost and further increase land acquisition requirements.
- There are 30 at-grade intersections and 88 property driveways directly accessing the highway along the length of the study area. To achieve the required design criteria all intersections and driveways would have to be eliminated by either:
  - Connecting the local roads or driveways to the local arterial road where it is on the same side.
  - Providing a bridge structure across the upgraded highway where the local arterial road is on the opposite side, or providing an additional frontage road to direct local traffic to the north or south where a bridge structure is provided across the upgraded highway.

  Each of the above options would add to the cost and increase land acquisition requirements.
- The existing road reservation is generally around 25m wide with development on both sides. At most locations it would not be possible to fit an additional carriageway within the existing road reserve. A road reserve approximately 80 to 100m wide would be required just for the upgraded highway, not including the frontage roads and local road network that would be required for access to the local area and for access to properties fronting the existing highway.
- There are several sections with 6% grade and a long sustained grade of over 8% down St Helena Hill.
- Options involving the widening of the existing highway would also introduce constructability issues and construction staging issues due to the added complexity of construction while allowing for the safe passage of highway traffic, local traffic and local access.

5.14.3 Provision of Local Road Network

If the upgraded highway is on a new alignment then the existing highway would be retained as a separate local road network. Grade separation would be required wherever the upgraded highway crosses the existing highway. For cost reasons the number of these crossings should be kept to a minimum and the vertical alignment of the upgraded highway should be developed considering vertical clearance requirements.

Grade separation would also generally be required where the upgraded highway crosses the main local access roads, unless suitable alternative local access arrangements could be made. Local roads likely to require grade separation include Ross Lane, Martins Lane east and west, Old Byron Bay Road, Watsons Lane, Brooklet Road, Broken Head Road, Lawlers Road, Coopers Shoot Road, Bangalow Road and Saint Helena Road. As above, the number of locations where the upgraded highway crosses the local roads should be kept to a minimum and the vertical alignment of the upgraded highway should be developed considering vertical clearance requirements.

5.14.4 Connections at Each End of the Study Area

At the north end of the study area, the upgraded highway would preferably connect to the south end of the 1.9 km of duplication constructed as part of the Ewingsdale Interchange. However, south of the Ewingsdale Interchange bridge, the highway climbs for 900 m at a 6% grade, compared with the desirable maximum length of 500 m at the absolute maximum 6% grade (see **Section 4.5.3**). Therefore, upgrade proposals should consider reduction of this long steep grade.

At the south end of the study area, an alignment climbing the escarpment between Sandy Flat Road and Ross Lane was developed and approved as part of the Ballina Bypass EIS and RTA has commenced land acquisition for that alignment. It was therefore accepted that the Ballina Bypass EIS alignment would be adopted for any options which climb the escarpment in this vicinity. However, the expanded study area does create opportunities for consideration of other alignment options beginning at Sandy Flat Road and diverging to the east, away from the Ballina Bypass EIS alignment.

5.14.5 Casino-Murwillumbah Railway

The railway is not operating at present but is a constraint in that the highway upgrade must allow for the future re-opening of the railway. Grade separation would therefore be required where any options cross the existing railway and clearance requirements must therefore be considered.

5.14.6 Tunnel

Some options may involve a tunnel through St Helena Hill. Options that limit the tunnel length to no more than about 400 m are preferred in order to avoid significantly increasing the complexity of ventilation, lighting, maintenance and safe egress in the event of an emergency.

5.14.7 School Bus Routes

School buses use a number of the local roads crossing the study area including Broken Head Road, Bangalow Road and St Helena Road. Any modifications to these roads needed for any route options should take bus route requirements into consideration.

6 Development of Route Options

6.1 Study Area Zones

To assist in the development of the initial route options and selection of the long list of options, the study area was divided into three zones as listed below and shown on **Figure 6.1.**

- Tintenbar Zone: southern zone from the southern end of the study area to just north of Knockrow
- Newrybar Zone: central zone of the study area from north of Knockrow to south of Bangalow
- Bangalow Zone: northern zone of the study area from south of Bangalow to just north of Ewingsdale and the northern end of the study area.

Key characteristics of each zone that influenced the development of initial route options and the selection of the long list of route options are listed in **Table 6.1**.

6.2 Development of Initial Options

The first step in the development of initial options was to superimpose the constraints mapping on a three-dimensional digital terrain model (DTM) and on aerial photography of the study area (**see Chapter 5**). Option development commenced with the brainstorming of possible corridor placements that were then developed and refined in three dimensions using specialised road design software which interacts with the DTM. Using the software a three dimensional model was developed for each initial route option showing the physical extent of cuts and fills as the option passes through the terrain. In this way a large number of initial route options were developed, checked against the aerial photography and constraints, and then refined where possible to reduce impacts on the identified constraints while maintaining functionality.

The development of initial route options was generally limited to corridors within the defined study area but options which extended outside the study area boundary in some locations were also considered. Specialist investigations were extended beyond the study area boundary where required.

Following the initial development and refinement of option corridors, a Project Team Feasible Options Workshop was held to identify the weaker performing options. Weaker performing options did not satisfy design criteria, had unacceptable impacts, or would be very difficult or costly to build. These weaker options were removed from further assessment or consideration and the outcome of the workshop was the establishment of a long list of route options for further investigation.

6.3 Description of Long List of Route Options

The selected long list of route options is shown in **Figure 6.2**. The long list is made up of sections and there are some eight to ten section combinations in each of the zones. Locations where it is possible to cross from one section to another are shown as ‘nodes’. For ease of presentation, the figure combines the sections into 13 options (A-M). However, through the multiple combinations of the various sections, it is possible to develop over 200 options from the long list.

Option L, shown on **Figure 6.2**, generally follows the existing Pacific Highway. In the Bangalow zone, Section L4 incorporates ‘Option B Modified’ from the Bangalow to St Helena Environmental Impact Statement (EIS).

The long list of route options are described in the following sections.

Figure 6.1 Study Area Zones

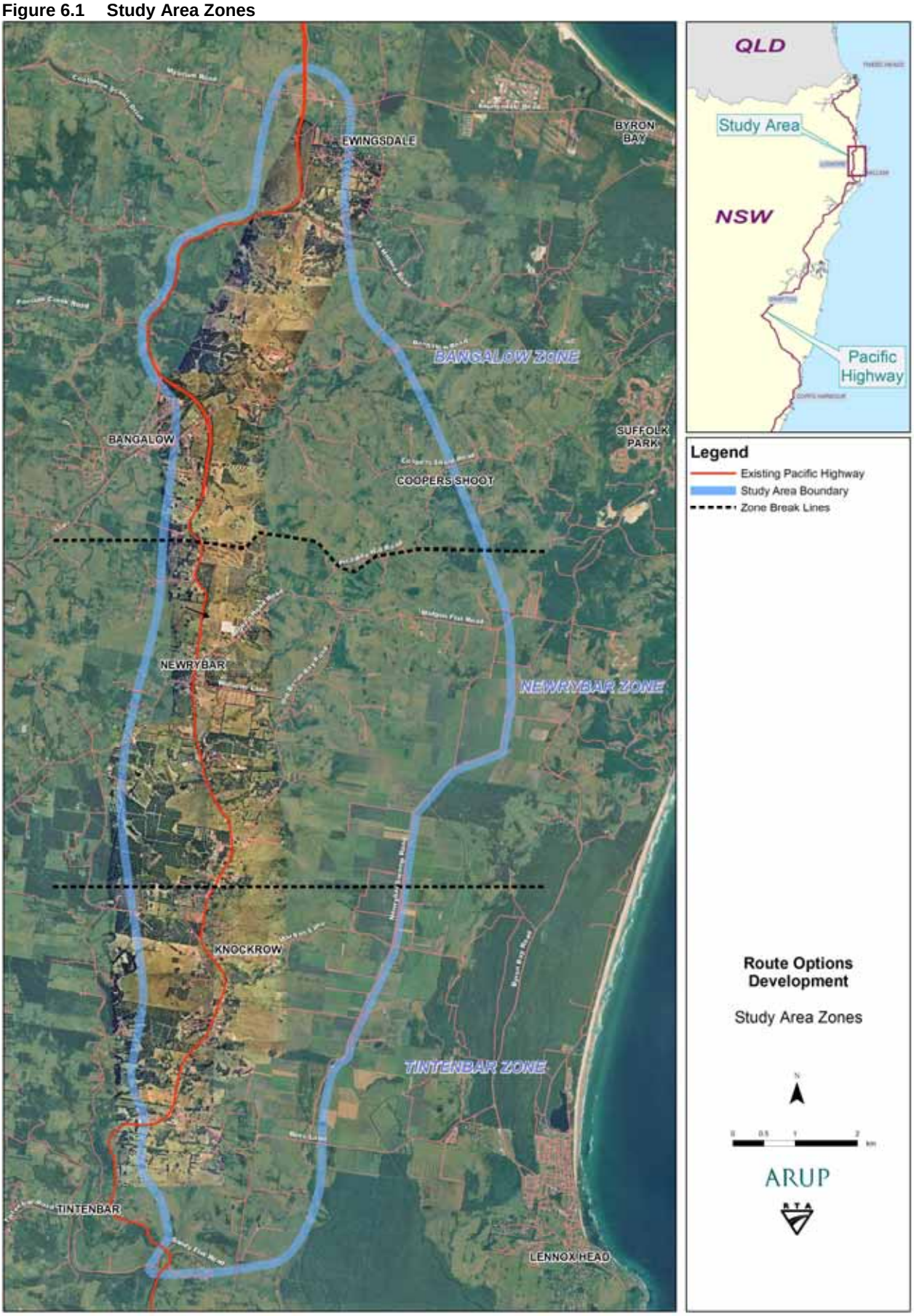
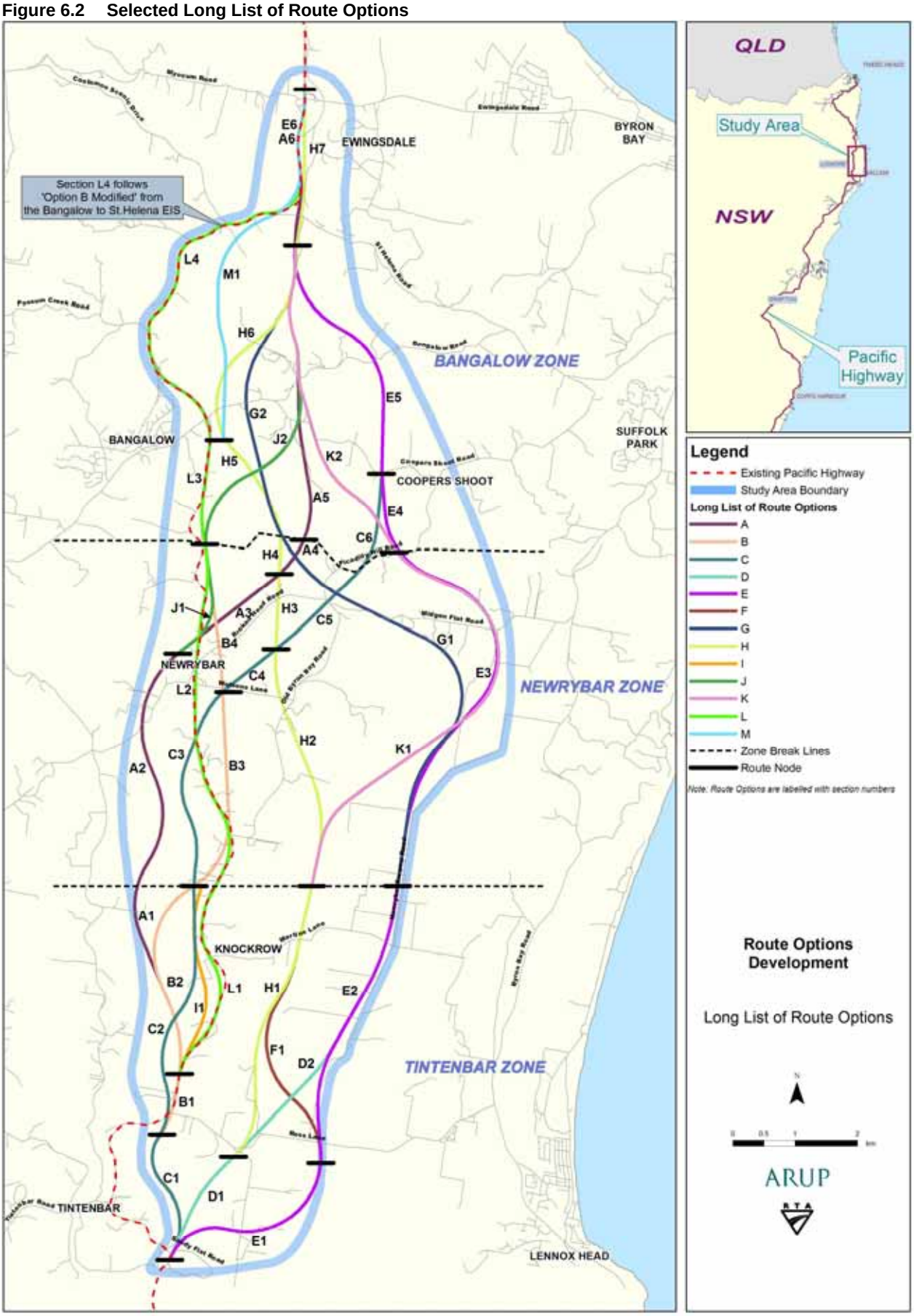


Table 6.1 Key Characteristics by Zone

Zone	Characteristics
Tintenbar	• Urban investigation area, including Cumbalum Ridge proposal • Lower reaches of Rous Water's Emigrant Creek Catchment • Areas of geotechnical instability on the eastern escarpment • Ballina Shire Council escarpment protection zoning 7(d1) • Rous Water reservoir and treatment facility at Knockrow, as well as supply pipelines from the west • Telstra's optic fibre cable follows the existing highway • Prominent hills and ridges across the plateau • Contiguous residential clusters along the existing highway, Ross Lane and Martins Lane • High value terrestrial ecology on the coastal plain and Sandy Flat • PAD on the coastal plain
Newrybar	• Newrybar Village and school • Upper reaches of Rous Water's Emigrant Creek Catchment • Areas of geotechnical instability on escarpment • Ballina Shire Council escarpment protection zoning 7(d1) • State significant farmland • Macadamia Castle • Hogans Bluff, an area of high value terrestrial ecology • Prominent hills and ridges across the plateau • Proposed Road Reserve Zoning 9A (extends for about 1.5 km on the eastern side of the existing highway to the north of Newrybar) • Contiguous residential clusters along the existing highway, Old Byron Bay Road, Broken Head Road and Midgen Flat Road • Isolated high value terrestrial ecology on the coastal plain, escarpment and Emigrant Creek areas
Bangalow	• Bangalow Village • Ewingsdale residential area • Coopers Shoot residential area • Proposed Road Reserve Zoning 9A (extends for about 1.5 km on the eastern side of the existing highway to the north of Newrybar) • Areas of geotechnical instability on the northern escarpment of St Helena • Byron Shire Council scenic escarpment zone 7D • State significant farmland • Casino-Murwillumbah Railway • Significant hills and ridges across the full plateau including St Helena Hill • Contiguous residential clusters along the existing highway, Piccadilly Hill Road, Coopers Shoot Road, St Helena Road and Bangalow Road • High value terrestrial ecology at Bangalow Creek, St Helena Hill escarpment and other areas • Ewingsdale Interchange

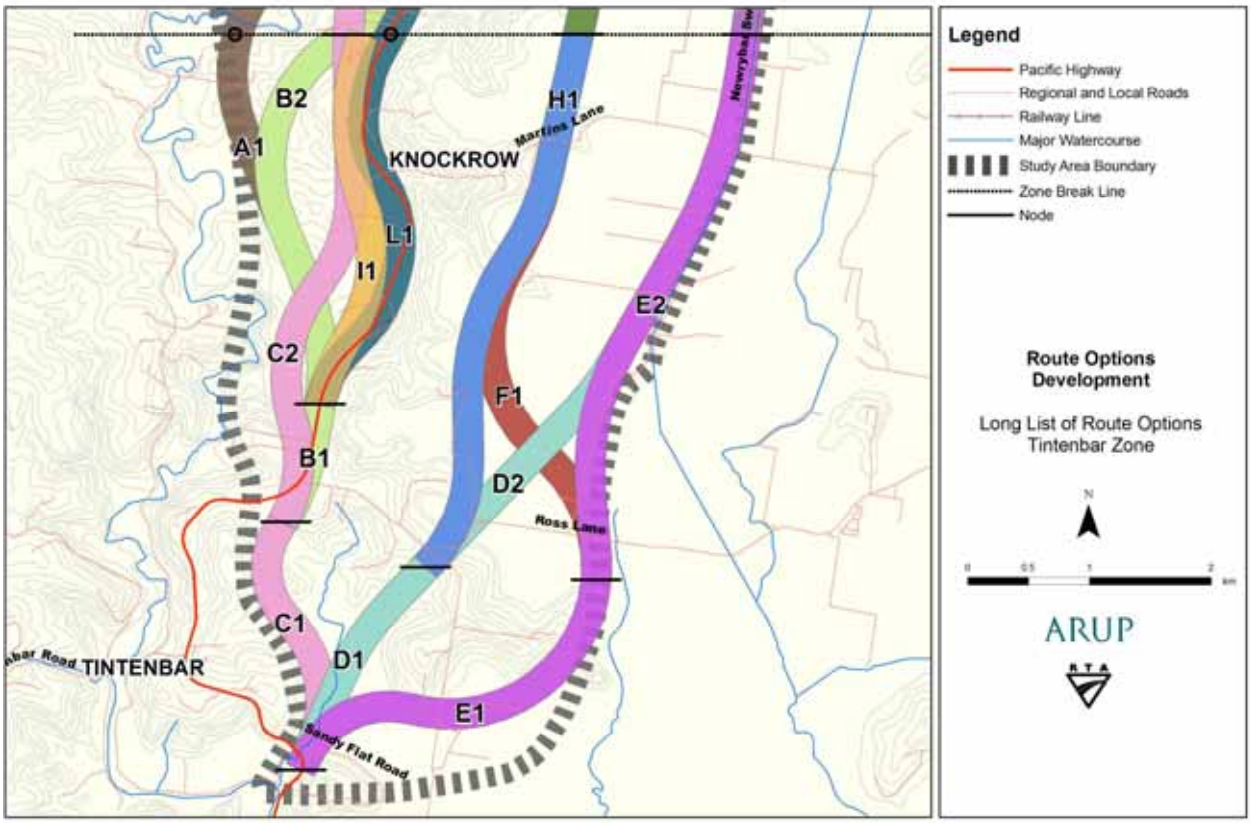
Figure 6.2 Selected Long List of Route Options



6.3.1 Tintenbar Zone Sections

Sections in the Tintenbar Zone are shown in **Figure 6.3**. Options beginning with Section C1 climb the escarpment immediately and remain on the plateau. Section D1 and E1 follow the coastal plain.

Figure 6.3 Sections in the Tintenbar Zone



Key characteristics of ***plateau options*** which begin with C1 are as follows:

- Section C1 follows the approved Ballina Bypass alignment between Sandy Flat and Ross Lane. The horizontal and vertical alignment of this Section approaches minimum design criteria.
- Upgrading of the existing highway south of Ross Lane is not included because of the poor alignment and poor safety record of this area.
- At the south end Section C1 passes through Ballina Shire Council's urban investigation zone.
- The hilly topography on the plateau means that sections would have significant depths of cut and fill.
- The plateau options pass through the Rous Water Emigrant Creek Catchment.
- Section A1 is on the west side of the existing highway and passes close to Emigrant Creek Dam.
- More dwellings would need to be acquired for the options near the existing highway. The majority of the dwellings that would need to be acquired are within 200m of the existing highway.
- Section B1 and L1 follow the existing highway and would therefore have a greater requirement for service/access roads.
- All the plateau options cross the regional wildlife corridor (as do all coastal plain options).

Key characteristics of ***coastal plain options*** which begin with Section D1 or E1 are:

- Section E1 skirts to the east of the ridge line which Ross Lane follows down from the plateau. Section D1 is a shorter variation which passes through a saddle in this ridge line.

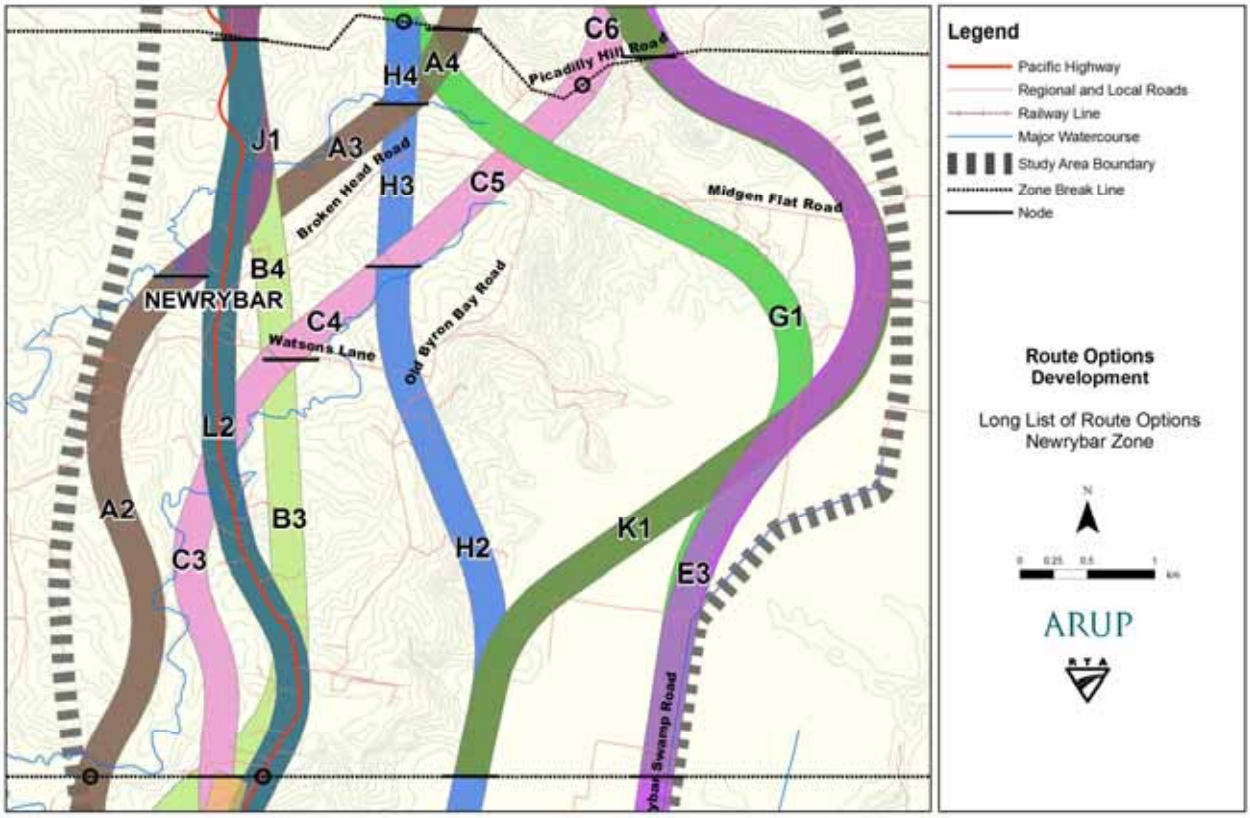
- There is generally less development on the coastal plain and these sections would directly affect fewer dwellings and would require fewer service/access roads.
- All coastal plain options would be raised above existing ground for flood immunity and would have flatter grades.
- On the north side of Ross Lane, Section H1 is located closer to the base of the escarpment while Section E2 follows Newrybar Swamp Road on the eastern side of the study area. Section H1 would have less impact on flooding and would require fewer drainage structures compared to Section E2.
- The coastal plain options impact Ballina Shire Council's urban investigation zones to a greater extent than the plateau options. Sections D1 and E1 go through the Council's proposed Cumbalum development. Of the coastal plain options, Section E1 would have the greatest impact on proposed residential areas within the Cumbulam North development proposal.
- Coastal plain sections are separate from the existing highway and would generally require fewer service/access roads.
- Section E1 passes adjacent to the Ballina Nature Reserve.
- All the coastal plain options cross the regional wildlife corridor (as do all plateau options).

6.3.2 Newrybar Zone Sections

Sections in the Newrybar zone are shown in **Figure 6.4**. Key characteristics of the sections include:

- In terms of severance to contiguous settlements:
  - K1 and E3 perform well.
  - A2 and G1 perform mid-range.
  - B3, C3, H2/H3 perform poorly.
- Sections L2, C3, B3 and B4 pass in close proximity to Newrybar.
- More dwellings would need to be acquired for the sections near the existing highway (e.g. L2). The majority of these dwellings are within 200 m of the existing highway.
- There is generally less development on the coastal plain and Sections H2, K1 and E3 would directly affect fewer dwellings and would require fewer service/access roads.
- The options located on the plateau cut across the east-west valleys and ridges, and generally have greater cuts and fills compared to options in the coastal plain.
- Options away from the existing highway generally require fewer service/access roads
- All plateau options traverse the Rous Water Catchment.
- Floodplain options are raised above existing ground for flood immunity and have flatter grades.
- Sections H4, A4 and G1 pass through areas designated as State Significant Farmland.
- Sections A2-J1, B3-B4 and E3 have less of an impact on vegetation than other sections in the zone.
- Section G1 and C5 perform poorly in terms of impact on vegetation.
- Sections L2, J1 and B4 follow an area of 9(a) zoning for future highway development.

Figure 6.4 Sections in the Newrybar Zone



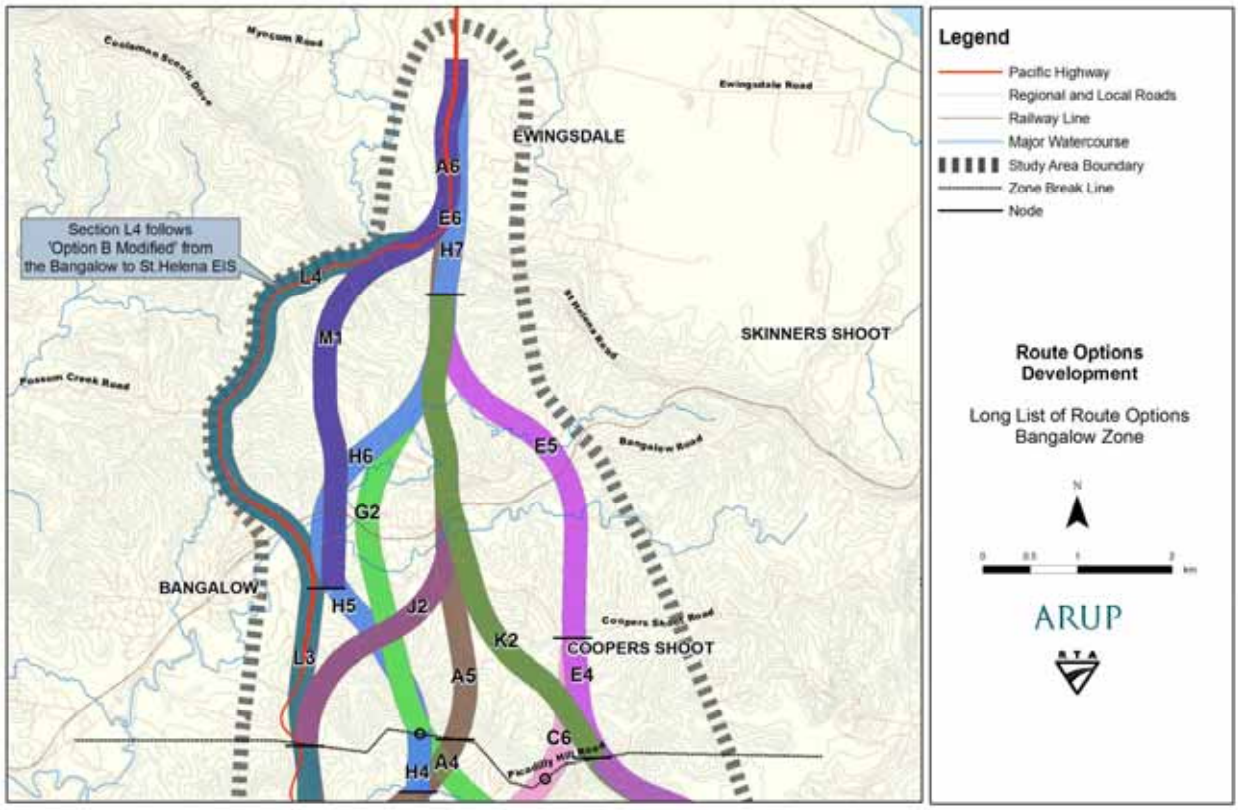
6.3.3 Bangalow Zone Sections

Sections in the Bangalow zone are shown in **Figure 6.5**. Key features of the sections include:

- There are no clear differentiators by section, but significant engineering challenges exist in this zone.
- In terms of severance to contiguous settlements:
  - Sections L3 and H6 perform well.
  - Sections C6 and E4-E5 perform mid-range.
  - Sections A5, A6, G2, H7, J2 perform poorly.
- All sections cut across east-west valleys and ridges.
- All sections have significant depths of cut and fill across the plateau.
- Sections L3 and J2 (part) follow an area of 9(a) zoning for future highway development, but the zoning may not be wide enough and grades would approach the maximum permissible values.
- Sections following the existing highway come in close proximity to Bangalow.
- Central Sections J2, H5, G2 and A5 pass through areas designated as State Significant Farmland.
- Geotechnical issues, high constraint ecology, topography, aesthetics and contiguous settlements limit feasible options for crossing St Helena Hill.
- Section L4 follows the Bangalow to St Helena EIS Option B Modified. It does not conform to the design criteria set out in **Section 4.3**.
- Apart from Section L4, the only non-tunnel section is M1. Section M1 follows the alignment of 'Option F Modified' from the Bangalow to St Helena EIS where it passes through St Helena ridge.

- All options, except for L4 and M1, pass under St Helena Hill in a tunnel, with the southern approach affecting businesses on the south side of St Helena.
- Based on the geotechnical and engineering investigations, the tunnel length would be relatively short, probably in the range 200 to 300 m depending on portal treatments.
- Three sections were identified for the northern approach to the tunnel. In each case the tunnel would be about the same length and the portals would be in about the same location:
  - Section E6 retains the 900 m of existing duplication that climbs at a 6% grade south from the Ewingsdale interchange, connecting to the south end of this duplication. At this point the grade reduces to 1.8% then increases to 4.4% as it climbs to the tunnel portal.
  - Section A6 is the same as E6 but maintains a steady 3% grade from the south end of the existing duplication. This section would require fill or a viaduct on the approach to the portal.
  - Section H7 involves reconstruction all the way from the Ewingsdale Interchange at a flatter 4.4% grade, on an alignment slightly closer to Ewingsdale. The total length of reconstruction increases but the existing highway could be retained for Bangalow traffic as well as other local traffic.
- Options from Ewingsdale Interchange to St Helena Hill on the west side of the existing highway are not feasible because of adverse geotechnical conditions.
- More dwellings would need to be acquired for the Sections near the existing highway (e.g. L3-L4). The majority of these dwellings are within 200m of the highway. H5-L4 also performs poorly. E4-E5 performs well.
- Most options have an impact on the high value vegetation in this zone as it is scattered from east to west across the study area.

Figure 6.5 Sections in the Bangalow Zone



7 Evaluation of Long List of Route Options

7.1 Methodology

The assessment process was initially conducted on a zone-by-zone basis for the zones and sections described in **Chapter 6**. By considering the nodes within each zone where it would be possible to switch from one section to another, a long list of possible section combinations or route options within each of the three zones was generated, resulting in:

- Tintenbar Zone – 9 route options.
- Newrybar Zone – 18 route options.
- Bangalow Zone – 28 route options.

By considering the various section combinations within each zone, the Sieve 1 evaluation process (see **Section 2.1**) allows identification of the best performing section combinations, avoiding the possibility that an entire corridor within a zone could be eliminated simply because it performed poorly in one section. Application of Sieve 1 and the pairwise, as described in **Sections 7.2** and **7.3**, allows the long list of route options within each zone to be compared and the best performing route options within each zone to be identified.

Because highly ranked route options from one zone may only connect to a poorly ranked route option from an adjacent zone, the process of evaluation of the long list could not be carried out entirely on a zone by zone basis. As the evaluation process proceeded, it was possible to develop a general grouping of better performing route options within each zone made up of the best performing sections. Those section combinations or route options which perform well within each zone were then reviewed to identify the better performing options within each zone that can also connect to a better performing option in an adjacent zone. This process was necessary to ensure that a section combination which performs well in one zone is not shortlisted if it can only be connected to a poor performing option the adjacent zone(s). Similarly, a section combination which performs only moderately well in one zone may be shortlisted if it can be connected to a good performing option(s) in the adjacent zone(s). This was necessary to ensure that the shortlisted options included the best route options over the full length of the study area.

The evaluation of the long list of options is based on a generic corridor width of 250 m. This corridor represents the area of investigation at this stage of the study and will be refined in later stages of the study to the actual road reserve width requirements. This is the actual land that would be required for the physical roadway (highway and service roads), public utility plant (if required), earthworks and maintenance clearances. On the ground it is generally delineated by boundary fences separating the road reserve from frontage properties and would range from about 80 m to 200 m wide.

7.2 Sieve 1 Criteria

The Sieve 1 evaluation criteria (see **Appendix A**) were measured either quantitatively or qualitatively for all of the route option ‘section combinations’ described in this chapter.

Based on the results of the measurements (unweighted), the criteria for each option (initially by ‘section combination’ and then by route option) were assigned a ‘performance or level of impact score’. **Appendix B** provides the results of the scoring for each criterion for the long list of route options (by section combinations) and the resulting ranking.

7.3 Pairwise

It is recognised that individuals, interest groups and communities value project specific issues differently. In order to reflect these differing values a 'pairwise' evaluation process was adopted.

The process involves taking one evaluation criterion/measure at a time and selecting whether it is of more or less importance than every other criterion/measure. This process is spreadsheet based and provides a weighting or relative importance for each criterion/measure. The advantage of using a pairwise approach is that it distinguishes between benefits and disbenefits potentially offered by the project rather than reacting to specific impacts or rating all impacts as high.

The pairwise exercise was undertaken with three groups: the Project Team (RTA and Arup), the Planning Focus Group (generally local and state agency representatives) and the CLG. Individuals within these groups were asked to complete a pairwise analysis and the results were combined by group to provide a sensitivity test or set of weightings. The summary results of the pairwise process are presented in **Appendix C**. This summary provides the separate results of the Project Team, agency representatives, and the CLG. The resulting criteria ranking by each group is also provided.

The pairwise results for the Project Team were used as the base case for analysis and those from the CLG and Planning Focus Group were used for sensitivity testing. It should be noted that several members of the CLG felt the results of the pairwise exercise reflected that the CLG was not representative of the community and that the results should not be used in any analysis of the options.

Application of the pairwise in the route selection process is described in the following sections.

7.4 Performance of Long List of Route Options

The results of applying the selection criteria and pairwise analysis for the section combinations of the longlisted sections are tabulated for each zone in **Table 7.1**. The section codes, which identify the path the route has taken, are also shown in this table.

The Bangalow Zone long list of options includes three alignments that utilise a tunnel through St Helena Hill - A6, E6, and H7. Due to the similarity in selection criteria ratings of these sections, E6 was chosen as a typical alignment for the tunnel and tunnel approaches. This rationalised the 28 options into 12 options for ease of comparison.

Performance results are assessed and reviewed on a zone by zone basis in the following sections. The best performing combinations of sections within each zone are considered as potential components of the short list of options.

Table 7.1 Results of Application of Selection Criteria and Weightings for each Zone (Best Performing Options)

Tintenbar Zone																			
Section Combinations		C1 B1 A1	C1 B1 B2	C1 B1 I1	C1 B1 L1	C1 C2	D1 D2	D1 H1	E1 E2	E1 F1									
Unweighted	Score	146	148	137	135	156	139	149	135	132									
	Rank	***4***	***3***	***6***	***7***	***1***	***5***	***2***	***7***	***9***									
Project Team Weighted	Score	3.60	3.64	3.26	3.25	3.87	3.77	3.99	3.61	3.47									
	Rank	***6***	***4***	***8***	***9***	***2***	***3***	***1***	***5***	***7***									
CLG Weighted	Score	3.82	3.85	3.61	3.63	4.05	3.36	3.72	3.23	3.19									
	Rank	***3***	***2***	***6***	***5***	***1***	***7***	***4***	***8***	***9***									
Agency Weighted	Score	3.67	3.66	3.29	3.29	3.90	3.51	3.68	3.47	3.32									
	Rank	***3***	***4***	***8***	***9***	***1***	***5***	***2***	***6***	***7***									
Newrybar Zone																			
Section Combinations		A2 A3 A4	A2 J1	A2 A3 H4	L2	B3 B4	B3 C4 H3 H4	B3 C4 H3 A4	B3 C4 C5	C3 B4	C3 C4 H3 H4	C3 C4 H3 A4	C3 C4 C5	H2 H3 A4	H2 H3 H4	H2 C5	K1	G1	E3
Unweighted	Score	138	160	141	156	160	144	141	139	163	144	137	139	149	151	148	145	131	150
	Rank	***16***	***2***	***12***	***4***	***2***	***10***	***12***	***14***	***1***	***10***	***17***	***14***	***7***	***5***	***8***	***9***	***18***	***6***
Project Team Weighted	Score	3.50	4.05	3.55	3.83	3.92	3.54	3.49	3.40	4.08	3.60	3.44	3.47	3.81	3.84	3.72	3.95	3.53	4.03
	Rank	***14***	***2***	***11***	***7***	***5***	***12***	***15***	***18***	***1***	***10***	***17***	***16***	***8***	***6***	***9***	***4***	***13***	***3***
CLG Weighted	Score	3.56	4.13	3.58	4.21	4.16	3.67	3.65	3.56	4.24	3.67	3.55	3.60	3.79	3.81	3.77	3.61	3.26	3.70
	Rank	***16***	***4***	***14***	***2***	***3***	***9***	***11***	***15***	***1***	***10***	***17***	***13***	***6***	***5***	***7***	***12***	***18***	***8***
Agency Weighted	Score	3.45	4.05	3.51	3.89	3.95	3.49	3.44	3.39	4.06	3.57	3.40	3.44	3.73	3.77	3.70	3.73	3.36	3.84
	Rank	***13***	***2***	***11***	***4***	***3***	***12***	***15***	***17***	***1***	***10***	***16***	***14***	***8***	***6***	***9***	***7***	***18***	***5***

Bangalow Zone																			
Section Combinations		J2 E6	L3 L4	L3 H6 E6	H5 L4	H5 H6 E6	G2 E6	A5 E6	K2 E6	C6 E5 E6	E4 E5 E6	L3 M1	H5 M1						
Unweighted	Score	152	126	150	124	147	152	159	155	152	155	145	141						
	Rank	***4***	***11***	***7***	***12***	***8***	***4***	***1***	***2***	***4***	***2***	***9***	***10***						
Project Team Weighted	Score	3.77	3.11	3.78	3.06	3.72	3.74	4.00	3.88	3.80	3.87	3.57	3.54						
	Rank	***6***	***11***	***5***	***12***	***8***	***7***	***1***	***2***	***4***	***3***	***9***	***10***						
CLG Weighted	Score	3.90	3.45	3.89	3.34	3.77	3.91	4.07	3.98	3.88	3.94	3.78	3.60						
	Rank	***5***	***11***	***6***	***12***	***9***	***4***	***1***	***2***	***7***	***3***	***8***	***10***						
Agency Weighted	Score	3.82	3.19	3.82	3.11	3.70	3.79	4.04	4.00	3.92	3.99	3.72	3.64						
	Rank	***5***	***11***	***6***	***12***	***9***	***7***	***1***	***2***	***4***	***3***	***8***	***10***						

7.4.1 Tintenbar Zone – 9 options

Of the nine options in this zone, five performed well while the remaining four underperformed by comparison. This conclusion can be drawn regardless of the weighting applied. There was little variation in rankings according to pairwise and the five better performers included all section combinations which ranked within the first four in at least one of the pairwise rankings. This approach deleted the worst options, but ensured that any options which performed reasonably well according to at least one of the three applied weightings were given further consideration. The five section combinations are listed in **Table 7.2** and further described below.

Table 7.2 Best Performing Tintenbar Options

Section Combinations	**C1 B1 A1**	**C1 C2**	**C1 B1 B2**	**D1 H1**	**D1 D2**
Unweighted Score	146	156	148	149	139
Rank out of 9	4	1	3	2	5
Base Case					
Project Team Weighted Score	3.60	3.87	3.64	3.99	3.77
Rank out of 9	6	2	4	1	3
Sensitivity Tests					
CLG Weighted Score	3.82	4.05	3.85	3.72	3.36
Rank out of 9	3	1	2	4	7
Agency Weighted Score	3.67	3.90	3.66	3.68	3.51
Rank out of 9	3	1	4	2	5

Route C1-C2 utilises the majority of the Ballina Bypass design north of Sandy Flat Road before diverting slightly to the west of the existing highway for the remaining section of this zone. Its benefits include good performance in terms of engineering and cost, as well as limited severance on residential and future residential areas.

Section combination D1-H1 also performed well in this zone. Section D1 follows a valley towards a saddle in the ridge line which Ross Lane follows to the east of the existing highway. On the north side of the saddle Section H1 is located close to the base of the escarpment, limiting the impact on flooding and also avoiding the worst of the soft soils in the coastal plain. Grades are relatively flat compared to plateau options and it would be raised above existing ground to provide flood immunity. There is generally less development on the coastal plain and this option would directly affect fewer dwellings and would require fewer service/access roads compared to plateau options.

