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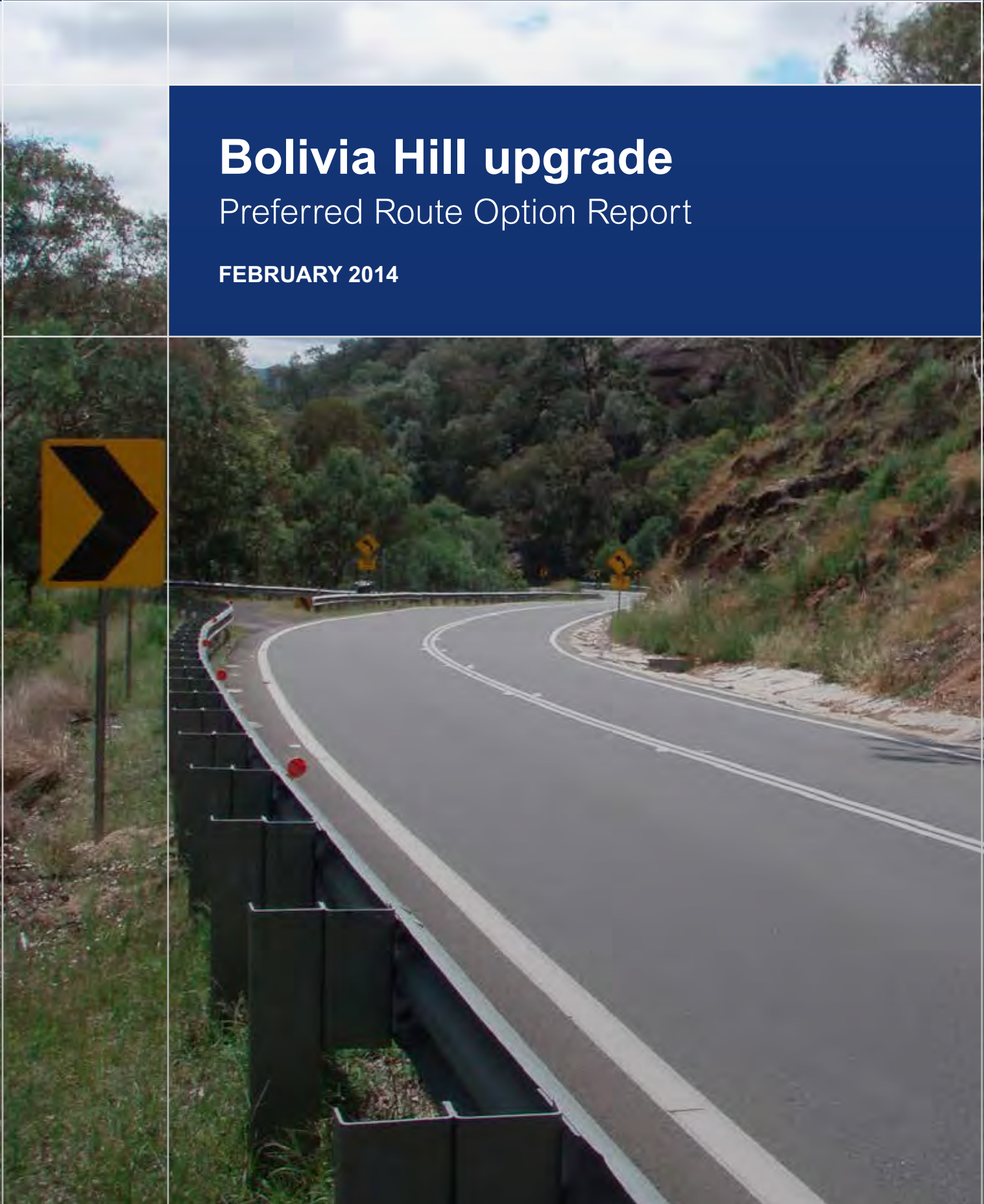


Transport
Roads & Maritime
Services

Bolivia Hill upgrade

Preferred Route Option Report

FEBRUARY 2014



Executive summary

Introduction

The New England Highway (HW9) is a major link between the Hunter Region and the New England area and beyond.

Bolivia Hill is a steep winding section of the New England Highway between Glen Innes and Tenterfield within the local government area of Tenterfield. The existing highway corridor is narrow with a rock face to the east and a steep drop to the west.

The Australian Government has committed \$6 million for planning of safety works at Bolivia Hill and a future Tenterfield heavy vehicle bypass. Planning for the Bolivia Hill upgrade has involved development of route options and identification of a preferred route. In December 2013, the Australian Government announced an additional \$80 million for construction of the Bolivia Hill upgrade.

The objectives of the Bolivia Hill upgrade project are to:

- Improve road safety
- Improve road transport productivity, efficiency and reliability of travel
- Minimise the impact on the natural, cultural and built environment
- Provide value for money.

Study area characteristics

An area covering approximately 4.5 square kilometres between the top of Bolivia Hill in the south and Pyes Creek bridge in the north formed the immediate study area for investigations of road upgrade options. This area covers a length of approximately three kilometres of the existing highway and extends around 750 metres either side of the highway.

There are significant constraints for road upgrade options in the study area including:

- Very steep terrain
- The Main Northern Railway (disused)
- Agricultural industry
- Aboriginal and non-Aboriginal cultural heritage items
- Areas identified as Endangered Ecological Communities and the presence of threatened species.

None of these constraints lead to any potential route being discarded in its own right. However, it is combinations of desirable and non-desirable attributes of routes that lead to their recommendation or discard as a feasible route.

Community and stakeholder engagement

Community engagement is a key factor for the successful outcome of this project.

Community engagement is necessary to:

- Understand the issues raised by the community and ensure that these are considered in the route options development process
- Inform the community of the process and provide an opportunity to influence decisions taken during the course of the project
- Seek community knowledge and data to assist the investigation of potential impacts
- Improve the overall design outcomes by minimising impacts and optimising mitigation measures.

Engagement approach

During the development of the preferred route, the approach to stakeholder engagement included:

- Tailoring engagement to communicate with different stakeholder groups
- Carrying out consultation activities during key periods of project development
- Understanding and addressing stakeholder issues, where possible
- Incorporating consultation outcomes into the project's development.

Engagement carried out

Community and stakeholder engagement activities conducted during key project phases included:

- Establishment of engagement tools: 1800 freecall number, project email address, project webpage
- Media advertising
- Community updates
- Community survey
- Community drop-in sessions
- Letters to stakeholders
- Meeting with Tenterfield Shire Council.

No major issues were raised as a result of the display of the Recommended Preferred Option in August/September 2013.

The project development process

Route options identification

The identification of a shortlist of route options which best met the objectives of the project was undertaken using the generally recognised route options development process, as described below.

Initially, a list of 10 route options (with two variants of one option, making a total of 11 options) was identified using engineering and route selection principles. These options are shown in **Figure ES-1**.

The development of the shortlist of route options from the list was based on a qualitative assessment of the relative impacts of each plus a quantitative assessment of the relative cost of each.

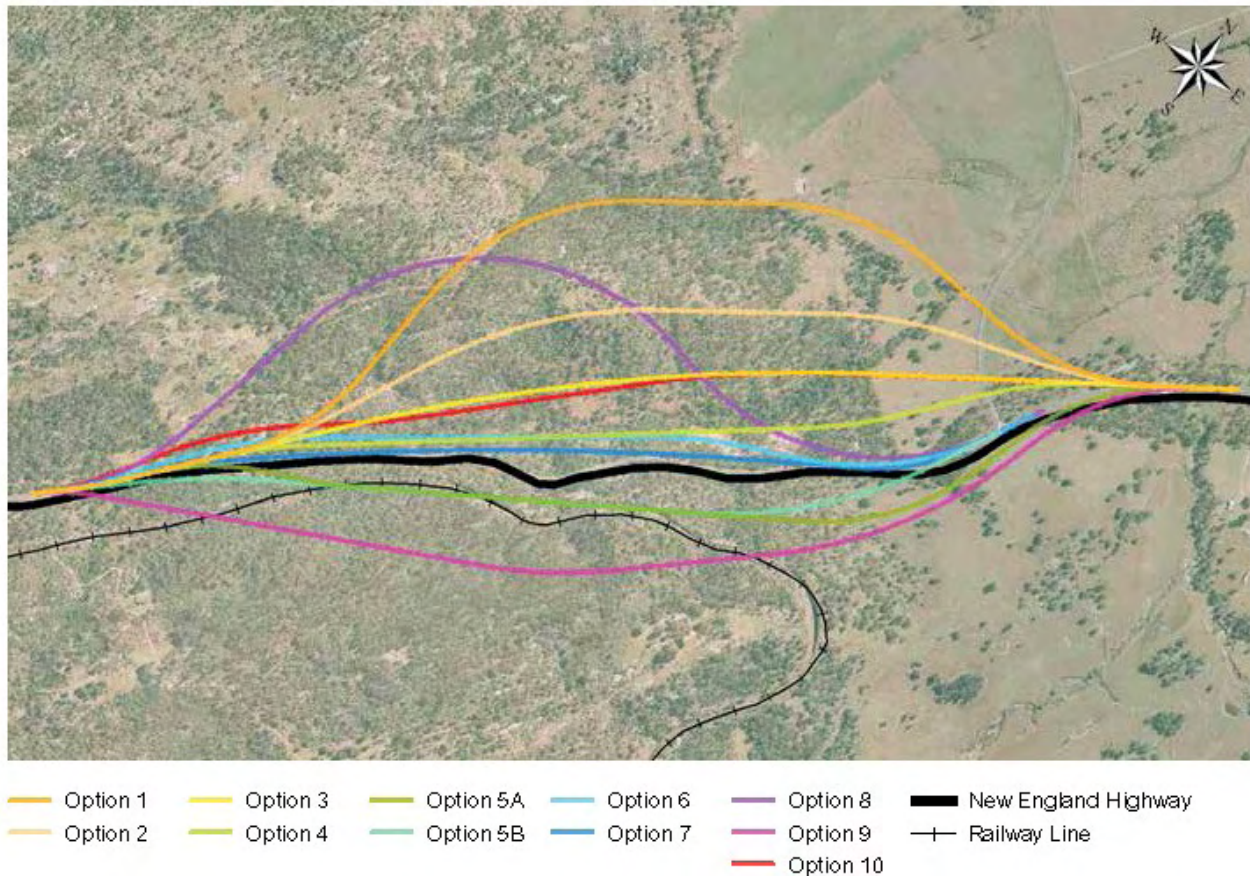


Figure ES-1 List of route options

Shortlisting of route options for further development

The shortlisting process of route options for this project followed four phases:

- ***Determination of a list of options***

A list of options was developed using engineering and route selection principles.

- ***Initial assessments***

Each potentially feasible route was reviewed in detail in relation to many specific evaluation categories. This established a preliminary understanding of how routes performed relative to the project objectives. The evaluation categories comprised:

- | | |
|--|-----------------------|
| – Community input | – Utilities |
| – Alignment, staging and access | – Planning and zoning |
| – Water quality | – Land use |
| – Terrestrial ecology | – Ground conditions |
| – Flooding and drainage | – Cost |
| – Aboriginal and non-Aboriginal heritage | – Traffic |
| – Climate | |

- ***Technical workshop***

This process involved a qualitative assessment of how well each of the options met the project objectives using a workshop format with internal technical specialists from Roads and Maritime Services (Roads and Maritime), Transport for NSW and Cardno. The evaluation categories were utilised to

debate each scenario in the workshop. The list of feasible route options subsequently identified routes that performed better than others.

- **Conclusions**

The outcome of the internal technical workshop process was a shortlist of four feasible route options. Three of the shortlisted options (Option 2, Option 6 and Option 10) are to the west of the existing highway. Option 7 is an upgrade of the existing highway that utilises as much of the existing road as possible and straightens out the substandard bends in the steepest section of the road.

These options were reviewed in relation to similar projects on the New England Highway such as Devils Pinch (south of Glen Innes) to refine the criteria and reduce the cost.

Development of the shortlisted route options

The following additional specialist studies were undertaken following the shortlisting of options to provide input into evaluation of the options and the selection of a preferred option:

- Terrestrial and aquatic biodiversity field studies
- Aboriginal and non-Aboriginal field studies.

The shortlisted options were subsequently reviewed in light of the additional studies as well as a set of revised design criteria (from that used for the initial option identification and assessment). Costs of the revised shortlisted options were then reassessed. All of the revised shortlisted options contained one northbound (downhill) lane and two southbound (uphill) lanes. The revised shortlisted options are shown in **Figure ES-2**.



Option 2 *Estimated cost \$150 million*



Option 6 *Estimated cost \$123 million*



Option 7 *Estimated cost \$115 million*



Option 10 *Estimated cost \$157 million*

Figure ES-2 **Shortlisted options with cost estimates in 2013 dollars**

Review of shortlisted options

As the shortlisted options were each estimated to cost in excess of the anticipated funding available the Roads and Maritime Major Projects Review Committee (MPRC) requested the project team to further

investigate an optimised solution that provided greater value for money, while still meeting the other project objectives. The option should align with the objectives of the NSW Government's submission to the Australian Government by:

- realigning the small radius curves
- widening the shoulders to improve road safety.

Preferred option selection

Development of the recommended preferred option

Revised design criteria were proposed to aid in reducing costs.

The option would also only require one lane in each direction as it had been previously established through the option assessment process that there is no warrant for overtaking lanes.

Two options were developed and costed. The options were designated Option 7a and Option 7b as they are sub-options of the previously shortlisted Option 7.



Figure ES-3 Option 7b

The options were examined in a value engineering workshop. Following a review of Options 7a and 7b and the previously shortlisted options 2, 6, 7 and 10 the workshop concluded that:

- Both the options met the project objectives as well as, or better than, the four previously shortlisted options
- Option 7b, at an estimated cost of \$60 million (\$2013), represents better value for money than Option 7a at an estimated cost of \$80 million (\$2013).

Workshop participants therefore agreed that Option 7b should be taken forward as the recommended preferred option for approval. The alignment of Option 7b is shown in **Figure ES-3**.

The recommended preferred route option

Option 7b was presented to the MPRC on 23 May 2013 with the recommendation that it be taken forward to the next stage of the project as the preferred option. The MPRC agreed that the Recommended Preferred Route Option Report be finalised with **Option 7b** as the preferred option and presented to the community.

Community feedback

The recommended preferred route option was presented to the community in September 2013. There were no changes proposed to the recommended preferred route option as a result of community feedback although a number of issues / recommendations will be addressed in the next stages of design.

The preferred route option

Option 7b has been confirmed as the preferred option. This preferred option was selected as it performs well across a combination of the technical input, the findings of the value management process, community feedback and best meets the project objectives.

Next steps

The proposed upgrade of this section of the New England Highway has been developed considering social, environmental and economic objectives in a way that achieves the best functional and community outcome.

Concept design and environmental impact assessment of the preferred option will be the next steps following announcement and publication of this report. Further ground survey, geotechnical and other investigations will be carried out to provide input into the refinement of the design and environmental impact assessment.

When completed, the environmental impact assessment will be publicly exhibited and input again sought from the community.

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Glossary of terms and abbreviations

AADT	Average annual daily traffic counts are published by Roads and Maritime. The total volume of traffic passing a roadside observation point over a period of a year, divided by the number of days per year.
Aboriginal cultural heritage	The tangible (objects) and intangible (dreaming stories, songlines, places) cultural practices and traditions associated with past and present day Aboriginal communities.
AHD	Australian Height Datum.
AHIMS	Aboriginal Heritage Information Management System is a register of NSW Aboriginal heritage information maintained by the NSW Office of Environment and Heritage.
Alignment	The geometric layout (of a road) in plan (horizontal) and elevation (vertical).
ARI	Average recurrence interval of a flood event used to describe the frequency or probability of floods occurring (eg a 100 year ARI flood is a flood that occurs or is exceeded on average once every 100 years).
AR&R	Australian Rainfall and Runoff.
ASRIS	Australian Soil Resource Information System.
ASS	Acid Sulfate Soils are 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 run-off that can pollute waters and liberate toxins.
AWS	Automatic Weather Station.
BoM	Bureau of Meteorology.
BP	Before Present.
Carriageway	The portion of a roadway used by vehicles including shoulders and auxiliary lanes.
Catchment	The area from which a surface watercourse or a groundwater system derives its water.
CHL	Commonwealth Heritage List. A list of places owned or leased by the Commonwealth, which have heritage value.
CO	Carbon monoxide.
Concept Design	Initial functional layout design for a road or road system, to establish feasibility, to provide a basis for estimating, environmental impact assessment and to determine further investigations needed for detailed design.
Cost Benefit Analysis	An economic based assessment considering the merits of a project from the viewpoint of the community at large rather than that of the organisation responsible for the project.
Critical Habitat	The habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species.

Cutting	Formation resulting from the construction of the road below existing ground level – the material is cut out or excavated.
EEC	Endangered Ecological Community under the NSW <i>Threatened Species Conservation Act 1995</i> .
Environmental Impact Assessment (EIA)	The process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of proposals prior to major decisions being taken and commitments made.
Ephemeral	Existing for a short duration of time.
ESD	Ecologically Sustainable Development.
DECCW	Department of Environment, Climate Change and Water (functions are now within the Office of Environment and Heritage or the Department of Primary Industries).
ECA	Ecological Constraints Analysis.
EIS	Environmental Impact Statement.
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i> (NSW).
EPBC Act	<i>Environmental Protection and Biodiversity Conservation Act 1999</i> (Commonwealth).
FM Act	<i>Fisheries Management Act 1994</i> (NSW).
GDE	Groundwater dependent ecosystem.
GIS	Geographic Information System.
GMU	Groundwater Management Units.
IAP2	International Association for Public Participation.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
ISEPP	<i>State Environmental Planning Policy (Infrastructure) 2007</i> (NSW).
ITW	Internal Technical Workshop.
Key stakeholder	The key stakeholders are groups who are proactively engaged during the project.
KTP	Key Threatening Process.
LEP	Local Environmental Plan.
Level of service	A measure of the quality of road operating conditions, including speed, travel time, freedom to manoeuvre, traffic interruptions, and comfort and convenience.
LGA	Local Government Area.
MLALC	Moombahlene Local Aboriginal Land Council.
NHL	National Heritage List. A list established by the Australian Government of places of outstanding heritage significance.

NO _x	Oxides of nitrogen.
NPT	Roads and Maritime Network Planning Targets.
NPWS	National Parks and Wildlife Service.
NR	Nature Reserve.
NSW	New South Wales.
OEH	NSW Office of Environment and Heritage (formerly known as Department of Environment and Climate Change and Water).
PAC	Planning Assessment Commission.
PAD	Potential Archaeological Deposit. Any location considered to have a moderate to high potential for subsurface archaeological material.
PACHCI	Procedure for Aboriginal Cultural Heritage Consultation and Investigation.
Project	Bolivia Hill Upgrade.
Project team	The team, comprising representatives of Roads and Maritime, Cardno (as the lead technical consultant) and other technical specialists, that is working on the project.
PROR	Preferred Route Option Report (this report).
Reduced level (RL)	The vertical distance between a survey point and the Australian Height Datum (AHD) .
Roads and Maritime	Roads and Maritime Services (formerly known as RTA: Roads and Traffic Authority) .
RNE	Register of the National Estate.
RPROR	Recommended Preferred Route Option Report.
RST	Road Surface Temperature.
SAL	Strategic Agricultural Lands.
SES	State Emergency Services.
SEPP	State Environmental Planning Policy.
SHI	NSW State Heritage Inventory.
SHR	NSW State Heritage Register. A register of places and items of particular importance to the people of NSW.
SO ₂	Sulfur Dioxide.
SSD	State Significant Development.
SSI	State Significant Infrastructure.
TEC	Threatened Ecological Community. An ecological community identified by relevant legislation that is likely to become extinct or is in immediate danger of extinction.
TfNSW	Transport for New South Wales.

TSC Act	<i>Threatened Species Conservation Act 1995 (NSW).</i>
TSR	Travelling Stock Route.
TS&CR	Travelling Stock and Camping Reserves.
VKT	Vehicle kilometres travelled.
VMS	Value management study.

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1 Introduction

1.1 Background

Roads and Maritime Services (Roads and Maritime) engaged Cardno in September 2012 to carry out an options and route assessment study and preliminary environmental assessment for upgrading approximately three kilometres of the New England Highway (HW9) at Bolivia Hill between Glen Innes and Tenterfield.

The New England Highway passes through the Bolivia Range about 55 kilometres north of Glen Innes in NSW. The Bolivia Range runs east west and connects with the Great Dividing Range to the east and Deepwater River passes around the range to the west. Bolivia Hill (1225 metres) and Little Bolivia (1100 metres) are hills within the Range. Both the New England Highway (1025 metres) and the Main Northern Railway line (disused) pass through gaps in the range just to the west of Bolivia Hill.

The existing highway at Bolivia Hill has a deficient horizontal alignment (curves with 75 kilometres per hour advisory speeds), steep grades (up to nine per cent) and an adverse crash history with respect to fatalities and injuries. It has narrow or no road shoulders with a rock face to the east and steep drop to the west. Traffic volumes at Bolivia Hill are relatively low with little or no growth over recent years.

The study includes development of route options and identification of a preferred option. A concept design and environment assessment will be carried out for the preferred option. Results of each of the main stages of the study will be put on public display.

Community engagement is a key aspect of this project. The broader community will have the opportunity to make a demonstrable input to the process and to ensure that the requirements and aspirations of the community will be adequately and appropriately addressed. This is particularly relevant to:

- Any potential impacts on rural areas within the study area
- Social and economic impacts
- Accessibility of the road network for local and through traffic
- Potential impacts on water quality
- Potential impact on flooding
- Potential impacts on land uses
- Threatened flora and fauna species
- Aboriginal and non-Aboriginal heritage
- Visual impact
- Noise.

The project is currently in the preferred option development and display phase.

This document has been prepared to explain the preferred option development process. It describes the investigative work and analysis that has led to the identification of the recommended preferred option. It describes the recommended preferred option and summarises the next steps.

1.2 Project objectives

The aim of the project is to determine a preferred New England Highway corridor route at Bolivia Hill. The objectives of the Bolivia Hill upgrade project are to:

- Improve road safety
- Improve road transport productivity, efficiency and reliability of travel
- Minimise the impact on the natural, cultural and built environment
- Provide value for money.

The preferred option development and selection process is one that seeks to identify the route that best meets these objectives. This process is set out in more detail in **Chapters 7 to 10**.

1.3 The study area

The study area identified for the proposed upgrade covers an area that starts at the top of Bolivia Hill (known as Chainage 56.4 kilometres) and descends to the valley floor to the north, ending at Pyes Creek bridge (known as Chainage 59.4 kilometres). The area is approximately three kilometres long and approximately 0.75 kilometres wide on either side of the existing highway. **Figure 1-1** shows the study area.

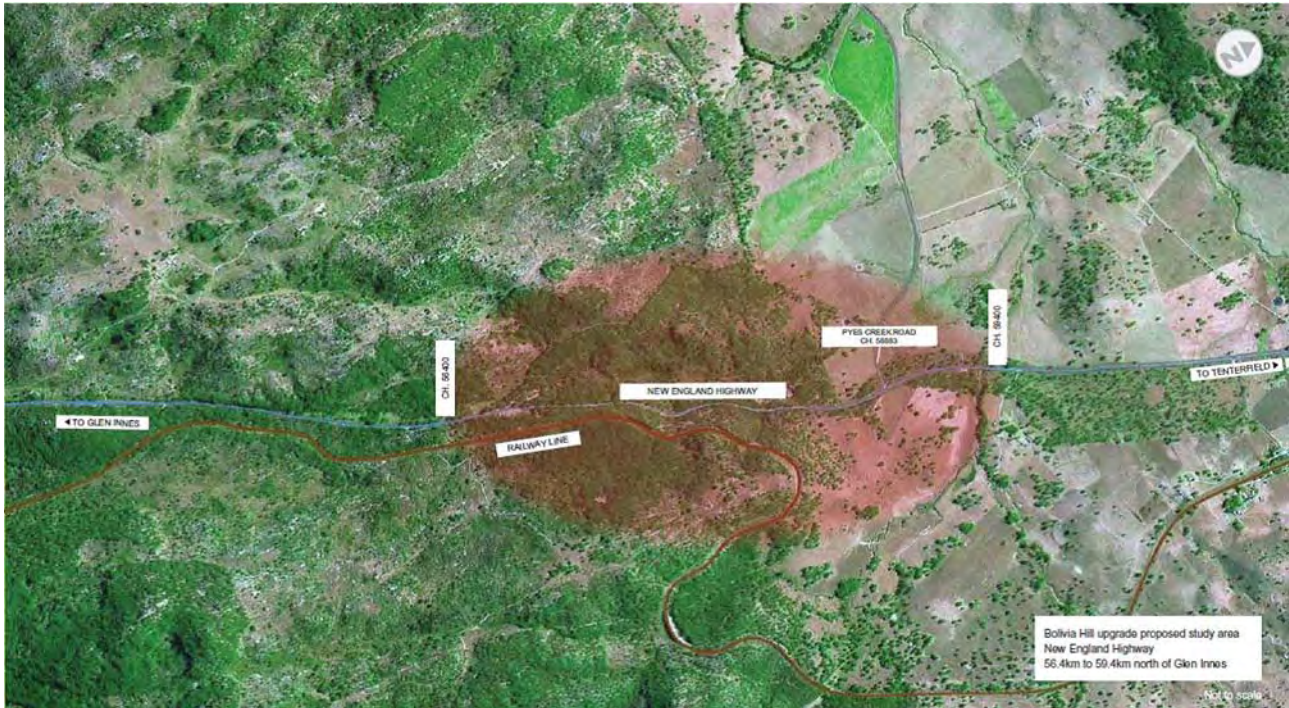


Figure 1-1 The study area (shaded red)

Significant constraints that influence the location and design of the route options include:

- The existing highway corridor
- Sub-standard road geometry of the existing highway
- Very steep terrain
- The Main Northern Railway (disused)
- Agricultural industry
- Aboriginal and non-Aboriginal cultural heritage items
- Areas identified as Threatened Ecological Communities and the presence of threatened species.

1.4 The existing highway

The section of the New England Highway that passes through the Bolivia Range is approximately nine kilometres long but the length of road locally known as "Bolivia Hill" is the section of the highway that descends 100 metres (980 metres to 880 metres AHD) over two kilometres on the northern granite escarpment of the range. This alignment has steep cross falls and narrow road corridors with hard rock cutting to the east of the alignment and steep rockfill embankments to the west. In the 1950s, a 35 metre deep rockfill embankment was constructed in the steep gully halfway down the northern escarpment. The steep downslope batter and gorge have carved out a granite ridgeline that is locally known as the central ridge. Some wetland areas and rock pools are located in the drainage lines.

Figures 1-2 to 1-4 show views of the existing highway within the study area.



Figure 1-2 Looking north on the New England Highway at the southern end of the study area



Figure 1-3 Looking north on the New England Highway from about the centre of the study area



Figure 1-4 Looking south on the New England Highway from just south of Pyes Creek Road

1.5 Project development process

Figure 1-5 shows a summary of the route options development and selection process. **Chapters 7 to 10** include descriptions of the route options development and preferred route option selection phases.

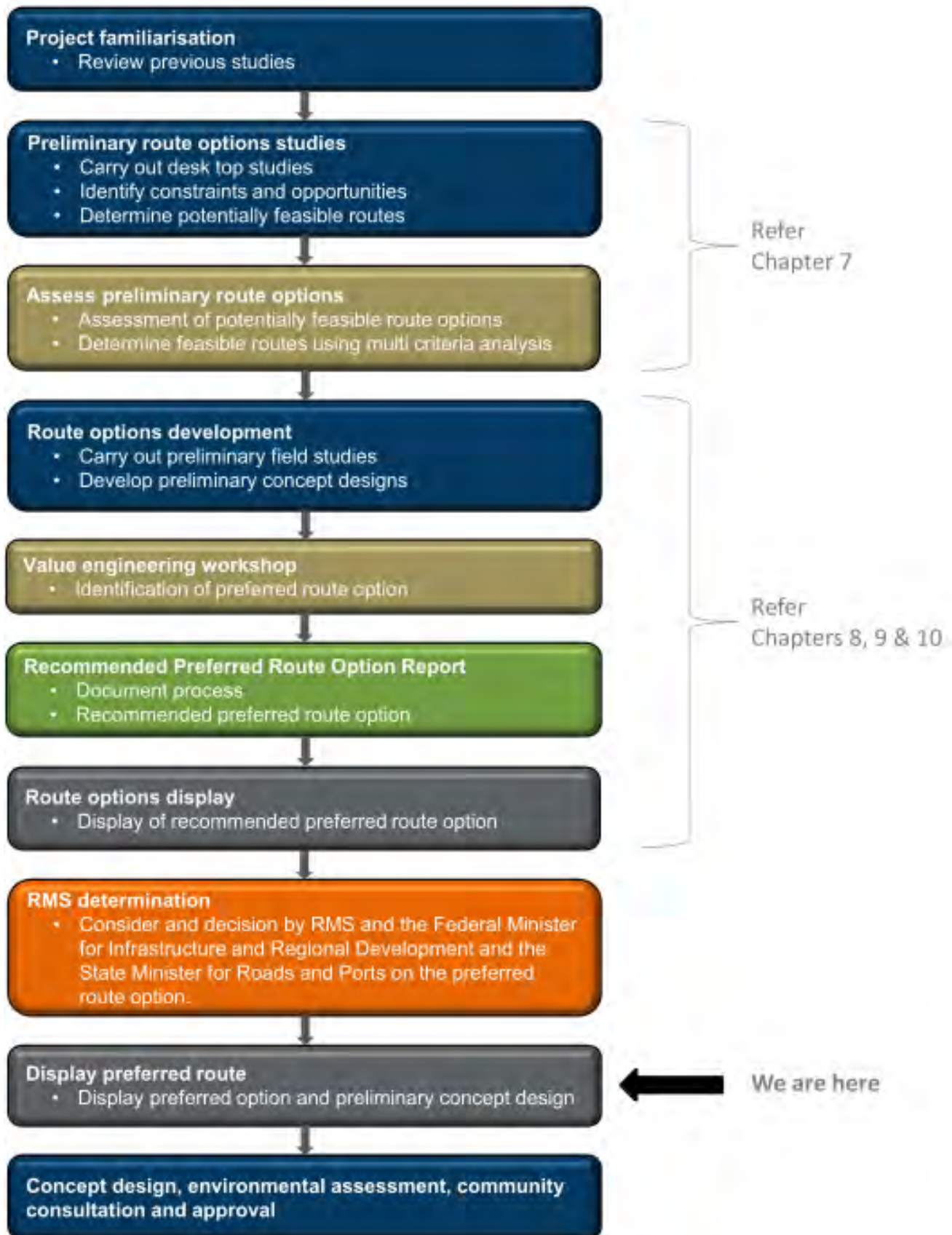


Figure 1-5 Project development process

Figure 1-6

1.6 Specialist studies

A number of key environmental, engineering and economic issues influence the location and design of the preferred option. Preliminary investigations are complete and include reviews of studies from previous investigations into the upgrade as well as field surveys specifically undertaken for the purposes of the assessment of options.

The current investigations comprise a review of existing background data, fieldwork and analysis to provide a more detailed understanding of the physical, social and economic aspects of the study area. Specialist studies conducted during the route options development phase include:

- Geotechnical (desktop)
- Topography, geology and soils
- Traffic, transport and road safety
- Public utilities and services
- Social-economic
- Flora and fauna (terrestrial and aquatic)
- Cultural heritage (Aboriginal and non-Aboriginal)
- Flooding and drainage
- Land use and planning
- Climate
- Visual amenity.

Further specialist studies were completed following the initial route options development stage to input into evaluation of route options and the selection of a preferred option:

- Flora and fauna (terrestrial and aquatic)
- Cultural heritage (Aboriginal and non-Aboriginal).

1.7 Roads and Maritime environmental commitment

Through its Environmental Policy 2009¹, Roads and Maritime is committed to undertaking activities in an environmentally responsible manner and to manage any risks that may lead to an impact on the environment. To this end, environmental management is considered an essential element of effective road and traffic related infrastructure planning, construction, maintenance and operation.

1.8 Ecologically sustainable development

Ecologically Sustainable Development (ESD) is development that aims to meet the needs of Australians today, while conserving our ecosystems for the benefit of future generations. Consideration of this is an important part of the project development process. This section provides an overview of the principles of ESD and provides a discussion on how they have been integrated into the options assessment process.

1.8.1 NSW Ecologically Sustainable Development Requirements

In NSW, Section 5(a)(vii) of the *Environmental Planning and Assessment Act 1979* (EP&A) Act states that ESD is a primary objective of the planning process under the Act. In accordance with the EP&A Act, Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* sets out the principles of ESD as follows:

¹ The Roads and Maritime Environmental Policy 2009 is available to download from the Roads and Maritime website www.rta.nsw.gov.au

- **The precautionary principle** – if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by:
 - Careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment
 - An assessment of the risk-weighted consequences of various options.
- **Inter-generational equity** – the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations
- **Conservation of biological diversity and ecological integrity** – that conservation of biological diversity and ecological integrity should be a fundamental consideration
- **Improved valuation pricing and incentive mechanisms** – environmental factors should be included in the valuation of assets and services, such as:
 - Polluter pays, i.e. those who generate pollution and waste should bear the cost of containment, avoidance or abatement
 - The users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste
 - 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.

1.8.2 **Commonwealth Ecologically Sustainable Development Requirements**

The *National Strategy for Ecologically Sustainable Development* (ESDSC, 1992) sets out the broad strategic and policy framework for governments to cooperatively make decisions and take actions to pursue ESD in Australia. The Strategy defines ESD as “*using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased*”.

1.8.3 **Application of the Principles**

The following outlines how each of the principles of ESD have been addressed within the route options assessment for the Bolivia Hill upgrade project.

The Precautionary Principle

The project has involved a number of desktop and field investigations to identify the biophysical, social and cultural environment of the study area (see **Chapter 5**). Explicit consideration was made of key constraints and opportunities identified in the route options assessment, with the information collated on the existing environment informing assessment criteria adopted in the scoring of the various route options. Where the impacts associated with a particular option were not known, a conservative approach was adopted.

The precautionary principle will also be applied during the environmental impact assessment phase, with the recommendations incorporated into the design and construction methodology where reasonable and feasible.

Inter-generational equity

The consideration of the potential environmental, social, cultural and economic impacts of the route options considered has sought to optimise the long-term benefits associated with the proposal. One of the core objectives of the project is to improve road safety, and the achievement of this objective will provide a long term benefit to the community.

The future environmental impact assessment of the project will ensure that the potential for long-term negative impacts is minimised. The risk of any long-term impacts occurring would be managed via the development of a series of environmental management and mitigation measures.

Ongoing community consultation will assist in identifying the community's concerns. This will enable the community to continue to provide feedback and raise issues for consideration by the Roads and Maritime as the project proceeds.

Conservation of biological diversity and ecological integrity

Field surveys of terrestrial and aquatic biodiversity have been undertaken, targeting conservation significant species and communities known, or with potential to, occur in the study area. This has led to the development of a considerable amount of information, and has enabled the preparation of maps overlaying the route options on sensitive communities and species records. This information was considered in the route options assessment and selection of the recommended preferred option, with an effort being made to minimise the impacts on biodiversity, particularly for conservation significant species habitat or communities.

The information collated will also be used to inform the development of the preferred option through the detailed concept design process.

Improved valuation pricing and incentive mechanisms

As discussed above, consideration of the potential environmental impacts of the project was incorporated into the options assessment. In addition, the route options assessment has involved an economic evaluation of the various options, including consideration of the project cost and the development of a cost:benefit ratio. This has been used in comparing the route options and selection of the preferred option.

1.9 Report objective

The objective of this report is to describe the preferred option that has emerged from the route options selection process.

More specifically, the report:

- Presents the justification for the project and its strategic context
- Outlines community engagement to date and key issues arising
- Confirms the constraints and opportunities which influence the development of feasible route options including social, environmental and engineering issues
- Confirms the design parameters applicable to this project
- Explains the route options development process and specifically the filtering of potential route options to a proposed shortlist of feasible options
- Presents the comparison between the feasible options, addressing engineering, environmental, social and economic issues
- Presents the preferred option
- Outlines the next steps.

1.10 Report structure

This report has twelve chapters:

- | | |
|------------------|---|
| Chapter 1 | introduces the project. |
| Chapter 2 | outlines the strategic context of the project. |
| Chapter 3 | addresses the community and stakeholder involvement in the preliminary route options development process. |
| Chapter 4 | considers the strategic and statutory planning approvals process pertinent to the project. |
| Chapter 5 | describes the existing environment in biophysical, social and cultural terms. |

- Chapter 6** outlines the design criteria and physical constraints that influence the development of the route options.
- Chapter 7** addresses the preliminary route options development and assessment process.
- Chapter 8** presents the shortlist of feasible options and their specific impacts on the existing environment.
- Chapter 9** outlines the development of the preferred option.
- Chapter 10** presents the preferred option and its specific impacts on the existing environment.
- Chapter 11** documents the next steps of the project.
- Chapter 12** lists documents referenced during this stage of the project.

1.11 Assumptions and suitability of assessment

This report has been prepared based on desktop studies (i.e. review and analysis of existing published information such as reports, mapping, government policy and planning documents), targeted field investigations and assessment of the route options including constructability and strategic estimates of cost.

Assumptions and limitations specifically related to the various specialist studies carried out for this report are identified in the relevant sections of this report.

The project team has exercised all reasonable skill and care in preparing this report and has taken reasonable steps to ensure that the information contained in this report is accurate and up to date.

The information contained in this report is for conducting a comparative assessment of the preliminary route options and identifying a preferred route option. The alignments presented in this report are preliminary only and may be further refined during the concept design phase based on further investigations and feedback from the community and other stakeholders.

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2 Strategic context

2.1 Introduction

The New England Highway is a major link between the Hunter Region and the New England area and beyond.

Bolivia Hill is a steep winding section of the New England Highway between Glen Innes and Tenterfield. The existing highway corridor is narrow with a rock face to the east and a steep drop to the west.

The Australian Government has committed \$6 million for planning of safety works at Bolivia Hill and a future Tenterfield heavy vehicle bypass.

2.2 Planning context

The study area is located within the New England region of NSW within the local government area of Tenterfield. The *New England North West Strategic Land Use Plan 2012* (the Plan) prepared by the NSW Department of Planning and Infrastructure guides development and land use planning within this region.

The Plan sets out a planning framework to develop the New England region over the next 20 years and manage growth. The population within this region is predicted to increase because of growth within the mining sector, which is subsequently expected to create a demand for additional housing and infrastructure.

The Plan aims to address challenges associated with future growth within the region, having particular regard to potential land use conflict between mining and agricultural industries. The Plan also identifies essential infrastructure required to support population growth. The New England Highway is acknowledged as performing a vital role in providing a means of regional freight distribution, and an important connection to other state roads.

The project's planning context is further documented in **Chapter 4**.

2.3 Transport

2.3.1 Existing traffic and transport conditions

A detailed analysis of the existing traffic and transport conditions can be found in **Appendix A**. The information following provides an overview of the findings within **Appendix A**.

2.3.1.1 *Existing daily traffic volumes*

Annual average growth rates have been determined by analysing historical Annual Average Daily Traffic (AADT) data as well as data collected in October 2010 and November 2012 from surveys that were carried out by Roads and Maritime and commissioned by Cardno, respectively. It should be noted that the 2010 and 2012 survey data have been seasonally adjusted to represent AADT. Also, these survey data were collected as vehicle counts and subsequently converted to axle pairs to compare against Roads and Maritime count station data. **Figure 2-1** illustrates the changes in traffic volumes for the AADT figures (based on a seven day week) and provides an indication of the annual changes in traffic volumes from preceding survey years to the latest available figures. It can be seen that there has been a continuous decline in average traffic volumes at an increasing rate since 1998.

It is noted that the period of continuous decline coincided with the gradual shift of freight movements from semi-trailers to B-Double trucks. Since two B-Doubles are able to convey the same volume of freight as three semi-trailers, this partly contributed to the decline in AADT. Further to this, the upgrade of the Pacific Highway from Yelgun to Chinderah (completed in August 2002) removed the major constraint on B-Doubles operating on the Pacific Highway. Because of this upgrade, B-Double movements have been shifting towards the Pacific Highway and this has expedited the decline in AADT on the New England Highway at Bolivia Hill.

A summary of the average weekday traffic volumes is presented in **Table 2-1** that indicates an average of 2001 vehicles per day. The average daily volumes represent the five day average of weekday traffic volumes.

Table 2-1 Average weekday traffic volumes (5 day week)

Location	Average weekday volumes (VPD)		
	Northbound	Southbound	Total
New England Highway at vehicle pull over, Bolivia Hill*	933	1068	2001

* 8.5km north of Bridge over Four Mile Creek

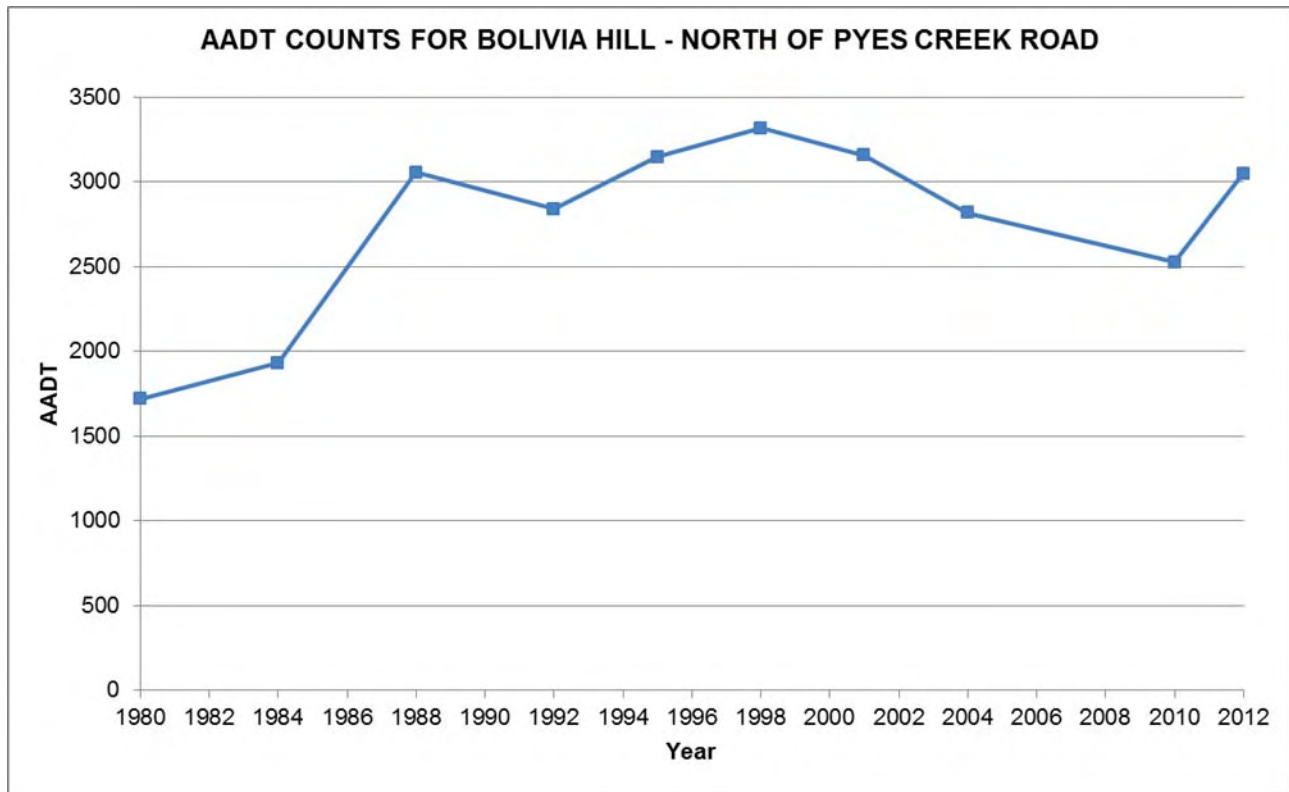


Figure 2-1 AADT growth in the New England Highway corridor (7 day week)

2.3.1.2 Peak traffic flows

Traffic volumes collected in November 2012 along the subject section of the New England Highway were observed to be relatively consistent between 10pm and 5am. The peak traffic flows occur between 12pm and 1pm (164 vehicles) and 3pm and 4pm (163 vehicles). **Figure 2-2** highlights the daily two-way traffic volumes composition.

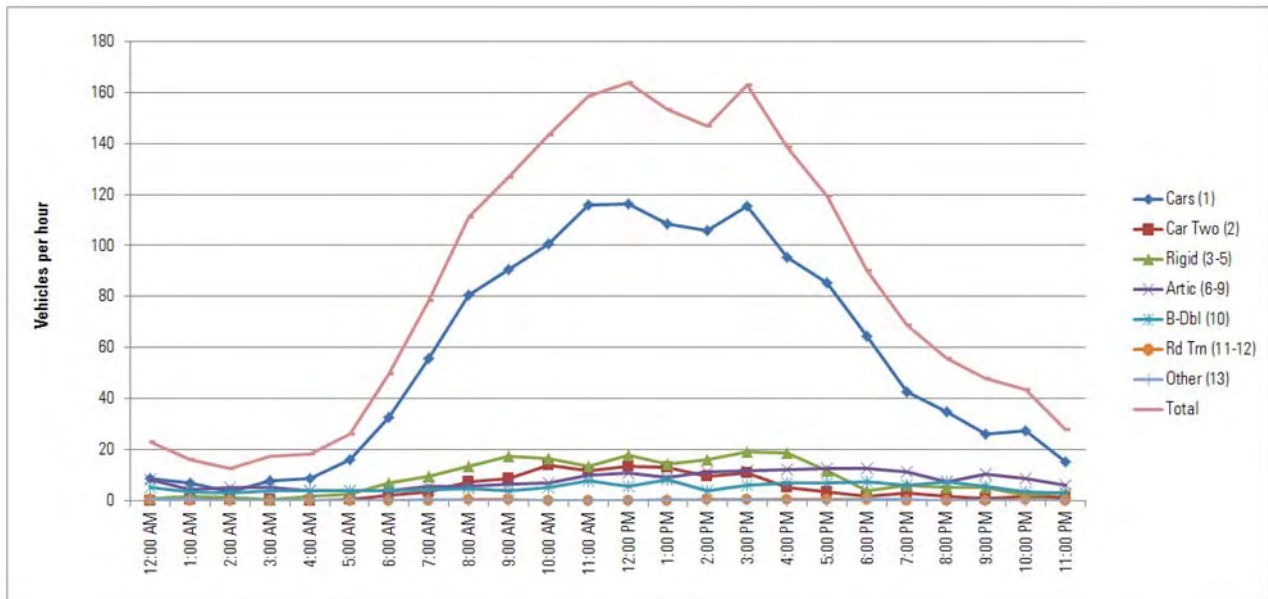


Figure 2-2 Daily traffic volumes composition: Two-way

2.3.1.3 Vehicle speeds

The 85th percentile speeds in the area from the November 2012 data are generally above the posted speed limit of 80 kilometres per hour. Note that the speed limit on the subject section of the New England Highway was changed on 9 October 2012 from 100 kilometres per hour to 80 kilometres per hour to better reflect the roadside environment and alert drivers to the change in the road alignment. Northbound vehicles usually travel at higher speeds than the southbound vehicles. **Figure 2-3** illustrates the 85th percentile speeds in both the northbound and southbound directions.

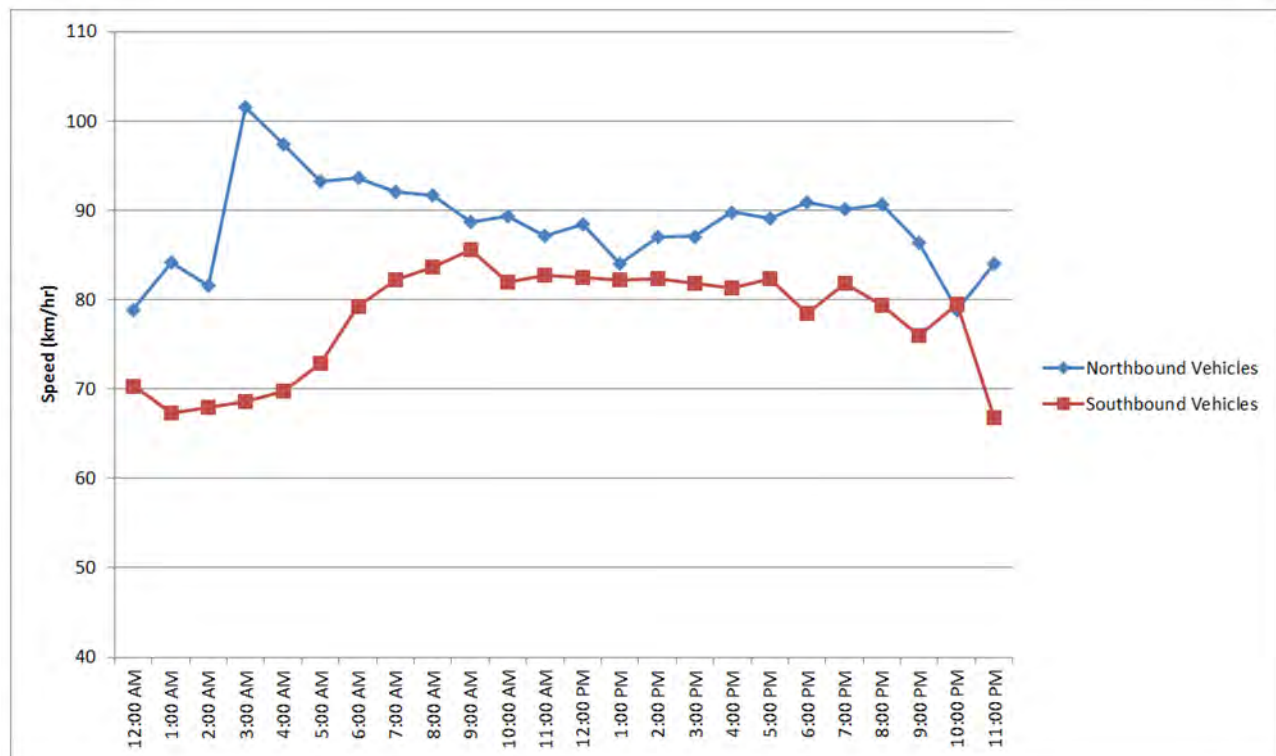


Figure 2-3 85th percentile speeds

2.3.1.4 Freight movements

From the data collected in November 2012, **Table 2-2** presents a summary of the proportion of heavy vehicles during an average weekday. The heavy vehicle proportions are shown as a percentage of total volumes for two-way average weekday daily traffic volumes.

Table 2-2 Vehicle composition

Location	Direction	% Composition				
		LV	HRV*	AV^	Tot HV~	AV of HV
Bolivia Hill at vehicle pull over, 8.5 km north of Bridge over Four Mile Creek	Northbound	73%	12%	15%	27%	57%
	Southbound	74%	9%	17%	26%	64%
	Both directions	74%	10%	16%	26%	60%

LV = Light Vehicle * HRV = Heavy Rigid Vehicles ^ AV = Articulated Vehicles ~HV = Total Heavy Vehicles

The daily percentage of light and heavy vehicle distribution is shown in **Figure 2-4**, while **Figure 2-5** highlights the daily two-way heavy vehicle traffic volumes composition.



