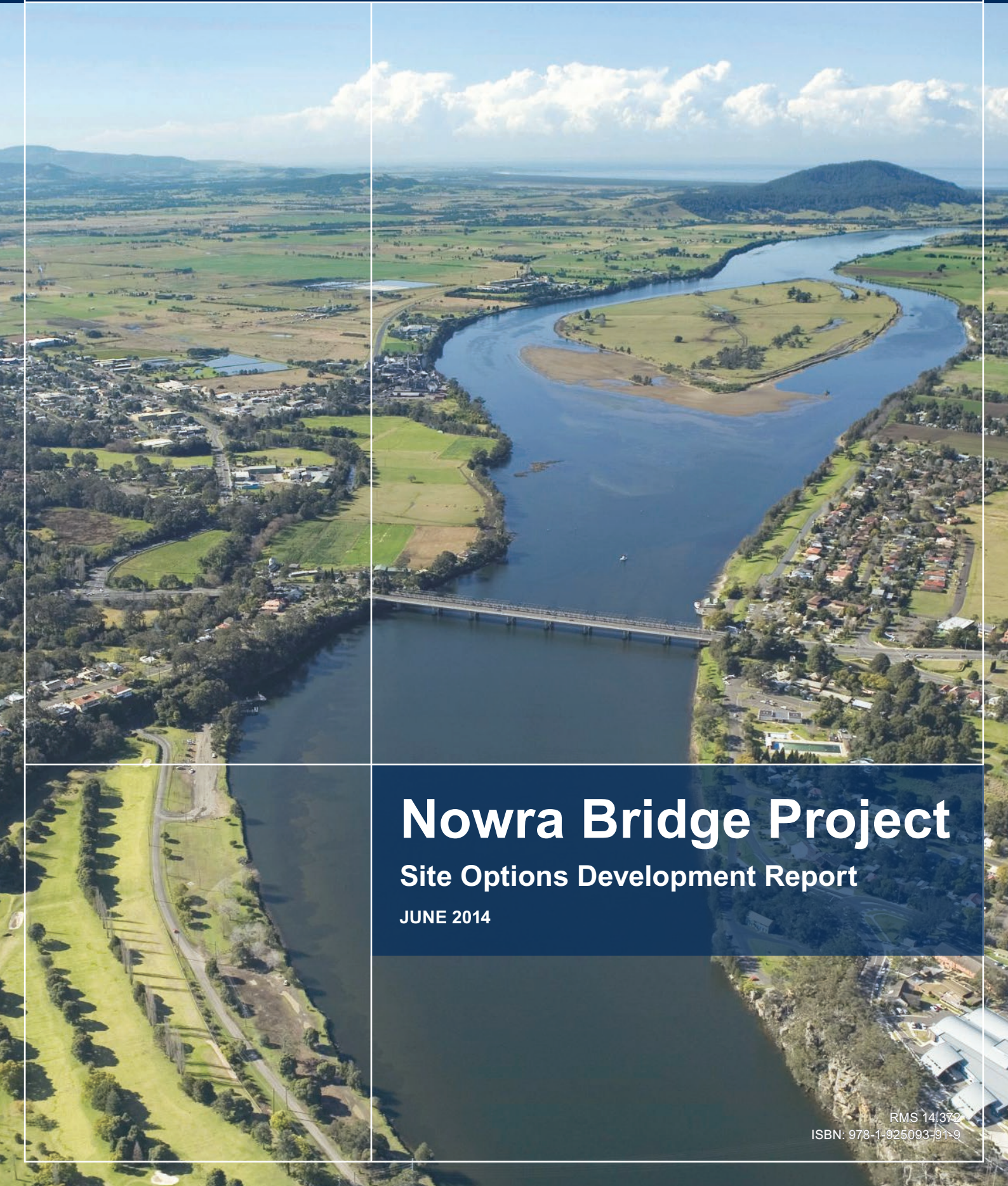




Transport
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Services



Nowra Bridge Project

Site Options Development Report

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Roads and Maritime Services

Nowra Bridge Project
Site Options Development Report
June 2014

Prepared for
Roads and Maritime Services

Prepared by
AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, Australia

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Document controls

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Nowra Bridge Project Site Options Development Report

Approval and authorisation

Prepared by:	AECOM
Accepted on behalf of the Roads and Maritime Services by:	Nick Boyd Project Development Manager Project Development Infrastructure Development
	Signed: 
	Date: 30 June 2014

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Executive Summary

Context and need for the project

Roads and Maritime Services has prepared a site options development study to identify and assess potential locations for a new bridge crossing of the Shoalhaven River at Nowra; located within the Shoalhaven local government area (Shoalhaven LGA).

The Princes Highway crosses the Shoalhaven River on two independent bridge structures. One bridge has two southbound lanes and the other bridge has three northbound lanes. The southbound bridge was constructed in 1880 and is recognised as a heritage item of state significance. Its significance is based on a range of factors including its landmark status, its design and technical features, its role in the development of the Nowra region, and the fact that it is the only American pin-jointed 'Whipple' truss bridge in service in NSW. This bridge carried two-way traffic until 1980 when a concrete box girder bridge was constructed immediately alongside the western 'upstream' side.

In 2012, Roads and Maritime started investigating options to improve conditions on the Princes Highway crossing over the Shoalhaven River at Nowra.

During the initial assessment of the project, the team identified three main issues with the crossing:

1. Increasing maintenance difficulties with the southbound iron truss bridge
2. Capacity issues due to high traffic volumes during peak times
3. Limitations on the movement of some large freight vehicles due to the southbound iron truss bridge structure

A recent condition assessment of the southbound bridge shows there are a number of large maintenance tasks required in the short to medium term to ensure it continues to operate safely.

Some of the maintenance work identified can be completed from underneath the bridge without interfering with traffic. However, jobs on the deck and trusses cannot be carried out safely or efficiently unless the bridge is closed to traffic.

Around 46,500 vehicles cross the Shoalhaven River on an average day. These high traffic volumes prevent the closure of the bridge during the day as it would cause unacceptable delays on the Nowra Bomaderry road network during AM and PM peak periods. This is due to the reduction of lane capacity from five lanes in total to three. Early assessments concluded that no closures of the southbound bridge should be planned during peak periods.

Of the jobs requiring bridge closures, it was assessed that some of the smaller jobs could be completed at night when the traffic volumes are lower. Some of the more complex jobs cannot be carried out under nightshift conditions as there is not enough time to complete the tasks before the bridge needs to re-open to peak morning traffic.

Volume and capacity modelling shows that during peak periods the Shoalhaven River crossing is currently operating at or close to capacity. With traffic volumes predicted to increase by around 6 per cent by 2016, even if a solution could be found to effectively carry out maintenance without causing unacceptable traffic delays, capacity issues would need to be addressed.

In addition to maintenance and capacity difficulties, the truss structure also restricts the movement of some freight vehicles which are unable to use the bridge due to their size or weight.

There is also a risk of damage to the truss structure in the event of a collision with an oversized vehicle. Such an impact could close the bridge until the damage is repaired.

Planning needs to make sure this crossing can safely cope with traffic now and into the future. During this initial project assessment it became clear that planning should focus on a new bridge that could address the issues above and provide an opportunity to improve conditions for the wider network.

The aim of this study is to recommend a preferred site for a new bridge crossing of the Shoalhaven River. This document has been prepared to provide details of the preliminary data review and supplementary data collection process that assisted the identification and analysis of the potential options. It provides an overview of value management activities and outcomes and outlines the approach used to recommend a preferred site option.

This study did not assume that a new river crossing should only be considered in the immediate area of the current Princes Highway corridor. A wider study area was considered around the three strategic transport corridors through Nowra Bomaderry including the current Princes Highway road corridor, a western bypass corridor, and a corridor to the east that could cater for a future extension of the South Coast rail line across the river.

Objectives and opportunities

There are many opportunities that may be achieved with the introduction of a new bridge. For the project to be successful it must satisfy the following objectives as a minimum:

- To overcome the significant maintenance burden as well as freight vehicle limitations of the southbound bridge by providing a new crossing serviced by a modern cost effective structure
- Ensure a quality asset that can be maintained under existing and forecast traffic volumes
- Improve travel conditions and reduce traffic congestion
- Improve accessibility, safety and efficiency for all road users and public transport
- Improve southbound access for oversize or large vehicles
- Minimise any project related impacts on the physical and social environment as much as possible
- Minimise the project's ongoing maintenance 'whole of life' cost
- Ensure any new bridge structure is compatible with the long-term transport network in the Nowra region.

The project also provides other opportunities:

- Potential to refurbish the iron truss bridge for a purpose other than carrying highway traffic
- A new crossing location may help Shoalhaven City Council achieve the vision for Nowra Bomaderry stated in the Structure Plan
- A new crossing location may reconfigure the current highway approach road network to improve safety, accessibility, and efficiency for all road users
- A new crossing location may look at both a future bypass of Nowra and a future railway corridor across the Shoalhaven River.

Preliminary data review

The initial phase of this study was to review preliminary data from Roads and Maritime supplemented with information from other sources. The aim was to familiarise the project team with available information, talk with the community, gather information to assist the identification of site options, and identify knowledge 'gaps' where additional data would need to be collected to assess options.

The technical studies available mostly focused on fixing traffic congestion around the bridges. Although the studies reviewed were not recent, and mostly assumed the existing southbound bridge would still be in use, the findings were still considered relevant. It became apparent during review of these investigations that any potential option would need to ensure traffic and transport efficiency on the Princes Highway for the future.

The environmental and geotechnical investigations focused on desktop analysis and a review of existing literature in broad study areas. This was used to identify high risk constraints within the study areas to help identify potential site options. It was recommended that more targeted investigations would be needed on any option around the existing Princes Highway so that they could be differentiated.

Conversations with the community included the project need as well as discussing the potential site locations. There was an indication from the community for Roads and Maritime to further investigate a bypass option, an option that could potentially cater for rail and the need to address congestion issues at the intersections close to the current bridges.

Development of site options

At the conclusion of the preliminary data review phase which included community and stakeholder consultation, there was satisfactory evidence to justify the selection of site options for further assessment.

The below five site options (Options A – E) were identified within three transport corridors:

- The western bypass (regional services) corridor:

Option A – western bypass alignment

Construction of a new bridge as part of a potential future western bypass of Nowra. This option would follow an alignment that skirts to the west of Nowra Bomaderry and follows the route identified on the Shoalhaven Local Environmental Plan (SLEP).

- The existing Princes Highway corridor:

Preliminary data clearly identified a need to look at a number of options on the existing Princes Highway corridor. In particular, previous traffic studies identified the further away a new bridge is from the existing Princes Highway, the less traffic it would attract. Therefore options close to the existing bridges were most likely to address the immediate objectives for the project. Three options were considered on the Princes Highway corridor.

Option B – immediately west (upstream)

Construction of a new bridge immediately west (upstream) of the existing northbound concrete box girder bridge on the Princes Highway.

Option C – existing southbound alignment

Construction of a new bridge on the alignment of the existing southbound iron truss bridge on the Princes Highway. This option would require demolition of the existing southbound iron truss bridge, after which a new bridge would be built on the old alignment.