The route option comprising Sections C1-B1-B2 follows the Ballina Bypass then follows the existing highway for about 1 km before diverting to the west.

The other two section combinations that performed reasonably well were C1-B1-A1 and D1-D2.

Options based on Section E1 (E1-E2 and E1-F1) performed poorly, as did options involving section L1 and I1 which follow on or close to the existing highway.

7.4.2 Newrybar Zone – 18 options

The Newrybar Zone has the most sections and the most possible route options. It also proved to be the most complex to analyse because the performance of the section combinations varied significantly according to the pairwise that was applied.

In order to reduce the number of section combinations to a more manageable number, options which ranked within the top six in at least one of the pairwise rankings were considered to perform relatively well and were taken forward for further consideration. This allowed deletion of the worst options but ensured that any options which performed reasonably well according to at least one of the three applied weightings were given further consideration. The 18 shortlisted options are reduced in this way to eight best performing Newrybar zone options as presented in **Table 7.3**.

Table 7.3 Best Performing Newrybar Options

Section Combinations	**A2 J1**	**L2**	**B3 B4**	**C3 B4**	**H2 H3 A4**	**H2 H3 H4**	**K1**	**E3**
Unweighted Score	160	156	160	163	149	151	145	150
Rank out of 18	2	4	2	1	7	5	9	6
Base Case								
Project Team Weighted Score	4.05	3.83	3.92	4.08	3.81	3.84	3.95	4.03
Rank out of 18	2	7	5	1	8	6	4	3
Sensitivity Tests								
CLG Weighted Score	4.13	4.21	4.16	4.24	3.79	3.81	3.61	3.70
Rank out of 18	4	2	3	1	6	5	12	8
Agency Weighted Score	4.05	3.89	3.95	4.06	3.73	3.77	3.73	3.84
Rank out of 18	2	4	3	1	8	6	7	5

Table 7.3 includes four section combinations located on the plateau for the full length: A2-J1, C3-B4, B3-B4 and L2. By staying close to the existing Pacific Highway, these plateau options tend to perform well regarding:

- Environmental constraints.
- Engineering constraints, such as length through soft soils and length through flood prone land.
- Constraints relating to the decrease in property value, such as relative noise burden and the acquisition of dwellings not currently within 200m of the existing highway.

Also included are four section combinations located, for at least part of the zone, on the coastal plain: H2-H3-H4, H2-H3-A4, K1 and E3. In the Sieve 1 analysis these options do not generally perform as well as the best plateau options, but they do provide links to the better performing section combinations in the Tintenbar and Bangalow zones.

7.4.3 Bangalow Zone – 28 options

As noted at the start of **Section 7.4**, the Bangalow zone long list included three alignments that utilise a tunnel through St Helena Hill - A6, E6, and H7. Due to the similarity in selection criteria ratings of these sections, E6 was chosen as a typical alignment for the tunnel and tunnel approaches and this rationalised the 28 options into the 12 options shown in **Table 7.1.**

The number of section combinations was further reduced as before by selecting those section combinations which ranked within the top six in at least one of the pairwise rankings. Two exceptions were made as follows:

- Combination C6-E5-E6 was excluded because the only connecting option in the Newrybar Zone (section combination C3-C4-C5) performs poorly and was not selected for further consideration in that zone.
- Even though the analysis indicates that non-tunnel options performed relatively poorly, the best performing non-tunnel option (section combination L3-M1) has been retained for further consideration.

Excluding C6-E5-E6 but including the non-tunnel option L3-M1, the best performing Bangalow zone options are reduced from twelve to seven as shown in **Table 7.4.**

Table 7.4 Best Performing Bangalow Options

Section Combinations	**J2 E6**	**L3 H6 E6**	**L3 M1**	**A5 E6**	**K2 E6**	**G2 E6**	**E4 E5 E6**
Unweighted Score	152	150	145	159	155	152	155
Rank out of 12	4	7	9	1	2	4	2
Base Case							
Project Team Weighted Score	3.77	3.78	3.57	4.00	3.88	3.74	3.87
Rank out of 12	6	5	9	1	2	7	3
Sensitivity Tests							
CLG Weighted Score	3.90	3.89	3.78	4.07	3.98	3.91	3.94
Rank out of 12	5	6	8	1	2	4	3
Agency Weighted Score	3.82	3.82	3.72	4.04	4.00	3.79	3.99
Rank out of 12	5	6	8	1	2	7	3

It should be noted that application of the three pairwise weightings did not greatly affect the relative rating of section combinations in this zone.

One of the better performing section combinations in this zone was A5-E6. This section combination passes through the saddle where Tinderbox Road connects to Bangalow Road before passing across Tinderbox Creek to a tunnel under St Helena Hill.

Section combination K2-E6 similarly performed well. This section combination is a continuation of E3 or K1 which climb the escarpment in the Newrybar Zone, before passing through the same saddle at Tinderbox Road and again with a tunnel under St Helena Hill.

Section combinations J2-E6, L3-H6-E6 and E4-E5-E6 are also better performing options. L3-H6-E6 follows part of the Bangalow Bypass before crossing Bangalow Creek and following the Tinderbox Creek valley to the tunnel under St Helena Hill. J2-E6 has a flatter grade down to Bangalow Creek but would require a number of viaducts. Section combination E4-E5-E6 crosses Bangalow Creek and Tinderbox Creek further to the east before curving back to the tunnel under St Helena Hill.

These three options would pass through a tunnel under St Helena Hill. The tunnel in Section E6 would be 200 to 300 m long and the tunnel pavement would be about 40 m below the surface at the deepest point.

As described in **Section 6.3.3**, there are three options for the northern approaches to the tunnel. In each case the tunnel would be about the same length and the portals would be in about the same location. Each of the northern approach options could connect to any of the options on the south side of the tunnel, or to Section M1, however they rated similarly in the pairwise analysis and so were not included in the comparison table. An assessment of the three options for the northern approaches to the tunnel is included in **Section 7.5.2**.

As noted above, the section combination L3-M1 is included for consideration as a non-tunnel option despite its lower ranking. It follows part of the Bangalow Bypass but continues in a straight line where the existing bypass veers to the left up the hill. It continues towards the existing highway, joining an alignment very similar to the alignment of the Bangalow to St Helena EIS Option F. It passes through St Helena Hill in an open cutting approximately 35 m deep, and would require a viaduct structure about 500 m long across the lower land on the north side of the cutting.

7.5 Technical Review

The better performing options from each zone were assessed both qualitatively and quantitatively to assist in shortlisting the route options. The objectives in the shortlisting process were to facilitate the identification of a short list of route options that achieved the following:

- Performed well overall.
- Resulted in at least two route options through each zone - but limited the number of shortlisted options (for example, by not shortlisting similar options through the same area where one option is clearly better than the other).

Therefore it was not simply a matter of selecting the highest ranked options in each zone, since some options connected to relatively poor performing sections in adjacent zones.

Figure 7.1 shows the better performing section combinations from the long list of route options, as derived in **Section 7.4**, and how they can be linked to options in adjacent zones.

By assessing the performance of section combinations initially within zones and then as combinations over two or more zones, the short list of route options can be derived as described in the following sections.

7.5.1 Tintenbar Zone

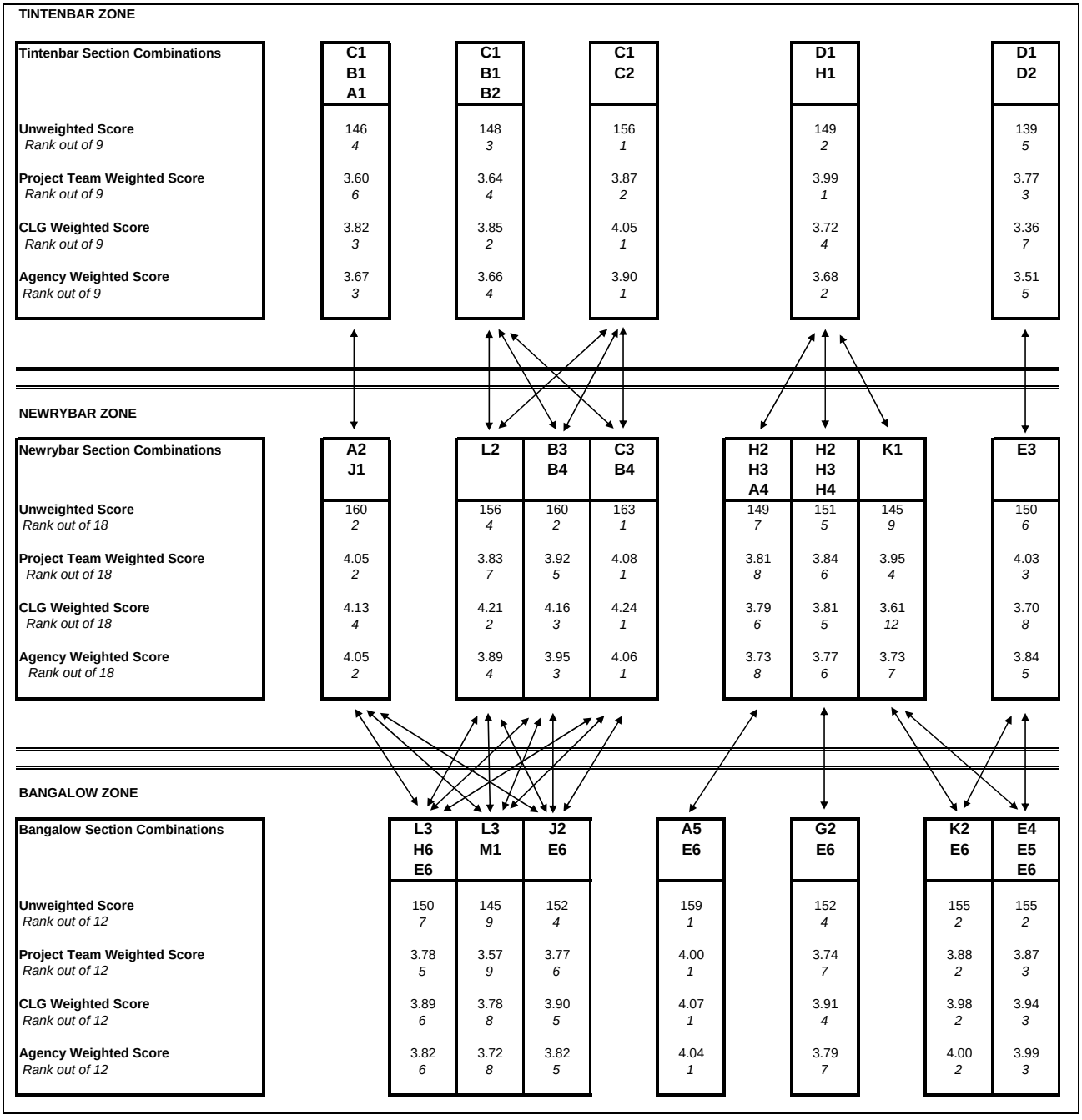
Within the Tintenbar zone, 3 of the 5 better performing options have been selected for shortlisting. Two options were not carried forward. Details are provided below:

- Option C1-C2 performs well and connects to good options in the Newrybar zone and has been included in the short list.
- Option D1-H1 performs well and connects to good options in the Newrybar zone and has been included in the short list.
- Option C1-B1-B2 has the advantage of allowing utilisation of the full length of the approved Ballina Bypass alignment (including the Ross Lane interchange), and also utilises the existing highway corridor in Section B1. However, Section B2 does not perform as well as Section C2. An adjustment has therefore been made in shortlisting this option by connecting B2 onto C2 where the two sections cross part way through (now Option C1-B1-B2/C2). This change would not significantly affect the rankings and has the advantage of moving the option further from Emigrant Creek Dam.
- Option D1-D2 is the second coastal plain option but does not perform nearly as well as Option D1-H1. It has not been included on the short list.

- Option C1-B1-A1 has not been shortlisted, primarily because there are two other shortlisted plateau options through this zone (C1-C2 and C1-B1-B2/C2) which perform better, and also because of concern about its proximity to Emigrant Creek Dam.

The shortlisted options from the Tintenbar zone are therefore Option C1-C2, Option D1-H1, and Option C1-B1-B2/C2.

Figure 7.1 Better Performing Section Combinations



7.5.2 Bangalow Zone

The next zone assessed was Bangalow, primarily because it is the other end zone and therefore influenced by options in one adjacent zone only.

There was remarkable consistency in the ranking of options within this zone with little variation when different weightings were applied.

- The best performing options within this zone were Option A5-E6, Option K2-E6 and Option E4-E5-E6. Options A5-E6 and K2-E6 have been shortlisted. Option E4-E5-E6 was not shortlisted because it begins and ends at the same nodes as shortlisted Option K2-E6, but was consistently ranked lower.
- The next options assessed were the three which commence at the Newrybar/Bangalow zone boundary where it crosses the existing highway. These options are L3-H6-E6 (follows the existing Bangalow bypass before diverting east up the Tinderbox Creek valley to the tunnel), Option J2-E6 (passes through the Tinderbox Road saddle before connecting to the tunnel approach), and Option L3-M1 (connects onto part of the old Bangalow to St Helena EIS Option F, avoiding the need for a tunnel). The first two options are ranked higher than Option L3-M1 regardless of the weighting applied (despite having a higher cost than the non-tunnel option). Option L3-H6-E6 and Option J2-E6 therefore have been shortlisted in preference to the non-tunnel Option L3-M1.
- Option G2-E6 had an overall ranking lower than the four shortlisted options and connects only to Option H2-H3-H4 which has a relatively low ranking in the Newrybar zone compared to the other options shown in the Newrybar Zone **Table 7.3**. On this basis, Option G2-E6 has not been shortlisted.

As described at the start of **Section 7.4** and in **Section 6.3.3**, three options for the northern approaches to the tunnel were included in the longlisted Bangalow zone options, E6, A6 and H7. To simplify the evaluation of the Bangalow zone, the shortlisting process for this zone as described above has been based on tunnel approach Option E6. A separate assessment has been carried out for the three northern approaches to determine which option(s) should be shortlisted. Assessment of the three tunnel approaches has been based on Section A5, the most highly rated southern approach to the tunnel. Using Section A5 as the common approach, the Sieve 1 process and pairwise has been applied to the three northern approach options:

- Section E6 which retains the 900 m of existing duplication that climbs at a 6% grade south from the Ewingsdale interchange, connecting to the south end of this duplication. At this point the grade reduces to 1.8% then increases to 4.4% as it climbs to the tunnel portal.
- Section A6 which is the same as E6 but maintains a steady 3% grade from the south end of the existing duplication.
- Section H7 which would involve reconstruction all the way from the Ewingsdale Interchange at a flatter 4.4% grade, on an alignment slightly closer to Ewingsdale.

The results of applying the evaluation criteria and pairwise to the three northern approaches to the tunnel are shown in **Table 7.5.**

The results indicate that the choice of northern tunnel approach does not have a major effect on the unweighted or weighted scores. Had Sections A5 and K2 been combined with Sections A6 or H7 rather than E6, Sections A5 and K2 would still have been shortlisted as the better performing Bangalow zone options.

In terms of selecting which northern approach options should be selected for the short list, application of the Sieve 1 criteria and pairwise has not identified any major differences between the three options. Sections E6 and A6 have the same horizontal geometry and the differences in vertical grading are small. It is proposed to shortlist Section E6 with the intention of reviewing the vertical geometry during the refinement of the short list of options in the next stage of design development.

Table 7.5 Comparison of Bangalow Options for Northern Approach to Tunnel

Section Combinations	**A5 E6**	**A5 A6**	**A5 H7**
Unweighted Score	159	158	158
Rank out of 3	1	2	2
Base Case			
Project Team Weighted Score	4.00	3.93	3.94
Rank out of 3	1	3	2
Sensitivity Tests			
CLG Weighted Score	4.07	4.04	4.02
Rank out of 3	1	2	3
Agency Weighted Score	4.04	4.00	3.98
Rank out of 3	1	2	3

Even though Option H7 is slightly closer to Ewingsdale, it is proposed that this option be shortlisted for the following reasons:

- The flatter grades of Option H7 are considered to have the potential to reduce noise levels from southbound climbing vehicles as well as reducing compression braking for northbound trucks.
- Option H7 would allow the existing highway to be retained for local traffic.

The shortlisted options from the Bangalow zone are therefore Option A5-E6, Option K2-E6, Option L3-H6-E6 and Option J2-E6, which connect to northern approach section E6 and Option A5-H7, Option K2-H7, Option L3-H6-H7 and Option J2-H7 which connect to northern approach section H7.

7.5.3 Newrybar Zone

Determination of the shortlisted options within this zone was more difficult because of the number of options and the fact that there were significant variations in ranking depending on the pairwise applied. The selection process was assisted by reference to the shortlisted options in adjacent sections.

- Option C3-B4 performs well, connects to good options in both the Tintenbar and Bangalow zones, and has been shortlisted.
- Other plateau options under consideration were Option L2, Option B3-B4 and Option A2-J1. Option A2-J1 is the western most option and was eliminated because it only connects to Tintenbar option C1-B1-A1 which was not highly ranked compared to other Tintenbar options and was not shortlisted in the Tintenbar zone. Option L2 (on-line existing highway option) and Option B3-B4 (generally just to the east of the existing highway) had similar rankings and the same connectivity to adjacent sections. It was decided to shortlist Option L2, primarily because, together with the shortlisted on-line options in adjacent zones (Tintenbar C1-B1-B2/C2 and Bangalow L3-H6), it would allow a full assessment of the on-line upgrade option.
- Four coastal plain options (H2-H3-A4, H2-H3-H4, K1 and E3) were considered and none of the coastal plain options stands out as clearly better than others. The decision on which coastal plain option(s) to shortlist was therefore made by referring to the performance of connecting options in adjacent zones.
  - Option H2-H3-A4, while not a good performer in isolation, connects to highly ranked shortlisted options in both the Tintenbar zone (Option D1-H1) and Bangalow zone (Option A5-E6) and has therefore been shortlisted.

- Option K1, while not as good in isolation, connects to good options in both the Tintenbar zone (Option D1-H1) and Bangalow zone (Option K2-E6) and has therefore been shortlisted.
- Option E3 connects only to Option D1-D2 in Tintenbar zone which did not perform nearly as well as D1-H1 and was not shortlisted. Therefore Option E3 has not been shortlisted in this section.
- Option H2-H3-H4 connects only to Option G2-E6 in Bangalow zone which did not perform as well comparatively as other Bangalow zone options and was not shortlisted. Therefore Option H2-H3-H4 has not been shortlisted in this section.

Concern has been expressed about geotechnical issues where Option H2-H3-A4 climbs the escarpment (Section H2) traversing it as a side slope. Option K1 utilises a spur line to climb the escarpment and geotechnical issues would be less significant. Inclusion of coastal plain Option K1 ensures that an alternative coastal plain option is available should difficulties arise with other route options.

The shortlisted options from the Newrybar zone are therefore Option L2, Option C3-B4, Option H2-H3-A4, and Option K1.

7.5.4 Confirmation of Short List of Route Options

The final step of the Sieve 1 evaluation was to combine the short list of options in each zone into corridor options over the full length from north to south and to renumber the routes for simplicity. **Figure 7.2** graphically displays the sections which make up the short list of options. The shortlisted options were renamed Option A, Option B, Option C and Option D to simplify the identification of the options for public display and further assessment. Option A incorporates an upgrade following the general alignment of the existing corridor, Option B is a plateau option in an entirely new corridor and Options C and D are partly located on the eastern coastal plain. The new names for the short list are provided in **Table 7.6** which also shows the long list sections that were combined to form the short list.

7.5.4.1 Option B Modified from the Bangalow to St Helena EIS

Options involving an upgrade of the existing highway (Sections L3-L4 and H5-L4) were included in the long list of options for the Bangalow zone. As noted in **Chapter 1**, recommendations from the Northern Pacific Highway Noise Taskforce (RTA2003) were the catalyst for further review of Option B from the Bangalow to St Helena EIS. Section L4 incorporates Option B Modified from the Bangalow to St Helena EIS. The assessment results in **Table 7.1** show that the two options with Section L4 were rated lowest of the Bangalow zone options regardless of the weighting applied. **Table 7.1** also shows that there was a considerable margin between the unweighted and weighted scores of L3-L4 and H5-L4 and the unweighted and weighted scores of the other ten longlisted Bangalow zone options.

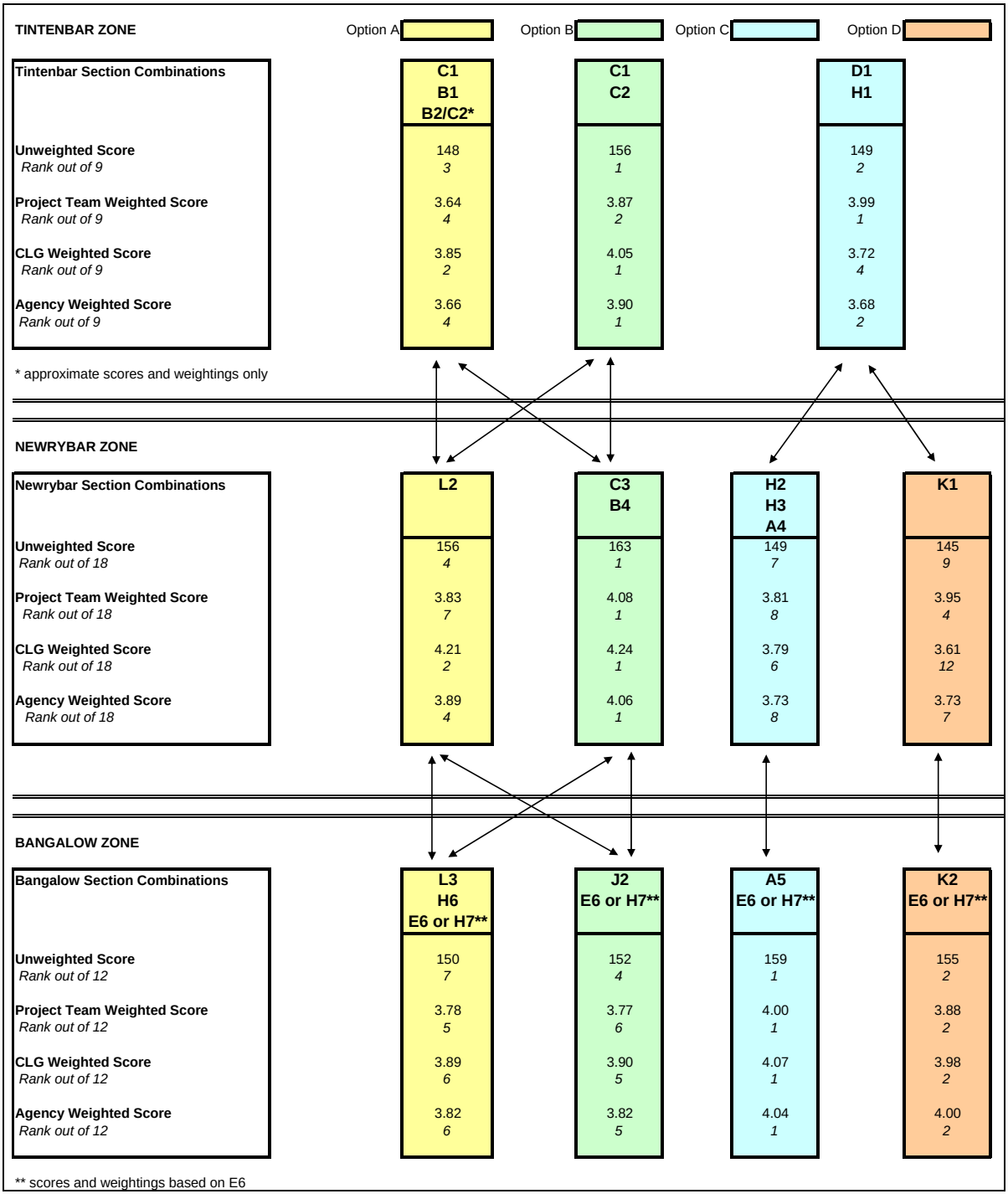
Particular issues which contributed to the relatively poor ranking of options incorporating Section L4 (Option B Modified) were:

- It does not meet the highway design criteria established for the upgrade. In particular the design speed of 80 km/h and the sustained 8% grade on the escarpment are considerably below the adopted design standard and would be inconsistent with the standards of adjoining sections of the highway.
- It would force local traffic to share the upgraded highway, as it would not be possible to retain the existing highway as a separate road for local traffic usage. Intermediate interchanges would be required at Possum Creek Road and at Fowlers Lane/Coolamon Scenic Drive, in addition to the existing interchange providing access to Bangalow. The design would also include an at-grade intersection at St Helena Road. The additional interchanges and the greater mixing of local and through traffic with this option would be inconsistent with the standards of adjoining sections of the highway.
- It would be between 1.2 km and 1.8 km longer than other shortlisted route options, adding to travel times for all users.

- It performed poorly in terms of noise impacts and would require acquisition of a greater number of dwellings.
- It crosses more wildlife corridors than other options.

For these reasons neither of the two Bangalow options incorporating Section L4 (Option B Modified) was included in the best performing Bangalow zone options taken forward for further consideration, and neither option made the shortlist.

Figure 7.2 Sections Making up Short List of Route Options



7.5.4.2 Other Non-Tunnel Options

Apart from Section L4, the only other non-tunnel section included in the longlisted options for Bangalow zone was Section M1. Section M1 joins an alignment very similar to the alignment of the Bangalow to St Helena EIS Option F. It passes through St Helena Hill in an open cutting approximately 35 m deep, and would require a viaduct structure about 500 m long across the lower land on the north side of the cutting.

The two options incorporating M1 were not included in the best performing Bangalow zone options taken forward for further consideration. The assessment results in **Table 7.1** show that the two options with Section M1 performed relatively poorly regardless of the weighting applied. Of the twelve Bangalow zone options shown in **Table 7.1**, the only options assessed as worse than the options with M1 were the two options incorporating Section L4 that followed the existing highway. The other eight options, all of which incorporated a tunnel under St Helena Hill, were generally assessed as performing better than options incorporating M1. The only exception was using the Agency weightings – in this instance, Option H5-M1 was rated marginally ahead of Option H5-H6-E6. This is not significant because Option H5-H6-E6 was not included in the best performing Bangalow zone options and was not shortlisted. Cost/engineering was the only selection criteria category where the M1 options rated better than the best performing options. In other respects, particularly in terms of safety and loss of agricultural land, the M1 options generally rated worse than the best performing options. Because of the relatively poor rated performance of the M1 options, they were not shortlisted.

Table 7.6 Final Short List of Route Option Sections

Short List Section Names	Combined from Long List Section Names
A/B	C1
A1	B1-B2/C2-L2
A2	L3-H6
B1	C2-C3-B4
B2	J2
C/D	D1-H1
C1	H2-H3-A4-A5
D1	K1-K2
T1	E6
T2	H7

8 Impacts of Short List of Route Options

8.1 Overview of Approach to Assessment

This chapter discusses the potential impacts of the short list of options. Key impact areas addressed include:

- Engineering (design, safety, cost and constructability)
- Traffic and transport
- Geotechnical
- Hydrology
- Drinking water catchments
- Aquatic ecology
- Terrestrial ecology
- Planning and land use
- Socio-economic effects
- Cultural heritage
- Visual
- Noise.

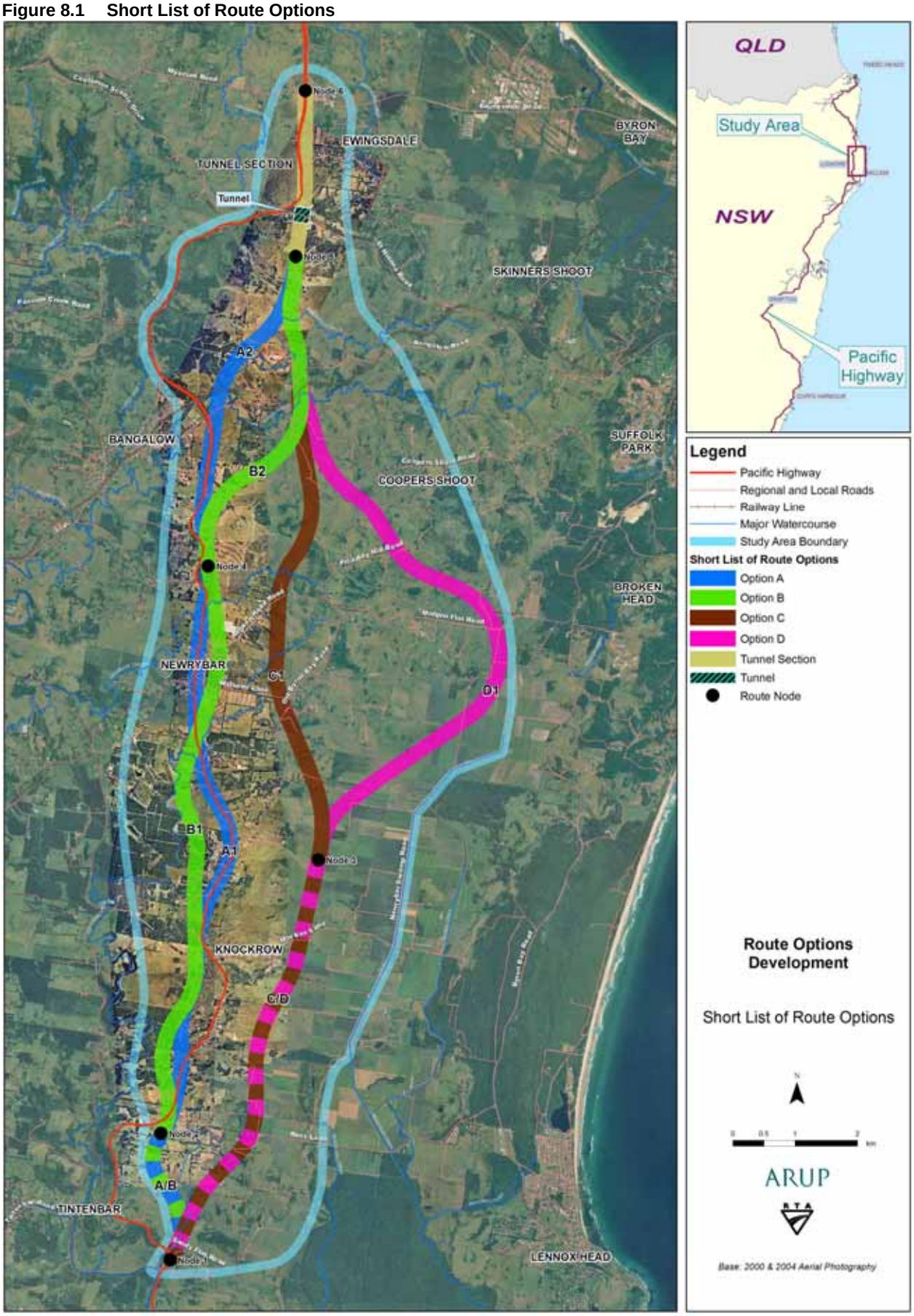
Within each of these issues an assessment of the short list of options is provided on a section by section basis. The short list sections are:

- Common section A and B (Node 1 to 2)
- Section A1 (Node 2 to 4)
- Section B1 (Node 2 to 4)
- Section A2 (Node 4 to 5)
- Section B2 (Node 4 to 5)
- Common section C and D (Node 1 to 3)
- Section C1 (Node 3 to 5)
- Section D1 (Node 3 to 5)
- Tunnel Section (Node 5 to 6).

There are two tunnel options (T1 and T2) within the Tunnel Section (see **Section 7.5.2**). Where T1 and T2 differ significantly in engineering and environmental characteristics, a comparison of these differences is provided by subject matter in report tables. Where there is no substantial difference in T1 and T2, characteristics are presented for both options as T1/T2. Where tables in this chapter make no specific mention of T1 or T2, the impacts of T1 and T2 are similar and T1 values have been included in tables for Options A, B, C and D.

The short list of options is shown in **Figure 8.1.** As noted in Chapter 1, the evaluation of the long list was based on a generic corridor width of 250 m. This corridor represents the area of investigation at this stage of the study and will be refined in later stages. This corridor width has also been assumed in the assessment of potential impacts of the short list of options, and therefore impacts identified are for comparison of the options and are not absolute values. The actual road reserve width requirements will be taken into account in the selection of the preferred route.

Figure 8.1 Short List of Route Options



8.2 Engineering

8.2.1 Overview

The engineering characteristics of each section making up the short list of route options are shown in **Table 8.1**

Table 8.1 Engineering Comparison of Short List Sections

	Short List Sections									
Engineering Characteristic	**A/B**	**A1**	**B1**	**A2**	**B2**	**C/D**	**C1**	**D1**	**T1**	**T2**
Length (m)	2,205	9,791	9,983	5,280	5,448	6,616	10,589	12,917	2,516	2,509
Length of major bridges - highway (m)	0	0	100	660	780	0	559	0	0	0
Length of major bridges – local (m)	0	60	297	285	160	0	340	268	0	0
Length of grades exceeding 4.5% (m)	861	561	394	1131	0	0	0	0	890	0
Comparative travel time for heavy vehicles (minutes)	1.5	7.5	7.3	3.7	3.8	4.1	8.8	8.8	2.2	1.9
Number of horizontal curves with radius less than minimum (750 m)	1	0	0	0	0	0	0	0	0	0
Number of horizontal curves with radius less than desirable (750 m-1200 m)	1	3	2	1	0	0	0	0	1	0
Length (m) of route that utilises existing road reserve	2,205	4,210	890	1,694	50	490	0	0	1,747	458
Length (km) through potentially fog prone areas.	1.7	1.8	2.0	2.6	1.3	6.3	2.9	7.4	1.0	1.1

8.2.2 Common Section A/B (Node 1 to 2)

This section follows the approved Ballina Bypass alignment between Sandy Flat and Ross Lane. The alignment diverges away from the existing highway at Sandy Flat Road and crosses Sandy Flat before climbing the escarpment. RTA has commenced land acquisition for this section.

In engineering terms, the key issue in this section is that the horizontal and vertical alignments approach minimum design criteria, and include a 5.9% grade over about 1 km.

Soft soils and settlements would increase the cost of this section and also present some construction issues which could be overcome with appropriate design and construction.

8.2.3 Section A1 (Node 2 to 4)

Section A1 generally follows the existing highway alignment but diverts to the west of the existing highway for about 2 km past Knockrow and also diverts to the east of the existing highway just north of where it crosses Skinners Creek, utilising the Byron Shire Council 9(a) zoning to avoid the sharp bends on the existing highway alignment. The Ross Lane interchange from the Ballina Bypass EIS would be retained.

The alignment passes through rolling terrain and the vertical alignment is undulating with no grades steeper than 4.5%. The alignment passes in front of Macadamia Castle but there would be no direct access between the upgraded highway and Macadamia Castle. Section A1 crosses Emigrant Creek where the existing highway crosses, about 1 km south of Newrybar.

The alignment passes just to the east of Newrybar, between the village and the school. Access between the upgraded highway and Newrybar or Broken Head Road would not be possible, but continued local access between Newrybar and Brokenhead Road would be provided by bridges over or under the upgraded highway.

The key engineering issue in this section would be the difficulties in providing a new local road network giving access to all local properties as well as providing for local traffic movement within the area separate from the upgraded highway. Appropriate design and construction measures would also be required to protect water quality in the Emigrant Creek Catchment.

8.2.4 Section B1 (Node 2 to 4)

Section B1 diverges to the west away from the Ballina Bypass alignment at the top of the escarpment. An interchange would still be provided at Ross Lane, but reconfigured and moved slightly to the west. The reconfigured interchange would also allow access between the upgraded highway and the existing highway which would be retained for local access.

From the top of the escarpment, Section B1 remains to the west of the existing highway, passing through similar rolling terrain with an undulating vertical alignment and grades not exceeding about 3.5%.

Section B1 passes about 250 m to the west of Macadamia Castle. Just after crossing Emigrant Creek, Section B1 would cross under the existing highway to the eastern side, passing about 350 m east of Newrybar and about 200 m east of the school. The alignment would be in a cutting underneath Broken Head Road, with Broken Head Road passing on a bridge above the upgraded highway.

Section B1 then crosses Skinners Creek before merging with the Section A1 alignment utilising the Byron Shire Council 9(a) zoning to the east of the existing highway.

There are no major engineering or design difficulties in this section, although appropriate design and construction measures would be required to protect water quality in the Emigrant Creek Catchment.

8.2.5 Section A2 (Node 4 to 5)

Section A2 commences within the Byron Shire Council 9(a) zoning at the top of the ridge line on the south side of Bangalow Creek valley. A 30 m deep cutting is required at the top of the ridge, with a 5.3% grade for over 1 km before rejoining the existing highway at the south end of the Bangalow Bypass. A viaduct structure up to 200 m long would be required about half way down, just before connecting to the existing Bangalow Bypass.

The alignment follows the Bangalow Bypass for about 900 m before diverting to the east at a point just south of the existing Bangalow Bypass interchange with Bangalow Road. Section A2 would pass above Bangalow Road on a bridge and would also pass above Bangalow Creek and the railway line on a bridge. North of the railway line the alignment diverts to the east and skirts the edge of Tinderbox Creek before the southern approach to the tunnel. Another viaduct would be required across the Tinderbox Creek tributary directly opposite the Tinderbox piggery.

The major engineering issue in this section would be provision of a new local road network giving access to properties fronting the existing highway as well as providing for local traffic movement to and from Bangalow and Lismore separate from the upgraded highway.

8.2.6 Section B2 (Node 4 to 5)

From Node 4, Section B2 would pass through a 20 m deep cutting and follow the Byron Shire Council 9(a) zone for a short distance before diverting to the east. It crosses a number of steeply sided ridges and valleys while falling at a grade of 2.7% over a distance about 2.5 km down to a bridge over

Bangalow Creek. Two long viaduct structures with a total length of up to 800 m would be required on the descent.

Grade separation would be provided where the alignment crosses the railway line and Bangalow Road. Section B2 passes in a cutting up to 20 m deep through a saddle in the ridge where Tinderbox Road connects to Bangalow Road.

The alignment then crosses Tinderbox Creek before merging with the Section A2 alignment on the southern approach to the tunnel.

There are no major engineering issues in this section, although the viaducts required on the descent into Bangalow Creek would add to the cost and construction period.

8.2.7 Common Section C/D (Node 1 to 3)

From the southern end, the Common Section C/D crosses Sandy Flat floodplain then follows a narrow valley towards the elevated ridge (spur) on which Ross Lane is located. The alignment passes through a saddle in this ridge in a cutting up to 20 m deep. Ross Lane would pass above the upgraded highway on a bridge. An interchange would be provided either at Sandy Flat or at Ross Lane, allowing access to the old highway as well as to the Lennox Head area.

North of Ross Lane, Common Section C/D crosses the Newrybar Floodplain, remaining close to the escarpment with several cuts through spurs at the edge of the escarpment. Martins Lane is located on the second spur and a bridge would be provided to carry Martins Lane above the upgraded highway.

Common Section C/D crosses the floodplain below the escarpment and crosses many small creeks drainage canals that drain the escarpment and the flat agricultural land. Across the floodplain the upgraded highway would be raised on an embankment above at least the 20 year flood level. Flood studies would be carried out to determine the required height of the embankment and the location and size of floodway openings.

No major geotechnical issues in terms of construction or settlements are expected through this section, although soft soils and settlements would increase the cost of this section and also present some construction issues which could be overcome with appropriate design and construction.

8.2.8 Section C1 (Node 3 to 5)

North of the point where the route options diverge, Section C1 climbs the side of the escarpment to the top of the plateau. The grade would be 4.5% over a distance of about 2.5 km. A viaduct structure or fill would be required near the start of the climb up the escarpment.

At the top of the escarpment the alignment would pass under Old Byron Road in a cutting about 25 m deep. Old Byron Road would pass above the highway on a bridge.

From the top of the escarpment the alignment drops and crosses the upper reaches of Emigrant Creek before climbing again towards Broken Head Road. Section C1 would cross under Broken Head Road in a cutting up to about 20 m deep with Broken Head Road on a bridge over the top of the highway.

The alignment then drops towards the upper reaches of Skinners Creek which would be crossed by a substantial bridge up to 300 m long and 20 m high. From Skinners Creek the alignment climbs and passes through the area on the top of the next ridge which is designated as State Significant agricultural land. The cutting through this ridge would be about 30 m deep.

The grade down to Bangalow Creek would be 4.5% over almost 2 km, with a viaduct up to 300 m long and 20 m high required across a valley on the descent.

Grade separation would be provided where the alignment crosses the railway line and Bangalow Road. Section C1 then merges with the Section B2 alignment where it passes in a cutting up to 20 m deep through a saddle in the ridge where Tinderbox Road connects to Bangalow Road, then crosses Tinderbox Creek on the southern approach to the tunnel.

There would be some geotechnical issues with Section C1, including landslide hazards and loose colluvial soils where the alignment climbs the escarpment. Earthworks volumes and cutting depths are also greater on this alignment in comparison to the other options.

8.2.9 Section D1 (Node 3 to 5)

North of the divergence of Options C and D, Section D1 remains on the Newrybar Floodplain until just north of Midgen Flat Road. It then climbs the ridge spur projecting from the escarpment at a grade of 4.5% over about 1.8 km. The wide sweep adds over 2 km to the overall length in comparison to the other options.