Figure 2-4 Daily percentage traffic composition two-way

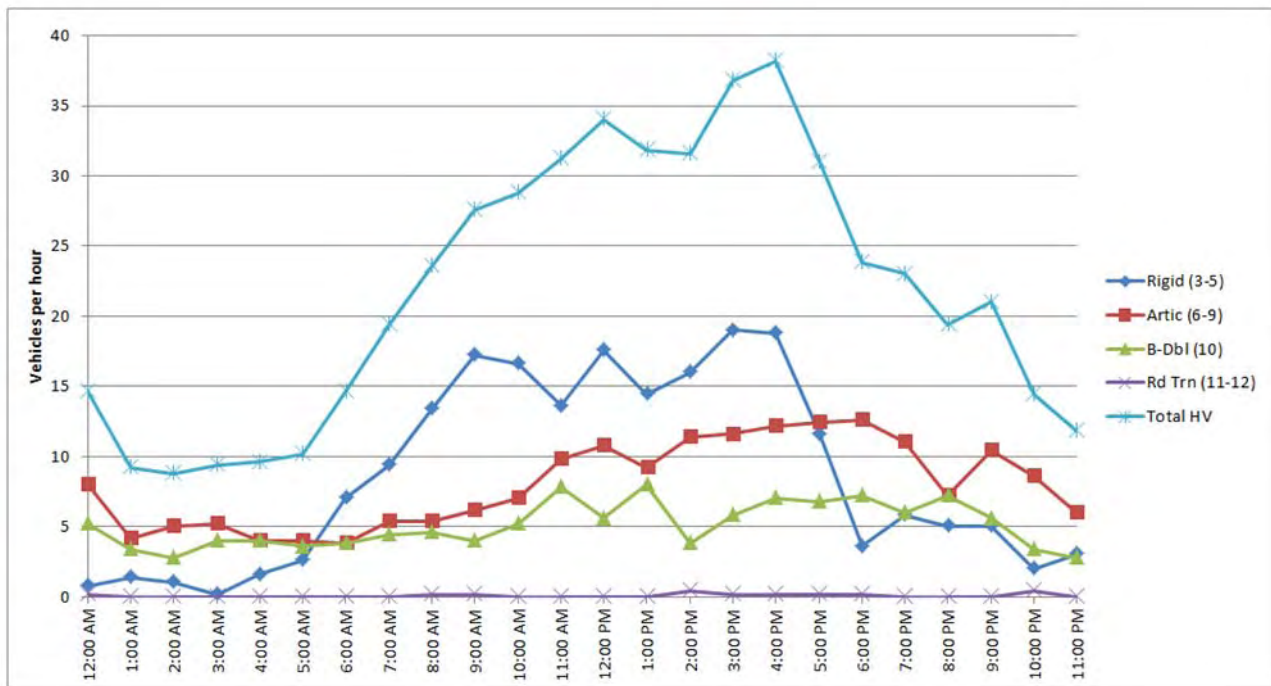


Figure 2-5 Daily heavy vehicle traffic volumes composition two-way

2.3.1.5 Public transport movements

Although there are no major public transport routes along the New England Highway within the study area, there are two long distance coaches operating along the Tenterfield-Armidale corridor (327 and 328) which pass through Bolivia Hill once daily in each direction. There is also a school bus service that operates along the Tenterfield / Bolivia / Bungulla route once in the morning and once in the afternoon period.

2.3.1.6 Existing overtaking lane provision

The following overtaking lane provisions are contained both within and in the vicinity of the study area.

For northbound traffic:

- 1.0 kilometre overtaking lane starting from 5.1 kilometres south of Pyes Creek Road (outside study area)
- 1.6 kilometre overtaking lane starting from 3.8 kilometres north of Pyes Creek Road (outside study area).

For southbound traffic:

- 1.9 kilometre overtaking lane starting from 2.2 kilometres south of Pyes Creek Road (within study area)
- 1.0 kilometre overtaking lane starting from 6.4 kilometres north of Pyes Creek Road (outside study area).

2.3.1.7 Headway – per cent following

Roads and Maritime Services *Network Performance Measures and Network Planning Targets* (2010) stipulates that an overtaking lane is warranted in locations where per cent time following is greater than 65 per cent. The time spent following is defined as vehicles with less than six seconds headway (ie distance measured in time between the front of the leading vehicle and the front of the trailing vehicle).

The traffic survey undertaken in November 2012 showed that the per cent following is as follows:

- Northbound – 37 per cent
- Southbound – 23 per cent.

Hence, based on per cent following, current conditions suggest no requirement for overtaking lanes in either direction based on existing traffic operations. However, future growth in the corridor may alter this requirement.

2.3.1.8 Road safety

Roads and Maritime supplied crash data for the study area for the five year period from 2008 to 2013.

The road section considered for the crash analysis is the stretch of New England Highway that lies 56.4 kilometres to 59.4 kilometres north of Glen Innes (**Figure 1-1**). The crash data received from Roads and Maritime was applied to the appropriate length of road to allow for a detailed crash investigation. **Table 2-3** presents the tow away, injury and fatal crashes for the period from March 2008 to February 2013 (inclusive).

Table 2-3 Summary of crash types (2008–2013)

No. of crashes by crash type (08–13)				Severity index	%HV crashes	Casualty crash rate per kilometre
Tow (T)	Injury (I)	Fatality (F)	Total			
5	0	3	8	1.75	0%	0.20
Crashes per 100MVKT			Casualty Rate per 100MVKT		Fatality Rate per 100MVKT	
72.73			27.27		27.27	

The number of incidents and their severities were assessed along with a severity index and the number of casualties. The purpose of calculating the severity index was to enable a comparison of the impact of crashes from a wider community perspective. This severity index considers the total number of crashes on a road and assigns a weighting to fatal and casualty crashes aimed at reflecting their relative importance to the community. The upper limit for this severity index is three, while the lowest figure possible is one (provided there has been one crash on the length of road being considered). The data shows that the severity of crashes is 1.75, which is worse than the average severity index for undivided rural roads within NSW (1.25) as provided by Roads and Maritime for the Newell Highway Study. This suggests that when crashes do occur they tend to be more severe than those occurring on similar classes of roads.

The proportion of heavy vehicle crashes was compared to the corresponding percentage of heavy vehicle movements. It is noted that there are no crashes involving heavy vehicles during this period. However, the heavy vehicle proportion of the total traffic flow is 26 per cent.

The annual average casualty crash rate per kilometre was calculated at 0.20, which is below the NSW state wide average annual casualty crash rate per kilometre of 0.40. This suggests that per length of road this section of the New England Highway is performing better than the state average.

The annual casualty crash rate per kilometre does not take into account the significant variations in traffic volumes along routes, and may therefore understate relatively high crash rates on particular lengths of road operating with significantly lower traffic volumes. For this reason, a second measure, of casualty crashes per 100 million vehicle kilometres travelled (100MVKT) is also used, especially to compare casualty crash rates on roads that carry higher and lower traffic volumes. Based upon this additional measure, the crashes per 100MVKT is 72.73, while the corresponding casualty and fatality rates are both 27.27, due to the absence of injury (non-fatal) crashes during the period analysed.

According to the detailed crash data received from Roads and Maritime, most of the crashes have occurred in fine weather when the surface condition was dry. It is noted that the two fatal crashes recorded were because of speeding motorists (one light vehicle and one motorcycle), with the light vehicle being pursued by a law enforcement authority. The data analysis did not indicate any common recurring vehicle crash themes or vehicle crash types.

3 Community and stakeholder engagement

Community and stakeholder engagement for the Bolivia Hill upgrade focused on the investigation of options and the development of the preferred route option.

3.1 Stakeholder engagement overview

Stakeholder engagement was originally to be progressed over five consultation periods:

No.1 - Announcement of project and study area

No.2 - Preliminary route options and assessment methodology and selection criteria

No.3 - Route options development report

No.4 - Route selection report

No.5 - Preferred route option.

As the project developed, stakeholder engagement reduced from five consultation periods to two. As such, stakeholder engagement period No.2 refers to the preferred route option. **Chapters 7 to 10** describe in detail the process through which the preferred option was developed.

Appendix B provides detailed stakeholder engagement reports for consultation periods No.1 and No.2.

3.2 Engagement approach

During the development of the preferred route, the approach to stakeholder engagement included:

- Tailoring engagement to communicate with different stakeholder groups
- Carrying out consultation activities during key periods of project development
- Understanding and addressing stakeholder issues, where possible
- Incorporating consultation outcomes into the project's development.

3.3 Stakeholders

Bolivia Hill upgrade stakeholders included anyone with a current or future interest in the project.

3.3.1 Stakeholder identification

Stakeholder identification involved:

- Roads and Maritime project team providing known stakeholder contacts
- Discussions with Roads and Maritime project team
- Discussions with Transport for NSW (TfNSW)
- Discussions with Department of Infrastructure and Transport (DoIT)
- Discussions with Tenterfield Shire Council and Glen Innes Severn Council
- Discussion with local stakeholders
- Respondents to community updates, surveys, media releases and public displays.

3.3.2 Key community and other stakeholders

One hundred and twelve project stakeholders were identified by, met with or contacted the project team. These stakeholders are recorded in the Consultation Manager database for the project and grouped in the following categories:

- Residents
- Property owners

- Community groups
- Federal government
- State government
- Local government
- Transport operators
- Elected representatives
- Industry associations
- Media.

A list of project stakeholders is provided in **Appendix B**. The distribution of stakeholders by category is shown in **Figure 3-1**. The majority of project stakeholders were identified as residents.

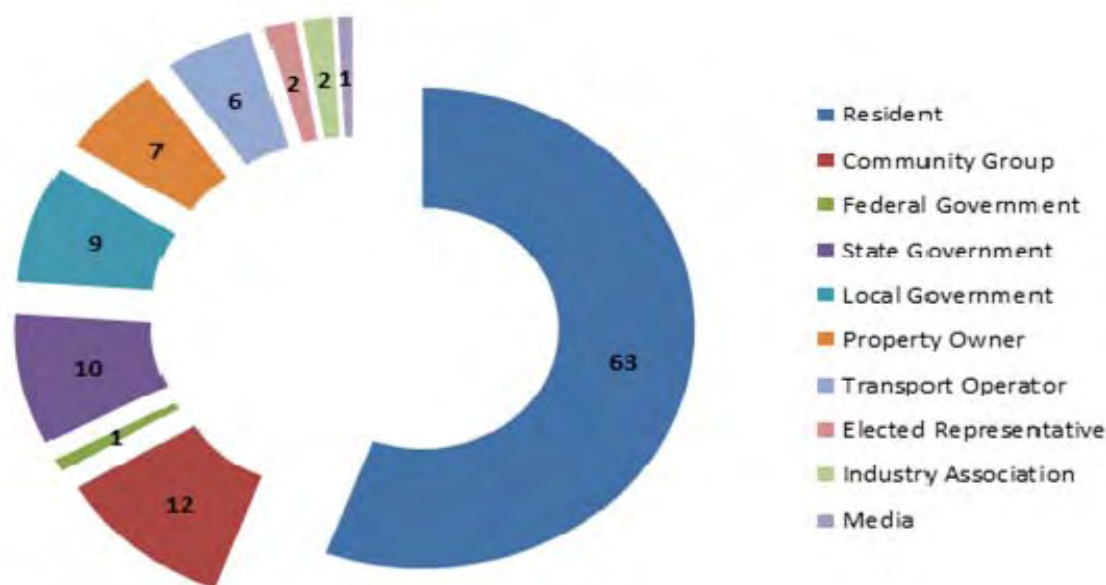


Figure 3-1 Project stakeholders by category of stakeholder

3.4 Stakeholder engagement activities

This section details the activities and outcomes of the Bolivia Hill Upgrade stakeholder engagement period No.1 and No.2.

3.4.1 Stakeholder engagement activities

An overview of each of the stakeholder engagement activities carried out during consultation period No.1 and No.2 are provided below with the key outcomes from the consultation activities discussed in **Section 3.4.2**.

3.4.1.1 *Project website, 1800 number and project email address*

1800 number and project email address

A free call 1800 number (1800 024 535) and email address <boliviahill@cardno.com.au> were set up to allow the community and other stakeholders to speak with the project team at any time during the project.

The 1800 number and project email address were monitored during business hours, contact received out-of-hours was responded to within one business day.

Project team members answered queries, provided project updates, collected qualitative data and feedback from community members.

Project website

The project website provided:

- An overview of the project
- Contact information including phone, email
- Display and communication materials.

3.4.1.2 Public displays and communication materials

Letters to organisational stakeholders

Letters were sent to over 30 regional, state and national organisational stakeholders advising them of the project commencement, the project study area and the opportunity to contact the project team either by attending community drop-in sessions, or through the project 1800 number and project email and mailing address.

Accessing private property

Property owners within the study area received:

- An addressed letter advising them of the commencement of the project and the study area, noting that their property may be within the project study area.
- A letter requesting written permission to enter their land to undertake environmental and other investigations. This letter was accompanied by a Roads and Maritime 'permit to enter' form and a flyer detailing the types of studies that may be carried out.
- Follow-up phone calls to discuss property access and request the completed 'permit to enter' form.

All but one property owner within the study area provided permission for the project investigations to occur on their land.

Information poster and recommended preferred route option report

Information posters and copies of the recommended preferred route option report were printed and distributed to a number of public venues in Tenterfield and Glen Innes as detailed in **Table 3-1**.

Table 3-1 Display locations

Locations in the Tenterfield LGA	Locations in the Glen Innes Severn LGA
Tenterfield Council Customer Service **	Glen Innes Severn Council Customer Service **
Council Library **	Council Library **
Tenterfield Community Hub	Glen Innes Motor Registry
Rouse Street Medical Centre	United Petroleum Service – truck stop
Tenterfield Motor Registry	Visitor Centre
Tenterfield Local Post Office	Coach stop (arranged by visitor centre contact)
Tenterfield Bowling Club	McDonald's (arranged by visitor centre contact)
Tenterfield Visitor Centre	Community Centre

** displayed *information* poster and recommended preferred route option report.

A copy of the information poster is provided in **Appendix B**.

Media advertising

Local radio and newspapers advertisements were used to announce key project milestones including:

- Tenterfield Bypass and Bolivia Hill Upgrade projects, October 2012
- Release of the recommended preferred route option report, September 2013
- Community drop-in sessions, November 2012 and September 2013.

Community updates

Four community updates were released during the project's development. Community updates provided information on:

- Project objectives, study area and contact details, September 2012
- Community consultation activities and project progress, July 2013
- Preliminary route options assessment process and outcomes factsheet, September 2013
- Recommended preferred route option and upcoming consultation activities, September 2013.

Australia Post's unaddressed mail service distributed about 9800 community updates, in total, to premises in Tenterfield, Glen Innes, Bolivia, Deepwater and Emmaville. In addition, community updates were available at key venues such as council customer service, public libraries and motor registries and via download from the project website.

Copies of community updates are provided in **Appendix B**.

Community survey

To gain an understanding of known constraints and issues and receive comments for consideration in the development of the route options a community survey was distributed to residents and businesses in Tenterfield, Glen Innes, Bolivia, Deepwater and Emmaville (October 2012). The survey was available on the project website and an electronic link to the survey provided to local councils in the New England area.

A copy of the survey is provided in **Appendix B**.

3.4.1.3 Community drop-in sessions

Community drop-in sessions were held in November 2012 and September 2013. Members of the project team, including the project managers from Roads and Maritime and Cardno, were on hand to answer questions from community members and listen to their feedback. Materials such as maps and a display poster provided additional information about the project. Details of the session dates, locations and attendance are provided in **Table 3-2** and **Table 3-3**.

Table 3-2 Tenterfield community drop-in session, consultation period No.1 and No.2

Tenterfield	
Date	Wednesday 14 November, 2012
Time	2pm – 8pm
Location	Tenterfield Golf Club, Pelham Street, Tenterfield
Project team attendees	Gurjit Singh – Roads and Maritime Project Manager Nick McTeigue – Roads and Maritime Stakeholder Consultation John Rayment – Cardno Project Manager Larissa Miller – Cardno Stakeholder Consultation

Tenterfield	
Community and other stakeholder attendance	11
Date	Thursday 19 September 2013
Time	3 – 7pm
Location	Sir Henry Parkes School of Arts, Rouse Street and Manners Street
Project team attendees	Steven Brailsford – Roads and Maritime Project Officer Prue Burke – Roads and Maritime Stakeholder Consultation John Rayment – Cardno Project Manager Larissa Miller – Cardno Stakeholder Consultation
Community and other stakeholder attendance	Six

Table 3-3 Glen Innes community drop-in session, consultation period No.1 and No.2

Glen Innes	
Date	Thursday 15 November, 2012
Time	2pm – 8pm
Location	Glen Innes Severn Learning Centre, Gray Street
Project team attendees	Gurjit Singh – Roads and Maritime Project Manager Nick McTeigue – Roads and Maritime Stakeholder Consultation John Rayment – Cardno Project Manager Larissa Miller – Cardno Stakeholder Consultation
Community and other stakeholder attendance	11
Date	Wednesday 18 September 2013
Time	3 – 7pm
Location	Glen Innes Severn Learning Centre, Gray Street
Project team attendees	Steven Brailsford – Roads and Maritime Project Officer Prue Burke – Roads and Maritime Stakeholder Consultation John Rayment – Cardno Project Manager Larissa Miller – Cardno Stakeholder Consultation
Community and other stakeholder attendance	12

3.4.1.4 Stakeholder meeting

The project team met with Tenterfield Shire Council. The meeting was an opportunity to introduce the team, provide an overview of the project and discuss issues, constraints and opportunities for the project known to Council. Meeting details are provided in **Table 3-4**.

Table 3-4 Meeting with Tenterfield Shire Council

Tenterfield Shire Council	
Date	Wednesday 14 November, 2012
Time	12:30pm – 1:30pm
Location	Tenterfield Shire Council, Rouse Street, Tenterfield
Project team attendees	Gurjit Singh – Roads and Maritime Project Manager Nick McTeigue – Roads and Maritime Stakeholder Consultation John Rayment – Cardno Project Manager
Council attendees	Dennis Gascoigne – Director Engineering Services Brian Murray – Deputy Mayor

While the project study area falls within the Tenterfield Shire Council's local government area, the project team also met interested Glen Innes Severn Council staff informally at the community meeting in Glen Innes on 15 November 2012.

3.4.2 Outcomes of stakeholder engagement activities

Stakeholder engagement outcomes are outlined below and detailed responses provided in appendices as stated.

3.4.2.1 1800 number and project email address

The project has received 11 phone calls to the free call 1800 number and 17 emails to the project email address, summarised in **Table 3-5**.

Table 3-5 1800 number and project email address outcomes

Issue	Detail	Number of phone calls/emails
Consultation period No. 1 – route option development		
Route location	<ul style="list-style-type: none"> Property owner enquiring about proposed route location Interested in route options as purchasing property in the study area. 	2
Local knowledge	<ul style="list-style-type: none"> To advise of the location of an angel statue close to the top of the hill. 	1
Media enquiry	<ul style="list-style-type: none"> Tenterfield Star enquired about the project. 	1

Issue	Detail	Number of phone calls/emails
Community update and survey and contact database	<ul style="list-style-type: none"> • Thank you for the delivery of the community update and survey • To provide contact details • Completion of the community survey • To advise an issue with the project's online community survey*. 	7
Community drop-in sessions	<ul style="list-style-type: none"> • Advising attendance at community session • Interested in the outcome of the community meetings as could not attend. 	3
Study or consultation process	<ul style="list-style-type: none"> • Enquiry about whether the project would include a Heritage Impact Statement • Department of Industry requesting GIS file • Question the stakeholder engagement approach and other elements of the project • Local councils to arrange provision of a link to the community survey on their websites. 	11
Consultation period No. 2 – preferred route option		
Route suggestion	<ul style="list-style-type: none"> • Suggestion to include an uphill overtaking lane as the Pacific Highway will be subject to increased flooding from global warming which will lead to heavy vehicles being diverted to the New England Highway • Suggestion to leave the current alignment as the uphill lanes and to build the downhill lanes to the west as a single lane (as occurred in the Moonbi area near Tamworth) • Preference for Option 6 to be built as used for northbound (downhill) traffic while retaining the existing road for southbound (uphill) traffic • Preference for separation of the uphill and downhill lanes, similar to Option 10 with the existing road retained as the uphill lanes heading south. 	3
Interest in project	<ul style="list-style-type: none"> • Call to register interest in the project and attendance at the drop-in session. 	1
Interest in providing contractor services	<ul style="list-style-type: none"> • Calls from various contractors expressing interest in the project's likelihood of proceeding to construction and its potential staging. 	5

**Note: The survey did not allow community members to complete the survey if they had selected the 'other' answer for two questions. This was rectified within a few hours.*

3.4.2.2 Letter correspondence from stakeholders

The project received two letters from stakeholders in response to the project announcement letter sent in November 2012:

- Fisheries NSW, a branch of the NSW Government Department of Primary Industries, 26 November 2012. This letter outlined the environmental study requirements to facilitate appropriate assessment for the project including the standard minimum requirements for environmental assessment.
- Mineral Resources Branch (MRB) of the Division of Resources and Energy, Department of Trade & Investment, Regional Infrastructure & Services, 6 December 2012. This letter provided detail of the mineral resource issues in the project study area including the potential geotechnical issues that might arise, particularly associated with granite-related mineralisation.

These letters are attached as part of **Appendix B**.

3.4.2.3 Community survey

The community survey requested both quantitative and qualitative data from respondents. Quantitative data was in the form of details about where the respondent resided, the type of road user that they identified as and their frequency of travel on the New England Highway through Bolivia Hill. This was used to provide an understanding of the different types of road users. Key issues raised include:

- Issues with the current road, almost 50 per cent of respondents identified safety as a key concern
- General route option considerations, comments focused on improving the road alignment, considering the need for environmental protection and widening the road
- Specific route options proposed, providing additional lanes (either an additional southbound lane, an additional northbound lane or providing three lanes) was popular along with the provision of a dual carriageway.

Complete survey responses are provided in **Appendix B** along with maps received from community members with route option suggestions.

3.4.2.4 Community drop-in sessions

The community drop-in sessions in both Tenterfield and Glen Innes attracted few community attendees. Despite the low numbers, the community members that attended were generally very familiar with the project study area and able to provide significant information and local expertise.

Key outcomes from the drop-in sessions are outlined below with a record of the feedback from the sessions provided in **Appendix B**.

Issue	Detail
Consultation period No. 1- route option development	
Issues and concerns with the existing road	Issues related to the existing road included the heavy vehicle use of the highway, in particular the possibility they could lose control on the downhill; safety; poor weather, including black ice; the danger of head-on traffic and the potential for rock fall from a landslide. Attendees largely recognised that the hill was dangerous and an upgrade would improve the safety conditions for drivers.

Issue	Detail
Route option considerations	<p>Suggested opportunities and features for consideration in the development of route options including:</p> <ul style="list-style-type: none"> • Use of the existing alignment • Provision of two lanes in each direction • Providing a passing lane for a cheaper option • Widening the existing roadway • Providing a tunnel • Using the existing railway line • Using fill from the higher side of the hill to fill the lower side • Splitting the road.
Environmental and heritage preservation	<p>Attendees discussed the need for environmental and heritage preservation within the project study area. This included discussion about native flora and the extensive vegetation throughout the project study area and fauna likely to be found. Heritage information provided included location of a cobblestone road; need to consult with the Moombahlene Local Aboriginal Land Council; details of the old telephone line in the study area; railway line construction and the legend of a local market gardener.</p>
Consultation period No. 2 – preferred route option	
Recommended preferred route comments	<p>General comments on the recommended preferred route option included:</p> <ul style="list-style-type: none"> • Construction impact on traffic • Landslides • Details on the accidents that had occurred on the road in the past, their causes and the difficulties faced in rescue operations • Expense associated with proposed bridge construction • The use of the existing alignment prevents requirement to acquire private property.
Route suggestions	<p>Attendees indicated preference for a range of different route features including:</p> <ul style="list-style-type: none"> • Creation of a lookout point • An uphill overtaking lane • Create a wider roadway by lowering the road, creating fill for sections of the road • Additional safety measures including speed strips and a widened median • Retention of existing pavement • Use the existing rock wedge to support the new route • Source construction materials locally wherever possible • An emergency stopping lane for downhill traffic.

There was no objection to the project raised at the community drop-in sessions; support for the project was generally expressed, as the road is currently considered dangerous, with the above suggestions raised for consideration.

3.4.2.5 Stakeholder meeting with Tenterfield Council

The meeting with Council provided the project team with Council's perspective of the future traffic growth in the region; Council pointed to factors such as 'tree change', increasing 'grey nomad' travellers and the effort Council is expending to attract Queensland visitors that could drive increased traffic on the New England Highway through the project study area. Council requested that the Benefit Cost Ratio (BCR) assessment consider other drivers of growth in the region and not just the declining annual average daily traffic (AADT) trend. Council stated that it is possibly a socio-demographic issue instead of a traffic one. Council recognised the upgrade would be expensive.

Council's Director Engineering Services also proposed upgrading the existing alignment, noting that the vertical alignment is not as important as long as a southbound passing lane is provided.

Council's comments demonstrated an understanding of the need to provide a cost effective route option, in line with the project's objective of "value for money".

Complete minutes from the meeting with Tenterfield Shire Council are provided in **Appendix B**.

3.4.3 Incorporation into development of route options

Key issues, comments and recommended options from the stakeholder engagement period No.1 and No.2 were reported to Roads and Maritime and the wider project team. Stakeholder comments were considered to see whether and the extent to which they should be positively reflected in the development of the project.

The engagement outcomes were distributed to the following project team leaders:

- Roads and Maritime Project Manager
- Roads and Maritime Stakeholder Engagement Manager
- Cardno Project Manager
- Cardno Environment Manager
- Cardno Road Designer
- Cardno Constructability Manager
- Cardno Traffic Engineer.

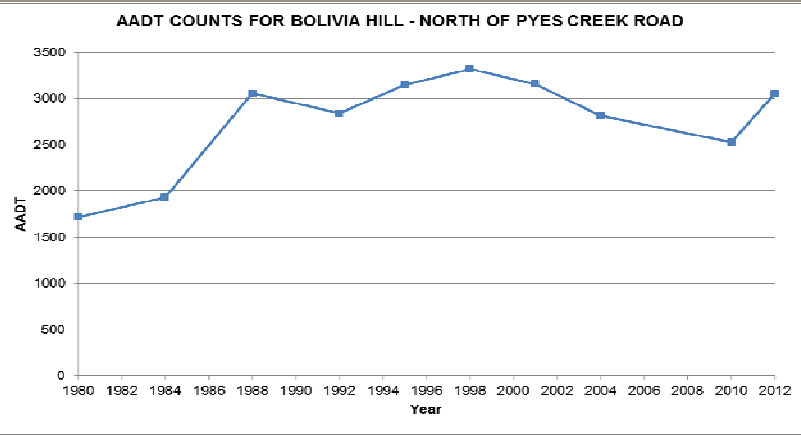
Table 3-6 and Table 3-7 summarise the key issues, comments and recommended options raised and provides a comment from the relevant discipline leader on how this has been considered in the development of the preferred route option.

Table 3-6 Consideration of engagement outcomes in consultation period No.1 – route options development

Issue/comment		Raised in	Addressed by	Consideration in route options development
Issues raised	Safety	Survey	Road design	Improving the road's safety is a key project objective.
	Steep gradient	Survey	Road design	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.
	Sharp bends	Survey	Road design	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.
	Falling rocks	Surv/Sess	Road design	Geotechnical investigations are being undertaken and will assess the stability of the existing rocks. Rock fences shall be installed with any option.
	Slippery / black ice	Surv/Sess	Road design	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.
	Camber / drainage	Survey	Road design	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.
	Breakdown of heavy vehicles	Survey	Road design	Widened shoulders (2.0 m) have been incorporated into all options to allow for breakdowns and through traffic to pass safely.
	Getting caught behind HVs	Session	Road design	Traffic studies have shown that overtaking lanes are not required.
	HVs losing control on way down	Session	Road design	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.
	Narrow width	Survey	Road design	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective, with travel lanes at 3.5 m wide and shoulders to 2.0 m.
	Lack of safety areas	Survey	Road design	Safety areas will be considered in the detailed design stage.
	Route is unsafe because it is two-way	Session	Road design	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.
	Community survey should be available to complete electronically	Email	Stakeholder engagement	The survey is now available electronically on the Roads and Maritime website and can be accessed directly: https://www.surveymonkey.com/s/K27QMH9 .
	The survey is basic and won't provide enough information	Email	Stakeholder engagement	This is a preliminary stage of the project and therefore only the most basic level of response from interested parties is being sought at present. As the project progresses more detailed information will be provided and it will be possible for respondents to make more specific and more detailed submissions.
	The survey should have included Armidale, Uralla, Guyra and residents in these towns only read the Armidale Independent and Express - not the newspapers where the community sessions were advertised.	Email	Stakeholder engagement	We will liaise with all councils in the New England area to see if the project information and survey link can be added to their websites.
	Queried the number of households in towns the received the survey via unaddressed mail.	Email	Stakeholder engagement	The delivery figure of 4,500 households was provided by Australia Post as the number of deliveries they would make to individual mailboxes in the areas we supplied to them as having to be covered.

Issue/comment		Raised in	Addressed by	Consideration in route options development
Environment/heritage issues raised	The volumes of heavy vehicles at Bolivia Hill compared with other highways in NSW.	Email	Traffic Engineer	<p>Roads and Maritime vehicle counts undertaken during October 2010 indicated an average daily vehicle count of 1,802 vehicles per day (bidirectional flow) through the project study area, of which heavy vehicles make up 26 per cent (approximately 470 vehicles per day). Cardno have recently commissioned traffic counts to be collected to determine if any change in volumes have occurred since the Roads and Maritime data was collected. This data is reported in Chapter 2 (Section 2.3).</p> <p>In comparison, it is noted that traffic flows along the Newell Highway range from 1,225 – 4,048 (approximately 37 per cent heavy vehicles) vehicles per day between the town centres. This indicates that the traffic flows at Bolivia Hill are in the lower percentile of average daily flows when compared to those along the Newell Highway. Cardno do not have access to detailed traffic flow data along the Pacific Highway.</p>
	Animals in the area include: koalas, black pigs, possibly deer, large kangaroos	Session	Environment	<p>Fauna specialists have considered the impacts on potential fauna in the area. Flora and fauna specialists conducted a thorough ecology assessment, which included desktop and field surveys. The specific purpose of the field surveys involved the collation of information concerning:</p> <ul style="list-style-type: none"> fauna species which regularly utilise habitat within and adjacent to the corridor the location, extent and utilisation of any areas of suitable habitat for fauna species listed under the provisions of the Commonwealth's <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act) and NSW's <i>Threatened Species Conservation Act 1995</i> (TSC Act). <p>The results of the survey updated initial constraints mapping and clearly identifies the locations of protected fauna, critical habitat, threatened species, populations, ecological communities and other relevant ecological constraints (eg wildlife corridors).</p>
	Cobblestone road – north of the site on old alignment of the highway.	Session	Environment	<p>Noted. A heritage specialist (Niche Environment and Heritage) have considered the impacts on non-Aboriginal heritage in the area and have addressed these issues in a Non-Aboriginal Heritage Assessment report. If at any time during the course of the study there is a significant heritage item or place identified, all of the necessary studies will be conducted to comply with the requirements of the <i>Heritage Act 1977</i> and the <i>National Parks and Wildlife Act 1974</i>.</p>
	Council has a Heritage Committee – contact Toni Hull for information	Session	Environment	<p>Noted. Niche Environment and Heritage contacted Council's Heritage Committee as part of their consultation process.</p>
	Consult with LALC	Session	Environment	<p>Noted. Niche Environment and Heritage contacted the Moombahlene Local Aboriginal Land Council as part of their consultation process.</p>
	A property owner within the project study area expressed concern about ecologist investigations	Session	Environment	<p>Ecology field studies will not be conducted on any property without prior owner consent. At present, fieldwork will not be undertaken at one property (LOT: 134 DP: 751487) as consent has not been provided.</p>
	This section of the railway line was the site of the first workers strike in the country	Session	Environment	<p>The Desktop Heritage Assessment report has noted that a section of the main north railway line runs through the study area. Further a non-Aboriginal heritage investigation is to be completed as part of the next stage of the project, which will include:</p> <ul style="list-style-type: none"> Consulting with the local historical society Conducting further historical research focussing on the railway line Undertaking a site survey of proposed route options with representatives of the local historical society Assessing the significance of any identified heritage items Preparing a detailed non-Aboriginal heritage impact assessment that provides recommendations to mitigate any impacts the proposed highway upgrade may have on identified heritage items. <p>The heritage study was informed by the comment provided.</p>
	Preserve the angel statue (located close to the top of the hill), either leave in place or relocate it.	Surv/Sess	Environment	<p>Noted. Heritage studies considered the impacts to the statue and if there are any impacts associated with the preferred option then necessary mitigation measures of the statue will be identified for the protection, which may include relocation.</p>

Issue/comment	Raised in	Addressed by	Consideration in route options development
There are trees throughout the project study area	Session	Environment	Noted. Flora and fauna specialists considered the impacts on potential flora and vegetation communities in the area and have addressed these issues in specialist reports. Flora and fauna specialists conducted a thorough ecology assessment, including desktop and field surveys. The results of the field survey were used to inform the route option design process in order that impacts to vegetation can be avoided or minimised to the fullest.
Part of the nature reserve belonged to the Hamilton family	Session	Stakeholder engagement	Noted.
Old Telephone line in study area to the west of the current road alignment.	Session	Environment	Heritage specialists (Niche Environment and Heritage) considered the impacts on non-Aboriginal heritage in the area and addressed these issues in a Heritage Assessment report. If at any time during the course of the study there is a significant heritage item or place identified, all of the necessary studies to comply with the due diligence requirements of the <i>Heritage Act 1977</i> and the <i>National Parks and Wildlife Act 1974</i> .
‘Hurry’s Hill’ – first settlers arrived at BH 1841.	Session	Environment	Heritage specialists (Niche Environment and Heritage) considered the impacts on non-Aboriginal heritage in the area and addressed these issues in a Heritage Assessment report. If at any time during the course of the study there is a significant heritage item or place identified, all of the necessary studies to comply with the requirements of the <i>Heritage Act 1977</i> and the <i>National Parks and Wildlife Act 1974</i> will be conducted.
Quin Chee story: Chinese man – left wife in china and was never reunited. He had a market garden.	Session	Environment	Heritage specialists (Niche Environment and Heritage) considered the impacts on non-Aboriginal heritage in the area and addressed these issues in a Heritage Assessment report. If at any time during the course of the study there is a significant heritage item or place identified, all of the necessary studies to comply with the requirements of the <i>Heritage Act 1977</i> and the <i>National Parks and Wildlife Act 1974</i> will be conducted.
Project area included a stock route, to the west of the current road alignment.	Session	Environment	Heritage specialists (Niche Environment and Heritage) considered the impacts on non-Aboriginal heritage in the area and addressed these issues in a Heritage Assessment report. If at any time during the course of the study there is a significant heritage item or place identified, all of the necessary studies to comply with the requirements of the <i>Heritage Act 1977</i> and the <i>National Parks and Wildlife Act 1974</i> will be conducted.
Project area has significant native flora	Session	Environment	Noted. Flora and fauna specialists considered the impacts on potential flora and vegetation communities as part of the route options assessment. Flora and fauna specialists conducted a thorough ecology assessment, which included desktop and field surveys. The results of the field survey updated constraints mapping and clearly identifies the locations of protected flora and fauna, critical habitat, threatened species, populations, ecological communities and other relevant ecological constraints (eg wildlife corridors). A detailed description of all vegetation communities encountered during the survey with supporting information has been documented. The conservation significance of each community has been identified at a national, state and local level, with specific consideration given to the known or likely representation in adjacent protected areas such as National Parks, Conservation Areas, State Forests and Reserves managed under the <i>National Parks and Wildlife Act 1974</i> . A description of the condition of each vegetation community, including a qualitative description of extent of disturbance, and level of weed infestation has been provided. Possible mitigation measures may include: <ul style="list-style-type: none"> • The provision of offsets/compensatory habitat in accordance with National and State regulation guidelines • The location and design of fauna over or underpasses • Specific design criteria (ie. fencing, culverts and culvert furniture etc.) in accordance with Roads and Maritime policies and guidelines.
Query regarding a Heritage Impact Statement would be prepared for the project	1800 number	Environment	Heritage specialists (Niche Environment and Heritage) conducted a thorough heritage assessment, including desktop and field surveys. If at any time during the course of the study there is a significant heritage item or place identified, all of the necessary studies to comply with the requirements of the <i>Heritage Act 1977</i> and the <i>National Parks and Wildlife Act 1974</i> will be undertaken, which may include a Heritage Impact Statement.

Issue/comment		Raised in	Addressed by	Consideration in route options development	
Route option comments	A Glen Innes Heritage Study exists.	Session	Environment	Heritage specialists (Niche Environment and Heritage) considered all available documents/report relating to the study area for the heritage assessment, including this identification.	
	Straighten alignment	Survey	Road design	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.	
	Environmental protection	Surv/Sess	Environment	The importance of the environmental values of the area is acknowledged by the study team, and environmental studies and assessments were carried out in parallel with the development of route options. This approach enables key environmental constraints to be identified and for impacts to be avoided through the modification of designs wherever possible, and is considered preferable to alternative approaches where design precedes the environmental assessment, and the opportunity to modify designs to avoid impacts can be lost.	
	Widen road	Surv/Sess	Road design	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.	
	Cost/value for money	Surv/Sess	Road design	Value for money is a key project objective.	
	Provide sign posting	Survey	Road design	Sign posting will be considered in the detailed design stage.	
	Reduce grades	Survey	Road design	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.	
	Construction Traffic Management: If Pacific Highway is closed where to NE Highway? If Newell Highway is closed where to NE Highway?	Surv/Sess	Traffic engineering	If the project progresses to construction, a construction traffic management plan will be prepared to manage changes to the road's operation. The New England Highway will remain operational throughout any construction works.	
	NE Highway with very little upgrade and traffic has increased by 75% in last 5 years.	Survey	Traffic engineering	The chart shows the Average Annual Daily Traffic (AADT) for the New England Highway through the project study area providing an indication of the annual changes in traffic volumes from preceding survey years to the latest available figures. It can be seen that there has been a continuous decline in average traffic volumes at an increasing rate since 1998, with only a minimal increase of 105 vehicles experienced between 2010 and 2012.	
	Heritage protection	Survey	Environment	Heritage specialists (Niche Environment and Heritage) conducted a thorough heritage assessment, including desktop and field surveys. If at any time during the course of the study there is a significant heritage item or place identified, all of the necessary studies to comply with the requirements of the <i>Heritage Act 1977</i> and the <i>National Parks and Wildlife Act 1974</i> will be undertaken, which may include a Heritage Impact Statement.	
Consider/maintain aesthetic value		Surv/Sess	Environment	Noted. Environmental assessments of the preferred option will consider the impacts to landscape and aesthetic value, and will propose the necessary mitigation measures for protection.	
Transparent and fair property acquisition		Survey	Stakeholder Engagement	Potential property acquisition will be conducted by Roads and Maritime through a process of consultation and negotiation that aims for a mutually acceptable property value.	
Protection from rock fall		Survey	Road design	Geotechnical investigations are being undertaken and will assess the stability of the existing rocks. Rock fences shall be installed with any option.	

Issue/comment		Raised in	Addressed by	Consideration in route options development
Specific route option comments	Make provision for extra lanes in future	Survey	Road design	Traffic studies have shown that two northbound lanes are not required.
	Two southbound lanes	Surv/Sess	Road design	Traffic studies have shown that two southbound lanes are not required.
	Two northbound lanes	Surv/Sess	Road design	Traffic studies have shown that two northbound lanes are not required.
	Provide three lanes	Surv/Sess	Road design	All options have been designed for a three lane configuration.
	Provide dual carriageway	Surv/Sess	Road design	Traffic studies have shown that two northbound lanes are not required. A dual carriageway cross section was developed and used for all options at the early stage of the study, and was not considered value for money.
	Use existing route	Surv/Sess	Road design	The use of the existing route is being considered for southbound traffic only with a northbound lane constructed independently west of the existing alignment.
	Overtaking lane	Survey	Road design	Traffic studies have shown that overtaking lanes are not required.
	Follow rail line	Surv/Sess	Road design	Due to existing topography, this is not achievable. This would also impact the nature reserve.
	Provide safety areas/ramp	Survey	Road design	Safety areas and locations will be considered in the detailed design stage.
	Avoid rail line	Survey	Road design	Rail line has been avoided in all shortlisted options.
	Use rocks from Bolivia Hill for road base	Surv/Sess	Constructability	Material won from excavation at Bolivia Hill is suitable for use in road embankments.
	Northbound lane to be west of gully	Surv/Sess	Road design	The use of the existing route is being considered for southbound traffic only with a northbound lane constructed independently west of the existing alignment.
	Split the road, use the little ridge between existing road and the creek bed	Session	Road design	The use of the existing route is being considered for southbound traffic only with a northbound lane constructed independently west of the existing alignment.
	Provide breakdown lane	Survey	Road design	Two metre wide shoulders have been provided. This allows ample space for vehicles to pull off the main carriageway safely.
	Tunnel	Surv/Sess	Road design	Tunnel has been considered, however, due to cost of construction in granite this is not viable, and would not provide value for money.
	Improve Pyes Creek Road intersection	Surv/Sess	Road design	Intersection designs will be considered in the detailed design stage.
	Double lanes	Survey	Road design	Traffic studies have shown that two lanes are not required for traffic in either direction.
	Bypass along rail line during construction	Survey	Road design	Due to existing topography, this is not achievable. This would also impact the nature reserve.
	Avoid Bolivia Hill Nature Reserve	Survey	Road design	Nature Reserve avoided in all options.

Table 3-7 Consideration of engagement outcomes in consultation period No.2 – preferred route option

Issue/comment		Raised in	Addressed by	Consideration in route options development
Comments on the Recommended Preferred Route Option	There will be a lot of construction traffic. Concern about the length of construction time and traffic flow disturbance that will occur.	Community session	Project Manager	If the project progresses to construction, a construction traffic management plan will be prepared to manage changes to the road's operation. The New England Highway will remain operational throughout any construction works.
	Concern about landslides and the impact of making a cutting into the rock face.	Community session	Project Manager	Geotechnical investigations will be undertaken and will assess the stability of the existing rocks. Rock fences shall be installed with any option.
	Accidents can be attributed to people speeding down the hill.	Community session	Project Manager	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.
	There is an area of the road where a waterfall occurs when it rains, with the gully on one side and no room up against the rock wall on the other side.	Community session	Project Manager	This area is in the length of road that will be abandoned and replaced by a bridge.
	The cost is quite high.	Community session	Project Manager	Value for money is a key project objective. The preferred option has the lowest cost of all options considered.
	The old curve will be a blind spot on the new alignment if the existing pavement is kept as a pull over area.	Community session	Project Manager	This curve is in the length of road that will be abandoned and replaced by a bridge. It is not proposed to use the abandoned pavement as a public pull off area.
	It can be very slow stuck behind a semi-trailer going at five miles an hour up the hill, an overtaking lane would address this.	Community session	Project Manager	Traffic studies have shown that two southbound lanes are not required.
	There is plenty of water in Deepwater River when it is needed for construction.	Community session	Project Manager	Construction requirements will be considered in the next stages of the design.
	Not sure if an overtaking lane is needed.	Community session	Project Manager	Traffic studies have shown that two southbound lanes are not required.
	Owners of Bolivia Hill Station support Option 7b and are happy that it doesn't impact their property. The part of their property close to the road is fertile and ideal for cattle. Want to keep it and not have it acquired.	Community session	Project Manager	The preferred option (Option 7b) does not impact on Bolivia Hill Station.
Suggestions for Preferred Route Option	Query regarding option for an emergency stop lane on the north bound, downhill side. Concern over out of control trucks that clear the roadway in front of them.	Community session	Project Manager	Improving road safety is a key project objective and an improved geometry standard is a critical criterion to this objective.
	Suggestion to include an uphill overtaking lane as the Pacific Highway will be subject to increased flooding from global warming which will lead to heavy vehicles being diverted to the New England Highway.	Phone/email	Project Manager	Traffic studies have shown that two southbound lanes are not required.
	Suggestion to leave the current alignment as the uphill lanes and to build the downhill lanes to the west as a single lane (as occurred in the Moonbi area near Tamworth).	Phone/email	Project Manager	The use of the existing route was considered for southbound traffic only with a northbound lane constructed independently west of the existing alignment. This cost of this option was high and it was considered not to provide value for money.
	Preference for Option 6 to be built as used for northbound (downhill) traffic while retaining the existing road for southbound (uphill) traffic.	Phone/email	Project Manager	The use of the existing route was considered for southbound traffic only with a northbound lane constructed independently west of the existing alignment. This cost of this option was high and it was considered not to provide value for money.
	Preference for separation of the uphill and downhill lanes, similar to Option 10 with the existing road retained as the uphill lanes heading south.	Phone/email	Project Manager	The use of the existing route was considered for southbound traffic only with a northbound lane constructed independently west of the existing alignment. This cost of this option was high and it was considered not to provide value for money.
	Consider existing road pavement, on the curve that is being replaced by the bridge, as an extended rest area and lookout point.	Community session	Project Manager	It is not proposed to use the abandoned pavement as a public pull off area due to safety concerns for vehicles entering and exiting the area.

Issue/comment	Raised in	Addressed by	Consideration in route options development
Preference for an overtaking lane going up the hill (south bound).	Community session	Traffic Engineer	Traffic studies have shown that two southbound lanes are not required.
Suggestion to cut into the rockface to create fill for the new route. Although blasting could cause rocks to fall, drilling using an expender will cause the rocks to come apart easily.	Community session	Project Manager	The preferred alignment cuts into the rock face towards the northern end of the alignment. The use of the excavated rock will be assessed in the next stages of design. The methods for excavation of the rock will be assessed in the next stages of design.
Suggestion to dig the road deeper for wider access, this will also create fill for low spots on the road.	Community session	Project Manager	The preferred option attempts to match the existing road level where possible to minimise construction staging and traffic management issues during construction. The final geometry of the proposed upgrade will be refined during the next stages of design.
Suggestion to create a lot of fill by taking six inches off a road's surface without ripping everything up.	Community session	Project Manager	The preferred option attempts to match the existing road level where possible to minimise construction staging and traffic management issues during construction. The final geometry of the proposed upgrade will be refined during the next stages of design.
Suggestion to tweak the vertical alignment to adjust the grade.	Community session	Project Manager	The final geometry of the proposed upgrade will be refined during the next stages of design.
Use speed strips at the top of the hill on approach to warn drivers and slow them down.	Community session	Traffic Engineer	Delineation requirements will be considered in the next stages of the design.
Suggestion to leave the existing pavement in places rather than demolish it.	Community session	Project Manager	The preferred option attempts to match the existing road level where possible to minimise construction staging and traffic management issues during construction. The final geometry of the proposed upgrade will be refined during the next stages of design.
Spend the savings made on Bolivia Hill on the Gwydir Highway.	Community session	Roads and Maritime	Funding is project specific. Any cost saving will be for the government to re-allocate.
This recommended preferred route is my idea, except that I suggest bringing the bridge into the bend a little bit because there is a small rock wedge in closer to the existing road that could be used to support the new road.	Community session	Project Manager	The final geometry of the proposed upgrade will be refined during the next stages of design.
The new road should be as straight as possible, removing the bend closest to Pyes Creek Road on the recommended preferred route option. Build this piece of road first.	Community session	Project Manager	The final geometry of the proposed upgrade will be refined during the next stages of design. Construction staging sequence will be considered during the next stages of design.
Suggestion to extend the option through to Pyes Creek Road.	Community session	Project Manager	The existing section of highway between the northern end of the preferred option and Pyes Creek Road conforms to the current design standards, provides a safe traffic environment and adequate levels of service, and therefore extending the project is not warranted.
Suggestion for a turning lane at Pyes Creek Road, take a corner off Bolivia Station to achieve this.	Community session	Project Manager	The intersection at Pyes Creek Road has acceptable geometry and a turning lane is not warranted justified at this stage.
Suggestion to store construction equipment at Bolivia Station.	Community session	Project Manager	Construction requirements will be considered in the next stages of the design.

Issue/comment	Raised in	Addressed by	Consideration in route options development
Preference for Option 10, along the bullock track. This would be built as the new downhill lanes and the existing road would be retained as the uphill lanes heading south. Traffic will be completely separated, and construction will be far easier as it will occur away from the existing road. Option 7 will still be subject to water runoff from the rock face.	Community session	Project Manager	The use of the existing route was considered for southbound traffic only with a northbound lane constructed independently west of the existing alignment. This cost of this option was high and it was considered not to provide value for money. Water runoff from the rock face will be considered during the next stages of design.
Suggestion to have two lanes at the top of the hill as trucks will be slower at that point.	Community session	Project Manager	The existing southbound overtaking lane is approximately 400 metres south of the southern end of the preferred option.
Suggestion to use locally sourced fill material from five or six local quarries or the property to the west of the proposed bridge.	Community session	Project Manager	Construction requirements will be considered in the next stages of the design.
Don't use cats eyes in the middle of the lanes.	Community session	Traffic Engineer	Delineation requirements will be considered in the next stages of the design.
Do use wider than normal double lines.	Community session	Traffic Engineer	Delineation requirements will be considered in the next stages of the design.
Speak to nearby land owner about potential fill from their property for construction.	Community session	Project Manager	Construction requirements will be considered in the next stages of the design.

4 Statutory and strategic planning

This chapter sets out and addresses the current strategic and statutory planning framework applicable to the development of the Bolivia Hill upgrade project.

Planning investigations have sought to outline the State Government's strategic planning direction for NSW and the New England North West Region, and determine the statutory planning framework applicable to land within the study area, including land use zoning, planning permissibility and development approval process.

4.1 Strategic planning framework

The following strategic planning documents provide broad planning principles that aim to guide future development within NSW and more specifically within the New England North West Region.

4.1.1 New South Wales State Plan

NSW 2021-A Plan to Make NSW Number One (NSW 2021), released in September 2011, is the NSW Government's 10-year strategic plan to:

- Rebuild the economy
- Return quality services
- Renovate infrastructure
- Strengthen our local environment and communities
- Restore accountability to government.

The associated *NSW 2021 Baseline Report* sets out available performance data on goals and targets. It provides the foundation for future performance monitoring and public reporting, and provides the technical context for each NSW 2021 target.

Although not specified by the report, the project is consistent with the overall objectives of the State Plan by improving road infrastructure and vehicle safety within the region.

4.1.2 New England North West Strategic Regional Land Use Plan 2012

The *New England North West Strategic Regional Land Use Plan* (2012) has been developed in accordance with the *NSW Strategic Regional Land Use Policy* (2012), which comprises of multiple initiatives being staged over time to address land use conflict in regional areas.

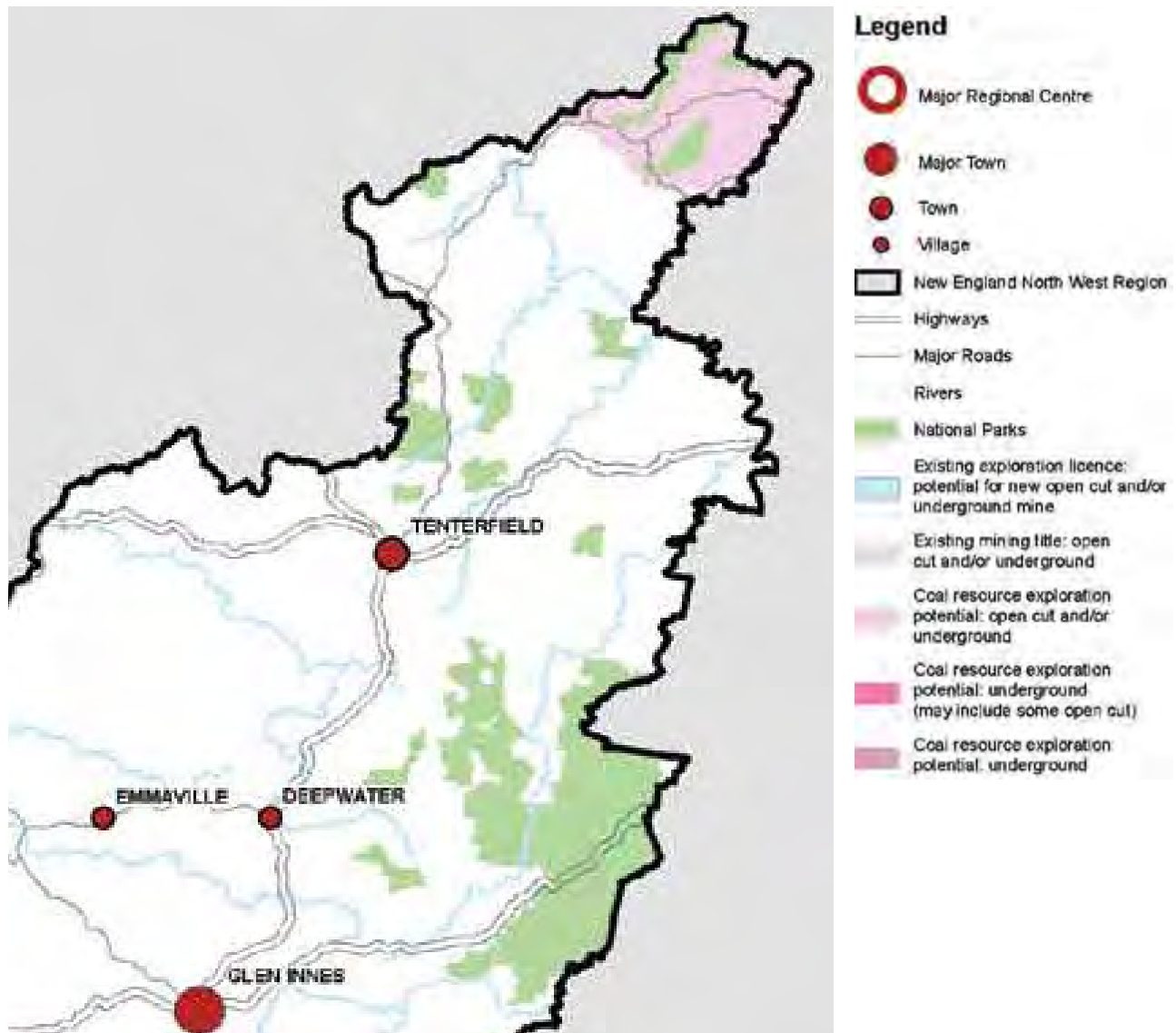
The plan provides a strategic framework for the New England North West region, delivering the necessary context for Government investment priorities, servicing strategies and local planning over the next 20 years.