Option D – immediately east (downstream)

Construction of a new bridge immediately east (downstream) of the existing southbound iron truss bridge on the Princes Highway.

- The area around a possible extension of the South Coast Rail line:

Early conversations with other NSW Government agencies indicated that the idea of a shared bridge was worth pursuing.

Option E – eastern potential rail option

Construction of an eastern option, with a new bridge downstream of the existing southbound iron truss bridge. This option could potentially allow for a future rail extension across the Shoalhaven River.

Information on alternative options considered but not selected for further assessment can be found in Chapter 3.

Supplementary data collection and analysis

A number of key environmental, engineering and economic issues influence the identification of a preferred location. A further data collection and analysis phase was required to enhance the existing background material so the identified options could be assessed. The goal of the supplementary data collection and analysis phase was to provide a thorough understanding of the functional, socio-economic and environmental constraints and opportunities for the five potential site options to inform the assessment process.

- **Environmental investigation:**
A preliminary environmental investigation (PEI) was carried out to complete a broad scale assessment of the five potential site options. The aim was to identify potential opportunities and environmental constraints that may influence the selection and development of a recommended site option for a new bridge.
- **Traffic assessment:**
Previous studies identified the benefits of improving the current traffic capacity at the existing crossing site. More information was required to gain a better understanding of the current and future traffic and transport conditions, and to determine how potential site options would accommodate current and future traffic demands.
- **Landscape and urban design assessment:**
An understanding of the landscape and the key structural elements of the landscape experience was necessary to define urban design objectives. A landscape character and visual impact assessment was carried out.
- **Design and construction considerations:**
Preliminary concept layouts were prepared for selected options, constructability reviews were carried out, and relative costs were also prepared to inform the assessment process.

Value management process

Value management is a development process used in many industries including Roads and Maritime to bring together technical experts and key project stakeholders to develop a way forward for large infrastructure projects. An important part of this process was the completion of a value management workshop where the project team and selected stakeholders evaluated the five site options using the data collected and analysed in this study.

The 35 workshop participants included Roads and Maritime project team members, key study specialists, key stakeholders from government and non-government agencies, businesses/chambers of commerce and other key stakeholders including two community representatives.

The workshop process built on the expertise of the participants to clarify the purpose of the project and what the project should achieve to be successful. Participants then agreed on the most appropriate criteria for the options to be assessed and weighted them in order of perceived importance.

Once assessed, the performance of the options, together with the relative strategic cost estimates was discussed so that the group could draw conclusions around which option provided best 'value for money'.

By the end of the workshop, the participants recommended:

- Roads and Maritime should focus planning for a new river crossing immediately west (upstream) of the existing bridges (Option B)
- Roads and Maritime should further develop Option D (immediately east of the existing bridges) as a contingency in the event that a design solution for Option B cannot be achieved

- Roads and Maritime should ensure the project addresses traffic performance of the intersections at Bolong Road, Illaroo Road and Bridge Road.

The working group asked that this recommendation be subject to Roads and Maritime sufficiently:

- Investigating potential impacts and improvements to traffic efficiency and north/south connectivity issues on the immediate approaches to the new bridge
- Carrying out further investigation into public utility impacts including additional costs
- Investigating fully the potential environmental, cultural and social impacts
- Working with Council to ensure the project can integrate with their long term strategic plans
- Clarifying the adjoining Aboriginal land claim issues
- Minimising the risk of disruption to road users during construction.

Roads and Maritime gathered feedback following the workshop and received an overwhelmingly positive response from the community about the value management workshop recommendation.

Preferred site option selection process and recommendations

The final recommendation of the preferred location was informed by three sources of information:

- Technical input from existing and supplementary data sources
- Feedback from the community at various stages throughout the study
- The recommendations of the value management process.

Option B, which is immediately west (upstream) of the existing Princes Highway river crossings is recommended as the preferred site for a new bridge across the Shoalhaven River. This option is recommended because:

- Option B would present less risk to the stability of the existing river crossings during construction activities when compared to the other Princes Highway options
- Option B is better suited to a preferred incremental launch construction methodology
- Option B would have relatively less property impacts
- Option B could be constructed and operated regardless of whether the southbound iron truss bridge is maintained or removed. (At the time this report was written the future of the southbound bridge was yet to be decided)
- Option B has been well received by the community as the recommended preferred option
- Option B would provide relatively better value for money than most of the other options.

This recommendation is subject to a list of issues to be resolved that were identified during the value management process.

It is also recommended that Roads and Maritime respond to community concerns by attempting to find design solutions to improve traffic conditions at Bolong Road, Illaroo Road and Bridge Road / Pleasant Way.

These recommendations will be provided to the NSW Government to inform a decision on the preferred location to focus planning.

1 Context

1.1 Background and need for the project

1.1.1 Background

Roads and Maritime Services has prepared a site options development study to identify and assess potential locations for a new bridge crossing of the Shoalhaven River at Nowra; located within the Shoalhaven local government area (Shoalhaven LGA).

Figure 1-1 shows the Princes Highway crossing the Shoalhaven River on two independent bridge structures. One bridge has two southbound lanes and the other bridge has three northbound lanes. The southbound iron 'Whipple' truss bridge was constructed in 1880 and is of state heritage significance. Its significance is based on a range of factors including its landmark status, its design and technical features, its role in the development of the Nowra region, and the fact that it is the only American pin-jointed 'Whipple' truss in service in NSW. At the time of its construction, the iron truss bridge was intended to carry twin railway tracks as part of a South Coast Railway to Bega. However, when the railway was completed in 1893 the line terminated at Bomaderry and the bridge was reconfigured for two lanes of road traffic.

This bridge carried two-way traffic until 1980 when a concrete box girder bridge was constructed immediately alongside the western 'upstream' side.



Figure 1-1 Princes Highway crossings of the Shoalhaven River (looking north west)

1.1.2 Need for the project

In 2012, Roads and Maritime started looking at options to improve conditions on the Princes Highway crossing over the Shoalhaven River at Nowra.

During the initial assessment of the project, the team identified three main issues with the crossing:

1. Increasing maintenance difficulties associated with the southbound iron truss bridge
2. Capacity issues due to high traffic volumes during peak times
3. Constraints on the movement of some large freight vehicles due to the southbound iron truss bridge structure

The southbound iron truss bridge is over 130 years old and like any bridge of this age requires regular maintenance. A recent condition assessment of the structure has shown there are a number of large maintenance tasks required in the short to medium term to ensure it continues to operate safely. These are explained in Chapter 1.3 of this report.

Some of the maintenance work identified can be completed from barges in the river below and does not interfere with traffic. However, jobs such as strengthening the piers and joints, work on the top chords, work on the bridge deck or work requiring large machinery on the bridge deck, cannot be carried out safely with the bridge open to traffic. This decision has been made after previous works on the bridge identified unacceptable safety risks due to the proximity of workers and traffic.

Around 46,500 vehicles cross the Shoalhaven River on an average day. During peak periods the crossing is already nearing its maximum capacity with five lanes on the two bridges in operation. Reducing this crossing to three lanes (as would be the case if the existing southbound bridge was closed for maintenance) would cause extensive delays during the AM and PM peak periods. As there is no feasible alternative route (closest alternative route to access Nowra from Bomaderry without the Princes Highway crossing is around 300 kilometres), any extended closure of the southbound bridge during peak times would represent an unreasonable and unacceptable delay on the network.

Traffic volumes drop at night to less than a quarter of the daily peak volumes, and it is reasonable to close the southbound bridge for limited night shift hours (opening to traffic each morning). Though inefficient, some of the smaller jobs can be carried out under night closures. For example in late April 2014, work started to remove corrosion from the top chords requiring the full closure of bridge each night. At the time this report was written this work and associated nightly closures was still underway.

Some of the larger and more complex jobs identified in the recent asset assessment cannot be carried out under nightshift conditions as there is simply not enough time to complete the task before the bridge needs to re-open for peak morning traffic. If roads and Maritime were to address only the tasks identified in the recent assessment at once, it has been estimated a full closure of the bridge for around 12 to 18 months would be required.

Volume and capacity modelling shows that during peak periods the Shoalhaven River crossing is currently operating at or close to capacity. With traffic volumes predicted to increase by around 6 per cent by 2016, even if a solution could be found to effectively carry out maintenance without causing unacceptable traffic delays, capacity issues would need to be addressed. More information on traffic analysis including future traffic modelling is included in Chapter 4.3.

The southbound bridge also restricts the movement of higher mass limit (heavy vehicles that have been reconfigured to carry more weight than normal) and vehicles higher than 4.6m. To travel south of Bomaderry these vehicles have to wait for an escort to travel safely in the wrong direction across the northbound bridge, which is currently happening around once a week. As well as having an impact on traffic, this also has resourcing implications for local police who are required to provide the escort. There is also high risk of damage to the iron truss structure from an impact with an oversized vehicle. Such an impact with the structure could potentially close the bridge to all traffic for an extended period until repaired. This last occurred in 1997 and closed the bridge to all heavy vehicles and reduced the bridge to once lane for five months until repaired and assessed as safe to open.

Planning needs to make sure this crossing can safely cope with traffic now and into the future. As part of the early project assessment it became clear that planning should focus on a new bridge that could address these issues and provide an opportunity to improve conditions at this crossing. It should be noted that options for just maintaining the southbound iron truss bridge (without the need for a new bridge) were initially considered (see Chapter 3).

It was not the intention of this study to decide on the future of the existing southbound iron truss bridge. For the purpose of the site options development study it was assumed that the existing southbound iron truss bridge would either be retained or removed.

It was also not assumed that a new river crossing should only be considered in the immediate area of the current Princes Highway corridor. A wider study area was considered around the three strategic transport corridors through Nowra Bomaderry including the current Princes Highway road corridor, the western bypass corridor, and a corridor to the east that could cater for a future extension of the South Coast rail line across the river.

The aim of the site options development study is to recommend a preferred location for a new bridge crossing of the Shoalhaven River. This document has been prepared to provide details of the preliminary and supplementary data collection process that allowed for the identification and analysis of five potential site options; an overview of value management activities and outcomes; and a description of the approach used to recommend a preferred site option.

1.2 Existing highway corridor and connecting road network

The Princes Highway is the main north-south transport corridor linking Sydney and Wollongong to the NSW South Coast and north-eastern Victoria. The highway is an important freight, bus and tourist route for the south coast, particularly beyond Bomaderry where the existing rail service terminates. Key tourist destinations accessed by the highway include Nowra and the south coast, with peak traffic volumes experienced on weekends and during holiday periods.

The section of the highway that crosses the Shoalhaven River is around 120 kilometres south of Sydney and 30 kilometres south west of Kiama. The existing river crossings are key components of the regional and local transport network. More specifically, they provide a critical link for the residents of Bomaderry and North Nowra to access the commercial centre of Nowra. Nowra's population centre north of the river is so significant that Shoalhaven City Council (SCC) refers to Nowra as 'Nowra Bomaderry'.