At the top of the escarpment the alignment passes under Picadilly Hill Road in a cutting up to about 20 m deep in hard rock. Picadilly Hill Road would be carried above the highway on a bridge. There is then a gentle grade down to a bridge over Bangalow Creek. Grade separation would be provided where the alignment crosses the railway line and Bangalow Road. Section D1 then merges with the Section B2 and Section C1 alignments where they pass through the Tinderbox Road saddle. The depth of the cutting through the saddle would be greater on Section D1 than for B2 or C1. D1 then follows the same alignments as B2 and C1 across Tinderbox Creek to the southern approach to the tunnel.

Engineering issues with this alignment would be similar to but not as marked as for Section C1. Earthworks volumes also would be less than for Section C1.

8.2.10 Tunnel Section (Node 5 to 6)

From Node 5, Sections T1 and T2 climb at a grade of about 4% to the tunnel portal. The approximate tunnel length would be 200 to 300 m in both cases. The position of the portals and the length of the tunnel for each option will be confirmed in the next phase of the study. The tunnel would be centrally located about St Helena Road and the tunnel floor would be at a maximum depth of about 45 m.

On the north side of the tunnel, the alignments and grading of T1 and T2 differ. T1 would retain the 900 m of existing duplication that climbs at a 6% grade south from the Ewingsdale interchange, connecting to the south end of this duplication. At this point the grade reduces to 1.8% then increases to 4.4% as it climbs to the northern tunnel portal. Option T2 would involve reconstruction all the way from the Ewingsdale Interchange at a flatter 4.4% grade, on an alignment slightly closer to Ewingsdale.

The geotechnical investigation found that conditions are generally quite good for a tunnel under St Helena Hill, with basalt layers of medium to very high strength, with relatively few fractures and low to moderate permeability. This rock provides relatively good tunnel support conditions, with low groundwater inflows and impact on groundwater regime. The most likely tunnel excavation method would be drill and blast. There are landslide hazards on the slopes north and south of the tunnel which would be addressed during the design and construction of the tunnel portals.

8.2.11 Summary of Short List of Options over the Full Length

The key engineering characteristics of the four shortlisted route options are summarised in **Table 8.2**. Separate data is provided depending on whether Options A, B, C and D are combined with the northern tunnel Approach Option T1 or Option T2.

Table 8.2 Engineering Comparison of Short List of Route Options

	With Tunnel Approach Option T1				With Tunnel Approach Option T2			
	Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
	A/B	A/B	C/D	C/D	A/B	A/B	C/D	C/D
	A1	B1	C1	D1	A1	B1	C1	D1
	A2	B2	T1	T1	A2	B2	T2	T2
Engineering Characteristic	T1	T1			T2	T2		
Length (m)	19,792	20,152	19,721	22,049	19,785	20,145	19,714	22,042
Length of major bridges – highway (m)	660	880	559	0	660	880	559	0
Length of major bridges - local (m)	345	457	340	268	345	457	340	268
Length of grades exceeding 4.5% (m)	3,443	2,145	890	890	2,553	1,255	0	0
Comparative travel time for heavy vehicles (minutes)	14.9	14.8	15.1	15.0	14.6	14.5	14.8	14.8
Number of horizontal curves with radius less than minimum (750 m)	1	1	0	0	1	1	0	0
Number of horizontal curves with radius less than desirable (750 m-1200 m)	6	4	1	1	5	3	0	0
Length (m) of route that utilises existing road reserve	9,856	4,892	2,237	2,237	8,567	3,603	948	948
Length (km) through potentially fog prone areas.	7.1	5.9	10.1	14.6	7.2	6.0	10.2	14.8
Indicative Strategic Cost estimate ($million)	400	410	400	385	410	420	410	395

Note: the approximate length of tunnel for all options is 200 to 300 m.

8.3 Traffic and Transport

The key traffic and transport issues in relation to the short list are:

- Highway level of service.
- Access to upgraded highway.
- Local access considerations.
- Travel times.

8.3.1 Highway Level of Service

With two lanes in each direction it is predicted that the highway upgrade between Tintenbar and Ewingsdale would operate at Level of Service B in 2012 and reach Level of Service C during 2033, 21 years after the nominal opening year 2012.

This Level of Service analysis is representative of all shortlisted route options and based on predicted traffic volumes shown in **Table 8.3**. Whilst there are minor differences in horizontal and vertical geometry between route options, all options are being designed within the same framework and design standards as identified in the *Pacific Highway Design Guidelines* (RTA 2005). In some cases additional climbing lanes may be required to maintain a consistent Level of Service.

Table 8.3 Forecast Traffic Volumes and Level of Service

Forecast Year	AADT	AADV	Level of Service for Upgraded Highway
2003 (Base)	12,841*	10,882	-
2012	16,539	14,016	B
2022	20,648	17,499	B
2032	24,757	20,981	B
2042	28,867	24,463	C

* Actual recorded data

8.3.2 Access to the Upgraded Highway

At the southern end of the project, a full interchange would be provided either at Ross Lane (for Options A and B) as part of the Ballina Bypass project, or at either Sandy Flat Road or in the vicinity of Ross Lane (for Options C and D). At the northern end of the project, all of the shortlisted route options would utilise the existing Ewingsdale Interchange. It is anticipated that the Ewingsdale Interchange would also provide access to the existing highway which would continue to service Bangalow and Lismore from the north.

Opportunities for an intermediate interchange at Bangalow Road have been investigated, however, this would result in additional traffic passing through the main street of Bangalow, which is considered inappropriate. An additional interchange at Bangalow Road would also have the potential to attract Byron Bay traffic and significantly affect local traffic patterns in the area.

8.3.3 Local Access Considerations

All options would intersect a number of local roads where access to the upgraded highway would not be provided. These local roads 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 where grade separation across the upgraded highway would be provided.

Options B, C and D would permit local access and connectivity to be maintained through the use of the existing highway under significantly reduced traffic conditions.

As Option A utilises much of the existing highway alignment south of Bangalow, service roads would be provided on either side of the upgraded highway to connect intersecting roads and property

accesses, as well as providing local north/south connections. East-west connections between these service roads would be provided where appropriate to maintain local connectivity. This treatment would ensure that local access routes and connectivity are not adversely affected by the upgraded highway.

In addition to connectivity of the local road network, where there is currently property access across a proposed route alignment, alternate access would be provided.

8.3.4 Travel Times

All options are relatively similar in terms of travel times (see **Table 8.2**). Even though Option D is longer than the other options, average travel speed would be higher because of the longer lengths of flat grade.

8.4 Geotechnical

The location of the short list of route options in relation to geotechnical characteristics is shown in **Figure 8.2** and **Figure 8.3**.

8.4.1 Common Section A/B (Node 1 to 2)

Data from the Ballina Bypass geotechnical investigations (Robert Carr & Associates 2002) indicates that the route over Sandy Flat floodplain is underlain by soft soils typically up to about 5 m depth. Close to the intersection with the existing Pacific Highway soft soils are present to depths of up to 10 m. The presence of shallow soft soils would be an issue for construction of fill embankments. Surcharging, and possibly staged construction, would be required to limit long-term settlements and maintain stability during construction. Wick drains would be needed in the deeper soft soils to accelerate the rate of settlement and increase strength of the soft soils during construction.

8.4.2 Section A1 (Node 2 to 4)

Section A1 traverses relatively subdued rolling hills with some incised gullies on the top of the plateau. Cuts and fills would be mainly less than 5 m deep, with one cut up to about 15 m deep between Old Byron Road and Watsons Lane. If cuts were required, drill and blast would be unlikely. Fill materials won from cuttings would mainly be suitable for use as general fill. Geotechnical issues for embankment construction are expected to be relatively routine.

Although this section is relatively close to the top of the escarpment, it is unlikely to be impacted by landslide hazards on the escarpment. Some of this section traverses the Bangalow Soil Landscape, which has a medium landslide hazard rating.

8.4.3 Section B1 (Node 2 to 4)

A review of available data indicates that from a geotechnical perspective Section B1 is similar to Section A1.

8.4.4 Section A2 (Node 4 to 5)

On review of existing information geotechnical data, issues for Section A2 are expected to be similar to those for Section A1.

Section A2 would include a cut about 30 m deep within the upper slopes of the southern side of the broad valley occupied by Byron Creek. While details of the geotechnical qualities for this section have not yet been ascertained it is likely that high strength basalt at shallow depth would be encountered. Drill and blast would be likely with the opportunity to win select materials for construction. Similarly, there is currently uncertainty about conditions in some cuts up to about 15 m deep, north of Byron Creek.

Landslide hazards (mainly medium rating) occur along this section.

Figure 8.2 Geotechnical Features

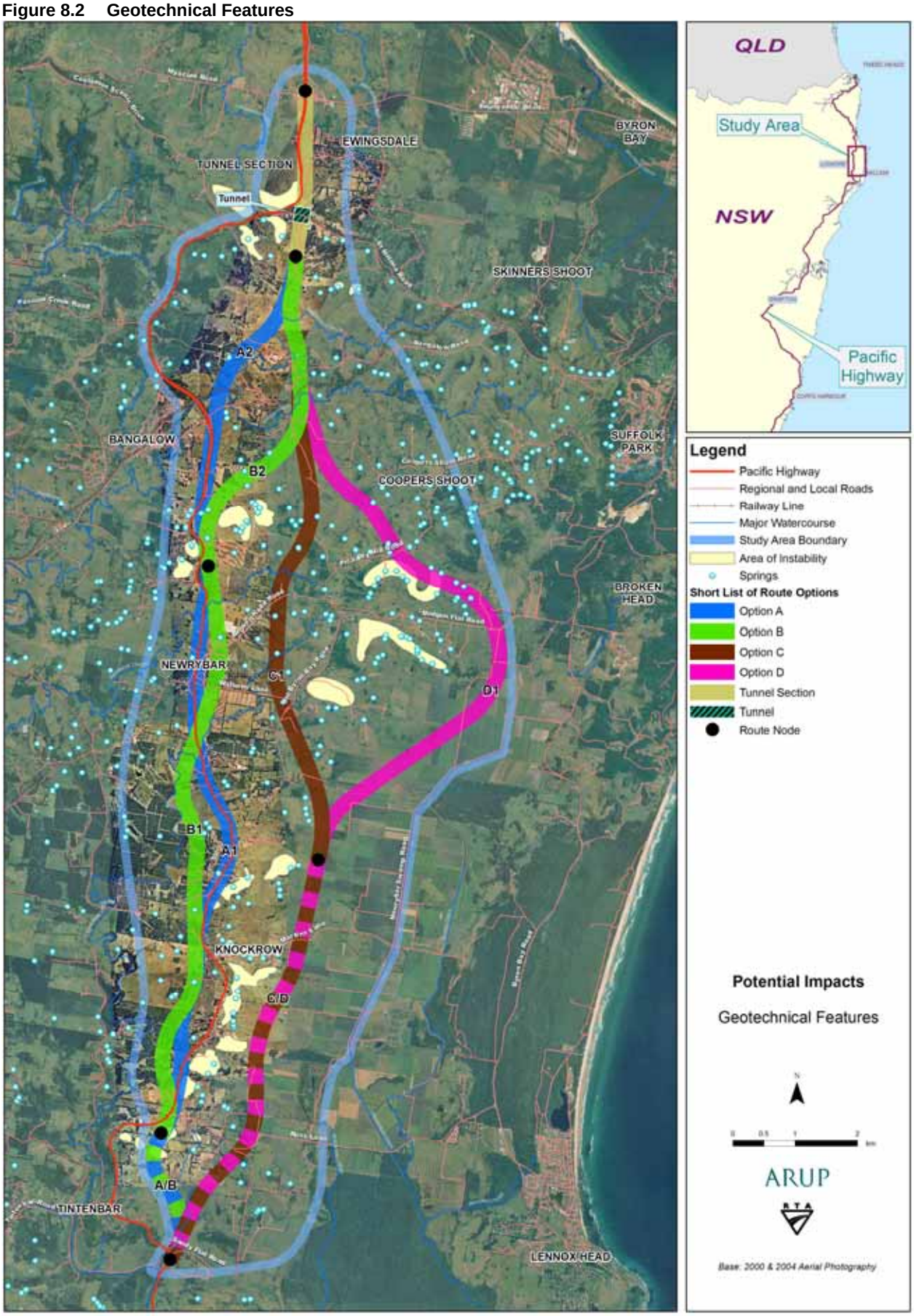
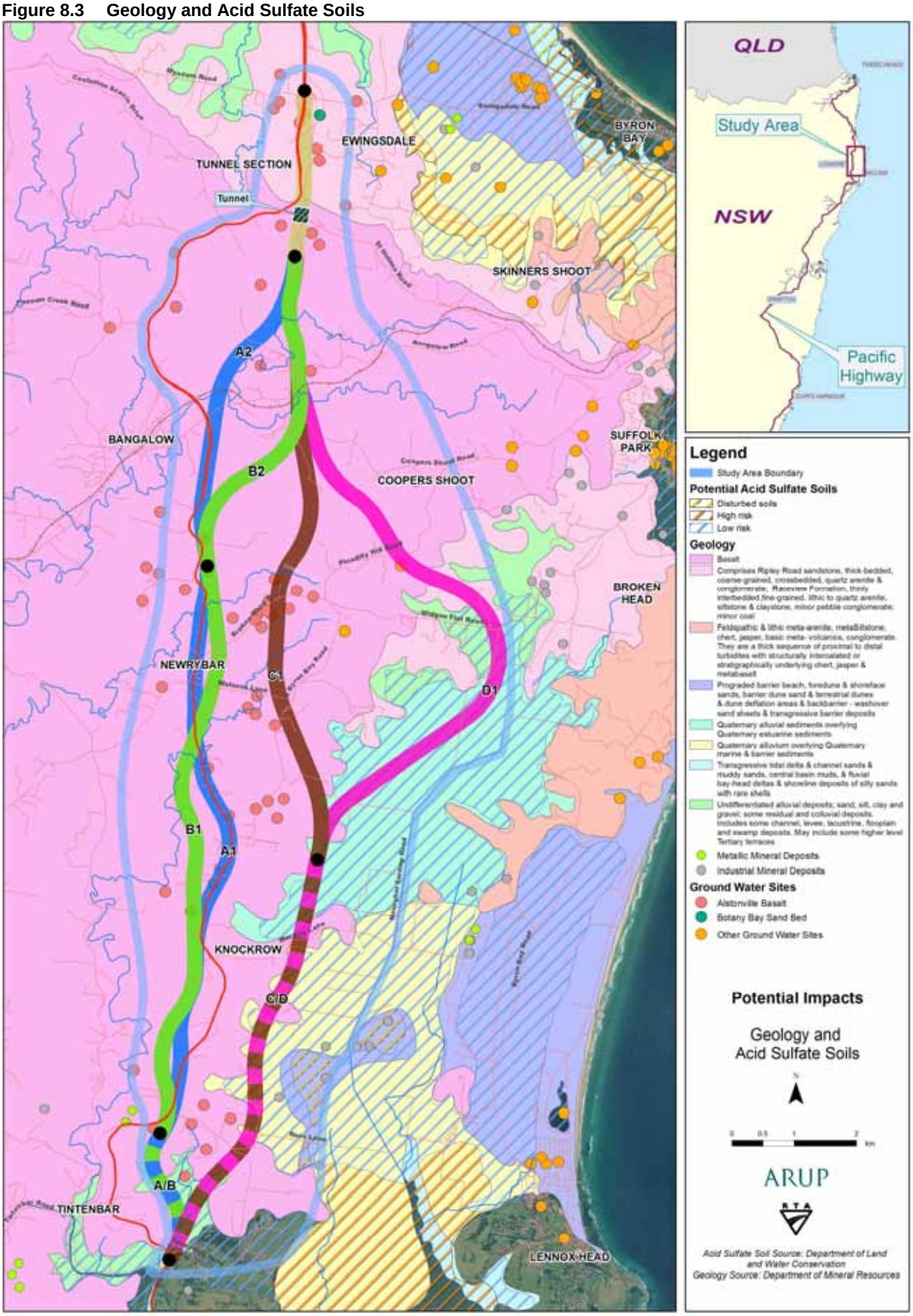


Figure 8.3 Geology and Acid Sulfate Soils



8.4.5 Section B2 (Node 4 to 5)

Available information indicates that Section B2 is similar to Section A2.

8.4.6 Common Section C/D (Node 1 to 3)

From the southern end, the Common Section C/D traverses the Sandy Flat floodplain. The current investigation data indicates variable conditions, with most of the route over Sandy Flat expected to be underlain by soft soils up to about 5 m depth. Close to the intersection with the existing Pacific Highway soft soils are present to depths of up to 10 m. The presence of shallow soft soils could be an issue for construction of fill embankments. Surcharging, and possibly staged construction, would be required to limit long-term settlements and maintain stability during construction. Wick drains would be needed in the deeper soft soils to accelerate the rate of settlement and strength increase of the soft soils during construction.

The existing data tends to indicate that the poorest conditions for embankment construction in the Sandy Flat floodplain occur at the southernmost end of the route, along and closest to the proposed Ballina Bypass section. It is likely that the soil conditions improve north-east of the Ballina Bypass alignment, where the soft soils are thinner or absent.

Common Section C/D would cut through the elevated ridge (spur) on which Ross Lane is located. Within the likely cut depth the spur is underlain by Lismore Basalt, and one borehole drilled indicates residual soil overlying extremely weathered rock. Drill and blast would be unlikely to be required. The cut would likely be at batter slopes of 2H:1V or shallower. Excavated material would probably be suitable only as general embankment fill.

North of Ross Lane, Common Section C/D mainly traverses Newrybar Floodplain, with several cuts through spurs at the edge of the escarpment. Variable rock conditions would be expected in the cuttings with the possibility of drill and blast in some.

On the floodplain the highway would likely be on fill embankments. From Ross Lane to Martins Lane, geological conditions beneath Nerwybar floodplain are expected to comprise mainly low compressibility clays and sands. No significant geotechnical issues are expected for embankment construction and performance.

North of Martins Lane, soft soils (and possibly organic clays) are expected at the surface to typically less than 5 m depth, over low compressibility clays and sands. Relatively routine surcharging and possibly staged construction would be required to limit long-term embankment settlements and maintain embankment stability during construction.

Common Section C/D traverses the plain below the escarpment and hence would be required to cross many small creeks and/or artificial drainage canals that drain the escarpment. All watercourses to be crossed for these two route options represent negligible or low constraints, with the main consideration being the mitigation of potential acid sulfate soils during construction.

8.4.7 Section C1 (Node 3 to 5)

North of the point where the route options diverge, Section C1 traverses the escarpment to the top of the plateau. Landslide hazards (high hazard rating) and colluvial soils are present along the section of the route that traverses the escarpment.

Geological conditions on top of the plateau would be expected to comprise basaltic soils and rock. The route would traverse areas where landslide hazards (mainly medium rating) are present.

Several deep cuts and fills (greater than 10 m) are expected. For most cuts it is unlikely that drill and blast would be required. The deepest cut is up to 30 m deep (coincides with access lane to Piccadilly Farm). As such, drill and blast would probably be required in this cut and there may be the opportunity to obtain select materials for construction. The design and construction of most of the embankments would likely involve routine practice, but some, where there is an assessed instability risk, may require more intensive investigation and design.

8.4.8 Section D1 (Node 3 to 5)

North of the divergence of Options C and D, Section D1 remains on the Newrybar Floodplain until just north of Midgen Flat Road. Soft soils (and possibly organic clays) are expected at the surface to typically less than 5 m depth, over low compressibility clays and sands. There is also the possibility of encountering some deeper layers of soft soils (between about 5 m and 10 m depth), particularly where the route diverges away from the footslopes. Relatively routine surcharging, and possibly staged construction, would be required to limit long-term embankment settlements and maintain embankment stability during construction.

This part of the route is generally far enough away from the escarpment footslopes to be unaffected by landslide hazards.

North of Midgen Flat Road, the route traverses a spur in the escarpment to the top of the plateau. Landslide hazards (medium rating) are present along this spur, increasing to a high rating on the steepest part of the escarpment (**Figure 8.2**). Similar to Option C1, this section would require significant additional geotechnical investigation to develop a sound understanding of the potential instability hazards and obtain information for the design of measures to limit the risks of instability to the highway. An assessment of the risks to the highway of instability from slopes above the highway would also need to be conducted.

Geological conditions on top of the plateau are expected to comprise basaltic soils and rock. The route would traverse areas where landslide hazards (mainly medium rating) are present.

Several deep cuts and fills (greater than 10 m) would be expected in Section D1. For most cuts, weathered basalt would be encountered within 15 to 20 m of surface and it is unlikely that drill or blast would be required. At a deep cut at the crest of the escarpment (Piccadilly Hill Road) basalt of variable strength would be encountered 10 m or less from surface. As such, drill and blast would probably be required and there may be the opportunity to obtain select materials for construction.

The design and construction of most of the embankments would likely involve routine practice, but some, where there is an assessed instability risk, may require more intensive investigation and design.

8.4.9 Tunnel Section (Node 5 to 6)

The tunnel section is mainly expected to be within a basalt layer of medium to very high strength, with relatively few fractures and low to moderate permeability. This unit offers the benefit of:

- Relatively good tunnel support conditions.
- Low groundwater inflows and impact on groundwater regime.
- A tunnel through this rock type would likely need to be excavated by drill and blast.

Excavation from the northern and southern portals would be expected to encounter variable geotechnical conditions, with interlayered low and high strength basalt, some of which would require excavation by drill and blast. There are landslide hazards on the slopes north and south of the tunnel. These hazards would be an issue for the design and construction of the tunnel portals.

Some earthworks would be required at the northern approach to the tunnel. These earthworks are mainly outside of the area impacted by landslide hazards and are expected to be within routine construction practice.

8.5 Hydrology

8.5.1 Overview of Impacts

The hydrological characteristics reviewed in the determination of impacts associated with the short list of options include:

- Number of waterway crossings.
- Height above waterways.
- Proximity to the existing Pacific Highway.
- Length through flood prone land.

The location of waterways in relation the short list of route options is shown in **Figure 8.4**.

8.5.2 Characteristics of Route Option Sections

Characteristics of the route options by section are provided in **Table 8.4**.

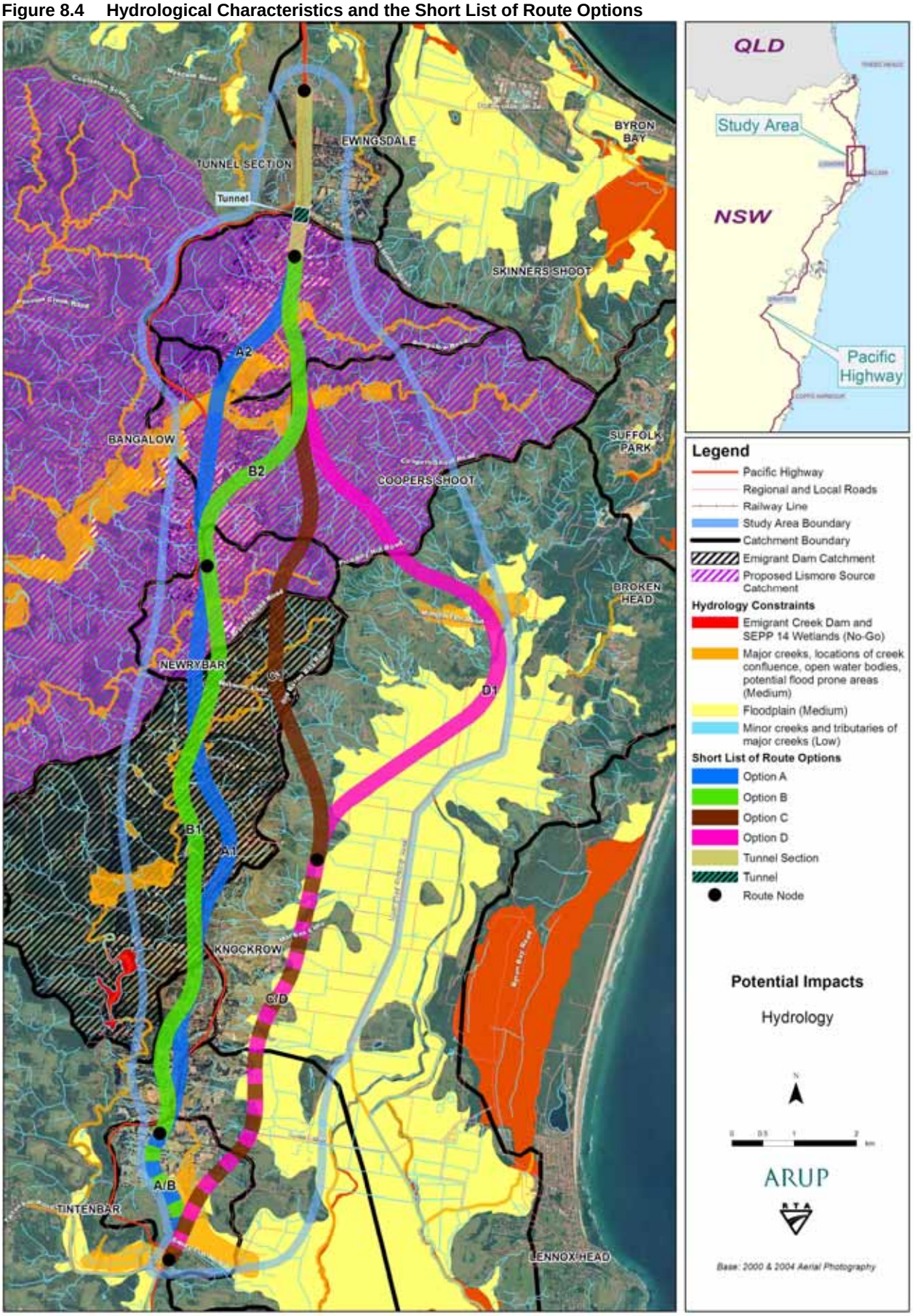
In addition to characteristics identified in **Table 8.4**, selected hydrological issues are further described in **Section 8.5.3**.

Table 8.4 Key Hydrological Characteristics

Section	Named Creek Crossings	Distance from existing Pacific Highway[1] crossing	Height of crossing (above ground level)	Through flood prone land (length)[2]
A/B	Floodway at Sandy Flat	n/a	n/a	Yes (870 m)
A1	Waterbody on tributary to Emigrants Creek	n/a	n/a	No
B1	Emigrant Creek Skinners Creek	250 m 700 m	15 m 7 m	No
A2	Byron Creek	400 m	20 m	No
B2	Byron Creek Tinderbox Creek	2500 m n/a	20 m 13 m	No
C/D	Floodway at Sandy Flat	n/a	n/a	Yes (5060 m)
C1	Byron Creek Tinderbox Creek Emigrant Creek Skinners Creek	2500 m n/a n/a n/a	20 m 13 m 15 m 7 m	Yes (390 m)
D1	Byron Creek Tinderbox Creek	2500 m n/a	20 m 13 m	Yes (5170 m)
Tunnel Section	-	-	-	No

1. Existing Pacific Highway crossings can be used as a guide for design. Where the existing Pacific Highway can not be used as guide (due to distance) “n/a” is used.
2. Approximate length of section within Q100m flood zone

Figure 8.4 Hydrological Characteristics and the Short List of Route Options



8.5.3 Features of Route Option Sections

Common Section A/B

This route section essentially replicates the Ballina Bypass route. It passes over the known floodway at Sandy Flat and is above the 1 in 100 year flood level indicated on the Ballina Shire Minimum Fill Levels Plan (4.0 m AHD). As part of the Ballina Bypass EIS, it was demonstrated that a total waterway opening width of 10 m was required to maintain existing flood inundation patterns.

Section A1

Section A1 does not pass through areas of flood prone land. The route segment crosses both Emigrant Creek and Skinners Creek, and appropriately sized waterway openings would be required to maintain existing drainage patterns.

Section B1

Similar to Section A1, Section B1 does not pass through areas of flood prone land. The route segment crosses both Emigrant Creek and Skinners Creek, and appropriately sized waterway openings would be required to maintain existing drainage patterns.

Section A2

Parts of Section A2 are in a cutting and flow paths running perpendicular to the highway would be broken. Cut-off drains would be required to locally divert flows to the nearest low point under which they would be carried beneath the highway through culverts or below a bridge structure.

Section B2

Similar to Section A2 there are areas where the highway is in cut and flow paths are running perpendicular to the highway, thus cut-off drains would be required to locally divert flows.

Common Section C and D

This section passes over the known floodway at Sandy Flat and is above the 1 in 100 year flood level indicated on the Ballina Shire Minimum Fill Levels Plan (4.0 m AHD). When compared with Section A/B, this option crosses a wider section of the floodway. It is therefore likely that a larger total opening width beneath the highway would be required in order to maintain existing flood inundation patterns.

The extent and level of flooding of the coastal plain under existing conditions and with Section C/D superimposed would be evaluated through numerical modelling as part of the next phase of the study. Cross drainage would be required to enable water flowing down from the escarpment to drain to the Newrybar Drain, and to allow the spread of flood waters. Both Martins Lane East and Ross Lane are crossed in locations of higher ground level such that the highway can pass beneath them at a level higher than the 100 year flood level indicated on the Ballina Shire Minimum Fill Levels Plan.

Section C1

Section C1 climbs from the coastal plain to the plateau. As a result, parts of the section are in cutting, effectively interrupting cross drainage paths. As for Sections A2 and B2, cut off drains would be required to manage flows.

Section D1

Section D1 runs significantly closer to the Newrybar Drain than Section C1 and therefore passes through a large area identified as floodplain on DoNR and Council mapping. It is noted that the mapping of floodplain (at this stage of the study) extends roughly to the 10 m contour line, due to historical flood modelling being undertaken only as far as Ross Lane and the lack of survey detail available for previous flood studies.

8.5.4 Summary of Route Options

Options A and B perform well as they have minimal interaction with floodplain areas. Based on the information available to date regarding the extent of flooding on the coastal plain, both Options C and D have extensive sections within the floodplain, with Option D having the largest footprint within potentially floodable land. The impact on the flooding regime associated with all the options would be low.

The extent and level of flooding under existing conditions and with each of the route options would be evaluated through numerical modelling as part of the next phase of the study.

Table 8.5 Length through Flood Prone Land

Route Option	A	B	C	D
Approximate length through flood prone land	870 m	870 m	5,450 m	10,230 m

8.6 Drinking Water Catchments

8.6.1 Overview of Impacts

Two drinking water catchments are located within study area: the Emigrant Creek Dam Catchment (Rous Water) and the proposed Lismore Water Source (part of the Wilson River Catchment).

For the purposes of assessing the short list of route options, the length of the option section through the drinking water catchment area is measured. Additionally, the proximity of the option section to Emigrant Creek and Emigrant Creek Dam is considered.

Through application of best management practices during construction and operation, impacts on the catchment areas can be minimised. Two of the route option sections, A1 and B1, require particular consideration with respect to Emigrant Creek Dam Catchment as discussed below in **Section 8.6.3**.

Emigrant Creek Dam itself is located outside of the study area. Emigrant Creek Dam Catchment is considered to be a higher constraint than the Lismore Water Source as Emigrant Creek Dam is an existing water supply, compared to the proposal for the Lismore Source. Also, the existing highway and the plateau highway upgrade options pass close to the Dam itself, providing less opportunity for filtration of potentially contaminated surface waters. There is also potential for cumulative water quality impacts. While all of the highway upgrade options pass through the proposed Lismore Water Source, they are significantly further upstream in the catchment area.

8.6.2 Characteristics of Route Option Sections

Table 8.6 shows the length of the sections through the drinking water catchments.

Table 8.6 Length through Drinking Water Catchments by Section

	Approximate Length Through Catchment Area (m)								
Catchment	**A/B**	**A1**	**B1**	**A2**	**B2**	**C/D**	**C1**	**D1**	**T1/T2**
Emigrant Creek Dam	0	4800	4000	0	0	0	1900	0	0
Proposed Lismore Water Source	0	2200	1700	5250	5500	0	5900	5500	470

Section A1

Part of this section is to the west of the existing highway, bringing it closer to Emigrant Creek generally and also closer to the Emigrant Creek Dam. Approximately 2 km of the route runs alongside Emigrant Creek at reasonably close proximity (within 300 m) to the creek line, and at some locations is no more than 50 m from the creek. Best management practices would be required to minimise likelihood of impacts on the creek.

Section B1

Similar to Section A1, part of this section route is to the west of the existing highway, bringing it closer to Emigrant Creek generally and also closer to the Emigrant Creek Dam. The route also passes over an open water body on a tributary of Emigrant Creek. As for A1, best management practices would be required to minimise likelihood of impacts on the creek.

8.6.3 Summary of Route Options

All options would traverse either current drinking water catchment zones or proposed drinking water catchment zones (see **Table 8.7**). Option B is closer to Emigrant Creek than the existing Pacific Highway. Best practice management measures would be required to minimise impacts to the drinking water catchment.

Table 8.7 Length through Drinking Water Catchment by Route Option

	Approximate Length through Catchment Area (m)				
Catchment	**A**	**B**	**C**	**D**	**T1/T2**
Emigrant Creek Dam	4800	4000	1900	0	0
Proposed Lismore Water Source	7450	7200	5900	5500	470
Total Length (m)	12250	11200	7800	5500	470

8.7 Aquatic Ecology

8.7.1 Overview of Impacts

To predict potential aquatic ecology impacts, the number of crossings of waterways was determined for each route option section (see **Figure 8.5).**

In addition, databases were searched for the possible presence of threatened or endangered species.

8.7.2 Characteristics of Route Option Sections

Table 8.8 shows the number of waterways crossed per section. The aquatic ecology characteristics of the waterways are described in **Section 5.7**.

No high constraint waterways are crossed by any of the route option sections. Generally all crossings of waterways could be carried out without causing disturbance to aquatic habitat and water quality and they therefore pose a low potential impact. Two exceptions are noted for Sections A1 and B1 (see **Section 8.7.3**).

Figure 8.5 Aquatic Ecology Characteristics and the Short List of Route Options

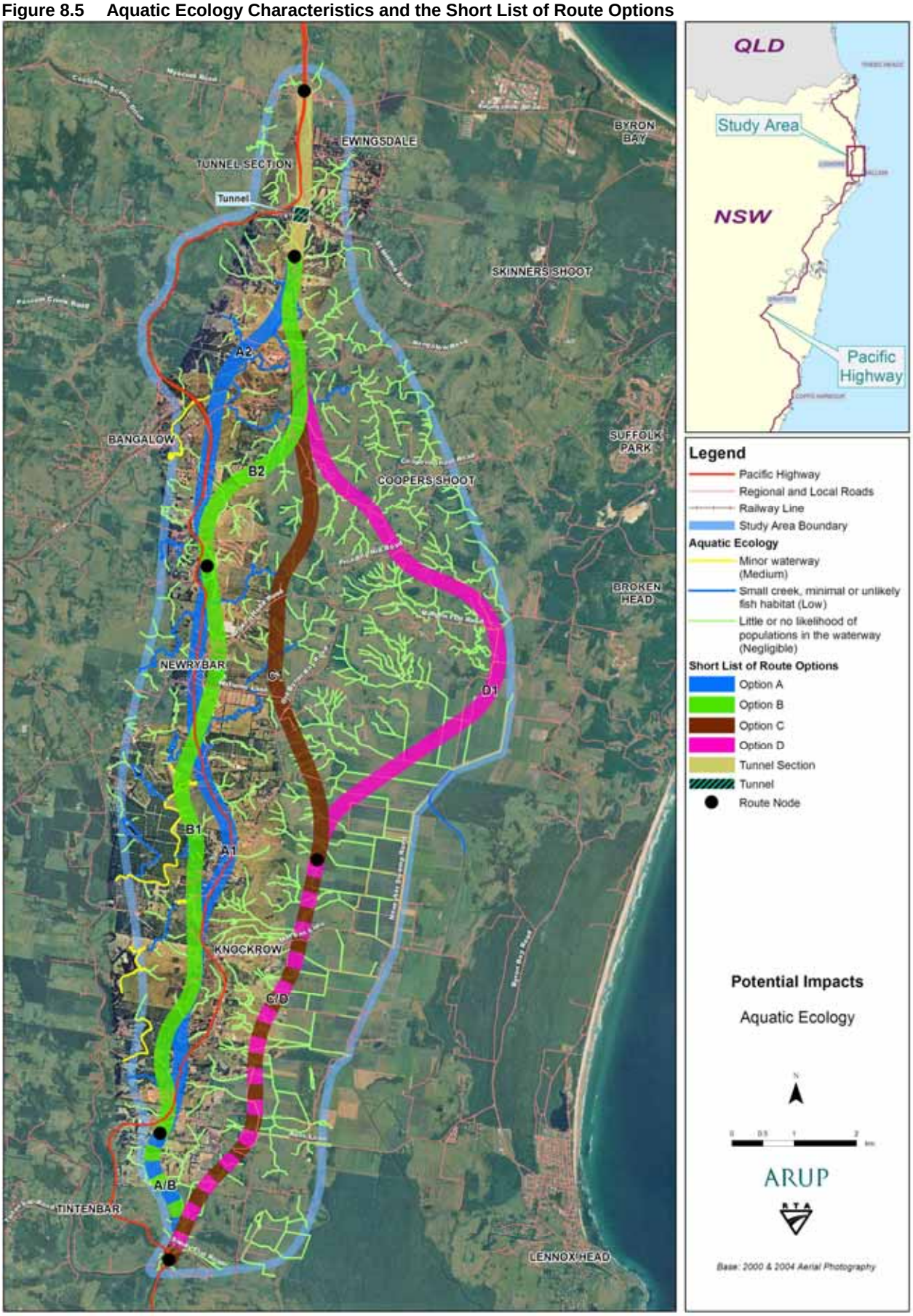


Table 8.8 Number of Waterways Crossed

Section	Type and Number of Waterways Crossed			Potential Impact
	Negligible or Low Constraint	Medium Constraint	Comment	
A/B	4	0	Sandy Flat Creek highly disturbed, flood controls create barrier to fish passage.	Low
A1	10	1	Crosses very close to wetland on Yarrenbool property.	Medium
B1	17	2	Crosses over wetland on Yarrenbool property and the Palm Springs Fish Hatchery.	Medium
A2	11	0	Crossings not considered significant in relation to aquatic habitat.	Low
B2	14	0	Crossings not considered significant in relation to aquatic habitat.	Low
C/D	23	0	Crossings not considered significant in relation to aquatic habitat. Consideration of construction in acid sulfate soils required.	Low
C1	26	0	Crossings not considered significant in relation to aquatic habitat.	Low
D1	26	0	Crossings not considered significant in relation to aquatic habitat.	Low
T1	2	0	Crossings not considered significant in relation to aquatic habitat.	Low

As well as looking at the number of crossings, cumulative impacts are also considered. Cumulative impacts of a new road through the study area relate to the potential for road run-off to enter watercourses at crossing points, impacting on water quality with flow-on effects to aquatic biota. Also there is potential for contaminants accumulated on the road to enter watercourses where the alignment of a new road would parallel a watercourse. The potential for these impacts to occur would be reduced by normal design and construction practices, including:

- Watercourses would be crossed as close to perpendicularly as possible.
- They would be built such that water draining from the crossing is directed away from the watercourse, or contained in water quality control ponds prior to entering the watercourse.
- Few, if any in-stream structures would be required.
- Little or no damage to creek banks would occur due to the small size of most watercourses.

8.7.3 Features of Route Option Sections

Section A1

Section A1 has one crossing over a tributary to Emigrants Creek very close to the established wetland constructed on the Yarrenbool property. This represents a medium potential impact.

Section B1

Section B1 would require crossings over established wetland constructed on the Yarrenbool property, Newrybar and at the Palm Springs Fish Hatchery (both drain into Emigrant Creek). These represent a medium potential impact.

Section B1 is also aligned close to and at many points parallel to Emigrant Creek, and hence represents potential for cumulative impacts on water quality due to road run-off.

Sections A2 and B2

Sections A2 and B2 are aligned close to, and at many points parallel to Tinderbox Creek, and hence like Section B1 represent potential for cumulative impacts on water quality due to road run-off although this is a smaller watercourse compared to Emigrant Creek.

Common Section C/D

Common Section C/D traverses the plain below the escarpment and hence would be required to cross many small creeks and/or artificial drainage canals that drain the escarpment. All watercourses to be crossed for these two route options represent negligible or low constraints, with the main consideration being the mitigation of potential Acid Sulfate Soils during construction.

8.7.4 Threatened or Endangered Species

The following species have been identified as requiring consideration in the study area.

- Eastern freshwater cod (*Maccullochella ikei*).
- Oxleyan pygmy perch (*Nannoperca oxleyana*).
- Olive perchlet (*Ambassis agassizii*).
- Freshwater catfish (*Tandanus tandanus*).

Future investigations would determine the exact presence of these species. For all sections it is considered that appropriate mitigation can be provided to ensure there is a low potential impact to threatened species.

8.7.5 Summary of Route Options

A summary of the waterways crossed by the short list of route options is provided in **Table 8.9.**

No waterways of high constraint (for example Emigrants Creek Dam) are crossed by any of the route options.

Table 8.9 Number of Waterways Crossed by Route Options

	Number of Crossings of Waterways			
Waterway Type	**A**	**B**	**C**	**D**
Negligible or Low Constraint Waterways	27	37	51	51
Medium Constraint Waterways	1	2	0	0

Note: Route option totals include Tunnel Section Option T1.

8.8 Terrestrial Ecology

8.8.1 Overview of Impacts

The terrestrial ecological characteristics used in assessing the short list of route options include:

- The number of patches and area of high and medium value remnant and regenerated vegetation or habitat that potentially would be affected by the route option.
- The number of ‘edges’ created through remnant and regenerated habitat areas (edges are used for evaluation due to the significant correlation between the number of edges in habitat areas and the degree of degradation in that habitat).
- The number of times a wildlife corridor would be crossed.

The conservation significance of each patch of vegetation habitat within the study area was based on a combination of the factors (including size, connectivity, occurrence of significant plant and/or animal species, vegetation communities and/or habitats and formal conservation/reserve status).