The plan identifies the following challenges facing growth within the region:

- Balancing agriculture and resource development
- Existing road and rail capacity
- Increase demand for infrastructure
- Increase demand for housing and services
- Natural hazards and climate change
- Protecting the environment and cultural heritage.

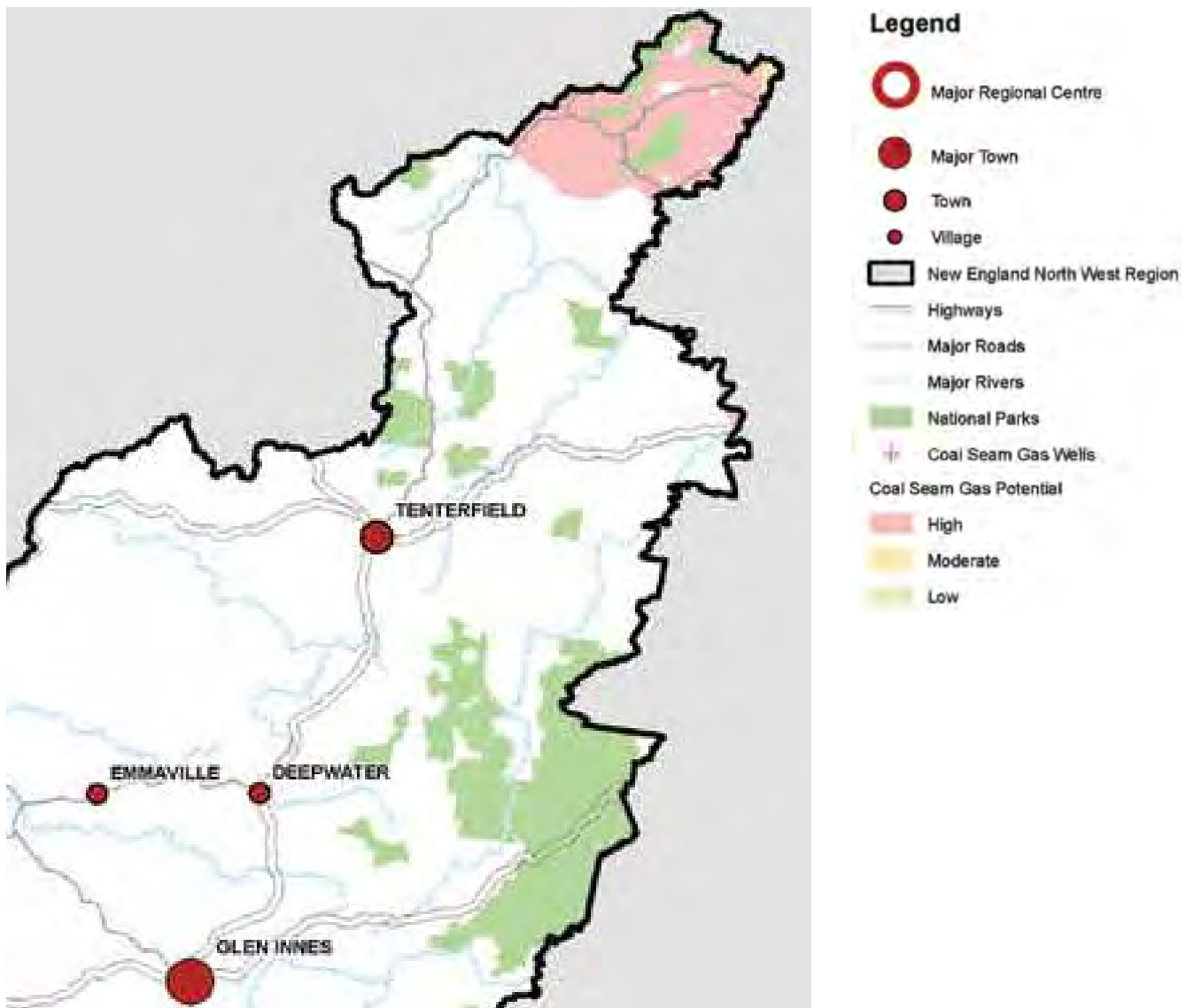
The plan aims to support continued growth within the region and address challenges relating to land use conflict arising as a result of mining activities, having particular regard to the rapid emergence of the coal seam gas mining industry.

To assist in planning for growth and balancing future land uses within the region, land identified as having coal resources, coal gas seam resources, other mining resources and Strategic Agricultural Lands (SAL) uses have been mapped as shown in Figures 4-1, 4-2, 4-3 and 4-4.



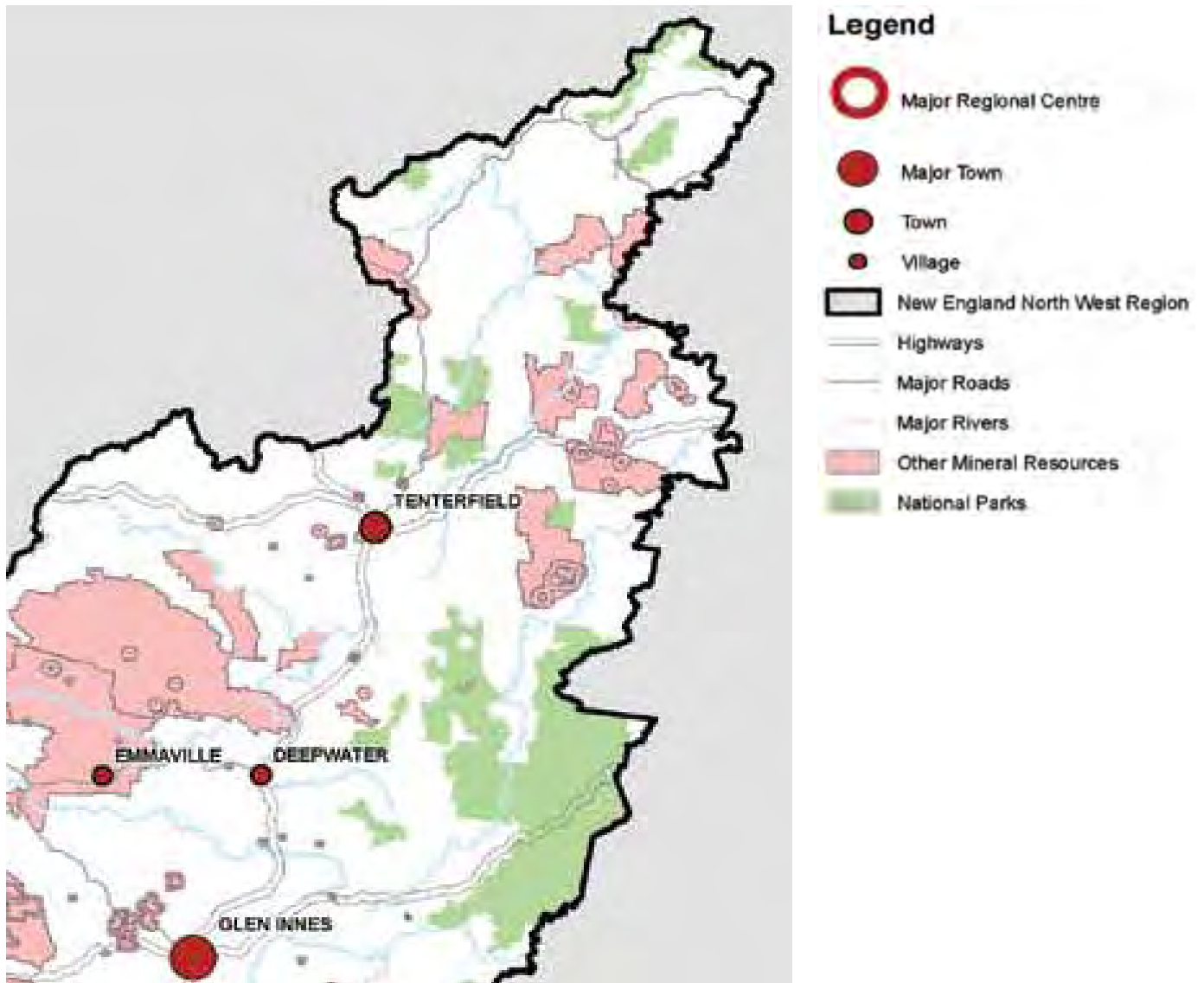
Source: New England North West Strategic Regional Land Use Plan (2012)

Figure 4-1 New England North West Strategic Land Use Plan – Coal Resources



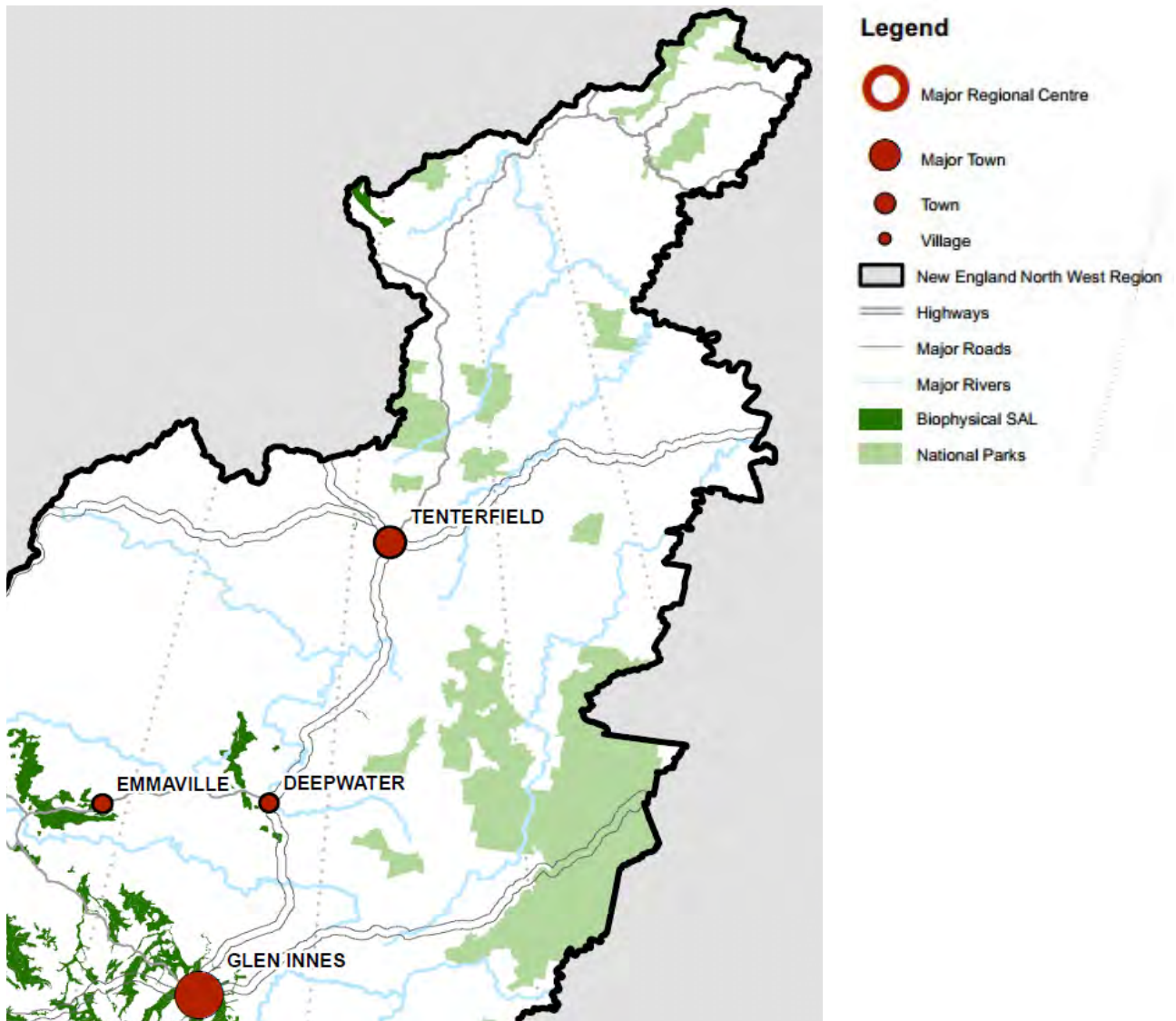
Source: New England North West Strategic Regional Land Use Plan (2012)

Figure 4-2 Strategic Land Use Plan – Coal Seam Gas Resource



Source: New England North West Strategic Regional Land Use Plan (2012)

Figure 4-3 Strategic Land Use Plan – Other Mineral Resources



Source: New England North West Strategic Regional Land Use Plan (2012)

Figure 4-4 Strategic Land Use Plan – Strategic Agricultural Lands

Land within the study area is not identified as having any coal or coal seam gas. It is understood that gold, tin, silver, high quality silica and arsenic were previously mined in the region, however mining locations and details of the previous mining activities are not known. No obvious signs of previous mining activities were observed during inspection of the project study area in October 2012. However, the Roads and Maritime Report '*HW9 Bolivia Hill Realignment, Preliminary Desktop Study of Geology, Slope Stability, Geotechnical Design and Pavement Design*', dated March 2012, indicates:

'Many small unmapped workings were observed on the ridgeline to the east of the current alignment, and a vertical shaft accessing a 40cm quartz vein hosting minor quantities of sphalerite and traces of chalcopyrite in the adjacent valley to the west of the current alignment'.

The '*New England North West Strategic Regional Land Use*' plan (2012) identifies the New England Highway as performing a vital role in servicing current and future populations within the region. The New England Highway is an important north-south road corridor that connects with other state roads and key centres such as Armidale and Tamworth. The highway also provides a means for regional freight distribution.

Overall, the Bolivia Hill upgrade project is consistent with the NSW Government's strategic direction for the region. Proposed improvements to the New England Highway will assist in servicing future industry and population growth within the region by improving road safety. The project is unlikely to result in conflict between land uses, or inhibit opportunities for agricultural or mining growth.

4.2 Statutory planning framework

The project must address the relevant provisions contained under the following state and local environmental planning instruments.

4.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) provides the legal framework and planning and assessment process for consideration of all development within NSW. The Act aims to encourage the proper management, development and conservation of natural and artificial resources to ultimately promote the sharing of responsibility between state and local government and facilitate public involvement in the planning assessment process.

In NSW, there are a number of different systems for the assessment of development proposals. These assessment systems are specifically tailored to cater for varying size, nature and complexity of different project types. These factors will determine which assessment system applies to a particular development.

The assessment systems set out under the Act include:

- State significant assessment system (Part 4 and SEPP)
- Part 3A (now repealed and not accepting new applications)
- Local and regional development (generally Part 4)
- Part 5.

Most development is assessed under Part 4 of the Act. To be approved under the Part 4 system, development must be permitted with consent under the relevant environmental planning instrument. Assessments under Part 4 are undertaken in accordance with state and local planning provisions.

SEPP (State and Regional Development) 2011 classifies development over a certain size or located in a sensitive environmental area as State Significant Development (SSD) or State Significant Infrastructure (SSI). SSD is assessed by the Minister under Part 4 (Division 4.1) of the Act (previously Part 3A now repealed). Both SSD and SSI are assessed by the Department of Planning and Infrastructure and determined by the Planning Assessment Commission (PAC).

Part 5 of the EP&A Act applies to development undertaken by a public authority that does not require consent under Part 4. The Part 5 system is commonly used to assess activities such as roads, railways, dredging and forestry works that do not require consent. If these activities are judged by the relevant public authority to significantly effect the environment, then an Environmental Impact Statement (EIS) will need to

be prepared and considered by this authority. Development classified as SSI under SEPP (State and Regional Development) 2011 is assessed under Part 5.1 of the Act.

The proposed development is likely to be determined under Part 5 of the Act, unless the road is developed on land reserved under the *National Parks and Wildlife Act 1974*, in which case development consent would be required under Part 4 as per the provisions under *State Environmental Planning Policy (Infrastructure) 2007*.

It is noted under Section 118 of the National Parks and Wildlife Act that a boundary adjustment for the purpose of a road may be permissible within a nature reserve. An adjustment of the boundary of land is to be made by the Director-General by a notice published in the Gazette.

4.2.2 State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (SEPP Infrastructure) aims to facilitate the delivery of infrastructure across NSW. This policy overrides other environmental planning instruments, including Local Environmental Plans, and provides specific planning provisions and development controls relating to various types of infrastructure.

Division 17 of SEPP Infrastructure provides provisions relating to roads and traffic. Under Clause 94, development for the purpose of a road (or road infrastructure facility) may be carried out on behalf of a public authority without consent on any land regardless of local zoning provisions.

Notwithstanding this, the development of a road may not be carried out without consent on land reserved under the *National Parks and Wildlife Act 1974* unless the development:

- “(a) is authorised by or under the *National Parks and Wildlife Act 1974*, or
- (b) is, or is the subject of, an existing interest within the meaning of section 39 of that Act, or
- (c) is on land to which that Act applies over which an easement has been granted and is not contrary to the terms or nature of the easement.”

In accordance with this provision, roads may be developed under SEPP Infrastructure without consent on any land except land that is reserved under the *National Parks and Wildlife Act 1974*.

Given part of the study area is occupied by the Bolivia Hill Nature Reserve (reserved under the *National Parks and Wildlife Act 1974*) further investigations will be required to determine whether an easement (or other agreement/provision) exists that would allow Roads and Maritime to develop a road through Bolivia Nature Reserve without consent. In lieu of any authorised agreement between Roads and Maritime and the National Parks and Wildlife Authority, a new road on land occupied by the Nature Reserve cannot be undertaken without consent under SEPP Infrastructure and would therefore require consent under Part 4 of the Act.

Development permitted without consent under SEPP Infrastructure requires assessment under Part 5 of the Act. It cannot be determined at this stage whether an EIS is required.

4.2.3 State Environmental Planning Policy (State and Regional Development) 2011

State Environmental Planning Policy (State and Regional Development) 2011 SEPP (State and Regional Development) identifies development classified as State Significant Development (SSD) and State Significant Infrastructure (SSI).

Development assessed under Part 5 of the Act is considered SSI under Schedule 3 of SEPP (State and Regional Development) 2007 only if the preparation of an EIS is required, as outlined below:

“1 General public authority activities

- (1) *Infrastructure or other development that (but for Part 5.1 of the Act and within the meaning of Part 5 of the Act) would be an activity for which the proponent is also the determining authority and would, in the opinion of the proponent, require an environmental impact statement to be obtained under Part 5 of the Act.*
- (2) *This clause does not apply to development if the proponent is a council or county council.*
- (3) *This clause does not apply to development specified in any other clause of this Schedule.”*

Accordingly, the project will not be classified as SSI unless an EIS is required.

4.2.4 Tenterfield Local Environmental Plan 1996

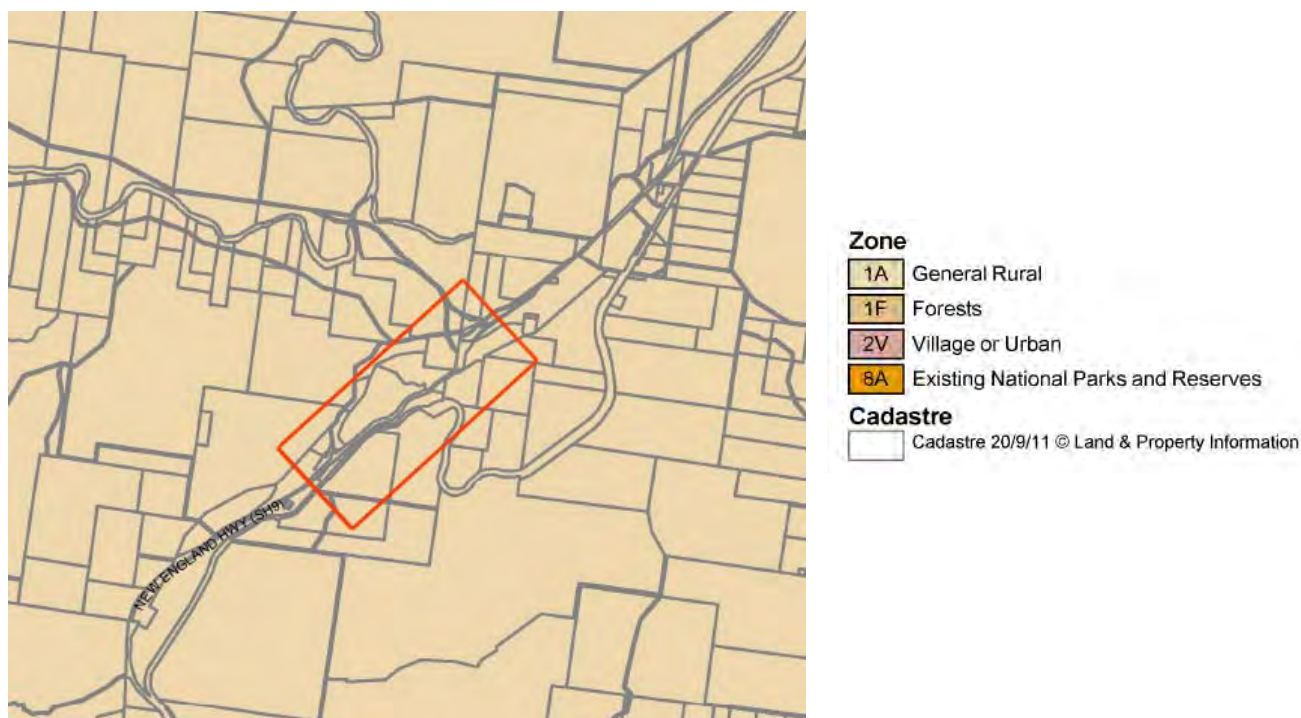
4.2.4.1 **Zoning**

Land within the study area is zoned 1(a) General Rural under *Tenterfield Local Environmental Plan* (LEP) 1996 as shown in **Figure 4-5**.

The objectives of this zone are:

- “(a) *to promote efficient sustainable agricultural utilisation of agricultural land, particularly prime crop or pasture land;*
- (b) *to protect or conserve:*
 - (i) *soil stability by controlling development in accordance with soil capability;*
 - (ii) *forests of commercial value for timber production;*
 - (iii) *valuable deposits of minerals, coal, petroleum and extractive materials by controlling the location of development to enable the efficient extraction of those deposits;*
 - (iv) *trees and other vegetation in environmentally sensitive areas where the conservation of the vegetation is likely to reduce land degradation; and*
 - (v) *water resources;*
- (c) *to enable the development of land within this zone for purposes that are compatible with the rural character of the land;*
- (d) *to enable the development of land for other purposes where it can be demonstrated by the applicant that no other land or buildings in the locality could reasonably be used for the proposed purpose and that such a use will not detrimentally affect the amenity of any existing or proposed nearby development.”*

Roads are considered ancillary to rural land uses permitted within the 1(a) General Rural zone and therefore meet the zone objectives.



Source: Tenterfield LEP 1996

Figure 4-5 Tenterfield LEP 1996 Zoning Map with study area overlain (in red)

4.2.4.2 Planning permissibility

Development within the 1(a) zone is unrestricted, however, the Council must take into consideration the potential impact of the proposed development having regard to the following provisions under Clause 10 of the LEP 1996:

- “(a) *the present use of the land, the potential use of the land for the purpose of agriculture and the potential for sustained agricultural production of any land concerned which is prime crop or pasture land;*
- (b) *vegetation, timber production, land capability (including soil resources and soil stability) and water resources (including the quality and stability of water courses and ground water storage and riparian rights);*
- (c) *the future recovery from known or prospective areas of valuable deposits of minerals, coal, petroleum, sand, gravel or other extractive materials;*
- (d) *the protection of areas of significance for nature conservation or of high scenic or recreational value, and places and buildings of archaeological or heritage significance, including Aboriginal relics and places;*
- (e) *the cost of providing, extending and maintaining public amenities and services to the site of the development; and*
- (f) *future expansion of settlements in the locality.”*

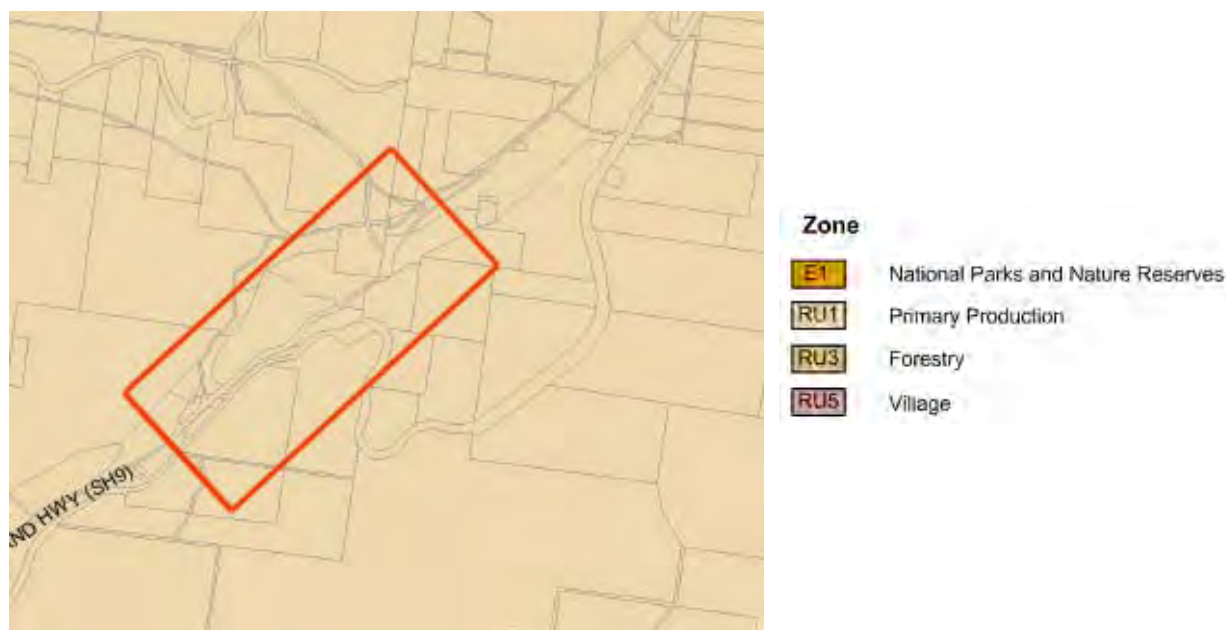
Any new road must consider these provisions. It is envisaged that the proposed road upgrade will meet the Council requirements.

4.2.5 Tenterfield Local Environmental Plan 2013

The *Tenterfield Local Environmental Plan 2013* has been prepared in accordance with the NSW Standard Template for Local Environmental Plans. Public exhibition of the draft LEP ended on 2 November 2012, and the LEP was gazetted on 19 April 2013.

Land within the study area is zoned RU1 – Primary Production as shown in **Figure 4-6**. The development of roads is permitted without development consent on land zoned RU1 under the LEP 2013.

It is important to note that the draft zoning does not recognise the Bolivia Hill Nature Reserve as being zoned separately under E1 National Parks and Nature Reserves.



Source: Tenterfield LEP 2013

Figure 4-6 Tenterfield LEP 2013 Zoning Map with study area overlain (in red)

4.3 Approval process

State Environmental Planning Policy (Infrastructure) 2007 (SEPP Infrastructure) is the key environmental planning instrument applicable to the development of roads within NSW. The provisions under SEPP Infrastructure prevail over the provisions under Tenterfield LEP 1996.

SEPP Infrastructure permits the development of a road without consent on any land, unless land is occupied by a National Park or Nature Reserve under the *National Parks and Wildlife Act 1974* (unless agreement from the National Parks and Wildlife Authority has been obtained). Accordingly, any options that propose to develop road on land within the bounds of the Bolivia Hill Nature Reserve cannot be undertaken without consent under SEPP Infrastructure and will require consent under Part 4 of the *Environmental Planning and Assessment Act 1979* as noted in **Section 4.2.1**.

Development permitted without consent under SEPP Infrastructure will require assessment under Part 5 of the Act. Assessments under Part 5 are administered by the relevant public authority (in the case of this project, Roads and Maritime) and require the preparation of a *Review of Environmental Factors*. If the proposal is found to have significant environmental impact then an Environmental Impact Statement (EIS) may be required.

If an EIS is required, then the development is classified as State Significant Infrastructure and will be assessed in accordance with SEPP State and Regional Development under Part 5.1 of the Act. SSI is determined on behalf the Minister by the Planning Assessment Commission (PAC).

5 The existing environment

An understanding of the characteristics of the existing natural and social-economic environment is essential to provide base information for assessment of route options and aid selection of a preferred route option. This chapter describes the existing biophysical, social and cultural environment of the study area.

The description of the biophysical environment includes topography, geology and soils, water resources, terrestrial and aquatic ecology, climate and air quality, bushfire, infrastructure and utilities, and the social and cultural environment that includes cultural heritage, demographics and social-economic profiles and visual amenity.

5.1 Assessment Methodology

5.1.1 Initial Desktop Investigations

Initial desktop investigations comprising a review of available information were conducted to provide basic information on the environmental constraints and opportunities associated with the study area, and to assess the relative potential impacts of Options 1-10 in Phase 1 of the route options assessment (see **Section 7.2**). The outcomes of the desktop investigations were also used to develop an initial shortlist of four options for further investigation (see **Sections 8.2 - 8.5**).

5.1.2 Additional Detailed Investigations

Based on the findings of the initial desktop investigations and taking into account the alignment of the four shortlisted options, Cardno developed survey methodologies for more detailed field investigations in consultation with the Roads and Maritime. Field surveys were conducted to characterise:

- Terrestrial biodiversity
- Aquatic biodiversity
- Aboriginal cultural heritage
- Non-Aboriginal heritage.

These field surveys provided additional information used to compare the shortlisted options, and identify the preferred route option (**Chapter 10**). It is intended that the detailed field investigations may also be used to inform any subsequent environmental impact assessment of the preferred option.

5.2 Biophysical environment

5.2.1 Topography, geology and soils

A desktop study of topography, geology and soils was conducted, comprising a review of:

- Geological maps
- Topographical maps
- Acid sulfate soil maps
- Review of the information compiled in a preliminary geotechnical assessment for the project (Roads and Maritime, 2012).

Further detailed site investigations of geological or soil characteristics were not conducted at this stage.

5.2.1.1 *Topography*

The study area consists of two topographically distinct portions – a southern portion and a northern portion (see **Figure 5-1**).

The southern portion comprises two prominent ridgelines with steep side slopes, containing areas of sub-vertical to 60° granite outcrops and soil covered slopes of up to about 20° to 25°, containing scattered granite boulders. The ridgelines are located east and west of the current New England Highway alignment.

The ridgeline west of the current highway alignment strikes north-east to south-west and has a maximum elevation within the study area of around RL1040 metres. The ridgeline east of the current highway alignment strikes north-north-east to south-south-west and has a maximum elevation within the study area of around RL1000 metres.

The northern portion of the study area has reasonably flat topography and is grass covered with no rock outcrops (**Figure 5-1**).

5.2.1.2 Geology

Bolivia Hill is located within the New England Fold belt. Bolivia Hill is formed from an early Triassic granitoid, the 'Bolivia Range Leucomonzogranite'. Reference to aerial photographs of the study area shows major structural lineaments running in a north-north-east direction through the range.

Geology maps show granite covering the southern, hilly part of the New England Highway with the Dundee Rhyodacite over the northern end of the study area (1:100000 Geological Sheet 9239) (**Figure 5-2**). Fresh, slightly weathered granite outcrops are observed along ridgelines and in some areas on the sides of hills in the study area. Rail cuttings predominantly expose slightly weathered to fresh granite as the cuttings occur towards the top of the hill. The existing New England Highway cuttings are on the side of the hill and expose both distinctly weathered granite and slightly weathered to fresh granite.

The rock weathering and strength variations within the study area, particularly abrupt changes in weathering, may have implications for any options that involve tunnelling. This is discussed in further detail in **Section 6.4**.

Granite may also weather to form rounded fresh corestones within a more weathered matrix. The corestones can be of a size ranging from about 0.5 metre diameter to many metres in diameter. These conditions can cause difficulty with excavation and final trimming of cut slopes, where high strength corestones project above the final cut profiles. Some corestone development in a weathered matrix can be observed in the railway cuttings, though depth of weathering is minimal (generally around one to three metres only). No corestones have been observed in the existing road cuttings.

5.2.1.3 Acid sulfate soils

Acid sulfate soils (ASS) are soils that contain iron sulfides and when exposed to air after being disturbed produce sulfuric acid caused by oxidation of the sulfides. ASS are typically found in mangroves, saltmarshes, floodplains, swamps, wetlands, estuaries, and brackish or tidal lakes, particularly in low-lying coastal areas.

The Australian Soil Resource Information System website shows the study area to be located within an area defined as C4 Extremely Low Probability/Very Low Confidence of ASS. Less than one kilometre north of Brickyard Creek, the map shows B4 Low Probability/Very Low Confidence of ASS. Based on this information, it is considered that there is a generally low probability of ASS occurrence in the study area.

5.2.1.4 Acid rock drainage

Acid rock drainage requires the presence of sulfide minerals (sulfidic ores) in rock, particularly iron sulfide or pyrite. These can form within veins (eg quartz) within the granite rock. Acid rock drainage is primarily associated with coal mining, however it can be associated with any metaliferous mine.

Although no obvious veining was observed within outcrops in the study area, Roads and Maritime (2012) indicated past mining activities accessing quartz veins and, therefore, any excavations associated with the proposal may encounter some acid producing rock. Sampling and laboratory testing will be required to determine the acid producing potential of the rock material.

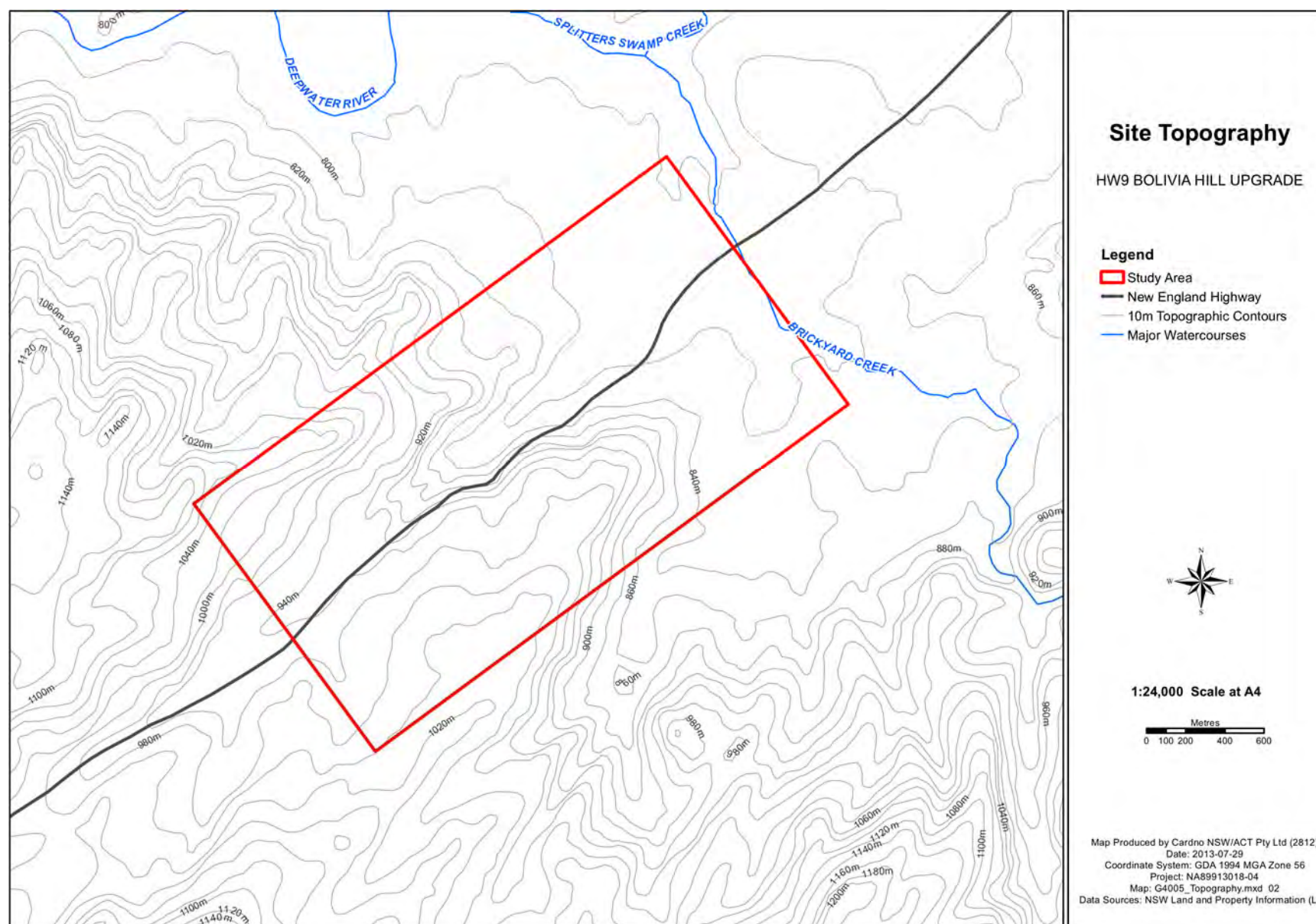


Figure 5-1 Study area topography

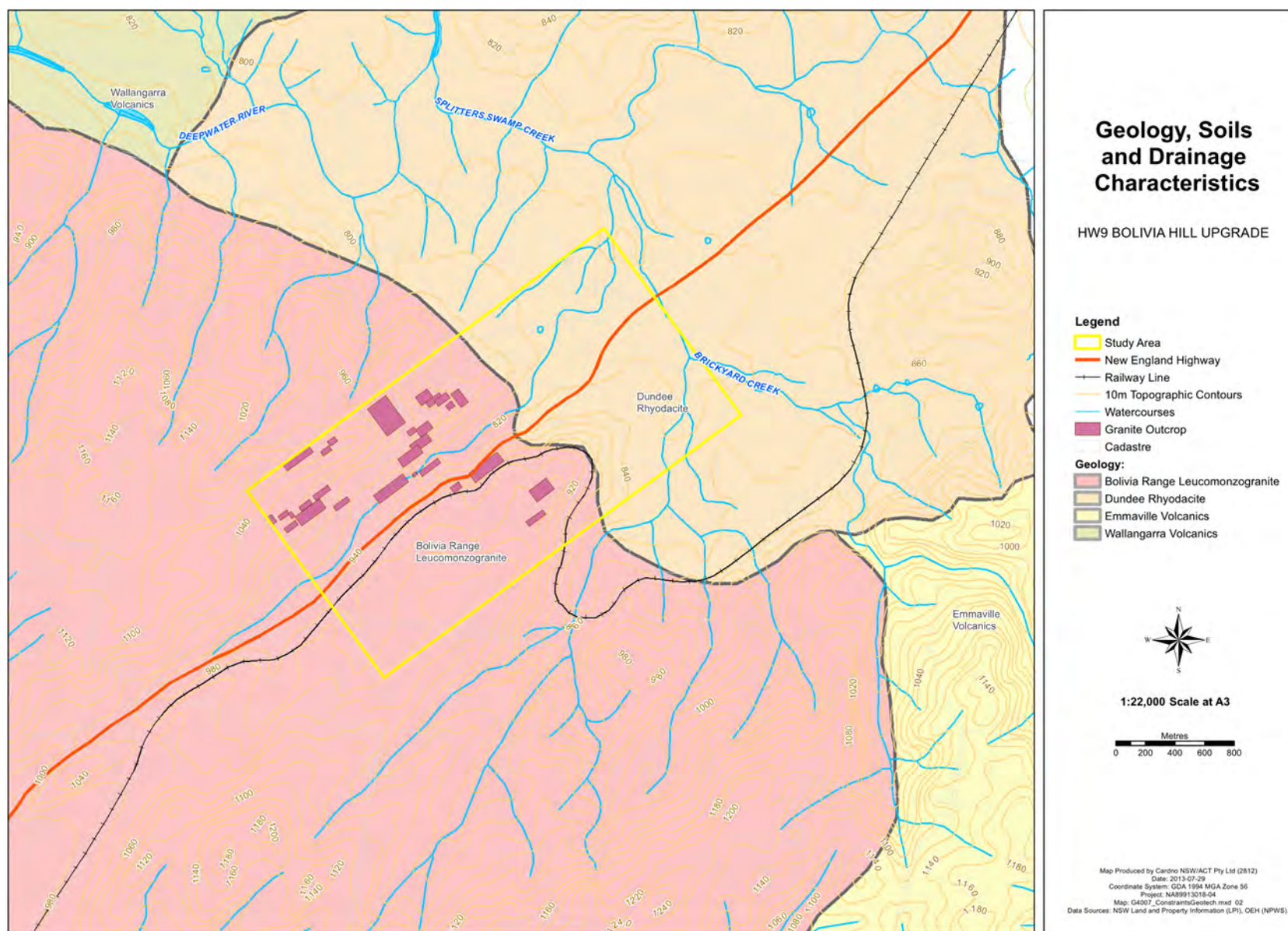


Figure 5-2 Geology, soils and drainage constraints of the study area

5.2.2 Water resources

5.2.2.1 **Surface water hydrology**

Figure 5-1 shows surface drainage lines in the study area. The study area lies at the headwaters of the Deepwater River, a tributary of the MacIntyre River.

The main watercourse in the study area is a first order stream that is unnamed and flows in a north-easterly direction roughly parallel to the New England Highway on the western side. The headwaters of this watercourse lie at an elevation of approximately RL940 metres at the south-eastern end of the study area, and falls to about RL820 metres towards the base of Bolivia Hill (**Figure 5-2**). It then meanders across flat terrain forming a local floodplain and crosses Pyes Creek Road about 400 metres west of the highway. The unnamed watercourse has a catchment area of approximately 530 hectares comprised of forested and rural land. The watercourse has gouged a deep (approximately 20 metres) steep sided gorge exposing fresh granite outcrop, approximately 200 metres west of the current road alignment.

The main unnamed watercourse has a minor tributary in the upper part of its catchment that runs parallel to the main gully and close to the western side of the New England Highway, and is separated from the main gully by a small ridgeline. This tributary joins the main gully about 150 metres west of the highway and is indicated on the hydrology constraints map in **Figure 6-1**.

At the northern end of the study area is Brickyard Creek, which is a fourth order stream that intersects the study area. Brickyard Creek has a catchment area of approximately 1,700 hectares, with the majority of the catchment lying south-east of the New England Highway.

No river flow gauges are located within the main unnamed watercourse or on Brickyard Creek. The nearest river flow gauging station is located on Deepwater River, approximately five kilometres downstream of the study area.

Several minor overland flow paths convey runoff from the two main ridgelines within the study area and thereafter into the main unnamed watercourse. Site inspections in September 2012 indicated that all overland flow paths running off the ridgelines were dry at the time, with only minor ponded water observed in some areas.

Given the distance of the existing road from the main unnamed watercourse and its floodplain, there are no instances of flooding of the existing road that have been identified and no local flooding issues were identified during the consultation period.

Further information is available in **Section 6.3**, which details the outcomes of hydrological and hydraulic modelling of the catchment that has been undertaken.

5.2.2.2 **Groundwater hydrology**

Groundwater resources are defined and recognised by State and Territory agencies as Groundwater Management Units (GMUs) or Unincorporated Areas.

A GMU is a hydraulically connected groundwater system that is recognised as a major aquifer with high production and high usage. The Australian Natural Resources Data Library states that *“this definition allows for management of the groundwater resource at an appropriate scale at which resources issues and intensity of use can be incorporated into groundwater management practices”*. GMUs may be grouped into provinces with respect to state or geological boundaries.

Unincorporated Areas are defined as those areas not included as a GMU.

The study area is located within an Unincorporated Area indicating limited groundwater resources.

The locations of existing groundwater bores are shown in **Figure 5-3**, as sourced from the NSW Groundwater Database.

Figure 5-3 indicates that there are no registered groundwater bores within the study area. A review of three boreholes northeast of the study area indicates only one recording a very low yield of 0.37 L/s. This suggests very limited groundwater resources in the region.

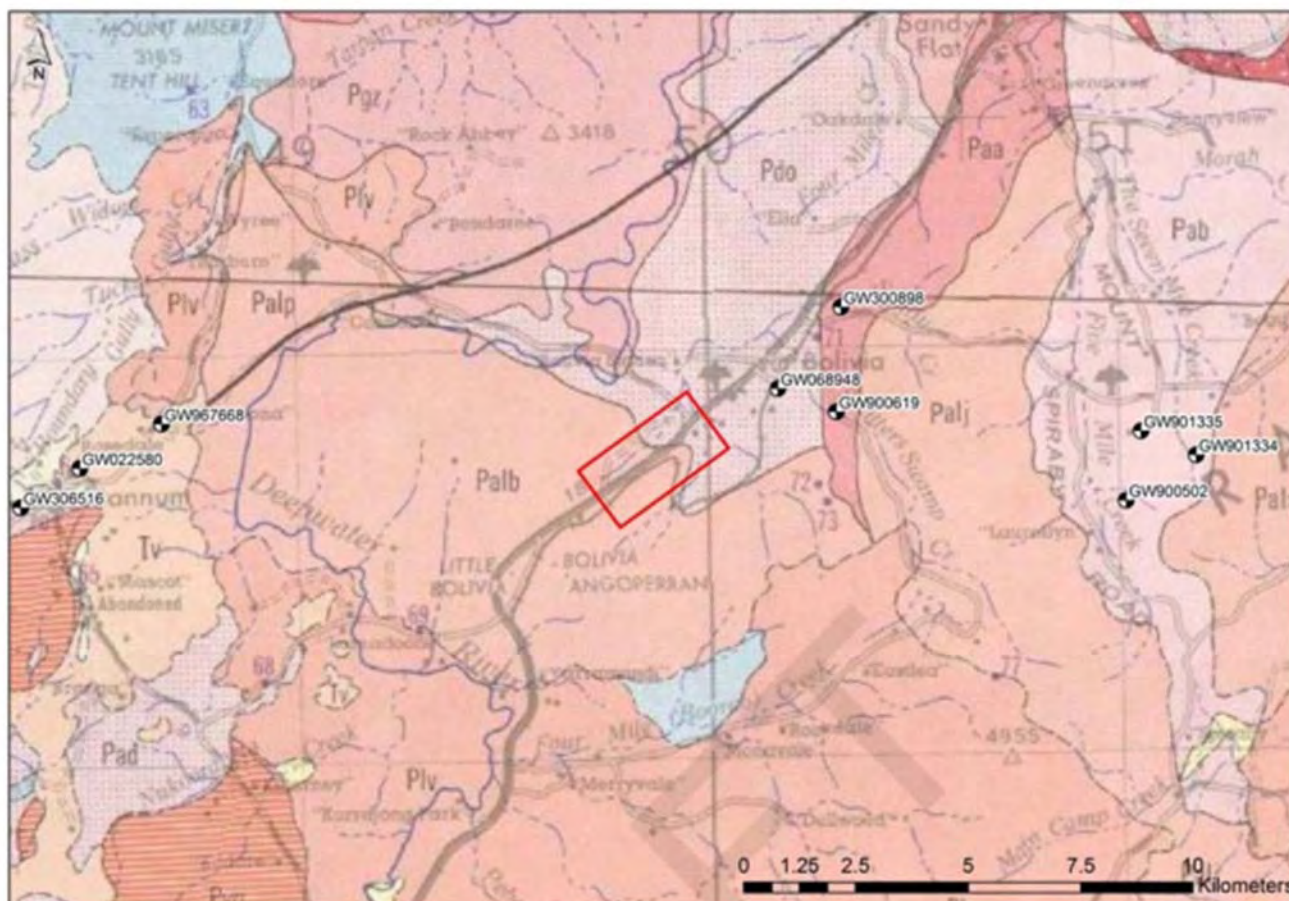


Figure 5-3 Location of registered boreholes

Source: <http://waterinfo.nsw.gov.au/gw/>

5.2.3 Terrestrial biodiversity

An assessment of potential constraints associated with terrestrial biodiversity on the route selection and design process was conducted based on a combination of desktop and field investigations of the flora, fauna and ecosystems of the study area.

The initial desktop assessment involved a review of the relevant Commonwealth, state and local government databases containing information concerning flora, fauna, vegetation communities and other environmentally relevant features. There are also several scientific reports and management plans of relevance to the study area and the surrounding landscape that were reviewed and considered as part of the assessment.

Specifically, the following resources are relevant to the study area:

- Aerial images of the study area (GoogleEarth)
- NSW Bionet Wildlife Atlas (using a 10x10 kilometre polygon around the study area)
- PlantNET
- EPBC Act Protected Matters Search Tool (using a 10x10 kilometre polygon around the study area)
- *Vegetation and Floristics of the Tenterfield Nature Reserves* (Hunter, 2002)
- *Plan of Management: Bluff River Nature Reserve and Bolivia Hill Nature Reserve* (NPWS, 2011).

Based on the findings of the desktop review a field survey was conducted between October and December 2012 and involved:

- Flora surveys to develop vegetation maps and identify conservation significant vegetation
- Trapping of arboreal and ground-dwelling fauna

- Motion trigger infrared camera traps
- Aural detection, including passive digital audio/ultrasonic recordings
- Diurnal and nocturnal spotlight transect surveys
- Searches for scats, tracks, scratches and other signs
- Habitat assessments.

The detailed methodology for the terrestrial biodiversity impact assessment is provided in Cardno (2013a; **Appendix D**).

5.2.3.1 Bolivia Hill Nature Reserve

The Bolivia Hill Nature Reserve (NR) forms the eastern boundary of the existing alignment of the New England Highway in the study area (**Figure 5-4**). The reserve encompasses an area of 1,782 hectares and is considered to be of high floral diversity, supporting a number of threatened ecological communities and threatened flora and fauna species (NPWS, 2011).

NPWS (2011) identified the following key threatening processes (KTPs) for the Bolivia Hill NR:

- Weeds and pest animals
- Non-prescribed/ uncontrolled fire
- Isolation and fragmentation of vegetation and fauna through clearing and development
- Climate change.

While many of these processes relate to competition for resources and degradation of habitat by feral fauna species, some could be exacerbated by the project including:

- Invasion by exotic grass species
- Fire frequency increases
- Loss of hollow-bearing trees
- Micro habitat (ie rock, fallen timber and trees) removal
- Isolation and fragmentation via vegetation clearing.

Based on the likely requirements of the project, including vegetation clearance for the road corridor and preparation of laydowns and site offices for construction, it is considered that the project is likely to increase the probability of KTPs occurring if mitigation measures are not employed. Due to the high ecological value of the Bolivia Hill NR, any shortlisted route options should avoid this area in so far as is reasonable and feasible.

5.2.3.2 Vegetation communities and flora species

The desktop review of available database resources suggested that there was potential for up to 12 different vegetation communities, and 18 flora species listed as Vulnerable or Endangered under the TSC Act or EPBC Act, within a 10x10 kilometre search area surrounding the study area.