Near the river crossings, the Princes Highway corridor is connected to the local road network at the following three signalised intersections, which are located to the north and south of the existing bridges; as shown in Figure 1-2:

- The Princes Highway and Bolong Road intersection is located around 300 metres to the north of the Shoalhaven River. Bolong Road provides an alternative route - known locally as the 'Sandtrack' - to the Princes Highway for light vehicles (vehicles less than five tonnes) travelling to Gerringong and beyond
- The Princes Highway and Illaroo Road intersection is located less than 50 metres north of the Shoalhaven River. Illaroo Road is the primary point of access to and from North Nowra
- The Princes Highway and Bridge Road / Pleasant Way intersection is located around 150 metres south of the Shoalhaven River. Bridge Road is the primary point of access for traffic travelling between Nowra central business district (CBD) and the north of the Shoalhaven River.

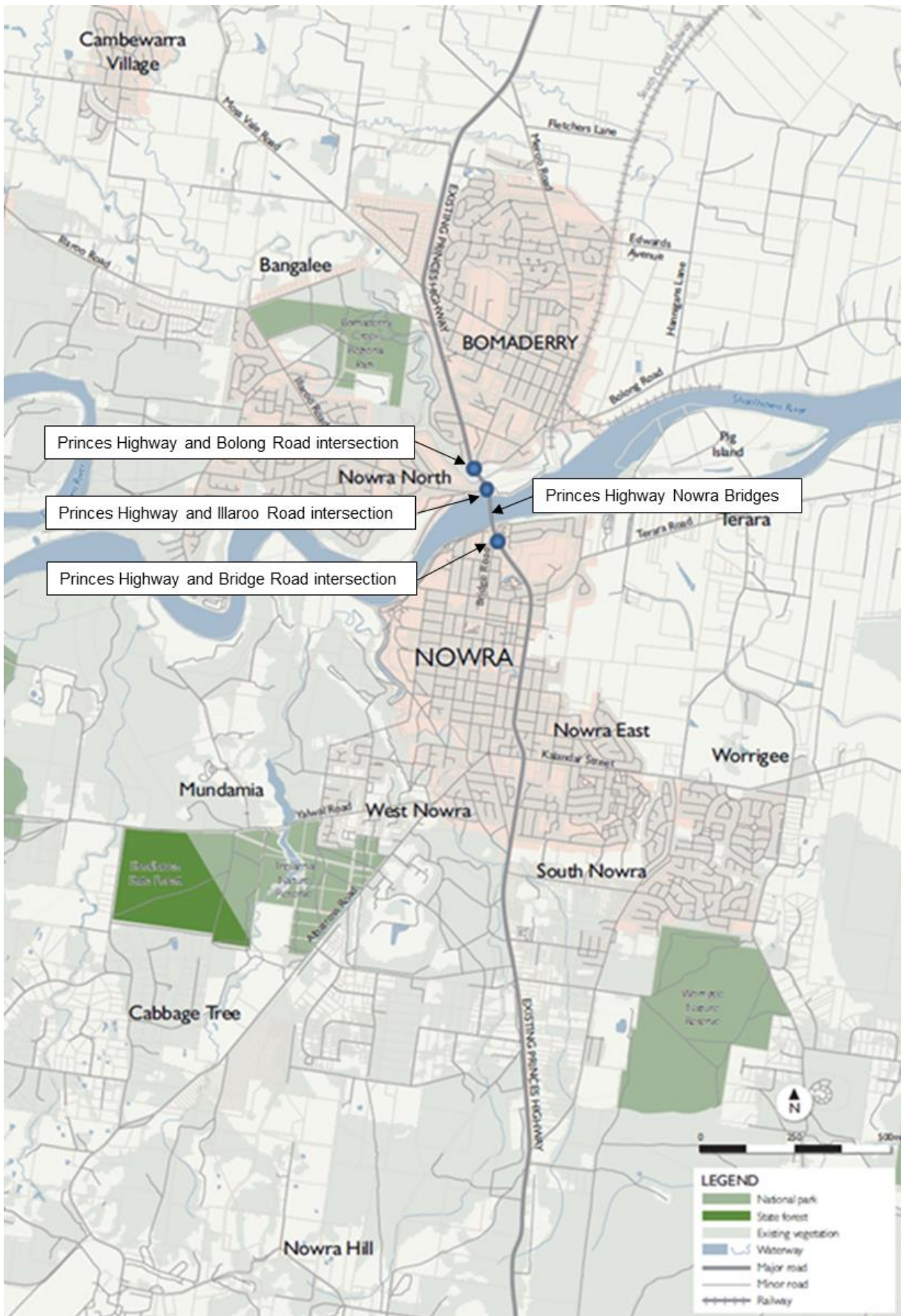


Figure 1-2 Princes Highway corridor and connecting road network

1.3 The bridge, objectives, and opportunities

1.3.1 The southbound iron truss bridge

The southbound iron truss bridge was built between 1879 and 1880 and was opened to traffic in August 1881.

The bridge is known as a 'Whipple pin-jointed truss' and is the only bridge of this design still in use in New South Wales.

The bridge is listed as having State significance in the Roads and Maritime Section 170 (S170) Register.

The listing states the bridge has significance because:

- It is the only American pin-jointed Whipple truss in service in New South Wales
- It has been an important item of infrastructure in the history of New South Wales for over 120 years
- It is a technically sophisticated bridge structure and unique for its time
- It has strong aesthetic lines despite its lightweight appearance
- It contributed significantly to the social and commercial development of the South Coast District of New South Wales
- It is associated with the famous American civil engineer and specialist bridge designer, C Shaler Smith.

The bridge has an overall length of 342 metres with the end truss of 56 metres, 7 trusses of 38.5 metres and an approach span of 15 metres. There is a 1.3 metre wide footway and the bridge is 5.8 metres wide between kerbs. Eight piers support the bridge structure.

The bridge is configured for two lanes of traffic. Due to the truss structure, vehicles and vehicles over 4.6 metres high and Higher Mass Limit vehicles (heavy vehicles that have been reconfigured to carry more weight than normal) cannot use the iron truss bridge. To travel south these vehicles require a police escort over the northbound bridge.

Vehicles between 4.3 and 4.6 metres high are still able use the bridge by moving to the centre of the bridge, using up both lanes.

The risk of an over height vehicle damaging the structure through a major or minor collision is high. To help reduce this risk the over height detection system was upgraded in 2013/14. The system activates for any vehicles between 4.3 and 4.6 metres high with a message to move to the centre of the Bridge. A separate message activates for vehicles over 4.6 metres high advising them to stop and call for an escort.

Figure 1-3 and 1-4 outline the typical configuration of a 'Whipple' Truss bridge.

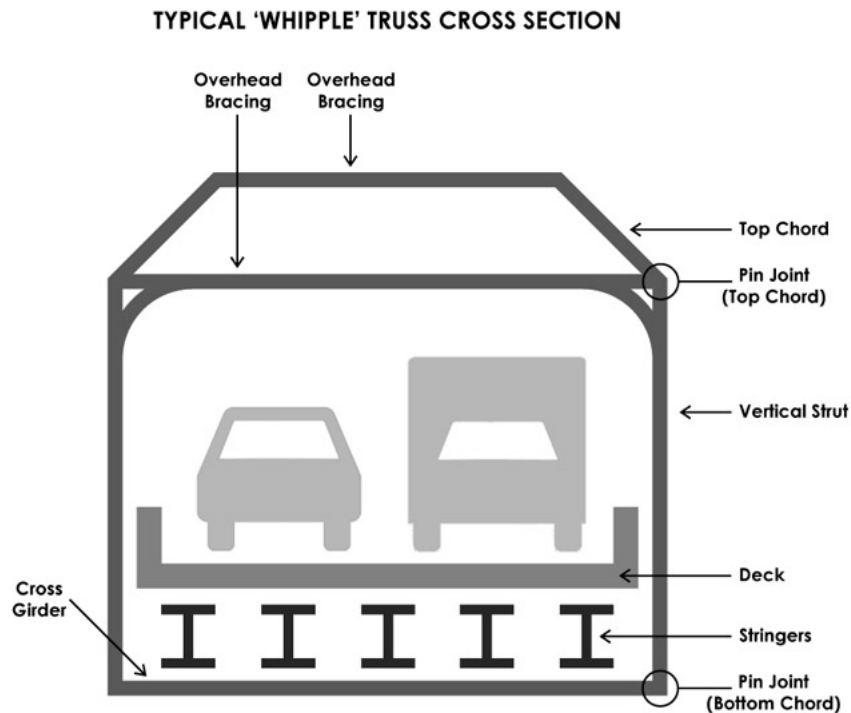


Figure 1-3 Typical cross section for a 'Whipple' Truss arrangement

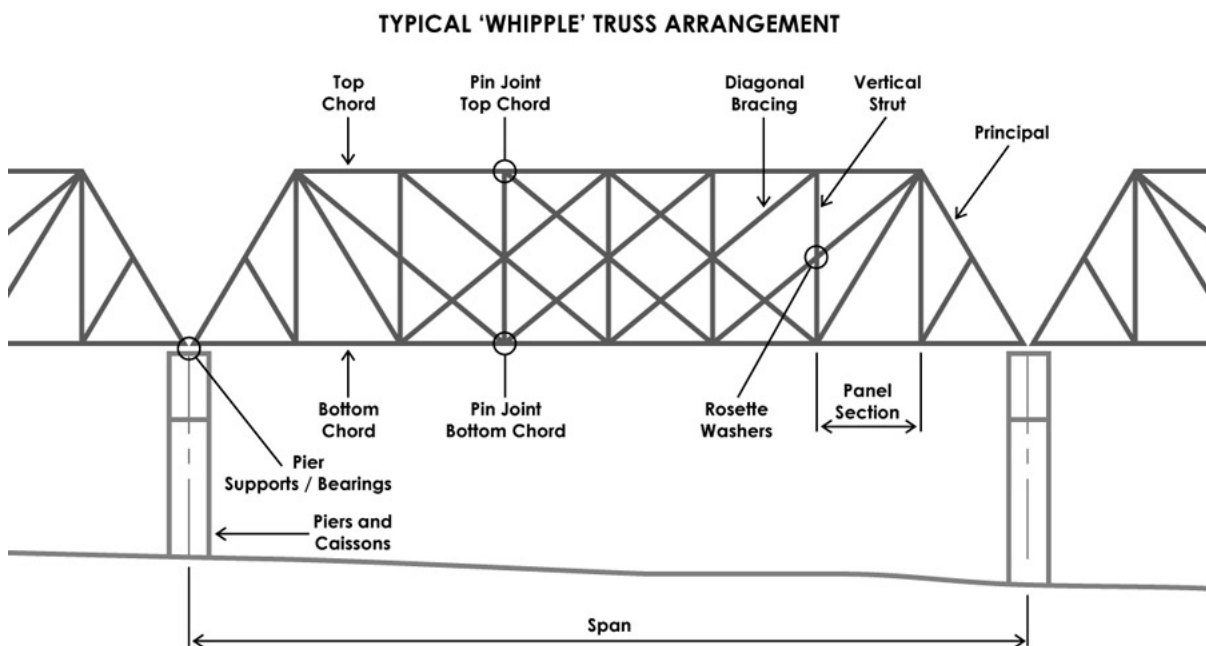


Figure 1-4 Typical 'Whipple' Truss arrangement

There have been a number of changes to the bridge since it was built:

- The original deck was timber and this was replaced in the 1950's with a corrugated steel deck and asphalt.
- At the same time in the 1950's a footpath was added on the eastern (downstream) side
- In 1981 the deck was again replaced, this time with a concrete deck and traffic barriers. The concrete deck is supported on corrugated steel similar to the deck installed in the 1950's

- In 1981 the footpath on the eastern (downstream) side was upgraded.
- The first truss span on the northern end was severely damaged by a heavy vehicle impact in 1997 and the bridge was closed for around 24 hours. The bridge was restricted to one lane for around five months until the damage could be repaired and parts of the truss replaced. During this time heavy vehicles were not able to use the southbound bridge and had to be transferred onto the northbound bridge.
- A cathodic protection system (to reduce corrosion) was installed on the caissons of the piers in 2010 to protect the piers from corrosion below the water level.