Vegetation was categorised into four classes: no-go areas, high, medium and low constraints. No-go areas include National Park Estates and SEPP 14 wetlands. Generally, any native vegetation located within a regional or sub-regional wildlife route option, or that contains key habitat or threatened species, is large in size or well connected, is categorised as a high constraint. High constraint vegetation generally consists of rainforest with minimal Camphor Laurel infestation. All other vegetation, including rainforest with moderate Camphor Laurel infestation, and patches of Camphor Laurel located within a wildlife route option, is identified as a medium constraint. Low constraint vegetation includes cleared land, farmland, crops or plantations.

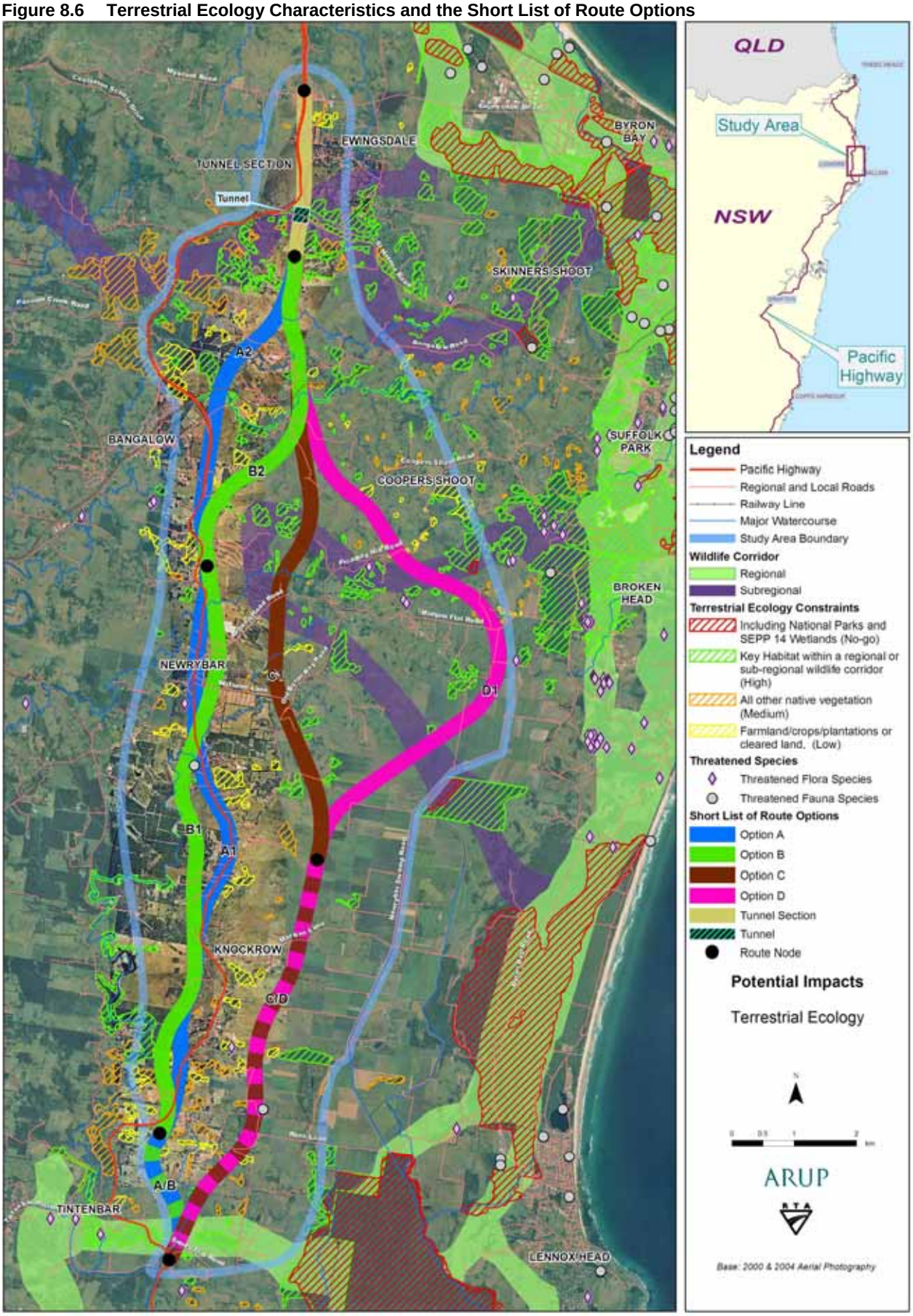
8.8.2 Characteristics of Route Option Sections

Characteristics of the route option sections are provided in **Table 8.10**. **Figure 8.6** shows the location of vegetation (of varying significance), wildlife corridors and recorded threatened species in relation to the short list of route options.

Table 8.10 Terrestrial Ecology Impacts by Section

Characteristic	A/B	A1	B1	A2	B2	C/D	C1	D1	T1/T2
Number of patches of high value vegetation or habitat likely to be affected	4	1	1	7	11	6	15	15	4
Approximate area of high constraint vegetation crossed (ha)	3.5	2	2	6	7.5	3.5	14.5	8.5	5
Number of patches of medium value vegetation or habitat likely to be affected	1	5	3	0	2	2	2	5	0
Approximate area of medium constraint vegetation crossed (ha)	5	11	9	0	2.5	3	2.5	3.5	0
Number of ‘edges’ created through remnant and regenerated habitat areas	5	4	4	6	9	8	12	11	4
Number of times a regional wildlife corridor is crossed	1	0	0	0	0	1	0	0	0
Number of times a sub-regional wildlife corridor is crossed	0	0	0	0	0	0	2	2	1

Figure 8.6 Terrestrial Ecology Characteristics and the Short List of Route Options



Threatened Species

While the habitat in some of the potentially affected vegetation patches has been recorded to contain threatened species (from the DEC Atlas of NSW Wildlife), many of the vegetation patches have had no recording of threatened species. However, it is likely that threatened species exist within these areas given the disturbed and highly fragmented nature of much of the vegetation in the local area. **Table 8.11** identifies the previous recordings of threatened species.

Table 8.11 Previous Recordings of Threatened Species by Section

Section	Threatened Species
A1	The plant species *Diploglottis campbellii*. The birds Black-necked Stork *Ephippiorhynchus asiaticus* and Rose-crowned Fruit-Dove *Ptilinopus regina.*
B1	The Black-necked Stork *Ephippiorhynchus asiaticus* and the Rose-crowned Fruit-Dove *Ptilinopus regina* are very close to B1.
A2	The plant species *Syzygium moorei*.
B2	*Syzygium moorei.*
D1	Section D1 comes within approximately 200 m of a 'no go area', identified as such due to the presence of a large population of Grey-headed Flying-foxes *Pteropus poliocephalus*.

8.8.3 Summary of Route Options

A summary of the terrestrial ecology characteristics of the short lost of route options is provided in **Table 8.12.**

Table 8.12 Terrestrial Ecology Summary

Characteristic	A	B	C	D
Number of patches of high value vegetation or habitat likely to be affected	16	20	25	25
Approximate area of high constraint vegetation crossed (ha)	16.5	18	23	17
Number of patches of medium value vegetation or habitat likely to be affected	6	6	4	7
Approximate area of medium constraint vegetation crossed (ha)	16	16.5	5.5	6.5
Number of 'edges' created through remnant and regenerated habitat areas	19	22	24	23
Number of times a regional wildlife a corridor is crossed	1	1	1	1
Number of times a sub-regional wildlife a corridor is crossed	1	1	3	3
Recorded Threatened Species	4	1	0	0

Note: Route option totals include Tunnel Section Option T1.

Key characteristics of the route options are described below.

Option A

- Crosses area of high constraint vegetation including five patches that are within wildlife corridors and one patch that contains remnant vegetation.
- Four previous records of threatened species occur along Option A - plant species *Digloglottis campbellii* and *Syzygium moorei* and bird species Rose-crowned Fruit-dove and Black-necked Stork.

- Two wildlife corridors are crossed by Option A, one regional and one sub-regional.

Option B

- Crosses area of high constraint vegetation, five patches fall completely within the route option. These patches are within wildlife corridors and one patch contains remnant vegetation.
- One previous threatened species record, *Syzygium moorei*, occurs within Option B, with three other threatened species records, *Digloglottis campbellii*, Rose-crowned Fruit-dove and Black-necked Stork, occurring relatively close to Option B.
- Option B crosses a regional and a sub-regional wildlife corridor.

Option C

- Crosses area of high constraint vegetation, six patches are within the wildlife corridors, two of which contain remnant vegetation and one of which supports an Endangered Ecological Community, Swamp Sclerophyll Forest. Of the patches of high constraint to be impacted, two would be fragmented and four lie completely within the route option.
- No previous records of threatened species along Option C.
- Crosses four regional and sub-regional wildlife corridors.

Option D

- Crosses area of high constraint vegetation, seven patches are within the wildlife corridor and one supports an Endangered Ecological Community, Swamp Sclerophyll Forest.
- No previous records of threatened species along Option D.
- Comes within 200 m of a 'no go area', identified as such due to the presence of a large population of Grey-headed Flying-foxes.
- Crosses regional and sub-regional wildlife corridors four times.

While Options C and D have no previous records of threatened species, it is likely that threatened species exist within these areas given the disturbed and highly fragmented nature of much of the vegetation in the local area (see **Table 8.11**).

8.9 Planning and Land Use

8.9.1 Overview of Impacts

A number of land use characteristics and environmental planning issues have been considered. They include:

- Area and nature of the land use affected directly by the alignment of route option.
- Area of State or regionally significant agricultural land directly affected.
- Area and nature of agricultural businesses directly affected by the alignment of the route option, and indirectly by severance caused as a result of the alignment of the route option.
- Location and nature of existing and proposed urban uses.

8.9.2 Characteristics of Route Option Sections

The primary land use in the study area is agriculture which is impacted by all the route option sections. Recognising the importance of agriculture in the study area, a summary of the potential agricultural impacts by route option section is provided in **Table 8.13.** A more detailed breakdown of agricultural land uses is provided in **Section 8.9.3. Figure 8.7, Figure 8.8** and **Figure 8.9** show the impacts of the short listed options on general land use, State and regionally significant farmland, and high constraint land use areas.

Figure 8.7 General Land Use

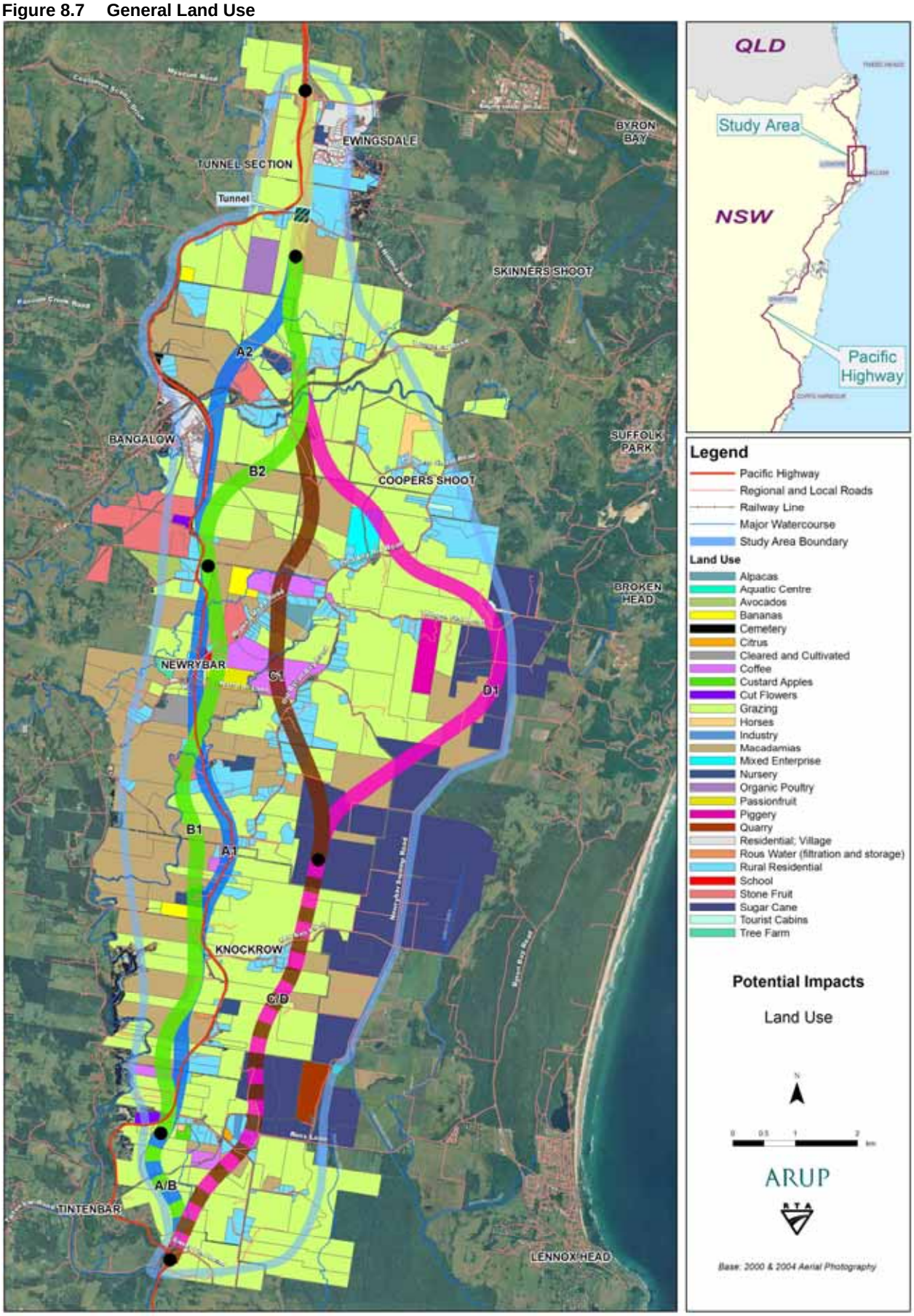


Figure 8.8 Land Use from Northern Rivers Farm Protection Project

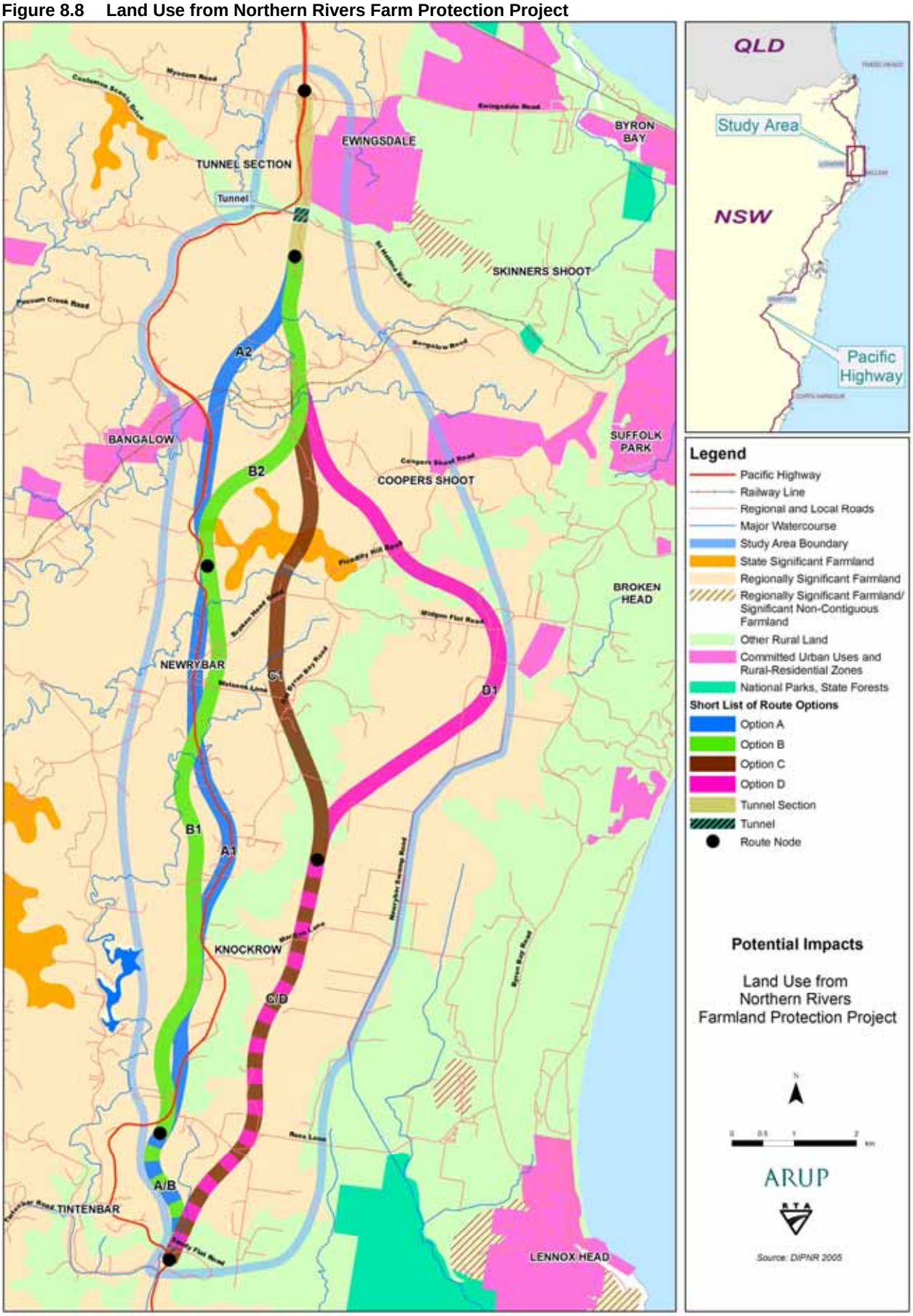


Figure 8.9 High Constraint Land Use

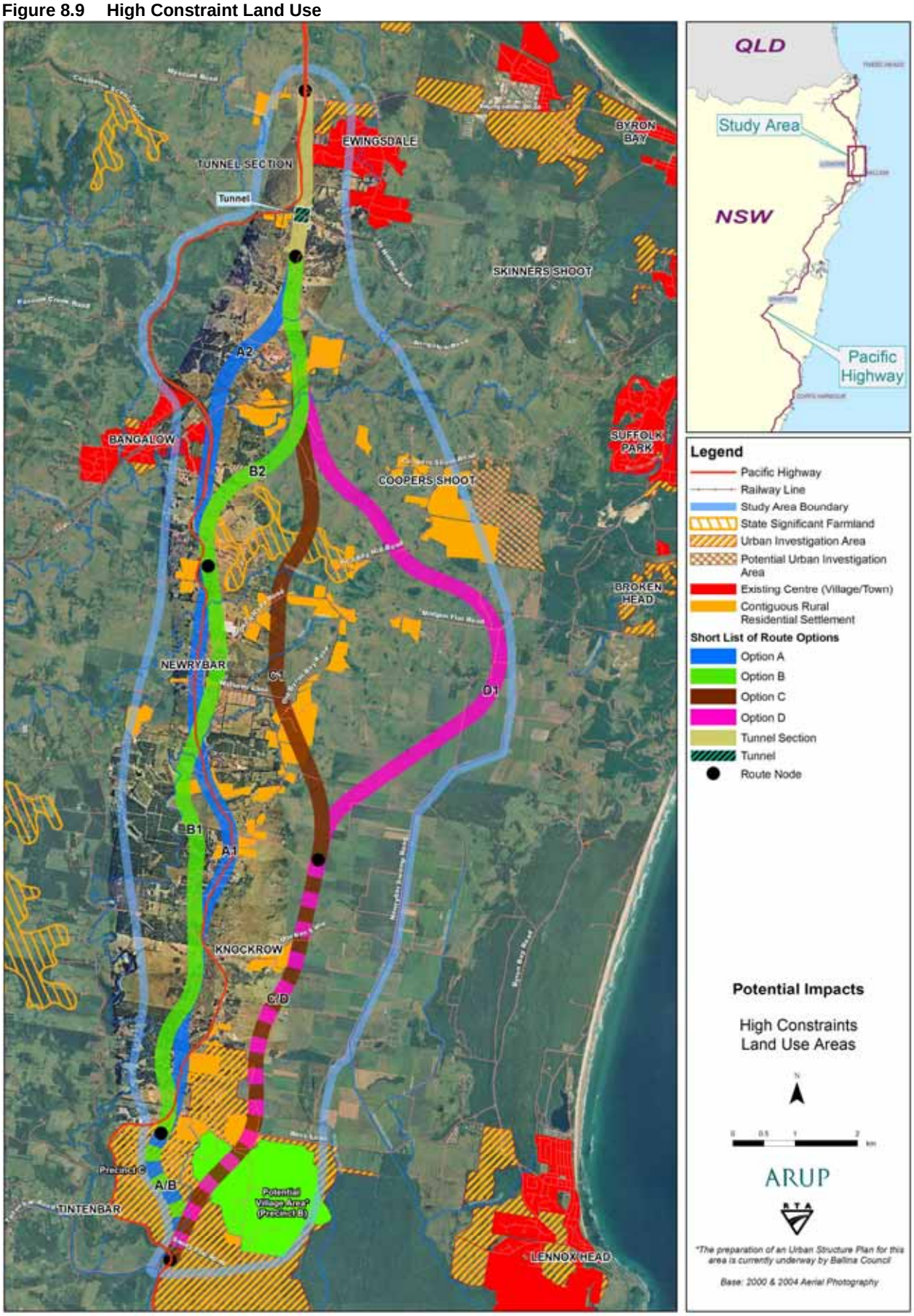


Table 8.13 Potential Agricultural Impacts

Characteristic of Section[1]	Approximate Area (ha)									
	A/B	A1	B1	A2	B2	C/D	C1	D1	T1	T2
Regionally significant farmland directly affected[2]	44	231	240	125	132	164	187	269	59	54
State significant farmland directly affected[2]	0	0	0	3	5	0	10	0	0	0
Agricultural land directly affected[3]	51	187	218	105	122	145	221	302	37	32
Agricultural land indirectly affected (severance) [3]	28	132	195	67	69	90	111	164	8	3
Agricultural land – total affected[3]	79	319	413	172	191	235	332	466	45	35

1. Area based on indicative 250 m wide corridor.
2. Based on DIPNR mapping.
3. The area is a measure of the non-viable residual land. Non-viability was determined on a case-by-case basis and is based on available information such as land use type, access and location of properties.

   The discrepancy between the total directly affected farmland as measured from the DIPNR mapping in Figure 8.8 and the directly affected farmland as measured from the land use shown in Figure 8.7 is that the DIPNR mapping was inclusive of areas such as public roads, residential usage, etc. These areas are excluded from measurements based on the land uses shown in Figure 8.7. Furthermore, the map provided by DIPNR is generally less accurate due to the large scale of the original map received from DIPNR.

8.9.3 Features of Route Option Sections

Common Section A/B

The primary land use in this section is grazing. The area that would potentially be affected by this section represents approximately 2% of grazing land use in the study area (see **Table 8.14**).

Table 8.14 Agricultural Land Use in Common Section A/B

Agricultural Land Use	Approximate Area (ha)			Approximate Percentage of Land Use in Study Area	
	Directly Affected	Indirectly Affected (severance)	Total Affected	Directly Affected	Total Affected
Grazing	51	28	79	1.5%	2.4%

Section A1

This section primarily contains macadamia and grazing enterprises with other enterprises including coffee, banana, cut flower, nursery and stone fruit (see **Table 8.15**).

Where Section A1 follows the existing highway alignment closely, it generally impacts on the eastern edge of the agricultural properties (the part of the property closest to the current highway). This could have a lesser impact on enterprise operation and viability, depending on size of enterprise and location of infrastructure, than severance that occurs towards the middle of the property.

Section A1 south of Carney Place would sever one of the large macadamia farms in the study area. This could have a large impact on the operation and viability of this enterprise. Although Macadamia

Castle would not be directly impacted (that is, by land take) by this section, access would be restricted (see **Section 8.10.4** for socio-economic impacts).

Section A1 would pass close to Newrybar Public School.

Approximately 20 hectares of rural residential land would be directly affected by Section A1.

Table 8.15 Agricultural Land Use in Section A1

	Approximate Area (ha)			Approximate Percentage of Land Use in Study Area	
Agricultural Land Use	**Directly Affected**	**Indirectly Affected (severance)**	**Total Affected**	**Directly Affected**	**Total Affected**
Bananas	6	10	16	13%	36%
Coffee	7	12	19	5%	13%
Cut flowers	1	0	1	10%	10%
Grazing	93	67	160	3%	5%
Macadamias	65	36	101	5%	8%
Nursery	7	6	14	17%	32%
Stone fruit	8	1	9	7%	8%

Section B1

Section B1 would primarily impact macadamia and grazing enterprises (See **Table 8.16**). While the impacts are largely the same as for Section A1, there is greater potential for severance as Section B1 lies west of the existing highway. This severance would be likely to have an impact on enterprise operation and viability.

Approximately 13 ha of rural residential land would be directly impacted (see **Section 8.10.4** for socio-economic impacts). Macadamia Castle would not be directly impacted by this section.

Table 8.16 Agricultural Land Use in Section B1

	Approximate Area (ha)			Approximate Percentage of Land Use in Study Area	
Agricultural Land Use	**Directly Affected**	**Indirectly Affected (severance)**	**Total Affected**	**Directly Affected**	**Total Affected**
Bananas	6	10	16	13%	36%
Coffee	11	9	20	7%	13%
Cut Flowers	1	0	1	10%	10%
Grazing	72	75	147	2%	4%
Macadamias	100	74	174	7%	13%
Nursery	7	6	13	16%	31%
Passionfruit	8	14	22	64%	100%
Stone fruit	13	7	20	12%	18%

Section A2

Section A2 would potentially impact grazing, macadamia and stone fruit enterprises (see **Table 8.17**). Approximately 4 ha of rural residential land would be directly impacted by Section A2.

Table 8.17 Agricultural Land Use in Section A2

	Approximate Area (ha)			Approximate Percentage of Land Use in Study Area	
Agricultural Land Use	**Directly Affected**	**Indirectly Affected (severance)**	**Total Affected**	**Directly Affected**	**Total Affected**
Grazing	84	67	151	3%	5%
Macadamias	13	0	13	1%	1%
Stone fruit	8	0	8	7%	7%

Section B2

Section B2 would primarily impact grazing and macadamia enterprises (see **Table 8.18**). Approximately 5 ha of rural residential land at the Tinderbox Road area would be directly impacted by Section B2.

Table 8.18 Agricultural Land Use in Section B2

	Approximate Area (ha)			Approximate Percentage of Land Use in Study Area	
Agricultural Land Use	**Directly Affected**	**Indirectly Affected (severance)**	**Total Affected**	**Directly Affected**	**Total Affected**
Grazing	107	51	158	3%	5%
Macadamias	15	18	33	1%	2%
Nursery	<1	0	<1	1%	1%

Common Section C/D

This section would primarily impact grazing, macadamia and sugar cane enterprises (see **Table 8.19**). This section would generally sever enterprises towards one end of properties. This is likely to have a lesser impact on enterprise operation and viability (depending on size of enterprise and location of infrastructure) than severance that occurs towards the middle of a property.

Access to Newrybar Swamp Road is important for producers and in general this would not be compromised by Common Section C/D. Enterprises in the area, particularly sugar cane producers, use the road for access to properties and for storage and haulage.

Table 8.19 Agricultural Land Use in Common Section C/D

	Approximate Area (ha)			Approximate Percentage of Land Use in Study Area	
Agricultural Land Use	**Directly Affected**	**Indirectly Affected (severance)**	**Total Affected**	**Directly Affected**	**Total Affected**
Coffee	1	0	1	0%	<1%
Grazing	103	76	179	3%	5%
Macadamias	18	5	23	1%	2%
Sugar cane	23	9	32	3%	4%

Common Section C/D impacts on land subject to Ballina Council's Cumbalum Structure Plan project, which forms part of the *Ballina Urban Land Release Strategy* (Ballina Shire Council 2000). This section would directly impact approximately 20 ha of 'potential urban development', including land for residential and open space purposes, as identified in Ballina Council's preliminary draft Cumbalum Structure Plan. Further, Ballina Council feels that this section may indirectly impact the potential future development by affecting the structure and function of the area as a whole.

Section C1

Enterprises that would be directly impacted by Section C1 are grazing, macadamia, sugar cane and coffee (see **Table 8.20**). The three major coffee producers in the study area would be affected by this section, as would one of the larger macadamia farms in the study area. Section C1 would also sever the macadamia and sugar cane enterprise north of Martins Lane East.

Section C1 would also sever and impact on the high constraint rural residential clusters on Old Byron Bay Road, Broken Head Road and Tinderbox Road (29 ha of rural residential land would be impacted by this section).

Table 8.20 Agricultural Land Use in Section C1

	Approximate Area (ha)			Approximate Percentage of Land Use in Study Area	
Agricultural Land Use	**Directly Affected**	**Indirectly Affected (severance)**	**Total Affected**	**Directly Affected**	**Total Affected**
Alpacas	5	14	19	25%	100%
Bananas	0	0	0	1%	1%
Coffee	25	10	35	17%	23%
Grazing	105	47	153	3%	5%
Macadamias	42	26	68	3%	5%
Nursery	<1	0	<1	1%	1%
Sugar cane	43	14	57	6%	8%

Section D1

Enterprises that would be impacted by Section D1 include grazing, sugar cane, macadamias, nursery and a mixed enterprise (see **Table 8.21**). The potential severance of enterprises in this section, particularly macadamias and sugar cane would significantly impact on enterprise operation and viability. For many properties, direct access to Newrybar Swamp Road would potentially be severed. This would affect access and haulage requirements.

Section D1 would also impact on the rural residential cluster at Tinderbox Road (approximately 3 ha of rural residential land would be impacted by Section D1). Approximately 1 ha of a tourism enterprise (cabins) would be impacted.

Table 8.21 Agricultural Land Use in Section D1

	Approximate Area (ha)			Approximate Percentage of Land Use in Study Area	
Agricultural Land Use	**Directly Affected**	**Indirectly Affected (severance)**	**Total Affected**	**Directly Affected**	**Total Affected**
Grazing	156	100	256	5%	8%
Macadamias	56	13	68	4%	5%
Mixed Enterprise	7	10	17	19%	46%
Nursery	1	0	1	2%	2%
Sugar Cane	82	41	123	11%	17%

Tunnel Section

The Tunnel Section would primarily impact on grazing enterprises with over 30 ha of rural residential also impacted.

Table 8.22 Agricultural Land Use in the Tunnel Section

	Approximate Area (ha)			Approximate Percentage of Land Use in Study Area	
Agricultural Land Use	**Directly Affected**	**Indirectly Affected (severance)**	**Total Affected**	**Directly Affected**	**Total Affected**
T1					
Grazing	37	8	45	1%	1%
T2					
Grazing	32	3	34	1%	1%

8.9.4 Summary of Route Options

A summary of impacts of the short list of route options is provided in **Table 8.23.**

Table 8.23 Summary of Agricultural Land Affected

Approximate area (ha) [1]	A	B	C	D	T1	T2
Regionally significant farmland directly affected[2]	400	416	351	433	59	54
State significant farmland directly affected[2]	3	5	10	0	0	0
Agricultural land directly affected[3]	344	391	366	447	37	32
Agricultural land indirectly affected (severance)[3]	227	291	201	254	8	3
Agricultural land - total affected[3]	571	683	567	701	45	34

1. Area based on indicative 250 m wide corridor.
2. Based on DIPNR mapping.
3. The area is a measure of the non-viable residual land. Non-viability was determined on a case-by-case basis and is based on available information such as land use type, access and location of properties.

   The discrepancy between the total directly affected farmland as measured from the DIPNR mapping in Figure 8.8 and the directly affected farmland as measured from the land use shown in Figure 8.7 is that the DIPNR mapping was inclusive of areas such as public roads, residential usage, etc. These areas are excluded from measurements based on the land uses shown in Figure 8.7. Furthermore, the map provided by DIPNR is generally less accurate due to the large scale of the original map received from DIPNR.

Option A

This option would potentially impact 65 properties. This option, where it most closely follows the current highway alignment, would generally impact the part of the property closest to the current highway. This would be likely to have a lesser impact on enterprise operation and viability, depending on size of enterprise and location of infrastructure, than severance that occurs towards the middle of the property.

Option B

This option would potentially impact 59 properties. This option generally lies to the east or west of the current highway. As a consequence, rather than severing one end of the property as in Option A, more properties would be likely to be severed towards the middle of the properties. This could have a greater impact on enterprise operation and viability.

Option C

This option would potentially impact 50 properties. This option would generally sever enterprises towards one end of the property. This would be likely to have a lesser impact on enterprise operation and viability, depending on size of enterprise and location of infrastructure, than severance that occurs towards the middle of the property. Option C would be unlikely to impact on property access from Newrybar Swamp Road.

This option would impact the rural residential clusters at Dufficys Land, McLeish Road, and Glenross Drive as well as land identified by Ballina Shire Council for future residential development. It would also sever the rural residential clusters on Old Byron Bay Road and Broken Head Road.

Option D

This option would potentially impact 47 properties. Similar to Option C, it would it impact the rural residential clusters at Dufficys Land, McLeish Road and Glenross Drive as well as land identified by Ballina Shire Council for future residential development. This option would also sever and impact the rural residential cluster at Tinderbox Road.

Severance of properties in Newrybar Swamp north of Martins Lane East would impact on direct access to the Newrybar Swamp Road as well as on enterprise operation and viability.

8.10 Socio-economic Effects

8.10.1 Overview of Impacts

The following key quantified socio-economic impacts were considered in relation to each of the short list of options:

- Number of dwellings acquired (with assumed resultant resident relocation).
- Impacts on agricultural land.
- Impacts on businesses and tourism.
- Impact on community facilities.

Other potential socio-economic impacts addressed that may occur, but which are not as easily quantified, include:

- Concern about whether property (dwellings, businesses and farms) would be affected.
- Changes in amenity.
- Changes in community linkages.
- Improved safety.

8.10.2 Number of Dwellings to be Acquired

The number of dwellings that would potentially be acquired and related resident relocation (based on average household size within the study area CCDs of 2.97 persons) are shown in **Table 8.24**.

Table 8.24 Dwellings Potentially Acquired

	A/B	A1	B1	A2	B2	C/D	C1	D1	A	B	C	D	T1	T2
Dwellings	0	59	18	8	10	6	13	8	67	28	19	14	6	8
Affected residents (estimated)	0	175	54	24	30	18	39	24	199	84	57	42	18	24

Option A

The majority of dwellings potentially acquired would generally be in the southern section (A1) where the route option closely follows the existing highway. A relatively small number of dwellings would potentially need to be acquired in the northern section where the route option diverts from the existing highway route option and away from houses located close to the highway.

The related number of affected residents would be concentrated in the section generally between Knockrow and Newrybar, resulting in a major social impact in a relatively localised area.

Option B

For this option, the majority of the dwellings potentially acquired would be in the southern (B1) section where the route option, although largely located away from the existing highway route option, would traverse closely settled rural areas.

The related number of affected residents would be more concentrated in the section south of Newrybar, resulting in a major social impact in a relatively localised area.

Option C

For about half its length, this option would traverse the relatively less intensively settled coastal plains. As this route option ascends the escarpment to the plateau (C1), it would potentially affect a greater number of dwellings.

The related number of affected residents would be relatively evenly spread along the entire 20 km length of this route option. While there would be social impacts with this dwelling loss and related resident relocation, it would not be as locally concentrated as with Option A or B.

Option D

As with Option C, for about half its length this option traverses the less intensively settled coastal plains. The easterly diversion of this route option east of Newrybar and south of Coopers Shoot would result in a small number of dwellings to be potentially acquired.

The related number of affected residents would be relatively evenly spread along the entire length of this route option. The social impact of this dwelling loss would be similar to Option C.

Tunnel Section

Section T1 generally follows the existing highway alignment and would potentially require up to 6 dwellings to be acquired. Section T2 is generally located slightly to the east of the existing highway alignment, resulting in potentially 8 dwellings to be acquired.

8.10.3 Impacts on Agricultural Land and Production

Impacts on agricultural land and production are covered in the land use impact discussion in **Section 8.9**. The land use impacts are also direct socio-economic impacts for owners of agricultural land being acquired or severed.

8.10.4 Impacts on Businesses (non-farms)

Potential impacts on businesses (other than farms) within and adjacent to the study area would fall into four categories:

- Those businesses with direct highway frontage and access and which have a high reliance on turnover generated by non-local highway traffic – Macadamia Castle at Knockrow is the only example of a business in the study area which falls into this category.
- Those businesses located within Newrybar village (the general store and Harvest Café) which are located only a small distance off the highway and are easily accessible by highway traffic and which have some reliance on turnover generated by non-local highway traffic.
- Those businesses located in Bangalow township which is a tourist destination in itself but also provides a range of services to highway traffic (given the distance to other such services to the north and south of Bangalow).
- Those bed and breakfast facilities in the area whose attractiveness may be affected by impacts associated with the options including noise and visual amenity.

Impact on Macadamia Castle

Based on discussions with the owner/operator of Macadamia Castle, this business has a very substantial reliance on highway traffic (80% of turnover). The extent to which trade levels for this business would be affected would depend, in part, on the traffic levels that would remain on the existing highway once the upgraded highway is completed as well as marketing activities that the business itself undertakes. However, it is reasonable to assume that all options have the potential to substantially affect trade levels for this business. Options A and B may have a lesser impact due to their closer proximity and ability to visually identify the Castle and thereby market better.

Impact on Businesses (non-farm) in Newrybar and Bangalow

Discussions with operators of businesses in Newrybar and Bangalow indicated they currently attract about 30% of their turnover from non-local highway traffic.

The impacts of the highway upgrade on these businesses depends in part on the volumes of traffic that would remain on the existing highway, the overall growth in the regional tourism sector, and the development of Bangalow as a 'tourist destination'. A summary of the impacts on businesses is shown in **Table 8.25**.

Table 8.25 Impacts on Businesses

Option	Macadamia Castle	Newrybar Businesses	Bangalow Businesses
A	Medium/Major	Minor	Minor
B	Medium/Major	Minor	Minor
C	Major	Minor/Medium	Minor/Medium
D	Major	Minor/Medium	Minor/Medium

Note: Route option totals include Tunnel Section Option T1.

8.10.4.1 Tourism Impacts

The study area is located within the hinterland of Byron Bay, which is a key destination for both domestic and international tourists. As a result, tourism is an important economic activity at the regional level which contributes to the economic well-being of many businesses within the Byron Bay hinterland, including those in or close to the study area. While the potential impacts on existing farm and other businesses have been considered, it is possible that some of the shortlisted options could affect local and regional tourism in varying ways.

Option A

While provision would be made for local access along this route option, the existing visual and physical relationship between the highway and adjoining land uses would be changed substantially and may not offer the same 'tourist amenity' at the local level as those options that would enable the existing highway to remain in largely its existing form.

Option B

This option would generally enable the existing highway to remain in its existing form to function as a local/regional access road. The physical and functional relationship between the adjoining land uses and this road would remain essentially the same but with substantially improved safety and amenity resulting from the removal of large volumes of heavy traffic in particular. This change would enable the existing highway to be promoted as a tourist route and may encourage the development of more tourist-related uses.

Option C

This option would enable the existing highway to remain fully in its existing form to function as a local/regional access road. The physical and functional relationship between the adjoining land uses and this road would remain the same but with substantially improved safety and amenity resulting from the removal of large volumes of heavy traffic in particular. This change would enable the existing highway to be promoted as a tourist route and may encourage the development of more tourist-related uses. Advance signage would be required to direct highway users to this route as well as maintenance of the connectivity of the largely east-west local road system on the coastal plains and plateau sections traversed by this option.

Option D

The comments above in relation to Option C also apply to this option. In addition, the central section of this option would take the upgraded highway to within 3 km of the coast at its closest point to the south west of Broken Head. As a result in the longer term, there may be pressure to have an interchange located somewhere in this section to provide more direct access to coastal settlements from Broken Head north to Byron Bay which could arguably assist aspects of the regional tourism industry.

8.10.4.2 Concern about Property Impacts

Based on community input received to date through the CLG and other submissions, there is significant concern and angst amongst those residing on the plateau and those in the coastal plain portions of the study area. Those on the plateau are concerned about property acquisition, impacts on agricultural land and farm businesses, noise and the social character of their area. Those on the coastal plain have expressed anger because they never expected an upgrade of the Pacific Highway in their area, and concern that the introduction of a highway would destroy the amenity and character of the area and property values. Thus, based on community perceptions and values, there are significant socio-economic impacts associated with all of the shortlisted options.

For the purposes of this report, residents not currently living within 200 m of the centreline of the existing Pacific Highway whose properties potentially would be directly affected by the short list of options are considered 'newly affected residents'.

There are relatively small numbers of dwellings, and thus residents, which are in this category that could be classified as 'newly affected' as shown in **Table 8.26.**

Table 8.26 'Newly Affected Dwellings' Potentially Acquired

Option	'Newly Affected Dwellings'	'Newly Affected Residents'
A	4	12
B	15	45
C	19	57
D	14	42
T1	2	6
T2	3	9

As would be expected because of the distance from the existing highway, there would be more 'newly affected' residents along Option C than along other options. Options B and D would have similar numbers of residents in this category - even though Option D is further away from the existing highway, it traverses relatively less densely settled farmlands than Option B. Option A would have the lowest number of 'newly affected residents' as it follows the existing highway route option for most of its length.

It should be noted however, that some residents in the coastal plain section of the study area have a broader definition of 'newly affected' and consider the entire coastal plain area and those living in it or near it to be affected by potential noise, visual and community character issues.