These results were ground-truthed during the flora and vegetation surveys undertaken by Dr John Hunter between October and November 2012. The field surveys recorded a total of 374 vascular plant taxa, from 87 families and 239 genera with the proportion of exotic species being 17 percent (Hunter, 2012).

A total of 10 vegetation communities were recorded by Hunter (2012), as mapped in **Figure 5-4**. Details concerning the name, extent, condition and conservation status of each community are provided in **Table 5-1**, along with some general comments regarding each community. Four of these communities are considered to support the requisite species, and be of a suitable quality and structure, to be classified threatened ecological communities (TECs) under the TSC Act and/or the EPBC Act. These communities are mapped in **Figure 5-5**.

A total of 20 threatened flora species were identified via the desktop review, primarily within the Bolivia Hill NR by Dr Hunter and others. Four species were confirmed from the study area via the field surveys (Hunter, 2012):

- Black Cypress Pine (*Callitris endlicheri*)
- Bolivia Wattle (*Acacia pycnostachya*)
- Bolivia Hill Pimelea (*Pimelea venosa*)
- Pungent Bottlebrush (*Callistemon pungens*).

The recorded locations of these species are shown in **Figure 5-4**. For all 20 threatened flora species, their critical habitat requirements and likelihood of occurrence ratings for the study area are discussed in **Table 5-2**. The likelihood of occurrence ratings for both flora and fauna are based on the following criteria:

- **Confirmed** – Species recorded during current surveys of the study area
- **Likely** – Study area supports known critical habitat resources for the species and a NSW Atlas record exists for the species within 10 kilometres of the study area
- **Possible** – Study area supports known critical habitat resources for the species, the EPBC Protected Matters Search Tool indicates the species is likely to occur within 10 kilometres of the study area, but there is no NSW Atlas record of the species within 10 kilometres of the study area
- **Unlikely** – Study area contains very limited, degraded or no known habitat for the species.

The field survey results also noted impacts associated with weed abundance were noted as a KTP, with the most prolific weed species being African Lovegrass (*Eragrostis curvula*), Whiskey Grass (*Andropogon virginicus*) and Coolatai Grass (*Hyparrhenia hirta*).

Table 5-1 Vegetation communities within the study area

Community	Total Mapped Extent (ha)	TEC Extent (ha) (% of total mapped extent)	Conservation Status		Comments
			TSC Act*	EPBC Act*	
C1. Fuzzy Box – Yellow Box – Blakely's Red Gum Grassy Woodland	2.6	0.0 (-)	-	-	Though areas dominated by <i>Eucalyptus conica</i> (Fuzzy Box) are not listed as a TEC within the New England Tablelands Bioregion, such areas should be considered at least as near threatened. This is because areas dominated by Yellow Box and Blakely's Red Gum would be considered to be part of the EEC of box gum woodlands, both of which species occur in this community.
C2. Fuzzy Box – Ribbon Gum – Blakely's Red Gum Grassy Woodland	24.6	12.8 (52%) Ribbon Gum - Mountain Gum - Snow Gum grassy open forest/woodland of the New England Tableland Bioregion	EEC	-	Though the overstorey is intact, most of the understorey in the mapped units is dominated by <i>Eragrostis curvula</i> (African Lovegrass) which is listed as a KTP (Invasion by Perennial Exotic Grasses) on the TSC Act. This is an unusual and undescribed assemblage type that is probably unique to the region between Deepwater and Tenterfield.
C3. New England Tea-tree – Pungent Bottlebrush – Swamp Tea-tree Wet Heath	1.5	1.5 (100%) Montane Peatlands & Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands & Australian Alps Bioregions	EEC	-	This community has been affected by past grazing and clearing activities and regular fire. These disturbance activities are known to negatively affect the formation of peat. Some erosion has occurred though the centre of these wet heaths within the Nature Reserve.
C4. Derived Grassland (Red Grass – Wiregrass)	127.5	32.6 (28.5%) Aspects of this community resemble two TECs: 1. Ribbon Gum - Mountain Gum - Snow Gum grassy open forest/woodland of the New England Tableland Bioregion 2. White Box Yellow Box Blakely's Red Gum grassy woodlands*	EEC EEC	- CE	Much of this assemblage is dominated by species listed as a KTP (Invasion of Exotic Perennial Grasses) on the TSC Act and includes dense swards of <i>Eragrostis curvula</i> (African Lovegrass), <i>Andropogon virginicus</i> (Whiskey Grass) and <i>Hyparrhenia hirta</i> (Coolatai Grass). It is highly important that the spread of these introduced grasses is not exacerbated.

Community	Total Mapped Extent (ha)	TEC Extent (ha) (% of total mapped extent)	Conservation Status		Comments
			TSC Act*	EPBC Act*	
C5. Derived Grassland (Wire Grass – Bamboo Grass)	1.6	0 (-)	-	-	Highly disturbed areas commonly dominated by the introduced <i>Hyparrhenia hirta</i> (Coolatai Grass) which is listed as a KTP (Invasion of Exotic Perennial Grasses) on the TSC Act. Found on highly disturbed and exposed areas associated with the railway cutting.
C6. Carex Fen	6.9	6.9 (100%) Aspects of this community resemble two TECs:	EEC	-	There may be difficulty in determining which TEC this assemblage falls within without on-ground work. Fens are sensitive to small changes in groundwater flow.
		1. Carex Sedgelands of the New England Tableland, Nandewar, Brigalow Belt South & NSW North Coast Bioregions* 2. Montane peatlands & swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands & Australian Alps Bioregions	EEC	-	
C7. Broad-leaved Stringybark – Rough-barked Apple – Blakely's Red Gum Woodland	200.1	11.9 (5.9%) Aspects of this community resemble White Box Yellow Box Blakely's Red Gum grassy woodlands*	EEC	CE	
C8. Blakely's Red Gum – Rough - barked Apple – Fuzzy Box Grassy Woodland*	42.2	39.3 (93.1%) Aspects of this community resemble two TECs:	EEC	CE	Small open patches within the intact mosaic are dominated by <i>Eragrostis curvula</i> (African Lovegrass). Care should be taken not to spread this invasive species that is listed as a KTP (Invasion by Perennial Exotic Grasses). Most of this community would be included within the Box – Gum Grassy Woodlands TECs. Furthermore, most of the area mapped as this entity is of very high quality.
		1. White Box Yellow Box Blakely's Red Gum grassy woodlands* 2. Ribbon Gum - Mountain Gum - Snow Gum grassy open forest/woodland of the New England Tableland Bioregion	EEC	-	

Community	Total Mapped Extent (ha)	TEC Extent (ha) (% of total mapped extent)	Conservation Status		Comments
			TSC Act*	EPBC Act*	
C9. Broad-leaved Stringybark – Mountain Banksia – Apple Box Shrubby Woodland and Forest	48.6	4.2 (8.5%) Aspects of this community resemble: Ribbon Gum - Mountain Gum - Snow Gum grassy open forest/woodland of the New England Tableland Bioregion	EEC	-	Much of this assemblage has been cleared within the study area though a reasonable area remains in very good condition. It is within this community that the extant population of the Endangered <i>Pimelea venosa</i> is found.
C10. Black Pine – Caley's Ironbark – Kurrajong Shrubland, Shrubby Woodland & Dry Rainforest	18.9	0 (-)	-	-	The threatened <i>Acacia pycnostachya</i> (Bolivia Hill Wattle) is more commonly found in this community than any other and at times forms a dominant overstorey on some rocky slopes.

* EEC = Endangered Ecological Community under the TSC Act; CE = Critically Endangered Community under the EPBC Act.

Table 5-2 Threatened plant species recorded in the study area

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
<i>Callitris endlicheri</i>	Black Cyprus Pine	-	3	Usually found on stony hills or ridges.	Confirmed This species was commonly recorded within the New England Tea-tree – Pungent Bottlebrush – Swamp Tea-tree Wet Heath community, as well as the Black Pine – Caley's Ironbark – Kurrajong Shrubland, Shrubby Woodland and Dry Rainforest community, and was also recorded within the Broad-leaved Stringybark – Rough-barked Apple – Blakely's Red Gum Woodland community.
<i>Almaleea cambagei</i>	Torrington Pea	V	E1	Wet heath and acid swamp, and along watercourses on granite, above 900 m altitude.	Possible Watercourses within the study area provide potentially suitable habitat for this species. The broad distribution of this species is known to include the vicinity of the study area.

Scientific Name	Common Name	Conservation Status [*]		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
<i>Acacia pycnostachya</i>	Bolivia Wattle	V	V	Dry sclerophyll forest, open woodland and dry heath. Occurs amongst granite outcrops, on hillsides at altitudes of 700 to 900 m. Soil types range from sandy and skeletal on exposed outcrops, to shallow sandy loams in less exposed sites.	Confirmed A large population of this species was recorded within an area of Rock Outcrop Shrubland. Occasional individuals of this species were also found scattered through the Blakely's Red Gum – Rough-barked Apple – Fuzzy Box Grassy Woodland community. Potential habitat within the site occurs elsewhere within dry sclerophyll communities with granite outcrops.
<i>Eucalyptus boliviana</i>	Bolivia Stringybark	-	V	Low dry sclerophyll woodland on gritty sandy soils over granite and among outcropping boulders.	Possible The study area provides potentially suitable habitat for this species, specifically, dry sclerophyll forest with granite outcrops. This species is known only from the Bolivia Hill Nature Reserve and nearby locations.
<i>Homoranthus croftianus</i>	Bolivia Homoranthus	-	E1	Open exposed situations in shrubland and low woodland on granitic outcrops.	Possible The study area provides potentially suitable habitat for this species, specifically, dry sclerophyll woodland on granite outcrops. This species is known only from the Bolivia Hill region.
<i>Arthraxon hispidus</i>	Hairy Jointgrass	V	V	Moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps.	Possible The study area provides potentially suitable habitat for this species, particularly along waterways in sclerophyll communities. The broad distribution of this species is known to include the study area.
<i>Boronia boliviensis</i>	Bolivia Hill Boronia	-	E1, 3	Dry sclerophyll forest and low shrublands amongst granite boulders, and heaths on granite outcrops.	Possible The study area provides potentially suitable habitat for this species, specifically, dry sclerophyll forest with granite outcrops and rock outcrop shrubland. This species is known only from the Bolivia Range.

Scientific Name	Common Name	Conservation Status [*]		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
<i>Pimelea venosa</i>	Bolivia Hill Pimelea / Bolivia Riceflower	E	E1, 3	Granite outcrops among granite boulders in skeletal or black sandy soil. Vegetation ranges from relatively more open woodland to shrubland to open grassland, on the western side of Bolivia Hill.	Confirmed One population of this species was found within the Broad-leaved Stringybark – Mountain Banksia – Apple Box Shrubby Woodland and Forest community. This is the only known extant population of this species. Potential habitat within the site occurs elsewhere within the woodland communities featuring granite outcrops.
<i>Acacia pubifolia</i>	Velvet Wattle	V	E1	Rocky granite hillsides, in sandy, stony or loamy soil in eucalypt-scrub woodland or forest.	Unlikely Although potentially suitable woodland habitat for this species is present within the site, this species is not known to occur in the vicinity of the study area.
<i>Boronia granitica</i>	Granite Boronia	E	V	Grows on granitic soils or screes amongst rock outcrops, often in rock crevices. It has been found in dry sclerophyll forests, woodlands and heathlands on mostly shallow soils.	Possible The study area provides potentially suitable habitat for this species, specifically, dry sclerophyll forest with granite outcrops. The broad distribution of this species is known to include the study area.
<i>Callistemon pungens</i>	Pungent Bottlebrush	V	-	Grows in or near rocky watercourses, usually in sandy creek beds on granite or sometimes on basalt.	Confirmed Found as a shrub within community C3. Habitat restricted to heath swamp and wetlands
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V	V	Known from a range of habitats, including swamp-heath and woodland.	Unlikely Although potentially suitable woodland habitats are present within the study area, the distribution of this species is not known to encompass the study area.
<i>Diuris pedunculata</i>	Small Snake Orchid	E	E1	Grows on grassy slopes or flats. Often on peaty soils in moist areas. Also on shale and trap soils, on fine granite, and among boulders.	Possible The study area provides potentially suitable habitat for this species, specifically, peat soils supporting wet heath. The predicted distribution of this species encompasses the study area.
<i>Eucalyptus nicholii</i>	Narrow-leaved Black Paperbark	V	V	Dry grassy woodland, on shallow soils of slopes and ridges.	Possible The study area provides potentially suitable habitat for this species, specifically, dry sclerophyll forest. The predicted distribution of this species encompasses the study area.

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
<i>Haloragis exalata</i> <i>subsp. velutina</i>	Tall Velvet Sea-berry	V	V	Damp places near watercourses, and in steep rocky slopes of gorges.	Unlikely Although watercourses within the study area may provide potentially suitable habitat for this species, the broad distribution of this species is not known to include the study area.
<i>Lepidium peregrinum</i>	Wandering Pepper- cress	E	E1	Open riparian forest.	Unlikely Although watercourses within the study area may provide potentially suitable habitat for this species, the broad distribution of this species is not known to include the study area.
<i>Streblus pendulinus</i>	Siah's Backbone	E	-	Warmer well-developed rainforests, gallery forest and seasonal rainforest, chiefly along watercourses.	Unlikely The study area does not provide suitable rainforest habitat.
<i>Thesium australe</i>	Austral Toadflax	V	V	Grassland or woodland, often in damp sites.	Possible The study area provides potentially suitable habitat for this species, specifically, grasslands and woodlands. This species has previously been recorded from the Bolivia Hill region.
<i>Tylophora linearis</i>	-	E	V	Dry scrub and open forest.	Unlikely Although the study area provides potentially suitable dry sclerophyll habitat, the known distribution of this species does not encompass the study area.
<i>Tylophora woollsii</i>	Cryptic Forest Twiner	E	E1	Moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins.	Unlikely Although the study area provides potentially suitable moist habitat, the known distribution of this species does not encompass the Study Area.

*Note: EPBC Act Status: E=Endangered; V=Vulnerable; M=Migratory. TSC Act Status: E4A=Critically Endangered Species; E1=Endangered Species; V = Vulnerable Species; 3 = Category 3 Sensitive Species

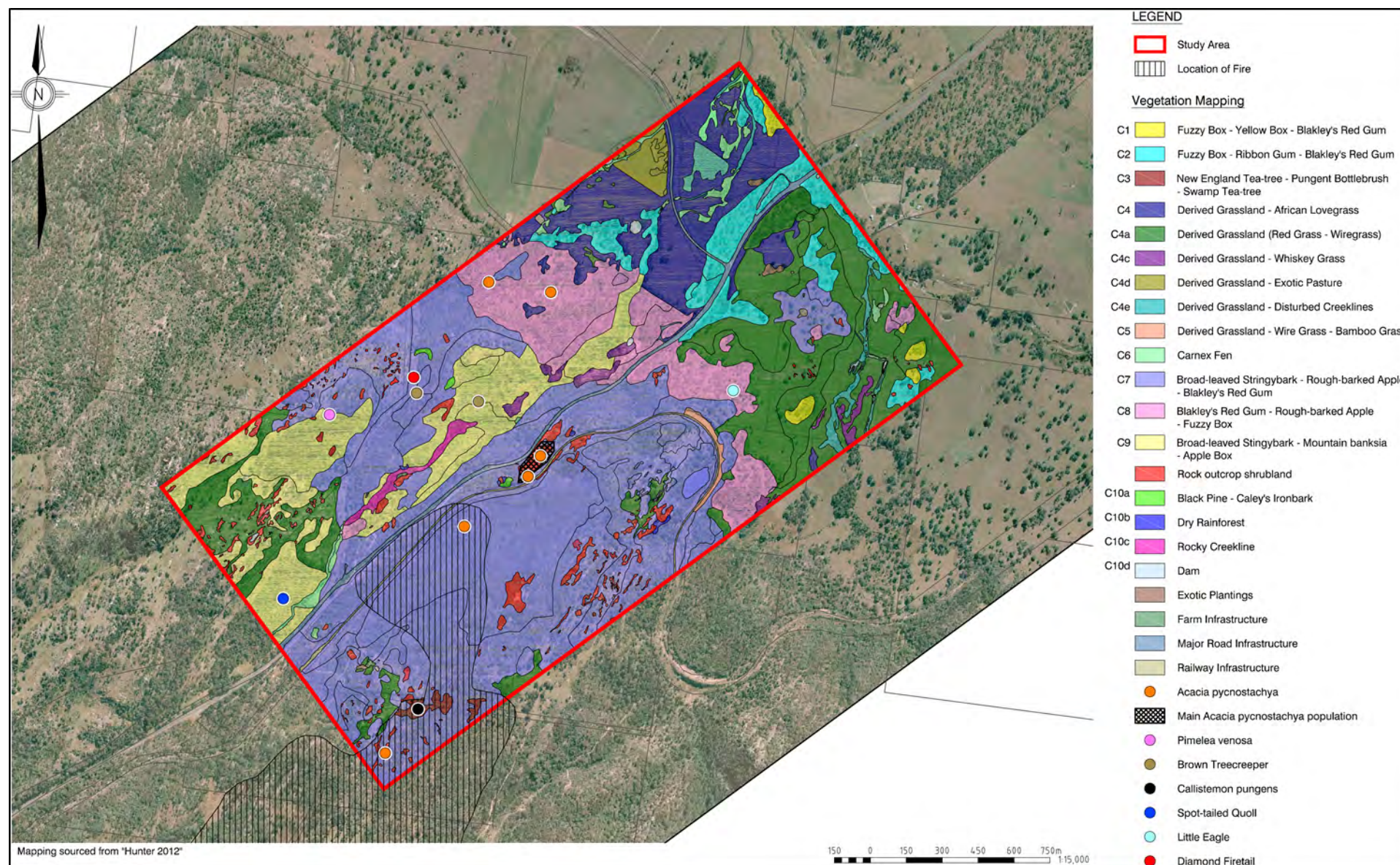


Figure 5-4 Vegetation biodiversity constraints of the study area

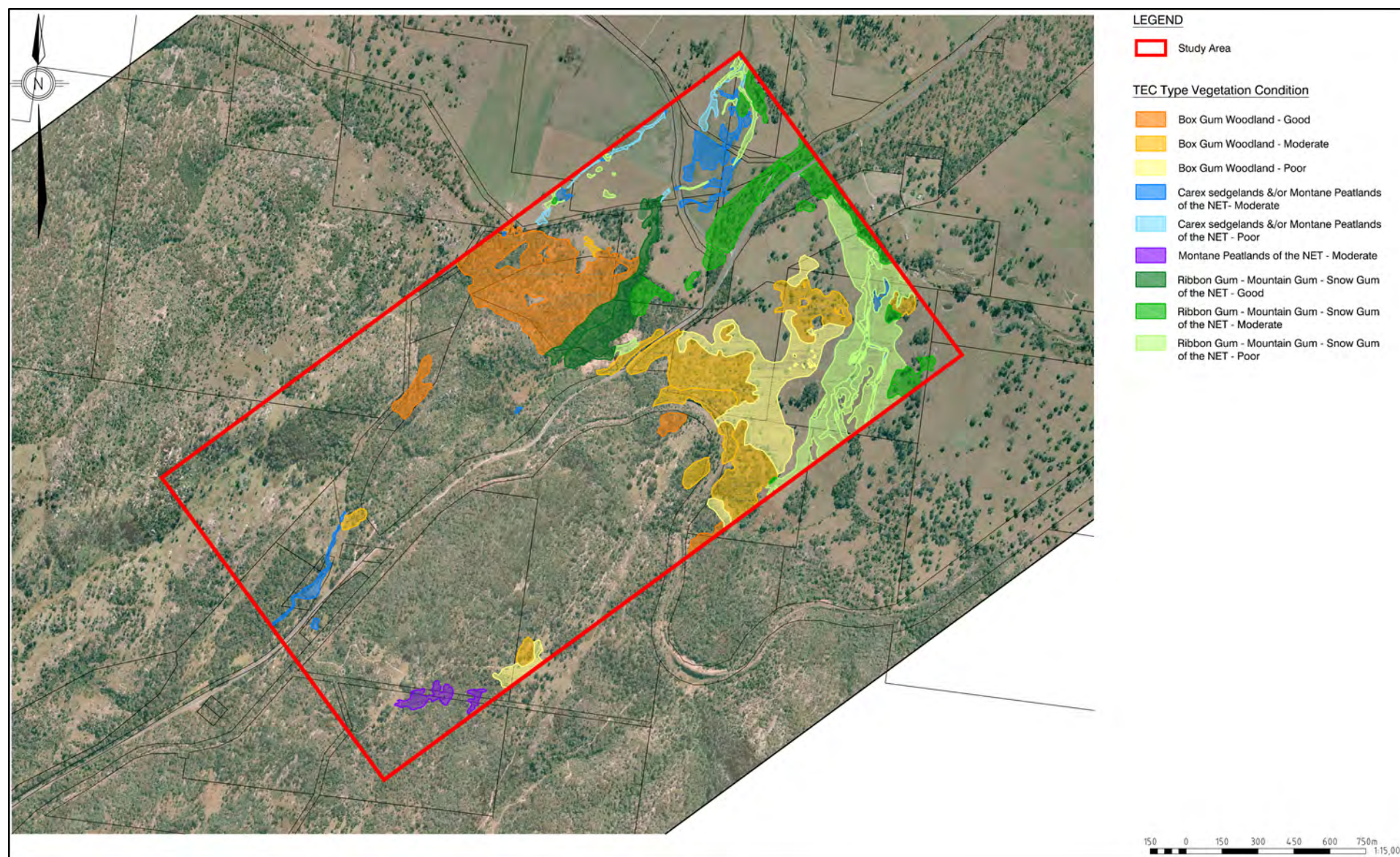


Figure 5-5 Map of threatened ecological communities in the study area and their condition

5.2.3.3 Fauna species

A review of available data collated for the desktop assessment indicated that there are a number of threatened fauna species previously recorded from within the study area or that are likely to occur based on the presence of potentially suitable habitat (**Table 5-3**).

A total of 115 fauna species were recorded during the field surveys a complete list of which has been provided in Cardno (2013a; **Appendix D**). This comprised 105 native species and 10 introduced species. Diversity was greatest within the bird group with a total of 58 native and one introduced species. A total of nine native species of reptile and nine amphibian species (including one introduced species) were also recorded from the study area. A single native species of crustacean was also recorded during the field surveys. A number of mammals were recorded, a relatively large proportion of which were exotic species.

An assessment of the likelihood of occurrence within the study area of threatened fauna species that have been reported as occurring, or potentially occurring, within 10 kilometres of the study area is provided in **Table 5-3**. **Table 5-3** presents the findings of the assessment along with specific comments where appropriate regarding habitat requirements for specific species.

Considering the survey records by vegetation community type, community C9 (see **Figure 5-4**) showed the greatest diversity of those communities surveyed. C3 had the lowest faunal diversity, however this is due to the community only being surveyed for native frog species.

It is also noted that the Endangered Tusked Frog population of the Nandewar and New England Tableland Bioregions is known to occur (or have occurred) in that part of the Border Rivers-Gwydir Catchment Management Region, which encompasses the study area. However, there are no records of the Tusked Frog (*Adelotus brevis*) within Atlas of NSW Wildlife search results for the study area, and no Tusked Frogs were recorded during field surveys. In this respect the formal NSW Scientific Committee listing of this population notes that “*The New England Tablelands and Nandewar population of Tusked Frog represents a distinct and disjunct high-elevation population that is at the western limit of the species' range in NSW. Given the apparent lack of records from this population in the last 25 years, its numbers are likely to be reduced to a critical level, if it is not already extinct.*” Given the above facts and circumstances, the Tusked Frog is considered to be unlikely to occur within the study area.

5.2.3.4 Fauna habitat

Assessments of fauna habitat were also undertaken to assist the assessment of potential impacts, recording features such as hollow trees, fallen logs, boulders, caves and grasses. A comprehensive overview of the survey findings are provided in **Appendix D**. The habitat assessments indicate that the quality and condition of fauna habitats is variable across the study area. The majority of the survey sites were found to have a well-developed vegetation community that was in most instances well connected to the surrounding landscape. While there was evidence of weed invasion within the sites, levels of infestation were generally low and did not detract from the overall value of the area as habitat for native fauna. Possibly due to the rocky, shallow soils of the study area none of the sites were considered to have a well-developed or dense shrub or groundlayer; however an abundance of rocks, fallen logs and leaf litter would compensate somewhat for the protection and cover usually afforded by vegetation.

A general decline in habitat quality was recorded below Bolivia Hill, towards the north-eastern section of the study area. This was found to be associated with lower elevations and a more ‘plain-like’ position within the landscape. The relatively poor habitat condition recorded for the survey sites in this part of the study area is primarily driven by the isolation and fragmentation effects of the existing highway and the surrounding agricultural pastures, that have been substantially cleared. However, weed infestation and clearing have also contributed to a reduced overall condition. One of the sites recorded as being of low quality at the time of the survey was located within a portion of the Bolivia Hill NR that had been recently subjected to an uncontrolled fire, although that microhabitat features such as boulders and rock crevices remained as did many of the hollows in unburnt canopy trees. Consequently, once there is vegetation regrowth the habitat quality of the burnt area is expected to increase.

The nature and availability of micro-habitat features was found to be reasonably consistent across the study area. The dominant fauna habitat features are driven by the underlying geology with an abundance of boulders, rocks, crevices, outcrops and similar geological formations that provide fauna refugia.

Interspersing these 'rock-based' habitat features are well-developed and structured vegetation communities, which provide numerous hollows, fallen logs and substantial leaf-litter abundance all of which are important micro-habitat features for native fauna. Again, it is recognised that there was a decline in the abundance of boulders and rock crevices towards the lower elevation plains to the north and east of the study area. However, this part of the study area was found to support a number of important micro-habitat features, the most prevalent of these being a well-developed ground layer vegetation and hollow bearing trees, which would be expected to (in part) compensate for the absence of rocks and boulders, supporting small terrestrial mammals despite the prevalence of invasive flora species in parts. The hollow bearing trees would serve as suitable nesting and roosting sites for hollow dependant fauna, though the relatively isolated and fragmented nature of these patches means that they are more likely to support the more gregarious and disturbance tolerant bird groups (ie parrots) and common arboreal mammals (ie Common Brush-tailed possum).

Table 5-3 Threatened terrestrial fauna species recorded in the study area

Scientific Name	Common Name	Conservation Status [*]		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Frogs					
<i>Philoria sphagnicolus</i>	Sphagnum Frog	-	V	High moisture levels. Found in Sphagnum Moss beds or seepages on steep slopes. Habitat occurs in rainforest and wet sclerophyll forest. Burrow in loose, moist soil or moss, under leaf litter in soaks/seepages, or may use cracks/cavities next to small waterfalls.	Likely There are a number of rocky well vegetated watercourses within the Study Area most notably south east of Sites A1, B2 and A3 and associated with communities C7 and C9.
<i>Mixophyes balbus</i>	Stuttering Frog	V	E1	Typically found in association with permanent streams through temperate and sub-tropical rainforest and wet sclerophyll forest. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor.	Possible Permanent sections of the watercourses below sites A1, B2 and A3 support appropriate habitat again these areas are associated with communities C7 and C9.
Reptiles					
<i>Underwoodisaurus sphyrurus</i>	Border Thick-tailed Gecko	V	V	Dry sclerophyll open forest and woodland. Preference for canopy cover between 45-60%, medium rock cover and high litter cover. Shelter sites include rocks, decaying logs, bark, and litter in rocky rubble. Usually shelters on litter substrate, shaded by nearby vegetation.	Likely All sites surveyed, with the exception of B3 and A4 support appropriate habitat. However, within the suitable sites there may only be small pockets that could be considered most suitable. The eastern facing bases of rock mounds, cliffs or crevices at sites A2 and B2 (Communities C7 and C9) would be considered most suitable. A single record from previous surveys has been made at the southern extent of the study area.
<i>Delma torquata</i>	Collared Delma	V	-	Normally inhabits eucalypt-dominated woodlands and open-forests. Suitable habitats are commonly associated with exposed rocky outcrops on ridges or slopes in vegetation communities dominated by Narrow-leafed Ironbark.	Possible Study area supports appropriate habitat features notably Site A1, A2 and B2 but the range of this species does not extend this far south and no vegetation communities supported Narrow-leafed Ironbark. Most closely aligned communities include C7 and C9.

Scientific Name	Common Name	Conservation Status *		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
<i>Elseya belli</i>	Bell's Turtle	V	V	Shallow to deep pools in upper reaches or small tributaries of major rivers in granite country. Occupied pools are most commonly less than 3m deep with rocky or sandy bottoms and patches of vegetation. Most typically uses narrow stretches of rivers or streams 30 - 40m wide. Nests are dug out in riverbanks of sand or loam.	Unlikely Very limited areas of possibly suitable habitat and this species has not been found in this area previously. Generally restricted to the headwaters of river systems to the north and south of the study area.
Birds					
<i>Hieraaetus morphnoides</i>	Little Eagle	-	V	Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch.	Confirmed A single individual was recorded overflying site B4. The entire study area would be considered suitable habitat for various life stages of this species.
<i>Glossopsitta pusilla</i>	Little Lorikeet	-	V	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other species. Riparian habitats are used. Isolated flowering trees in open country are used eg paddocks, roadside remnants and urban trees. Nests in hollows in the limb or trunk of smooth-barked Eucalypts.	Likely Much of the study area supports the required habitat for this species particularly those areas with a higher abundance of hollow bearing trees, (ie A1, A2, B2, B4 and A3) which fall within Communities C7, C8 and C9.
<i>Tyto novaehollandiae</i>	Masked Owl	-	V, 3	Lives in dry eucalypt forests and woodlands. Often hunts along the edges of forests, including roadsides. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	Likely The study area supports the range of habitat resources required to support this species. Those communities within the study area that contain suitable hollows are expected to be, primarily communities C7, C8 and C9.
<i>Stagonopleura guttata</i>	Diamond Firetail	-	V	Open grassy woodland, heath and farmland or grassland with scattered trees.	Confirmed A single individual was recorded from within the study area within Site A2, which is within Community C7.

Scientific Name	Common Name	Conservation Status *		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	-	V	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest. Mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey. Fallen timber is an important habitat component for foraging. Hollows in standing dead or live trees and tree stumps are essential for nesting.	Confirmed A number of individuals were recorded from sites A1, A2 and B2 which are within Communities C7 and C9. However, all communities within the study area are likely to provide habitat resources for this species from time to time.
<i>Anthochaera phrygia</i>	Regent Honeyeater	E, M	E4A	Dry open forest and woodland, particularly Box-Ironbark woodland and riparian forests of river Sheoak and Mistletoe. Regularly occur in remnant trees or patches of woodland in farmland, partly cleared agricultural land and riverine forest. Usually nest in the canopy of forests or woodlands, and in the crowns of tall trees, mostly eucalypts.	Likely The study area supports the range of habitat resources required to support this species. Most particularly the well-developed canopies within communities C7, C8 and C9.
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E	E1	Tall, dense, grassy ground-cover in open Eucalyptus forests or woodlands. The ground-layer vegetation is usually about 1.0–1.5m tall and fairly dense, providing about 65–90 coverage.	Unlikely Only site B3 and A4 support the required dense ground layer and these are otherwise likely to be too disturbed and small in area to support this species on a regular basis.
<i>Erythrorchis radiates</i>	Red Goshawk	V	E4A	Inhabit open woodland and forest, preferring a mosaic of vegetation types and are often found in riparian habitats along or near watercourses or wetlands. Preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers.	Unlikely The study area supports some of the habitat features required but lacks a well-developed broad scale mosaic of habitats (ie clearly defined riparian habitat amongst Eucalypt woodland).

Scientific Name	Common Name	Conservation Status *		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
<i>Geophaps scripta scripta</i>	Squatter Pigeon	V	E1	Occurs mainly in grassy woodlands and open forests and plains that are dominated by eucalypts. Has also been recorded in sown grasslands with scattered remnant trees, disturbed habitats (ie around stockyards, along roads and railways, and around settlements), in scrub and in acacia growth.	Possible This species has been recorded from within 40km of the study area. Site A2 (community C7) is located within a vegetation community listed as known habitat. A possible but unconfirmed sighting was made during the surveys.
<i>Lathamus discolor</i>	Swift Parrot	E	E1	Inhabits dry sclerophyll eucalypt forests and woodlands. Occasionally occurs in wet sclerophyll forests. In northern New South Wales, Narrow-leaved Red Ironbark, Forest Red Gum forests and Yellow Box forest are commonly utilised. Occur in areas where eucalypts are flowering profusely or where there are abundant lerp infestations.	Possible The entire study area supports the requisite habitat however surveys during profuse flowering would be required to increase detectability.
<i>Leipoa ocellata</i>	Malleefowl	V, M	E1	Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall areas. Prefers habitats with a dense but discontinuous canopy and dense and diverse shrub and herb layers. Breeding habitat characterised by light soil and an abundant leaf litter.	Unlikely The study area does not support areas of floristically rich mallee.
<i>Rostratula australis</i>	Australian Painted Snipe	V	E1	Generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	Unlikely While there are areas of open water within the study area they generally lack the intact and dense fringing vegetation expected for this species.

Scientific Name	Common Name	Conservation Status [*]		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Mammals					
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	E	V	Prefers mature wet forest habitat. Suitable den sites include hollow logs, tree hollows, rock outcrops and caves. Require large areas of relatively intact vegetation to forage.	Confirmed This species was only recorded from within site A1 on two separate occasions. However the critical habitat resources (rock crevices, ground hollows for denning and available prey species) present within A1 (community C9) are comparable to that which occurs through the entire study area excluding the lower plain slopes. Past observations of this species along with the findings of this assessment are considered to indicate that the study area and the immediately surrounding landscape supports a functional, possibly important, population of this species.
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	-	V	Prefers moist habitats, with trees taller than 20m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	Likely The mountainous regions with steep cliff faces (ie below site A2 in community C7) and those areas associated with Bolivia Hill (ie B1 also in C7) within the Study Area support the required habitat for this species. Further, echolocation calls which may be attributed, but not definitively, to this species were recorded from detectors located within all of the communities within the study area.
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing Bat	-	V	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.	Confirmed Definitive echolocation calls were recorded at detectors located within all of the major vegetation communities surveyed.
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	-	V	A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings. Occasionally found along cliff-lines in wet eucalypt forest and rainforest.	Possible While no significant cave sites were recorded from this survey it is likely that they occur, particularly within the vertical outcrop below site A2 (community C7 and C9) with both of these communities supporting the requisite vegetation for foraging.

Scientific Name	Common Name	Conservation Status *		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
<i>Chalinolobus dwyeri</i>	Large-eared Bat	V	V	Roosts in cave entrances, cliff crevices, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (<i>Petrochelidon ariel</i>), frequenting low to mid-elevation dry open forest and woodland close to these features. Requires a combination of sandstone cliff/escarpment to provide roosting habitat that is adjacent to higher fertility sites, particularly box gum woodlands or river/rainforest corridors.	Unlikely Elevation of the study area and the surrounding landscape likely precludes the presence of this species.
<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat	V	V	Occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands. Moister woodland of various eucalypt species with a distinct shrub layer frequently adjacent to watercourses. Roosts in tree hollows, crevices, and under loose bark.	Unlikely Study area supports the habitat features required to support this species. However current known and predicted range ceases approximately 50km west of the study area.
<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	V	E1	Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges. A range of vegetation types are associated with habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest.	Possible The study area, particularly within Bolivia Hill NR and the higher slopes of sites B2 and B4 (communities C8 and C9) supports the specific habitat requirements for this species.
<i>Phascolarctos cinereus</i>	Koala	V	V	Inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus <i>Eucalyptus</i> . Spend most of their time in trees, but will descend and traverse open ground to move between trees.	Possible Despite an abundance of Eucalypt species the only recognised 'food' tree recorded within the study area was <i>Eucalyptus viminalis</i> (Manna Gum) which was recorded from within community C2. However the trees within the study area could be considered a potentially suitable for both foraging and resting. In addition to this there has been a past recorded sighting of this species within 10km of the study area.

Scientific Name	Common Name	Conservation Status *		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo	V	V	Can be found in dry and wet sclerophyll forests to coastal heaths and scrubs. Dense understorey with occasional open areas is essential, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. Dig small holes in the ground.	Unlikely Generally recorded from more coastal environments east of the Great Dividing Range.
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	V	-	Found from coastal areas and up to 100km inland on sandstone country. Deeper top soils and softer substrates are preferred for digging burrows. Inhabits open heathland, open woodlands with heathland understoreys and vegetated sand dunes.	Unlikely May be within or very edge of range for this species however key habitat requirement of deep topsoil is absent from the majority of the study area.
<i>Pseudomys oralis</i>	Hastings River Mouse	E	E1	Variety of dry open forest types with dense, low ground cover and a diverse mixture of ferns, grass, sedges and herbs. Access to seepage zones, creeks and gullies is important, as is permanent shelter such as rocky outcrops. Nests may be in either gully areas or ridges and slopes.	Possible The study area supports the required habitat resources for this species including specific micro-habitat characteristics such as fallen timber and rock crevices (notably C7, C8 and C9). Individuals have been recorded from within protected reserves 20km from the study area.
<i>Pteropus poliocephalus</i>	Grey-headed Flying Fox	V	V	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.	Likely Though not recorded from these surveys the study area supports the required habitat resources particularly for foraging (ie densely treed areas of all woodland sites ie A1, A2 and B2 which are associated with communities C7 and C9). Surveys conducted over a number of seasons would likely detect their presence. It is recognised that there is only one known roost site within the vicinity of the study area and this is located 60km to the south east.

*Note: EPBC Act Status: E=Endangered; V=Vulnerable. TSC Act Status: E4A=Critically Endangered Species; E1=Endangered Species; V = Vulnerable Species; 3 = Category 3 Sensitive Species

5.2.3.5 **Fauna corridors**

Due to the location and size of the study area it is likely that it forms part of fauna movement corridors on both a local and regional scale. **Figure 5-6** shows the general direction of these expected movements though it should be noted that this is based on a broad assessment of the surrounding landscape and specific corridors, such as any patterns of movement across the road corridor, could only be further delineated by detailed and specific investigations targeting specific fauna (eg spotted-tailed quoll or macropods).

Despite the likely barrier effects of the New England Highway, the primary local movement corridor for fauna is expected to be northwest to southeast, linking the Study Area with the broader Bolivia Hill NR and areas of intact vegetation to the northwest. Local fauna movements are likely to occur in a north to northeast direction through the Study Area to areas of intact vegetation to the north. An unnamed tributary of Splitters Swamp Creek flows south to north in the northern section of the study area and is traversed by the existing highway alignment. This tributary ultimately joins Deepwater River and as such, this tributary and associated riparian zone is expected to play an important role in fauna movements through the study area and ultimately the surrounding landscape.

There appears to be no dedicated safe fauna passage infrastructure (eg dedicated culverts, directional fencing etc) incorporated into the design of the existing section of highway through Bolivia Hill.

5.2.3.6 **SEPP 44 Koala habitat**

The entire Tenterfield LGA, which encompasses the study area, is listed under the *State Environmental Planning Policy No.44 – Koala Habitat Protection* (SEPP 44 Koala). Although Roads and Maritime is generally not bound by the provisions of SEPP 44 (as ISEPP removes development consent requirements), the principles of SEPP 44 were considered to assess the potential impacts of the proposal on the Koala (*Phascolarctos cinereus*).

Section 4 of SEPP 44 defines 'core koala habitat' as an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

Section 4 of SEPP 44 defines 'potential koala habitat' as areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

The surveys undertaken did not record any core koala habitat within the study area. In addition, the results of the flora surveys indicate that the majority of the study area is unlikely to support potential koala habitat. Only one species of Eucalypt listed in Schedule 2 of SEPP 44, was recorded from within the study area. This species is *Eucalyptus viminalis* (Manna Gum), and was recorded from within community C2. The results of the survey indicate that this species may be co-dominant or a secondarily dominant species within the community. The lack of SEPP 44 core or potential Koala habitat notwithstanding it should be taken into consideration that the study area does support a large number of Eucalypt species and recorded sightings have been made of the Koala within 10 kilometres of the study area. Consequently, the area may serve as a link between areas of more suitable habitat and may at times support resting or sheltering Koalas as they move between areas of habitat external to the study area.

5.2.3.7 **Summary of terrestrial biodiversity significance**

Based on the survey and assessment results, the study area either supports or is likely to support:

- Four endangered ecological communities (refer **Table 5-1** and **Figure 5-5**)
- Four threatened flora species (refer **Table 5-2** and **Figure 5-4**)
- Twelve threatened fauna species (refer **Table 5-3**).

An assessment of the overall biodiversity significance of the habitat contained within different sectors of the study area was undertaken based on consideration of the presence of threatened ecological communities, the presence of threatened species and the overall condition of the vegetation communities. **Figure 5-6** illustrates the distribution of biodiversity significance of the study area.

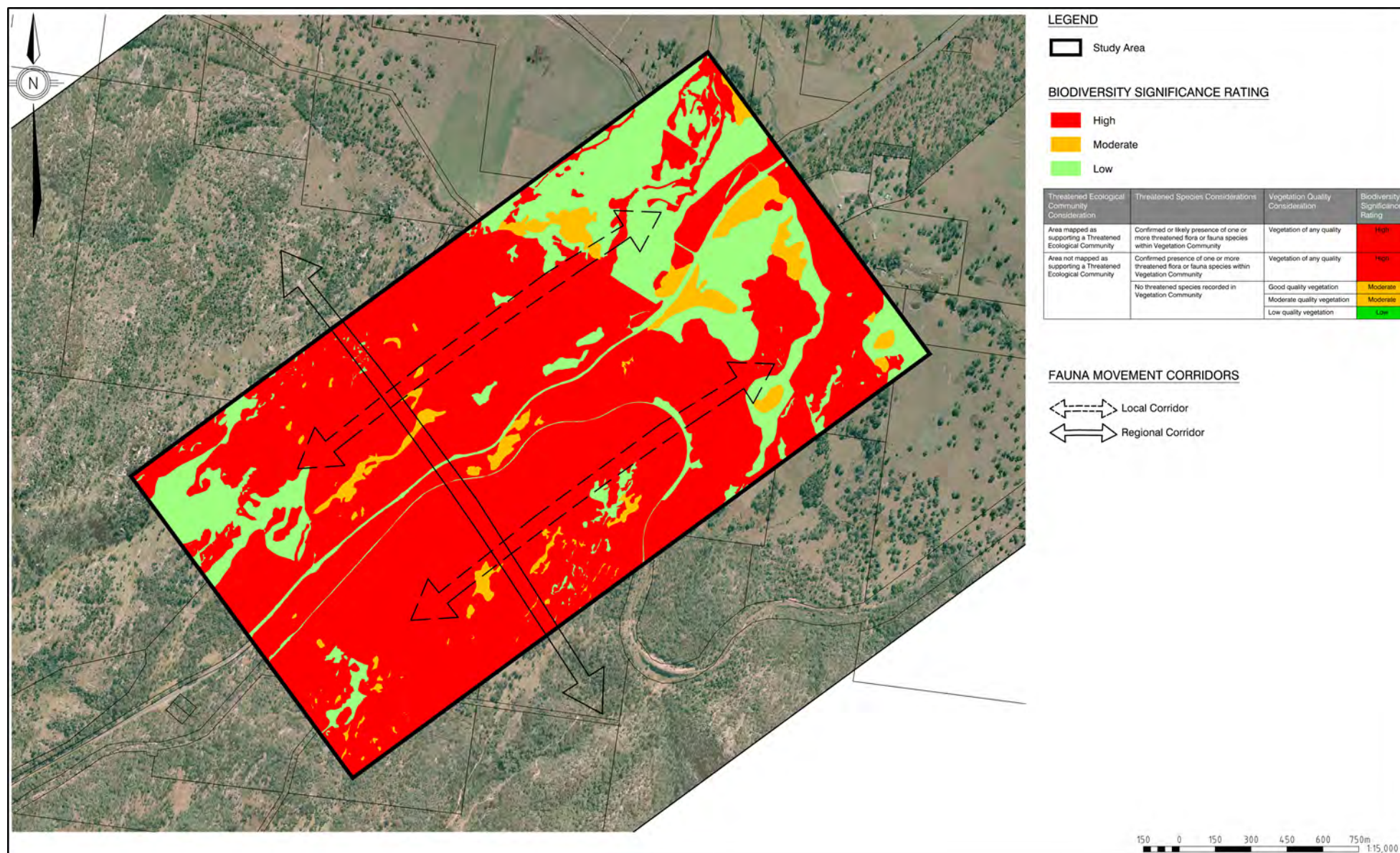


Figure 5-6 Fauna corridors through the study area

5.2.4 Aquatic biodiversity

Preliminary desktop analysis indicates that there are several ephemeral creeks surrounding the study area and a gully that exists adjacent to the New England Highway that carries runoff towards Brickyard Creek and subsequently into Deepwater Creek. As noted in **Table 5-3**, there is potential for frogs, waterbirds and fish listed as Endangered or Vulnerable under the TSC and/or EPBC Acts to occur within these waterways. Route options which traverse or are in close proximity to these waterways are more likely to have impacts on aquatic ecology and this has been considered in the assessment of route options outlined in **Chapter 7**.

The initial desktop assessment involved a review of the relevant Commonwealth, state and local government databases containing information concerning flora, fauna, vegetation communities and other environmentally relevant features. There are also several scientific reports and management plans of relevance to the study area and the surrounding landscape that were reviewed and considered as part of the assessment.

Specifically, the following resources are relevant to the study area:

- EPBC Act Protected Matters Search Tool (using a 10x10 km polygon around the study area)
- NSW FM Act list of threatened, endangered and protected fish species in NSW
- NSW Bionet Wildlife Atlas (using a 10x10 kilometre polygon around the study area)
- OEH Critical Habitat Register.

Based on the findings of the desktop review, a field survey was conducted from late February to March 2013, and involved:

- Assessments of aquatic habitat value
- In situ water quality sampling
- Aquatic macroinvertebrate sampling
- Finfish and freshwater crayfish/yabbie sampling
- Surveys of aquatic macrophytes.

The sampling sites adopted in the field survey included:

- Brickyard Creek upstream (BC US) – existing highway crossing with bridge
- Confluence of Brickyard Creek and Swamp Creek (BC CON) – downstream of the study area
- Tributary 3 (TRIB 3) – located at the base of Bolivia Hill
- Tributary 4 (TRIB 4) – located halfway down Bolivia Hill
- Tributary 5 (TRIB 5) – located in the upstream extent of the tributary.

Five sites were surveyed as that was deemed sufficient to represent the various habitats within the study area. While locating safe access points to the Tributary, swamplands habitat was located just upstream of the study area that was unlike habitat elsewhere in the study; hence the inclusion of Site TRIB 5 in the study area. Downstream of the study area is expected to be impacted by the proposed re-alignment works. Therefore, a site was selected downstream (BC CON) in order to provide accurate information on the nature of these potential impacts.

The detailed methodology for the terrestrial biodiversity impact assessment is provided in Cardno (2013b; **Appendix E**). The location of the sampling sites is shown in relation to the study area in **Figure 5-7**.

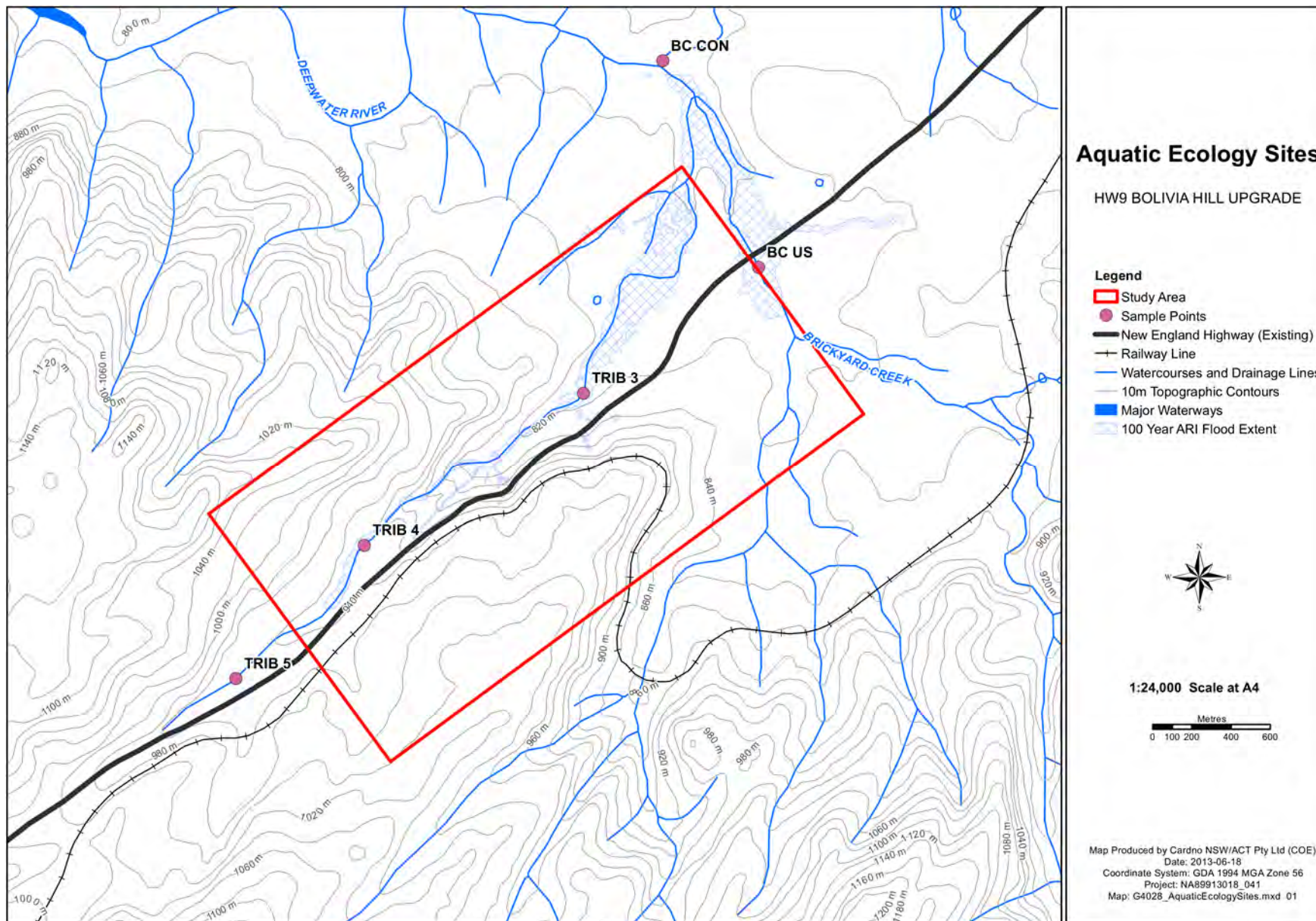


Figure 5-7 Aquatic biodiversity sampling sites

5.2.4.2 Aquatic species and populations

A search of the NSW Bionet Wildlife Atlas identified a large number of species protected under the TSC Act and/or the EPBC Act that could occur, or have previously occurred, within 10 kilometres of the study area. These included:

- Eight species of flora associated with aquatic habitats
- Nine species of aquatic fauna
- One endangered population
- Two threatened ecological communities.

The protected, threatened and endangered flora and fauna species associated with aquatic habitats identified in the Bionet search are listed in **Table 5-4**. An assessment of the likely presence of each species within the study area was conducted. It is noted that some of these species, the endangered population, and the communities have all previously been considered in the assessment of terrestrial biodiversity in **Section 5.2.3**. Hence, they are not addressed in this section.

The giant dragonfly, an endangered species under the TSC Act, is the third largest dragonfly in Australia and one of the largest dragonflies in the world. The giant dragonfly is found along the east coast of NSW from the Victorian border to northern NSW, including the study area. They live in permanent swamps and bogs with some free water and open vegetation. The main threats to the giant dragonfly are:

- Changes to natural fire regimes
- Clearing and development of land resulting in habitat loss and/or degradation
- Weed invasion
- Decreased water quality through pollution
- Eutrophication and sedimentation
- Impacts on swamp hydrology from factors such as construction of works.

The NSW Bionet Wildlife Atlas search also identified one endangered population protected under the EPBC Act and associated with aquatic habitat that could occur or have previously occurred within 10 kilometres of the study area:

- Tusked Frog (*Adelotus brevis*) population in the Nandewar and New England Tableland Bioregions.