The bridge is at a point in its life where major refurbishment work is necessary. A recent condition assessment has confirmed that although the bridge is structurally sound, it requires major refurbishment in the short to medium term to ensure it continues to operate safely. The condition assessment of the bridge identified the following essential maintenance work:

- Because of its location, age and materials the bridge is constantly exposed to risk of corrosion, and this needs to be addressed by:
 - Cleaning, assessing, strengthening and painting all the pins in the top chord of the trusses where the vertical and diagonal components are joined
 - Cleaning, assessing, strengthening and painting all the ends of the trusses where the diagonal components are joined to the bottom chords and bearing supports
 - Repairing the end cross girder supports where the diagonal components are joined to the bottom chords and bearing supports
 - Cleaning and painting the end cross girders
 - Potentially increasing the frequency of inspections on the bridge from once every two years to annually
- The cast iron caissons are also constantly exposed to risk of corrosion particularly below water level and have other defects requiring attention:
 - Work to strengthen two piers where cracking on the caissons has occurred
 - Investigate options for strengthening the piers and carry out works if required
 - Maintain the cathodic protection system
 - Potentially increase the frequency of underwater inspections from once every four years to once every two years
- The attachment of the deck to the stringer supports is suffering from ongoing failures as are parts of the concrete deck at the piers:
 - Continue to carry out concrete repairs as needed
 - Investigate options for a new attachment system that will be more flexible and less prone to failure.
- The width inside the trusses is very narrow and low resulting in a high risk of impact from vehicles damaging various parts of the bridge. There are a number of locations on the bridge with minor impact damage and there are also a number of loose and broken components requiring attention:
 - Tighten loose components
 - Replace broken components
 - Repair impact damage on members where necessary
 - Investigate options for providing impact protection to the trusses.

Some of the smaller maintenance jobs are currently underway utilising night closures. However, if all of this work was to be carried out in one go (with the bridge closed to traffic) it could take around 12 to 18 months to complete. Given the high volumes of traffic that rely on the southbound bridge daily, any closures would have substantial impacts on traffic in the Nowra Bomaderry area and southbound traffic would need to be effectively relocated.

It is important to note that the recent assessment of the condition of the bridge also analysed the ability of the southbound bridge to continue to safely carry traffic and there is no immediate risks to the travelling public. However these issues need to be addressed in the short to medium term or the safety of the bridge would need to be re-assessed.

The southbound bridge is over 130 years old and cannot be expected to continue to carry modern day highway traffic volumes into the future without major refurbishment.

1.3.2 Objectives

Although there are many opportunities that may be achieved with the introduction of a new bridge, to be successful the new bridge must satisfy the following objectives as a minimum:

- To overcome the significant maintenance burden as well as freight vehicle limitations of the southbound bridge by providing a new crossing serviced by a modern cost effective structure
- Ensure a quality asset that can be maintained under existing and forecast traffic volumes
- Improve travel conditions and reduce traffic congestion
- Improve accessibility, safety and efficiency for all road users and public transport
- Improve southbound access for oversize or large vehicles
- Minimise any project related impacts on the physical and social environment as much as possible
- Minimise the project's ongoing maintenance 'whole of life' cost
- Ensure any new bridge structure is compatible with the long-term transport network in the Nowra region.

1.3.3 Opportunities

Although the new crossing location must satisfy the objectives stated above as a minimum, a new crossing provides other opportunities:

- There may be opportunity to refurbish the iron truss bridge for a purpose other than carrying highway traffic
- A new crossing location may provide opportunities for SCC to achieve the vision for Nowra Bomaderry stated in the Structure Plan
- A new crossing location may provide opportunity to reconfigure the current highway approach road network to improve safety, accessibility, and efficiency for all road users
- A new crossing location may provide an opportunity to look at both a future bypass of Nowra and a future railway corridor across the Shoalhaven River.

1.4 Planning context

The Nowra Bridge project is part of a suite of Princes Highway upgrades that will provide a four-lane transport corridor between Waterfall and Jervis Bay Road, Falls Creek; improve road safety; and enhance traffic efficiency (including for freight) on the NSW South Coast. Figure 1-5 provides details of the current status of these upgrades.

The NSW Government is committed to progressing the planning of the Nowra Bridge project with the current objective of identifying a preferred site option for a new river crossing. More specifically, the NSW Government allocated \$2 million to progress investigations to date. A further \$10 million has been committed by the Federal Government to complete planning.

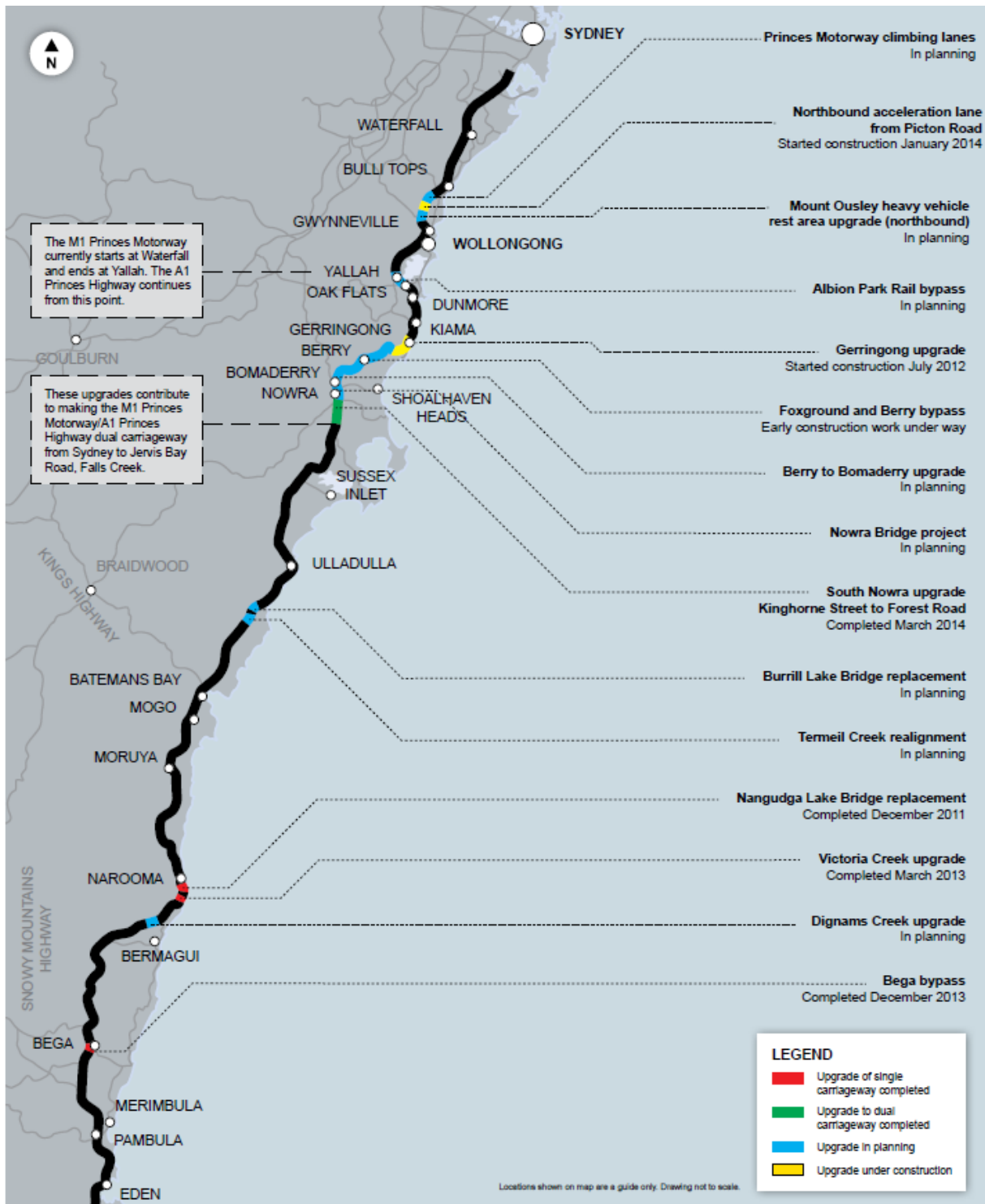


Figure 1-5 Princes Highway upgrades – progress since December 2011

1.5 Project development process

If the Nowra Bridge project proceeds to construction, it will be a major road infrastructure project for regional NSW. As such it will be subject to the planning, assessment and approvals processes that are typical for such large scale infrastructure projects.

1.5.1 Typical process for major road infrastructure projects

The main stages for major road infrastructure projects are divided into two areas; as shown in Figure1-6:

- *Project development* milestones that take place prior to construction activities
- *Project delivery* milestones associated with construction activities.

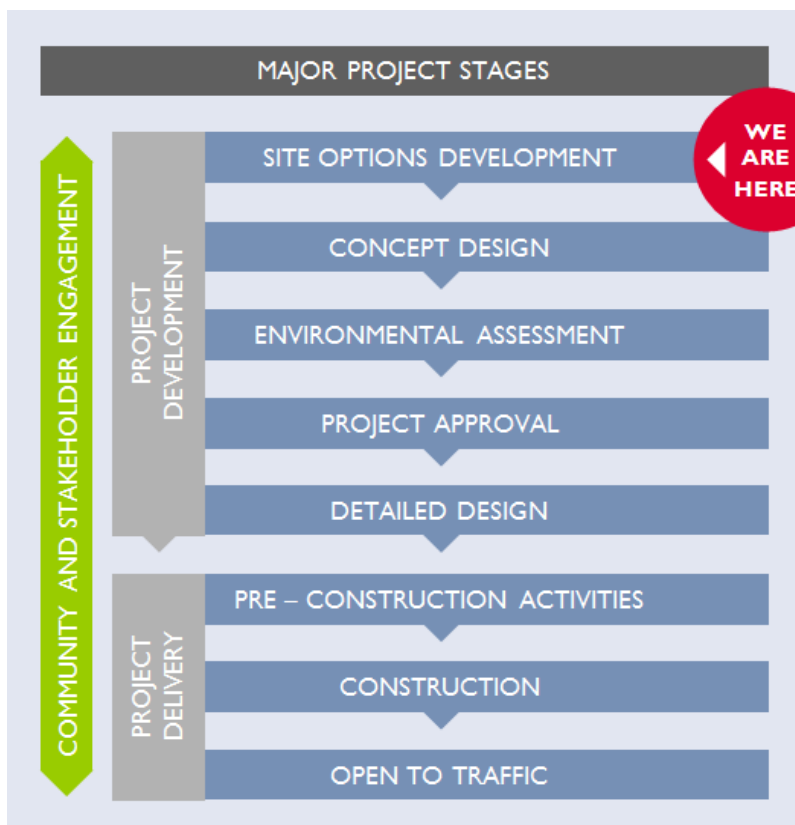


Figure 1-6 Project development and delivery stages for a major road infrastructure project

The Nowra Bridge project is in the early stages of the *project development* stage, which typically starts with the identification and assessment of route or site options. Once a preferred route or site option has been identified, the project can progress into the concept development phase, where concept design work is carried out. The final concept must be subject to the appropriate level of environmental assessment before the project can be approved for construction.