8.10.4.3 Residential Amenity

For residents living in close proximity to the existing Pacific Highway, there are several potential adverse effects of increasing traffic levels (especially heavy traffic at night) including:

- Noise impacts that affect residential amenity and, potentially, individual well being through sleep disturbance in response to specific noise events such as the use of engine brakes.
- Concerns about potential accidents that could affect people and/or assets.

Relocation of the highway away from its existing alignment could result in varying levels of amenity improvements for these residents as the function of that part of or all of the existing highway could change significantly.

Other residents may be faced with adverse amenity impacts if the highway is upgraded along a new alignment. Contemporary approaches to the design and implementation of highway upgrades incorporate many measures to mitigate adverse socio-economic effects on affected landowners and nearby residents. However, even if projected noise levels or visual impacts are assessed as meeting relevant guidelines or otherwise 'satisfactory' or 'acceptable', the introduction of a major infrastructure element to a previously perceived undisturbed (or relatively undisturbed) locale can change residents' sense of well being or strength of attachment to a particular place. This is particularly an issue for those parts of the study area at some distance from the existing highway where residents may never have contemplated the prospect of a highway upgrading option being identified in their locality.

8.10.4.4 Impacts on Community Facilities and Access to Community Facilities

There are no community facilities in the study area directly impacted by the short list of options. Options A and B are located near the Newrybar Primary School; however, if the local road network is maintained, there should not be any impact on access to the school. Options C and D would not affect any community facilities.

8.10.4.5 Impacts on Community Linkages and Community Severance

The potential impacts of the short list of route options on community linkages and severance are listed in **Table 8.27**.

Potential impacts on rural residential clusters would include:

- Option A - As most of the recently developed rural residential clusters are located away from the existing highway route option, Option A would have little effect on these rural residential clusters.
- Option B – Option B would sever and impact the rural residential cluster at Tinderbox Road.
- Option C - Option C would significantly impact on the rural residential clusters at Dufficys Land, McLeish Road and Glenross Drive as well as land identified by Ballina Shire Council for future residential development in the Cumbalum area. This option could also have a potentially significant impact on amenity for the rural residential cluster at Martins Lane East and traverse the rural residential clusters on Old Byron Bay Road, Broken Head Road and Tinderbox Road.
- Option D - Similar to Option C, this option would significantly impact the rural residential clusters at Dufficys Land, McLeish Road and Glenross Drive as well as land identified by Ballina Shire Council for future residential development in the Cumbalum area. This option would also sever and impact on the rural residential cluster at Tinderbox Road.

Table 8.27 Community Severance

Option	Community Severance Impacts
Option A	May adversely affect community linkages and cause community severance in the Knockrow area. The severance impacts could result from the greater physical dislocation between remaining residents on the east and west sides of the upgraded highway.
Option B	May create a number of 'pockets' of farms and dwellings; physically separating properties, dwellings and residents that were previously contiguously located.
Option C	This option may introduce a physical barrier through rural parts of the coastal plain and plateau land in the northern part of the study area and thus physically separate properties, dwellings and residents that were previously contiguously located.
Option D	As above but would affect a larger rural area than Option C.

8.10.4.6 Improved Safety

A key imperative for highway upgrade projects such as the Tintenbar to Ewinsgdale upgrade proposal is the achievement of road safety improvements, principally for highway users, but also for local vehicular and pedestrian traffic where this access currently occurs on sections of the highway or intersects with it. These safety benefits are likely to accrue across the wide 'community' of existing and future highway users as well as local communities such as Knockrow, Newrybar and rural areas along the highway where residents currently have to access or cross the busy highway for a variety of day-to-day activities.

Safety benefits would be derived from all shortlisted options through the provision of a separate local road network which would be free of through traffic.

8.10.4.7 Summary of Socio-Economic Effects

There is a potentially wide and varied range of both positive and adverse socio-economic impacts of the Tintenbar to Ewingsdale Pacific Highway upgrading. Some of these impacts would be manifest in physical terms and thus design and implementation measures can mitigate many of the adverse elements. A summary of the socio-economic effects are listed in **Table 8.28.**

Table 8.28 Summary of Socio-Economic Effects of the Short List of Route Options

Option	Socio-Economic Effects
Option A	• Option A would affect the highest number of dwellings and residents who would potentially have to relocate and thus would have a relatively high impact on community severance. • The impact on agricultural land and production would be high. • The impact on Macadamia Castle would be medium to major, but minor on businesses in Bangalow and Newrybar. • The impact on local and regional tourism would be higher than other options as the opportunity to use the existing highway as a tourist route would be limited. • As most of the recently developed rural residential clusters are located away from the existing highway route option, Option A would have little effect on these rural residential clusters.
Option B	• Option B would affect the second highest number of dwellings and residents who would have to relocate and thus have a relatively high impact on community severance. • The impact on agricultural land and production would be high. • The impact of this option on Macadamia Castle would be medium to major, but minor on businesses in Bangalow and Newrybar. • The impact on local and regional tourism would be lower than Option A as there would be more opportunity to use the existing highway as a tourist route, but higher than Options C and D. • As most of the recently developed rural residential clusters are located away from the existing highway route option, Option B would have little effect on these rural residential clusters.
Option C	• Option C would result in a relatively low number of dwellings affected and residents who would have to relocate and thus have a relatively low impact on community severance. • The impact on agricultural land and production would be high. • The impact of this option on Macadamia Castle would be major, but minor to medium on businesses in Bangalow and Newrybar. • The impact on local and regional tourism would be lower than Options A and B as the opportunity to use the existing highway as a tourist route would be fully available. • This option would significantly impact on a number of rural residential clusters as well as land identified by Ballina Shire Council for future residential development in the Cumbalum area.
Option D	• Option D would result in the lowest number of dwellings affected and residents who would have to relocate and thus have a low impact on community severance. • The impact on agricultural land and production would be high. • The impact of this option on Macadamia Castle would be major, but minor to medium on businesses in Bangalow and Newrybar. • The impact on local and regional tourism would be lower than Options A and B as the opportunity to use the existing highway as a tourist route would be fully available. • This option would have a large impact on a number of rural residential clusters as well as land identified by Ballina Shire Council for future residential development in the Cumbalum area.

8.11 Cultural Heritage

8.11.1 Overview of Impacts

To evaluate the short list of route options the following characteristics were considered:

- Number of high value indigenous sites directly affected.
- Number of medium value indigenous sites directly affected.
- Number of high value non-indigenous sites directly affected.
- Number of medium value non-indigenous sites directly affected.
- Areas of potential archaeological deposits (PADs) directly affected (ha).

The location of the short listed route options in relation to heritage sites are shown in **Figure 8.10** and **Figure 8.11**.

8.11.2 Characteristics of Route Option Sections

This section provides an overview of the possible impacts to heritage sites, places and areas of potential for the short list of route options. **Table 8.29** provides a summary of the impacts for each option section.

No high or medium value indigenous sites or high value non-indigenous sites would likely be impacted by the option selected. One section (Section A1) would potentially impact one medium value non-indigenous site.

Table 8.29 Evaluation of Route Option Sections

Heritage Characteristics	A/B	A1	B1	A2	B2	C/D	C1	D1	T1	T2
Number of medium value non-indigenous sites directly affected	0	1	0	0	0	0	0	0	0	0
Areas of potential archaeological deposits directly affected (ha)	0.0	0.0	0.0	0.4	3.7	0.0	3.6	2.8	0.0	0.0
Potential Impact (Low, Medium, High)	L	M	L	L	L	L	L	L	L	L

8.11.3 Features of Route Option Sections

Common Section A/B

The basal slopes of the spurs adjacent to Sandy Flat Creek have a high archaeological potential for indigenous sites, depending upon the degree of slope and disturbance levels of the ground.

Section A1

Section A1 mostly follows the existing highway and is therefore within previously heavily disturbed ground. No indigenous sites were identified along Section A1. Section A1 crosses four spurs of with archaeological potential but any relatively undisturbed areas of ground are likely to be small.

The village of Newrybar was identified as a site of medium heritage value. The village contains a number of historic buildings which were considered to be of local historic value. Section A1 would potentially have a moderate level impact to the heritage significance of Newrybar, with potential impact on the historic bakery.

Figure 8.10 Aboriginal Heritage

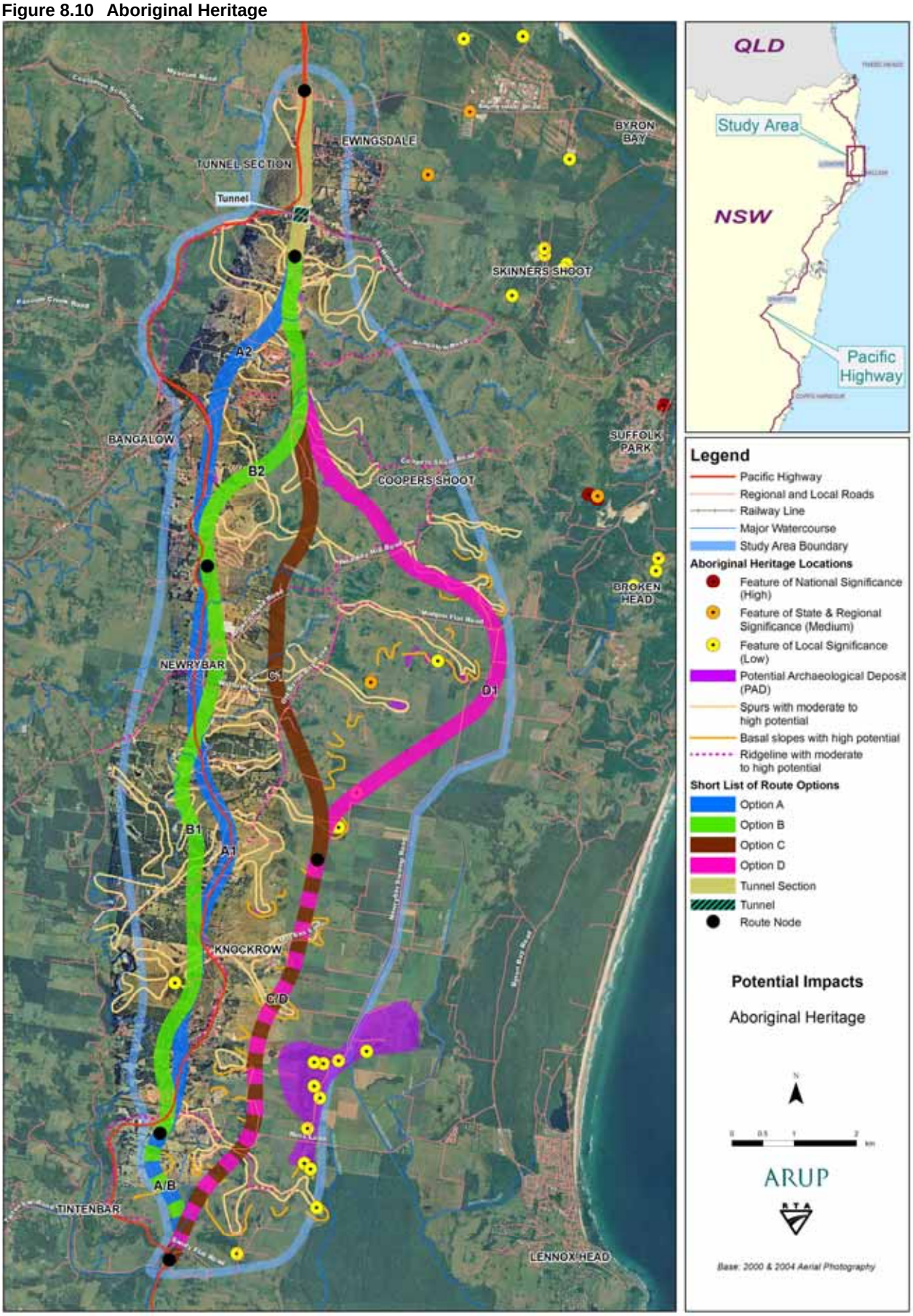
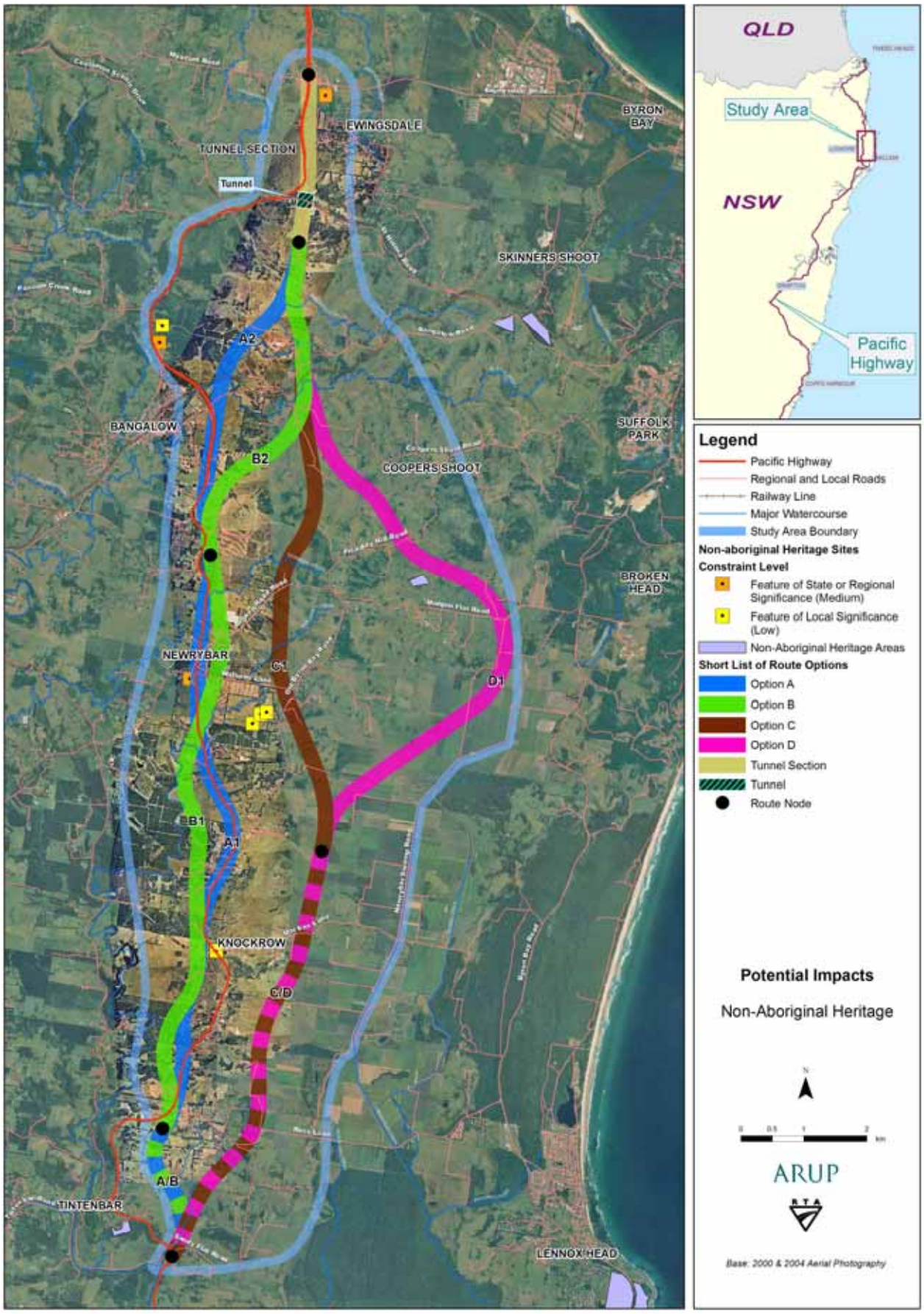


Figure 8.11 Non-Aboriginal Heritage



Section B1

While Section B1 crosses about five spur lines that have a moderate to high potential to contain indigenous sites, the route option would cross the spurs mostly at perpendicular angles, thus reducing the potential impact on these landforms. Based on current knowledge, Section B1 is likely to have a low level of impact on the heritage significance of the study area.

Section A2

This option would impact on two potential archaeological deposits identified during the field survey, with the impact area calculated to be about 0.4 hectares. Overall, this option is likely to have a low impact level on heritage places however the presence or absence of sites within the potential archaeological deposits would need to be confirmed before further assessment could be made.

Section B2

Section B2 would impact approximately 3.7 ha of two potential archaeological deposits recorded in the area. There are an additional six spur crests that were identified as having potential to contain indigenous sites that would be impacted within this route section. Although the presence or absence of sites within the areas of potential would be the subject of further assessment, it is considered that Section B2 would be likely to have a low level of impact on the potential archaeological record.

Common Section C and D

This section crosses three spur crests and seven areas of basal slope adjacent to the former Newrybar Swamp. While the topographic features are considered to have high indigenous archaeological potential, the potential would be dependent upon the level of disturbance, the slopes and other environmental characteristics. This section is considered likely to have a low to moderate impact on the archaeological record within the study area.

Section C1

Section C1 would potentially impact on 3.6 ha of two potential archaeological deposits. This option would also be likely to impact a site of low heritage significance, as well as crossing about eight spur crests with moderate to high potential to contain indigenous archaeological sites.

Section D1

This section would impact on two indigenous sites of low archaeological significance. It would also impact on about 2.8 ha of potential archaeological deposits and cross about six spur crests identified as having moderate to high indigenous archaeological potential.

Tunnel Section

The tunnel section does not contain any known heritage sites. There is very low potential for heritage sites to be affected with this section.

8.11.4 Summary of Route Options

A summary of the potential impact for each complete option on the indigenous and non-indigenous heritage of the study area is shown in **Table 8.30**. Overall, it shows that all options have a generally low level of heritage impact. However, there are areas identified with moderate to high indigenous archaeological potential that would be impacted by all of the options.

Table 8.30 Summary of Heritage Impacts

Heritage Characteristic	A	B	C	D
Number of medium value non-indigenous sites directly affected	1	0	0	0
Approximate area of potential archaeological deposits directly affected (ha)	0.4	3.7	3.6	2.8

Note: Route option totals include Tunnel Section Option T1.

8.12 Visual

8.12.1 Overview of Impacts

The visual overview of the short list of route options focuses on two characteristics:

- Visual sensitivity of the study area.
- Visual effect of the route.

Visual Sensitivity

In order to determine the visual sensitivity of the study area and for the purposes of evaluating the short list of route options, three aspects of the existing landscape were measured:

- Scenic quality of the landscape and landscape character type - the likelihood and the extent to which the overall character of the landscape setting would be affected by changes to parts of that landscape, such as the construction of a new route alignment and associated infrastructure. The study area is divided into five landscape character types and the tunnel section.
- Number and sensitivity of viewers - this measures how sensitive people viewing the landscape would be to changes in the visual environment. Based on an approximation of the number of potential viewers and the activities they are engaged in, six types of viewing locations or places are identified throughout the study area.
- Distance from existing highway infrastructure - this is a measure of the influence of the existing highway and associated concentrations of infrastructure on the landscape character, based on the distance away from the current highway alignment.

Visual Effect

Visual effect relates to the magnitude of the route. It measures the extent of change created by a new highway alignment, in relation to the visibility of any highway infrastructure elements. The visual effect is represented by the following two aspects:

- Degree of exposure of the route - the degree of exposure is based on the visibility of the route as a result of the position and alignment of the route in the landscape. The study area is divided into five landscape setting units and the tunnel section which provide different degrees of exposure or concealment for the route alignment.
- Scale of new infrastructure - this assesses the scale or size of the highway elements such as cut and fills embankments. The most visually obvious new infrastructure elements of any new highway alignment would be the cuttings and embankments associated with cut and fills, required to provide a road with grades that satisfy the engineering performance criteria for a major new highway.

8.12.2 Characteristics of Route Option Sections

The selected visual aspects presented are:

- Visual sensitivity - scenic quality of the landscape and landscape character type (see **Figure 8.12**) - measured as length of route through landscape type.

- Visual effect - degree of exposure of the route (see **Figure 8.13**) - measured as length of route viewed from each landscape unit.

Table 8.31 provides a summary of the two aspects above in relation to the route option sections.

Table 8.31 Selected Visual Aspects of Route Option Sections

Select Visual Aspects	A/B	A1	B1	A2	B2	C/D	C1	D1	T1	T2
Approximate length of route (m) through:										
Coastal flats	0	0	0	0	0	3600	300	4800	0	0
Undulating hills and ridges with limited areas of mature vegetation	0	1900	1600	3000	4000	0	5400	4500	500	500
Enclosed Valleys	2200	300	200	0	0	2200	0	100	0	0
Undulating hills and ridges with extended areas of mature vegetation	0	5800	7400	2200	1400	0	2000	600	0	0
Escarpment	0	1600	300	0	0	1300	2200	2500	1800	1600
Tunnel and approach cuttings	-	-	-	-	-	-	-	-	400	600
Approximate length of route (m) exposed to:										
Lower slopes and valleys	2200	4600	6200	4600	3500	2300	4900	3800	300	500
Exposed ridge lines with extensive vegetation cover	0	2400	2200	300	300	0	800	200	0	0
Coastal flats	0	0	0	0	0	3400	200	4700	0	0
Exposed ridge lines with limited vegetation cover	0	1200	800	400	1600	0	1900	1200	100	0
Escarpment	0	1400	400	0	0	1300	2100	2500	1800	1600
Tunnel and approach cuttings	-	-	-	-	-	-	-	-	400	600

8.12.3 Features of Route Option Sections

Common Section A/B

The mix of grazing land and native vegetation remnants on the valley floors and open and vegetated hillsides creates a landscape of some visual interest which is considered to be of medium scenic quality.

The location of much the section on the lower slopes and valley floor of Sandy Flat Creek, together with its location away from the current highway mean that the section would be relatively well concealed from many viewers within the study area, with the most exposed portion of the section located near Ross Lane where the section climbs up the escarpment.

The climb up the escarpment would require large cut and fill embankments, however, the land surrounding Common Section A/B is sparsely populated, featuring no towns or villages, resulting in an overall low visual sensitivity.

Figure 8.12 Visual Sensitivity: Quality of the Landscape and Landscape Character Type

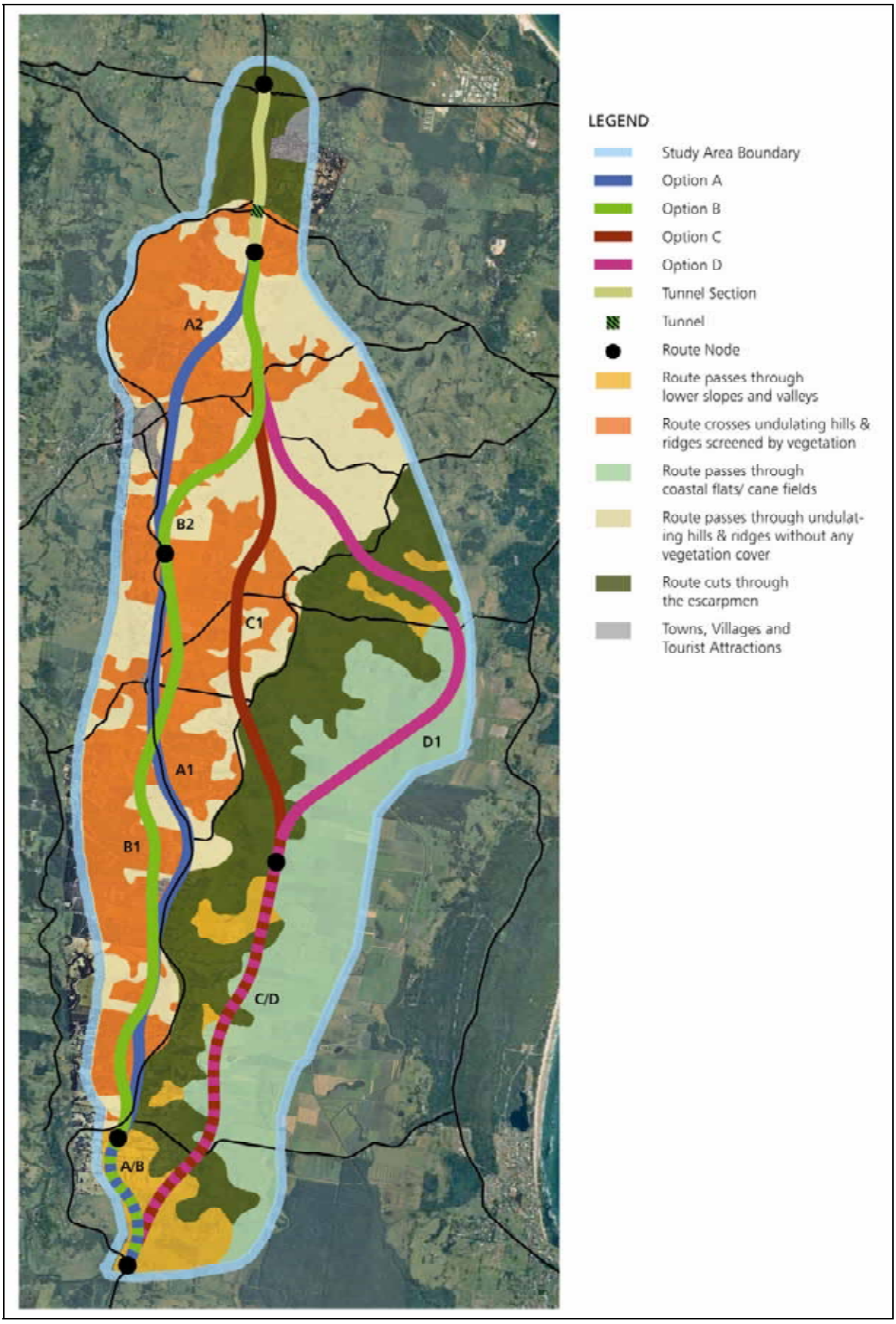
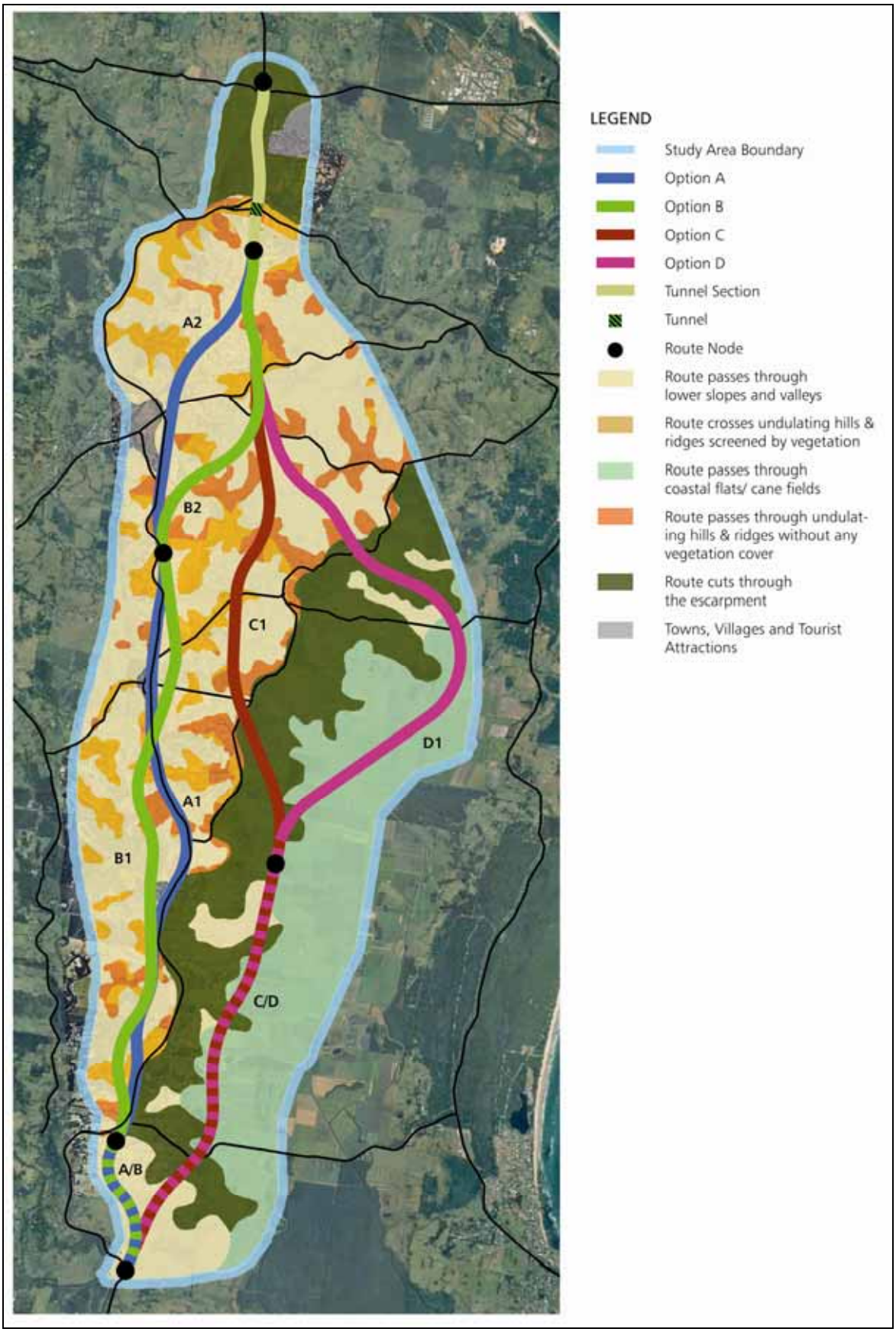


Figure 8.13 Visual Effect: Degree of Exposure of the Route



Section A1

The character of the landscape through which this section passes is highly scenic and diverse. It includes spectacular views towards the ocean from along the top of the escarpment around the Knockrow area, as well as extended sections of strongly patterned but varied agricultural landscapes on the undulating high plateau. Sensitive viewers would include tourists travelling along the Pacific Highway, visiting the Macadamia Castle and travelling along scenic tourist routes (such as Old Byron Road); residential housing in and around Newrybar; and rural residential properties along the local ridge line roads, many of which enjoy scenic views of the area.

Large cuttings and fill embankments would be required for much of its length, to accommodate a second carriageway. However, as the section closely follows the existing highway, the overall visual sensitivity of the viewers with regard to the option is reduced. The visual exposure of the section varies considerably for this section but remains low overall, as more than two thirds of the section extends through areas which would not be greatly exposed to viewers outside the highway route option.

Section B1

Similar to section A1, the character of the landscape along which this section passes is very scenic and provides a high degree of visual interest. While section B1 avoids the escarpment itself, more than three quarters of the section extend through highly scenic agricultural landscapes of the elevated plateau. Combined with the high concentration of viewers in this part of the study area, the sensitivity to visual changes in the landscape would be relatively high.

Sensitive viewers include visitors and residents of the village of Newrybar, residents of rural properties on farms and in residential clusters along the local road system, as well as locals and tourists travelling along the Pacific Highway, and visiting the Macadamia Castle, or along local roads such as Broken Head Road.

While about two thirds of the section would require noticeable to large cuttings and fill embankments, the alignment of much of the section through areas with limited visual exposure means that the visual effect of the section on the study area as a whole would be relatively low.

Section A2

The scenic character of the landscape through which the section passes is mixed, featuring some less attractive and visually interesting bare grazing lands, as well as some highly scenic and diverse agricultural landscapes such as immediately north of Bangalow.

While the majority of the section follows the valleys or lower hill sides of Tinderbox Creek and its tributaries and is relatively well concealed from many vantage points within the study area, there is a high concentration of viewers in the area who would be sensitive to changes in the visual landscape of the area. These include large numbers of locals and tourists travelling along the Pacific Highway and Bangalow Road, as well as visitors and residents of Bangalow which has become a major tourist destination.

As there might be an expectation that the upgraded highway would follow the existing alignment more closely, the significant distance to existing highway infrastructure of the northern part of the section would increase the sensitivity of viewers to visual changes to the landscape in that part of the study area. Further, cuttings and fill embankments along about a third of the section are noticeable in size, with another third being large to very large, resulting in a larger visual effect of those sections that are exposed to viewers.

Section B2

The scenic character of the landscape through which the section passes is mixed, featuring some less visually interesting bare grazing lands, as well as some highly scenic and diverse agricultural landscapes such as east of Bangalow or around Bangalow Road.

While the northern section of the section follows the valleys or lower hill sides of Tinderbox Creek and its tributaries and is relatively well concealed from many vantage points within the study area, the

southern part of the section cuts through some of the more exposed hills and ridges, a fact which is also reflected in the number and size of cuttings and fill embankments along the section, with about half of the section requiring embankments greater than 5 m in height.

The southern portion of Section B2 in particular would be more exposed to viewers, due to the alignment of the section as well as the concentration of potential viewers in this part of the study area. Potential viewers include large numbers of locals and tourists travelling along the Pacific Highway, Bangalow Road and (to a lesser degree) Coopers Shoot Road and St Helena Road. These are complemented by visitors and residents of Bangalow which has become a major tourist destination. As there might be an expectation that an upgraded highway would be relatively near the existing alignment, the significant distance of the section from the existing highway may increase the sensitivity of viewers to visual changes to the landscape in that part of the study area.

Common Section C/D

The location of much of the section through escarpment spurs and the coastal flats means that Common Section C/D would be relatively exposed to a relatively large number of viewers, both locals and visitors, travelling along the Pacific Highway which in this section enjoys particularly good views over the coastal flats and towards the ocean. Viewers also include locals travelling along local link roads such as Ross Lane and, to a lesser degree, Martins Lane East.

Noticeable cuttings and fill embankments would be required along the majority of the section in order to provide a flood-free section. However, due to the significant elevation of the escarpment, these embankments would be less prominent when viewed from the escarpment above (where the majority of viewers would be). The impact on the landscape of the coastal flats itself would be relatively low as this landscape character is considered to be of lower scenic value overall.

While the remoteness of the section's alignment relative to local population centres and major tourist sites reduces the number of potential viewers, they are likely to be highly sensitive to changes in the visual landscape. This is due to the open exposure of the coastal flats to viewers along the escarpment, as well as the great distance of the section from existing infrastructure and development concentrations where a major road might be expected to be located.

Section C1

This section contains a mix of landscape character types. It is this mix that reduces the overall visual sensitivity of the route option, even though significant portions of it cut through highly scenic and visually important areas such as the escarpment and the agricultural landscapes of the elevated plateau. Similarly, the overall degree of exposure of this section is reduced by the fact that significant portions of the route run through areas of lower slopes and valleys where the road would be relatively well concealed, even though in the sections where the route climbs the escarpment, the route would be extremely exposed.

In addition to the open and exposed nature of some of the route, its distance away from the existing highway and urban infrastructure means that viewers are likely to be more sensitive to the visual effects of the highway on the landscape. Apart from the impact of disturbing the visually iconic escarpment, more than half of the alignment requires large cuttings and fill embankments greater than 5 m in height which would also have a significant impact on the visual landscape.

The visual changes to the landscape would be seen by a number of viewers in the study area, including locals and tourists travelling along the scenic Old Byron Road, Bangalow Road and Midgen Flat Road, as well as viewers (primarily locals) travelling along and living in rural residential properties located off those roads as well as off Coopers Shoot Road, St Helena Road and to a lesser degree Newrybar Swamp Road. The remoteness of the route's alignment relative to local population centres and major tourist sites reduces the number of potential viewers, relative to some of the other options.

Section D1

While a third of the section cuts through the highly scenic and visually important face of the escarpment, long portions of it pass through scenically less valuable landscape on the flats, reducing the overall visual sensitivity of the section. Similarly, even though more than half of the section is extremely exposed to views (including portions through the escarpment and exposed hills and ridges), the overall degree of exposure of the alignment is reduced by the remaining portions which run through areas where the road would be relatively well concealed when seen from a distance, such as the lower slopes and valleys.

In addition to the open and exposed nature of some of the section, its distance away from the existing highway and urban infrastructure means that viewers are likely to be more sensitive to the visual effects of the highway on the landscape. Apart from the impact of disturbing the visually iconic escarpment, the section requires significant cuttings and fill embankments, including large and very large cuttings and embankments for more than 40% of its length.

Sensitive viewers include local rural residences, and locals and tourists travelling along Old Byron Road, Bangalow Road, Midgen Flat Road, Coopers Shoot Road, St Helena Road and to a lesser degree Newrybar Swamp Road. However, the remoteness of the section's alignment relative to local population centres and major tourist sites reduces the number of potential viewers, relative to some of the other options.

Tunnel Section

The majority of the tunnel option is located in the highly scenic escarpment, which is located on the northern study area boundary and visible from great distances. Apart from being very exposed to views, the portion of the study area affected by the tunnel also has a large number of potential viewers who would be sensitive to changes in the visual environment. These include locals and tourists travelling along the existing Pacific Highway alignment, visitors to McLeod's Shoot Lookout, residents of the village of Ewingsdale and in the cluster of rural residential housing along St Helena Road. They would be most sensitive to the significant changes in the visual environment south of the St Helena Ridge, resulting from the deviation of the section from the existing highway alignment and creating a tunnel under the St Helena Ridge.

8.12.4 Summary of Route Options

A summary of the selected visual parameters is provided in **Table 8.32**.

Table 8.32 Summary of Visual Aspects of Route Options

Select Visual Aspects	A	B	C	D	T1	T2
Approximate length of route (m) through:						
Coastal flats	0	0	3900	8400	0	0
Undulating hills and ridges with limited areas of mature vegetation	4900	5600	5400	4500	500	500
Enclosed valleys	2500	2400	2200	2300	0	0
Undulating hills and ridges with extended areas of mature vegetation	8000	8800	2000	600	0	0
Escarpment	1600	300	3500	3800	1800	1600
Tunnel and approach cuttings	0	0	0	0	400	600

Table 8.32 continued

Select Visual Aspects	A	B	C	D	T1	T2
Approximate length of route (m) exposed to:						
Lower slopes and valleys	11400	11900	7200	6100	300	500
Exposed ridge lines with extensive vegetation cover	2700	2500	800	200	0	0
Coastal flats	0	0	3600	8100	0	0
Exposed ridge lines with limited vegetation cover	1600	2400	1900	1200	100	0
Escarpment	1400	400	3400	3800	1800	1600
Tunnel and approach cuttings	0	0	0	0	400	600

8.13 Noise Environment

8.13.1 Overview of Impacts

A Community Noise Burden (CNB) approach has been used to assess and compare the various route options. The CNB is a quantitative evaluation of the overall noise impact of each route option made by summing the noise impact at all of the individual residences over the length of the route option.

For this project, the *absolute* and *relative* noise burdens have been included in the Sieve 1 evaluation criteria as follows:

- Absolute CNB: This is a quantitative evaluation of potential annoyance caused by absolute traffic noise levels on residential receivers up to 300-500 m from a route option.
- Relative CNB: This is a quantitative evaluation of potential annoyance caused by *change* in noise levels at residential receivers up to 300-500m from a route option. (It should be noted that there is a correlation between this criterion and potential changes in property value. It can therefore be recognised as a proxy for potential property value change.)

The noise impact resulting from each of the proposed routes has been determined based on the product of the number of residences exposed to a specific noise level and a weighting based on the subjective annoyance factor of that noise level. For the Relative CNB, the noise impact is based on the product of the number of residences exposed to a change in noise level, and weighted based on the subjective annoyance factor of that change in noise level and the absolute level from which the change has occurred.

8.13.2 Characteristics of Route Option Sections

The results of the evaluation are provided in **Table 8.32**. The likely impact of the individual road sections is proportional to the value of the Community Noise Burden. Higher noise burdens represent a higher level of impact.

Table 8.33 Absolute and Relative CNB for Route Option Sections

Route Option Section	A/B	A1	B1	A2	B2	C/D	C1	D1	T1	T2
Absolute CNB	33	1576	834	263	303	349	475	229	344	384
Relative CNB	3	-288	-794	10	-4	-408	-722	-739	23	29

In general, at the south of the study area, routes joining the proposed Ballina Bypass interchange would necessarily include significant gradients that could result in noise from trucks engine braking or labouring up the inclines. Alternative routes further to the east would result in an alignment without any significant gradients, and could therefore result in less truck noise.

In the middle of the study area, western alignments are likely to affect many existing residents and traverse undulating terrain, while an eastern alignment would be predominately flat with no gradients, and impact fewer residences. Residences along the edge of the escarpment (e.g. Old Byron Bay Road) would have a raised viewpoint overlooking alignments on the eastern side of the study area. While they are unlikely to specifically require noise mitigation, their raised viewpoint would also make it difficult to screen noise from the road using noise barriers or earth bunds.

8.13.3 Features of Route Option Sections

Common Section A/B

The CNB values for the sections indicate that Section A/B has a relatively low impact, since it is not close to any existing residences. However, Section A/B does have some large gradients (5.9%) which is likely to result in 'peak' noise events from trucks using engine braking.

Section A1

Section A1 has a higher noise impact than Section B1, since it more closely follows the existing highway, which has many nearby residences. Noise mitigation using barriers is unlikely to be cost-effective in this area, since there are many widely spaced residences, so architectural treatments and low-noise pavements are more likely to be used to mitigate noise impacts.

Sections A2 and B2

Sections A2 and B2 both have a similar overall impact, although Section A2 more closely follows the existing highway.

Common Section C/D

Section C/D is likely to result in fewer 'peak' noise levels from trucks since it follows a relatively flat alignment through the Newrybar Swamp floodplain. Residences on the escarpment (e.g. Carney Place, Old Byron Bay Road) are likely to be exposed to noise from the Common Section C/D alignments, since many overlook the floodplain. Mitigation would also be difficult with noise barriers due to the elevated position of many of these residences, although the noise level is not likely to exceed EPA road traffic noise criteria.