This population is thought to be locally extinct in the study area, as discussed in **Section 5.2.3.3**.

Three species of fish were found within the study area: Australian smelt (*Retropinna semoni*), mountain galaxids (*Galaxia olidus*) and eastern mosquito fish (*Gambusia holbrooki*). In addition, a longneck turtle (*Chelodina longicollis*) was recorded from Brickyard Creek. Mountain galaxids are a common native fish of highland creeks, whereas eastern mosquito fish are an exotic species listed under the NSW FM Act as a noxious pest. Mosquito fish (invasive) were found at both Brickyard Creek sites but not at the Tributary sites. No protected, endangered or vulnerable fish species were recorded during the field survey.

Table 5-4 Threatened aquatic fauna species recorded in the study area

Scientific Name	Common Name	Conservation Status [*]			Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act	FM Act		
Flora species associated with aquatic habitats						
<i>Almaleea cambagei</i>	Torrington pea	E	V	-	See Table 5-2 .	Possible (see Table 5-2).
<i>Diuris pedunculata</i>	Small snake orchid	E	E	-	See Table 5-2 .	Possible (see Table 5-2).
<i>Thesium australe</i>	Austral toadflax	V	V	-	See Table 5-2 .	Possible (see Table 5-2).
<i>Euphrasia orthocheila</i> subsp. <i>peraspera</i>	Tenterfield eyebright	E	-	-	See Table 5-2 .	Possible (see Table 5-2).
Frogs						
<i>Philoria sphagnicolus</i>	Sphagnum frog	V	-	-	See Table 5-2 .	Likely (see Table 5-2).
Insects						
<i>Petalura gigantea</i>	Giant dragonfly	-	E	-	The giant dragonfly is found along the east coast of NSW from the Victorian border to northern NSW, including the area of the proposed alignment. They live in permanent swamps and bogs with some free water and open vegetation.	Likely There is known critical habitat resources for the giant dragonfly within the study area.
Fish						
<i>Tandanus tandanus</i>	Freshwater catfish	V	-	V	Freshwater catfish are found in a wide variety of habitats, including rivers, creeks, lakes and billabongs. They generally prefer sluggish or still waters. Water temperatures of around 24°C may induce spawning.	Unlikely The waterways of the study area are not of sufficient depth, and ponds are not of sufficient size, to support freshwater catfish.

Scientific Name	Common Name	Conservation Status*			Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act	FM Act		
<i>Maccullochella peeli</i>	Murray cod	V	-	E	Murray cod has the ability to live in a diverse range of habitats, including clear rocky streams (such as those found in the upper western slopes of NSW), to slow-flowing, turbid rivers and billabongs. Within this range of habitats, Murray cod is usually found near complex structural cover such as large rocks, snags, overhanging vegetation and other woody structures and is frequently found in the main channel and larger tributaries or rivers. They are sometimes found in floodplain channels when they contain water, although this usage appears limited.	Unlikely Given the small size of the waterways surveyed and the known habitat of the species, it is unlikely to be found in the study area.
<i>Ambassis agassizii</i>	Olive perchlet	-	-	E	Inhabit rivers, creeks, ponds and swamps. They are usually found in slow-flowing or still waters, often near overhanging vegetation or amongst logs, dead branches and boulders. They often congregate around suitable shelter (eg large woody debris and vegetation) during the day but disperse during the night to feed on micro-crustaceans and insects, including larvae.	Unlikely The species distribution is limited only to a few known sites in the Darling River drainage, not near the study area.
<i>Mogurnda adspersa</i>	Purple spotted gudgeon	-	-	E	Occur in inland drainages of the Murray-Darling basin as well as coastal drainages of northern NSW and Queensland. They live among weeds, rocks and snags in rivers, streams and billabongs, where they feed on small fish, insect larvae, worms, tadpoles and some plant matter.	Likely There is known habitat for the purple spotted gudgeon within the study area and previous records of the species occurring within the general locality of the study area.
<i>Bidyanus bidyanus</i>	Silver perch	-	-	V	Silver perch prefer fast-flowing, open waters, especially where there are rapids and races, however they will also inhabit warm, sluggish water with cover provided by large woody debris and reeds.	Unlikely The habitats described within the study area do not suit the habitat requirements of this species.

*Note: EPBC Act Status: E=Endangered; V=Vulnerable. TSC Act Status: E=Endangered Species; V = Vulnerable Species. FM Act Status: E=Endangered Species; V=Vulnerable Species.

5.2.4.3 Aquatic habitats

The general characteristics of the two watercourses surveyed in the field include series of small pools interspersed with small fast flowing creek channels. The survey was conducted shortly after a large rainfall event, it is likely that these creeks can be ephemeral in dry conditions (as was observed by other study team members in October 2012), and that during these times the pools act as refugia for aquatic species. The Brickyard Creek sites surveyed tended to have finer, sandy bed material, when compared to the Tributary sites, which were characterised by a higher proportion of pebbles, gravel and cobbles, with some rock outcropping in places.

The assessment of aquatic habitats found that Brickyard Creek generally low to moderate aquatic habitat value. The Brickyard Creek upstream site (BC US) was located upstream of the existing highway crossing of Brickyard Creek. The habitat assessment found that this site was impacted by historic clearing of riparian vegetation and adjacent agricultural activities. The riparian zone was sparsely vegetated with all *Eucalyptus* sp. (> 20 metres) and several smaller trees and shrubs, mainly *Salix* sp. and *Eucalyptus* sp. Ground cover consisted of grasses and weeds. Aquatic macrophytes were present in moderate densities, including the species *Paspalum* sp., *Juncus* sp., *Cyperus* sp., *Schoenoplectus* sp. and *Ludwigia* sp. Further downstream at the confluence of Brickyard Creek and Splitters Swamp Creek (Site BC CON), the banks were devoid of any riparian vegetation and there was evidence of unstable, eroding banks. Groundcover was densely populated by grasses. There were few instream macrophytes present, primarily *Paspalum* sp., *Juncus* sp., *Ranunculus* sp. and *Persicaria* sp.

The aquatic habitat assessment characterised all the Tributary sites as having moderate aquatic habitat value. Site TRIB 3 had sparsely distributed in-stream macrophytes were observed including, *Paspalum* sp., *Eleocharis* sp. and *Cyperus* sp. The riparian zone was densely covered in *Acacia* shrubs, grasses and herbs, with sparse *Eucalyptus* sp. trees interspersed. At site TRIB 4 a dirt road crossed the creek, impounding a large pool upstream. Land upstream of the dirt road crossing was cleared and in agricultural use, while land downstream had moderate cover of riparian vegetation consisting of grasses, shrubs and trees. Macrophytes were sparsely distributed, and included *Schoenoplectus validus*, *Paspalum* sp. and *Carex* sp. Weeds were densely abundant at ground level along the banks. *Eucalyptus* sp. and *Acacia* sp. were dominant shrubs and trees present. Two water dragons were also observed during the survey. Site TRIB 5 consisted of swamplands, including several small pools, narrow creeks and channels. The highway was located adjacent to the right bank. The vegetation consisted mainly of swampland with dense emergent growth, comprising *Carex* sp. Some *Typha* sp., *Paspalum* sp. are present with other grasses also present. The riparian zone consisted of woodlands comprising mainly *Eucalyptus* sp., *Acacia* sp., and *Banksia* sp.

The water quality in these watercourses was generally compliant with the ANZECC/ARMCANZ (2000) guidelines for aquatic ecosystem health for south-east Australian waterways, noting that turbidity levels were elevated, thought to be due to the recent rainfall in the catchment.

The aquatic macroinvertebrate sampling conducted provides an indication of the general 'health' of the watercourses. The macroinvertebrate taxa collected during this field survey are indicative of a degraded ecosystem, with many pollution tolerant taxa present. A total of 48 macroinvertebrate taxa were recorded from the 10 samples collected during the aquatic macroinvertebrate sampling. The minimum number of taxa represented in an individual sample was 11 at Site TRIB 3 and the maximum was 25 at Site TRIB 4.

5.2.4.4 Fish passage

Fish were found at all sites except for TRIB 5, indicating that any obstructions currently present downstream of Site BC US and Site TRIB 4 are not currently acting as barriers to fish passage.

5.2.4.5 Summary of aquatic biodiversity significance

In general, the study area is classified as having moderate aquatic biodiversity significance due to the likely or possible presence of some species of aquatic species of conservation significance, specifically the purple spotted gudgeon. Habitat that supports the giant dragonfly where it occurs within the study area would be classed as having high significance. In general, the watercourses located adjacent to agricultural lands have lower aquatic biodiversity significance due to impacts of agricultural activities on habitat extent and quality.

5.2.5 Climate and air quality

Based on available data from the closest operating Australian Bureau of Meteorology (BoM) monitoring station located near Tenterfield (Signal Station AWS 056032) approximately 30 kilometres north of the study area, the following climatic statistics are indicative of the study area:

- Temperature
 - Annual mean maximum temperature of 21.4°C
 - Annual mean minimum temperature of 8°C
 - January is the hottest month, with a mean maximum temperature of 27.1°C
 - July is the coldest month, with a mean minimum temperature of 1°C.
- Minimum temperatures
 - The lowest temperature recorded at the signal station is –10.6°C (July 2006)
 - The annual mean lowest temperature recorded between 1965-2012 is –6.9°C
 - Sub-freezing temperatures have been recorded from May to November, with the lowest temperatures occurring in June – August.
- Humidity
 - Annual mean relative humidity is 75 per cent at 9am and 55 per cent at 3pm
 - June has the highest mean relative humidity, with a 9am mean of 82 per cent
 - September has the lowest mean relative humidity, with a 3pm mean of 46 per cent.
- Rainfall
 - Annual mean rainfall is 852.1 millimetres, with a mean of 81.5 rain days per annum
 - January is the wettest month, with a mean rainfall of 115.7 millimetres
 - August is the driest month, with a mean rainfall of 43.7 millimetres.
- Wind
 - Annual mean wind speed at 9am is 8.8 kilometres per hour and 13.1 kilometres per hour at 3pm
 - August has the highest mean average wind speed of 14.4 kilometres per hour at 3pm
 - July has the lowest mean average wind of 6.7 kilometres per hour at 9am
 - Average annual wind direction blows in a north-east direction.

As indicated by the community engagement survey responses (**Sections 3.5.2.1 and 3.5.3.2**), low temperatures during the winter months (particularly July) have the potential to create black ice along the road as its surface temperature drops, resulting in dangerous driving conditions. Summary statistics from the BoM indicate that between April and October, temperatures at the Tenterfield Signal Station (at 838 metres) can drop to below 0°C, as per the following monthly lowest temperature statistics:

- 5th percentile for April is –1.7°C
- 5th percentile for May is –6.4°C
- 5th percentile for June is –8.4°C
- 5th percentile for July is –9.8°C
- 5th percentile for August is –7.9°C
- 5th percentile for September is –6.0°C
- 5th percentile for October is –2.8°C

The following information is drawn substantively from Vaisala (2009) who prepared an analysis of road surface temperature for the *Great Western Highway - Mount Victoria to Lithgow Preliminary Environmental Assessment*, which is at a similar altitude to Bolivia Hill.

In addition to low temperatures during the winter months, there are several other factors that can influence the road surface temperatures (RSTs) and may cause black ice during the winter months.

- **Time of day** – the maximum RST normally occurs in the early afternoon and the minimum occurs around dawn. Directly after sunset the RST falls quickly, but its decline will level off so that during the latter part of the night there is little variation of RSTs.
- **Solar radiation** – incoming solar radiation varies throughout the winter in proportion with the total amount of daylight and height of the sun in the sky. Minimum solar input occurs on the shortest day (21 June) but the actual incident solar radiation at one place is also dependent on cloud cover and ‘sky view factor’.
 - *Cloud cover* – clouds reflect and absorb solar radiation, thus the amount of direct solar radiation reaching the surface is reduced. They absorb heat not only from above but also from below due to re-radiation from the earth's surface. This absorbed heat is then re-radiated and at night this can significantly offset surface cooling (Vaisala, 2009).
 - *Sky view factor* – relates to the amount of “visible sky” and is used to determine the maximum incoming solar radiation that could conceivably occur, compared to that of the actual. It varies from 0.0 when there is no visible sky (eg inside a tunnel) to 1.0 when there are no visible obstructions (eg an open hilltop). According to Vaisala (2009), the sky view factor depends upon tree and building cover, which reduce the incoming solar radiation to the surface via shading.
- **Seasonal variation** – as the height of the sun and angle of incidence of incoming solar radiation changes, the effect of the sky view factor will change with the seasons. Additionally, the amount of foliage present on the trees will also influence the sky view factor in the winter because as trees lose their leaves, more long wave radiation will escape at night and the rate of cooling will increase (Vaisala, 2009). Therefore, the distribution of RST can be variable at the winter margins (eg October compared to June or July), when solar input is that much greater due to increasing hours of sunlight and the increased angle of the sun. These factors can trigger some sections of open road with high sky view factors to absorb enough solar radiation during the daytime to offset their normally rapid cooling regime after sunset.
- **Latitude** – the length of days and the height of the sun are both affected by latitude and are important influences on the amount of solar radiation reaching the surface during daylight hours (eg a road section that has a high sky view factor will receive greater solar input). In higher latitudes, if all other factors are equal, such a stretch of road could be expected to display relatively low RSTs due to unrestricted cooling after dark (Vaisala, 2009). Conversely, in lower latitudes where the angle of incidence of solar input is higher and the days are longer, there may be sufficient heat absorbed during the day to offset the cooling after dark. As the study area is in a mid-latitude location the latitude is unlikely to influence the RST.
- **Altitude** – in general, the higher the altitude the lower the road minimum temperature because of the decrease in air temperature with the height that occurs in a normal, unstable atmosphere (Vaisala, 2009). The environmental lapse rate (the fall of air temperature with height above sea level) is usually about 6°C per 1000 metres in altitude (Vaisala, 2009), and the RSTs could be expected to decline with altitude at a similar rate. The altitude of the Tenterfield Signal Station 838 metres and has recorded a lowest temperature of –10.6°C. As the height over the study area ranges up to 1225 metres, colder temperatures may be expected in the study area in comparison to the temperatures recorded at the Tenterfield Signal Station.

Frost hollows can cause the lowest temperatures to be recorded in valley bottoms, especially on clear and calm nights due to either the formation of inversions and/or the pooling of cold air. A frost hollow will occur where a slope is sufficiently steep, such as where the current highway drops steeply to the west near the central ridge, causing drainage to take place and resulting in lower RSTs.

- **Topography** – overnight a road surface cools by radiation. The topography controls radiative cooling from the surface by influencing the sky view factor, thereby limiting the amount of long wave radiation that can escape. The effect of radiative heat loss to the environment is further reduced by trees, cloud cover, traffic and cuttings. These features reflect, absorb and re-emit radiation from the road back to the surface, thereby offsetting radiation loss from the road surface and maintaining temperatures. Therefore, during the night, roads lined with trees, roads passing through cuttings, under bridges and in tunnels will tend to stay warmer than more exposed sections (Vaisala, 2009).

It should also be considered that sheltered roads may warm more slowly than more exposed roads, as early morning solar radiation cannot reach the road surface. This can be an important factor if, for example overnight conditions lead to the formation of 'hoar' frost on the road surface and surrounding fields. After sunrise, these hoar frost deposits are melted or sublimated by the incident solar radiation on exposed road sections (Vaisala, 2009).

In shaded sections where solar radiation is unable to penetrate directly to the surface, RSTs may remain below freezing and early morning traffic can then compact the hoar frost into ice. Hence, areas with a low sky view factor can be more hazardous for a longer period of time than exposed sections if the RST falls below 0°C.

With respect to air quality, in the immediate vicinity of the New England Highway vehicle exhaust emissions containing carbon monoxide (CO), nitrogen oxides (NO_x), and sulfur dioxide (SO₂) are likely to be elevated in the roadside environment. However, specific data for roadside air quality is not available.

The study area is located in the Tenterfield LGA which is predominantly comprised of low to medium density or rural residential land and parkland, therefore, the overall regional air quality is expected to be generally high. The National Pollutant Inventory identifies the most commonly reported pollutants for the Tenterfield LGA as:

- Nitrogen
- Phosphorus.

5.2.6 Bush fire

In the summer of 2002/03, 90 per cent of the Bolivia Hill NR was subject to wildfire (NPWS, 2011). The area had not been burnt by a wildfire since 1965. Selected areas were burnt every three to four years prior to reserve gazettal to manage pasture in the northern cleared end of the reserve (NPWS, 2011). Areas affected by fire were recorded during the field surveys for this study and are shown on **Figure 5-4**.

According to Tenterfield Shire Council's Bushfire Prone Land Map (2004), all of the potential route options would traverse through bushfire prone land. A map of the bushfire risk in the study area is provided in **Figure 5-8**. The following classifications are provided by the Rural Fire Service for bush fire prone lands identified in the figure:

- Light orange coloured areas are 'Vegetation Category 1', which is the most hazardous vegetation category
- Yellow coloured areas are 'Vegetation Category 2', which is the smaller, more isolated pockets of vegetation which are of a lesser hazard than the light orange vegetation category
- Dark orange coloured areas are bushland that is classified as 'Vegetation Buffer 100m & 30m'. These are the areas in which developments and people are most likely to be affected by a bush fire burning in the vegetation (yellow or light orange) areas. The dark orange area extends for a distance of 100 metres from the 'light orange' vegetation category 1 areas and for a distance of 30 metres from the 'yellow' vegetation category 2 areas.

All routes selected for the shortlist options and the design of the preferred route, should take into consideration the bushfire risk to the area.

5.2.7 Existing major infrastructure and utilities

Utility and service infrastructure are present in the study area. This infrastructure is described below and shown in **Figure 5-9**.

5.2.7.1 *Main Northern Railway*

The Main Northern Railway line was the original rail transport route between Sydney and Brisbane. The railway corridor runs roughly parallel to the highway for approximately half the project length before veering to the east. The line is currently disused.

5.2.7.2 *Telecommunications*

Telstra buried local cable runs parallel and to the west of the highway north of the project area. These cables veer to the west and cut the north-western corner of the study area.

5.2.7.3 *Electrical transmission lines*

An Essential Energy power line traverses the north-eastern side of the study area.

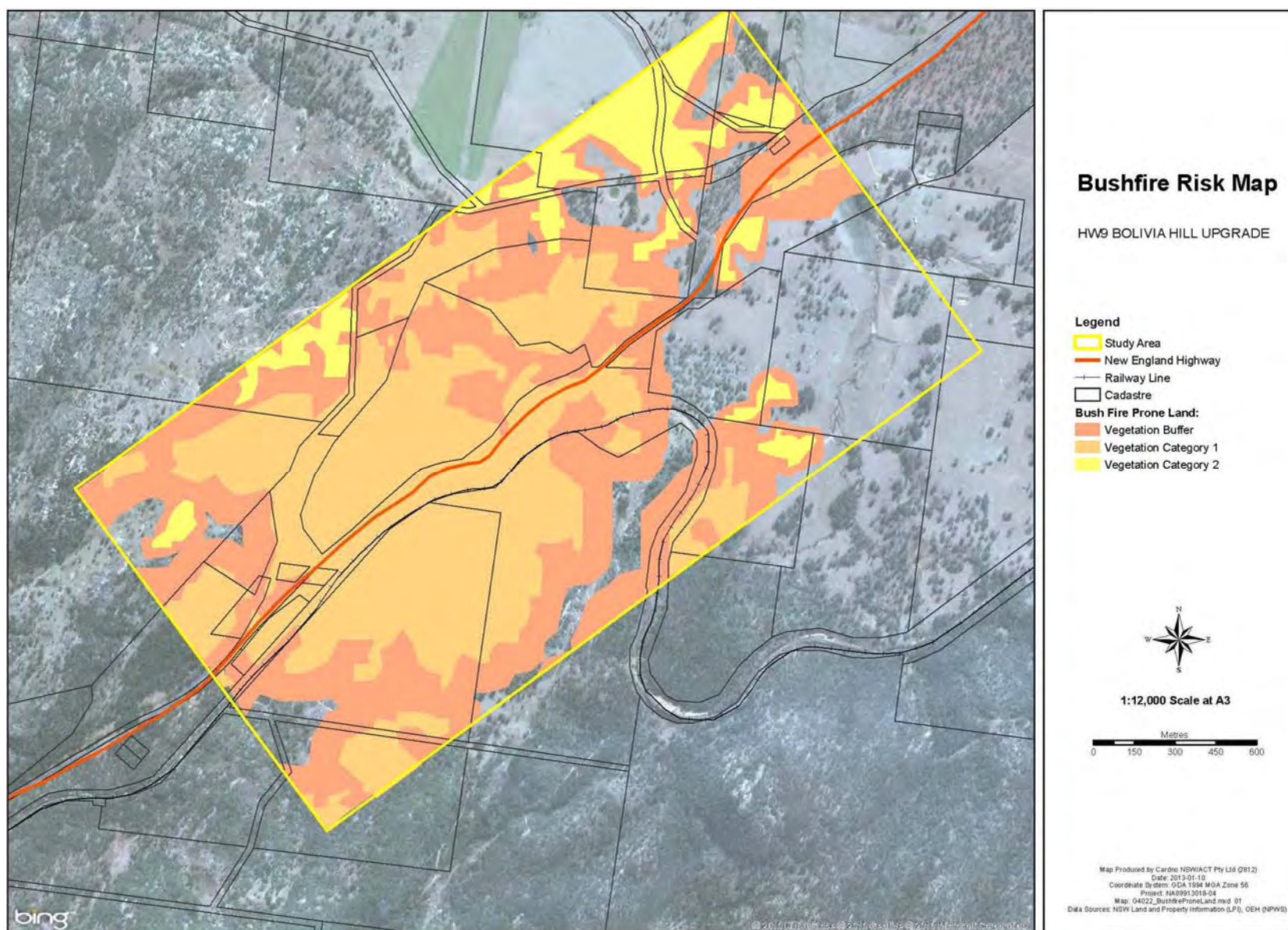


Figure 5-8 Bushfire risk of the study area

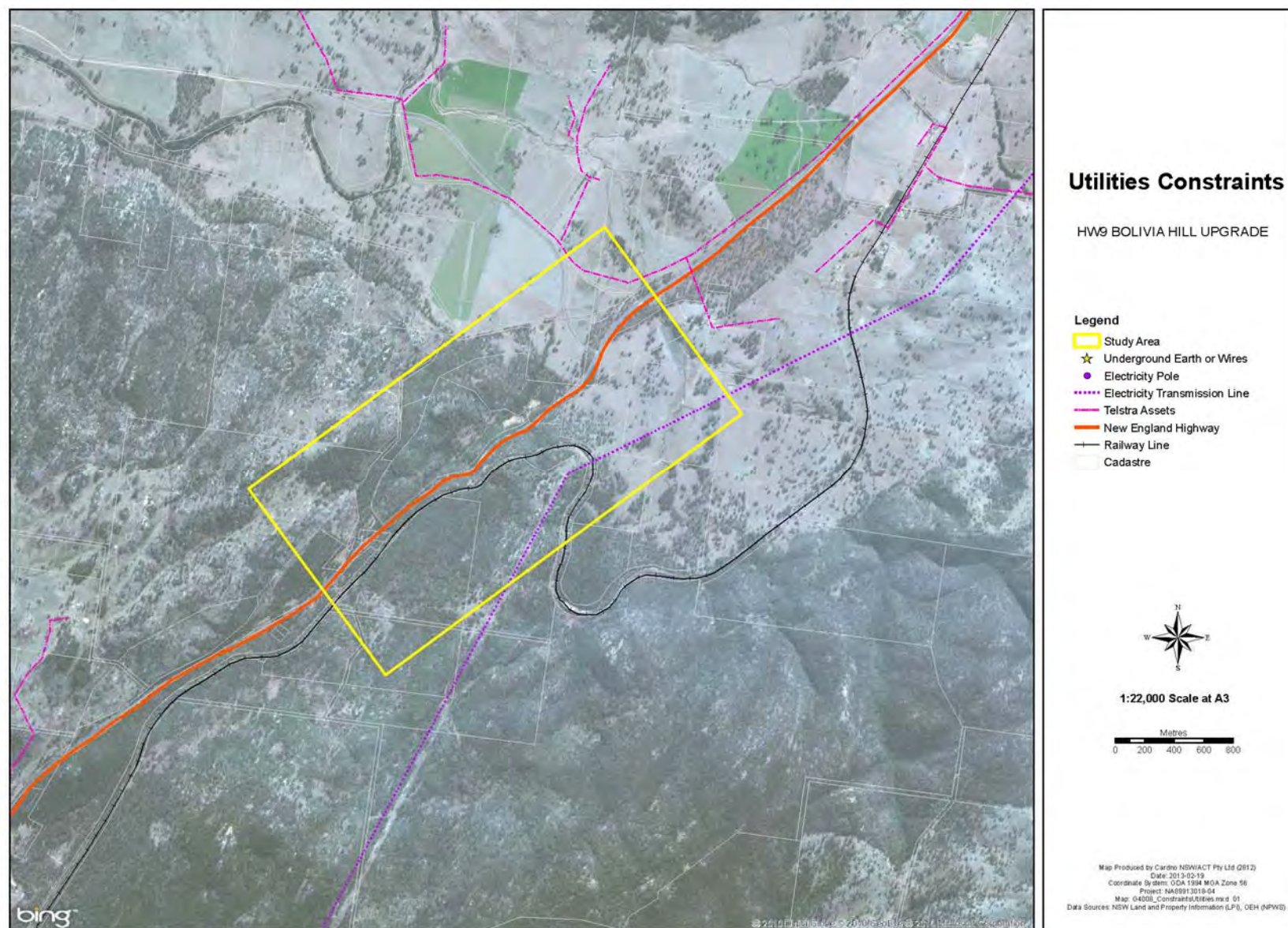


Figure 5-9 Existing major infrastructure and utilities

5.3 Social and cultural environment

Niche Environment and Heritage Pty Ltd (Niche) participated in the study team to assess both Aboriginal and non-Aboriginal cultural heritage in the study area and input into the route options assessment process. This section describes the findings of their desktop and field investigations into the cultural heritage aspects of the study area.

5.3.1 Aboriginal heritage

An assessment of potential constraints associated with Aboriginal cultural heritage for the route selection and design process was conducted based on a combination of desktop and surveys of the heritage of the study area. The findings are reported in Niche's (2013a) *Aboriginal Archaeological Assessment Report (Appendix F)*.

The assessment was conducted in accordance with the following guidelines:

- Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010a)
- Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010b)
- Procedures for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI) (Roads and Maritime, 2011).

The main objective of the assessment was to identify the location of Aboriginal sites, objects or places to seek to avoid those locations for any route option.

The archaeological assessment involved the following tasks:

- Desktop review of previous studies and reports relevant to the study area
- Search of the Aboriginal Heritage Information Management System (AHIMS) maintained by the OEH to identify known Aboriginal objects and sites within the study area
- Search of the NSW State Heritage Register (SHR), the NSW State Heritage Inventory (SHI) and Local Environmental Plan Heritage Schedules
- Search of the World Heritage List, the National Heritage List (NHL), the Commonwealth Heritage List (CHL) and the Register of the National Estate (RNE)
- Search of the National Native Title Register
- Consideration of the landscape context and land use history
- Site surveys to assess archaeological potential of the study area
- Consultation with the Moombahlene Local Aboriginal Land Council (LALC) in accordance with Stage 2 of PACHCI.

More detailed information on the adopted methodology is provided in Niche (2013a; **Appendix F**).

5.3.1.1 **Places of known or reported Aboriginal significance**

The register searches revealed no sites of known archaeological significance of relevance to the study area, except for one record returned from the AHIMS search. The record was for a ceremonial site, although it is located further to the north-east and well outside of the study area (see **Figure 5-10**).

No native title claims or registrations exist over the land within the study area.

5.3.1.2 **Landscape context**

Many fauna species exist in the study area that may have been utilised by Aboriginal people for food and other resources. Fauna species that would have comprised food resources include Eastern grey kangaroo (*Macropus giganteus*), brush-tailed rock wallaby (*Petrogale penicillata*), eastern pigmy possum (*Cercartetus nanus*), spotted-tail quoll (*Dasyurus maculatus*), yellow-bellied glider (*Petaurus australis*), squirrel glider

(*Petaurus norfolcensis*), Brush-tailed phascogale (*Phascogale tapoatafa*), Koala (*Phascolarctos cinereus*), Emu (*Dromaius novaehollandiae*) as well as many species of birds, fish, reptiles and amphibians.

Many species within the vegetation communities are also known to have been used by Aboriginal people in the past. Some old growth trees occur in close proximity to the proposed route options. Where remnant native vegetation occurs, the vegetation may have significance to contemporary Aboriginal people as an example or link between the landscape of today and that inhabited by their ancestors. Brickyard Creek and its tributary would have provided a varied and rich range of resources including fish, bird, mammal, reptile and amphibians.

5.3.1.3 Previous studies

Based on current archaeological studies, occupation of the New England Tablelands dates back to approximately 9000 years. Archaeological dates from an archaeological excavation at the Graman A2 rock shelter, located approximately 80 kilometres north-east of Glen Innes, confirms Aboriginal occupation has occurred in the region during the Holocene (AMBS, 2010). Other archaeological sites suggesting long occupation of the area are Graman B1 (c. 5400 BP), Bendemeer 2 (c. 5000BP) and Moore Creek rock shelters 4 and 6 (c. 4000 BP).

McBryde (1974) has conducted extensive archaeological research in the region including a systematic field survey and targeted excavation aimed at providing evidence to reconstruct human occupation in the region. McBryde's (1974) field survey located the remains of both Bora grounds and stone arrangements that were interpreted as the archaeological remains of ceremonial sites. A bora ground, registered on the AHIMS (see **Section 5.3.1.1** and **Figure 5-10**), is located within five kilometres of the subject area. McBryde's (1974) survey also located evidence of past artistic life in the form of rock art sites and geometric carving on trees. The rock art in the region is usually painted or drawn (pictographs) onto granite surfaces, such as the vertical faces of boulders or in rock shelters or overhangs. Rock engravings (petroglyphs) do exist, especially in the western part of the region but they are generally less common than painted or drawn art (McBryde, 1974).

In 1995, Telstra Australia commissioned a study (Griffiths, 1995) to conduct an archaeological survey between the towns of Deepwater and Tenterfield in northern NSW. The assessment predicted that site types in the region might include; quarries, open campsites, scarred trees and ceremonial/bora sites (Griffiths, 1995); however, the survey did not find any Aboriginal heritage sites.

In 2008, Hudson undertook an archaeological investigation further north on the outskirts of Tenterfield, for members of the Moombahlene LALC. The assessment located:

- Two rock art sites
- Two scar trees
- One possible burial site
- One potential archaeological deposit (PAD) (Hudson, 2009).

Both rock art sites are pecked engravings on granite outcrops located near a creek (Hudson, 2009). The possible burial site is a large earthen mound oriented east–west (Hudson, 2009). The presence of rock art and ceremonial sites suggests that the area is highly significant to the local Aboriginal people (Hudson, 2009).

To the south, Australian Museum Business Services (AMBS, 2010) completed a regional desktop Aboriginal cultural heritage study for Glen Innes Severn Council that identified 70 Aboriginal cultural heritage sites within the Glen Innes LGA. The site types recorded included, open campsites, scarred trees, isolated finds, stone arrangements, bora/ceremonial sites, burials, natural mythological sites, axe grinding grooves, water holes and rock art sites (AMBS, 2010).

The results of these studies confirm that Aboriginal people were active in the region and that a broad range of site types are likely to occur within the study area.

5.3.1.4 Ethnohistory

Much of the information about Aboriginal people in the Northern Tablelands comes from early historical sources and some provide accounts of first contact between European explorers and Aboriginal people, although the sources are often fragmentary and many are biased.

The study area is located on the border of the Jukambal tribes' traditional land and the Ngarabul tribes' traditional land. The Jukambal people lived from Glen Innes and north-east towards Drake, Tenterfield and near Wallangarra. The Ngarabul (also spelled Ngoorbul, Nugumbul, Narbal or Narbul) people are the traditional owners of the land around the Glen Innes region, including Bolivia; their territory included Glen Innes, Deepwater, to Bolivia Station and to the Mole River in the north.

There is evidence, supported by oral history, which suggests the Aboriginal people of the Northern Tablelands moved through the landscape seasonally. In 1842, Oakes, the commissioner of Crown Land for the Macleay and Clarence districts wrote that the natives traversed the landscape to the coast in the season of fishing and to the interior during more favourable conditions for hunting.

The Ngarabul territories were defined by places in the physical landscape and were guarded, although some movement between territories was sanctioned at times. Tribal boundaries were indicated by marking trees while marked stones would indicate the boundaries of hunting grounds or fishing waters (Campbell, 1978; Kerr *et al.*, 1999). Evidence of trade and intermarriage between the Ngarabul people and the Aboriginal groups in the Northern Tablelands exists in the material record. Stone traded from Graman and Moore Creek has been located in the Tablelands (AMBS, 2010).

Archaeological evidence and historic accounts suggest that ceremonies were often held by the Ngarabul people on the flat ground of the river plains.

The first European to encounter Aboriginal people in the region was John Oxley, a European explorer, who entered the New England region in 1818. Oxley described the Aboriginal people in the New England region as having poor condition and physique compared to the large manly figures he encountered in the interior (Oxley, 1818). Oxley and later Cunningham both described the local Aboriginal people as flighty and were very often not able to interact with them, as they would disappear when approached by white men. Tension is reported between many of the original squatters and land owners and the native people (Walker, 1963).

In 1844, a massacre of Aboriginal people occurred at Bluff Rock. The massacre involved the Bolivia Station manager Edward Irby (**Section 5.3.2.2** notes further details of Bolivia Station), who found a shepherd had been attacked with spears and axes and left floating in the river. Edward and his brother, assisted by Charles Windeyer of the neighbouring Deepwater Station, pursued the local Aboriginal tribe to Bluff Rock and drove them over the edge. This resulted in the death of several men, women and children (New England Examiner, 1870). Another massacre occurred at Deepwater Station, also in 1844, which resulted in the death of seven Aboriginal men, four Aboriginal women and five Aboriginal children (AMBS, 2010).

Not all associations between the Aboriginal people of the New England region and European settlers were unpleasant. Many Aboriginal people were employed by station owners as permanent shepherds, stockmen and horse breakers and provisions of medicine and blankets was made available by the government in the early 1850's (Walker, 1963).

5.3.1.5 Aboriginal heritage survey findings

Based on review of previous archaeological assessments in the broader region, the topography and geology of the landscape and a search of the AHIMS register; it is likely that Aboriginal heritage sites occur within the study area.

Figure 5-10 shows a predictive model of areas with moderate and high potential for Aboriginal cultural heritage sites, prepared based on landform, hydrology, ethnographic and historic accounts and previous archaeological investigations. The predictive model suggests the site types most likely expected to occur within the subject area include:

- Open camp sites (artefact scatter)
- Isolated finds
- Rock art sites

- Scarred trees
- Ceremonial sites (bora grounds or stone arrangements).

The predictive model also suggests that other site types may be found in the study area, including burial sites, axe grinding groove sites, contact/historical sites and quarry sites.

The surface survey validated these predications by locating a number of sites (**Table 5-5**). The sites located during the surface survey were also located in the expected landforms with past occupational activity focused on and around the creek lines and lower slopes. The rock art site was located in the granite clusters along the ridgeline in the upper slope. The archaeological sites located during the field survey provide evidence of past Aboriginal occupation in the hinterlands environment. The site types located during the field survey indicate long term occupation and camping rather than evidence of traversing through the landscape or simply a transport corridor.

Table 5-5 Summary of sites located during the surface survey

Site	Feature(s)	Landform	Overall Significance
Bolivia Hill AS1	Artefact scatter and PAD	Creek line	Moderate
Bolivia Hill CMST1	Culturally modified scar tree	Creek line	Moderate
Bolivia Hill GG1	Grinding grooves site	Creek line	Moderate
Bolivia Hill RA1	Rock art site	Upper slope	Moderate
Bolivia Hill PAD1	PAD	Lower slope	Unknown
Bolivia Hill PAD2	PAD	Lower slope	Unknown
Bolivia Hill PAD3 (AS1)	PAD and artefact scatter	Creek line	Unknown
Bolivia Hill PAD4	PAD	Creek line	Unknown

Detailed site descriptions are provided in Niche (2013a; **Appendix F**). These sites have not been mapped in this report due to their sensitive nature. Site Bolivia Hill RA1 is located outside of the subject area while the remaining seven sites are located within the subject area.

5.3.1.6 Summary of Aboriginal cultural heritage significance

An assessment of the scientific values and significance of the sites against the Burra Charter (Australia ICOMOS, 1999) and the OEH guidelines (NPWS, 1997) (**Table 5-5**) was conducted, noting that further consultation with the local Aboriginal community would be required to confirm the cultural heritage significance. In addition, additional archaeological investigation would be required to confirm the significance of the PADs.

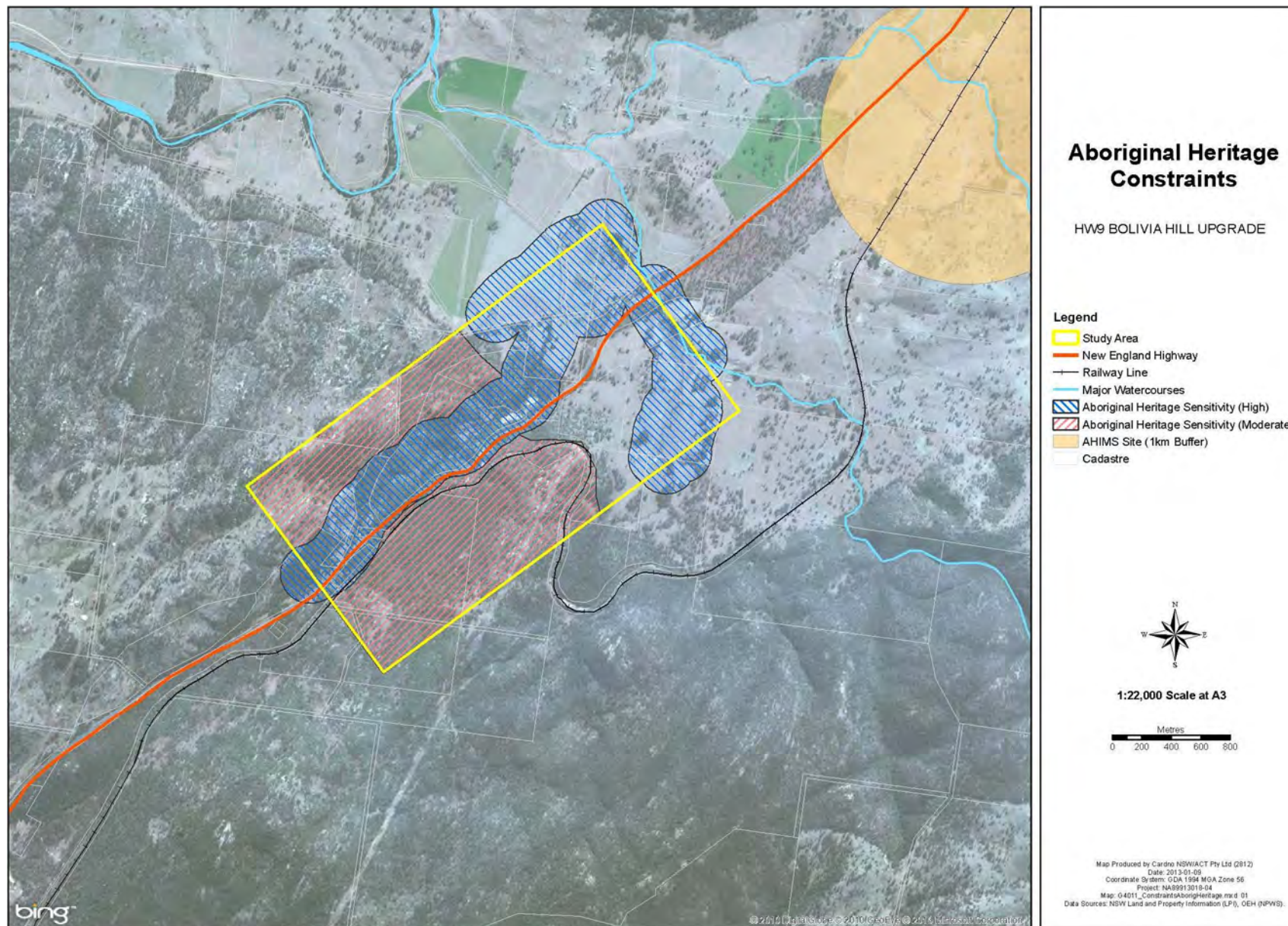


Figure 5-10 Aboriginal heritage constraints in and around the study area

5.3.2 **Non-Aboriginal heritage**

An assessment of potential constraints associated with historic heritage for the route selection and design process was conducted based on a combination of desktop and surveys of the study area. The findings are reported in Niche's (2013b) *Historic Heritage Assessment Report (Appendix G)*.

The aim of this assessment was to identify whether non-Aboriginal heritage items occur, or are likely to occur, in the study area and assess their likely heritage significance. This will assist with the selection of a preferred route option for the proposed highway upgrade at Bolivia Hill.

The assessment was undertaken in accordance with the best practice standards outlined in the *NSW Heritage Manual* (DUAP, 1996) and included the following tasks:

- An initial desktop review of previous studies and reports relevant to the study area
- A search of the NSW SHR, the NSW SHI, Local Environmental Plan Heritage Schedules
- A search of the World Heritage List, the NHL, the CHL and the RNE
- Consultation with the Tenterfield and District Historical Society and field survey of the proposed route options (and 100 metre buffer)
- Additional detailed historical research, including the review of archival materials at the Mitchell Library, Crown Plans held by NSW Land and Property Information Section, and the National Library of Australia's digital archives.

More detailed information on the adopted methodology is provided in Niche (2013b; **Appendix G**).

5.3.2.1 **Register searches**

Searches of the NHL, CHL, RNE, SHR, SHI and the Tenterfield LEP (1996) on 22 October 2012, did not identify any heritage items located within or in close proximity to the study area. However, under the Tenterfield LEP (2013), gazetted on 9 April 2013, the Bolivia Station and outbuildings on Pyes Creek Road (Lot 14, DP751498) have been listed as having local heritage significance. It is noted, however, that this specific site is located outside of the 100 metre buffer placed around the route options and is therefore unlikely to be impacted by any of the route options considered.

5.3.2.2 **Previous studies**

Halliday (1988) reported that John Oxley was the first explorer to travel through the New England area, while travelling to Port Macquarie in 1818. Previous studies also note that Allan Cunningham was the first to have approached within 15 miles of modern day Tenterfield after discovering Darling Downs in 1827. In 1840, the Ogilvie brothers travelled through the area on their return journey to the Hunter River (Baldwin, n.d.). In 1893, Deepwater Station, to the south-west of the study area, was acquired. Archibald and Charles Windeyer were the original owners of Deepwater Station. William Collin, who later became Deepwater Station manager, took up the land for the Windeyer brothers in 1939 (Halliday, 1988).

The first recorded use of the Bolivia name was in 1840 when a South American squatter took up land between Deepwater and Tenterfield (NPWS, 2011). In 1843, Edward Irby took over Bolivia Station and utilised it for sheep and cattle (Halliday, 1988). A part of the study area encompasses the southern corner of Bolivia Station.

The Main Northern Railway Line, which runs through the south-eastern portion of the study area, was the original rail transport route between Sydney and Brisbane, primarily constructed by the Hunter River Railway Company (Halliday, 2004). It was the Cobb and Co. coaching company, however, which won the railway construction contract between Glen Innes and Tenterfield. Work began in 1884, however in the same year work between Deepwater and Tenterfield ceased due to strike action by the navvies due to a reduction in their wages. In 1884, work was delayed again as several thousand sleepers, along with other timber used in the construction of culverts and bridges were condemned. The railway line was eventually extended through Bolivia Hill and up to Tenterfield in 1886 (Halliday, 2004).

The development of the Main Northern Railway Line improved transport to the New England region. Where there had previously been more than 500 teams working the road between the tablelands and the coast, the railway line meant that these teams were significantly reduced and the speed and efficiency of transport was

greatly improved. The construction of the railway also saw the development of several new towns including Bolivia, Sandy Flat, Bungulla and Bluff Rock (Halliday, 2004).

The village at Bolivia Hill was on the western side of the railway line and extended along the gully at the foot of Bolivia Hill. The main road from Glen Innes to Tenterfield ran through the township and over the hill. Within the town were a number of businesses and services, including two hotels, two bakeries, two butchers shops, two general stores, two produce stores, two tobacconists, a barber, saddler, boot maker and a number of boarding houses. As the township became quite large, and probably also due to the bushrangers in the area, a police reserve was approved within the township. As many of the railway workers had brought their families to live in the town at Bolivia Hill it also became necessary for a school in the township, and a second school was established at Horseshoe Bend. Other features of the township included brickyards (on Bolivia Station near the highway) and a telegraph line. The Armidale to Tenterfield telegraph line ran near the railway.

Travelling Stock Routes (TSR) and Travelling Stock and Camping Reserves (TS&CR) were developed as wide pathways for the movement of stock from one place to another, often with wide verges for stock to graze. Many TSRs have fenced areas for camping with watering facilities for stock to drink (Smiles *et al.*, 2011). It is thought that most TSRs were developed from Aboriginal travelling routes and that the camping reserves were originally Aboriginal camping grounds. Aboriginal travel routes connected food and water and the routes were along the least difficult terrain avoiding natural obstacles (Smiles *et al.*, 2011). In many cases, a road for travellers passed down the middle of TSRs. Inns were positioned along TSRs catering for travellers, most of which have disappeared but some still survive, such as the Bolivia Inn on the New England Highway, which later operated as a boarding house and a post office (Halliday, 2004).

Three TSRs have been gazetted running through the centre of the study area:

- TSR 370 - Notified on the 8 January 1875 and extension Notified 8 May 1882
- TSR. 22252 - Notified 23 February 1895
- TS & CR 22242 - Notified 23 Feb 1895.

TSR 370 was replaced by TSR 22252. Both TSR 22252 and TS & CR 22242 are still current and are under the control of the rural lands board (pers. comm., Armidale Lands Office).

The Crown plan for TSR 22252 and TS & CR 22242 was surveyed on the 4 November 1898 and shows the TSR western boundary and the eastern boundary as the railway (Rhode, 1898). Only the northern end of the plan includes part of the study area, but it is quite clear that the area that was once the Bolivia Township by 1898 had become a camping ground TS & CR 22242 along the TSR.

TSRs were heavily used up until the late 1940s but with a series of wet years and the rise of motor transport, their usage began to decline. Recent years of drought have resulted in a rise in the usage of TSRs as they provide a place to graze and access to drinking water (Smiles *et al.*, 2011).

The first main road through Bolivia Hill was an old bullock track known as Centre Ridge. The track was to the west of the current New England Highway and followed a steep spur in a direct route over the Bolivia Range. The route is used by the current Brisbane to Sydney telegraph line, and parts of the road are still visible today (Schiffmann *et al.*, 1988). The next road to be used was known locally as the Bullock Track and was located to the west of Centre Ridge Road. The Bullock Track was in use for about 40 years over which time improvements were carried out on the road. This road ran along the path of the TSR, and where both these roads met and became one road, is where the township of Bolivia was established. Both these roads were part of the Great Northern Road, which linked Sydney with Brisbane over the New England Tablelands.

In August 1928 the NSW main road system was reorganised and the Great Northern Road was gazetted as part of State Highway 9, it was renamed State Highway 9, the Great Northern Highway in May 1929. State Highway 9 stretched from Sydney to Tenterfield. On the 24 Mar 1933 State Highway 9 was renamed the New England Highway (Ozroads, 2013).

5.3.2.3 Non-Aboriginal heritage predictive model

The Tenterfield and District Historical Society provided very useful information on the following heritage items within the study area:

- Jackson's house site, Pye Creek Road – built by Bolivia Station in the 1910s and relocated in the 1980s
- The Public Watering Point / TSR adjacent to the current highway
- Quin Chee's Market Garden – established in the 1880s by a Chinese gardener named Quin Chee, who transported produce to Tenterfield on a horse and buggy
- Silver / lead mining and the presence of huts in the area
- Brickyard Creek, where clay was sourced for the Railway to make bricks
- A Cobb & Co track across Bolivia Hill
- A railway camp on the Horseshoe Bend
- Various memorials along the highway.

This information, along with the historical accounts, was used to scope the field survey. In addition, members of the Historical Society attended the field survey to assist in locating sites of heritage significance.

5.3.2.4 Non-Aboriginal heritage survey findings

The non-Aboriginal heritage survey was conducted in January 2013. A total of 14 non-Aboriginal heritage items were identified during the field survey (**Table 5-6** and **Figure 5-11**). Eleven of these sites are located within the study area. It should be noted that Sites 3, 11 & 13 are located outside the study area boundary.

An additional 11 sites were identified through detailed historical research following the completion of the field survey (**Table 5-7** and **Figure 5-12**). All of these sites are likely to be located within the study area, although further field survey would be required to confirm their locations.

Table 5-6 Summary of non-Aboriginal heritage sites located during the field survey

Site ID	Site name	Description	Condition / Integrity	Located within study area?
1	Angel memorial	Angel statue with bronze plaque.	Average	Y
2	Jackson's homestead site	Former homestead site. Two corrugated iron water tanks on timber stumps. Stone rubble and brick platform. A small 2m square concrete pad for former shed. Corrugated iron.	Average	Y
3	Drill holes in bullock track	Evidence of blasting in the 1950s as preparation to use as a deviation road.	Average	N
4	Harry and Lenny memorial	Harry and Lenny written in white paint on rock face. Flowers in small vases attached to post and wire fence above rock face.	Average	Y
5	Hut remains	Corrugated iron collapsed roof above timber supports. Small pile of clay bricks 1m south of iron. Likely to be chimney remains. Structure appears to be a former timber hut.	Poor	Y
6	Johnson memorial	Two wooden crosses. One painted yellow one brown. Both for Graham Johnson our gentle giant 6-10-87 18-01-09.	Average	Y
7	Mine shaft	Rubble stone pile used to fill mine shaft. Site dimension is 2m ² .	Average	Y
8	Former bridge	Concrete blocks noted on edge of rock face. Disturbed by later rubble retaining wall added to new bridge. No other remains evident.	Poor	Y

Site ID	Site name	Description	Condition / Integrity	Located within study area?
9	Quarry	Quarry in eroded area.	Average	Y
10	Quin Chee's market garden and well	Cleared area near creek and circular depression.	Poor	N
11	Stone rubble creek crossing	Large angular stones imported to form level creek crossing.	Average	Y
12	Timber creek crossing	Small crossing constructed of machine cut timber logs laid directly on ground.	Average	N
13	Timber bridge	Small timber bridge. Built on concrete and rubble approaches. Reinforced using large timber beams with timber decking.	Average	N
14	Telegraph line remains	Remains of 12 telegraph poles on the western side of the current highway alignment.	Poor	Y

Table 5-7 Summary of non-Aboriginal heritage sites located during historical research

Site ID	Site name	Description	Condition / Integrity	Located within study area?
15	Former Bolivia township	Crown Plans for Portions 2A, 5A, 6A-10A, 4A, and 3A.	Unknown	Y
16	Former house site	Crown Plan of Portion 105-107.	Unknown	Y
17	Brickyards	Crown Plan of Portion 12A-15A and Portion 113.	Unknown	Y
18	Culvert	Crown Plan of Portion 12A.	Unknown	Y
19	Police reserve	Crown Plan of Portion 112.	Unknown	Y
20	Former public school site and reserve	Crown Plan of Portion 116 and 117.	Unknown	Y
21	Travelling stock routes (two)	1905 Parish Map.	Unknown	Y
22	Bullock Track (west of current highway)	Crown Plan of Portion 2A, 5A and 6A-10A and CP4921-1603.	Unknown	Y
23	Former Road (current highway)	Crown Plan of Portion 2A, 5A and 6A-10A and CP4921-1603.	Unknown	Y
24	Former Road (adjacent to railway)	Crown Plan of Portion 2A, 5A and 6A-10A and CP4921-1603.	Unknown	Y
25	Telegraph line	1905 Parish Map & Crown Plan 4921-1603.	Unknown	Y

Detailed site descriptions are provided in Niche (2013b; **Appendix G**).