Roads and Maritime consider community and stakeholder engagement to be an important part of the development and delivery of any major infrastructure project, and implement various methods to continuously inform and engage throughout the life of a project.

1.5.2 The site options process for the Nowra Bridge project

The *project development* stage for the Nowra Bridge project began in late 2012 when funding was made available by the NSW Government to start investigations to improve conditions on the Princes Highway crossing over the Shoalhaven River at Nowra.

Figure 1-7 provides an overview of the Nowra Bridge project *site options development and assessment* process.

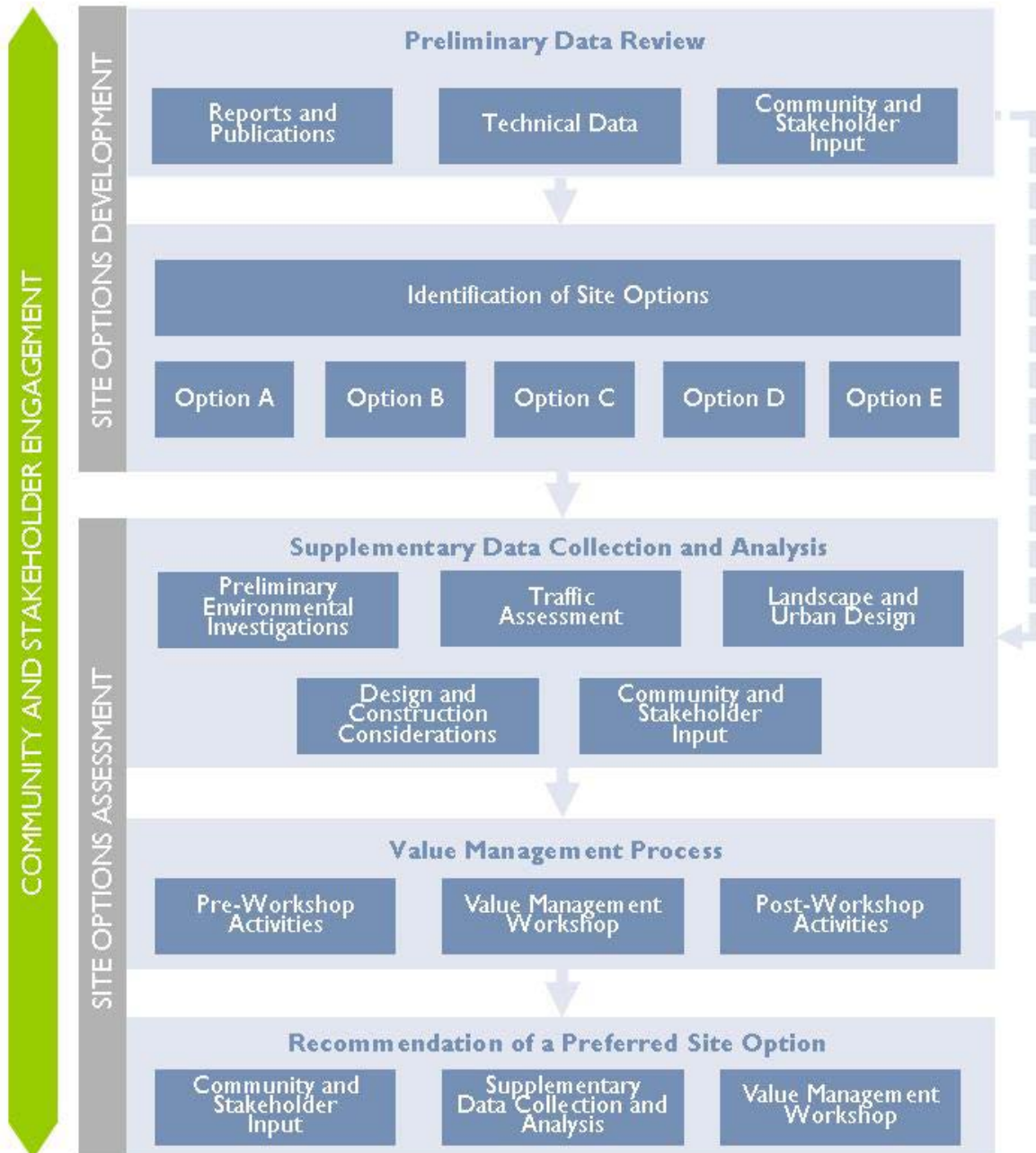


Figure 1-7 Overview of the Nowra Bridge site options development and assessment process

This process involved the collection of historical material and information during a preliminary data review phase. This ensured that the project team were familiar with all available data and also to identify 'gaps' in the knowledge base. These 'gaps' formed the basis for supplementary investigations across a range of technical areas.

Community and stakeholder engagement began in late 2013 to introduce the needs, opportunities and expected constraints associated with the project. This also provided an opportunity to gain information about the project that the project team may not have been aware of. The information gathered during the preliminary data review and stakeholder engagement phases were used to identify five site options for a preferred crossing location.

Additional data necessary to address 'gaps' in the knowledge base included:

- A preliminary environmental investigation (PEI) of all the identified site options, including field work where appropriate and feasible
- A desktop review of the possible Aboriginal and Non-Aboriginal constraints in the area of the site options, including a review of the Roads and Maritime Section 170 (S170) heritage assessment of the iron 'Whipple' truss bridge
- A preliminary landscape character and urban design assessment of the Shoalhaven River and foreshore through Nowra Bomaderry
- A desktop review of sensitive land uses that may be affected in the short and longer term by any of the site options, as well as consultation with some potentially directly affected property owners
- Some preliminary design work to assess the likely impact of site options on surrounding property, particularly in the most constrained areas around the existing river crossings
- An assessment of possible constructability issues, safety in design issues and other risks that may be encountered during the construction of the site options
- Extensive traffic modelling of the possible benefits, impacts and expected use of the site options, and sensitivity testing of additional river crossing locations at away from the existing river crossings
- A review of the crash history in the area of the existing river crossings, and a stage 5 'existing' road safety audit
- Consultation with other NSW Government transport agencies to assess the feasibility of catering for a future rail extension across the Shoalhaven River.

A value management process was carried out in early 2014 and involved a workshop held on Thursday 22 May 2014, with a diverse range of specialists from various NSW Government agencies, Shoalhaven City Council, emergency services, as well as representatives from the community, industry and other stakeholders. The value management process recommended a preferred option, subject to a series of issues to be addressed.

The site options and assessment process will conclude with a NSW Government approved location for a new crossing of the Shoalhaven River in Nowra. The approved location will be informed by the results of the preliminary and supplementary data gathering activities, the recommendation of the value management process as well as input from the community and stakeholders. The *Site Options Development Report* considered all of this information and recommends the preferred location to concentrate future efforts on concept development for a new bridge.

1.6 Structure of the report

This report has been structured into the following chapters:

- Chapter 2 provides details of the preliminary data review
- Chapter 3 includes an overview of the site option identification and development process
- Chapter 4 provides details of supplementary data collection and analysis
- Chapter 5 outlines the value management process, activities and outcomes
- Chapter 6 documents the preferred site option selection process.

2 Preliminary data review

The aim of the preliminary data review phase was to:

- Familiarise the project team with the available information, understand the key findings and determine whether the historical information was still relevant
- Collate a range of information to help the project team inform the community of the known issues, and assist with community consultation
- Gather enough information to assist the identification of site options for further assessment
- Identify areas of knowledge 'gaps' where additional supplementary investigations would be necessary to assess the identified site options.

It became clear during the preliminary data review phase that previous Roads and Maritime river crossing studies and Shoalhaven City Council's Nowra Bomaderry Structure Plan were two comprehensive and key sources of information. Available information from all sources is presented in Chapter 2.4.

At the conclusion of the preliminary data review phase there was satisfactory evidence to justify the selection of five site options for further investigation and analysis (see Chapter 3).

This phase also identified knowledge 'gaps' where supplementary data collection would be needed so the five site options could be appropriately assessed (see Chapter 4).

2.1 Roads and Maritime river crossing studies

Roads and Maritime previously commissioned SMEC to carry out the following two studies into the location and feasibility of an alternative crossing of the Shoalhaven River:

- Additional Shoalhaven River Crossing, Nambaa Island to Bangalee (2004)
- Princes Highway Shoalhaven River Crossing Interchange Study (2005).

The 2004 study investigated potential locations for an additional crossing of the Shoalhaven River to improve road transport safety and efficiency. It is important to note that this study assumed that the existing southbound bridge would remain in service and a new crossing would be a third crossing of the Shoalhaven River. This study did not intend to identify a preferred new crossing site but did conclude that the most feasible location for an additional crossing would be near the existing crossings. The 2004 study highlighted additional traffic congestion issues associated with the intersections on the approaches to the current crossings. Opportunities were identified to address traffic capacity issues associated with these intersections.

Further investigations of these opportunities and constraints was the subject of the 2005 study, which gathered additional traffic data and developed strategic designs for existing intersections on the southern and northern approaches to the bridges. Options were considered to improve the efficiency of traffic approaching and crossing the river. These options assumed that the existing southbound bridge would remain in place. However, other intersection arrangements, required to support a third river crossing in the vicinity of the existing crossings, were considered as part of this study.

At the time of publication of the SMEC studies, the maintenance issues of the existing southbound bridge as known today were not well defined or understood. As such, the studies focused solely on traffic capacity issues.

The key findings of the historical SMEC studies, together with other relevant additional material, are presented by technical area in Section 2.4.

2.2 Shoalhaven City Council Nowra Bomaderry Structure Plan

Shoalhaven City Council (SCC) has developed a number of recent planning studies. The most comprehensive document is the Nowra Bomaderry Structure Plan. This document provides a comprehensive 'whole-of-Council' analysis and sets the Council's development-conservation agenda for the next 20-30 years, including transport and land-use plans for the Nowra Bomaderry area.

The Structure Plan presents existing and future constraints and opportunities for the Nowra Bomaderry area as considered by SCC. More specifically, the document describes the urban structure of Nowra Bomaderry in terms of the following areas:

- Living areas: consolidating existing urban areas and identifying new neighbourhoods
- Conservation areas: protecting threatened species and vegetation communities, providing riparian corridors and habitat linkages
- Employment areas: supporting existing retail centres, developing new neighbourhood centres and identifying future industrial land
- Community facilities: providing for new primary and high schools and identifying future recreation and community facility provision
- Transport: identify a western bypass road and district road network
- Urban infrastructure: providing for new infrastructure to service new neighbourhoods
- Implementation: proposing an indicative implementation phasing sequence.