Sections C1 and D1

For the eastern alignments, Sections C1 and D1 both perform well, since they impact fewer properties than the western sections. Option C1 has several long moderate grades (4.5%) which would result in 'peak' noise from trucks, compared with only short sections of moderate grade (4.5%) in D1. Option C1 is likely to result in noise impacts at properties along Old Byron Bay Road and Broken Head Road, while D1 would result in noise impacts at Piccadilly Hill Road and Coopers Shoot.

The eastern alignments (Sections C/D, C1 and D1) are closer to the coastal towns of Lennox Head, Broken Head and Suffolk Park than the existing highway, which could result in audible traffic noise in these areas which are not currently affected by high levels of highway traffic noise, although it would not be considered a significant impact and would be well below EPA road traffic noise criteria.

All of the sections (A2, B2, C1 and D1) would result in noise impacts at residences along Tinderbox Road.

Tunnel Sections

The tunnel approach Options T1 and T2 both have a similar noise burden, although tunnel approach Option T2 has a marginally higher absolute and relative CNB since the tunnel approach is marginally closer to Ewingsdale. Despite this, tunnel approach Option T2 would be expected to result in fewer

'peak' noise events from truck engine braking, since the gradient is lower (4.4%) than tunnel approach Option T1 (6.0%).

Residences on St Helena Hill Road are likely to experience a significant noise benefit due to the tunnel, although they would still be exposed to noise from traffic at the nearby tunnel approaches.

8.13.4 Summary of Route Options

Both the Absolute and Relative CNB have also been evaluated for each of the shortlisted routes as a whole (i.e. Option A, B, C and D). In each case the CNB has been normalised against the case of an upgraded highway on the existing alignment. The normalised Absolute and Relative CNBs are shown in **Figure 8.14** and **Figure 8.15**.

The analysis shows that the absolute and relative noise impacts of the shortlisted route options result in lower noise impacts than an upgraded route on the existing alignment. The eastern routes (C/D) perform better than the western routes (A/B).

Figure 8.14 Absolute Community Noise Burden, Short List of Route Options

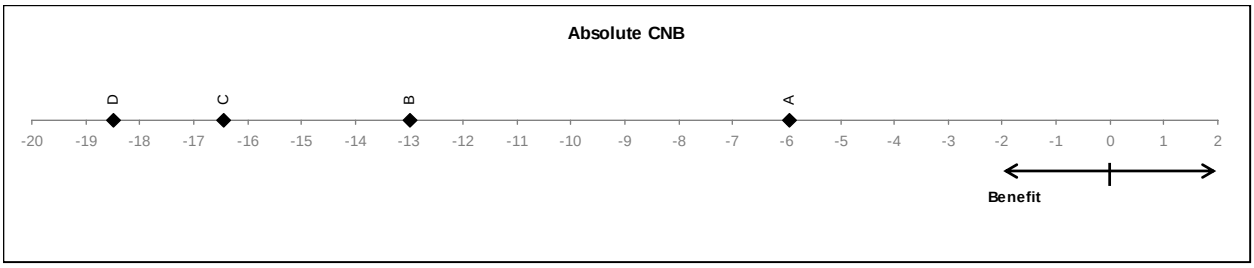
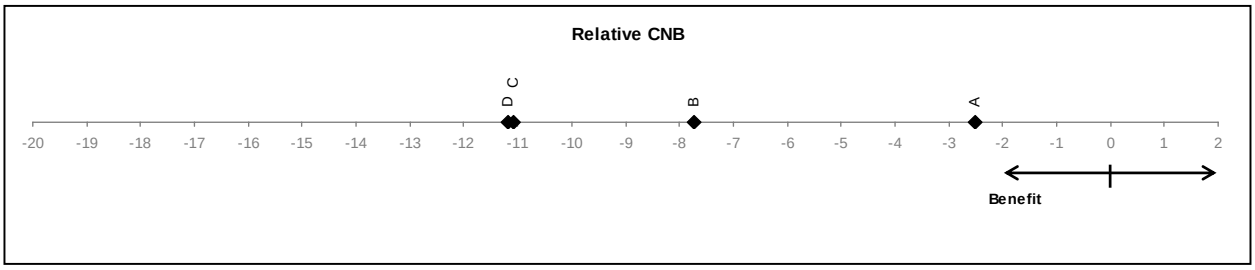


Figure 8.15 Relative Community Noise Burden, Short List of Route Options



8.14 Summary of Likely Impacts

A summary of likely impacts of the short list of route options is provided in **Table 8.34**. It is a compilation of data provided in the preceding sections. Additionally, the key design features of the short list of route options are listed in **Table 8.35**.

Table 8.34 Summary of Potential Impacts

	Route Options (Note 1) A	B	C	D
Engineering Characteristics				
Length (m)	19,792	20,152	19,721	22,049
Approximate length of tunnel (m)	200-300	200-300	200-300	200-300
Length of major bridges - highway (m)	660	880	559	0
Length of major bridges - local (m)	345	457	340	268
Length of grades exceeding 4.5% (m)	3,443	2,145	890	890
Comparative travel time for heavy vehicles (minutes)	14.9	14.8	15.1	15.0
Number of horizontal curves with radius less than minimum (750m)	1	1	0	0
Number of horizontal curves with radius less than desirable (750m-1200m)	6	4	1	1
Length (km) of route that utilises existing road reserve	9.9	4.9	2.2	2.2
Length (km) through potentially fog prone areas	7.1	5.9	10.1	14.6
Indicative Strategic Cost Estimate ($million)	400	410	400	385
Socio-Economic Characteristics				
Agriculture and Property				
Regionally Significant (DIPNR) Farmland affected (ha)	459	475	410	492
State Significant (DIPNR) Farmland affected (ha)	3	5	10	0
Agricultural land directly affected (ha)	380	428	403	484
Agricultural land indirectly affected (severance) (ha)	235	300	209	262
Number of dwellings acquired	73	34	25	20
Drinking Water Catchments - approximate length of route (m) through:				
Emigrant Creek Dam Catchment	4800	4000	1900	0
Proposed Lismore Water Source Catchment	7920	7670	6370	5970
Noise				
Absolute CNB (Note 2)	2216	1514	1168	922
Relative CNB (Note 3)	-252	-772	-1107	-1124
Visual				
Visual Sensitivity - approximate length of route (m) through:				
1. Coastal flats	0	0	3900	8400
2. Undulating hills and ridges with limited areas of mature vegetation	5400	6100	5900	5000
3. Enclosed valleys	2500	2400	2200	2300
4. Undulating hills and ridges with extended areas of mature vegetation	8000	8800	2000	600
5. Escarpment	3400	2100	5300	5600
6. Tunnel and approach cuttings	400	400	400	400
Visual Effect: approximate length of route (m) exposed to:				
1. Lower slopes and valleys on plateau	11700	12200	7500	6400
2. Exposed ridge lines with extensive vegetation cover	2700	2500	800	200
3. Coastal flats	0	0	3600	8100
4. Exposed ridge lines with limited vegetation cover	1700	2500	2000	1300
5. Escarpment	3200	2200	5200	5600
6. Tunnel and approach cuttings	400	400	400	400
Environmental Characteristics				
Terrestrial Ecology				
Number of patches of high value vegetation or habitat likely to be affected	16	20	25	25
Approximate area of high constraint vegetation crossed (ha)	16.5	18	23	17
Number of patches of medium value vegetation or habitat likely to be affected	6	6	4	7
Approximate area of medium constraint vegetation impacted (ha)	16	16.5	5.5	6.5
Number of 'edges' created through remnant and regenerated habitat areas	19	22	24	23
Number of times a regional wildlife corridor is crossed	1	1	1	1
Number of times a sub-regional wildlife a corridor is crossed	1	1	3	3
Number of recorded threatened species potentially affected	4	1	0	0
Aquatic Ecology				
Negligible or low constraint waterways crossed	27	37	51	51
Medium constraint waterways crossed	1	2	0	0
Hydrology				
Length through flood prone land (m)	870	870	5060	10230
Cultural Heritage				
Number of medium value non-Indigenous sites directly affected	1	0	0	0
Areas of potential archaeological deposits directly affected (ha)	0.4	3.7	3.6	2.8

Notes:

1. Potential impacts assessment based on tunnel Option T1 at the northern end.
2. Absolute Community Noise Burdon (CNB) is a quantitative evaluation of potential annoyance caused by absolute traffic noise levels on residential receivers up to 300-500 m from a route option. Larger numbers imply a greater potential noise impact.
3. Relative Community Noise Burdon (CNB) is a quantitative evaluation of potential annoyance caused by change in noise levels at residential receivers up to 300-500m from a route option. Larger numbers imply a greater potential noise impact, in this case -252 represents a greater noise impact than -1124.

Table 8.35 Key Design Features of the Short List of Route Options

Option	Key features
Option A	• Plateau option that incorporates a tunnel under St Helena Hill. • Alignment uses the Ballina Bypass, from Sandy Flat Road to Ross Lane. • This alignment most closely follows the existing Pacific Highway with almost 10 km of existing road reserves being utilised. • This alignment also uses the 9(a) zoning near Bangalow and the Bangalow Bypass. • This option requires the construction of more extensive local access roads and would have high impacts on service relocations and acquisition of buildings. • This option crosses four major creeks.
Option B	• Plateau option that incorporates a tunnel under St Helena Hill. • Alignment uses most of the Ballina Bypass, from Sandy Flat Road to Ross Lane. • This alignment partly utilises the 9(a) zoning near Bangalow. • This option uses about 5 km of existing road reserve. • This option is slightly west of the existing Pacific Highway in the south and then switches to be slightly east of the existing highway north of Newrybar. • This option crosses four major creeks.
Option C	• Coastal plain option that incorporates a tunnel under St Helena Hill. • This option stays close to the foothills of the escarpment and then gradually climbs the escarpment by traversing the side slope. • This option traverses an area of geological instability as it climbs the side slope of the escarpment. • The option crosses some flood prone land and areas. • This option has a high impact on state significant farmland and severance of currently contiguous settlements, including those along Broken Head Road and Old Byron Bay Road. • This option crosses four major creeks.
Option D	• Coastal plain option that incorporates a tunnel under St Helena Hill. • This option stays close to the foothills of the escarpment prior to moving further east and climbing the escarpment via a ridge line. • This alignments traverses through flood prone land and areas with potentially deep soft soils. • This option is a longer route and is also close to the community of Coopers Shoot. • This option crosses two major creeks.
Northern Tunnel Section	• A tunnel 200 to 300 m long under St Helena Hill. • Two tunnel approach options were considered for this section of road on the north side of the tunnel. Approach Option T1 follows the existing road and has grades of 6%. Approach Option T2 is located up to 100 m east of the existing highway and has grades of about 4.5%. • There are no material differences between the tunnels required for these options.

9 Project Cost

9.1 Scope of the Works

The scope of the works has been broken down into the major elements of the highway upgrade through to construction and handover. These are:

- Project development.
- Investigation and design.
- Property acquisition.
- Public utility adjustments (included in construction).
- Construction.
- Handover.

9.2 Strategic Cost Estimates

Strategic cost estimates have been prepared in accordance with the *RTA Project Management Guidelines for Estimating, Scope and Cost Control for Development Projects* (Version 3, RTA 2000). The estimates are based on typical construction contract rates and on quantities derived from the preliminary concept design of the route options.

Estimates have been prepared in the form of a base component plus a contingency component for each item. The base component represents the bare cost of the works as set out in the concept design for each option. The contingency component includes allowance for normal contingency (covering any inadequacies in the concept design layouts or estimating methods) and risk contingency (covering major unknowns). The contingency allowance varies from 25% up to 50%, averaging about 40% overall. The contingency allowances have been set in consultation with RTA based on the risks identified in the risk management study and experience from previous projects.

Key contingency items include:

- Property acquisition contingency factor - 50 per cent.
- Noise mitigation contingency factor - 50 per cent.
- Earthworks contingency factor - 35 per cent.
- Drainage contingency factor - 50 per cent.
- Pavements contingency factor - 25 per cent.
- Bridges contingency factor - 35 per cent.
- Utilities adjustments contingency factor - 50 per cent.

Based on the shortlisted options described in Chapter 8, the indicative total cost of the project on completion has been estimated in the range $370 million to $440 million depending on the route chosen and the results of the design refinement process. These figures are based on January 2005 dollar costs. The estimate of total project cost includes all costs associated with the design, construction and handover of the project.

Strategic cost estimates have been prepared for each of the shortlisted route options A to D combined with tunnel approach Option T1 and again for each shortlisted route options A to D combined with tunnel approach Option T2.

The indicative cost estimates for each option are summarised in **Table 9.1**. The costs have been prepared for comparative purposes only and would be subject to change during design refinement.

The results indicate that there are no major cost differences between the short listed options. Option D would be slightly cheaper despite the extra length, a result of the lower volume of earthworks and fewer bridge structures. Tunnel approach Option T2 would be a little more expensive than T1 due to the need to reconstruct a greater length of the existing highway and also because the tunnel would be slightly lower and longer.

Table 9.1 Comparative Costs of Short List of Route Options

Short List Option	Length (km)	Indicative Cost
With Tunnel Approach Option T1		
A-T1	19,792	$400 million
B-T1	20,152	$410 million
C-T1	19,721	$400 million
D-T1	22,049	$385 million
With Tunnel Approach Option T2		
A-T2	19,785	$410 million
B-T2	20,145	$420 million
C-T2	19,714	$410 million
D-T2	22,042	$395 million

10 Next Steps

The project is being developed in a way that is both ecologically sustainable and achieves the best overall outcome for the whole community. The RTA recognises the importance of addressing social, ecological, engineering and cost factors while continuing to provide for future transport needs. Most importantly, dual carriageway roads and fewer highway connections will result in a safer road environment.

A preferred route has not been selected at this stage.

A preferred route will be selected by considering:

- The community's issues and comments on the route options.
- Information on the physical impact of each of these routes, in relation to economic, urban design, ecological, engineering and community issues.
- A value management process which will include a workshop. This workshop will be held with participants from the community, government and technical areas. The workshop will assess the performance of each of the route options against a range of agreed criteria.

Four route options have been identified for further consideration and assessment. Community response to these options is an important part of selecting a preferred route. The route options will be on display for approximately four weeks.

As the route options can be linked together in different ways, there are decisions to be made about a preferred route. The community is being invited to consider each of the options and combinations and provide comments on the reply paid feedback form included with the community update (the feedback form is also available on-line). Community feedback will be integrated into the value management workshop.

Investigation of the four shortlisted route options will continue in preparation for the value management process.

A value management workshop will be held to consider the full range of issues and constraints to locating a highway route. Following refinement of the preferred route, the concept design and environmental assessment phases would commence.

Community involvement will continue. A community liaison group, updates in the local media, newsletters, meetings with individuals and groups, and a project website will continue to keep the community informed and assist community input.

Abbreviations

Abbreviation	Definition
AADT	Annual Average Daily Traffic
AADV	Annual Average Daily Vehicles
AEP	Annual Exceedance Probabilities
AFG	Agricultural Focus Group
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment Conservation Council
ASS	Acid Sulfate Soils
BCR	Benefit Cost Ratio
CCD	Census Collection District
CLG	Community Liaison Group
CNB	Community Noise Burden
CO	Carbon Monoxide
CoRTN	Calculation of Road Traffic Noise
dB	Decibel
DCP	Development Control Plan
DEC	NSW Department of Environment and Conservation (formerly NSW EPA and NSW National Parks & Wildlife Service)
DIPNR	Department of Infrastructure, Planning and Natural Resources (now Department of Planning and Department of Natural Resources)
DoP	NSW Department of Planning (formerly part of DIPNR)
DPI	Department of Primary Industries (formerly NSW Fisheries, State Forests NSW and NSW Agriculture)
DoNR	NSW Department of Natural Resources (formerly part of DIPNR)
DTM	Digital Terrain Modelling
ECRTN	*Environmental Criteria for Road Traffic Noise* (DEC)
EIS	Environmental Impact Statement
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPA	NSW Environment Protection Authority (now NSW DEC)
EPBC Act	Commonwealth *Environment Protection Biodiversity Conservation Act 1999*
ESD	Ecologically Sustainable Development
km	Kilometre
LEP	Local Environment Plan
LALC	Local Aboriginal Land Council
LGA	Local Government Area
m	Metre

Abbreviation	Definition
MVK	Million Vehicle Kilometres Travelled
NAASRA	National Association of Australian State Road Authorities (now AUSTROADS)
NCREP	*North Coast Regional Environmental Plan 1988* (NSW DIPNR 1988)
NO_x	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NRRDB	Northern Rivers Regional Development Board
PAD	Potential Archaeological Deposit
PAH	Poly-Aromatic Hydrocarbon
PHUP	*Upgrading the Pacific Highway: Ten Year Pacific Highway Reconstruction Program* (RTA 1997)
PM_{10}	Particulate Matter (smaller than 10 micrometers in diameter)
$PM_{2.5}$	Particulate Matter (smaller than 2.5 micrometers in diameter)
ppm	Parts per Million
REP	Regional Environmental Plan
RDG	Road Design Guidelines
RODR	Route Options Development Report
RTA	NSW Roads and Traffic Authority
SEPP	NSW State Environmental Planning Policy
T2E	Tintenbar to Ewingsdale Pacific Highway Upgrade Project
TSC Act	NSW *Threatened Species Conservation Act 1995*
VMW	Value Management Workshop

Glossary of Terms

Term	Definition
1 in 100 year flood	Refers to the flood which occurs, on average, once every 100 years. Also known as the 100 year Average Recurrence Interval of a flood. These events are of a random nature. It is possible for there to be two 100 year floods in successive years; similarly the 100 year flood may not occur for 200 years and the 100 year flood may not be the largest flood in the last 100 years.
Aboriginal Heritage Information Management System	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.
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.
B-Double vehicle	Heavy transport vehicles that are 17.5 m to 36.5 m long, and have six or more axles in four groups. They are classified as Class 10 under the AUSTROADS vehicle classification system.
Barrier	An obstruction placed to prevent vehicle access to a particular area. This includes structures whose prime purpose is to restrain and/or redirect in a controlled manner vehicles which are out of control.
Batter	The side slope of walls, embankments and cuttings or the degree of such slope.
Benefit Cost Ratio (BCR)	The ratio of the present value of benefits to the present value of costs of a project.
Biological Diversity (Biodiversity)	The range and relative abundance of plant and animal life in a nominated area.
Biota	Animal and plant life characterising a particular region or flora and fauna collectively.

Term	Definition
Blackspot	An intersection, mid-block or short road section with a history of at least three casualty crashes over a five year period.
Buffer	Something that lessens or absorbs an impact.
Bund	A wall preventing the escape of liquids into the environment.
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.
Climbing Lanes	An auxiliary lane, usually on a long upgrade, primarily for the use of slow-moving vehicles. They differ from overtaking lanes in that the linemarking does not initially direct all traffic to the left hand side of the road.
Census Collection District (CD)	The areas designed for use in census years for the collection and dissemination of Population Census data
Community Noise Burden (CNB)	A measure of the potential annoyance caused by traffic noise levels on residential receivers.
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/.
dB(A)	Decibels using the 'A' weighted scale, measured according to the frequency of the human ear.
Demographic	Of or pertaining to population, especially in statistical terms.
Design speed	A nominal speed used for the design of geometric features of the road, such as curves.
Digital Terrain Modelling (DTM)	A three-dimensional model of the ground surface.
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.
Ephemeral	Watercourse which flows after heavy rain, and dries up during fine weather.
Evaluation Criteria	A system used to evaluate the route options. Sieve 1 criteria would be used to evaluate the long-list of options. Sieve 2 criteria would be used to evaluate the short-list of options.

Term	Definition
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).
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.
Hydraulic	Related to water and the flows and pressures within a connected water-containing system.
Hydrologic	Dealing with the properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rocks and in the atmosphere
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.
Land Use Zoning	This relates to the land use zoning identified in the Local Environment Plans (LEPs) - for this project, the Byron Shire LEP and Ballina Shire LEP. An example is Zoning 9(a) – Proposed road reserve zone.
Littoral	The shallow, shoreward region of a body of water sometimes inhabited by aquatic plants.
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.
National Highway	A highway that has been declared a National Highway by the Federal Government.
Noise Wall	A wall or barrier (noise barrier) erected to block or deflect noise.
Option B – Bangalow to St Helena	The proposed route that is the subject of the 1999 Bangalow to St Helena EIS, as modified.
Oxidation	The chemical process of oxygen combining with an element or compound (e.g. the oxidation of iron to form rust).
Pairwise	A tool used to assess the sensitivity 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.
PM_{10}	Usually airborne particulate matter less than 10μm (microns or one millionth of a metre) in diameter, a measure of dust.

Term	Definition
$PM_{2.5}$	Usually airborne particulate matter less than 2.5μm (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.
Road Corridor/Reservation	The strip of land along which a road is to be constructed.
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.
Shotcrete	Mortar or concrete sprayed using compressed air onto a disturbed surface to stabilise against erosion.
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.
State Highway	A main road that is a principal avenue of road communication between the east coast and the interior or otherwise within the State and connecting similar roads in other States.
Quaternary	The geologic time period comprising about the last 1.65 million years.
Terrestrial	Living or growing on land; not aquatic.
Tributaries	Rivers or streams flowing into a larger river or lake.
Verge	Strip adjacent to and abutting the hard shoulder of a carriageway of a road - usually grassed.
Vertical Alignment	The geometric form of the centreline of a carriageway in the vertical plane.
Viaduct	A long bridge, generally composed of a series of spans over land, which carries a road or railway.
Wetland	Land either permanently or temporarily covered by water. These areas are usually characterised by vegetation of a moist-soil or aquatic type.

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Appendix A

Sieve 1 Evaluation Criteria

CATEGORY		SIEVE 1 EVALUATION CRITERIA	EXPLANATION
Safety and Accidents	1	Qualitative comparison of likely crash rates for each option.	This criterion is based on the ability to meet the overall Pacific Highway objective of a maximum of 15 accidents per 100 MVK.
	2	Local traffic use of highway.	This criterion is measured as the estimated percentage of local trips using the Highway. Reduced use of highway by local traffic is desirable. Local traffic is defined as trips having an origin and destination within the newly defined study area. The higher performing options will have a lower local traffic use.
	3	Length (km) of highway between minimum and desirable design criteria.	The higher performing options will have a higher length (km) of route between the minimum and desirable design criteria.
	4	Length (km) of route through potentially fog prone areas.	This criterion will be qualitative and based on available information.
Travel Time and Transport Costs	5	Estimated travel time savings (minimum) compared with existing highway alignment in the study area.	This criterion is a measure of the highway travel time (minutes) savings for all vehicles based on a design speed of 110 km/h. The higher performing options will have a higher travel time saving.
Social and Health	6	Extent (percentage of grade) and length (km) of steep grades (i.e. in excess of 4.5%).	It should be noted that there is a correlation between this criterion and the occurrence of peak (Lmax) noise levels due to truck noise compression braking associated with steeper grades. In theory, this may also contribute to an increase in sleep disturbance. It should also be noted that the absolute maximum grade is 6%. The higher performing options will have a shorter overall length of steep grades.
	7	Number of dwellings to be acquired i.e. those located within the proposed route corridor.	For the purposes of the Sieve 1 evaluation, the route corridor is 250m. This is a worst-case scenario as the road reserve will vary throughout the length of proposed route options depending on the ground conditions. The higher performing options will have a lower number of dwellings to be acquired. This correlates to less social disruption.
	8	Number of dwellings to be acquired i.e. those located within the proposed route corridor that are not currently within 200 m (either side) of the existing highway alignment.	This criterion distinguishes between the dwellings that are already located within the vicinity of the highway and those that are not. The higher performing options will have a lower number of dwellings affected. This correlates to less social disruption.
	9	Area (ha) of private land (business and residential) to be acquired, i.e. land located within the proposed route corridor.	The higher performing options will have a lower area (ha) to be acquired.
	10	Area (ha) of private land (business and residential) to be acquired, i.e. land located within the proposed route corridor that is not currently within 200m (either side) of the existing highway alignment.	This criterion distinguishes between the areas of private land that are already located within the vicinity of the highway and those that are not. The higher performing options will have a lower area (ha) to be acquired.

CATEGORY		SIEVE 1 EVALUATION CRITERIA	EXPLANATION
	11	Number of currently contiguous settlement areas severed.	This is quantified as the number of times the route severs a recognised settlement. A contiguous settlement area is defined as a group of three contiguous houses or more. The higher performing options will have a lower number of settlements severed.
	12	Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEPs and/or relevant Shire strategies.)	This measure will provide an indication of severance by the route corridor. It is quantified as the area (ha) of future residential development land required for each option. In terms of extent, the severance impact is measured as a percentage of the area affected. Where required, a qualitative comment will be made on the level of impact. This will be based on available information at this stage. This is mapped as a 'high' constraint in the land use constraints mapping.
	13	Number and extent of severance impacts on individual residential properties.	This measure will provide an indication of severance by the route corridor. A property is severed when the route corridor divides a property into more than one land parcel. It is quantified as the number of individual properties severed. The extent of the severance impact is measured as a percentage of the property impacted (i.e. percentage of smallest land parcel remaining if the road severs the property.) The severance will be calculated on a case by case basis and equated to a level of impact. Where required, a qualitative comment will be made. This evaluation will be based on available information such as access and where dwellings are located within the property.
		Visual and Landscape	
	14	Number of dwellings within 1km of the highway route option.	The Sieve 1 evaluation limits the distance considered to 1km. Houses and their immediate surrounds that are located within 1km of the route have a high potential to be visually exposed to and therefore most highly impacted (visually) by the proposed highway route option. The higher performing options will have a lower number of residential properties within 1km. The Sieve 2 criteria used for comparison of the short-listed options is likely to include number of dwellings that will have the potential for views of the highway, taking account of topography. It should be noted that there is a correlation between this criterion and potential changes in property value. It can therefore be recognised as a proxy for potential property value change.

CATEGORY		SIEVE 1 EVALUATION CRITERIA	EXPLANATION
	15	Length (km) of route with visual benefit to the driver/passengers.	Certain parts of the study area are potentially more interesting than others from a driver/passenger perspective. This criterion will compare the driving experience for each of the options. Elevated routes with views of the ocean and coastal hinterland, and routes through areas with a variable landscape character will enhance the driver's experience. The higher performing options will have a longer length (km).
	16	Length (km) of route located on the coastal flats.	On the coastal flats, long sections of the highway are likely to be more visible than on the elevated plateau, where shorter sections of the highway are likely to be visible due to the undulating landform. The higher performing options will have a shorter length (km).
	17	Length (km) of route through scenic escarpment.	The 'scenic escarpment' used in the evaluation is that which is defined in the Local Environmental Plans and the wider context of the escarpment i.e. the area of escarpment that links the Ballina Shire 7(d1) scenic/escarpment zone and the Byron Shire 7D scenic/escarpment zone, accounting for topography. The higher performing options will have a shorter length (km).
	18	Length (km) of route through exposed ridges and hills.	There is potentially a greater issue in terms of visual interpretation if the highway runs along the ridges and hills. This is associated with the scale of infrastructure including 'cuttings' into the hillside and embankments etc. 'Exposed' is being defined as areas that are more likely to be seen from a wider range of viewpoints. The higher performing options will have a shorter length (km).
		Noise	
	19	Absolute Community Noise Burden.	This is a quantitative evaluation of potential annoyance caused by absolute traffic noise levels on residential receivers within 300-500m of the route option.
	20	Relative Community Noise Burden.	This is a quantitative evaluation of potential annoyance caused by change in noise levels at residential receivers within 300-500m of the route option. The modeling takes into account all natural terrain features. A 3-d model is used and calculations are made at individual residences. It should be noted that there is a correlation between this criterion and potential changes in property value. It can therefore be recognised as a proxy for potential property value change.
	21	Impacts on community facilities.	Community facilities includes schools, places of worship as well as access issues for pedestrian and cyclists. The higher performing options will impact on less community facilities.
	22	Length (km) of route that utilises existing road reserve (not as a service road).	The higher performing options will have a longer length (km).

CATEGORY		SIEVE 1 EVALUATION CRITERIA	EXPLANATION
Local Economic	23	Number of existing farm businesses and other businesses to be acquired i.e. those located within the proposed route corridor.	For the purposes of the Sieve 1 evaluation, the route corridor is 250m. The higher performing options will have a lower number of businesses affected. This indicates less economic disruption within the study area.
	24	Severance impact of businesses by type (% impacted).	This measure will provide an indication of severance by the route corridor. It incorporates total number of businesses severed including the business type. The extent of the severance impact is measured as a % of the business (land area) impacted. (i.e. % of smallest land parcel remaining if road severs the business) The severance will be calculated on a case by case basis and equated to a level of impact and where required, a qualitative comment will be made. This evaluation will be based on available information such as land use type, access and location of properties.
	25	Total loss of agricultural land based on land use type (measured as an area (ha)).	For a given land use, the less affected area will indicate less potential impact on that agricultural output type. The output area can also be presented as a % of the total land use type within the study area for each feasible route option.
	26	Area (ha) of state significant land impacted.	For this criterion, state significant land is that which has been identified from the 'Farmland Protection Project' mapping produced by DIPNR. In line with the land use constraints classification, the state significant land will be marked as a high constraint and the regionally significant land which makes up the majority of the study area will be marked as medium to high. The higher performing options will have a lower area (ha) of state significant land impacted.
Environment and Cultural Heritage	27	Number and area (ha) of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	This criterion accounts for potential affects to flora and fauna including threatened species and territorial animals. Where riparian flora and fauna has been mapped, this will also be included. The higher performing options will have a lower number and area (ha) impacted.
	28	Number of 'edges' created through remnant and regenerated habitat areas.	'Edges' and not 'area' is used as the criterion because of the significance of creating more edges in remnant or regenerated habitat areas. The more 'edges', the more degradation of the habitat. The higher performing options will have a lower number of 'edges' created.
	29	Number of times a wildlife corridor is crossed.	The higher performing options will have a lower number.
	30	Number of high and medium value sites of cultural heritage significance directly affected.	The cultural heritage evaluation includes indigenous and non-indigenous sites. The higher performing options will have a lower number and indicate lesser disturbance of cultural heritage sites.

CATEGORY		SIEVE 1 EVALUATION CRITERIA	EXPLANATION
	31	Area (ha) of high and medium potential for archaeological deposits directly affected.	The higher performing options will have a lower area (ha) affected.
	32	Number and value of waterways directly impacted.	The waterways have been assigned medium and low values accounting for: fish habitat, fish passage, threatened and protected species, sensitive and protected habitat, water quality and watercourse crossings. The higher performing options will have a lower number.
	33	Number of springs directly impacted.	The higher performing options will have a lower number.
	34	Number of contaminated sites directly impacted.	The higher performing options will have a lower number.
Engineering and Cost	35	Length (km) of route.	The higher performing options will have a shorter length (km).
	36	Relative costs of options.	Route option costs will represent the likely total project cost for each option, including allowances for design, project development costs incurred by RTA, land acquisition, mitigation measures etc. The prices for all options will include the cost of providing necessary upgrades to the local traffic network, if appropriate. The higher performing options will have a lower cost.
	37	Length (km) of route through areas of geological risk.	This criterion will account for the length of route through areas of (i) geological risk, (ii) areas of acid sulphate soils and (iii) areas of soft soils. The higher performing options will have a shorter length (km).
	38	Buildability.	This criterion will be assessed qualitatively. It includes aspects of construction techniques including traffic management, movement of construction materials through the study area, noise, dust, environmental management strategies, geological considerations and construction program.
	39	Length (km) of highway within flood prone land.	The 'flood prone land' mapped for this criterion has been prepared using information from a number of sources including the councils (Byron Shire, Ballina Shire and Richmond River County) and the DIPNR floodplain mapping. The higher performing options will have a shorter length (km).

Appendix B

Long List Evaluation

Assessment Process for Long List of Routes in the Tintenbar Zone with Base Case (Project Team) Pairwise Results

Sieve 1 Evaluation Criteria	Pairwise Rating (%)	1 C1 B1 A1 UW	1 C1 B1 A1 W	2 C1 B1 B2 UW	2 C1 B1 B2 W	3 C1 B1 I1 UW	3 C1 B1 I1 W	4 C1 B1 L1 UW	4 C1 B1 L1 W	5 C1 C2 UW	5 C1 C2 W	6 D1 D2 UW	6 D1 D2 W	7 D1 H1 UW	7 D1 H1 W	8 E1 E2 UW	8 E1 E2 W	9 E1 F1 UW	9 E1 F1 W
Safety and Accidents																			
1. Qualitative comparison of likely crash rates for each option	4.9%	4	0.20	4	0.20	4	0.20	4	0.20	4	0.20	5	0.25	5	0.25	5	0.25	5	0.25
2. Local traffic use of highway	2.0%	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10
3. Compliance to Desirable Geometrical Design Standards for Safety	3.1%	1	0.03	4	0.12	4	0.12	3	0.09	4	0.12	5	0.15	5	0.15	5	0.15	5	0.15
4. Length (km) through potentially fog prone areas.	0.3%	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	1	0.00	1	0.00	1	0.00	1	0.00
Travel Time and Transport Costs																			
5. Estimated travel time savings compared with existing Pacific Highway alignment in the study area.	1.2%	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	5	0.06	5	0.06	5	0.06	5	0.06
Social and Health																			
6. Extent and length of steep grades (ie in excess of 4.5%)	2.3%	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	5	0.11	5	0.11	5	0.11	5	0.11
7. Number of dwellings to be aquired located within the proposed road reserve	4.1%	4	0.16	3	0.12	2	0.08	1	0.04	4	0.16	5	0.20	5	0.20	5	0.20	5	0.20
8. Number of dwellings to be acquired located within the proposed road reserve that are not currently within 200m (either side) of the existing alignment.	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14
9. Area (ha) of private land (business & residential) to be acquired.	3.2%	3	0.10	3	0.10	3	0.10	3	0.10	3	0.10	2	0.06	2	0.06	1	0.03	1	0.03
10. Area (ha) of private land (business and residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	2.1%	3	0.06	3	0.06	5	0.11	5	0.11	4	0.09	2	0.04	2	0.04	1	0.02	1	0.02
11. Number of currently contiguous settlement areas severed.	4.1%	2	0.08	2	0.08	2	0.08	5	0.21	2	0.08	2	0.08	2	0.08	1	0.04	1	0.04
12. Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEP's and/or relevant Shire strategies.)	1.0%	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	1	0.01	1	0.01	3	0.03	3	0.03
13. Number and extent of severance impacts on individual residential properties.	3.4%	5	0.17	5	0.17	4	0.14	3	0.10	5	0.17	5	0.17	4	0.14	4	0.14	3	0.10
14. Visual and Landscape - Number of residential properties within 1km of the Highway route option.	1.8%	1	0.02	1	0.02	1	0.02	1	0.02	2	0.04	4	0.07	3	0.05	5	0.09	4	0.07
15. Length (km) of route with visual benefit to the driver.	1.2%	5	0.06	5	0.06	3	0.04	2	0.02	5	0.06	1	0.01	2	0.02	1	0.01	2	0.02
16. Length (km) of route located on the coastal flats.	1.3%	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	1	0.01	2	0.03	1	0.01	1	0.01
17. Length (km) of route through scenic escarpment.	3.0%	1	0.03	1	0.03	1	0.03	1	0.03	4	0.12	5	0.15	5	0.15	5	0.15	5	0.15
18. Length of route through exposed ridges and hills.	2.6%	2	0.05	3	0.08	2	0.05	1	0.03	2	0.05	5	0.13	5	0.13	5	0.13	5	0.13
19. Noise - Absolute Community Noise Burden	3.7%	4	0.15	3	0.11	1	0.04	1	0.04	4	0.15	5	0.18	4	0.15	5	0.18	4	0.15
20. Noise - Relative Community Noise Burden	3.5%	4	0.14	4	0.14	2	0.07	1	0.03	4	0.14	5	0.17	5	0.17	5	0.17	5	0.17
21. Impacts on community facilities.	2.4%	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12
22. Length (km) of route that utilises existing road reserve (not as a service road)	1.5%	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	2	0.03	2	0.03	2	0.03	2	0.03
Local Economic																			
23. Number of existing farm businesses and other businesses directly affected.	3.7%	3	0.11	3	0.11	1	0.04	1	0.04	3	0.11	4	0.15	4	0.15	5	0.19	3	0.11
24. Severance impact of businesses by type (% impacted).	3.0%	1	0.03	1	0.03	1	0.03	1	0.03	2	0.06	3	0.09	3	0.09	5	0.15	4	0.12
25. Total loss of agricultural land based on land use type (Area ha).	3.2%	4	0.13	4	0.13	4	0.13	5	0.16	3	0.10	1	0.03	2	0.06	2	0.06	1	0.03
26. Area (ha) of state significant land impacted.	2.5%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
Environment & Cultural Heritage																			
27. Number and area of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	4.0%	4	0.16	4	0.16	3	0.12	3	0.12	4	0.16	3	0.12	4	0.16	2	0.08	2	0.08
28. Number of 'edges' created through remnant and regenerated habitat areas.	2.9%	3	0.09	3	0.09	3	0.09	2	0.06	3	0.09	4	0.11	4	0.11	2	0.06	3	0.09
29. Number of times a wildlife corridor is crossed.	2.5%	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03
30. Number of high and medium value sites of cultural heritage significance directly affected.	3.5%	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18
31. Areas of high and medium potential for archaeological deposits directly affected.	2.4%	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	1	0.02	5	0.12	1	0.02	2	0.05
32. Number and value of waterways directly impacted	2.4%	3	0.07	3	0.07	4	0.09	5	0.12	3	0.07	5	0.12	5	0.12	5	0.12	5	0.12
33. Number of springs directly impacted.	2.3%	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	5	0.11	5	0.11	5	0.11	5	0.11
34. Number of contaminated sites directly impacted.	1.3%	5	0.07	5	0.07	5	0.07	4	0.05	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07
Engineering and Cost																			
35. Length (m)	0.8%	5	0.04	5	0.04	5	0.04	5	0.04	5	0.04	4	0.03	5	0.04	3	0.02	3	0.02
36. Relative costs of options.	3.2%	5	0.16	5	0.16	3	0.09	4	0.13	5	0.16	4	0.13	5	0.16	1	0.03	1	0.03
37. Length of route through areas of geological risk.	2.6%	4	0.11	4	0.11	4	0.11	4	0.11	5	0.13	2	0.05	4	0.11	2	0.05	3	0.08
38. Buildability	2.8%	3	0.08	3	0.08	3	0.08	3	0.08	4	0.11	3	0.08	4	0.11	3	0.08	3	0.08
39. Length of highway within flood prone land.	1.3%	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	3	0.04	3	0.04	3	0.04	3	0.04
Weighted Scores																			
Sum total			**3.60**		**3.64**		**3.26**		**3.25**		**3.87**		**3.77**		**3.99**		**3.61**		**3.47**
Ranking of Weighted Scores			**6**		**4**		**8**		**9**		**2**		**3**		**1**		**5**		**7**
Unweighted Scores																			
Sum Total		146.0		148.0		137.0		135.0		156.0		139.0		149.0		135.0		132.0	
Rank of Unweighted Scores		**4**		**3**		**6**		**7**		**1**		**5**		**2**		**7**		**9**	

Assessment Process for Long List of Routes in the Tintenbar Zone with Sensitivity Test (CLG) Pairwise Results