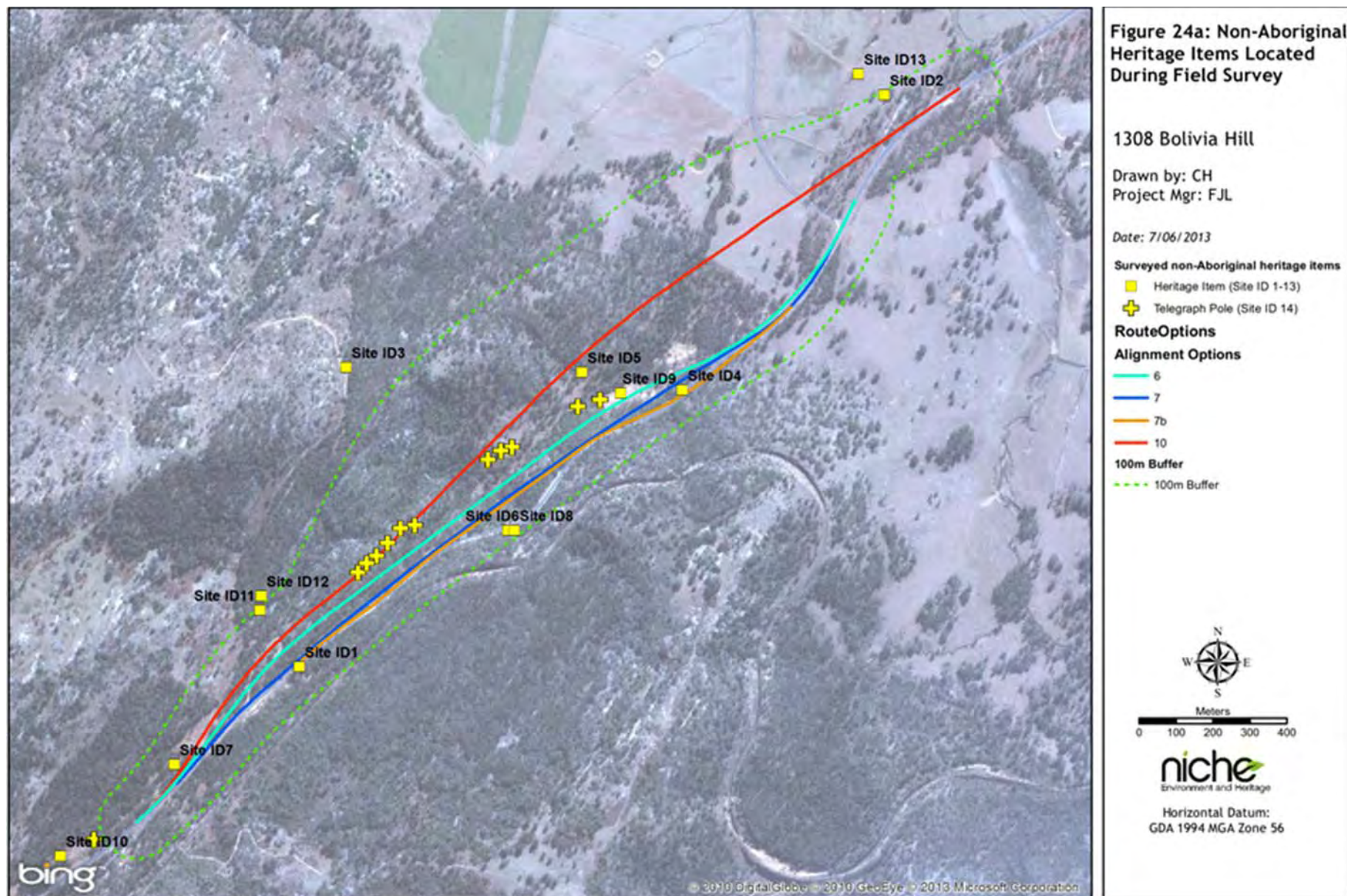


Figure 5-11 Non-Aboriginal heritage items located during the field survey

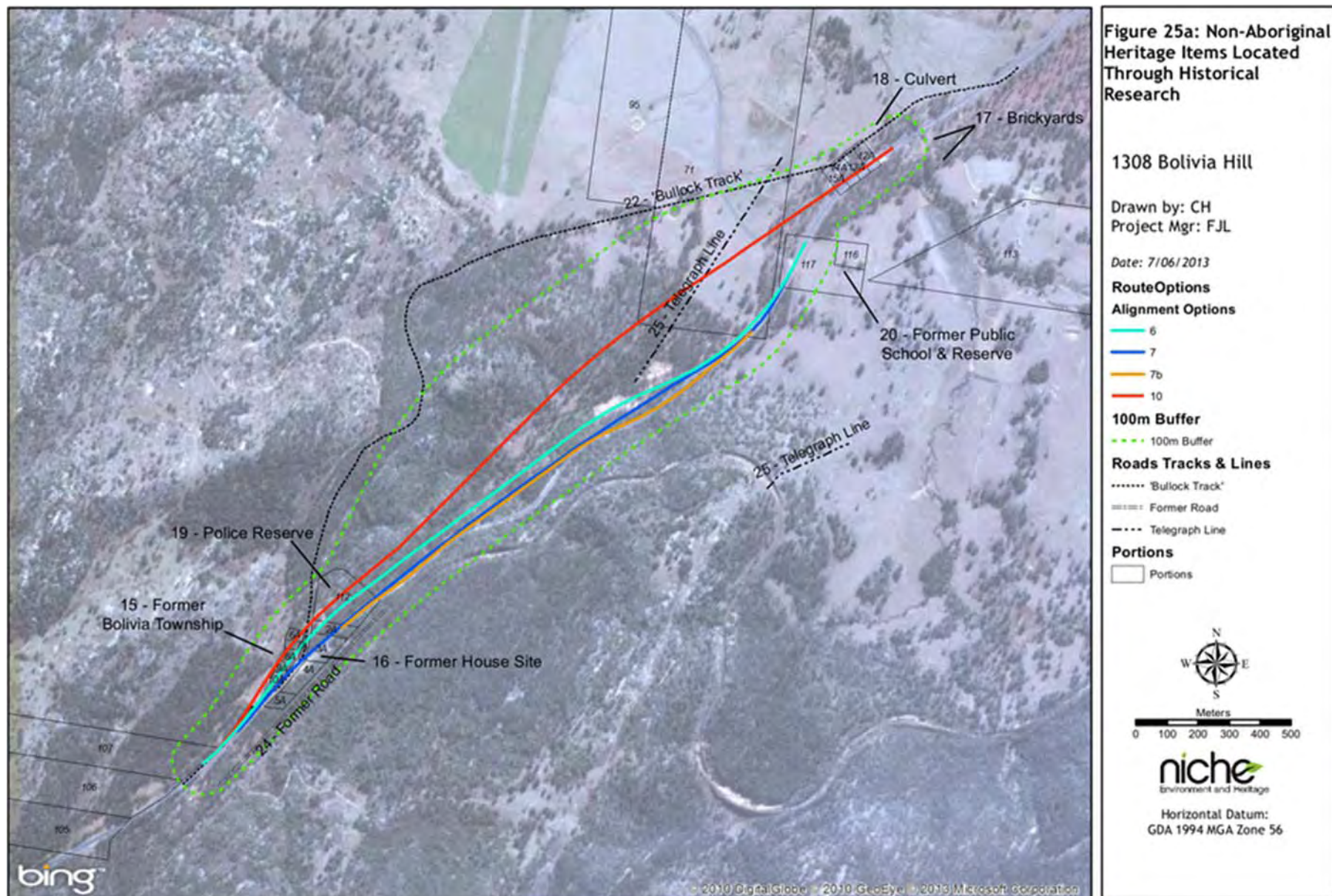


Figure 5-12 Non-Aboriginal heritage items located through historical research

5.3.2.5 Summary of non-Aboriginal heritage significance

An assessment of the scientific values and significance of the sites against the criteria provided in the *NSW Heritage Manual* (including the *Assessing Heritage Significance Guideline*) (DUAP, 1996).

These guidelines incorporate the aspects of cultural heritage value identified in the Burra Charter into a framework currently accepted by the NSW Heritage Council:

- (a) An item is important in the course, or pattern, or NSW's cultural or natural history (or the cultural or natural history of the local area)
- (b) An item has strong or special associations with the life or works of a person, or group of persons, of importance in the cultural or natural history of NSW (or the cultural and natural history of the local area)
- (c) An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievements in NSW (or the local area)
- (d) An item has a strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons
- (e) An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area)
- (f) An item possess uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area)
- (g) An item is important in demonstrating the principal characteristics of a class of NSW's:
 - Cultural or natural places, or
 - Cultural or natural environments (or a class of the local areas), or
 - Cultural or natural places, or
 - Cultural or natural environments.

Table 5-8 provides a preliminary significance assessment for the 20 heritage items located within the study area. Given that many of the sites have not been evaluated in the field, this assessment should be considered a preliminary guide only at this stage.

Table 5-8 Preliminary assessment of historic heritage significance

Site ID	Site name	Likely to satisfy the following criteria:	Likely level of significance
1	Angel memorial	(a), (d)	Local
2	Jackson's homestead site	(a), (e)	Local
4	Harry and Lenny memorial	(a), (d)	Local
5	Hut remains	(a)	Local
6	Johnson memorial	(a), (d)	Local
7	Mine shaft	(a)	Local
8	Former bridge	(a)	Local
9	Quarry	(a)	Nil
11	Stone rubble creek crossing	(a)	Local
12	Timber creek crossing	(a), (e)	Local
14/25	Telegraph line	(a)	Local
15	Former Bolivia township	(a), (b), (d), (e), (f), (g)	State and/or local
16	Former house site	(a), (e)	Local

Site ID	Site name	Likely to satisfy the following criteria:	Likely level of significance
17	Brickyards	(a), (b), (e), (f), (g)	Local
18	Culvert	(a)	Local
19	Police reserve	(a)	Local
20	Former public school site and reserve	(a)	Local
21	Travelling stock routes (two)	(a), (b)	Local
22	Bullock Track (west of current highway)	(a)	Local
23	Former Road (current highway)	(a)	Nil

Given its history of occupation and use, heritage items identified within the study area are generally considered locally significant for their historical heritage values, associative values, representative values, research potential and/or rarity. A wide range of items have been identified through field survey and detailed historical research. Further archaeological survey and investigation of the c1883 Bolivia township, former house site, police reserve, public school reserve, brickworks and culvert, however, would be required to determine their extent, condition and research potential. If substantially intact archaeological remains of Bolivia town have survived, they may be significant at a state level and careful management of the site and its heritage values would be required.

5.3.3 Demographics and social-economic profiles

An assessment of socio-economic profile of the study and potential impacts associated with the route selection and design process was conducted by Macroplan (2012) (**Appendix H**).

The location of the proposed upgrade is relatively isolated from existing townships and communities. The closest townships to the upgrade are Glen Innes (55 kilometres south) and Tenterfield (35 kilometres north). The proposal is, however, a part of a series of upgrades for the New England Highway with planning works initially focusing on a new bypass of Tenterfield and improvements to the Bolivia Hill stretch of road.

The LGAs of Glen Innes and Tenterfield are the most significant townships in proximity to Bolivia. The data in **Table 5-9** is for the State Suburb of Sandy Flats, which is the only information set from the 2011 Census that incorporates Bolivia.

Table 5-9 Census 2011 community profile data for Sandy Flat

Population by Age		Employment by Industry	
Age Cohort	2011	Industry	2011 Census
0-4	15	Agriculture, forestry and fishing	37
5-14	25	Construction	7
15-19	6	Manufacturing	6
20-24	11	Health care and social assistance	3
25-34	18	Other services	3
35-44	24	Inadequately described/Not stated	3
45-54	33	Total	59
55-64	36	Median Age	48
65-74	27	Median Household Income (\$/week)	670
75-84	10		
85+	6		
Total	211		

Note: Bolivia is included within the State Suburb of Sandy Flat.

Source: Census 2011 Basic Community Profile, MacroPlan Dimasi

Analysis of Census 2011 Community Profile data indicates that the Glen Innes LGA has registered a decline in population over the most recent census period, between 2006 and 2011. Despite this decline, an outright increase in the LGAs population was experienced over the 10 years to 2011. The resident population in Tenterfield LGA has expanded at a faster rate than Glen Innes – albeit marginally over the three Census periods (ten years) to 2011. However, consistent in both regions has been a reduction in younger residents (ie between the ages of 0-19 years). This has accentuated ‘ageing’ within the region and signifies a lack of job opportunities for younger people.

In its current state, road safety at Bolivia Hill is poor. Narrow road corridors and uneven/unsafe road surfaces present an unsafe passage for vehicles. According to a Roads and Maritime study, the New England Highway has been identified as the third most dangerous highway in NSW. Over the two years to 2010 the New England Highway registered approximately 12 fatalities and 135 total motor accidents. Over the decade to 2012, the Bolivia Hill section of the road was responsible for 13 crashes, resulting in four fatalities.

Improving the safety of Bolivia Hill will lead to improved safety conditions and travel efficiencies for vehicles travelling along this section of the New England Highway. Improved travel efficiency will increase vehicle flow and potentially increase usage along this route. Increased commercial vehicle usage can potentially be a catalyst for new and expanded business activity and thus employment in Glen Innes, Tenterfield and in regions served by the New England Highway.

It is expected that improvements to, and increased usage of the New England Highway would have potential to benefit business activity and local trade within the region. Those sectors of the economy that may potentially benefit from the upgrade works are retail, accommodation, food services and tourism sectors, which in turn will provide positive flow-on effects to other local industries. Overall, increased expenditure will support employment growth and output in the region.

As well as economic benefits, the upgrade also has potential to generate social benefits in the region. Improved employment prospects and new business growth will decrease the rate at which young residents are leaving the region and up-skill the existing local workforce. This in turn can promote investment in other sectors such as education and health.

Overall, having regard for the social and economic fabric of the region that the upgrade will serve and the broader set of road works that constitute the overall New England Highway upgrade, several potential economic, social and environmental benefits associated with the project have been identified:

- Improving the safety of the New England Highway and encouraging inland travel via the New England Highway
- Minimising congestion along this passage of roadway and improving the safety of travel
- Stimulation of the local economy – business and industry will benefit from the works. The improved road will provide a wider employment base for local residents particularly for younger residents
- Increased visitation and support for tourism and retail based employment.

Possible ‘costs’ associated with the Bolivia Hill upgrade project are limited, provided that the project is delivered within normal Roads and Maritime budget constraints and therefore represents ‘value for money’ construction. Note that environmental costs will be separately assessed but it is expected that, given the relatively small scale of the project, these will either be minimal or can be addressed by construction techniques.

5.3.4 Visual amenity

The study area and its immediate surrounds are considered to have moderate visual significance by virtue of:

- Their visibility above the surrounding landscape
- The rugged, natural form of the landscape, comprising rocky outcrops, indigenous bushland and some natural creeklines

- The existence of visible physical evidence of the European heritage of the locality, specifically the remaining Main Northern Railway line
- The availability of opportunities for regional views from the study area.

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6 Design considerations

6.1 Design criteria

Together with the characteristics discussed in **Chapter 5**, the design considerations form the basis of the guidelines and parameters to which the upgrade must attain. This chapter presents the design criteria that apply to this project.

6.1.1 Engineering design criteria

Standard national and state guidelines apply to the design, construction and operation of any new or upgraded road and cover categories including:

- Roads and Maritime corporate policies
- Occupational health and safety
- Road design
- Traffic
- Environmental policies
- Road safety.

6.1.2 Design life

Design life (being the duration that the upgrade should last for) has not been considered at this early stage of the project.

The economic analysis of the route options as part of the next phase of options analysis will consider design life of various infrastructure assets that comprise the upgrade. This provides a basis for whole of life cost analyses. The design life requirements will be developed and applied to all further stages of the project including concept design, detailed design and construction.

6.1.3 Flood immunity

The design must ensure that the appropriate level of flood immunity is provided. Roads and Maritime guidelines require that the pavement wearing surface of at least one carriageway remains above the water level during the design flood event. This project requires:

- A target of 100 year average recurrence interval (ARI) design flood event for new alignments
- For routes following the existing alignment, the minimum target is at least a 20 year ARI design flood event.

6.2 Technical criteria

Roads and Maritime stipulated minimum technical criteria for the upgrade. These incorporate standards and design guidelines required to achieve the project objectives. The stipulated technical criteria for the upgrade are summarised in **Table 6-1**. The original criteria required the design of the main carriageways and any ramps, including bridges, comply with the Network Planning Targets (NPT) in **Table 6-1**.

At the Internal Technical Workshop (ITW) (refer to **Section 7.4**), workshop participants agreed that consideration should be given to varying some of the design criteria set out by the NPT to make this route more consistent with the usage of the topography. Roads and Maritime sought and was granted internal approval to adopt revised design criteria for the shortlisted options as shown in **Table 6-1**.

When the recommended preferred option was investigated later in the project (refer to **Chapter 9**), Roads and Maritime sought and was granted internal approval to adopt further revised design criteria as shown in **Table 6-1**.

Table 6-1 Technical criteria

Design criteria	Original design requirement		Revised design requirement	
	Minimum requirement	NPT	Minimum requirement for initial shortlisted options	Minimum requirement for options 7a & 7b
Horizontal alignment - design speed	100 km/h	110 km/h	100 km/h	100 km/h
Absolute minimum horizontal curve radius	460m	460m	As per Austroads Guidelines – Minimum radius	As per Austroads Guidelines – Minimum radius
Vertical alignment – design speed	100 km/h	110 km/h	100 km/h	90 km/h
- Crest “K”	61	98	61	43
- Sag “K”	35	35	35	21
Maximum vertical grade	6.0%	6.0%	8.0%	9.0%
Stopping sight distance – reaction time (RT)	2.0 sec	2.5 sec	2.0 sec	2.0 sec
Horizontal	165 m	210 m	165 m	165 m
Vertical	165 m	210 m	165 m	140 m
Maximum superelevation	6.0%	6.0%	6.0%	6.0%
Number of lanes on each carriageway	Minimum of one lane southbound and one northbound, with consideration of overtaking lanes in each direction	Not specified	Two southbound and one northbound	One southbound and one northbound
Lane widths, including ramps and auxiliary lanes	3.5 m	3.5 m	3.5 m	3.5 m
Nearside (outside) shoulder width				
- main carriageway	2.5 m	2.5 m	2.5 m	2.0 m
- ramp	2.5 m	2.5 m	2.5 m	2.0 m
Outside (median) shoulder width				
- ramp	1.0 m	1.0 m	1.0 m	1.0 m
Clearance from edge of travel lane to safety barrier - nearside	3.0 m	3.0 m	3.0 m	2.0 m
Outside verge (adjacent to 4 to 1 or flatter batters), excluding rounding	0.5 m	0.5 m	0.5 m	0.5 m
Outside verge (adjacent barrier)	1.0 m	1.0 m	1.0 m	1.0 m

Design criteria	Original design requirement		Revised design requirement	
	Minimum requirement	NPT	Minimum requirement for initial shortlisted options	Minimum requirement for options 7a & 7b
Cutting berm width (adjacent SO gutter)	2.0 m	2.0 m	2.0 m	2.0 m
Outside clear zone	7.0 m	9.0 m	9.0 m	9.0 m
Bridges				
Width between kerbs				
Length of bridge (between abutments) > 50m	10.5 m	10.5 m	10.5 m	10.5 m
Length of bridge (between abutments) < 50m	11.0 m	11.0 m	11.0 m	11.0 m
Lane numbers per carriageway and widths	2 x 3.5 m	2 x 3.5 m	2 x 3.5 m	1 x 3.5 m
Offside shoulder width	1.0 m	1.0 m	1.0 m	1.0 m

6.3 Flooding and drainage

Flood investigations have been undertaken to develop an understanding of the existing flood behaviour and extents and the potential impact of the project. These investigations also relate to the flood immunity design criteria outlined in **Section 6.1.3**. The investigations involved numerical flood modelling where required within the study area.

Background information on the regional catchment and drainage context for the study area can be found in **Chapter 5 (Section 5.2.2)**.

Details on flooding and drainage can be found in the Preliminary Hydrology / Hydraulics Report in **Appendix C**.

6.3.1 Peak flow determination

Using topographical survey, available geographic information system (GIS) information and information collected during a site inspection in September 2012, local catchment delineation through the study area was undertaken.

Hydrological modelling for the study area was undertaken using the software *xp-rafts* (version 2009, XP Software). The hydrological model combines rainfall information with local catchment characteristics to estimate a runoff hydrograph.

Design rainfall depths and temporal patterns for the 100 year Average Recurrence Interval (ARI) event were developed using standard techniques provided in *Australian Rainfall and Runoff* (AR&R) (Engineers Australia, 1999). Based on the catchment type, available information and recommendations in AR&R (Engineers Australia 1999), rainfall losses were incorporated into the model.

No data was available for the calibration of the model and parameters in the model were based on experience and standard practice for similar catchment types.

6.3.2 Existing conditions flood level and extent determination

A hydraulic model converts runoff calculated using the hydrological model into water levels and velocities throughout the major creek systems and gullies in the study area. The model simulates the hydraulic behaviour of the water within the study area by accounting for flow in potential flow paths. It relies on boundary conditions, which include the runoff hydrographs produced by the hydrologic model and downstream conditions (commonly a water level or the characteristics of a hydraulic 'control' such as a bridge or weir).

Two dimensional (2D) hydraulic modelling was carried out to estimate the overland flow behaviour and the *Tuflow* 1D/2D modelling package (version Sept 2011, BMT WBM) was used for this study.

Two dimensional (2D) modelling requires a hydraulic roughness map that characterises ground surface roughness based on land use. In this assessment, surface roughness was characterised as bushland, open space and road land types based on aerial photography and information collected during the site visit.

No data was available for the calibration of the model and parameters in the model were based on experience and standard practice for similar floodplain types.

Figure 6-1 shows the results of the existing conditions modelling for the 100 year ARI flood extent.

6.3.3 Road level and watercourse crossing requirements

The proposed routes (**Chapter 7**) cross several watercourses. This provides an opportunity to control the flow during flood events with the provision of drainage structures (such as culverts and bridges) within the road embankment to ensure upstream water levels (afflux) are mitigated to acceptable levels. For some minor tributaries, there may be opportunity to mitigate downstream water levels by redirection of the tributary.

Where the route options preliminary designs crossed watercourses, bridge lengths were conservatively based on the 100 year ARI flood extent shown in **Figure 6-1** (ie to ensure clear passage of flood flows up to the 100 year ARI flood with no impediments such as bridge piers). In the assessment of the preferred option, bridges and culverts will be included in hydraulic models and limited techniques used to determine the required crossing opening requirements.

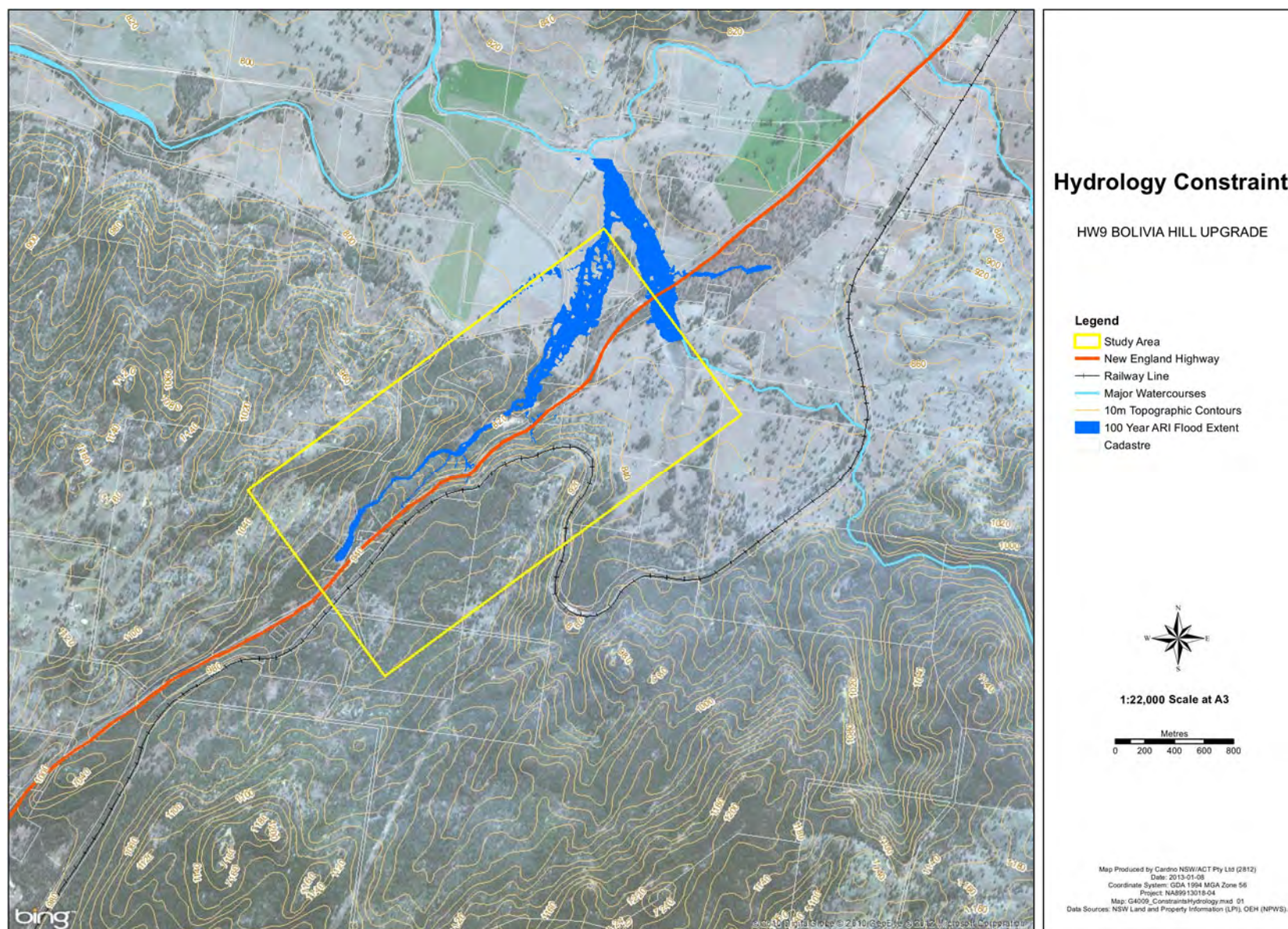


Figure 6-1 Existing 100 year ARI flood extents

6.3.4 Groundwater issues

The potential impacts to groundwater resources from construction of a new road alignment through the study area are considered minor or negligible (**Section 5.2.2.2**).

As the road is a linear feature, it does not cover a large area and is not considered to provide a risk to altering the recharge or water balance of an aquifer system. In addition, in the case of this site, there are no such significant aquifer systems. Specifically:

- Deep cuttings associated with the road alignment, if required, are still not expected to intercept any aquifer
- There are expected to be insignificant impacts to groundwater flow systems and aquifer water balances. Consequently:
 - Impacts to groundwater dependent ecosystems (GDEs) are expected to be small to negligible
 - Impacts to groundwater users will be negligible
 - There is anticipated to be neutral effect on the beneficial usage category of aquifers
- There is expected to be no requirement for substantial dewatering. Any dewatering required is likely to be superficial, associated with management of local and recent rainfall at the worksite.

6.4 Geotechnical considerations

A detailed analysis of the geotechnical considerations can be found in the Preliminary Geotechnical Assessment Report in **Appendix I**. The information following provides an overview of the findings within the Preliminary Geotechnical Assessment Report.

6.4.1 Geotechnical conditions

The geologic and soil conditions over the study area are described in **Chapter 5** and in more detail in **Appendix I**. A discussion of the design considerations associated with the geologic and soil conditions likely to be encountered follows.

6.4.1.1 Soils

Foundation conditions vary across the study area.

Overall, it is expected that any embankments within the hilly (southern) terrain where granite is exposed will require stripping of vegetation, topsoil and any sandy soil material to expose a weathered rock material. Depths of stripping are expected to be no more than one metre in most areas. The topsoil may be stockpiled on site and used for later top-soiling of embankment or cut slopes which should be designed at a slope of 2 Horizontal (H) : 1 Vertical (V) or shallower.

In the flatter terrain over the north end of the study area, removal of vegetation and topsoil will be required and will expose a clayey sandy soil subgrade.

6.4.1.2 Rock

Earth fill or rock fill may be used to construct the embankments. A hybrid embankment using a combination of earth fill and rock fill should be avoided due to the large variation of grading of the material leading to the potential of internal erosion of the embankment.

The design of rockfill embankments is described in *RTA QA Specification R44, Section 5.1.2* (2011).

It is expected that a large proportion of excavated material could be used as rockfill. Specification R44 requires a maximum size of 350 millimetres and therefore crushing and screening of excavated materials will be required to produce suitable rockfill to meet the specification.

6.4.2 Ground treatment options

The use of ground treatment options such as bridging layers, geo-reinforcement and/or stabilisation for the treatment of unstable or unsuitable ground is not expected to be required at this stage. Treatment options may be dependent on climatic conditions prior to and during construction.

6.4.3 **Suitability for tunnelling**

Rock types observed in surface exposure at Bolivia Hill (refer **Section 5.2.1**) include:

- Distinctly weathered granite with close joint spacing. Predominant joint set strikes north south and is sub-vertical
- Fresh granite (of assessed very high rock strength) with predominant joint set sub-vertical and striking north/south. Exfoliation joints were observed in exposure that parallel the slope surface and are expected to extend to shallow depth only. A two metre wide fresh to slightly weathered basalt dyke was also observed in exposure and has intruded along a north/south striking joint.

Issues to consider for tunnelling would include strength/weathering variations of the granite along the tunnel alignment. Abrupt changes in weathering are possible. The more weathered granite would likely require concrete lining support, while the support requirements for fresh granite would be considerably less. Portal entries are likely to be excavated within weathered granite and would require concrete lining and shotcrete support. It is possible the weathering variations, if encountered along the tunnel alignment, will result in permeability variations and complex hydrogeology where the tunnel is driven below the regional groundwater table. Water inflows and hydrostatic pressures acting on the tunnel face and walls may vary.

A detailed geotechnical investigation would be required to assess rock weathering and strength variations along the tunnel alignment, groundwater conditions and rock mass permeability.

The excavation method for any tunnel will need to be either drill and blast or tunnel boring machine.

6.5 **Property and land use impacts**

6.5.1 **Severance of land uses**

Severance of land use occurs if the highway passes through a land holding bisecting the holding into distinct parts (note: this does not include acquisition of land through widening of existing road / rail corridors). The impacts of the severance of land could include (but are not limited to):

- Reduction or elimination of land productivity if commercial activities are interrupted (agriculture, retail, industrial and the like), due either to the reduction in size of the overall holding or restricting access between the two separated parcels of land (eg for stock access or for crop maintenance). There are no retail or industrial uses within the study area
- Creation of residual lots that, due to their small size or characteristics, have little or no productive use (eg steep land that was otherwise used for grazing and now has limited accessibility)
- Increase in highway edge effects, such as an increase of water quality impacts and vehicle emissions, which may be located closer to sensitive land uses (eg organic farms and vineyards).

The proposed upgrade to the New England Highway should avoid fragmentation of productive agricultural land to retain land resource values.

6.5.2 **Agricultural land**

The Department of Primary Industries classifies land suitable for productive agriculture. Class 1 land is considered the most productive agricultural land. This class of land is protected from the development of other land uses where possible. The Agricultural Land Classification Map, prepared by Department of Primary Industries for Tenterfield Shire in 1991, identifies land within the study area as being classed: Agricultural Class 3, 4 and 5 (refer to **Figure 6-2**). The preferred design option must consider any impacts on agricultural land, having particular regard to land identified as Class 3, which may have potential to be utilised for regular cultivation. There is no Class 1 or Class 2 agricultural land in the study area.

Further, the *New England North West Strategic Regional Land Use Plan 2012* prepared by the NSW Department of Planning and Infrastructure identifies Strategic Agricultural Land (SAL) within the region. SAL includes both land with unique natural resource characteristics, known as biophysical strategic agricultural land, and clusters of significant agricultural industries that are potentially impacted by coal seam gas or mining development, known as critical industry clusters. To help address the challenge of achieving balanced land use outcomes in the region, areas with particularly high agricultural values have been

identified and mapped in consultation with key industry representatives and industry experts. The study area does not contain SAL as shown on the Strategic Agricultural Map as shown in **Chapter 4 (Figure 4-4)** of this report.

6.6 Construction resources and materials

6.6.1 Materials

The construction of the upgrade would require a number of different materials including:

- Earthworks materials
- Pavement materials
- Concrete
- Aggregates for concrete
- Sand
- Water
- Cement, and
- Steel reinforcement.

6.6.2 Sources of construction materials

A detailed analysis of the sources of earthworks and pavement materials can be found in **Appendix I**. The information following provides an overview of the findings within **Appendix I**.

6.6.2.1 *Earthworks*

From site observations to date, there are potentially three road construction material types available within the study area:

- Soil and completely weathered granite: This material may be suitable for use as earth fill, though quantities are expected to be very low
- Distinctly weathered granite materials: This material is likely to be suitable for use as earth fill, reinforced soil wall backfill, upper zone of formation and possibly select fill in pavements. Crushing and/or breakdown of oversize materials will be required to obtain desired materials grading
- Slightly weathered and fresh granite: This material is likely to be suitable as rock fill material, bridging, drainage material, and select layers. Crushing will be required to obtain the desired material grading.

6.6.2.2 *Pavement materials*

Crushing of slightly weathered and fresh granite has the potential for production of other pavement materials, subject to laboratory evaluation.

In addition to site won materials, alternate road construction materials suppliers (refer to **Appendix I**) are available in the vicinity of the study area.

6.6.2.3 *Other materials*

The availability of concrete, aggregates for concrete, sand, water and cement will be investigated in the next stage of the project.

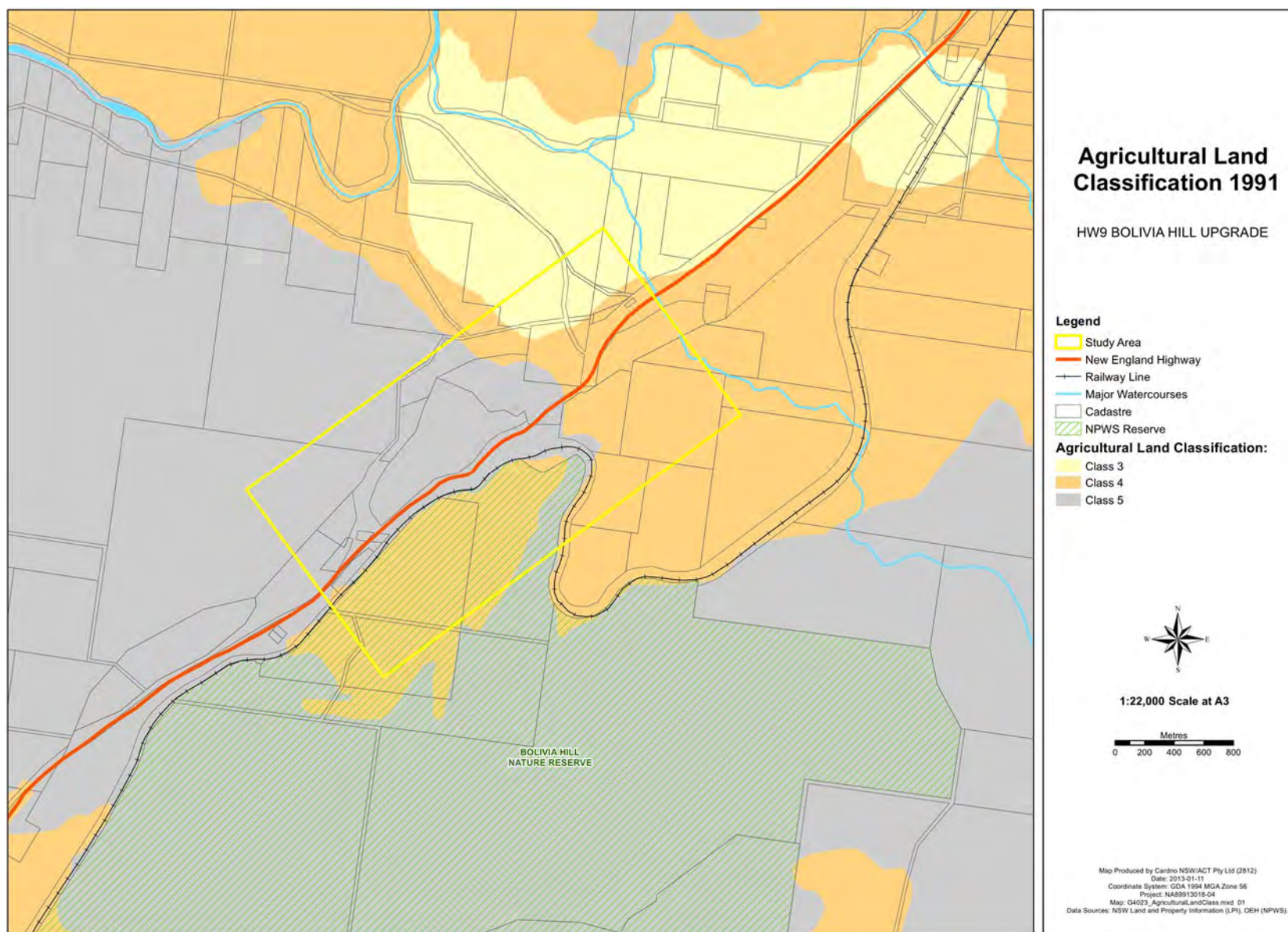


Figure 6-2 Agricultural land classification

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7 Development of route options

7.1 Assessment criteria and methodology

The identification of a shortlist of route options which best met the objectives of the project was undertaken using the generally recognised route options development process (see **Section 1.5**). **Table 7-1** sets out the broad project measurable / selection criteria based on the project objectives.

At the stage of assessment of preliminary route options, some of the studies relevant to the *Critical Criteria* listed in **Table 7.1** had yet to be carried out and therefore some of the *Critical Criteria* could not be assessed.

As the project progressed, additional studies were carried out that allowed the majority of the *Critical Criteria* to be assessed.

Table 7-1 Project measurable / selection criteria for assessment of preliminary route options

Project Objectives	Critical Criteria* ¹	Description of criteria that can be assessed
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work health and safety in construction and maintenance. 	<ul style="list-style-type: none"> Provide for an overtaking lane for southbound traffic and possibly a dual lane carriageway separated by wire rope. Provide an alignment that minimises problems in construction. Maintain at least one lane of the highway open during construction of the upgrade. Minimise work health and safety risk in construction and maintenance.
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	<ul style="list-style-type: none"> Provide appropriate horizontal and vertical road geometry.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and Non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	<ul style="list-style-type: none"> Minimise adverse impacts on native vegetation. Minimise adverse impacts on sensitive habitats. Minimise adverse impacts on Endangered Ecological Communities. Minimise adverse impacts on surface water quality. Minimise adverse impacts on flooding and drainage. Minimise adverse impacts on known non-Aboriginal heritage sites, values and areas of archaeological potential. Minimise adverse impacts on known Aboriginal heritage sites, values and areas of archaeological potential. Potential to use recycled or waste materials.

Project Objectives	Critical Criteria* ¹	Description of criteria that can be assessed
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios Net Present Value over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance) Comparative project costs. 	<ul style="list-style-type: none"> Minimise project cost.

Note *1 – Feasible routes must conform to critical criteria

The route options development process involved:

- Identification of physical, environmental and social constraints
- Qualitative assessment of a number of potentially feasible route options
- Rejection of any options which are fundamentally flawed
- Comparison of the performance of the remaining options against a set of criteria related to the project objectives
- Identification of the best performing options.

The development of the route options from a long to a shortlist is based on a qualitative assessment of the relative impacts of each one. A qualitative assessment of the routes determines whether one thing is larger, smaller or equal to another, without specifying the size of any difference. A quantitative assessment of the routes determines the amount or size of each aspect of the route being assessed and specifies the size of the difference.

The shortlisting process of route options for this project followed four phases:

- Determination of a list of options (refer **Section 7.2**)
- Initial assessments (refer **Section 7.3**)
- Internal Technical Workshop (refer **Section 7.4**)
- Conclusion and next steps (refer **Section 7.5**).

7.2 Phase 1: Determination of a list of options

7.2.1 Routes identified by the project team

Routes were identified by the project team and included in the “list” of routes that were then assessed.

Figure 7-1 presents the list of routes (11 alternate routes) that were carried forward into the second and third phases of the selection process.

Sections 7.2.2 to 7.2.12 provide descriptions of the options developed by the project team.

Section 7.2.13 describes options suggested by the community.

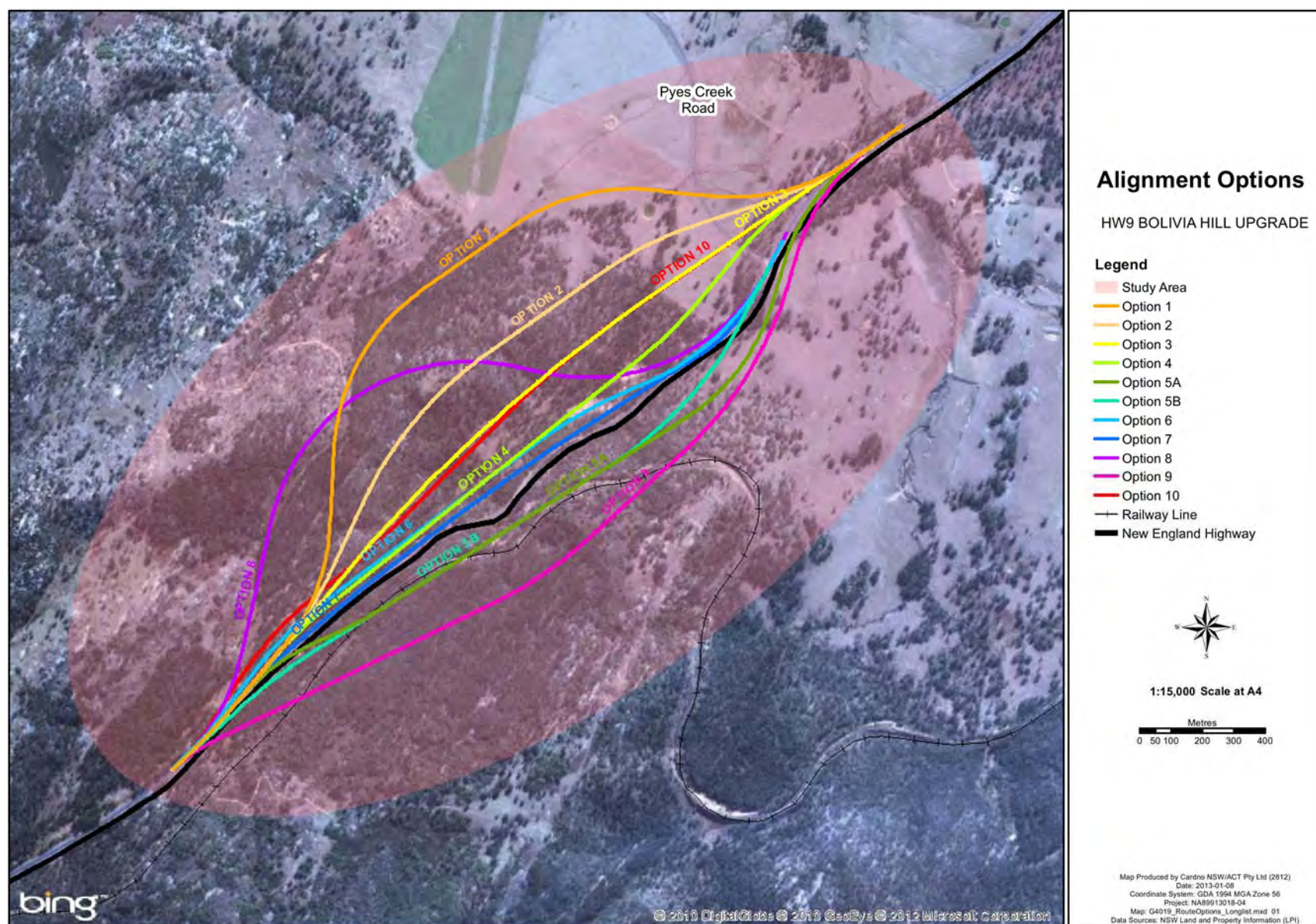


Figure 7-1 List of route options

7.2.2 Option 1

Option 1 attempts, in part, to follow the former Cobb & Co road to the west of the existing alignment to reduce property acquisition by using an existing road reserve where possible.



Figure 7-2 Option 1

The key features of this option are:

- Option 1 is 3450 metres long
- Deep cuts and high fills are required to achieve a maximum conforming vertical grade of 6 per cent
- The first 1000 metres (from the southern project boundary) consists of minor cut and fill plus a bridge 130 metres long over the watercourse in the gully to the west of the existing highway
- The alignment moves into a major cut through the ridge at the western extent of the study area. The cut is 700-800 metres long and up to 65 metres deep. A tunnel option (450 metres in length) through this section was assessed at a later stage for cost and constructability comparison
- The alignment then moves into extensive fill up to 15 metres high as it grades down to the Brickyard Creek floodplain. Extensive retaining walls may be required. A bridge up to 150 metres long will be required across the watercourse to the west of the existing highway just south of Pyes Creek Road
- To the north of the bridge the alignment is in minor fill with the last 200 metres being an upgrade of the existing highway
- Estimated cost \$584 million.

7.2.3 Option 2

Option 2 is similar to Option 1 but with an attempt to reduce both the amount of hard rock excavation required and the overall route length.

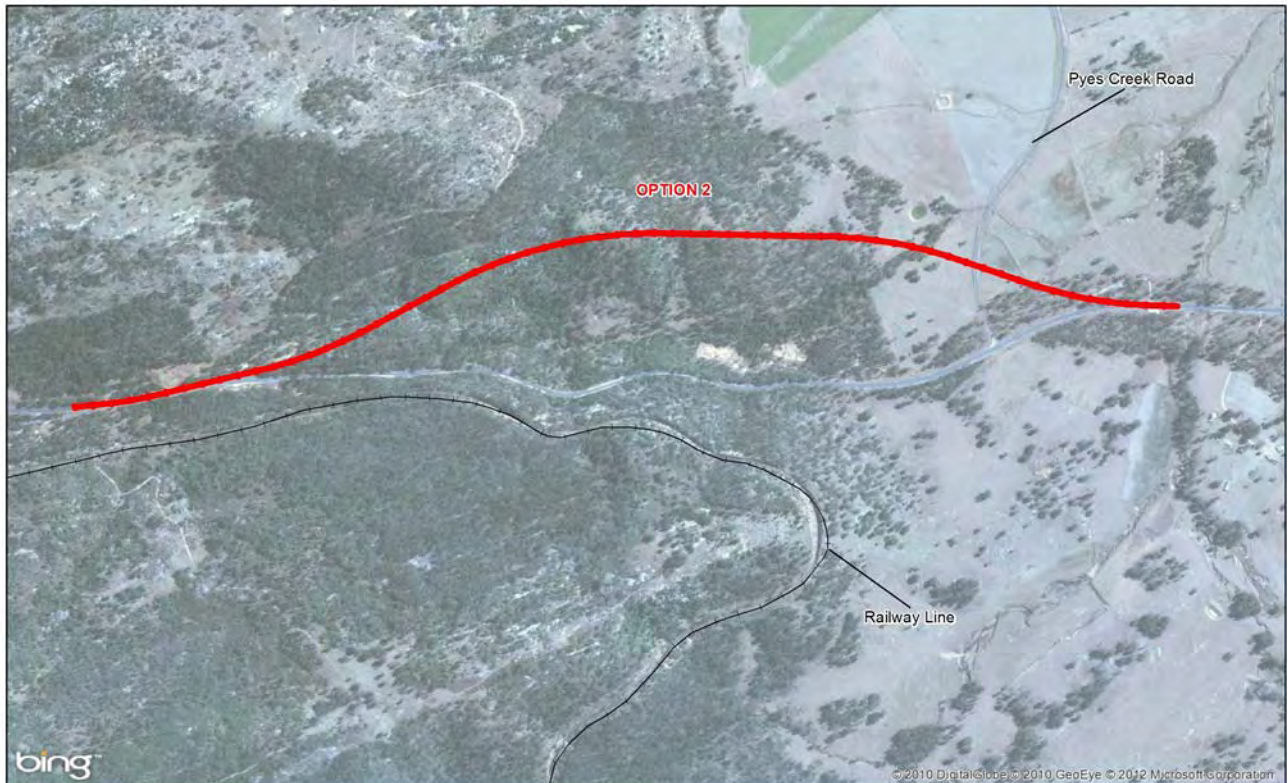


Figure 7-3 Option 2

The key features of this option are:

- Option 2 is 3200 metres long
- Deep cuts and high fills are required to achieve a maximum conforming vertical grade of 6 per cent
- The first 1050 metres (from the southern project boundary) consists of minor cut and fill plus a bridge 150 metres long over the watercourse in the gully to the west of the existing highway
- The alignment moves into a major cut through the ridge at the western extent of the study area. The cut is 600 metres long and up to 25 metres deep. The majority of the cut is on the western side of the alignment into the ridgeline
- The alignment then moves into extensive fill up to 20 metres high as it grades down to the Brickyard Creek floodplain. Extensive retaining walls and or bridges may be required. A bridge up to 200 metres long will be required across the watercourse to the west of the existing highway just south of Pyres Creek Road
- The high fill continues over Pyres Creek Road and grades down with the last 200 metres being an upgrade of the existing highway
- Estimated cost \$316 million (\$2013).

7.2.4 Option 3

Option 3 achieves the best geometric outcomes of all the routes identified as it is the most direct with minimal horizontal direction change; however this option requires a major bridge/viaduct.



Figure 7-4 Option 3

The key features of this option are:

- Option 3 is 3120 metres long
- The option has a maximum conforming vertical grade of 6 per cent
- The first 750 metres (from the southern project boundary) consists of minor cut and fill
- The alignment crosses the watercourse in the gully to the west of the existing highway then follows the line of the gully to the west of the waterway. A major bridge/viaduct up to 1500 metres long is required to keep the roadway out of the creek line
- The viaduct ends before Pyes Creek Road. High fill then grades down with the last 200 metres, being an upgrade of the existing highway
- Estimated cost \$445 million (\$2013).

7.2.5 **Option 4**

Option 4 aims to keep the alignment as close the existing highway alignment as possible while achieving conforming horizontal and vertical alignments.



Figure 7-5 Option 4

The key features of this option are:

- Option 4 is 3100 metres long
- The option has a maximum conforming vertical grade of 6 per cent
- The first 800 metres (from the southern project boundary) consists of minor cut and fill
- The next 200 metres requires extensive fill up to 20 metres high, possibly requiring extensive retaining walls
- The alignment then follows the line of the gully to the west of the highway on the eastern side of the waterway. A major bridge/viaduct up to 1000 metres long is required to keep the roadway out of the creek line
- The viaduct ends before Pyes Creek Road. High fill then grades down with the last 200 metres being an upgrade of the existing highway
- Estimated cost \$430 million (\$2013).

7.2.6 Option 5a

Option 5a is an eastern option that requires a tunnel underneath Bolivia Hill Nature Reserve that would ensure no disturbance to the nature reserve and the Main Northern Railway line.



Figure 7-6 Option 5a

The key features of this option are:

- Option 5a is 3200 metres long
- To achieve the maximum conforming vertical grade of 6 per cent, either a very deep cut through the railway reserve is required (producing extensive batters into the Bolivia Hill Nature Reserve) or a tunnel is required. The tunnel option was chosen for the purposes of assessment as deep cuts into the railway reserve and into the Bolivia Hill Nature Reserve were considered unacceptable
- The first 400 metres (from the southern project boundary) is an upgrade the existing highway in minor cut and fill
- The alignment then goes into cut for 300 metres to a tunnel portal west of the railway line
- Tunnel under the rail reserve for 1400 metres (as outlined above, open cut produces extensive batters into the Bolivia Hill Nature Reserve which were considered unacceptable)
- Fill then grades down for 700 metres to the existing highway
- The last 400 metres is an upgrade of the existing highway
- Estimated cost \$374 million (\$2013).