2.3 Other information

Other material referenced in this preliminary data collection and analysis phase includes:

- Database searches
- Regional strategy documents
- Newspaper articles
- Drawings and design information from the existing concrete box girder bridge.

A full listing of documents during the preliminary data collection and analysis phase is provided in Appendix A.

2.4 Discussion by technical area

The purpose of this preliminary data collection and analysis phase was to identify what was known and what additional information was needed, in each technical study area. However, in order to direct further study effort in the most appropriate areas it was necessary to take a view on the cumulative effects of the current levels of knowledge in each technical area.

The following sections include discussion under the following technical areas:

- Council plans and vision
- Community perspective and expectations
- Traffic and transport
- Environment
- Hydrology
- Utility infrastructure

- Geotechnical.

2.4.1 Council plans and vision

The Nowra Bomaderry Structure Plan Structure Plan largely presents the problems associated with the Princes Highway and existing bridges in terms of traffic and transport, which is discussed in detail in Section 2.4.3. The Princes Highway is the single north-south spine road through Nowra Bomaderry's system of urban areas and is described in the Structure Plan as the 'Achilles heel' of the of the Nowra Bomaderry road network. Further discussion of Council's position on traffic and transport issues, and how this was used in this current site options study, is presented in Chapter 4.

It is worth noting that the problems identified in the Structure Plan do not necessarily align with the problems identified by Roads and Maritime. Council, by the nature of their function, are required to address a wide-ranging set of local community issues. Roads and Maritime is required to address more regional traffic and transport issues. However, the aim of this current site options study was to consider multiple constraints and opportunities and identify the solution which best accommodated the needs of both agencies.

The Structure Plan identifies a long term need for a western bypass of Nowra Bomaderry. The Structure Plan states that only five per cent of traffic is through traffic and would use a bypass. It concludes that the bypass would need to also function as a local collector road providing greater access to the urban road network. A corridor for this bypass features in the Shoalhaven Local Environmental Plan (SLEP).

The Structure Plan also includes discussion regarding conflict between the dominant north-south movements on the highway and the growing east-west movements. To address congestion, Council believes it is likely that three additional river crossings may be required by 2036. These include a western bypass, an inner eastern bypass, and an inner western bypass.

Various additional Council reports are available to inform the study. However, the Structure Plan provides the consolidated and coordinated consideration of these individual studies. Relevant aspects of Council's Structure Plan are discussed in more detail in the following sections. Other relevant Council studies are summarised in Table 2-1.

Table 2-1 Relevant Shoalhaven City Council studies

Study	Purpose	Relevant issues
Draft Nowra CBD Master Plan Strategic Direction, 2011.	Outlines a strategic direction to revitalise the Nowra CBD over the next 25 years.	<ul style="list-style-type: none"> • Presents potential options for the treatment of the Northern Gateway • Includes a number of background documents describing Council's plans • Council's preferred long term option includes relocating CBD access from the highway to a new signalised intersection north of the Council Chambers and south of Graham Lodge.
The Shoalhaven Riverfront Gateway Masterplan Study Report, 2010.	To identify key development constraints and provide design principles for the redevelopment of the 'Gateway Precinct, Scenic Drive, Nowra' to inform the draft SLEP. Includes preliminary advice on the location and style of buildings and open space to minimise flood impacts.	<ul style="list-style-type: none"> • There is a desire to retain existing public spaces and to integrate the city with the river front in the area north of Hyam Street • There is the possibility of creating an effective visual "gateway" experience through both landscape and built form development which reflects the aspirations of the city • The opportunity exists to provide some high quality residential development opportunities which can take advantage of the views across the river and to the mountains but within walking distance of major civic facilities such as the Shoalhaven Entertainment Centre • Report comments that the Princes Highway / Bridge Road intersection remains a major congestion point • A significant floodwater flow path is required across Bridge Road and the Princes Highway to allow for extreme flood conditions • Bridge Road is viewed as the gateway into Nowra • Associated traffic study discusses possible reconfiguring options for the Highway / Bridge Road / Pleasant Way intersection. An additional 'local road' river crossing separating highway and local traffic is also discussed.
Draft Shoalhaven Local Environmental Plan 2013	Local planning instrument	<ul style="list-style-type: none"> • Land zoning map indicates an 'infrastructure' corridor for the West Nowra Bypass.
South Coast Transport Study, Maunsell McIntyre, 2000	Identification of present and future transport infrastructure improvements required in the region.	<ul style="list-style-type: none"> • Possible large population growth in the Shoalhaven area could possibly justify the electrification of the railway line to Bomaderry • Efficient truck movement of goods is a very important need to areas south and north of Nowra • Recommended to strengthen bridges to permit for the free movement of B-doubles between Nowra and Bega.
Nowra CBD Transport Strategy, Eppell Olsen & Partners, 2003.	Outlines the major transport and traffic management aspects for the Nowra CBD Strategy.	<ul style="list-style-type: none"> • Substantial growth is forecast for the south-east Nowra region. An East Nowra Sub-arterial Link road is proposed between the vicinity of North Street, across the floodplain to Kalandar Street.

2.4.2 Community and Stakeholder involvement

Previous communications for previous projects

In 2004 the then Roads and Traffic Authority (RTA) carried out a study to identify feasible locations for an additional crossing in Nowra. As part of the study two community events were held.

Workshop

A workshop was held on 11 February 2004 at the Shoalhaven City Council offices and included stakeholders from a range of organisations including government departments, service providers (utilities and telecommunications) transport and environment agencies.

The goal was to inform stakeholders of the results of the first stage of the study and to provide an opportunity for input. It was emphasised at the workshop that the aim was not to decide the best option or rate the options, but to ensure all possible options had been looked at and that input from stakeholders was received.

Presentation

A presentation on the study's goals was provided to Shoalhaven City Councillors on 31 May 2004 at the Shoalhaven City Council offices. Questions were taken from Councillors following the presentation. Councillors were most interested in when any proposed crossing might be built.

Councillors were informed that the study was preliminary and yet to be finalised, that the report was not intended to identify the preferred option, and that it was not possible to put a timeframe to a future crossing until a preferred option study had been carried out.

Table 2-2 presents a summary of the agency feedback that was captured at the two events.

Table 2-2 Summary of agency feedback - SMEC report

Agency	Summary of feedback
Department of Environment and Conservation	<ul style="list-style-type: none">• Extension of the rail line should be considered• Consideration in the planning of impacts to hydrology (flooding) and threatened species• Concern that the community does not understand how issues of timing and impacts to the environment need to be considered in the overall planning• A bridge location west of the existing bridge on Bomaderry Creek and association with Nowra Creek would not be supported.•
Department of Infrastructure, Planning and Natural Resources	<ul style="list-style-type: none">• The life expectancy of the old bridge needs to be considered and duplication would be based on the steel bridge life• Flooding impacts need to be considered in the crossing site and feeder roads• Local traffic congestion is a major driver in the need for a second crossing.
Local Aboriginal Council	<ul style="list-style-type: none">• There may be impacts on Aboriginal sites near Mundamine Creek and Redan Cave.
Telstra	<ul style="list-style-type: none">• Optical fibre cables near the existing bridge will need closer investigation for future works.
Department of Fisheries	<ul style="list-style-type: none">• Eastern routes would impact on commercial fishing.
Shoalhaven City Council	<ul style="list-style-type: none">• Traffic is expected to increase due to further land releases, which a bypass would not resolve as more than 50% traffic is local in origin.• Capacity of intersections at either end of the crossing needs to be factored into the process; a network analysis would need to part of a separate investigation.

Early consultation on the Nowra Bridge project

The below information relates to the early stages of the project. For information on community consultation activities carried out at later stages please refer to Chapter 5.

Roads and Maritime has been engaging with the Nowra and Bomaderry communities since the start of the Nowra Bridge project in 2012. In the early stages, Roads and Maritime communicated with stakeholders gathered from a desktop search and interested community members who had registered to receive information on the project website:

http://www.rms.nsw.gov.au/roadprojects/projects/princes_hway/nowra_bridge/index.html

Stakeholders included local businesses, government agencies, emergency services, transport agencies, council representatives, schools, hospitals, aged care facilities and historical societies.

The aim of the consultation during the early stages of the project was to introduce the project need and goals, to identify local issues and suggestions for potential site options, and to gather feedback from the community regarding the project development.

Key methods of communicating in the early stages of the project included:

- Regular updates to the project website
- Householder letters to the Nowra Bomaderry area
- Project emails – to registered stakeholders
- Project inbox – used to field inquiries relating to the Nowra Bridge project
- Regular media releases
- Targeted stakeholder meetings with interested community groups
- Community information sessions
- Door knocks with potentially affected property owners
- 1800 project telephone information line.

As part of these early consultation activities, four community meetings were held in November and December 2013 at the Nowra School of Arts. The key comments captured from the community meetings are summarised in Table 2-3. Additional information on community feedback received from the meetings and responses provided by Roads and Maritime is provided in the *Nowra Bridge Project Consultation Report* (refer to Appendix D).

Information gathered from the community in the early stages of the Nowra bridge project played a major role in the identification of potential site options (refer to Chapter 3).

Table 2-3 Summary of the issues captured during recent community consultation
(Please note that comments may not be factual)

Issue	Key comments and issues
Maintenance	<ul style="list-style-type: none"> • The iron truss bridge is no longer practical and should be replaced • The old bridge is in danger of collapse • Cost associated with maintaining the iron truss bridge is too high and should be removed and replaced.
Location	<ul style="list-style-type: none"> • Suggestions that the proposal should be located in the vicinity of the existing bridges • Suggestion that replacing the bridge in the same area may not be the best solution, given the current congestion issues at this location • The need to take into account the future urban development of Nowra • Recommendations were also submitted for a western, eastern and northern bypass of Nowra.
Property	<ul style="list-style-type: none"> • Acquisition of private property if a new bridge is to be constructed alongside the existing bridges.
Traffic	<ul style="list-style-type: none"> • Congestion issues, specifically that a new bridge on its own would not ease extensive traffic flows and that a new grade separated interchange at Bolong Road / Illaroo Road should be included. It was also suggested that the existing traffic lights should be removed and replaced with a roundabout • A new crossing should manage future traffic, including peak traffic volumes during holiday periods • Road safety issues need to be addressed, including crashes and incidents on both bridge approaches and the Moss Street intersection • Improving and resolving traffic conditions in the vicinity of the bridges is critical to longer term growth and development.
Accessibility/ connectivity	<ul style="list-style-type: none"> • The use of the existing iron truss bridge as a cycleway / pedestrian bridge should be considered • Importance of public access to pier / waterfront for recreational purposes • Inclusion of cycleway / dedicated cycle paths should be considered.
Environment	<ul style="list-style-type: none"> • Construction impacts on local amenity • Heritage impacts on the iron truss bridge, which is iconic and should be retained in some capacity • Noise impacts on the retirement village • Environmental issues, including endangered orchid species should be considered in any design of a bypass option • Risk of the iron truss bridge being washed downstream during a flood event, which needs to be considered if a new river crossing is to be built to the east.
Design	<ul style="list-style-type: none"> • The need for wider and additional lanes • Incorporation of both road and rail traffic on the new bridge • Options such as tunnels, a flyover, development of a scenic coastal route, or a local loop link road should be considered.