Sieve 1 Evaluation Criteria	Pairwise Rating (%)	1 C1 B1 A1 UW	1 C1 B1 A1 W	2 C1 B1 B2 UW	2 C1 B1 B2 W	3 C1 B1 I1 UW	3 C1 B1 I1 W	4 C1 B1 L1 UW	4 C1 B1 L1 W	5 C1 C2 UW	5 C1 C2 W	6 D1 D2 UW	6 D1 D2 W	7 D1 H1 UW	7 D1 H1 W	8 E1 E2 UW	8 E1 E2 W	9 E1 F1 UW	9 E1 F1 W
Safety and Accidents																			
1. Qualitative comparison of likely crash rates for each option	2.7%	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	5	0.13	5	0.13	5	0.13	5	0.13
2. Local traffic use of highway	1.6%	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08
3. Compliance to Desirable Geometrical Design Standards for Safety	1.5%	1	0.01	4	0.06	4	0.06	3	0.04	4	0.06	5	0.07	5	0.07	5	0.07	5	0.07
4. Length (km) through potentially fog prone areas.	2.3%	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	1	0.02	1	0.02	1	0.02	1	0.02
Travel Time and Transport Costs																			
5. Estimated travel time savings compared with existing Pacific Highway alignment in the study area.	1.0%	4	0.04	4	0.04	4	0.04	4	0.04	4	0.04	5	0.05	5	0.05	5	0.05	5	0.05
Social and Health																			
6. Extent and length of steep grades (ie in excess of 4.5%)	2.0%	4	0.08	4	0.08	4	0.08	4	0.08	4	0.08	5	0.10	5	0.10	5	0.10	5	0.10
7. Number of dwellings to be aquired located within the proposed road reserve	1.4%	4	0.06	3	0.04	2	0.03	1	0.01	4	0.06	5	0.07	5	0.07	5	0.07	5	0.07
8. Number of dwellings to be acquired located within the proposed road reserve that are not currently within 200m (either side) of the existing alignment.	2.1%	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10
9. Area (ha) of private land (business & residential) to be acquired.	1.6%	3	0.05	3	0.05	3	0.05	3	0.05	3	0.05	2	0.03	2	0.03	1	0.02	1	0.02
10. Area (ha) of private land (business and residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	2.2%	3	0.07	3	0.07	5	0.11	5	0.11	4	0.09	2	0.04	2	0.04	1	0.02	1	0.02
11. Number of currently contiguous settlement areas severed.	2.7%	2	0.05	2	0.05	2	0.05	5	0.13	2	0.05	2	0.05	2	0.05	1	0.03	1	0.03
12. Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEP's and/or relevant Shire strategies.)	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	1	0.03	1	0.03	3	0.09	3	0.09
13. Number and extent of severance impacts on individual residential properties.	1.9%	5	0.10	5	0.10	4	0.08	3	0.06	5	0.10	5	0.10	4	0.08	4	0.08	3	0.06
14. Visual and Landscape - Number of residential properties within 1km of the Highway route option.	1.6%	1	0.02	1	0.02	1	0.02	1	0.02	2	0.03	4	0.07	3	0.05	5	0.08	4	0.07
15. Length (km) of route with visual benefit to the driver.	1.6%	5	0.08	5	0.08	3	0.05	2	0.03	5	0.08	1	0.02	2	0.03	1	0.02	2	0.03
16. Length (km) of route located on the coastal flats.	3.7%	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	1	0.04	2	0.07	1	0.04	1	0.04
17. Length (km) of route through scenic escarpment.	2.7%	1	0.03	1	0.03	1	0.03	1	0.03	4	0.11	5	0.14	5	0.14	5	0.14	5	0.14
18. Length of route through exposed ridges and hills.	1.3%	2	0.03	3	0.04	2	0.03	1	0.01	2	0.03	5	0.07	5	0.07	5	0.07	5	0.07
19. Noise - Absolute Community Noise Burden	1.5%	4	0.06	3	0.05	1	0.02	1	0.02	4	0.06	5	0.08	4	0.06	5	0.08	4	0.06
20. Noise - Relative Community Noise Burden	2.4%	4	0.10	4	0.10	2	0.05	1	0.02	4	0.10	5	0.12	5	0.12	5	0.12	5	0.12
21. Impacts on community facilities.	1.6%	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08
22. Length (km) of route that utilises existing road reserve (not as a service road)	3.6%	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	2	0.07	2	0.07	2	0.07	2	0.07
Local Economic																			
23. Number of existing farm businesses and other businesses directly affected.	2.6%	3	0.08	3	0.08	1	0.03	1	0.03	3	0.08	4	0.10	4	0.10	5	0.13	3	0.08
24. Severance impact of businesses by type (% impacted).	2.1%	1	0.02	1	0.02	1	0.02	1	0.02	2	0.04	3	0.06	3	0.06	5	0.10	4	0.08
25. Total loss of agricultural land based on land use type (Area ha).	3.4%	4	0.14	4	0.14	4	0.14	5	0.17	3	0.10	1	0.03	2	0.07	2	0.07	1	0.03
26. Area (ha) of state significant land impacted.	3.4%	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17
Environment & Cultural Heritage																			
27. Number and area of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	3.8%	4	0.15	4	0.15	3	0.11	3	0.11	4	0.15	3	0.11	4	0.15	2	0.08	2	0.08
28. Number of 'edges' created through remnant and regenerated habitat areas.	3.3%	3	0.10	3	0.10	3	0.10	2	0.07	3	0.10	4	0.13	4	0.13	2	0.07	3	0.10
29. Number of times a wildlife corridor is crossed.	3.6%	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04
30. Number of high and medium value sites of cultural heritage significance directly affected.	2.9%	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15
31. Areas of high and medium potential for archaeological deposits directly affected.	3.0%	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	1	0.03	5	0.15	1	0.03	2	0.06
32. Number and value of waterways directly impacted	2.8%	3	0.09	3	0.09	4	0.11	5	0.14	3	0.09	5	0.14	5	0.14	5	0.14	5	0.14
33. Number of springs directly impacted.	3.6%	4	0.14	4	0.14	4	0.14	4	0.14	4	0.14	5	0.18	5	0.18	5	0.18	5	0.18
34. Number of contaminated sites directly impacted.	2.5%	5	0.12	5	0.12	5	0.12	4	0.10	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12
Engineering and Cost																			
35. Length (m)	2.6%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	4	0.11	5	0.13	3	0.08	3	0.08
36. Relative costs of options.	3.2%	5	0.16	5	0.16	3	0.10	4	0.13	5	0.16	4	0.13	5	0.16	1	0.03	1	0.03
37. Length of route through areas of geological risk.	3.8%	4	0.15	4	0.15	4	0.15	4	0.15	5	0.19	2	0.08	4	0.15	2	0.08	3	0.12
38. Buildability	3.3%	3	0.10	3	0.10	3	0.10	3	0.10	4	0.13	3	0.10	4	0.13	3	0.10	3	0.10
39. Length of highway within flood prone land.	4.1%	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	3	0.12	3	0.12	3	0.12	3	0.12
Weighted Scores																			
Sum total			**3.82**		**3.85**		**3.61**		**3.63**		**4.05**		**3.36**		**3.72**		**3.23**		**3.19**
Ranking of Weighted Scores			**3**		**2**		**6**		**5**		**1**		**7**		**4**		**8**		**9**
Unweighted Scores																			
Sum Total		146.0		148.0		137.0		135.0		156.0		139.0		149.0		135.0		132.0	
Rank of Unweighted Scores		**4**		**3**		**6**		**7**		**1**		**5**		**2**		**7**		**9**	

Assessment Process for Long List of Routes in the Tintenbar Zone with Sensitivity Test (Agency) Pairwise Results

Sieve 1 Evaluation Criteria	Pairwise Rating (%)	1 C1 B1 A1 UW	1 C1 B1 A1 W	2 C1 B1 B2 UW	2 C1 B1 B2 W	3 C1 B1 I1 UW	3 C1 B1 I1 W	4 C1 B1 L1 UW	4 C1 B1 L1 W	5 C1 C2 UW	5 C1 C2 W	6 D1 D2 UW	6 D1 D2 W	7 D1 H1 UW	7 D1 H1 W	8 E1 E2 UW	8 E1 E2 W	9 E1 F1 UW	9 E1 F1 W
Safety and Accidents																			
1. Qualitative comparison of likely crash rates for each option	3.1%	4	0.12	4	0.12	4	0.12	4	0.12	4	0.12	5	0.16	5	0.16	5	0.16	5	0.16
2. Local traffic use of highway	3.9%	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20
3. Compliance to Desirable Geometrical Design Standards for Safety	1.1%	1	0.01	4	0.04	4	0.04	3	0.03	4	0.04	5	0.05	5	0.05	5	0.05	5	0.05
4. Length (km) through potentially fog prone areas.	2.8%	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	1	0.03	1	0.03	1	0.03	1	0.03
Travel Time and Transport Costs																			
5. Estimated travel time savings compared with existing Pacific Highway alignment in the study area.	1.9%	4	0.08	4	0.08	4	0.08	4	0.08	4	0.08	5	0.09	5	0.09	5	0.09	5	0.09
Social and Health																			
6. Extent and length of steep grades (ie in excess of 4.5%)	1.1%	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	5	0.06	5	0.06	5	0.06	5	0.06
7. Number of dwellings to be aquired located within the proposed road reserve	2.9%	4	0.11	3	0.09	2	0.06	1	0.03	4	0.11	5	0.14	5	0.14	5	0.14	5	0.14
8. Number of dwellings to be acquired located within the proposed road reserve that are not currently within 200m (either side) of the existing alignment.	2.6%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
9. Area (ha) of private land (business & residential) to be acquired.	2.1%	3	0.06	3	0.06	3	0.06	3	0.06	3	0.06	2	0.04	2	0.04	1	0.02	1	0.02
10. Area (ha) of private land (business and residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	2.2%	3	0.07	3	0.07	5	0.11	5	0.11	4	0.09	2	0.04	2	0.04	1	0.02	1	0.02
11. Number of currently contiguous settlement areas severed.	3.8%	2	0.08	2	0.08	2	0.08	5	0.19	2	0.08	2	0.08	2	0.08	1	0.04	1	0.04
12. Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEP's and/or relevant Shire strategies.)	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	1	0.03	1	0.03	3	0.09	3	0.09
13. Number and extent of severance impacts on individual residential properties.	2.6%	5	0.13	5	0.13	4	0.10	3	0.08	5	0.13	5	0.13	4	0.10	4	0.10	3	0.08
14. Visual and Landscape - Number of residential properties within 1km of the Highway route option.	3.8%	1	0.04	1	0.04	1	0.04	1	0.04	2	0.08	4	0.15	3	0.11	5	0.19	4	0.15
15. Length (km) of route with visual benefit to the driver.	2.7%	5	0.14	5	0.14	3	0.08	2	0.05	5	0.14	1	0.03	2	0.05	1	0.03	2	0.05
16. Length (km) of route located on the coastal flats.	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	1	0.03	2	0.06	1	0.03	1	0.03
17. Length (km) of route through scenic escarpment.	3.3%	1	0.03	1	0.03	1	0.03	1	0.03	4	0.13	5	0.17	5	0.17	5	0.17	5	0.17
18. Length of route through exposed ridges and hills.	2.8%	2	0.06	3	0.08	2	0.06	1	0.03	2	0.06	5	0.14	5	0.14	5	0.14	5	0.14
19. Noise - Absolute Community Noise Burden	4.1%	4	0.17	3	0.12	1	0.04	1	0.04	4	0.17	5	0.21	4	0.17	5	0.21	4	0.17
20. Noise - Relative Community Noise Burden	3.6%	4	0.14	4	0.14	2	0.07	1	0.04	4	0.14	5	0.18	5	0.18	5	0.18	5	0.18
21. Impacts on community facilities.	2.5%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
22. Length (km) of route that utilises existing road reserve (not as a service road)	3.3%	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	2	0.07	2	0.07	2	0.07	2	0.07
Local Economic																			
23. Number of existing farm businesses and other businesses directly affected.	3.0%	3	0.09	3	0.09	1	0.03	1	0.03	3	0.09	4	0.12	4	0.12	5	0.15	3	0.09
24. Severance impact of businesses by type (% impacted).	3.0%	1	0.03	1	0.03	1	0.03	1	0.03	2	0.06	3	0.09	3	0.09	5	0.15	4	0.12
25. Total loss of agricultural land based on land use type (Area ha).	3.6%	4	0.14	4	0.14	4	0.14	5	0.18	3	0.11	1	0.04	2	0.07	2	0.07	1	0.04
26. Area (ha) of state significant land impacted.	3.7%	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19
Environment & Cultural Heritage																			
27. Number and area of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	3.2%	4	0.13	4	0.13	3	0.10	3	0.10	4	0.13	3	0.10	4	0.13	2	0.06	2	0.06
28. Number of 'edges' created through remnant and regenerated habitat areas.	2.6%	3	0.08	3	0.08	3	0.08	2	0.05	3	0.08	4	0.10	4	0.10	2	0.05	3	0.08
29. Number of times a wildlife corridor is crossed.	2.6%	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03
30. Number of high and medium value sites of cultural heritage significance directly affected.	2.6%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
31. Areas of high and medium potential for archaeological deposits directly affected.	1.6%	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	1	0.02	5	0.08	1	0.02	2	0.03
32. Number and value of waterways directly impacted	1.5%	3	0.04	3	0.04	4	0.06	5	0.07	3	0.04	5	0.07	5	0.07	5	0.07	5	0.07
33. Number of springs directly impacted.	1.1%	4	0.04	4	0.04	4	0.04	4	0.04	4	0.04	5	0.05	5	0.05	5	0.05	5	0.05
34. Number of contaminated sites directly impacted.	0.6%	5	0.03	5	0.03	5	0.03	4	0.02	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03
Engineering and Cost																			
35. Length (m)	0.3%	5	0.02	5	0.02	5	0.02	5	0.02	5	0.02	4	0.01	5	0.02	3	0.01	3	0.01
36. Relative costs of options.	2.2%	5	0.11	5	0.11	3	0.07	4	0.09	5	0.11	4	0.09	5	0.11	1	0.02	1	0.02
37. Length of route through areas of geological risk.	1.1%	4	0.05	4	0.05	4	0.05	4	0.05	5	0.06	2	0.02	4	0.05	2	0.02	3	0.03
38. Buildability	3.4%	3	0.10	3	0.10	3	0.10	3	0.10	4	0.13	3	0.10	4	0.13	3	0.10	3	0.10
39. Length of highway within flood prone land.	1.9%	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	3	0.06	3	0.06	3	0.06	3	0.06
Weighted Scores																			
Sum total			**3.67**		**3.66**		**3.29**		**3.29**		**3.90**		**3.51**		**3.68**		**3.47**		**3.32**
Ranking of Weighted Scores			**3**		**4**		**8**		**9**		**1**		**5**		**2**		**6**		**7**
Unweighted Scores																			
Sum Total		146.0		148.0		137.0		135.0		156.0		139.0		149.0		135.0		132.0	
Rank of Unweighted Scores		**4**		**3**		**6**		**7**		**1**		**5**		**2**		**7**		**9**	

Assessment Process for Long List of Routes in the Newrybar Zone with Base Case (Project Team) Pairwise Results

Sieve 1 Evaluation Criteria	Pairwise Rating (%)	1 A2 A3 A4		2 A2 J1		3 A2 A3 H4		4 L2		5 B3 B4		6 B3 C4 H3 H4		7 B3 C4 H3 A4		8 B3 C4 C5		9 C3 B4		10 C3 C4 H3 H4		11 C3 C4 H3 A4		12 C3 C4 C5		13 H2 H3 A4		14 H2 H3 H4		15 H2 C5		16 K1		17 G1		18 E3	
		UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W
Safety and Accidents																																					
1. Qualitative comparison of likely crash rates for each option	4.9%	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25
2. Local traffic use of highway	2.0%	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10
3 Compliance to Desirable Geometrical Design Standards for Safety	3.1%	5	0.15	5	0.15	5	0.15	4	0.12	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	4	0.12	4	0.12	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15
4. Length (km) through potentially fog prone areas.	0.3%	4	0.01	3	0.01	4	0.01	4	0.01	5	0.02	5	0.02	5	0.02	5	0.02	4	0.01	5	0.02	5	0.02	5	0.02	4	0.01	4	0.01	5	0.02	2	0.01	3	0.01	2	0.01
Travel Time and Transport Costs																																					
5. Estimated travel time savings compared with existing Pacific Highway alignment in the study area.	1.2%	2	0.02	5	0.06	5	0.06	4	0.05	5	0.06	5	0.06	2	0.02	3	0.04	5	0.06	5	0.06	2	0.02	3	0.04	3	0.04	5	0.06	3	0.04	3	0.04	1	0.01	5	0.06
Social and Health																																					
6. Extent and length of steep grades (ie in excess of 4.5%)	2.3%	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11
7. Number of dwellings to be aquired located within the proposed road reserve	4.1%	4	0.16	4	0.16	4	0.16	1	0.04	3	0.12	3	0.12	3	0.12	3	0.12	4	0.16	4	0.16	4	0.16	4	0.16	4	0.16	4	0.16	4	0.16	5	0.20	4	0.16	5	0.20
8. Number of dwellings to be acquired located within the proposed road reserve that are not currently within 200m (either side) of the existing alignment.	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	4	0.11	4	0.11	4	0.11	4	0.11	5	0.14	5	0.14	5	0.14	4	0.11	4	0.11	4	0.11	4	0.11	5	0.14	4	0.11	5	0.14
9. Area (ha) of private land (business & residential) to be acquired.	3.2%	1	0.03	2	0.06	1	0.03	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03	2	0.06	1	0.03	1	0.03	1	0.03	2	0.06	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03
10. Area (ha) of private land (business and residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	2.1%	1	0.02	3	0.06	1	0.02	5	0.11	3	0.06	2	0.04	2	0.04	2	0.04	3	0.06	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02
11. Number of currently contiguous settlement areas severed.	4.1%	1	0.04	2	0.08	2	0.08	5	0.21	1	0.04	1	0.04	1	0.04	1	0.04	2	0.08	2	0.08	1	0.04	2	0.08	1	0.04	1	0.04	1	0.04	5	0.21	2	0.08	2	0.08
12. Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEP's and/or relevant Shire strategies.)	1.0%	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05
13. Number and extent of severance impacts on individual residential properties.	3.4%	4	0.14	5	0.17	4	0.14	3	0.10	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	4	0.14	4	0.14	4	0.14	5	0.17	5	0.17	5	0.17
14. Visual and Landscape - Number of residential properties within 1km of the Highway route option.	1.8%	2	0.04	3	0.05	2	0.04	3	0.05	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04	1	0.02	1	0.02	1	0.02	3	0.05	3	0.05	3	0.05	5	0.09	5	0.09	5	0.09
15. Length (km) of route with visual benefit to the driver.	1.2%	5	0.06	4	0.05	5	0.06	3	0.04	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	4	0.05	4	0.05	4	0.05	1	0.01	1	0.01	1	0.01
16. Length (km) of route located on the coastal flats.	1.3%	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	1	0.01	2	0.03	1	0.01
17. Length (km) of route through scenic escarpment.	3.0%	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	1	0.03	1	0.03	1	0.03	2	0.06	3	0.09	3	0.09
18. Length of route through exposed ridges and hills.	2.6%	1	0.03	3	0.08	1	0.03	1	0.03	5	0.13	4	0.10	4	0.10	4	0.10	3	0.08	2	0.05	2	0.05	1	0.03	4	0.10	4	0.10	3	0.08	4	0.10	1	0.03	4	0.10
19. Noise - Absolute Community Noise Burden	3.7%	3	0.11	4	0.15	3	0.11	1	0.04	2	0.07	2	0.07	2	0.07	2	0.07	4	0.15	4	0.15	3	0.11	3	0.11	5	0.18	5	0.18	4	0.15	5	0.18	5	0.18	5	0.18
20. Noise - Relative Community Noise Burden	3.5%	5	0.17	5	0.17	5	0.17	1	0.03	3	0.10	4	0.14	3	0.10	3	0.10	4	0.14	5	0.17	4	0.14	4	0.14	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17
21. Impacts on community facilities.	2.4%	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	4	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12
22. Length (km) of route that utilises existing road reserve (not as a service road)	1.5%	1	0.01	3	0.04	1	0.01	5	0.07	3	0.04	1	0.01	1	0.01	1	0.01	3	0.04	1	0.01	1	0.01	1	0.01	1	0.01	1	0.01	1	0.01	1	0.01	1	0.01	1	0.01
Local Economic																																					
23. Number of existing farm businesses and other businesses directly affected.	3.7%	2	0.07	1	0.04	2	0.07	2	0.07	1	0.04	1	0.04	1	0.04	1	0.04	2	0.07	2	0.07	2	0.07	2	0.07	4	0.15	4	0.15	4	0.15	5	0.19	5	0.19	5	0.19
24. Severance impact of businesses by type (% impacted).	3.0%	4	0.12	4	0.12	4	0.12	4	0.12	3	0.09	2	0.06	2	0.06	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03	3	0.09	3	0.09	3	0.09	4	0.12	5	0.15	4	0.12
25. Total loss of agricultural land based on land use type (Area ha).	3.2%	2	0.06	3	0.10	2	0.06	5	0.16	4	0.13	3	0.10	3	0.10	3	0.10	4	0.13	3	0.10	3	0.10	3	0.10	4	0.13	5	0.16	4	0.13	1	0.03	2	0.06	3	0.10
26. Area (ha) of state significant land impacted.	2.5%	2	0.05	5	0.13	1	0.03	5	0.13	5	0.13	1	0.03	2	0.05	4	0.10	5	0.13	1	0.03	2	0.05	4	0.10	2	0.05	1	0.03	4	0.10	5	0.13	1	0.03	5	0.13
Environment & Cultural Heritage																																					
27. Number and area of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	4.0%	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	4	0.16	5	0.20	5	0.20	5	0.20	4	0.16	5	0.20	5	0.20	4	0.16	5	0.20	4	0.16	5	0.20
28. Number of 'edges' created through remnant and regenerated habitat areas.	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	3	0.09	5	0.14	5	0.14	4	0.11	3	0.09	5	0.14	5	0.14	3	0.09	4	0.11	4	0.11	4	0.11
29. Number of times a wildlife corridor is crossed.	2.5%	1	0.03	5	0.13	1	0.03	5	0.13	5	0.13	1	0.03	1	0.03	1	0.03	5	0.13	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03
30. Number of high and medium value sites of cultural heritage significance directly affected.	3.5%	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18
31. Areas of high and medium potential for archaeological deposits directly affected.	2.4%	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12
32. Number and value of waterways directly impacted	2.4%	1	0.02	1	0.02	1	0.02	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	3	0.07	2	0.05	2	0.05	2	0.05	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12
33. Number of springs directly impacted.	2.3%	3	0.07	3	0.07	3	0.07	4	0.09	3	0.07	2	0.05	2	0.05	2	0.05	5	0.11	3	0.07	3	0.07	4	0.09	3	0.07	3	0.07	4	0.09	4	0.09	1	0.02	3	0.07
34. Number of contaminated sites directly impacted.	1.3%	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	4	0.05	4	0.05	4	0.05	5	0.07	5	0.07	5	0.07
Engineering and Cost																																					
35. Length (m)	0.8%	4	0.03	5	0.04	4	0.03	5	0.04	5	0.04	5	0.04	5	0.04	5	0.04	5	0.04	4	0.03	4	0.03	5	0.04	5	0.04	5	0.04	3	0.02	3	0.02	4	0.03
36. Relative costs of options.	3.2%	1	0.03	3	0.09	1	0.03	1	0.03	3	0.09	2	0.06	2	0.06	1	0.03	2	0.06	1	0.03	1	0.03	1	0.03	2	0.06	2	0.06	1	0.03	3	0.09	2	0.06	5	0.16
37. Length of route through areas of geological risk.	2.6%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	4	0.11	4	0.11	4	0.11	3	0.08	3	0.08	2	0.05
38. Buildability	2.8%	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	5	0.14	5	0.14	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	5	0.14	5	0.14	5	0.14	4	0.11	4	0.11	4	0.11
39. Length of highway within flood prone land.	1.3%	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	3	0.04	3	0.04	3	0.04
Weighted Scores																																					
Sum total			3.50		4.05		3.55		3.83		3.92		3.54		3.49		3.40		4.08		3.60		3.44		3.47		3.81		3.84		3.72		3.95		3.53		4.03
Ranking of Weighted Scores			14		2		11		7		5		12		15		18		1		10		17		16		8		6		9		4		13		3
Unweighted Scores																																					
Sum Total		138.0		160.0		141.0		156.0		160.0		144.0		141.0		139.0		163.0		144.0		137.0		139.0		149.0		151.0		148.0		145.0		131.0		150.0	
Rank of Unweighted Scores		16		2		12		4		2		10		12		14		1		10		17		14		7		5		8		9		18		6	

Assessment Process for Long List of Routes in the Newrybar Zone with Sensitivity Test (CLG) Pairwise Results

Sieve 1 Evaluation Criteria	Pairwise Rating (%)	1 A2 A3 A4		2 A2 J1		3 A2 A3 H4		4 L2		5 B3 B4		6 B3 C4 H3 H4		7 B3 C4 H3 A4		8 B3 C4 C5		9 C3 B4		10 C3 C4 H3 H4		11 C3 C4 H3 A4		12 C3 C4 C5		13 H2 H3 A4		14 H2 H3 H4		15 H2 C5		16 K1		17 G1		18 E3	
		UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W
Safety and Accidents																																					
1. Qualitative comparison of likely crash rates for each option	2.7%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
2. Local traffic use of highway	1.6%	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08
3 Compliance to Desirable Geometrical Design Standards for Safety	1.5%	5	0.07	5	0.07	5	0.07	4	0.06	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	4	0.06	4	0.06	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07
4. Length (km) through potentially fog prone areas.	2.3%	4	0.09	3	0.07	4	0.09	4	0.09	5	0.11	5	0.11	5	0.11	5	0.11	4	0.09	5	0.11	5	0.11	5	0.11	4	0.09	4	0.09	5	0.11	2	0.05	3	0.07	2	0.05
Travel Time and Transport Costs																																					
5. Estimated travel time savings compared with existing Pacific Highway alignment in the study area.	1.0%	2	0.02	5	0.05	5	0.05	4	0.04	5	0.05	5	0.05	2	0.02	3	0.03	5	0.05	5	0.05	2	0.02	3	0.03	3	0.03	5	0.05	3	0.03	3	0.03	1	0.01	5	0.05
Social and Health																																					
6. Extent and length of steep grades (ie in excess of 4.5%)	2.0%	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10
7. Number of dwellings to be aquired located within the proposed road reserve	1.4%	4	0.06	4	0.06	4	0.06	1	0.01	3	0.04	3	0.04	3	0.04	3	0.04	4	0.06	4	0.06	4	0.06	4	0.06	4	0.06	4	0.06	4	0.06	5	0.07	4	0.06	5	0.07
8. Number of dwellings to be acquired located within the proposed road reserve that are not currently within 200m (either side) of the existing alignment.	2.1%	5	0.10	5	0.10	5	0.10	5	0.10	4	0.08	4	0.08	4	0.08	4	0.08	5	0.10	5	0.10	5	0.10	4	0.08	4	0.08	4	0.08	4	0.08	5	0.10	4	0.08	5	0.10
9. Area (ha) of private land (business & residential) to be acquired.	1.6%	1	0.02	2	0.03	1	0.02	2	0.03	2	0.03	1	0.02	1	0.02	1	0.02	2	0.03	1	0.02	1	0.02	1	0.02	2	0.03	2	0.03	2	0.03	1	0.02	1	0.02	1	0.02
10. Area (ha) of private land (business and residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	2.2%	1	0.02	3	0.07	1	0.02	5	0.11	3	0.07	2	0.04	2	0.04	2	0.04	3	0.07	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02
11. Number of currently contiguous settlement areas severed.	2.7%	1	0.03	2	0.05	2	0.05	5	0.13	1	0.03	1	0.03	1	0.03	1	0.03	2	0.05	2	0.05	1	0.03	2	0.05	1	0.03	1	0.03	1	0.03	5	0.13	2	0.05	2	0.05
12. Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEP's and/or relevant Shire strategies.)	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14
13. Number and extent of severance impacts on individual residential properties.	1.9%	4	0.08	5	0.10	4	0.08	3	0.06	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	4	0.08	4	0.08	4	0.08	5	0.10	5	0.10
14. Visual and Landscape - Number of residential properties within 1km of the Highway route option.	1.6%	2	0.03	3	0.05	2	0.03	3	0.05	2	0.03	1	0.02	1	0.02	1	0.02	2	0.03	1	0.02	1	0.02	1	0.02	3	0.05	3	0.05	3	0.05	5	0.08	5	0.08	5	0.08
15. Length (km) of route with visual benefit to the driver.	1.6%	5	0.08	4	0.06	5	0.08	3	0.05	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	4	0.06	4	0.06	4	0.06	1	0.02	1	0.02	1	0.02
16. Length (km) of route located on the coastal flats.	3.7%	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	1	0.04	2	0.07	1	0.04
17. Length (km) of route through scenic escarpment.	2.7%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	1	0.03	1	0.03	1	0.03	2	0.05	3	0.08	3	0.08
18. Length of route through exposed ridges and hills.	1.3%	1	0.01	3	0.04	1	0.01	1	0.01	5	0.07	4	0.05	4	0.05	4	0.05	3	0.04	2	0.03	2	0.03	1	0.01	4	0.05	4	0.05	3	0.04	4	0.05	1	0.01	4	0.05
19. Noise - Absolute Community Noise Burden	1.5%	3	0.05	4	0.06	3	0.05	1	0.02	2	0.03	2	0.03	2	0.03	2	0.03	4	0.06	4	0.06	3	0.05	3	0.05	5	0.08	5	0.08	4	0.06	5	0.08	5	0.08	5	0.08
20. Noise - Relative Community Noise Burden	2.4%	5	0.12	5	0.12	5	0.12	1	0.02	3	0.07	4	0.10	3	0.07	3	0.07	4	0.10	5	0.12	4	0.10	4	0.10	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12
21. Impacts on community facilities.	1.6%	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08
22. Length (km) of route that utilises existing road reserve (not as a service road)	3.6%	1	0.04	3	0.11	1	0.04	5	0.18	3	0.11	1	0.04	1	0.04	1	0.04	3	0.11	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04
Local Economic																																					
23. Number of existing farm businesses and other businesses directly affected.	2.6%	2	0.05	1	0.03	2	0.05	2	0.05	1	0.03	1	0.03	1	0.03	1	0.03	2	0.05	2	0.05	2	0.05	2	0.05	4	0.10	4	0.10	4	0.10	5	0.13	5	0.13	5	0.13
24. Severance impact of businesses by type (% impacted).	2.1%	4	0.08	4	0.08	4	0.08	4	0.08	3	0.06	2	0.04	2	0.04	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02	3	0.06	3	0.06	4	0.08	3	0.06	4	0.08	5	0.10
25. Total loss of agricultural land based on land use type (Area ha).	3.4%	2	0.07	3	0.10	2	0.07	5	0.17	4	0.14	3	0.10	3	0.10	3	0.10	4	0.14	3	0.10	3	0.10	3	0.10	4	0.14	5	0.17	4	0.14	1	0.03	2	0.07	3	0.10
26. Area (ha) of state significant land impacted.	3.4%	2	0.07	5	0.17	1	0.03	5	0.17	5	0.17	1	0.03	2	0.07	4	0.14	5	0.17	1	0.03	2	0.07	4	0.14	2	0.07	1	0.03	4	0.14	5	0.17	1	0.03	5	0.17
Environment & Cultural Heritage																																					
27. Number and area of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	3.8%	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	4	0.15	5	0.19	5	0.19	5	0.19	4	0.15	5	0.19	5	0.19	4	0.15	5	0.19	4	0.15	5	0.19
28. Number of 'edges' created through remnant and regenerated habitat areas.	3.3%	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	3	0.10	5	0.16	5	0.16	4	0.13	3	0.10	5	0.16	5	0.16	3	0.10	4	0.13	4	0.13	4	0.13
29. Number of times a wildlife corridor is crossed.	3.6%	1	0.04	5	0.18	1	0.04	5	0.18	5	0.18	1	0.04	1	0.04	1	0.04	5	0.18	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04
30. Number of high and medium value sites of cultural heritage significance directly affected.	2.9%	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15
31. Areas of high and medium potential for archaeological deposits directly affected.	3.0%	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15
32. Number and value of waterways directly impacted	2.8%	1	0.03	1	0.03	1	0.03	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	3	0.09	2	0.06	2	0.06	2	0.06	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14
33. Number of springs directly impacted.	3.6%	3	0.11	3	0.11	3	0.11	4	0.14	3	0.11	2	0.07	2	0.07	2	0.07	5	0.18	3	0.11	3	0.11	4	0.14	3	0.11	3	0.11	4	0.14	4	0.14	1	0.04	3	0.11
34. Number of contaminated sites directly impacted.	2.5%	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	4	0.10	4	0.10	4	0.10	5	0.12	5	0.12	5	0.12
Engineering and Cost																																					
35. Length (m)	2.6%	4	0.11	5	0.13	4	0.11	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	4	0.11	4	0.11	5	0.13	5	0.13	5	0.13	3	0.08	3	0.08	4	0.11
36. Relative costs of options.	3.2%	1	0.03	3	0.10	1	0.03	1	0.03	3	0.10	2	0.06	2	0.06	1	0.03	2	0.06	1	0.03	1	0.03	1	0.03	2	0.06	2	0.06	1	0.03	3	0.10	2	0.06	5	0.16
37. Length of route through areas of geological risk.	3.8%	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	4	0.15	4	0.15	4	0.15	3	0.12	3	0.12	2	0.08
38. Buildability	3.3%	4	0.13	4	0.13	4	0.13	4	0.13	4	0.13	5	0.17	5	0.17	4	0.13	4	0.13	4	0.13	4	0.13	4	0.13	5	0.17	5	0.17	5	0.17	4	0.13	4	0.13	4	0.13
39. Length of highway within flood prone land.	4.1%	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	3	0.12	3	0.12	3	0.12
Weighted Scores																																					
Sum total			**3.56**		**4.13**		**3.58**		**4.21**		**4.16**		**3.67**		**3.65**		**3.56**		**4.24**		**3.67**		**3.55**		**3.60**		**3.79**		**3.81**		**3.77**		**3.61**		**3.26**		**3.70**
Ranking of Weighted Scores			**16**		**4**		**14**		**2**		**3**		**9**		**11**		**15**		**1**		**10**		**17**		**13**		**6**		**5**		**7**		**12**		**18**		**8**
Unweighted Scores																																					
Sum Total		138.0		160.0		141.0		156.0		160.0		144.0		141.0		139.0		163.0		144.0		137.0		139.0		149.0		151.0		148.0		145.0		131.0		150.0	
Rank of Unweighted Scores		**16**		**2**		**12**		**4**		**2**		**10**		**12**		**14**		**1**		**10**		**17**		**14**		**7**		**5**		**8**		**9**		**18**		**6**	

Assessment Process for Long List of Routes in the Newrybar Zone with Sensitivity Test (Agency) Pairwise Results

Sieve 1 Evaluation Criteria	Pairwise Rating (%)	1 A2 A3 A4		2 A2 J1		3 A2 A3 H4		4 L2		5 B3 B4		6 B3 C4 H3 H4		7 B3 C4 H3 A4		8 B3 C4 C5		9 C3 B4		10 C3 C4 H3 H4		11 C3 C4 H3 A4		12 C3 C4 C5		13 H2 H3 A4		14 H2 H3 H4		15 H2 C5		16 K1		17 G1		18 E3	
		UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W
Safety and Accidents																																					
1. Qualitative comparison of likely crash rates for each option	3.1%	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16
2. Local traffic use of highway	3.9%	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20
3 Compliance to Desirable Geometrical Design Standards for Safety	1.1%	5	0.05	5	0.05	5	0.05	4	0.04	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	4	0.04	4	0.04	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05
4. Length (km) through potentially fog prone areas.	2.8%	4	0.11	3	0.09	4	0.11	4	0.11	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	4	0.11	5	0.14	5	0.14	5	0.14	4	0.11	4	0.11	5	0.14	2	0.06	3	0.09	2	0.06
Travel Time and Transport Costs																																					
5. Estimated travel time savings compared with existing Pacific Highway alignment in the study area.	1.9%	2	0.04	5	0.09	5	0.09	4	0.08	5	0.09	5	0.09	2	0.04	3	0.06	5	0.09	5	0.09	2	0.04	3	0.06	3	0.06	5	0.09	3	0.06	3	0.06	1	0.02	5	0.09
Social and Health																																					
6. Extent and length of steep grades (ie in excess of 4.5%)	1.1%	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06
7. Number of dwellings to be aquired located within the proposed road reserve	2.9%	4	0.11	4	0.11	4	0.11	1	0.03	3	0.09	3	0.09	3	0.09	3	0.09	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	5	0.14	4	0.11	5	0.14
8. Number of dwellings to be acquired located within the proposed road reserve that are not currently within 200m (either side) of the existing alignment.	2.6%	5	0.13	5	0.13	5	0.13	5	0.13	4	0.11	4	0.11	4	0.11	4	0.11	5	0.13	5	0.13	5	0.13	4	0.11	4	0.11	4	0.11	4	0.11	5	0.13	4	0.11	5	0.13
9. Area (ha) of private land (business & residential) to be acquired.	2.1%	1	0.02	2	0.04	1	0.02	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02
10. Area (ha) of private land (business and residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	2.2%	1	0.02	3	0.07	1	0.02	5	0.11	3	0.07	2	0.04	2	0.04	2	0.04	3	0.07	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02
11. Number of currently contiguous settlement areas severed.	3.8%	1	0.04	2	0.08	2	0.08	5	0.19	1	0.04	1	0.04	1	0.04	1	0.04	2	0.08	2	0.08	1	0.04	2	0.08	1	0.04	1	0.04	1	0.04	5	0.19	2	0.08	2	0.08
12. Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEP's and/or relevant Shire strategies.)	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14
13. Number and extent of severance impacts on individual residential properties.	2.6%	4	0.10	5	0.13	4	0.10	3	0.08	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	4	0.10	4	0.10	4	0.10	5	0.13	5	0.13	5	0.13
14. Visual and Landscape - Number of residential properties within 1km of the Highway route option.	3.8%	2	0.08	3	0.11	2	0.08	3	0.11	2	0.08	1	0.04	1	0.04	1	0.04	2	0.08	1	0.04	1	0.04	1	0.04	3	0.11	3	0.11	3	0.11	5	0.19	5	0.19	5	0.19
15. Length (km) of route with visual benefit to the driver.	2.7%	5	0.14	4	0.11	5	0.14	3	0.08	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	4	0.11	4	0.11	4	0.11	1	0.03	1	0.03	1	0.03
16. Length (km) of route located on the coastal flats.	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	1	0.03	2	0.06	1	0.03
17. Length (km) of route through scenic escarpment.	3.3%	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	1	0.03	1	0.03	1	0.03	2	0.07	3	0.10	3	0.10
18. Length of route through exposed ridges and hills.	2.8%	1	0.03	3	0.08	1	0.03	1	0.03	5	0.14	4	0.11	4	0.11	4	0.11	3	0.08	2	0.06	2	0.06	2	0.06	4	0.11	4	0.11	3	0.08	4	0.11	1	0.03	4	0.11
19. Noise - Absolute Community Noise Burden	4.1%	3	0.12	4	0.17	3	0.12	1	0.04	2	0.08	2	0.08	2	0.08	2	0.08	4	0.17	4	0.17	3	0.12	3	0.12	5	0.21	5	0.21	4	0.17	5	0.21	5	0.21	5	0.21
20. Noise - Relative Community Noise Burden	3.6%	5	0.18	5	0.18	5	0.18	1	0.04	3	0.11	4	0.14	3	0.11	3	0.11	4	0.14	5	0.18	4	0.14	4	0.14	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18
21. Impacts on community facilities.	2.5%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
22. Length (km) of route that utilises existing road reserve (not as a service road)	3.3%	1	0.03	3	0.10	1	0.03	5	0.16	3	0.10	1	0.03	1	0.03	1	0.03	3	0.10	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03
Local Economic																																					
23. Number of existing farm businesses and other businesses directly affected.	3.0%	2	0.06	1	0.03	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03	1	0.03	2	0.06	2	0.06	2	0.06	2	0.06	4	0.12	4	0.12	4	0.12	5	0.15	5	0.15	5	0.15
24. Severance impact of businesses by type (% impacted).	3.0%	4	0.12	4	0.12	4	0.12	4	0.12	3	0.09	2	0.06	2	0.06	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03	3	0.09	3	0.09	3	0.09	4	0.12	3	0.09	4	0.12	5	0.15
25. Total loss of agricultural land based on land use type (Area ha).	3.6%	2	0.07	3	0.11	2	0.07	5	0.18	4	0.14	3	0.11	3	0.11	3	0.11	4	0.14	3	0.11	3	0.11	3	0.11	4	0.14	5	0.18	4	0.14	1	0.04	2	0.07	3	0.11
26. Area (ha) of state significant land impacted.	3.7%	2	0.07	5	0.19	1	0.04	5	0.19	5	0.19	1	0.04	2	0.07	4	0.15	5	0.19	1	0.04	2	0.07	4	0.15	2	0.07	1	0.04	4	0.15	5	0.19	1	0.04	5	0.19
Environment & Cultural Heritage																																					
27. Number and area of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	3.2%	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	4	0.13	5	0.16	5	0.16	5	0.16	4	0.13	5	0.16	5	0.16	4	0.13	5	0.16	4	0.13	5	0.16
28. Number of 'edges' created through remnant and regenerated habitat areas.	2.6%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	3	0.08	5	0.13	5	0.13	4	0.10	3	0.08	5	0.13	5	0.13	3	0.08	4	0.10	4	0.10	4	0.10
29. Number of times a wildlife corridor is crossed.	2.6%	1	0.03	5	0.13	1	0.03	5	0.13	5	0.13	1	0.03	1	0.03	1	0.03	5	0.13	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03
30. Number of high and medium value sites of cultural heritage significance directly affected.	2.6%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
31. Areas of high and medium potential for archaeological deposits directly affected.	1.6%	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08
32. Number and value of waterways directly impacted	1.5%	1	0.01	1	0.01	1	0.01	4	0.06	4	0.06	4	0.06	4	0.06	4	0.06	3	0.04	2	0.03	2	0.03	2	0.03	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07
33. Number of springs directly impacted.	1.1%	3	0.03	3	0.03	3	0.03	4	0.04	3	0.03	2	0.02	2	0.02	2	0.02	5	0.05	3	0.03	3	0.03	4	0.04	3	0.03	3	0.03	4	0.04	4	0.04	1	0.01	3	0.03
34. Number of contaminated sites directly impacted.	0.6%	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	4	0.02	4	0.02	4	0.02	5	0.03	5	0.03	5	0.03
Engineering and Cost																																					
35. Length (m)	0.3%	4	0.01	5	0.02	4	0.01	5	0.02	5	0.02	5	0.02	5	0.02	5	0.02	5	0.02	5	0.02	4	0.01	4	0.01	5	0.02	5	0.02	5	0.02	3	0.01	3	0.01	4	0.01
36. Relative costs of options.	2.2%	1	0.02	3	0.07	1	0.02	1	0.02	3	0.07	2	0.04	2	0.04	1	0.02	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04	2	0.04	1	0.02	3	0.07	2	0.04	5	0.11
37. Length of route through areas of geological risk.	1.1%	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	4	0.05	4	0.05	4	0.05	3	0.03	3	0.03	2	0.02
38. Buildability	3.4%	4	0.13	4	0.13	4	0.13	4	0.13	4	0.13	5	0.17	5	0.17	4	0.13	4	0.13	4	0.13	4	0.13	4	0.13	5	0.17	5	0.17	5	0.17	4	0.13	4	0.13	4	0.13
39. Length of highway within flood prone land.	1.9%	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	3	0.06	3	0.06	3	0.06
Weighted Scores																																					
Sum total			**3.45**		**4.05**		**3.51**		**3.89**		**3.95**		**3.49**		**3.44**		**3.39**		**4.06**		**3.57**		**3.40**		**3.44**		**3.73**		**3.77**		**3.70**		**3.73**		**3.36**		**3.84**
Ranking of Weighted Scores			**13**		**2**		**11**		**4**		**3**		**12**		**15**		**17**		**1**		**10**		**16**		**14**		**8**		**6**		**9**		**7**		**18**		**5**
Unweighted Scores																																					
Sum Total		138.0		160.0		141.0		156.0		160.0		144.0		141.0		139.0		163.0		144.0		137.0		139.0		149.0		151.0		148.0		145.0		131.0		150.0	
Rank of Unweighted Scores		**16**		**2**		**12**		**4**		**2**		**10**		**12**		**14**		**1**		**10**		**17**		**14**		**7**		**5**		**8**		**9**		**18**		**6**	