7.2.7 **Option 5b**

Option 5b is a variant to Option 5a but uses steeper grades, which increases the length of the tunnel under the Bolivia Hill Nature Reserve, but reduces the overall route length to connect into the existing highway prior to Pyes Creek Road, limiting the intersection works required.

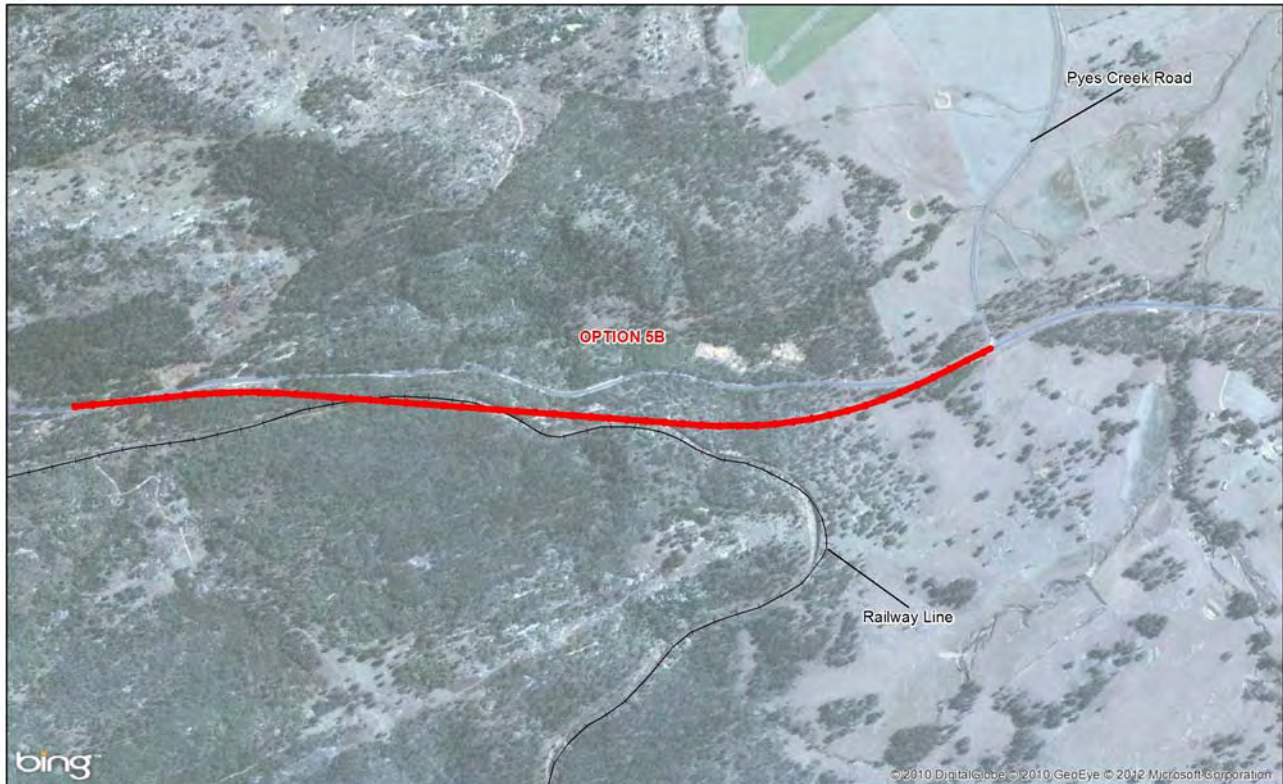


Figure 7-7 Option 5b

The key features of this option are:

- Option 5b is 2500 metres long
- This is a variation on Option 5a, shortening the total length
- To achieve the maximum conforming vertical grade of 6 per cent, either a very deep cut through the railway reserve is required (producing extensive batters into the Bolivia Hill Nature Reserve) or a tunnel is required. The tunnel option was chosen for the purposes of assessment as deep cuts into the railway reserve and into the Bolivia Hill Nature Reserve were considered unacceptable
- The first 400 metres (from the southern project boundary) is an upgrade the existing highway in minor cut and fill
- The alignment then goes into cut for 300 metres to a tunnel portal west of the railway line
- Tunnel under the rail reserve for 1300 metres (as outlined above, open cut produces extensive batters into the Bolivia Hill Nature Reserve which were considered unacceptable)
- The alignment is then in cut up to 20 metres deep for 350 metres until it joins the existing highway alignment
- The last 150 metres is an upgrade of the existing highway to the Pyes Creek Road intersection
- Estimated cost \$693 million (\$2013).

7.2.8 Option 6

Option 6 is a variant of Option 4. It also has conforming horizontal and vertical alignments, but presents a shorter route length and connects prior to Pyes Creek Road due to the alignment being further offline at the southern end.



Figure 7-8 Option 6

The key features of this option are:

- Option 6 is 2850 metres long
- The option has a maximum conforming vertical grade of 6 per cent
- The first 300 metres (from the southern project boundary) consists of minor cut and fill
- The next 600 metres goes into cut up to 25 metres deep
- The alignment then follows the line of the gully to the west of the highway on the eastern side of the waterway. A major bridge/viaduct up to 1000 metres long is required to keep the roadway out of the creek line
- From the end of the viaduct, fill up to 15 metres high tapers back to the existing highway over approximately 250 metres. The last 400 metres to just past Pyes Creek Road intersection is an upgrade of the existing highway
- Estimated cost \$278 million (\$2013).

7.2.9 Option 7

Option 7 is considered an upgrade to the existing highway, utilising as much of the existing pavement as possible. While it achieves a conforming horizontal alignment it has a non-conforming vertical alignment.



Figure 7-9 Option 7

The key features of this option are:

- Option 7 is 1950 metres long
- This option was developed to demonstrate a minimalist treatment of straightening out the bends in the steepest part of the highway. It has non-conforming grades up to 9.0 per cent in order to shorten the length and starts approximately 900 metres north of the other options (from the southern project boundary)
- The first 200 metres will require extensive retaining walls to keep the fill out of the creek line
- A major bridge up to 550 metres long will then be required to keep the road out of the creek line
- From the northern abutment at about eight metres high, fill tapers back 400 metres to the existing highway
- Estimated cost \$129 million (\$2013).

7.2.10 Option 8

Option 8 is a shorter variant of Options 1 and 2; it connects into the existing highway alignment prior to Pyes Creek Road.



Figure 7-10 Option 8

The key features of this option are:

- Option 8 is 3000 metres long
- This option was developed to demonstrate an alignment through areas not covered by other alignments to the west of the existing highway
- Deep cuts and high fills are required to achieve a maximum conforming vertical grade of 6 per cent
- The first 650 metres (from the southern project boundary) consists of minor cut and fill with a bridge over the watercourse in the gully 50 metres long
- The alignment moves into a major cut through the ridge at the western extent of the study area. The cut is 1300 metres long and up to 82 metres deep (or a tunnel approximately 1000 metres long)
- The alignment then moves into extensive fill up to 30 metres high for 500 metres as it grades down to the Brickyard Creek floodplain. Extensive retaining walls and or bridges may be required. A bridge up to 300 metres long will be required across the watercourse to the west of the existing highway
- The last 450 metres to just past Pyes Creek Road intersection is an upgrade of the existing highway
- Estimated cost \$1,073 million (\$2013).

7.2.11 Option 9

Option 9 is a variant of Option 5 with a significantly longer tunnel under the Bolivia Hill Nature Reserve; this eliminates the requirement for bridge structures at the northern tunnel portal.



Figure 7-11 Option 9

The key features of this option are:

- Option 9 is 3200 metres long
- As with Options 5a and 5b, to achieve the maximum conforming vertical grade of 6 per cent, either a very deep cut is required; producing extensive batters into the Bolivia Hill Nature Reserve or a tunnel is required. The tunnel option was chosen for the purposes of assessment as deep cuts into the railway reserve and into the Bolivia Hill Nature Reserve were considered unacceptable
- The first 250 metres (from the southern project boundary) consists of minor cut and fill
- It is assumed at this stage that the existing railway line must remain; therefore, the alignment goes into cut and then tunnel under the line. Two by two lane tunnels 1700 metres long will be required under the Bolivia Hill Nature Reserve
- From the northern portal of the tunnel, the alignment goes into extensive fill up to 22 metres high for 800 metres, possibly requiring extensive retaining walls
- The last 300 metres is an upgrade of the existing highway
- Estimated cost \$890 million (\$2013).

7.2.12 Option 10

Option 10 is a variant of Option 3 where it attempts to follow the ridgeline to the west of the existing highway while trying to avoid impact to the creek, and considerably reducing the overall length of bridge required.



Figure 7-12 Option 10

The key features of this option are:

- Option 10 is 2950 metres long. The option is a variation on Option 3 attempting to reduce the length of the viaduct
- The option has a maximum conforming vertical grade of 6 per cent
- The first 300 metres (from the southern project boundary) is in minor cut and fill
- The alignment then moves into extensive cut 650 metres long and up to 25 metres deep
- A major bridge/viaduct up to 900 metres long is then required to keep the road out of the creek line
- The alignment then moves into extensive fill up to 15 metres high for 1000 metres possibly requiring extensive retaining walls. A bridge up to 150 metres long will be required across the watercourse to the west of the existing highway
- The last 300 metres is an upgrade of the existing highway
- Estimated cost \$362 million (\$2013).

7.2.13 Community options

Options suggested by the community (refer to **Section 3.5**) were also assessed. Details of the community options can be found in **Appendix B**.

Community options included the following alignments:

- Several community members suggested an alignment to the western side of the study area. This alignment is similar to Option 1

- Several community members suggested an alignment to the east of the existing highway through Bolivia Hill Nature Reserve. This alignment is similar to Option 9
- Several community members suggested an alignment to the east of the existing highway along the existing railway alignment. This alignment is similar to Options 5a and 5b
- Several community members suggested adopting the current alignment for uphill (southbound) lanes and a new alignment to the west of the existing alignment for a downhill (northbound) lane. While this was considered for Options 6 and 10, it was not put forward as a specific option as it was determined to be economically unviable. The cost of building the single lane off line would not be significantly less than the cost of building the full three lane width off line but the existing alignment would require extensive rehabilitation works as it is currently non-compliant with the project's design criteria
- One community option included some expectation that the upgrade of the existing alignment (widening) could be considered. This proposal is similar to Option 7.

7.3 Phase 2: Initial assessments

The potentially feasible routes from Phase 1 were then assessed by the individual specialists independent from other influences in advance of the route options development workshop process (see below).

Each specialist was required to undertake preparatory assessments of the route options. This then ensured the optimum efficiency of the workshop so that impacts had already been determined prior to the workshop. This assessment was carried out subsequent to the constraints being identified as discussed in **Chapters 5 and 6** above.

The preparatory assessments included:

- Assessment against the project objectives (this involved a detailed assessment of the routes against the objectives and the constraints)
- Identification of preliminary “negotiable” and “non-negotiable” issues. Non-negotiable is the term applied to critical factors which categorically discount a route from further assessment
- Identification of preliminary discards of route options
- Identification of preliminary route preferences.

The specialist investigations categories comprised:

- Community input
- Alignment, staging and access
- Water quality
- Terrestrial ecology
- Flooding and drainage
- Aboriginal and non-Aboriginal heritage
- Climate
- Utilities
- Planning and zoning
- Land use
- Ground conditions
- Cost
- Traffic.

7.4 Phase 3: Internal technical workshop

The assessing and shortlisting of feasible route options was carried out through a workshop process over one day. The key project team members included specialists representing each of the categories described in **Section 7.3**.

At the workshop, the specialists summarised their preparatory work that included:

- An explanation of the category
- An explanation of features of a route which would be either beneficial or undesirable relative to that category
- A preliminary assessment of what are the critical issues, ie those which fundamentally influence the choice of route
- An explanation of study area relative to that category
- General findings of the list of routes
- Specific findings, analysis, assessment and initial preferences
- Identification of non-negotiable issues that would discard the route from further analysis.

The workshop provided an opportunity for participants to appreciate issues arising from other specialist categories resulting in a balanced assessment between specialist areas and issues.

The route options were assessed in turn to determine how they met the project objectives. This included identification of routes that failed to meet critical objectives and were therefore discarded.

A simple comparison exercise was then performed for every route comparing on a numerical scale how well the route met the project objectives.

The scale was as follows:

- 4 fully meets the criteria
- 3 significantly meets the criteria
- 2 partially meets the criteria
- 1 mostly does not meet the criteria
- 0 non-negotiable => discard

For each objective, combinations of specialist categories were applicable, ie a route may have attracted a different outcome for each specialist category for a specific objective. The workshop process included debate on each of these scenarios and determined a collective result.

7.4.1 Phase 3: Internal technical workshop outcomes

The internal technical workshop produced a provisional shortlist of route options and identified issues that require further detailed analysis in the next stage of the project.

The workshop's assessment of each option is provided in **Table 7-2**. The table includes a summary of the initial assessment of the list of options against project objectives and assessment criteria. The rationale behind the scoring is included in **Appendix J**.

7.4.1.1 Ranking of options

The options were initially ranked 1 (best) to 11 (worst) against the total score for each option.

To test the validity of this ranking, the following methods were also used:

- Equally weight each objective
 - Calculate the average score for Road Safety, Efficiency, Environment and Value for Money
 - Add each average score to obtain a score out of 16

- Rank each objective on total score for the objective and then sum the rankings. The option with the lowest score ranks best.

The rankings showed consistency over the three methods. The key issues and the outcomes of the workshop process were collated and are included in **Appendix J**.

Table 7-3 (following **Table 7-2**) provides an overall summary of the outcomes of the initial assessment of the list of options against the project objectives and assessment criteria.

Table 7-2 Rationale behind workshop scoring for each option

Option 1

Option 1 attempts, in part, to follow the former Cobb & Co road to the west of the existing alignment to reduce property acquisition by using an existing road reserve where possible.

Workshop outcomes

Option 1 scored poorly for constructability due to the long and deep cutting in very hard rock. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the high cost. Option 1 also scored poorly against the environmental objectives. The deep cut and high fills leave a very large footprint and would have a considerable impact on flora and fauna and create a significant visual impact. The cut would also require a large amount of rock to be transported away from site.

Overall, Option 1 scored very poorly against all the objectives and was not shortlisted to be taken forward for further investigation and design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work Health and safety in construction and maintenance. 	6 (equal)	<ul style="list-style-type: none"> Road safety will be improved with the vertical and horizontal alignment to improved geometry standards Scores poorly for constructability and work health and safety in construction and maintenance due to the long and deep cutting in very hard rock
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	5 (equal)	<ul style="list-style-type: none"> Although the alignment has conforming horizontal and vertical geometry, scores lower in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	9 (equal)	<ul style="list-style-type: none"> Scores poorly on impact to flora and fauna habitat due to the long, deep cut that leaves a very large footprint Scores well for non-Aboriginal impacts as it avoids most of the sensitive areas, only a small portion in Bolivia Station would be affected by the route Scores poorly for Aboriginal heritage as the route passes through areas of high and moderate Aboriginal heritage sensitivity Scores poorly in relation to surface water quality due to interference with existing floodplain and creek realignment Significant interference due to two proposed creek crossings results in a poor score for flooding and drainage Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the large cutting that would need to be transported away from site Scores poorly on visual impact with a large footprint due to the large cuts and fills.
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios NPV over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance). Comparative project costs. 	8 (equal)	<ul style="list-style-type: none"> Cost \$584 M \$455 M more than lowest cost option mainly due to the very large quantity of cut through hard rock Cost is considered excessive.

Option 2

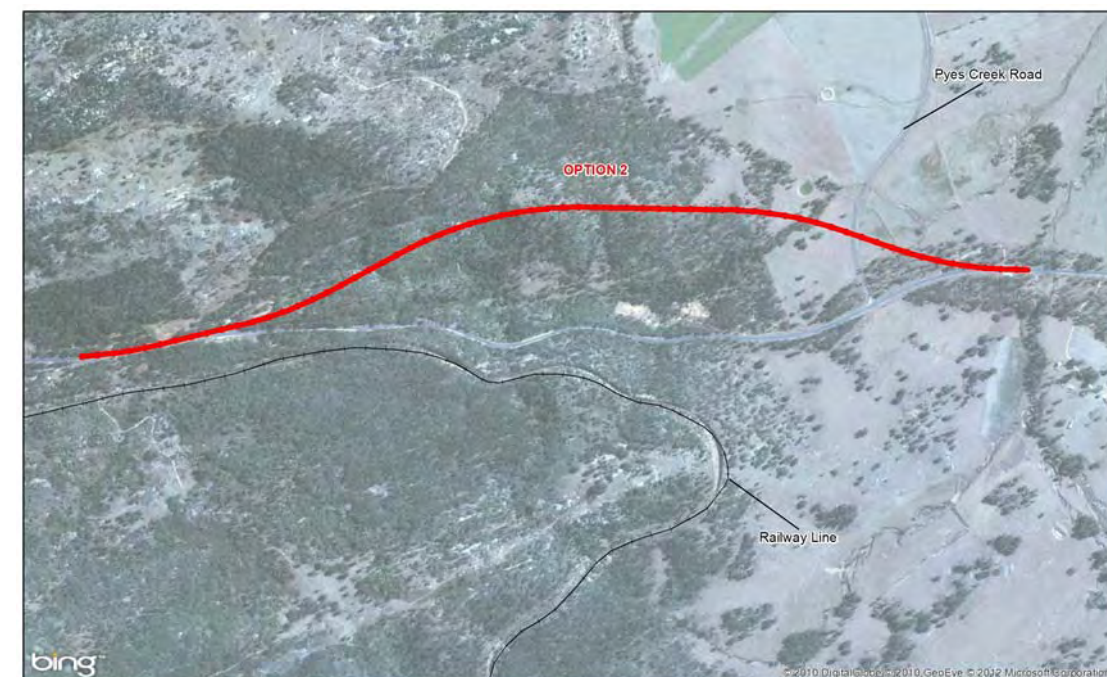
Option 2 is similar to Option 1 but with an attempt to reduce the amount of hard rock excavation required and the overall route length.

Workshop outcomes

Option 2 scored poorly for constructability due to the long and deep cutting in very hard rock. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the high cost. Option 2 also scored poorly against the environmental objectives. The deep cut and high fills leave a large footprint and would have a considerable impact on flora and fauna and create a significant visual impact, although the impacts are not as significant as in Option 1.

Overall Option 2 did not score well against the objectives. However, as the workshop participants agreed that Options 3 and 4 were variations of Options 10 and 6 respectively (these variations can be explored during refinement of the shortlisted options during the preliminary concept design stage of the project), the overall ranking of Option 2 was enough for the option to be investigated in the next stage of design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work Health and safety in construction and maintenance. 	5	<ul style="list-style-type: none"> Road safety will be improved with the vertical and horizontal alignment to improved geometry standards Scores poorly for constructability and work health and safety in construction and maintenance due to the long and deep cutting in very hard rock.
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	5 (equal)	<ul style="list-style-type: none"> Although the alignment has conforming horizontal and vertical geometry, scores poorly in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	6	<ul style="list-style-type: none"> Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route would still require removal of some vegetation Scores well for non-Aboriginal impacts as it avoids most of the sensitive areas, only a small portion in Bolivia Station would be affected by the route Scores poorly for Aboriginal heritage as the route passes through areas of high and moderate Aboriginal heritage sensitivity Scores poorly in relation to surface water quality due to interference with existing floodplain and creek realignment Significant interference due to two proposed creek crossings results in a poor score for flooding and drainage Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the large cutting that would need to be transported away from site Scores poorly on visual impact with a large footprint due to the large cuts and fills.
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios NPV over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance). Comparative project costs. 	3 (equal)	<ul style="list-style-type: none"> Cost \$316 M \$187 M more than lowest cost option, mainly due to the large quantity of cut through hard rock Ranked equal third on cost.

Option 3

Option 3 achieves the best geometric outcomes as it is the most direct with minimal horizontal direction change; this requires, however, a major bridge/viaduct.

Workshop outcomes

Option 3 scored well for constructability due to minimal cutting in very hard rock. Option 3 scored reasonably well against the environmental objectives due to its smaller footprint having a smaller impact on flora and fauna. The cost of the option was large due to the requirement for a very long bridge/viaduct required to minimise the impact on the creek to the west of the existing highway.

Overall Option 3 scored well against the majority of the objectives, however, workshop participants considered the alignment to be similar to Option 10. Option 3 was therefore considered as a variation to Option 10 (which had a better overall ranking than Option 3).

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work Health and safety in construction and maintenance. 	1 (equal)	<ul style="list-style-type: none"> Road safety will be improved with the vertical and horizontal alignment to improved geometry standards Acceptable score for constructability and work health and safety in construction and maintenance due to no major cut in hard rock.
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	1 (equal)	<ul style="list-style-type: none"> The alignment has conforming horizontal and vertical geometry. Scores higher than other conforming alignments with minimum radius curves.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	3	<ul style="list-style-type: none"> Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route will still require removal of some vegetation Scores well for non-Aboriginal impacts as it avoids most of the sensitive areas, only a small portion in Bolivia Station would be affected by the route Scores poorly for Aboriginal heritage as the route passes through a large area of high Aboriginal sensitivity along the 100yr ARI floodline A large viaduct/bridge is proposed which may minimise the creek realignment required The proposed viaduct results in a poor score for flooding and drainage due to the potential for piers and foundations which may impact on existing hydrology Scores well for recycling of waste material as the rock cut can be used in fill on site.
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios NPV over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance). Comparative project costs. 	6 (equal)	<ul style="list-style-type: none"> Cost \$445 M \$216 M more than lowest cost option mainly due to the very long bridge/viaduct Ranked equal sixth on cost.

Option 4

Option 4 aims to keep the alignment as close the existing highway alignment as possible while achieving conforming horizontal and vertical alignments.

Workshop outcomes

Option 4 scored well for constructability due to minimal cutting in very hard rock. Option 4 scored reasonably well against the environmental objectives due to its smaller footprint having a smaller impact on flora and fauna. The cost of the option was large due to the requirement for a very long bridge/viaduct required to minimise the impact on the creek to the west of the existing highway.

Overall Option 4 scored well against the majority of the objectives, however, workshop participants considered the alignment to be similar to Option 6. Option 4 was therefore considered as a variation to Option 6 (which had a better overall ranking than Option 4).

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work Health and safety in construction and maintenance. 	1 (equal)	<ul style="list-style-type: none"> Road safety would be improved with the vertical and horizontal alignment to improved geometry standards Acceptable score for constructability and work health and safety in construction and maintenance due to no major cut in hard rock.
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	1 (equal)	<ul style="list-style-type: none"> The alignment has conforming horizontal and vertical geometry. Scores higher than other conforming alignments with minimum radius curves.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	4	<ul style="list-style-type: none"> Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route would still require removal of some vegetation Scores well for non-Aboriginal impacts as it avoids most of the sensitive areas, only a small portion in Bolivia Station would be affected by the route Scores poorly for Aboriginal heritage as the route passes through a large area of high Aboriginal sensitivity along the 100yr ARI floodline A large viaduct/bridge is proposed which may minimise the creek realignment required and interference with the floodplain The proposed viaduct, while shorter than Option 3, would result in a poor score for flooding and drainage due to the potential for piers and foundations to impact on existing hydrology.
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios NPV over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance). Comparative project costs. 	6 (equal)	<ul style="list-style-type: none"> Cost \$430 M \$301 M more than lowest cost option due to the major bridge/viaduct. Ranked equal sixth on cost.

Option 5a

Option 5a is an eastern option that requires a tunnel underneath Bolivia Hill Nature Reserve that would ensure no disturbance to the nature reserve and the Main Northern Railway line.

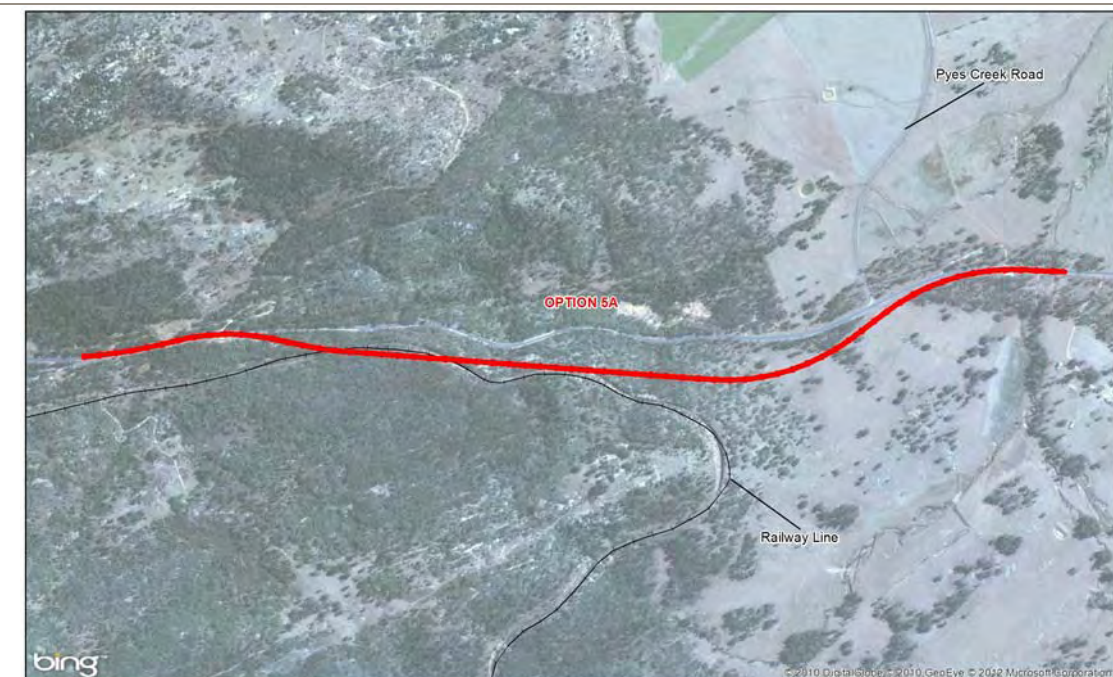
Workshop outcomes

Option 5a scored poorly for constructability due to tunnelling required in very hard rock. Tunnelling has additional design, safety and maintenance requirements that are technically challenging in this terrain. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the cost.

Option 5a scores poorly against the environmental objectives due to the large amount of rock excavated from the tunnel that would need to be transported away from site. Tunnelling also requires a large amount of water and therefore tunnelling activities may impact on surface water quality due to the requirement for extensive wastewater ponds.

Overall, Option 5a scored poorly against the majority of the objectives and was not shortlisted to be taken forward for further investigation and design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work Health and safety in construction and maintenance. 	6 (equal)	<ul style="list-style-type: none"> Road safety would be improved with the vertical and horizontal alignment to improved geometry standards Scores poorly for constructability and work health and safety in construction and maintenance due to tunnelling in hard rock.
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	5 (equal)	<ul style="list-style-type: none"> Although the alignment has conforming horizontal and vertical geometry, scores poorly in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	9 (equal)	<ul style="list-style-type: none"> Scores poorly for impacts to flora and fauna as the route passes through the Bolivia Hill Nature Reserve Scores poorly for impacts to non-Aboriginal heritage as the route passes through a large area of highly sensitive heritage land Scores well for Aboriginal heritage as it avoids highly sensitive land and only impacts a small portion of moderate sensitivity Scores well in regard to surface water quality as it avoids the existing hydrology constraints, however construction activities may impact on surface water quality Scores well as this option avoids the existing watercourse Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the tunnel that would need to be transported away from site.
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios NPV over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance). Comparative project costs. 	3 (equal)	<ul style="list-style-type: none"> Cost \$374 M \$245 M more than lowest cost option due to the very high cost of tunnelling through hard rock Ranked equal third on cost.

Option 5b

Option 5b is a variant to Option 5a but uses steeper grades, which increases the length of the tunnel under the Bolivia Hill Nature Reserve, but reduces the overall route length to connect into the existing highway prior to Pyes Creek Road, limiting the intersection works required.

Workshop outcomes

Option 5b scored poorly for constructability due to tunnelling required in very hard rock. Tunnelling has additional design, safety and maintenance requirements that are technically challenging in this terrain. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the cost.

Option 5b scores poorly against the environmental objectives due to the large amount of rock excavated from the tunnel that would need to be transported away from site. Tunnelling also requires a large amount of water and therefore tunnelling activities may impact on surface water quality due to the requirement for extensive wastewater ponds.

Overall, Option 5b scored poorly against the majority of the objectives and was not shortlisted to be taken forward for further investigation and design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work Health and safety in construction and maintenance. 	6 (equal)	<ul style="list-style-type: none"> Road safety would be improved with the vertical and horizontal alignment to improved geometry standards Scores poorly for constructability and work health and safety in construction and maintenance due to tunnelling in hard rock.
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	1 (equal)	<ul style="list-style-type: none"> The alignment has conforming horizontal and vertical geometry. Scores higher than other conforming alignments with minimum radius curves.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	9 (equal)	<ul style="list-style-type: none"> Scores poorly for impacts to flora and fauna as the route passes through the Bolivia Hill Nature Reserve Scores poorly for impacts to non-Aboriginal heritage as the route passes through a large area of highly sensitive heritage land Scores well for Aboriginal heritage as it avoids highly sensitive land and only impacts a small portion of moderate sensitivity Scores well in regard to surface water quality as it avoids the existing hydrology constraints however construction activities may impact on surface water quality Scores well as this option avoids the existing watercourse Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the tunnel that would need to be transported away from site.
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios NPV over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance) Comparative project costs. 	8 (equal)	<ul style="list-style-type: none"> Cost \$693 M \$564 M more than lowest cost option due to the very high cost of tunnelling through hard rock Cost is considered excessive.

Option 6

Option 6 is a variant of Option 4. It also has confirming horizontal and vertical alignments, but presents a shorter route length and connects prior to Pyes Creek Road due to the alignment being further offline at the southern end.

Workshop outcomes

Option 6 scored well for constructability due to minimal cutting in very hard rock. Option 6 also scored well against the environmental objectives due to its smaller footprint having a smaller impact on flora and fauna. Although the option requires a long bridge/viaduct to minimise the impact on the creek to the west of the existing highway, it is shorter than some other options and the overall cost of the option is therefore reduced.

Overall, Option 6 scored well against the majority of the objectives and the workshop participants considered that it should be investigated in the next stage of design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work Health and safety in construction and maintenance. 	1 (equal)	<ul style="list-style-type: none"> Road safety will be improved with the vertical and horizontal alignment to improved geometry standards Acceptable score for constructability and work health and safety in construction and maintenance due to no major cut in hard rock.
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	5 (equal)	<ul style="list-style-type: none"> Although the alignment has conforming horizontal and vertical geometry, scores poorly in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	2	<ul style="list-style-type: none"> Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route will still require removal of some vegetation Scores high for non-Aboriginal heritage as it avoids all areas of sensitivity Scores poorly for Aboriginal heritage as the route passes through a large area of high Aboriginal sensitivity along the 100yr ARI floodline (but less of an impact than Option 3) A large viaduct/bridge is proposed which may minimise the creek realignment for the main watercourse and interference with the floodplain The proposed viaduct, while shorter than Option 3, would result in a poor score for flooding and drainage due to the potential for numerous piers and foundations to impact on existing hydrology and minor watercourse realignment Scores well for recycling of waste material as the rock cut can be used in fill on site.
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios NPV over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance). Comparative project costs. 	2	<ul style="list-style-type: none"> Cost \$278 M \$149 M more than lowest cost option, mainly due to the major bridge/viaduct.

Option 7

Option 7 is considered an upgrade to the existing highway, utilising as much of the existing pavement as possible. While it achieves a conforming horizontal alignment it has a non-conforming vertical alignment.

Workshop outcomes

Option 7 scores poorly against other options on constructability and work health and safety in construction and maintenance as the majority of the length will be constructed under traffic control next to existing highway traffic. It also ranks last against the objective of improving road transport productivity efficiency and reliability of travel due to the 9% grade compared to 6% maximum of the other options. Option 7 does, however, score well against the environmental objectives, with a small area of disturbance of flora and fauna. Option 7 ranks as the lowest cost option, being \$149 M less than the next lowest cost option.

Although Option 7 did not fully comply with the design criteria (in that it the vertical alignment exceeded 6% slope), participants agreed that it should not be eliminated from the assessment as:

- Minor upgrade of the existing alignment should be an option for consideration
- Upgrading of the existing alignment was suggested by many community stakeholders.

Overall, Option 7 scored well and the workshop participants considered that it should be investigated in the next stage of design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	<ul style="list-style-type: none"> • Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance. 	11	<ul style="list-style-type: none"> • Although not unsafe, ranks last against improved geometry standard due to the vertical geometry containing a 9% grade where all other options have a conforming 6% maximum grade • Scores poorly against other options on constructability and work health and safety in construction and maintenance as the majority of the length will be constructed under traffic control next to highway traffic
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> • Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity. 	11	<ul style="list-style-type: none"> • Ranks last due to the 9% grade compared to 6% maximum of the other options.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> • Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity. 	1	<ul style="list-style-type: none"> • Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route will still require removal of some vegetation • Scores well for non-Aboriginal heritage as it avoids most areas of sensitivity (small impact in a small area along the rail line) • Scores poorly for Aboriginal heritage as the route passes through a large area of high Aboriginal sensitivity along the 100yr ARI floodline (but less of an impact than Option 3) • Scores poorly in relation to surface water quality due to interference with minor tributaries and resulting realignment required • Significant interference due to two proposed culvert crossings and large viaduct/bridge required results in a poor score for flooding and drainage • Scores well for recycling of waste material as the rock cut can be used in fill on site.
Provide value for money	<ul style="list-style-type: none"> • Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance). • Comparative project costs. 	1	<ul style="list-style-type: none"> • Cost \$129 M • Lowest cost option.

Option 8

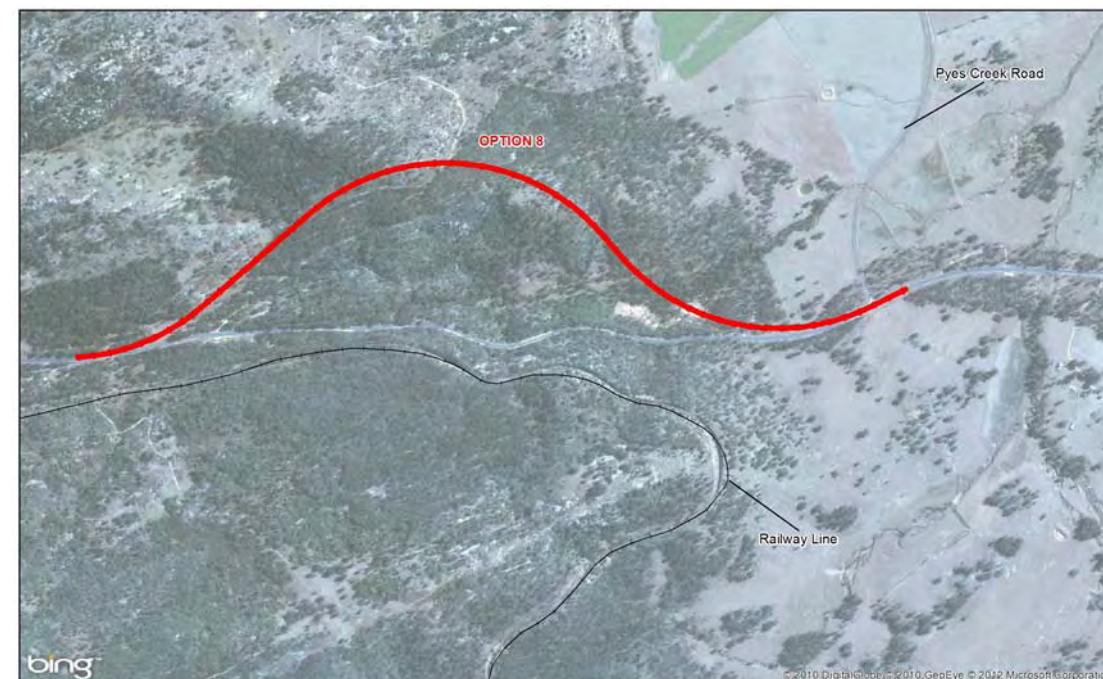
Option 8 is a shorter variant of Options 1 and 2, it connects into the existing highway alignment prior to Pyes Creek Road.

Workshop outcomes

Option 8 scored poorly for constructability due to the long and deep cutting in very hard rock. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the high cost. Option 8 also scored poorly against the environmental objectives. The deep cut and high fills leave a very large footprint and have a considerable impact on flora and fauna and create a significant visual impact. The cut would also require a large amount of rock to be transported away from site.

Overall, Option 8 scored very poorly against all the objectives and was not shortlisted to be taken forward for further investigation and design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work Health and safety in construction and maintenance. 	6 (equal)	<ul style="list-style-type: none"> Road safety will be improved with the vertical and horizontal alignment to improved geometry standards Scores poorly for constructability and work health and safety in construction and maintenance due to the long and deep cutting in very hard rock.
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	5 (equal)	<ul style="list-style-type: none"> Although the alignment has conforming horizontal and vertical geometry, scores poorly in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	7 (equal)	<ul style="list-style-type: none"> Scores poorly on impact on flora and fauna habitat due to the long, deep cut that leaves a very large footprint Scores well for non-Aboriginal heritage as it avoids all areas of sensitivity Scores poorly for Aboriginal heritage as the route passes through large areas of high and moderate Aboriginal heritage sensitivity Scores poorly in relation to surface water quality due to significant interference with existing watercourse alignment Significant interference on flooding and drainage due to realignment and large bridge required over floodplain Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the large cutting that would need to be transported away from site Scores poorly on visual impact with a large footprint due to the large cuts and fills.
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios NPV over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance) Comparative project costs. 	8 (equal)	<ul style="list-style-type: none"> Cost \$1,073 M \$944 M more than lowest cost option due to the excessive amount of cut through hard rock Cost is considered excessive.

Option 9

Option 9 is a variant of Option 5 with a significantly longer tunnel under the Bolivia Hill Nature Reserve; this eliminates the requirement for bridge structures at the northern tunnel portal.

Workshop outcomes

Option 9 scored poorly for constructability due to tunnelling required in very hard rock. Tunnelling has additional design, safety and maintenance requirements that are technically challenging in this terrain. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the very high cost.

Option 9 scores poorly against the environmental objectives due to the large amount of rock excavated from the tunnel that would need to be transported away from site. Tunnelling also requires a large amount of water and therefore tunnelling activities may impact on surface water quality due to the requirement for extensive wastewater ponds.

Overall, Option 9 scored poorly against the majority of the objectives and was not shortlisted to be taken forward for further investigation and design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work Health and safety in construction and maintenance. 	6 (equal)	<ul style="list-style-type: none"> Road safety would be improved with the vertical and horizontal alignment to improved geometry standards Scores poorly for constructability and work health and safety in construction and maintenance due to tunnelling in hard rock.
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	1 (equal)	<ul style="list-style-type: none"> The alignment has conforming horizontal and vertical geometry. Scores higher than other conforming alignments with minimum radius curves.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	7 (equal)	<ul style="list-style-type: none"> Scores poorly for impacts to flora and fauna as the route passes through the Bolivia Hill Nature Reserve Scores well for non-Aboriginal heritage as it avoids most areas of sensitivity (small impact in a small area along the rail line) Scores well for Aboriginal heritage as it avoids highly sensitive land and only impacts a small portion of moderate sensitivity Scores well in regard to surface water quality as it avoids the existing hydrology constraints, however construction activities may impact on surface water quality Scores well as this option avoids the existing watercourse Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the tunnel that would need to be transported away from site.
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios NPV over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance) Comparative project costs. 	8 (equal)	<ul style="list-style-type: none"> Cost \$890 M \$761 M more than lowest cost option due to the very high cost of tunnelling through hard rock Cost is considered excessive.

Option 10

Option 10 is a variant to Option 3 where it attempts to follow the ridgeline to the west of the existing highway while trying to avoid impact to the creek, and also considerably reducing the overall length of bridge required.

Workshop outcomes

Option 10 has an acceptable score for constructability due to a shallower cutting in very hard rock compared to other options with large cuts. Option 10 scored reasonably well against the environmental objectives due to its smaller footprint having a smaller impact on flora and fauna. The cost of the option was large due to the requirement for a very long bridge/viaduct required to minimise the impact on the creek to the west of the existing highway.

Overall, Option 10 scored well against the majority of the objectives and the workshop participants considered that it should be investigated in the next stage of design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	<ul style="list-style-type: none"> Reduced crash rate and injuries Improved road safety standards – improved geometry standard Minimise conflict points on the highway (intersections) Constructability Work Health and safety in construction and maintenance. 	1 (equal)	<ul style="list-style-type: none"> Road safety would be improved with the vertical and horizontal alignment to improved geometry standards Acceptable score for constructability and work health and safety in construction and maintenance due to no major cut in hard rock.
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none"> Reduced road freight user costs Reduced travel time Target a route level of service of A Increase road network capacity. 	5 (equal)	<ul style="list-style-type: none"> Although the alignment has conforming horizontal and vertical geometry, scores poorly in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none"> Impact on fauna habitat including threatened species Impact on flora including threatened species Water quality Air quality Noise and vibration impact Aboriginal and non-Aboriginal heritage Stormwater and drainage Residential and commercial properties impacted Ecological sustainability Visual impact and amenity. 	5	<ul style="list-style-type: none"> Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route would still require removal of some vegetation Scores well for non-Aboriginal impacts as it avoids most of the sensitive areas, only a small portion in Bolivia Station would be affected by the route Scores poorly for Aboriginal heritage as the route passes through a large area of high Aboriginal sensitivity along the 100yr ARI floodline Scores poorly in relation to surface water quality due to interference with existing creek alignment and floodplain The proposed viaduct results in a poor score for flooding and drainage due to the potential for piers and foundations to impact on existing hydrology Scores well for recycling of waste material as the rock cut can be used in fill on site.
Provide value for money	<ul style="list-style-type: none"> Cost benefit ratios NPV over 30 years Road user costs and benefits Infrastructure operating costs (including maintenance) Comparative project costs. 	3 (equal)	<ul style="list-style-type: none"> Cost \$362 M \$233 M more than lowest cost option mainly due to the major bridge/viaduct.

Table 7-3 Summary of initial assessment of list of options against project objectives and assessment criteria

Project Objectives	Critical Criteria*1	Description of criteria that can be assessed	1	2	3	4	5a	5b	6	7	8	9	10	
Improve road safety	<ul style="list-style-type: none">Reduced crash rate and injuriesImproved road safety standards – improved geometry standardMinimise conflict points on the highway (intersections)ConstructabilityWork health and safety in construction and maintenance.	<ul style="list-style-type: none">Provide for an overtaking lane for southbound traffic and possibly a dual lane carriageway separated by wire rope.	4	4	4	4	4	4	4	3	4	4	4	
		<ul style="list-style-type: none">Provide an alignment that minimises problems in construction.	1	2	3	3	1	1	3	1	1	1	3	
		<ul style="list-style-type: none">Maintain at least one lane of the highway open during construction of the upgrade.	4	4	4	4	4	4	4	3	4	4	4	
		<ul style="list-style-type: none">Minimise work health and safety risk in construction and maintenance.	2	3	3	3	2	2	3	1	2	2	3	
		Total for road safety		11	13	14	14	11	11	14	8	11	11	14
Improve road transport productivity efficiency and reliability of travel	<ul style="list-style-type: none">Reduced road freight user costsReduced travel timeTarget a route level of service of AIncrease road network capacity.	<ul style="list-style-type: none">Provide appropriate horizontal and vertical road geometry.	2	2	2	3	2	3	2	1	2	3	3	
		Total for road transport productivity		2	2	2	3	2	3	2	1	2	3	3
Minimise the impact on the natural, cultural and built environment	<ul style="list-style-type: none">Impact on fauna habitat including threatened speciesImpact on flora including threatened speciesWater qualityAir qualityNoise and vibration impactAboriginal and non-Aboriginal heritageStormwater and drainageResidential and commercial properties impactedEcological sustainabilityVisual impact and amenity.	<ul style="list-style-type: none">Minimise adverse impacts on native vegetation.	2	3	3	3	1	1	3	3	2	1	3	
		<ul style="list-style-type: none">Minimise adverse impacts on sensitive habitats.	2	3	3	3	1	1	3	3	2	1	3	
		<ul style="list-style-type: none">Minimise adverse impacts on surface water quality.	2	2	3	3	3	3	3	3	2	3	2	
		<ul style="list-style-type: none">Minimise adverse impacts on flooding and drainage.	2	2	2	3	3	3	2	3	2	3	2	
		<ul style="list-style-type: none">Minimise adverse impacts on known non-Aboriginal heritage sites, values and areas of archaeological potential.	2	2	1	2	4	4	3	3	2	4	1	
		<ul style="list-style-type: none">Minimise adverse impacts on known Aboriginal heritage sites, values and areas of archaeological potential.	3	3	3	3	2	2	4	3	4	3	3	
		<ul style="list-style-type: none">Potential to use recycled or waste materials.	1	1	4	2	1	1	3	4	1	1	3	
		Total for environment		14	16	19	19	15	15	21	22	15	16	17
		Provide value for money	<ul style="list-style-type: none">Cost benefit ratiosNPV over 30 yearsRoad user costs and benefitsInfrastructure operating costs (including maintenance)Comparative project costs.	<ul style="list-style-type: none">Minimise project cost.	0	2	1	1	2	0	3	4	0	0
Total for value for money				0	2	1	1	2	0	3	4	0	0	2
Combined Score			27	33	36	37	30	29	40	35	28	30	36	

7.5 Phase 4: Conclusion and next steps

7.5.1 Ranking of options

Table 7-4 and **Table 7-5** are derived from **Table 7-3** and present a summary of the workshop process findings. The first category of routes taken forward to the next stage comprises the routes that best meet the objectives of the project. Routes not taken forward comprise those routes that performed poorly on balance in relation to meeting the project objectives.

Table 7-4 Shortlist of routes

Shortlist of routes	Combined score	Comment
Option 6 (Option 4)	40 (37)	Option 4 considered a variation to Option 6
Option 10 (Option 3)	36 (36)	Option 3 considered a variation to Option 10
Option 7	35	-
Option 2	33	-

Table 7-5 Routes not taken forward

Routes not taken forward	Combined score
Option 1	27
Option 5a	30
Option 5b	29
Option 8	28
Option 9	30

The shortlisted route options in **Table 7-4** were taken forward with some modifications (refer to **Section 7.5.3**) for further analyses and subsequent consideration as the preferred route. These routes are shown in **Figure 7-13** and described in **Chapter 8**.

7.5.2 Assessment of community options

The community options were assessed as follows:

- An alignment to the western side of the study area. This alignment is similar to Option 1 and will therefore not be taken forward
- An alignment to the east of the existing highway along the existing railway alignment. This alignment is similar to Options 5a and 5b and will therefore not be taken forward
- An alignment to the east of the existing highway through Bolivia Hill Nature Reserve. This alignment is similar to Option 9 and will therefore not be taken forward
- The option of adopting the current alignment for uphill (southbound) lanes and a new alignment to the west of the existing alignment for a downhill (northbound) lane was considered. The workshop reached the conclusion that the cost effective solution is to either upgrade the existing alignment to cater for all traffic (such as Option 7 which has been shortlisted to be taken forward) **or** to build a new alignment to cater for all traffic (such as Option 6 or 10 which have also been shortlisted to be taken forward). The combined option will therefore not be taken forward
- An upgrade of the existing alignment (widening). This alignment is similar to Option 7 and will therefore be subject to further analyses and subsequent consideration as the preferred route.

7.5.3 **Review of design criteria**

Following agreement on the ranking of options, workshop participants expressed concern at the high cost of the shortlisted options.

Participants agreed that consideration should be given to varying some of the design criteria set out by the Roads and Maritime document *Network Performance Measures and Network Planning Targets, July 2010*, to make any upgrade route more consistent with the usage of the topography. The following conclusions were reached:

- Costs would be substantially reduced if a steeper vertical alignment was adopted – say 7-8 per cent. This would lower the grade line resulting in substantially shorter bridges, smaller retaining walls and smaller fills
- This project should be related to similar projects such as Devils Pinch on the New England Highway south of Glen Innes to refine the criteria and obtain approval from the federal government.

Approval to revised design criteria was obtained from Roads and Maritime internal experts subsequent to the workshop. The revised criteria are detailed in **Section 6.1.1**.

The traffic study (**Section 2.3.1** and **Appendix A**) established that there is no warrant for a northbound overtaking lane at Bolivia Hill based on the requirements of the *Network Performance Measures and Network Planning Targets, July 2010*. The workshop group agreed that further development of the shortlisted options should therefore be based on a three-lane cross section.

Costs would therefore be reduced from those reported for the options in **Section 7.2** when the revised design criteria are applied and a three-lane cross section is adopted. The revised costs are provided in **Chapter 8**.

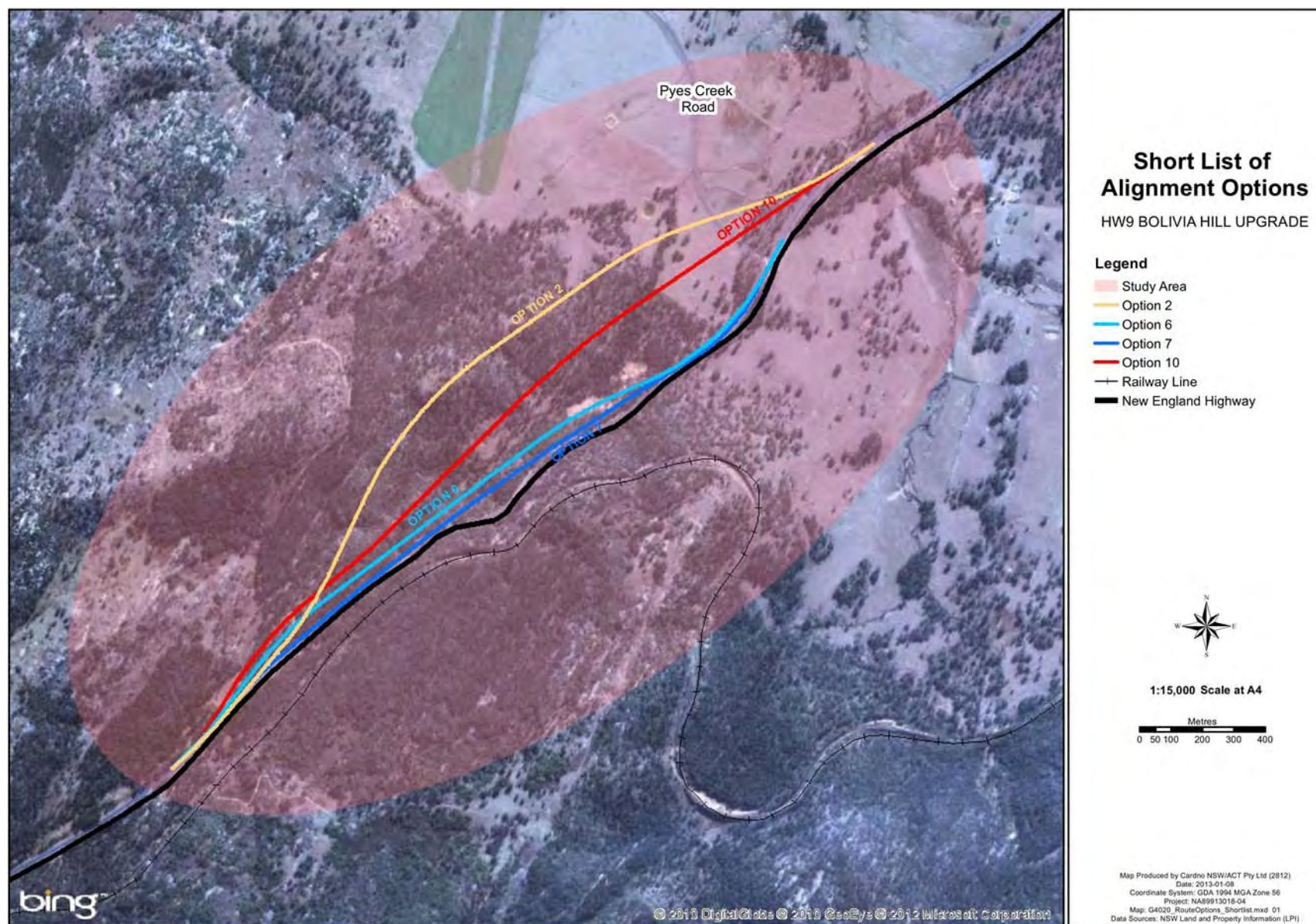


Figure 7-13 Shortlist of route options

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8 Description of shortlisted route options

8.1 Overview

Options 6, 10, 7 and 2 (in descending order of ranking) were revised in line with the recommendations of the Internal Technical Workshop (**Section 7.4**). The revised designs:

- Are in accordance with the revised design criteria detailed in **Section 6.1.1**
- Have a three-lane cross section consisting of one northbound (downhill) lane and two southbound (uphill) lanes.