Nowra Bridge in the media

From local media reports, there was evidence that speculation about a replacement bridge had been actively discussed from at least 2011, with the Shoalhaven Business Chamber President and the General Manager of Shoalhaven Council reported as expressing frustration that the then RTA was publicly denying plans to build a new bridge, despite operational inefficiencies, the high cost of maintaining the heritage bridge, and the restrictions on council strategic planning while the bridge issue remained unresolved (South Coast Register, 18 September 2011).

In June 2012, the NSW State Government announced the allocation of \$1 million towards a study to identify the preferred location for a proposed new bridge crossing. This was welcomed by the Mayor of Shoalhaven City Council (Council press release).

In March 2013, an announcement was made that the tender was awarded to carry out the study into the best possible location for a new bridge over the Shoalhaven River (South Coast Register, 6 March 2013). The announcement was made jointly by local MPs, Shelley Hancock (South Coast) and Gareth Ward (Kiama), who said that the study will provide the community and stakeholders with greater certainty about the future location of the southbound crossing, and that community engagement will be an important part of the project.

Community comments from blogs and responses to newspaper articles

Following the tender announcement in the South Coast Register (6 March 2013), there were six comments posted on the South Coast Register website. All expressed some degree of frustration over perceived completion times, limitations on traffic capacity, lack of a rail extension and heritage.

The Currarong Progress Association blog

This stakeholder group supported an extended rail line over the Shoalhaven River and quoted Neil Reilly and Gareth Ward. Neil Reilly raised the possibility of a rail extension to Canberra while Gareth Ward also raised the consideration of a rail bridge as part of the new road crossing with parliamentary colleagues.

2.4.3 Traffic and transport

Previous studies

In the preliminary data review phase a number of studies were identified as being relevant to the identification of a new crossing location from a traffic and transport perspective:

- Nowra Bomaderry Structure Plan
- Nowra CBD Master Plan
- SMEC studies from 2004 and 2005.

These studies were identified as key sources of information; which are discussed further in this section.

Nowra Bomaderry Structure Plan

(Shoalhaven City Council, Adopted 2006; endorsed by NSW Department of Planning February 2008)

The Nowra Bomaderry Structure Plan comprises two parts; Strategic Direction and Background Report. The Background Report provides the rationale and technical support to the Strategic Direction. Together these documents set Nowra Bomaderry's transport and land-use plans for a 20-30 year timeframe.

The adopted future Structure Plan is shown in Figure 2-1, which includes:

- A proposed western bypass and district road network
- Consolidating existing urban areas and identifying new neighbourhoods
- Supporting existing retail centres, developing new neighbourhood centres and identifying future industrial land.

Future developments in Nowra Bomaderry would be phased to meet the needs of the community. Factors influencing the development of new living areas north of the Shoalhaven River include the construction of an additional Shoalhaven River bridge, and development of the North Nowra Bomaderry Link Road.

The Structure Plan includes the following traffic and transport objectives:

- Provide a transport system that maximises equitable and affordable accessibility to activity areas
- Provide a road network which enables the efficient, safe and convenient transit of people and goods
- Implement a network that offers and encourages a range of transport modes
- Facilitate the development and operation of public transport
- Road network planning should provide for practical staging based on capacity needs
- Plan and provide a road network hierarchy which provides safe, efficient, and well-connected public transport routes
- Plan and provide safe, efficient, and well-connected pedestrian and cyclist routes.

The Structure Plan notes that the Princes Highway and various intersections with regional, collector, and local roads is a key constraint of the road network in the Nowra Bomaderry area, concluding that *'without significant capital investment, the Princes Highway and its key intersections will continue to suffer from major capacity deficiencies and resultant safety issues'*.

The Structure Plan provides an analysis of strategic traffic patterns, based on Origin-Destination (O-D) studies carried out in December 1994 and September 2003. The analysis indicates that the following proportions of traffic travel across the existing Shoalhaven Bridges during a typical day:

- Approximately 10-15 per cent of trips travel through the Nowra Bomaderry area without stopping
- Approximately 35-40 per cent of trips include an origin or destination outside the Nowra Bomaderry area
- Approximately 50 per cent of trips are generated by local traffic contained within the Nowra Bomaderry area.

As a result the Structure Plan suggests that:

- A complete bypass of Nowra Bomaderry will not resolve the issues on the existing Princes Highway
- A bypass of Nowra Bomaderry would need to include suitable access points to urban expansion areas to promote and maximise its use.

The Structure Plan acknowledges that Roads and Maritime (formerly RTA) has indicated that any bypass of Nowra Bomaderry would be a restricted access route, and the plan proposes Shoalhaven City Council continue to liaise with Roads and Maritime to determine if and where limited access may be feasible.

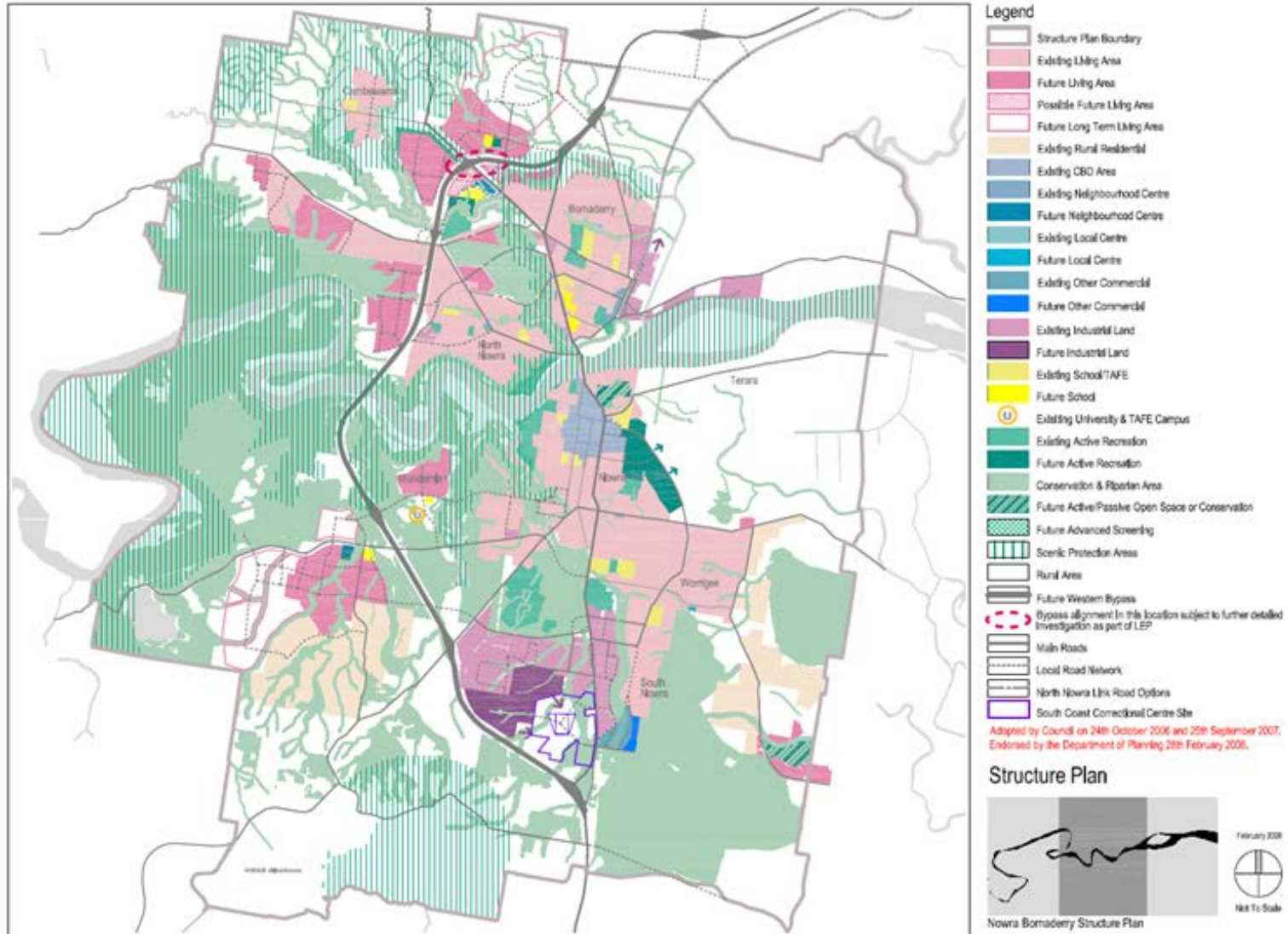


Figure 2-1 Nowra Bomaderry Structure Plan

Source: Nowra Bomaderry Structure Plan (Shoalhaven City Council, adopted 2006)

The Structure Plan proposes the following key road projects to address capacity issues in the short-medium term:

- North Nowra to Bomaderry Link Road: This upgrade is expected to reduce the demand on the Princes Highway | Illaroo Road intersection, and defer the need for an upgraded river crossing
- Shoalhaven River Bridge intersections: This comprises upgrades to the existing Princes Highway | Bolong Road, Princes Highway | Illaroo Road, and Princes Highway | Bridge Road intersections
- East Nowra Sub-Arterial (ENSA): This upgrade would construct a new road link connecting Greenwell Point Road to the Princes highway at North Street and Junction Street
- South Nowra Road Strategy: This strategy addresses capacity issues of the Princes Highway through South Nowra, to address accessibility and capacity issues
- Other new network links identified for further investigation:
 - Road infrastructure relating to urban expansion areas
 - New East-West Road in south west sector; connecting Hillcrest Avenue to Yalwal Road
 - Extension of Flinders Road to Cabbage Tree Lane and beyond
 - Warra-Warra Road to Flinders Industrial Estate
 - Yalwal Road to enable the development of new living areas
 - Moss Vale Road to enable the development of new living areas.

The Structure Plan acknowledges that a high dependence on private vehicle transport is expected to continue in the short-medium term, affecting parking demand, accessibility to and circulation within Nowra CBD. Despite this public and active transport schemes are identified for consideration.

In the long term the Structure Plan identifies the need for a western bypass to supplement the Princes Highway 'spine'. Land is reserved for this development within the Shoalhaven Local Environmental Plan (SLEP). It is suggested that a western bypass would:

- Provide a major collector road role, through the inclusion of several grade-separated interchanges to provide connectivity to the urban road network and Princes Highway
- Potentially be supplemented by additional river crossing capacity to the east of the Nowra Bomaderry area
- Not eliminate the need to provide additional river crossing capacity at the existing bridges.

Identified gaps in knowledge

The Structure Plan provided a comprehensive overview of planning direction proposed in the Nowra Bomaderry area. The Structure Plan was adopted in 2006 and incorporated a 2021 planning horizon. As the Structure Plan was adopted in 2006, the relevance, feasibility, and timescales of various options needed to be reconfirmed through discussion and collaboration between Roads and Maritime and SCC.

Since the adoption of the Structure Plan the transport planning landscape has changed, following the recognition that the existing southbound bridge would not continue in the same role in the medium-long term. Despite this change, the Structure Plan acknowledged the need to provide additional capacity at the existing bridge crossings.