Assessment Process for Long List of Routes in the Bangalow Zone with Base Case (Project Team) Pairwise Results

		1 J2 E6		2 J2 A6		3 J2 H7		4 L3 L4		5 L3 H6 E6		6 L3 H6 A6		7 L3 H6 H7		8 H5 L4		9 H5 H6 E6		10 H5 H6 A6		11 H5 H6 H7		12 G2 E6		13 G2 A6		14 G2 H7		15 A5 E6		16 A5 A6		17 A5 H7		18 K2 E6		19 K2 A6		20 K2 H7		21 C6 E5 E6		22 C6 E5 A6		23 C6 E5 H7		24 E4 E5 E6		25 E4 E5 A6		26 E4 E5 H7		27 L3 M1		28 H5 M1	
Sieve 1 Evaluation Criteria	Pairwise Rating (%)	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W
Safety and Accidents																																																				
1. Qualitative comparison of likely crash rates for each option	4.9%	5	0.25	5	0.25	5	0.25	1	0.05	5	0.25	5	0.25	5	0.25	1	0.05	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	4	0.20	4	0.20
2. Local traffic use of highway	2.0%	5	0.10	5	0.10	5	0.10	1	0.02	5	0.10	5	0.10	5	0.10	1	0.02	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10
3 Compliance to Desirable Geometrical Design Standards for Safety	3.1%	5	0.15	5	0.15	5	0.15	1	0.03	4	0.12	4	0.12	4	0.12	1	0.03	4	0.12	4	0.12	4	0.12	4	0.12	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	4	0.12	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	3	0.09	3	0.09
4. Length (km) through potentially fog prone areas.	0.3%	4	0.01	4	0.01	4	0.01	4	0.01	3	0.01	3	0.01	3	0.01	4	0.01	3	0.01	3	0.01	3	0.01	4	0.01	4	0.01	3	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01
Travel Time and Transport Costs																																																				
5. Estimated travel time savings compared with existing Pacific Highway alignment in the study area.	1.2%	4	0.05	4	0.05	5	0.06	2	0.02	4	0.05	4	0.05	4	0.05	2	0.02	4	0.05	4	0.05	5	0.06	4	0.05	4	0.05	5	0.06	4	0.05	4	0.05	4	0.05	5	0.06	4	0.05	4	0.05	5	0.06	4	0.05	4	0.05	5	0.06	3	0.04	3	0.04
Social and Health																																																				
6. Extent and length of steep grades (ie in excess of 4.5%)	2.3%	5	0.11	5	0.11	5	0.11	1	0.02	4	0.09	4	0.09	4	0.09	2	0.05	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	1	0.02	2	0.05
7. Number of dwellings to be aquired located within the proposed road reserve	4.1%	3	0.12	3	0.12	3	0.12	1	0.04	3	0.12	3	0.12	3	0.12	1	0.04	4	0.16	4	0.16	4	0.16	3	0.12	3	0.12	3	0.12	4	0.16	3	0.12	3	0.12	4	0.16	4	0.16	3	0.12	4	0.16	4	0.16	4	0.16	3	0.12	4	0.16
8. Number of dwellings to be acquired located within the proposed road reserve that are not currently within 200m (either side) of the existing alignment.	2.9%	5	0.14	5	0.14	4	0.11	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	4	0.11	4	0.11	4	0.11	5	0.14	5	0.14	4	0.11	5	0.14	5	0.14	4	0.11	5	0.14	5	0.14	4	0.11	5	0.14	5	0.14
9. Area (ha) of private land (business & residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	3.2%	2	0.06	2	0.06	2	0.06	4	0.13	2	0.06	2	0.06	2	0.06	3	0.10	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	2	0.06	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	2	0.06	1	0.03
10. Area (ha) of private land (business and residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	2.1%	2	0.04	2	0.04	2	0.04	5	0.11	3	0.06	3	0.06	3	0.06	4	0.09	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02	1	0.02	2	0.04
11. Number of currently contiguous settlement areas severed.	4.1%	2	0.08	2	0.08	2	0.08	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	2	0.08	2	0.08	2	0.08	2	0.08	2	0.08	2	0.08	1	0.04	1	0.04	2	0.08	2	0.08	2	0.08	2	0.08	2	0.08	5	0.21	5	0.21
12. Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEP's and/or relevant Shire strategies.)	1.0%	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05
13. Number and extent of severance impacts on individual residential properties.	3.4%	5	0.17	5	0.17	5	0.17	3	0.10	5	0.17	5	0.17	4	0.14	4	0.14	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17
14. Visual and Landscape - Number of residential properties within 1km of the Highway route option.	1.8%	5	0.09	5	0.09	5	0.09	1	0.02	2	0.04	2	0.04	2	0.04	2	0.04	3	0.05	3	0.05	3	0.05	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	4	0.07	5	0.09
15. Length (km) of route with visual benefit to the driver.	1.2%	4	0.05	4	0.05	5	0.06	3	0.04	4	0.05	5	0.06	5	0.06	2	0.02	3	0.04	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	5	0.06	3	0.04	4	0.05	4	0.05	5	0.06	4	0.05	5	0.06	4	0.05	4	0.05	3	0.04
16. Length (km) of route located on the coastal flats.	1.3%	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07
17. Length (km) of route through scenic escarpment.	3.0%	5	0.15	5	0.15	5	0.15	1	0.03	5	0.15	5	0.15	5	0.15	1	0.03	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	4	0.12	4	0.12
18. Length of route through exposed ridges and hills.	2.6%	3	0.08	3	0.08	3	0.08	1	0.03	4	0.10	4	0.10	4	0.10	1	0.03	3	0.08	3	0.08	3	0.08	3	0.08	3	0.08	4	0.10	3	0.08	3	0.08	4	0.10	3	0.08	3	0.08	4	0.10	4	0.10	4	0.10	4	0.10	4	0.10	4	0.10	3	0.08	3	0.08
19. Noise - Absolute Community Noise Burden	3.7%	3	0.11	4	0.15	3	0.11	1	0.04	4	0.15	4	0.15	3	0.11	2	0.07	5	0.18	5	0.18	4	0.15	4	0.15	4	0.15	5	0.18	4	0.15	5	0.18	5	0.18	5	0.18	4	0.15	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	3	0.11	5	0.18
20. Noise - Relative Community Noise Burden	3.7%	2	0.07	2	0.07	1	0.03	3	0.10	1	0.03	1	0.03	1	0.03	1	0.03	5	0.17	4	0.14	4	0.14	4	0.14	4	0.14	3	0.10	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	1	0.03	3	0.10
21. Impacts on community facilities.	2.4%	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12
22. Length (km) of route that utilises existing road reserve (not as a service road)	1.5%	3	0.04	3	0.04	1	0.01	5	0.07	4	0.06	4	0.06	3	0.04	5	0.07	3	0.04	3	0.04	1	0.01	3	0.04	3	0.04	1	0.01	3	0.04	3	0.04	1	0.01	3	0.04	3	0.04	1	0.01	3	0.04	3	0.04	1	0.01	3	0.04	3	0.04	1	0.01	4	0.06	3	0.04
Local Economic																																																				
23. Number of existing farm businesses and other businesses directly affected.	3.7%	4	0.15	5	0.19	5	0.19	3	0.11	1	0.04	2	0.07	1	0.04	3	0.11	1	0.04	2	0.07	1	0.04	1	0.04	2	0.07	2	0.07	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	2	0.07	2	0.07	2	0.07	3	0.11	2	0.07	1	0.04	1	0.04
24. Severance impact of businesses by type (% impacted).	3.0%	4	0.12	4	0.12	4	0.12	5	0.15	4	0.12	4	0.12	4	0.12	4	0.12	2	0.06	2	0.06	2	0.06	2	0.06	2	0.06	2	0.06	4	0.12	4	0.12	4	0.12	4	0.12	4	0.12	4	0.12	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	4	0.12	3	0.09
25. Total loss of agricultural land based on land use type (Area ha).	3.2%	3	0.10	2	0.06	3	0.10	5	0.16	4	0.13	3	0.10	4	0.13	4	0.13	3	0.10	2	0.06	3	0.10	4	0.13	3	0.10	4	0.13	5	0.16	4	0.13	5	0.16	4	0.13	3	0.10	4	0.13	3	0.10	2	0.06	3	0.10	3	0.10	2	0.06	3	0.10	2	0.06	1	0.03
26. Area (ha) of state significant land impacted.	2.5%	4	0.10	4	0.10	4	0.10	4	0.10	4	0.10	4	0.10	4	0.10	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	4	0.10	4	0.10	4	0.10	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	4	0.10	1	0.03
Environment & Cultural Heritage																																																			
27. Number and area of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	4.0%	3	0.12	3	0.12	3	0.12	3	0.12	4	0.16	3	0.12	4	0.16	2	0.08	3	0.12	3	0.12	3	0.12	3	0.12	3	0.12	3	0.12	3	0.12	3	0.12	3	0.12	4	0.16	3	0.12	3	0.12	4	0.16	4	0.16	4	0.16	4	0.16	4	0.16	2	0.08	2	0.08
28. Number of 'edges' created through remnant and regenerated habitat areas.	2.9%	1	0.03	1	0.03	1	0.03	2	0.06	3	0.09	3	0.09	3	0.09	2	0.06	2	0.06	2	0.06	2	0.06	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	2	0.06	2	0.06	2	0.06	2	0.06	2	0.06	4	0.11	3	0.09
29. Number of times a wildlife corridor is crossed.	2.5%	5	0.13	5	0.13	5	0.13	1	0.03	5	0.13	5	0.13	5	0.13	1	0.03	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
30. Number of high and medium value sites of cultural heritage significance directly affected.	3.5%	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18
31. Areas of high and medium potential for archaeological deposits directly affected.	2.4%	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12
32. Number and value of waterways directly impacted	2.4%	4	0.09	4	0.09	4	0.09	2	0.05	2	0.05	2	0.05	2	0.05	4	0.09	2	0.05	2	0.05	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	3	0.07	3	0.07
33. Number of springs directly impacted.	2.3%	4	0.09	4	0.09	4	0.09	2	0.05	3	0.07	3	0.07	3	0.07	2	0.05	4	0.09	4	0.09	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	5	0.11	3	0.07	3	0.07	3	0.07	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02
34. Number of contaminated sites directly impacted.	1.3%	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07
Engineering and Cost																																																				
35. Length (m)	0.8%	4	0.03	4	0.03	4	0.03	3	0.02	5	0.04	5	0.04	5	0.04	3	0.02	5	0.04	5	0.04	5	0.04	5	0.04	5	0.04	5	0.04	5	0.04	5	0.04	4	0.03	4	0.03	4	0.03	4	0.03	4	0.03	4	0.03	4	0.03	4	0.03	4	0.03	5	0.04	4	0.03
36. Relative costs of options.	3.2%	1	0.03	1	0.03	1	0.03	5	0.16	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	2	0.06	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	5	0.16	5	0.16
37. Length of route through areas of geological risk.	2.6%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	4	0.11	4	0.11	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	4	0.11	4	0.11
38. Buildability	2.8%	4	0.11	4	0.11	5	0.14	3	0.08	3	0.08	3	0.08	4	0.11	3	0.08	4	0.11	4	0.11	4	0.11	5	0.14	4	0.11	4	0.11	5	0.14	4	0.11	4	0.11	5	0.14	4	0.11	4	0.11	5	0.14	4	0.11	4	0.11	5	0.14	4	0.11	4	0.11	4	0.11
39. Length of highway within flood prone land.	1.3%	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07
Weighted Scores																																																				
Sum total			3.77						3.11		3.78						3.06		3.72						3.74				4.00						3.88				3.80						3.87						3.57		3.54
Ranking of Weighted Scores			6						11		5						12		8						7				1						2				4						3						9		10
Unweighted Scores																																																			
Sum Total		152.0						126.0		150.0						124.0		147.0						152.0				159.0						155.0				152.0						155.0						145.0		141.0	
Rank of Unweighted Scores		4						11		7						12		8						4				1						2				4						2						9		10	

Assessment Process for Long List of Routes in the Bangalow Zone with Sensitivity Test (CLG) Pairwise Results

		1 J2 E6		2 J2 A6		3 J2 H7		4 L3 L4		5 L3 H6 E6		6 L3 H6 A6		7 L3 H6 H7		8 H5 L4		9 H5 H6 E6		10 H5 H6 A6		11 H5 H6 H7		12 G2 E6		13 G2 A6		14 G2 H7		15 A5 E6		16 A5 A6		17 A5 H7		18 K2 E6		19 K2 A6		20 K2 H7		21 C6 E5 E6		22 C6 E5 A6		23 C6 E5 H7		24 E4 E5 E6		25 E4 E5 A6		26 E4 E5 H7		27 L3 M1		28 H5 M1	
Sieve 1 Evaluation Criteria	Pairwise Rating (%)	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W
Safety and Accidents																																																				
1. Qualitative comparison of likely crash rates for each option	2.7%	5	0.13	5	0.13	5	0.13	1	0.03	5	0.13	5	0.13	5	0.13	1	0.03	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	4	0.11	4	0.11
2. Local traffic use of highway	1.6%	5	0.08	5	0.08	5	0.08	1	0.02	5	0.08	5	0.08	5	0.08	1	0.02	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08
3 Compliance to Desirable Geometrical Design Standards for Safety	1.5%	5	0.07	5	0.07	5	0.07	1	0.01	4	0.06	4	0.06	4	0.06	1	0.01	4	0.06	4	0.06	4	0.06	4	0.06	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	4	0.06	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	3	0.04	3	0.04
4. Length (km) through potentially fog prone areas.	2.3%	4	0.09	4	0.09	4	0.09	4	0.09	3	0.07	3	0.07	3	0.07	4	0.09	3	0.07	3	0.07	3	0.07	4	0.09	4	0.09	3	0.07	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09	4	0.09
Travel Time and Transport Costs																																																				
5. Estimated travel time savings compared with existing Pacific Highway alignment in the study area.	1.0%	4	0.04	4	0.04	5	0.05	2	0.02	4	0.04	4	0.04	4	0.04	2	0.02	4	0.04	4	0.04	5	0.05	4	0.04	4	0.04	5	0.05	4	0.04	4	0.04	5	0.05	4	0.04	4	0.04	5	0.05	4	0.04	4	0.04	5	0.05	3	0.03	3	0.03
Social and Health																																																			
6. Extent and length of steep grades (ie in excess of 4.5%)	2.0%	5	0.10	5	0.10	5	0.10	1	0.02	4	0.08	4	0.08	4	0.08	2	0.04	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	1	0.02	2	0.04
7. Number of dwellings to be aquired located within the proposed road reserve	1.4%	3	0.04	3	0.04	3	0.04	1	0.01	3	0.04	3	0.04	3	0.04	1	0.01	4	0.06	4	0.06	4	0.06	3	0.04	3	0.04	3	0.04	4	0.06	3	0.04	3	0.04	4	0.06	4	0.06	3	0.04	4	0.06	4	0.06	4	0.06	3	0.04	4	0.06
8. Number of dwellings to be acquired located within the proposed road reserve that are not currently within 200m (either side) of the existing alignment.	2.1%	5	0.10	5	0.10	4	0.08	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	4	0.08	4	0.08	4	0.08	5	0.10	5	0.10	4	0.08	5	0.10	5	0.10	4	0.08	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10
9. Area (ha) of private land (business & residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	1.6%	2	0.03	2	0.03	2	0.03	4	0.07	2	0.03	2	0.03	2	0.03	3	0.05	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	2	0.03	2	0.03	2	0.03	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	2	0.03	1	0.02
10. Area (ha) of private land (business and residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	2.2%	2	0.04	2	0.04	2	0.04	5	0.11	3	0.07	3	0.07	3	0.07	4	0.09	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	2	0.04
11. Number of currently contiguous settlement areas severed.	2.7%	2	0.05	2	0.05	2	0.05	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	2	0.05	2	0.05	2	0.05	2	0.05	2	0.05	2	0.05	1	0.03	1	0.03	1	0.03	2	0.05	2	0.05	2	0.05	2	0.05	5	0.13	5	0.13
12. Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEP's and/or relevant Shire strategies.)	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14
13. Number and extent of severance impacts on individual residential properties.	1.9%	5	0.10	5	0.10	5	0.10	3	0.06	5	0.10	5	0.10	4	0.08	4	0.08	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10
14. Visual and Landscape - Number of residential properties within 1km of the Highway route option.	1.6%	5	0.08	5	0.08	5	0.08	1	0.02	2	0.03	2	0.03	2	0.03	2	0.03	3	0.05	3	0.05	3	0.05	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	4	0.07	5	0.08
15. Length (km) of route with visual benefit to the driver.	1.6%	4	0.06	4	0.06	5	0.08	3	0.05	4	0.06	5	0.08	5	0.08	2	0.03	3	0.05	4	0.06	4	0.06	4	0.06	4	0.06	4	0.06	5	0.08	3	0.05	4	0.06	4	0.06	4	0.06	5	0.08	4	0.06	5	0.08	5	0.08	4	0.06	4	0.06	3	0.05
16. Length (km) of route located on the coastal flats.	3.7%	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19
17. Length (km) of route through scenic escarpment.	2.7%	5	0.14	5	0.14	5	0.14	1	0.03	5	0.14	5	0.14	5	0.14	1	0.03	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	4	0.11	4	0.11
18. Length of route through exposed ridges and hills.	1.3%	3	0.04	3	0.04	3	0.04	1	0.01	4	0.05	4	0.05	4	0.05	1	0.01	3	0.04	3	0.04	3	0.04	3	0.04	3	0.04	4	0.05	3	0.04	3	0.04	4	0.05	3	0.04	3	0.04	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	4	0.05	3	0.04	3	0.04
19. Noise - Absolute Community Noise Burden	1.5%	3	0.05	4	0.06	3	0.05	1	0.02	4	0.06	4	0.06	3	0.05	2	0.03	5	0.08	5	0.08	4	0.06	4	0.06	4	0.06	5	0.08	4	0.06	4	0.06	5	0.08	4	0.06	5	0.08	5	0.08	5	0.08	4	0.06	5	0.08	5	0.08	5	0.08	3	0.05	5	0.08
20. Noise - Relative Community Noise Burden	2.4%	2	0.05	2	0.05	1	0.02	3	0.07	1	0.02	1	0.02	1	0.02	3	0.07	4	0.10	4	0.10	3	0.07	4	0.10	4	0.10	3	0.07	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	3	0.07
21. Impacts on community facilities.	1.6%	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08
22. Length (km) of route that utilises existing road reserve (not as a service road)	3.6%	3	0.11	3	0.11	1	0.04	5	0.18	4	0.15	4	0.15	3	0.11	5	0.18	3	0.11	3	0.11	1	0.04	3	0.11	3	0.11	1	0.04	3	0.11	3	0.11	1	0.04	3	0.11	3	0.11	1	0.04	3	0.11	3	0.11	1	0.04	3	0.11	3	0.11	1	0.04	4	0.15	3	0.11
Local Economic																																																				
23. Number of existing farm businesses and other businesses directly affected.	2.6%	4	0.10	5	0.13	5	0.13	3	0.08	1	0.03	2	0.05	1	0.03	3	0.08	1	0.03	2	0.05	1	0.03	1	0.03	1	0.03	2	0.05	2	0.05	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	2	0.05	2	0.05	2	0.05	3	0.08	2	0.05	1	0.03	1	0.03
24. Severance impact of businesses by type (% impacted).	2.1%	4	0.08	4	0.08	4	0.08	5	0.10	4	0.08	4	0.08	4	0.08	4	0.08	4	0.08	2	0.04	2	0.04	2	0.04	4	0.08	4	0.08	4	0.08	5	0.10	5	0.10	5	0.10	4	0.08	4	0.08	4	0.08	4	0.08	1	0.02	1	0.02	1	0.02	1	0.02	4	0.08	3	0.06
25. Total loss of agricultural land based on land use type (Area ha).	3.4%	3	0.10	2	0.07	3	0.10	5	0.17	4	0.14	3	0.10	4	0.14	4	0.14	3	0.10	2	0.07	3	0.10	4	0.14	3	0.10	4	0.14	5	0.17	4	0.14	5	0.17	4	0.14	3	0.10	4	0.14	3	0.10	2	0.07	3	0.10	3	0.10	2	0.07	3	0.10	2	0.07	1	0.03
26. Area (ha) of state significant land impacted.	3.4%	4	0.14	4	0.14	4	0.14	4	0.14	4	0.14	4	0.14	4	0.14	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	4	0.14	4	0.14	4	0.14	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	4	0.14	1	0.03
Environment & Cultural Heritage																																																			
27. Number and area of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	3.8%	3	0.11	3	0.11	3	0.11	3	0.11	4	0.15	3	0.11	4	0.15	2	0.08	3	0.11	3	0.11	3	0.11	3	0.11	3	0.11	3	0.11	3	0.11	3	0.11	3	0.11	4	0.15	4	0.15	4	0.15	4	0.15	4	0.15	4	0.15	2	0.08	2	0.08
28. Number of 'edges' created through remnant and regenerated habitat areas.	3.3%	1	0.03	1	0.03	1	0.03	2	0.07	3	0.10	3	0.10	3	0.10	2	0.07	2	0.07	2	0.07	2	0.07	2	0.07	2	0.07	2	0.07	1	0.03	1	0.03	1	0.03	1	0.03	2	0.07	2	0.07	2	0.07	2	0.07	2	0.07	2	0.07	2	0.07	4	0.13	3	0.10
29. Number of times a wildlife corridor is crossed.	3.6%	5	0.18	5	0.18	5	0.18	1	0.04	5	0.18	5	0.18	5	0.18	1	0.04	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18
30. Number of high and medium value sites of cultural heritage significance directly affected.	2.9%	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15
31. Areas of high and medium potential for archaeological deposits directly affected.	3.0%	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15	5	0.15
32. Number and value of waterways directly impacted	2.8%	4	0.11	4	0.11	4	0.11	2	0.06	2	0.06	2	0.06	2	0.06	2	0.06	2	0.06	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	5	0.14	5	0.14	4	0.11	5	0.14	5	0.14	4	0.11	5	0.14	5	0.14	3	0.09	3	0.09
33. Number of springs directly impacted.	3.6%	4	0.14	4	0.14	4	0.14	2	0.07	3	0.11	3	0.11	3	0.11	2	0.07	4	0.14	4	0.14	4	0.14	5	0.18	5	0.18	5	0.18	5	0.18	3	0.11	3	0.11	3	0.11	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04
34. Number of contaminated sites directly impacted.	2.5%	4	0.10	4	0.10	4	0.10	3	0.07	4	0.10	4	0.10	4	0.10	4	0.10	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	4	0.10	4	0.10	4	0.10	4	0.10	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12	5	0.12
Engineering and Cost																																																			
35. Length (m)	2.6%	4	0.11	4	0.11	4	0.11	3	0.08	5	0.13	5	0.13	5	0.13	3	0.08	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	5	0.13	4	0.11
36. Relative costs of options.	3.2%	1	0.03	1	0.03	1	0.03	5	0.16	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	2	0.06	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	5	0.16	5	0.16
37. Length of route through areas of geological risk.	3.8%	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	4	0.13	4	0.13	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	4	0.15	4	0.15
38. Buildability	3.3%	4	0.13	4	0.13	5	0.17	3	0.10	3	0.10	3	0.10	4	0.13	3	0.10	4	0.13	4	0.13	4	0.13	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	4	0.13	4	0.13
39. Length of highway within flood prone land.	4.1%	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21	5	0.21
Weighted Scores																																																			
Sum total			3.90						3.45		3.89						3.34		3.77						3.91						4.07						3.98						3.88						3.94				3.78		3.60
Ranking of Weighted Scores			5						11		6						12		9						4						1						2						7						3				8		10
Unweighted Scores																																																			
Sum Total		152.0						126.0		150.0						124.0		147.0						152.0						159.0						155.0						152.0						155.0				145.0		141.0	
Rank of Unweighted Scores		4						11		7						12		8						4						1						2						4						2				9		10	

Assessment Process for Long List of Routes in the Bangalow Zone with Sensitivity Test (Agency) Pairwise Results

Sieve 1 Evaluation Criteria	Pairwise Rating (%)	1 J2 E6		2 J2 A6		3 J2 H7		4 L3 L4		5 L3 H6 E6		6 L3 H6 A6		7 L3 H6 H7		8 H5 L4		9 H5 H6 E6		10 H5 H6 A6		11 H5 H6 H7		12 G2 E6		13 G2 A6		14 G2 H7		15 A5 E6		16 A5 A6		17 A5 H7		18 K2 E6		19 K2 A6		20 K2 H7		21 C6 E5 E6		22 C6 E5 A6		23 C6 E5 H7		24 E4 E5 E6		25 E4 E5 A6		26 E4 E5 H7		27 L3 M1		28 H5 M1	
		UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W	UW	W
Safety and Accidents																																																				
1. Qualitative comparison of likely crash rates for each option	3.1%	5	0.16	5	0.16	5	0.16	1	0.03	5	0.16	5	0.16	5	0.16	1	0.03	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	5	0.16	4	0.12	4	0.12
2. Local traffic use of highway	3.9%	5	0.20	5	0.20	5	0.20	1	0.04	5	0.20	5	0.20	5	0.20	1	0.04	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20	5	0.20
3 Compliance to Desirable Geometrical Design Standards for Safety	1.1%	5	0.05	5	0.05	5	0.05	1	0.01	4	0.04	4	0.04	4	0.04	1	0.01	4	0.04	4	0.04	4	0.04	4	0.04	5	0.05	5	0.05	5	0.05	5	0.05	4	0.04	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	3	0.03	3	0.03
4. Length (km) through potentially fog prone areas.	2.8%	4	0.11	4	0.11	4	0.11	4	0.11	3	0.09	3	0.09	3	0.09	4	0.11	3	0.09	3	0.09	3	0.09	4	0.11	4	0.11	3	0.09	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11
Travel Time and Transport Costs																																																			
5. Estimated travel time savings compared with existing Pacific Highway alignment in the study area.	1.9%	4	0.08	4	0.08	5	0.09	2	0.04	4	0.08	4	0.08	4	0.08	2	0.04	4	0.08	4	0.08	5	0.09	4	0.08	4	0.08	5	0.09	4	0.08	4	0.08	4	0.08	5	0.09	4	0.08	4	0.08	5	0.09	4	0.08	4	0.08	5	0.09	3	0.06	3	0.06
Social and Health																																																			
6. Extent and length of steep grades (ie in excess of 4.5%)	1.1%	5	0.06	5	0.06	5	0.06	1	0.01	4	0.05	4	0.05	4	0.05	2	0.02	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	1	0.01	2	0.02
7. Number of dwellings to be aquired located within the proposed road reserve	2.9%	3	0.09	3	0.09	3	0.09	1	0.03	3	0.09	3	0.09	3	0.09	1	0.03	4	0.11	4	0.11	4	0.11	3	0.09	3	0.09	3	0.09	4	0.11	3	0.09	3	0.09	4	0.11	3	0.09	3	0.09	4	0.11	4	0.11	3	0.09	4	0.11	4	0.11
8. Number of dwellings to be acquired located within the proposed road reserve that are not currently within 200m (either side) of the existing alignment.	2.6%	5	0.13	5	0.13	4	0.11	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	4	0.11	4	0.11	4	0.11	5	0.13	5	0.13	4	0.11	5	0.13	5	0.13	4	0.11	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
9. Area (ha) of private land (business & residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	2.1%	2	0.04	2	0.04	2	0.04	4	0.09	2	0.04	2	0.04	2	0.04	3	0.06	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	2	0.04	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	2	0.04	1	0.02
10. Area (ha) of private land (business and residential) to be acquired that is not currently within 200m (either side) of the existing alignment.	2.2%	2	0.04	2	0.04	2	0.04	5	0.11	3	0.07	3	0.07	3	0.07	4	0.09	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	2	0.04	2	0.04
11. Number of currently contiguous settlement areas severed.	3.8%	2	0.08	2	0.08	2	0.08	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	2	0.08	2	0.08	2	0.08	2	0.08	2	0.08	1	0.04	1	0.04	2	0.08	2	0.08	2	0.08	2	0.08	2	0.08	2	0.08	5	0.19	5	0.19
12. Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEP's and/or relevant Shire strategies.)	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14
13. Number and extent of severance impacts on individual residential properties.	2.6%	5	0.13	5	0.13	5	0.13	3	0.08	5	0.13	5	0.13	4	0.10	4	0.10	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
14. Visual and Landscape - Number of residential properties within 1km of the Highway route option.	3.8%	5	0.19	5	0.19	5	0.19	1	0.04	2	0.08	2	0.08	2	0.08	2	0.08	3	0.11	3	0.11	3	0.11	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	4	0.15	5	0.19
15. Length (km) of route with visual benefit to the driver.	2.7%	4	0.11	4	0.11	5	0.14	3	0.08	4	0.11	5	0.14	5	0.14	2	0.05	3	0.08	4	0.11	4	0.11	4	0.11	4	0.11	5	0.14	3	0.08	4	0.11	4	0.11	4	0.11	5	0.14	4	0.11	4	0.11	5	0.14	4	0.11	5	0.14	4	0.11	3	0.08
16. Length (km) of route located on the coastal flats.	2.9%	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	4	0.11	4	0.11	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14	5	0.14
17. Length (km) of route through scenic escarpment.	3.3%	5	0.17	5	0.17	5	0.17	1	0.03	5	0.17	5	0.17	5	0.17	1	0.03	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	5	0.17	4	0.13	4	0.13
18. Length of route through exposed ridges and hills.	2.8%	3	0.08	3	0.08	3	0.08	1	0.03	4	0.11	4	0.11	4	0.11	1	0.03	3	0.08	3	0.08	3	0.08	3	0.08	4	0.11	3	0.08	3	0.08	4	0.11	3	0.08	3	0.08	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	4	0.11	3	0.08	3	0.08
19. Noise - Absolute Community Noise Burden	4.1%	3	0.12	4	0.17	3	0.12	1	0.04	4	0.17	4	0.17	3	0.12	2	0.08	5	0.21	5	0.21	4	0.17	4	0.17	4	0.17	5	0.21	4	0.17	5	0.21	5	0.21	5	0.21	4	0.17	5	0.21	4	0.17	5	0.21	5	0.21	5	0.21	3	0.12	5	0.21
20. Noise - Relative Community Noise Burden	3.0%	2	0.07	2	0.07	1	0.04	3	0.11	1	0.04	1	0.04	1	0.04	1	0.04	5	0.18	4	0.14	3	0.11	4	0.14	4	0.14	3	0.11	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	5	0.18	1	0.04	3	0.11
21. Impacts on community facilities.	2.5%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
22. Length (km) of route that utilises existing road reserve (not as a service road)	3.3%	3	0.10	3	0.10	1	0.03	5	0.16	4	0.13	4	0.13	3	0.10	5	0.16	3	0.10	3	0.10	1	0.03	3	0.10	3	0.10	1	0.03	3	0.10	3	0.10	1	0.03	3	0.10	3	0.10	1	0.03	3	0.10	3	0.10	1	0.03	3	0.10	4	0.13	3	0.10
Local Economic																																																				
23. Number of existing farm businesses and other businesses directly affected.	3.0%	4	0.12	5	0.15	5	0.15	3	0.09	1	0.03	2	0.06	1	0.03	3	0.09	1	0.03	2	0.06	1	0.03	1	0.03	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	2	0.06	2	0.06	2	0.06	3	0.09	2	0.06	1	0.03	1	0.03
24. Severance impact of businesses by type (% impacted).	3.0%	4	0.12	4	0.12	4	0.12	5	0.15	4	0.12	4	0.12	4	0.12	4	0.12	2	0.06	2	0.06	2	0.06	1	0.03	2	0.06	2	0.06	2	0.06	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	4	0.12	3	0.09
25. Total loss of agricultural land based on land use type (Area ha).	3.6%	3	0.11	2	0.07	3	0.11	5	0.18	4	0.14	3	0.11	4	0.14	4	0.14	3	0.11	2	0.07	3	0.11	4	0.14	3	0.11	4	0.14	5	0.18	4	0.14	5	0.18	4	0.14	3	0.11	4	0.14	3	0.11	2	0.07	3	0.11	3	0.11	2	0.07	3	0.11	2	0.07	1	0.04
26. Area (ha) of state significant land impacted.	3.7%	4	0.15	4	0.15	4	0.15	4	0.15	4	0.15	4	0.15	4	0.15	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	4	0.15	4	0.15	4	0.15	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	5	0.19	4	0.15	1	0.04
Environment & Cultural Heritage																																																			
27. Number and area of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	3.2%	3	0.10	3	0.10	3	0.10	3	0.10	4	0.13	3	0.10	4	0.13	2	0.06	3	0.10	3	0.10	3	0.10	3	0.10	3	0.10	3	0.10	3	0.10	3	0.10	3	0.10	4	0.13	3	0.10	3	0.10	4	0.13	4	0.13	4	0.13	4	0.13	4	0.13	2	0.06	2	0.06
28. Number of 'edges' created through remnant and regenerated habitat areas.	2.6%	1	0.03	1	0.03	1	0.03	2	0.05	3	0.08	3	0.08	3	0.08	2	0.05	2	0.05	2	0.05	2	0.05	2	0.05	2	0.05	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	2	0.05	2	0.05	2	0.05	2	0.05	2	0.05	2	0.05	4	0.10	3	0.08
29. Number of times a wildlife corridor is crossed.	2.6%	5	0.13	5	0.13	5	0.13	1	0.03	5	0.13	5	0.13	5	0.13	1	0.03	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
30. Number of high and medium value sites of cultural heritage significance directly affected.	2.6%	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13	5	0.13
31. Areas of high and medium potential for archaeological deposits directly affected.	1.6%	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08	5	0.08
32. Number and value of waterways directly impacted	1.5%	4	0.06	4	0.06	4	0.06	2	0.03	2	0.03	2	0.03	2	0.03	4	0.06	2	0.03	2	0.03	4	0.06	4	0.06	4	0.06	4	0.06	4	0.06	4	0.06	4	0.06	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	5	0.07	4	0.06	3	0.04
33. Number of springs directly impacted.	1.1%	4	0.04	4	0.04	4	0.04	2	0.02	3	0.03	3	0.03	3	0.03	2	0.02	4	0.04	4	0.04	4	0.04	4	0.04	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	3	0.03	3	0.03	3	0.03	3	0.03	1	0.01	1	0.01	1	0.01	1	0.01	1	0.01
34. Number of contaminated sites directly impacted.	0.6%	4	0.02	4	0.02	4	0.02	3	0.02	4	0.02	4	0.02	4	0.02	4	0.02	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	4	0.02	4	0.02	4	0.02	4	0.02	4	0.02	4	0.02	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03
Engineering and Cost																																																			
35. Length (m)	0.3%	4	0.01	4	0.01	4	0.01	3	0.01	5	0.02	5	0.02	5	0.02	3	0.01	5	0.02	5	0.02	5	0.02	5	0.02	5	0.02	5	0.02	5	0.02	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	4	0.01	5	0.02	4	0.01
36. Relative costs of options.	2.2%	1	0.02	1	0.02	1	0.02	5	0.11	1	0.02	1	0.02	1	0.02	5	0.11	1	0.02	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	5	0.11	5	0.11
37. Length of route through areas of geological risk.	1.1%	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	4	0.05	4	0.05	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	5	0.06	4	0.05	4	0.05
38. Buildability	3.4%	4	0.13	4	0.13	5	0.17	3	0.10	3	0.10	3	0.10	4	0.13	3	0.10	4	0.13	4	0.13	4	0.13	4	0.13	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13	5	0.17	4	0.13	4	0.13
39. Length of highway within flood prone land.	1.9%	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09	5	0.09
Weighted Scores																																																			
Sum total			3.82						3.19		3.82						3.11		3.70						3.79				4.04						4.00				3.92						3.99						3.72		3.64
Ranking of Weighted Scores			5						11		6						12		9						7				1						2				4						3						8		10
Unweighted Scores																																																			
Sum Total		152.0						126.0		150.0						124.0		147.0						152.0				159.0						155.0				152.0						155.0						145.0		141.0	
Rank of Unweighted Scores		4						11		7						12		8						4				1						2				4						2						9		10	

Appendix C

Pairwise Results

T2E Summary of Pairwise - September 2005

No.	EVALUATION CRITERIA	Project Team Average (Note 1)	CLG Average (Note 2)	Agency Average (Note 2)	CLG Ranking	Agency Ranking	Project Team Ranking
1	Qualitative comparison of likely crash rates for each option.	4.9%	2.7%	3.1%	19	12	1
2	Local traffic use of highway.	2.0%	1.6%	3.9%	31	2	29
3	Length (km) of highway between minimum and desirable design criteria.	3.1%	1.5%	1.1%	36	37	13
4	Length (km) of route through potentially fog prone areas.	0.3%	2.3%	2.8%	24	18	39
5	Estimated travel time savings (minimum) compared with existing highway alignment in the study area.	1.2%	1.0%	1.9%	39	30	35
6	Extent and length of steep grades (ie in excess of 4.5%). **proxy for peak (Lmax) noise levels.*	2.3%	2.0%	1.1%	28	35	26
7	Number of dwellings to be acquired i.e. those located within the proposed route corridor.	4.1%	1.4%	2.9%	37	16	3
8	Number of dwellings to be acquired i.e. those located within the proposed route corridor that are not currently within 200m (either side) of the existing highway alignment.	2.9%	2.1%	2.6%	26	21	17
9	Area (ha) of private land (business & residential) to be acquired. i.e. land located within the proposed route corridor.	3.2%	1.6%	2.1%	30	29	11
10	Area (ha) of private land (business and residential) to be acquired i.e. land located within the proposed route corridor that is not currently within 200m (either side) of the existing highway alignment.	2.1%	2.2%	2.2%	25	27	28
11	Number of currently contiguous settlement areas severed.	4.1%	2.7%	3.8%	18	3	2
12	Area (ha) and extent of severance impacts on areas designated for future residential development (as identified in Ballina and Byron Shires LEP's and/or relevant Shire strategies).	1.0%	2.9%	2.9%	15	17	37
13	Number and extent of severance impacts on individual residential properties.	3.4%	1.9%	2.6%	29	25	9
14	*Visual & Landscape:* Number of dwellings within 1km of the route option. **proxy for potential changes in property value.*	1.8%	1.6%	3.8%	32	4	30
15	*Visual & Landscape* : Length (km) of route with visual benefit to the driver/passengers.	1.2%	1.6%	2.7%	33	20	36
16	*Visual & Landscape:* Length (km) of route located on the coastal flats.	1.3%	3.7%	2.9%	4	15	34
17	*Visual & Landscape* : Length (km) of route through scenic escarpment.	3.0%	2.7%	3.3%	17	9	15
18	*Visual & Landscape* : Length (km) of route through exposed ridges and hills.	2.6%	1.3%	2.8%	38	19	20
19	*Noise:* Absolute Community Noise Burden.	3.7%	1.5%	4.1%	35	1	6
20	*Noise* : Relative Community Noise Burden. ** proxy for potential changes in property value.*	3.5%	2.4%	3.6%	23	6	8
21	Impacts on community facilities.	2.4%	1.6%	2.5%	34	26	23
22	Length (km) of route that utilises existing road reserve (not as a service road).	1.5%	3.6%	3.3%	6	10	31
23	Number of existing farm businesses and other businesses to be acquired i.e. those located within the proposed route corridor.	3.7%	2.6%	3.0%	21	13	5
24	Severance impact of businesses by type (% impacted).	3.0%	2.1%	3.0%	27	14	14
25	Total loss of agricultural land based on land use type (area ha).	3.2%	3.4%	3.6%	9	7	10
26	Area (ha) of state significant land impacted.	2.5%	3.4%	3.7%	8	5	21
27	Number and area (ha) of high and medium value remnant and regenerated vegetation or habitat likely to be affected.	4.0%	3.8%	3.2%	3	11	4
28	Number of 'edges' created through remnant and regenerated habitat areas.	2.9%	3.3%	2.6%	11	24	16
29	Number of times a wildlife corridor is crossed.	2.5%	3.6%	2.6%	5	23	22
30	Number of high and medium value sites of cultural heritage significance directly affected.	3.5%	2.9%	2.6%	14	22	7
31	Areas (ha) of high and medium potential for archaeological deposits directly affected.	2.4%	3.0%	1.6%	13	32	24
32	Number and value of waterways directly impacted.	2.4%	2.8%	1.5%	16	33	25
33	Number of springs directly impacted.	2.3%	3.6%	1.1%	7	36	27
34	Number of contaminated sites directly impacted.	1.3%	2.5%	0.6%	22	38	32
35	Length (km) of route.	0.8%	2.6%	0.3%	20	39	38
36	Relative costs of options.	3.2%	3.2%	2.2%	12	28	12
37	Length (km) of route through areas of geological risk.	2.6%	3.8%	1.1%	2	34	19
38	Buildability.	2.8%	3.3%	3.4%	10	8	18
39	Length (km) of highway through flood prone land .	1.3%	4.1%	1.9%	1	31	33
	Note 1: Project Team - Base Case	100%	100.0%	100.0%			
	Note 2: CLG and Agency - Sensitivity Testing						