Estimated costs for each of the revised options were assessed.

8.2 Option 6

Option 6 has conforming horizontal and vertical alignments and connects to the existing highway prior to Pyes Creek Road.

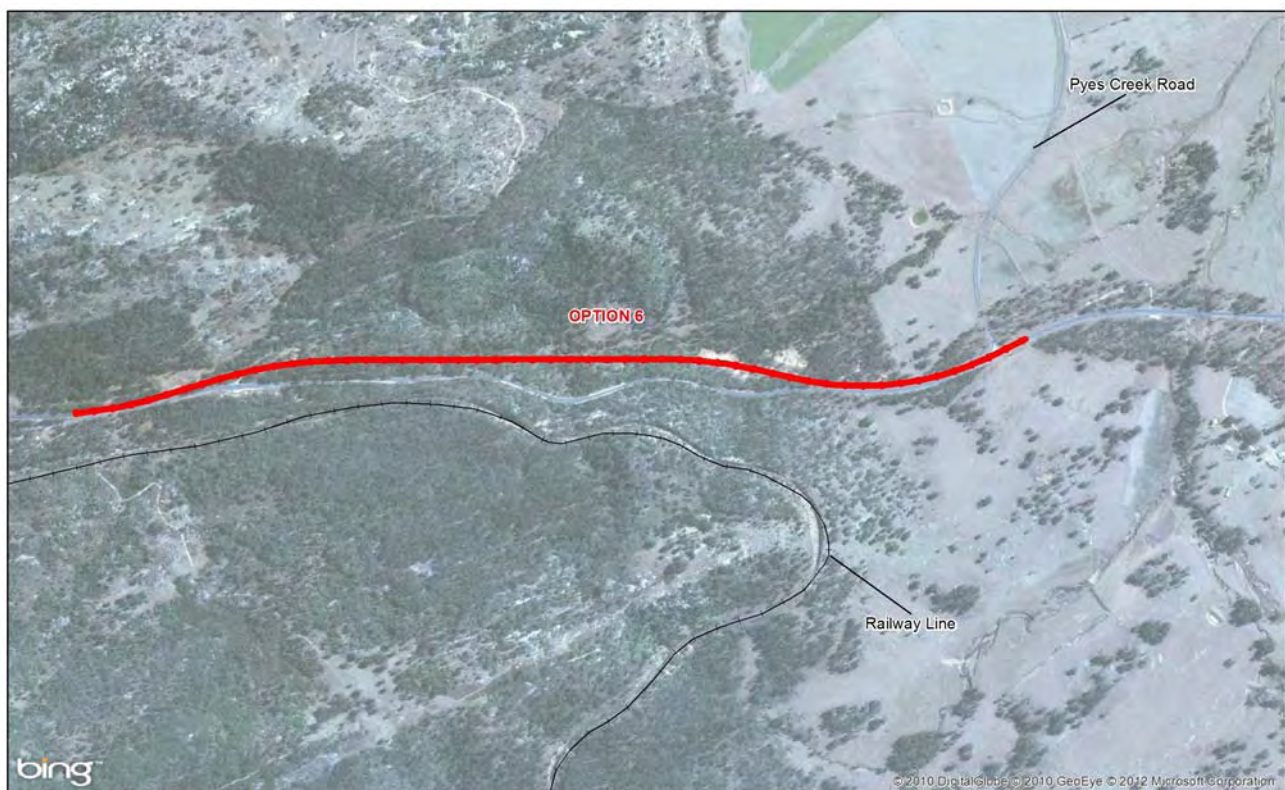


Figure 8-1 Revised Option 6

Key features of this revised option are:

- Option 6 is 2610 metres long
- The option has a maximum conforming vertical grade of eight per cent
- The first 300 metres (from the southern project boundary) consists of minor cut and fill
- The next 600 metres goes into cut up to 23 metres deep
- The alignment then follows the eastern side of the gully to the west of the highway in fill for 300 metres, including a retaining wall up to 12 metres high. A major bridge up to 350 metres long is then required to keep the roadway out of the creek line

- From the end of the bridge, fill up to 15 metres high tapers back to the existing highway over approximately 550 metres, including a retaining wall up to 15 metres high. The last 510 metres to just past the Pyes Creek Road intersection is an upgrade of the existing highway
- Estimated cost \$123 million (\$2013).

In summary, the major differences between the original and revised option are as follows:

Table 8-1 Original vs revised Option 6

Original Option 6	Revised Option 6
2850 metres long	Reduced to 2610 metres long
Two northbound (downhill) lanes and two southbound (uphill) lanes	One northbound (downhill) lane and two southbound (uphill) lanes
Vertical grade of 6 per cent	Increased to 8 per cent
Major cut up to 25 metres deep	Reduced to 23 metres deep
Major bridge up to 1000 metres long	Reduced to 350 metres long
Estimated cost \$278 million	Reduced to \$123 million

8.3 Option 10

Option 10 attempts to follow the ridgeline to the west of the existing highway while trying to avoid impact to the creek.

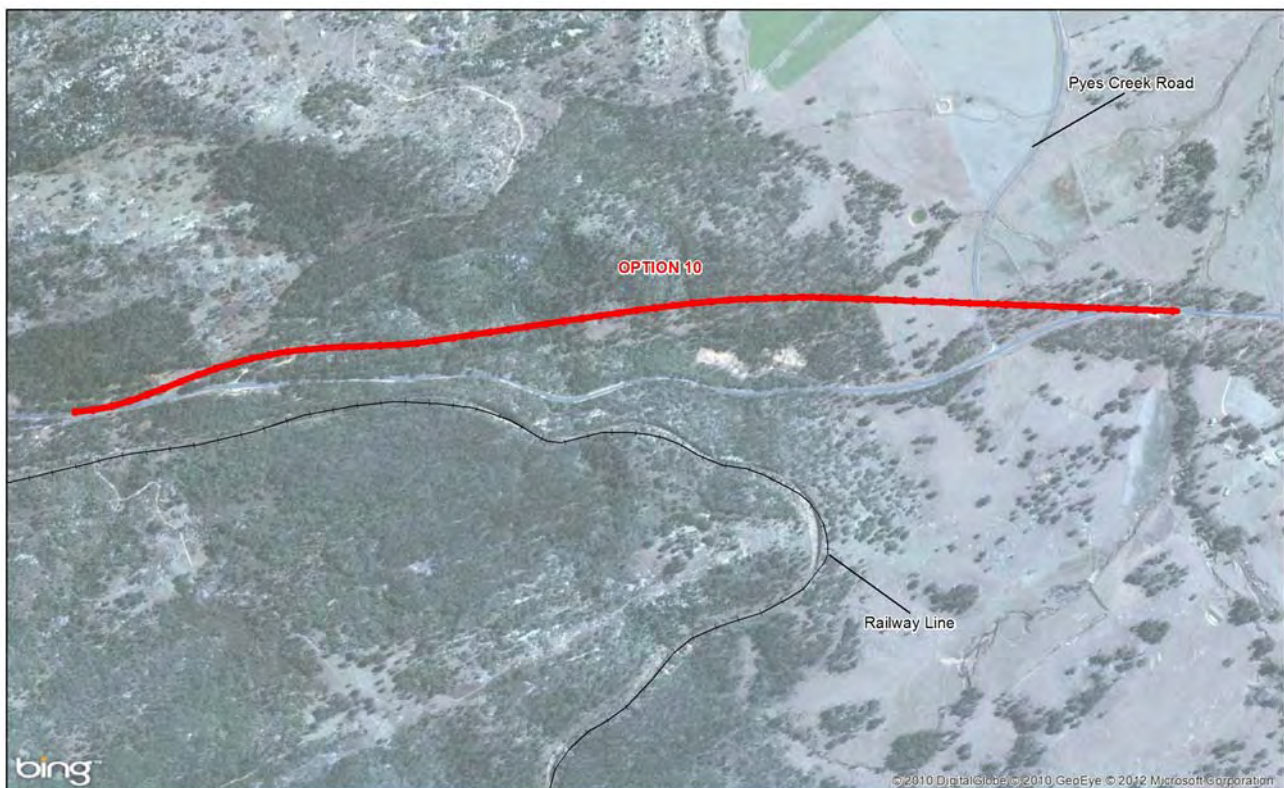


Figure 8-2 Revised Option 10

Key features of this revised option are:

- Option 10 is 3015 metres long

- The option has a maximum conforming vertical grade of eight per cent
- The first 350 metres (from the southern project boundary) is in minor cut and fill
- The alignment then moves into extensive cut 800 metres long and up to 32 metres deep
- The alignment then moves into fill for 150 metres supported by a retaining wall up to 18 metres high to keep the fill out of the creek line
- A major bridge up to 190 metres long is then required to keep the road out of the creek line
- The alignment then moves into fill for 600 metres with a retaining wall up to 15 metres high for 200 metres of the length to keep the road out of the creek line
- A bridge up to 90 metres long will be required across the watercourse to the west of the existing highway
- The alignment then moves into fill for 720 metres
- The last 160 metres is an upgrade of the existing highway
- Estimated cost \$157 million (\$2013).

In summary, the major differences between the original and revised option are as follows:

Table 8-2 Original vs revised Option 10

Original Option 10	Revised Option 10
2950 metres long	Increased to 3015 metres long
Two northbound (downhill) lanes and two southbound (uphill) lanes	One northbound (downhill) lane and two southbound (uphill) lanes
Vertical grade of 6 per cent	Increased to 8 per cent
Major cut up to 25 metres deep	Increased to 32 metres deep
Major bridge up to 900 metres long	Reduced to 190 metres long
Bridge 150 metres long	Reduced to 90 metres long
Estimated cost \$362 million	Reduced to \$157 million

8.4 Option 7

Option 7 is considered an upgrade to the existing highway, utilising as much of the existing pavement as possible. While it achieves a conforming horizontal alignment, it has a non-conforming vertical alignment.



Figure 8-3 Revised Option 7

Key features of this revised option are:

- Option 7 is 2350 metres long. Note that this is 400 metres longer than Option 7 described previously. The previous option was developed to demonstrate a minimalist treatment of straightening out the bends in the steepest part of the highway and joined back into the existing highway on the southern end as soon as possible. For this revised version, the existing highway is upgraded to three lanes from the start of the project area (at the southern end)
- The first 650 metres (from the southern project boundary) is an upgrade of the existing highway in minor cut and fill
- The next 390 metres is an upgrade of the existing highway requiring a retaining wall on the western side up to 10 metres high to keep the fill out of the creek line to the west of the highway
- A major bridge up to 330 metres long will then be required to keep the road out of the creek line
- From the northern abutment at about 12 metres high, a retaining wall 200 metres long is required to keep the road out of the creek line
- The alignment then moves into fill which tapers back 550 metres to the existing highway
- The final 255 metres to the Pyes Creek Road intersection is an upgrade of the existing highway
- Estimated cost \$115 million (\$2013).

Table 8-3 Original vs revised Option 7

Original Option 7	Revised Option 7
1950 metres long	Increased to 2350 metres long

Original Option 7	Revised Option 7
Two northbound (downhill) lanes and two southbound (uphill) lanes	One northbound (downhill) lane and two southbound (uphill) lanes
Major bridge up to 550 metres long	Reduced to 330 metres long
Estimated cost \$129 million	Reduced to \$115 million

8.5 Option 2

Option 2 attempts, in part, to follow the former Cobb & Co road to the west of the existing alignment.



Figure 8-4 Revised Option 2

Key features of this revised option are:

- Option 2 is 3090 metres long
- The option has a maximum conforming vertical grade of eight per cent
- The first 400 metres (from the southern project boundary) is an upgrade of the existing highway in minor cut and fill
- The alignment moves into fill for 535 metres to a bridge 80 metres long over the watercourse in the gully to the west of the existing highway. The bridge has a retaining wall at the southern abutment up to 18 metres high
- The alignment moves into a major cut through the ridge at the western extent of the study area. The cut is 650 metres long and up to 28 metres deep. The majority of the cut is on the western side of the alignment into the ridgeline. On the eastern side of the alignment, a retaining wall 180 metres long and up to 12 metres high is required to retain the fill on a steep slope
- The alignment then moves into 655 metres of fill up to 10 metres high as it grades down to the Brickyard Creek floodplain. A bridge up to 100 metres long will be required across the watercourse to the west of

the existing highway just south of Pyes Creek Road with a retaining wall at the southern abutment up to 10 metres high

- The fill continues for 670 metres over Pyes Creek Road and grades down with the last 190 metres being an upgrade of the existing highway
- Estimated cost \$150 million (\$2013).

In summary, the major differences between the original and revised option are as follows:

Table 8-4 Original vs revised Option 2

Original Option 2	Revised Option 2
3200 metres long	Reduced to 3090 metres long
Two northbound (downhill) lanes and two southbound (uphill) lanes	One northbound (downhill) lane and two southbound (uphill) lanes
Vertical grade of 6 per cent	Increased to 8 per cent
Bridge 150 metres long	Reduced to 80 metres long
Major cut up to 28 metres deep	Reduced to 25 metres deep
Major fill up to 20 metres high	Reduced to 10 metres high
Bridge 200 metres long	Reduced to 100 metres long
Estimated cost \$316 million	Reduced to \$150 million

8.6 Strategic concept design cost estimates for shortlisted options

8.6.1 Cost estimating approach

The construction costs for the options identified for the assessment of route options were compiled in accordance with the Roads and Maritime *Project Estimating Manual*, version 2.0 (31 March 2008). Project cost estimates are divided as per the Manual into the following six categories:

Category	Includes
Project development	The current route selection and concept design phase
Investigation and design	The detailed design and documentation phases
Property acquisition	The cost to purchase land required for road reserve
Public utility adjustment	The relocation or protection of existing public utilities
Construction	<ul style="list-style-type: none"> • Earthworks • Drainage • Pavement • Bridges and structures • Tunnel works • Provision for traffic • Miscellaneous.
Handover	The effort and documentation required at the completion of the project to hand over completed assets to the responsible management and maintenance authority.

At this strategic stage of the project, cost estimates include an average contingency of approximately 60 per cent based on a risk assessment of project parameters. It should also be noted that there have been various design assumptions that have been highly influential on the strategic estimates and reflect the conservative approach to design and corridor identification to ensure a robust outcome that would be deliverable in the future. Further planning and review could potentially realise major cost savings when the design is detailed and progressed with improved refinement.

Some of the key assumptions that are likely to influence the initial cost estimate of the project include:

- Design speed assumptions
- Carriageway configuration
- Major infrastructure (eg length of bridges)
- Limited level of detail available at this stage to fully quantify the design/construction requirements
- Nominated areas for property acquisition based on limited design
- Contingency – expected to be high at this stage of the project given its current strategic nature.

8.6.2 Cost estimate

Table 8-5 represents the strategic cost estimates for each of the shortlisted options (in their revised form). As certainty with design detail, quantities, and rates improve, the proportion of contingency in the estimate will diminish. The reported preliminary concept design cost estimates therefore include a relatively large allowance for risk and unknowns.

Table 8-5 Cost estimates for shortlisted options

Options	Base Cost	Contingency (60%)	Total Cost
Option 2	\$94,000,000	\$56,000,000	\$150,000,000
Option 6	\$77,000,000	\$46,000,000	\$123,000,000
Option 7	\$72,000,000	\$43,000,000	\$115,000,000
Option 10	\$98,000,000	\$59,000,000	\$157,000,000

8.7 Economic appraisal of the shortlisted options

8.7.1 Introduction

By undertaking a cost benefit analysis, it is possible to compare the various route options and determine the most economically viable alternative. A high level economic analysis was undertaken for the purpose of providing input for the comparison of shortlisted route options.

For the purposes of the analysis, it was assumed that the works would commence in 2016. Without further detailed information on construction phasing, it was assumed that the works would be undertaken over a two year period, with the road becoming operational in 2018.

The appraisal models all cash flows over a 30 year period from completion of construction in 2018, at a (real) discount rate of 4.4 per cent per annum based on requirements for federally funded projects. All cash flows have been discounted to 2013. The discounted cash flows from the 'without project' case and each of the options were subsequently used in the calculation of the economic indicators. Two economic indicators were calculated as outputs of the economic appraisal to evaluate the relative attractiveness for each of the options:

Net Present Value: measures the difference between benefits and costs, whilst accounting for the timing of benefits and costs. Net cash flows are discounted at the prescribed discount rate of 4.4 per cent, reflecting the notion that future benefits and costs have less value compared to current benefits and costs. A project with a Net Present Value greater than zero would be considered desirable, with the project having the highest modelled Net Present Value being the most desirable.

Benefit Cost Ratio: measures the return received per dollar of costs. The Benefit Cost Ratio is calculated by dividing the present value of all benefits by the present value of all costs. A project with a Benefit Cost Ratio greater than one would be considered desirable, with the project having the highest Benefit Cost Ratio being most desirable.

The benefit-cost analysis findings are documented in **Appendix L**.

8.7.2 Economic appraisal results

The results of the economic appraisal for the shortlisted options are shown in **Table 8-6**.

Table 8-6 Summary of economic analysis of shortlisted options

	Option 2	Option 6	Option 7	Option 10
NPV* (\$ million)	-\$100.4	-\$75.5	-\$71.7	-\$105.8
BCR*	0.19	0.26	0.25	0.18

*NPV = Net Present Value

*BCR = Benefit Cost Ratio

None of the shortlisted options produces a positive economic return. A sensitivity analysis was not undertaken at this stage of the assessment process.

8.8 Review of shortlisted options

As the shortlisted options were each estimated to cost in excess of the anticipated funding available the Roads and Maritime Major Projects Review Committee (MPRC) requested the project team further investigate an optimised solution that provided greater value for money, while still meeting the other project objectives. The option should align with the objectives of the NSW Government's submission to the Australian Government by:

- realigning the small radius curves
- widening the shoulders to improve road safety.

The option was then to be presented to the MPRC for endorsement as the recommended preferred option.

Chapter 9 describes the development of the preferred option.

Note that at this stage, Option 2, the lowest ranked of the shortlisted options, was removed from the shortlist of options for further evaluation, to be replaced by the recommended preferred option.

9 Investigation of the preferred option

9.1 The preferred option

The main objective of the preferred option is to improve road safety. However, the option still needs to satisfy the remaining three objectives:

- Improve road transport productivity, efficiency and reliability of travel
- Minimise the impact on the natural, cultural and built environment
- Provide value for money.

9.2 Development of the preferred option

The development of the preferred option involved the following steps:

1. Agreement on the objectives of the preferred option (refer above).
2. A site inspection was held on 17 April 2013 attended by senior engineers, designers and safety experts from both Roads and Maritime and Cardno to assess the documented and potential safety problem locations.

Reference was made on site to detailed crash data (refer to **Section 2.3.1** and the Detailed Traffic Assessment Report in **Appendix A**). The tow away, injury and fatal crashes for the period March 2008 to February 2013 are shown in **Figure 9-1**.



Figure 9-1 Crash locations

The team agreed that, as a minimum, a road safety option must address the concentration of accidents that includes the three fatal accidents on the substandard bend on the steepest part of the route (refer to **Figure 9-1**).

3. A workshop was held in Tenterfield following the site inspection to develop solutions to the safety problems. The workshop explored options that would resolve the safety issues while retaining as

much of the existing alignment as possible. Relaxation of design criteria was discussed to help in reduction of costs. The horizontal alignment should achieve a design speed of 100 kilometres per hour, however, the vertical alignment could be reduced to 90 kilometres per hour to enable much of the existing vertical alignment to be retained.

All options would only require one lane in each direction as it had been previously established that there is no warrant for overtaking lanes (refer to **Section 7.5.3**).

4. Approval to revise design criteria was obtained from Roads and Maritime internal experts subsequent to the workshop. The revised criteria are detailed in **Section 6.1.1**.
5. A design was developed using the revised design criteria. This option was designated Option 7a as it is a sub-option of Option 7. A refinement of Option 7a was also developed by making minor adjustments to the horizontal alignment and reducing shoulder widths from 2.5 metres to 2.0 metres to reduce the cost. This option was designated Option 7b.

Options 7a and 7b are shown in **Figure 9-2** and described in **Section 9.3**.

6. A strategic estimate of cost and an economic evaluation were undertaken for each option.



Figure 9-2 Options 7a and 7b

9.3 Description of the options

9.3.1 Option 7a

Option 7a is a sub-option of Option 7. The option has a cross section consisting of one northbound lane, one southbound lane with 2.5 metre wide shoulders on either side.



Figure 9-3 Option 7a

The key features of this option are:

- Option 7a is 1400 metres long and starts approximately 500 metres further north and finishes approximately 450 metres further south than Option 7
- As with Option 7, this option was developed to demonstrate a minimalist treatment of straightening out the bends in the steepest part of the highway. It has non-conforming grades up to 8.1 per cent in order to shorten the length and starts approximately 900 metres north of the other options
- The first 150 metres consist of a simple widening of the existing carriageway to the west by constructing a fill embankment to provide adequate shoulder width
- The next 435 metres will require extensive retaining walls to keep the fill embankment out of the creek line
- A major bridge up to 230 metres long will then be required to keep the road out of the creek line
- From the northern abutment, at about eight metres high, extensive retaining walls approximately 350 metres long are required to keep the fill out of the creek line
- Fill then tapers back 230 metres to the existing highway
- Estimated cost \$80 million (\$2013).

9.3.2 **Option 7b**

Option 7b is a refinement of Option 7a and although longer, it minimises the requirement for the long lengths of retaining walls. As with Option 7a, the option has a cross section consisting of one northbound lane and one southbound lane, however, the shoulders are narrowed to 2.0 metres wide on either side. A shoulder width of 2.0 metres is considered the minimum acceptable width to allow a maintenance truck to safely park beside the traffic lanes.



Figure 9-4 Option 7b

The key features of this option are:

- Option 7b is 1635 metres long and starts approximately 475 metres further north and finishes approximately 240 metres further south than Option 7
- As with Option 7, this option was developed to demonstrate a minimalist treatment of straightening out the bends in the steepest part of the highway. It has non-conforming grades up to 8.1 per cent in order to shorten the length and starts approximately 900 metres north of the other options
- The length and height of the retaining walls are reduced by narrowing the shoulders to 2.0 metres. The rock face next to the shoulder in the southbound lane is softened by casting a single sided Type F concrete barrier against the rock face
- The first 210 metres consist of a simple widening of the existing carriageway to the west by constructing a fill embankment to provide the required shoulder widths.
- The next 265 metres will require a retaining wall of up to three metres high to keep the fill embankment out of the creek line
- As the alignment diverges from the existing carriageway over the next 75 metres, the road will be widened by a cantilevered concrete structure on concrete piles
- The cantilevered concrete structure leads into a major bridge up to 360 metres long which is required to keep the road out of the creek line
- At the northern abutment of the bridge, a 60 metre long cantilevered concrete structure on concrete piles is again used to ease the alignment back towards the existing carriageway. The rock face next to

the southbound shoulder is softened by casting a single sided Type F concrete barrier against the rock face

- The next 110 metres widen out the existing carriageway, requiring a retaining wall of up to 2 metres high on the western side. The rock face next to the southbound shoulder is softened by casting a single sided Type F concrete barrier against the rock face
- The next substandard bend is straightened out by gently moving off the existing alignment to the west and then re-joining the existing carriageway 145 metres further along
- The alignment to straighten out the bend requires the next 150 metres to move to the east of the existing carriageway by cutting into the rock face. At this location, the angled rock face beside the road is flattening out, requiring only minor cut. The rock face next to the southbound shoulder is softened by casting a single sided Type F concrete barrier against the rock face
- Fill then tapers back 255 metres to the existing highway
- Estimated cost \$60 million (\$2013).

9.4 Strategic concept design cost estimates for the options

The approach to estimating the cost of the options was the same as for the shortlisted options (refer to **Section 8.6**). **Table 9-1** represents the strategic cost estimates for each of the options. As with the previously shortlisted options, the cost estimates include an average contingency of approximately 60 per cent based on a risk assessment of project parameters.

Table 9-1 Cost estimates

Options	Base Cost	Contingency (60%)	Total Cost
Option 7a	\$50,000,000	\$30,000,000	\$80,000,000
Option 7b	\$38,000,000	\$22,000,000	\$60,000,000

9.5 Economic appraisal of the options

The results are shown in **Table 9-2**.

Table 9-2 Summary of economic analysis

	Option 7a	Option 7b
NPV* (\$ million)	-\$40.4	-\$24.1
BCR*	0.39	0.52

*NPV = Net Present Value

*BCR = Benefit Cost Ratio

Neither of the options produces a positive economic return. As with the previously shortlisted options (refer to **Section 8.7.2**), sensitivity analysis was not undertaken at this stage.

The outcomes of the analysis suggest that all options considered have a BCR of less than 1.0, where the overall costs exceed the benefits of the works. However, based on the assessment to date, Option 7b has the highest benefit cost ratio and therefore would represent the best possible outcome economically of the five route alternatives shortlisted.

9.6 Preferred option selection

9.6.1 Evaluation of the options

The options were examined in a value engineering workshop on 1 May 2013 attended by the Roads and Maritime and Cardno teams that included safety experts from both organisations, and Transport for NSW personnel.

During the workshop it was noted that even though Option 7b was 235 metres longer than Option 7a and contained a bridge 130 metres longer than the bridge in Option 7a, the estimate of cost was \$20 million less. This difference is mainly due to a reduction in the height and length of retaining walls achieved by reducing the shoulder widths from 2.5 metres to 2.0 metres in combination with small adjustments in the horizontal alignment. The cost is very sensitive to the width of widening out from the western edge of the existing road.

Following a review of the previously shortlisted options 2, 6, 7 and 10, the workshop concluded that:

- Both options met the project objectives as well as, or better than, the four previously shortlisted options
- Option 7b, at an estimated cost of \$60 million (\$2013), represents better value for money than Option 7a at an estimated cost of \$80 million (\$2013).

In summary, Option 7b:

- Improves road safety by smoothing hazardous horizontal curves and widening the road shoulders, improving safety through better visibility, resulting in less risk of crashes
- Improves road transport productivity, efficiency and reliability of travel by providing a 100 kilometres per hour alignment. Trucks will be limited to 80 kilometres per hour downhill due to the 8.1 per cent slope (they are currently limited to 60 kilometres per hour)
- Minimises the impact on the natural, cultural and built environment. It has the least impact of all options studied. Option 7 previously rated best on this objective (refer to **Section 7.5.1**). Option 7b is approximately 715 metres shorter than Option 7 and its footprint lies substantially within the Option 7 footprint
- Provides value for money. Option 7b has the least cost of all options considered and shows the most favourable cost benefit ratio.

Workshop participants therefore agreed that Option 7b should be taken forward as the recommended preferred option.

9.6.2 Recommendation of a preferred option

Option 7b was presented to the MPRC on 23 May 2013 with the recommendation that it be taken forward to the next stage of the project as the preferred option. The MPRC agreed that the Recommended Preferred Route Option Report be finalised with **Option 7b** as the preferred option for community consultation.

9.6.3 Community feedback and submissions

The program and summary of key consultation activities and findings are outlined in **Chapter 3**. The consultation program to date has culminated in the collection of community submissions following the display of the project area and objectives in October 2012 and the display of the recommended preferred route option in September 2013. A detailed review of submissions received and the project team response to those submissions is provided in the Stakeholder Engagement Outcomes Report (October 2013). Key areas for consideration in determining a preferred option included:

- Functional issues generally including road safety for vehicles; improving the road geometry, maximising the use of existing highway to minimise land take, protection from rock falls and construction traffic management
- Environmental issues including environmental values and assets; the protection of flora and fauna and biodiversity issues such as wildlife corridors, water bodies and endangered ecological communities, regional history and noise and visual impacts
- Social issues including property acquisition, project timeframes, and impact mitigation
- Economic issues with particular reference to the cost of the project
- Process issues including the route options development process, effective and appropriate consultation, and the timely resolution of the preferred option selection.

No changes are proposed to the recommended preferred route option as a result of community feedback from the display of the recommended preferred route option in September 2013 although a number of issues and recommendations will be addressed in the next stages of design.

9.6.4 Selection of a preferred option

Option 7b has been confirmed as the preferred option.

The preferred option has been selected as the option that performs well across a combination of the technical input, the findings of the value management process and community feedback and which best meets the project objectives.

A detailed description of the preferred option is provided in **Chapter 10**.

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10 The preferred option

10.1 Description of the preferred option

The preliminary concept design for the preferred option is shown in **Figure 10-1** and **Figure 10-2**.

Option 7b is considered an upgrade to the existing highway, utilising as much of the existing pavement as possible. This option was developed to provide a minimalist treatment of straightening out the substandard bends in the steepest part of the highway.

The option has a cross section consisting of one 3.5 metre wide northbound lane and one 3.5 metre wide southbound lane with 2.0 metre wide shoulders on either side. A shoulder width of 2.0 metres is considered the minimum acceptable width to allow a maintenance truck to safely park beside the traffic lanes.

The key features of this option are:

- Option 7b is 1635 metres long
- It has grades up to 8.1 per cent in order to shorten the length required for upgrade
- The length and height of the retaining walls required for the upgrade are reduced by narrowing the shoulders to 2.0 metres. The rock face next to the shoulder in the southbound lane is softened by casting a single sided Type F concrete barrier against the rock face
- The carriageway cross section and straightened alignment are achieved by a combination of:
 - simple widening of the existing carriageway to the west in fill to provide the required shoulder widths
 - retaining walls of up to three metres high to keep the fill out of the creek line
 - cantilevered concrete structures on concrete piles where retaining walls would be too high
 - a major bridge up to 360 metres long which is required to keep the road out of the creek line
 - cutting into the rock face where the angled rock face beside the road is flattening out, requiring only minor cut
 - filling over the existing highway alignment
- An emergency stopping bay is provided adjacent to the southbound (uphill) lane approximately 500 metres south of the northern end of the upgrade.
- The section of road replaced by the proposed bridge between approximately station 500 metres and approximately station 950 metres (refer to **Figure 10-1**) will be abandoned and the existing pavement demolished. This section of road has a substandard alignment and is subject to rock falls.

10.2 Traffic and transportation issues

10.2.1 Road safety strategy

A key objective of this project is to improve road safety. The preferred option improves road safety by smoothing hazardous horizontal curves and widening the road shoulders, improving safety through better visibility, resulting in less risk of accidents.

The horizontal alignment of the preferred option is good, providing a 100 kilometres per hour alignment. However, the existing steep grades would remain, with a maximum grade of 8.1 per cent. The potential for higher speeds on the relatively steep downgrades in the northbound direction will be managed by limiting truck speed to 80 kilometres per hour. The different speeds for light and heavy vehicles will not present a safety issue given the low traffic volumes.

The rock face next to the shoulder in the southbound lane is softened by casting a single sided Type F concrete barrier against the rock face, helping to reduce damage to errant vehicles.

An emergency stopping bay is provided adjacent to the southbound (uphill) lane.

10.2.2 Road safety audit

A pre-construction – strategic phase audit was carried out on the preferred option.

Issues raised in the audit will be investigated during concept design.

A copy of the audit report is included in **Appendix M**.

10.2.3 Traffic and transport efficiency

The current alignment has an 80 kilometres per hour speed limit, with trucks limited to 60 kilometres per hour on the steep downhill (northbound) section of the highway.

The preferred option improves road transport productivity, efficiency and reliability of travel by providing a 100 kilometres per hour alignment, although trucks will be limited to 80 kilometres per hour downhill as noted in **Section 10.2.1**.

10.3 Engineering issues

10.3.1 Ground conditions

Widening of the existing road corridor will be required. Sections of fill and cut earthworks will be required.

The existing New England Highway cuttings are on the side of the hill and expose both distinctly weathered granite and slightly weathered to fresh, very high strength granite. Excavation by heavy ripping should be possible within the weathered zone. Within fresh rock, blasting is expected to be required.

Loose boulders or outcrops on the steep slopes above the existing highway may be destabilised by undercutting or vibration during excavation of adjacent cuttings.

Excavation for bridge piers within slightly weathered-fresh granite or rhyodacite will be extremely difficult and likely penetration depths will be minimal.

10.3.2 Flooding and drainage

Upgrading of existing transverse drainage pipes may be necessary. New transverse drainage pipes may also be required. There are no anticipated impacts on the conveyance of flows up to the 100 year ARI event and the design will achieve a 100 year ARI flood immunity.

10.3.3 Public utilities

There are no public utilities affected by the preferred option.

10.3.4 Earthworks

Widening of the existing road corridor will require sections of cut and fill earthworks. The preferred option will require the importation of fill as the amount of cut has been minimised due to the possibility of very hard rock.

It is expected that a large proportion of excavated material could be used as rockfill. Crushing and screening of excavated materials will be required to produce suitable rockfill.

Rockfill batters may be preferred to reduce the footprint of the proposed embankments.

10.3.5 Structures

The preferred option requires a 360 metre long bridge. Sections of cantilevered roadway supported on concrete piles are proposed at either end of the bridge to eliminate the need for high and expensive retaining walls. The alignment should suit standard bridge design and construction methods, however, excavation for piers and piles may be extremely difficult if very high strength rock is encountered.

The proposed alignment limits the height of retaining walls to 3.0 metres and allows the walls to be constructed from the existing highway rather than having to access the wall foundations from below the highway.

10.3.6 Constructability

As the preferred option consists predominantly of widening the existing highway, constructability becomes a major factor to be considered in the next stages of design and during construction. Construction will require the closure of one lane of the highway throughout the construction period, with traffic controlled by traffic signals. Some construction activities will require the temporary closure of the highway for periods up to 20 minutes.

10.4 Statutory planning and land-use

10.4.1 Planning and legislation

The preferred option is expected to have minimal impact on regional and local development and is consistent with local and state planning policies.

10.4.2 Land-use and property impacts

Widening will be required for the construction of the preferred option, but impacts of property acquisition will be minimised generally by widening to the west of the existing highway where the adjacent land is designated either road reserve or crown land.

Acquisition of a small area of private land may be required where the highway is widened to the east.

10.5 Environmental issues

10.5.1 Hydrology and water quality

Impacts on water quality in the operational phase are not expected to differ significantly from those currently occurring in relation to the existing road. Some existing drainage structures may require augmentation to achieve flood immunity, however, there are no major waterway crossings required for the preferred option.

During construction, there is potential for erosion from exposed surfaces cleared of vegetation, and this would result in declines in water quality and sedimentation of watercourses. This would require management via the implementation of appropriate erosion and sediment controls during construction.

10.5.2 Terrestrial biodiversity

In the operational phase, terrestrial flora and fauna may potentially be impacted by:

- Direct impacts, including mortality through vehicle strike or vegetation clearing/loss of habitat
- Indirect impacts, including edge effects (eg reduced habitat value along a road edge) and/or barrier effects (eg isolating habitat or restricting movement).

The impact of vehicle strikes on local fauna is not likely to be significantly different to that currently occurring, noting that there are opportunities through the design process to manage fauna passage. Options include fauna exclusion fencing, overpasses and/or underpasses. Based on observations made during the fauna surveys (**Section 5.2.3.3**) the following species or groups would benefit from a combined fauna passage/exclusion fencing approach:

- Macropods and other dispersive terrestrial fauna (ie Spotted-tailed Quoll)
- Arboreal mammals (ie possums and gliders).

During the construction phase, there are a range of potential impacts that would need to be considered further during the environmental impact assessment and appropriate management and mitigation measures developed.

The potential impacts on terrestrial biodiversity associated with Option 7b are considered less than those associated with the other options. A more comprehensive overview of potential impacts associated with the option and the type of mitigation measures that could be considered is provided in Cardno (2013a; **Appendix D**).

10.5.3 Aquatic biodiversity

As discussed in **Section 10.5.1**, no major waterway crossings are proposed under the preferred option and operational phase impacts on water quality are not expected to differ significantly. Hence, the potential operational phase impacts on aquatic biodiversity and fish passage are not expected to be significantly different from the existing condition. Two culverts will require augmentation, and there may be opportunities to improve fish passage through these structures by considering ‘fish friendly’ features in the design of these crossings.

The key potential construction phase impacts on aquatic biodiversity relate to management of water quality impacts, and erosion and sediment control in particular.

The potential impacts on aquatic biodiversity associated with Option 7b are considered less than those associated with the other options. A more comprehensive overview of potential impacts on aquatic biodiversity associated with the option and the type of mitigation measures that could be considered is provided in Cardno (2013b; **Appendix E**).

10.5.4 Heritage

The potential heritage impacts of Option 7b are generally expected to be less than for the other options considered.

As outlined in Niche (2013a; **Appendix F**), there is potential for direct impact on two Aboriginal cultural heritage sites:

- Bolivia Hill AS1
- Bolivia Hill PAD3.

The potential for impact should be confirmed during the concept design process and avoided where reasonable and feasible.

There is potential for direct impact on two heritage sites, both memorials (Niche, 2013b; **Appendix G**). This should be confirmed through development of the concept design. Direct impacts on heritage items associated with the old Bolivia township are not anticipated, but should also be subject to confirmation at a later stage.

During the construction phase there is potential to uncover previously unidentified Aboriginal and non-Aboriginal heritage sites, relics, or artefacts.

10.5.5 Noise and vibration

The preferred option follows the existing road corridor and is not likely to cause a significant change in the noise environment for the overall community. It should be noted that there are no fixed noise receivers within the study area. Whilst blasting may be required for excavation given the hard rock conditions in the area, this would be undertaken in accordance with relevant environmental guidelines and controls. If required, further investigation of any impacts of blasting would be undertaken during the concept design and environmental assessment process.

10.5.6 Visual amenity

The preferred option will have a visual impact as it descends the high ground from Bolivia Hill to the flat valley towards Pyes Creek Road. Bushland and pastoral views will be maintained on the descent from Bolivia Hill.

As the preferred option is based on an upgrade of the existing highway, the long-term impact could be expected to be similar to that of the existing highway apart from the provision of a new, large bridge. However, immediately following completion, the impact is likely to be greater as the wider formation will be noticeable and appear ‘new’. The western edge of the ‘new’ corridor provides the opportunity for landscape plantings.

Urban design and landscape input in the next stage of the project will ensure the bridge and retaining walls are integrated into the existing landscape that dominates the current highly valued visual experience.

10.6 Community issues

The community raised concerns about the existing road's safety performance, with a number of specific safety issues raised along with general concerns about safety. This community focus on safety demonstrates that the project objective to "improve road safety" is generally aligned with the community expectations for the project. The preferred option satisfies this objective.

Several of the route option suggestions from community members demonstrated support for the project objective "to improve road transport productivity, efficiency and reliability of travel" with initiatives such as provision of two southbound lanes or an overtaking lane and reduction of grades. While the preferred option does not provide additional lanes, it does improve road transport productivity, efficiency and reliability of travel by providing a safe alignment with reduced grades and a 100 kilometres per hour design speed.

The project objective to "minimise the impact on the natural, cultural and built environment" was also supported by community members; general route option considerations were focused on ensuring environmental protection and heritage protection. The preferred option satisfies this objective.

Community members that provided route option considerations noted that the cost of the proposed route should be taken into account; this reflects the fourth project objective of "Provide value for money" and demonstrates an understanding of the need for a route option that is cost effective. The preferred option has the least cost of all options considered and satisfies this objective.

10.7 Social-economic issues

The upgrade is a part of a series of upgrades for the New England Highway with planning works initially focusing on a new bypass of Tenterfield and improvements to the Bolivia Hill stretch of road.

Overall, having regard for the social and economic fabric of the 'region' that the upgrade will serve and the broader set of road works that constitute the overall New England Highway upgrade, several potential economic, social and environmental benefits associated with the project were previously identified.

Identified major regional outcomes include:

- Improving the safety of the New England Highway and encouraging inland travel via the New England Highway
- Minimising congestion along this passage of roadway and improving the safety of travel
- Stimulation of the local economy – business and industry will benefit from the works. The improved road will provide a wider employment base for local residents particularly for younger residents
- Increased visitation and support for tourism and retail based employment.

The preferred option ensures these outcomes are achievable.

10.8 Preliminary concept design estimate of cost

10.8.1 Cost estimating approach

The approach to estimating the cost of the preferred option was much the same as for the shortlisted options (refer to **Section 9.4**). However, at this stage of the project, Roads and Maritime policy is to use probabilistic estimation techniques using Monte Carlo analysis to determine a contingency for the preferred option.

Two estimates were produced as follows:

- The P50 cost value is an estimate of the project cost based on a 50 per cent probability that the cost will not be exceeded. The P50 estimate is one with equal chance of project overruns or under runs up until when the project scope can be finalised.
- The P90 cost value is an estimate of the project cost based on a 90 per cent probability that the cost will not be exceeded at any stage.

Details are included in the Cost Estimate Report in **Appendix K**.

As certainty with design detail, quantities, and rates improve, the proportion of contingency in the estimate will diminish. The reported preliminary concept design cost estimate therefore includes a relatively large allowance for risk and unknowns.

10.8.2 Cost estimate

The P50 and P90 cost estimates for the preferred option are shown in **Table 10-1**.

Table 10-1 Preferred option cost estimate

	Base Cost	P50	P90
Preferred Option 7b	\$36,000,000	\$45,000,000	\$60,000,000

The probabilistic P90 estimate confirms the original estimate for Option 7b (refer to **Section 9.4**).

10.9 Economic appraisal

The P90 cost estimate has been used in the economic evaluation. The P90 estimate is the same as the estimate used in the previous assessment for Option 7b (refer to **Section 9.5**). The results of the analysis are therefore as previously assessed. The results are shown in **Table 10-2**.

Table 10-2 Economic analysis of preferred Option 7b

	Preferred Option 7b
NPV* (\$ million)	-\$24.1
BCR*	0.52

*NPV = Net Present Value

*BCR = Benefit Cost Ratio

10.9.2 Sensitivity analysis

A sensitivity analysis was conducted on key parameters used to underpin the model to test the robustness of inferences made. Sensitivity tests were conducted on the following parameters:

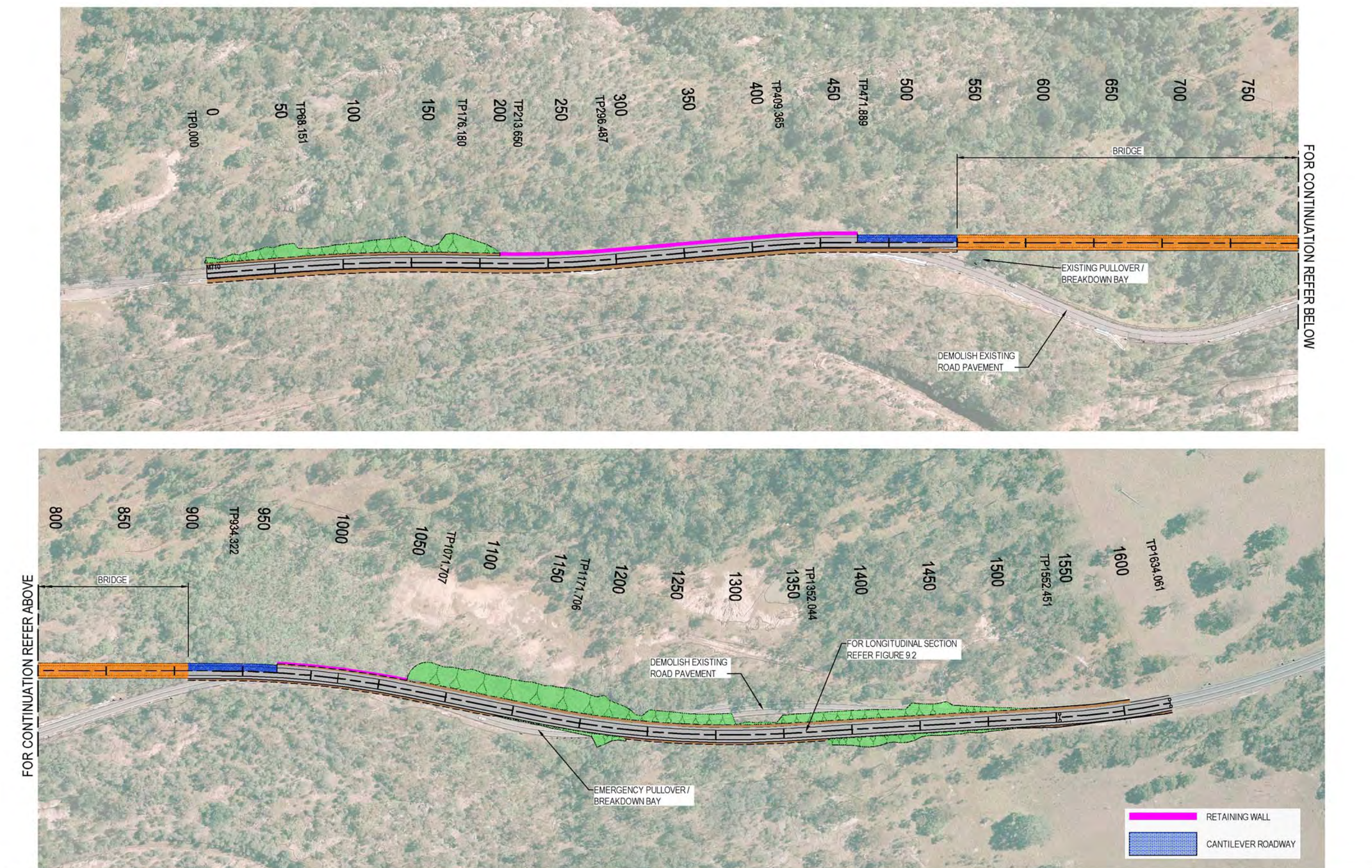
- Construction costs; plus or minus 20 per cent
- Road user costs, plus or minus 20 per cent
- High discount rate; 7 per cent.

The results of the economic appraisal are shown in **Table 10-3**. For simplicity, only the Benefit Cost Ratio results have been generated.

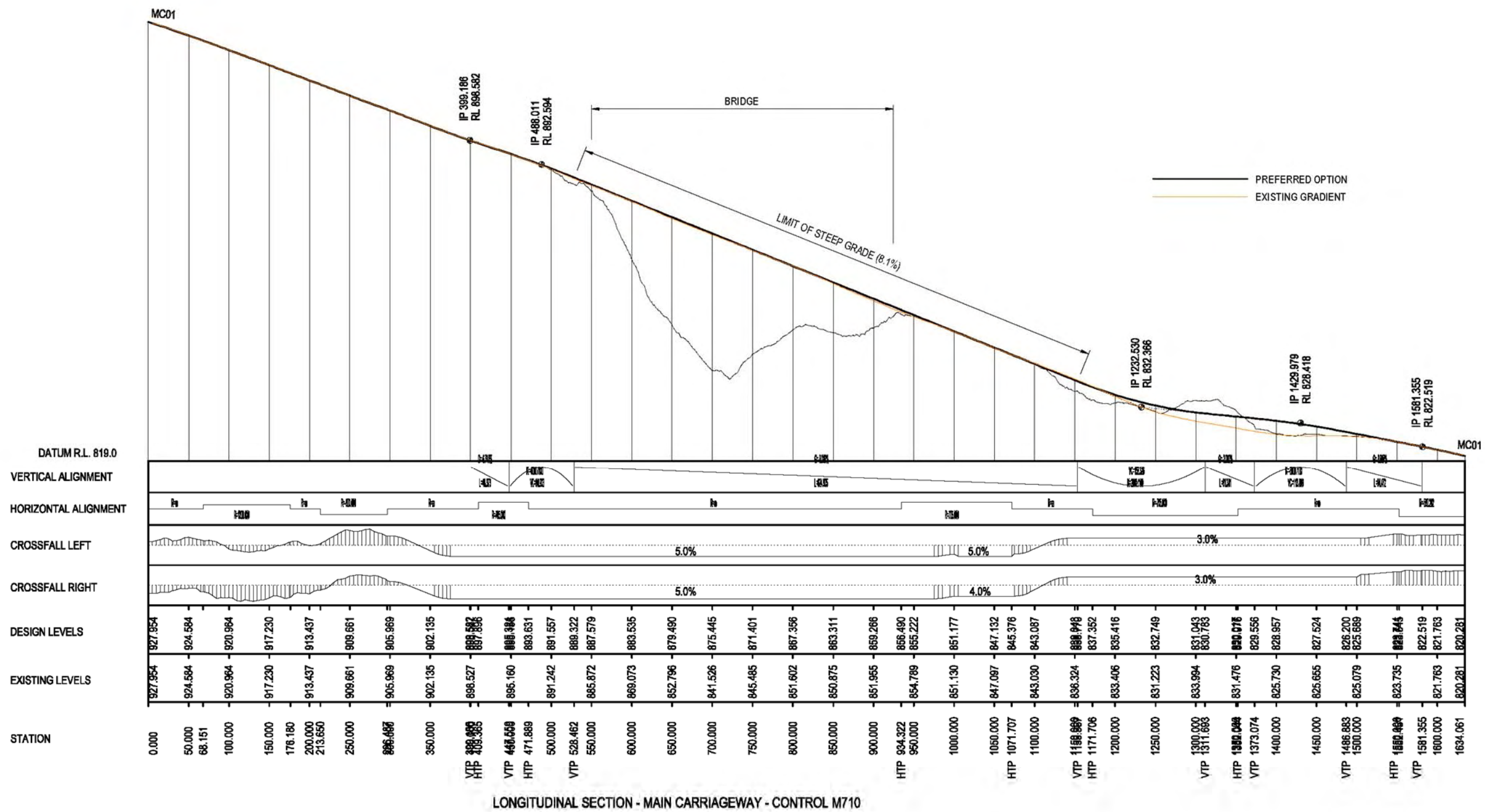
Table 10-3 Sensitivity analysis (Benefit Cost Ratio)

	Base Case	7% discount rate	Increased Capex (+20%)	Decreased Capex (-20%)	Road User Cost (+20%)	Road User Cost (-20%)
Option 7b	0.52	0.38	0.45	0.67	0.39	0.68

The results suggest that the economic appraisal results are relatively insensitive to the variables tested under the different scenarios.



BOLIVIA HILL UPGRADE
ASSESSMENT OF ROUTE OPTIONS
FIGURE 10.1 - PREFERRED OPTION PLAN



11 Summary of next steps

11.1 General

The importance of achieving a balance between environmental, community, technical and cost factors as well as meeting current and anticipated transport demands is well recognised. The Federal Government and the NSW Government are committed to this outcome. Moreover, the provision of a high standard highway will improve freight/commuter traffic efficiency and road safety.

11.2 Further project development and community consultation

Concept design and environmental impact assessment of the preferred option will be the next steps following announcement and publication of this report. Further ground survey, geotechnical and other investigations will be undertaken to provide input into the refinement of the design and environmental assessment.

The statutory planning and approvals requirements of the project are outlined in more detail in **Chapter 4**.

Apart from issues with constructability, the key issues identified are environmental; therefore it is crucial that the approvals process selected provides a robust and transparent assessment to satisfy legislative requirements and community expectations.

When completed, the environmental impact assessment will be publicly exhibited and input again sought from the community. Roads and Maritime may prepare a report on the submissions received and revise any environmental commitments documented in the environmental impact assessment. Roads and Maritime would also consider design modifications to the project to minimise environmental impacts.

11.3 Environmental impact assessment under the *Environmental Planning and Assessment Act 1979*

A detailed concept design will be carried out on the preferred route option. This will be the subject of more detailed environmental assessment (refer to **Section 4.2.1**) and community engagement.

11.4 Land acquisition and construction

Land acquisition may be required and may involve the acquisition of both whole and part lots. The process of acquiring land will not commence until planning approval has been obtained (ie environmental assessment of the concept design of the preferred route has been completed, including the acceptance of conditions) and funds have been made available. Construction may commence after the preceding activities and detailed design have been completed, subject to the availability of funds.

11.5 On-going community engagement

Roads and Maritime is committed to continuing community engagement throughout the whole process including concept design, environmental assessment, detailed design and construction. Information and progress will continue to be relayed via updates posted to community households and included in local media, meetings with individuals and groups and the project website. In conjunction with the information provided to the community, the project team will welcome continued feedback and comments.

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