Nowra CBD Master Plan (Transport Background Report)

(Arup on behalf of Shoalhaven City Council, 2010)

The Transport Background Report was developed by Arup as a supporting document to a 25 year Master Plan for Nowra CBD. It includes a review of previous studies, existing traffic conditions and future considerations to support land-use and transport network proposals relevant to the development of the Master Plan.

Conclusions of the Transport Background Report note that:

- The Shoalhaven River Bridges and adjacent intersections are particularly susceptible to higher traffic volumes
- A combination of local growth in the Nowra Region and background growth on the Princes Highway will lead to an increase of future traffic volumes through the CBD and highway, regardless of whether the Western Bypass goes ahead
- It is, however, essential to recognise the important role of the private vehicle in Nowra, and in future planning to accommodate the possible need for road improvements and expansion.

Potential access options proposed between Nowra CBD and the Princes Highway (Northern Gateway) are illustrated in Figure 2-2. The long-term road network strategy proposed is shown in Figure 2-3.

Identified gaps in knowledge

The relevance, feasibility, and timescales of various options presented by the Master Plan need to be confirmed through discussion and collaboration between Roads and Maritime and Shoalhaven City Council.

Although concepts for the Northern Gateway to Nowra CBD are proposed, no assessment of the performance of these options in traffic and transport terms appears to have been carried out.

Option 1A



Option 1B (recommended - short term)



Option 2A



Option 2B



Option 2C (recommended - long term)



Option 2D



Option 3A



Option 3B



Option 3C



Figure 2-2 Northern Gateway options overview

Source: Nowra CBD Master Plan (Arup on behalf of SCC, 2010)



Figure 2-3 Proposed road network hierarchy

Source: Nowra CBD Master Plan (Arup on behalf of SCC, 2010)

Additional Shoalhaven River Crossing – Numbaa Island to Bangalee Feasibility Study

(SMEC on behalf of RTA, June 2004)

The study (the 'Feasibility Study') investigated the feasibility of an additional crossing of the Shoalhaven River, considering traffic, environmental, community, and local government needs. It is important to note that at the time of publication of the SMEC studies, the maintenance issues of the existing southbound bridge as known today were not well defined or understood. The Feasibility Study assumed that the existing southbound bridge was to remain in service, and a third bridge was to be introduced. The study objectives did not include the recommendation/confirmation of a preferred crossing option; it was carried out to determine feasible and eliminate non-feasible crossing options. Specifically in traffic and transport terms the purpose of the Feasibility Study was:

- To identify broad strategic locations for additional river crossing
- Reduce delays on the existing bridge (existing and future)
- Determine implications for local and regional traffic movements
- Gain and incorporate feedback from government agencies and community on options.

Strategic traffic modelling was a key component of the Feasibility Study. This was used to analyse the relative merits of various crossing options in terms of forecast traffic expected to use the existing and new crossing. Effectively this demonstrated how each option would attract and accommodate strategic traffic demand travelling to and through Nowra and its surrounds. The traffic modelling task included:

- Review of existing and collection of additional traffic data, including intersection and origin-destination (O-D) surveys to confirm existing traffic demands and patterns
- Incorporation of forecast population and employment growth in the Shoalhaven area and nearby centres to enable the consideration of corresponding traffic growth
- Co-ordination with SCC's Nowra Bomaderry Structure Plan, SLEP, and Working document for Nowra Bomaderry Transport Models to analyse the merits of strategic locations proposed by pre-existing plans
- Consideration of roadway capacity, intersection capacity, and through/local traffic needs at a strategic level.

The Feasibility Study nominated 'likely' locations for an additional crossing based on information available at the time. These were six distinct options, located between a potential new western crossing aligned with the Shoalhaven SLEP Nowra bypass route to a new eastern crossing in the vicinity of Pig Island.

The eastern and western bypass options were included to test the viability of outer eastern and western bypass proposals, consistent with the Nowra Bomaderry Structure Plan. A number of options at or in close proximity to the existing bridge crossings were also considered. An overview of the options is provided in Figure 2-4.

Options were modelled using TRACKS strategic modelling software. By modelling alternative network options the relative 'attractiveness' to future traffic of each option was assessed. A key output of this modelling was the development of forecast traffic volumes on the existing and proposed bridges, as well as transport impacts at a strategic level on other parts of the network.

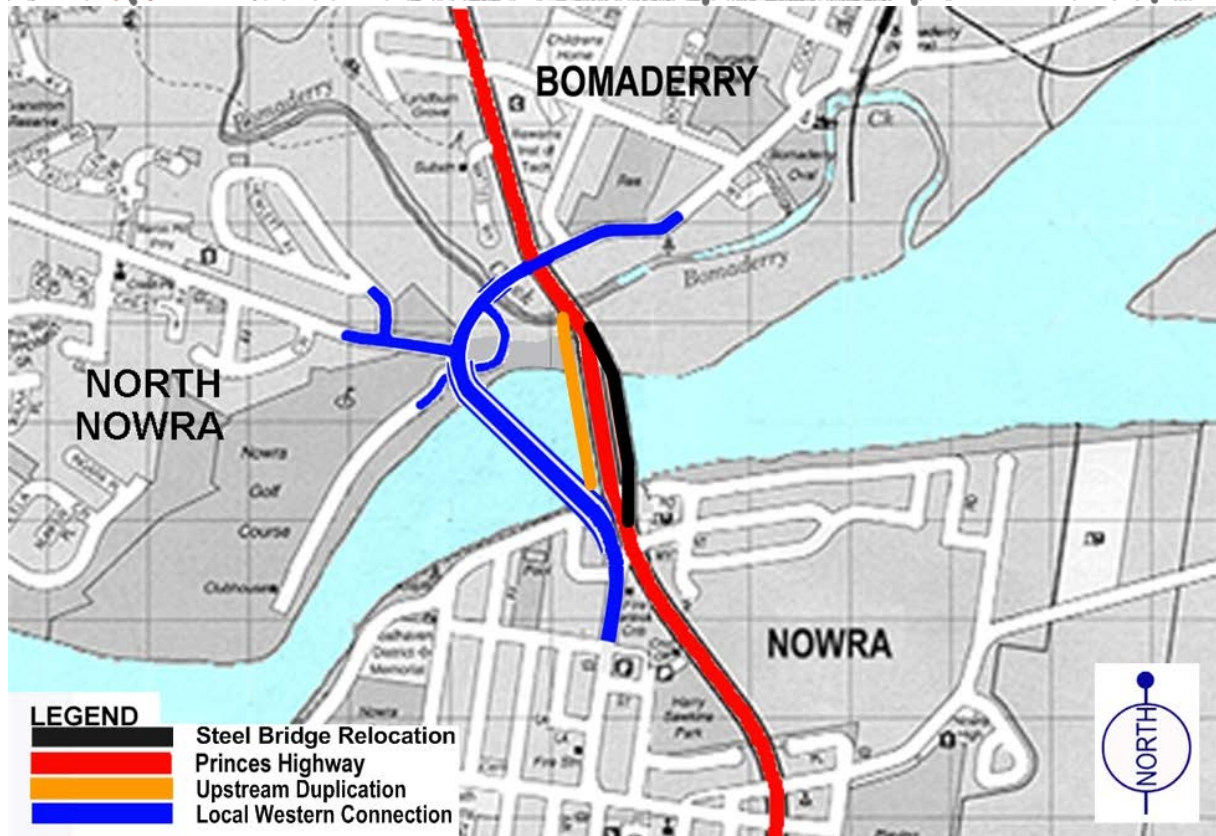
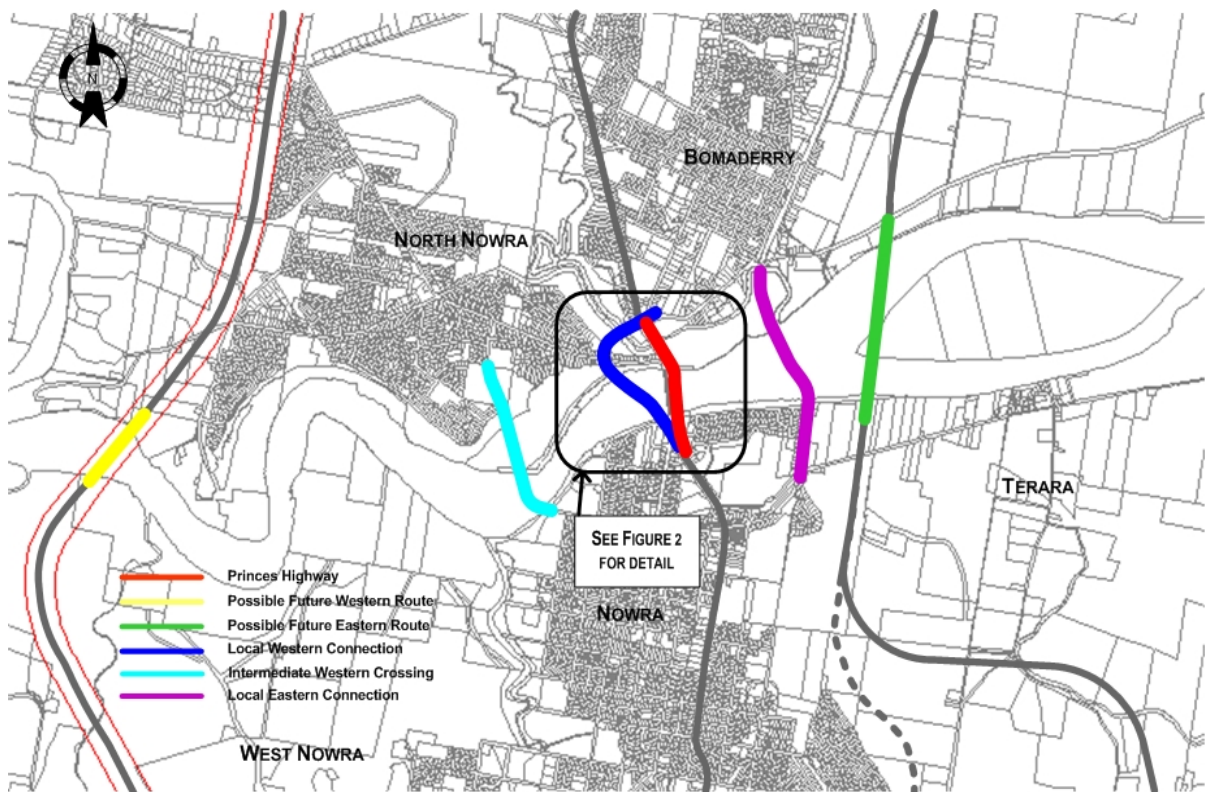


Figure 2-4 River crossing options nominated for consideration in 2004 feasibility study

Source: Additional Shoalhaven River Crossing - Numbaa Island to Bangalee (SMEC on behalf of RTA, June 2004)

Study findings and recommendations

The report provided the following conclusions and recommendations:

- In the short-medium term the most feasible solution appeared to be in the vicinity of the existing bridges. Options closest to the existing alignment attracted the greatest volumes of river crossing traffic; therefore these options seemed best to cater for existing and forecast traffic demand and patterns. It was acknowledged that these options may have impacts related to traffic and other associated issues (e.g. noise)
- Locations upstream and downstream of the existing crossing were noted to “also appear feasible”, although they were not favoured due to cost implications
- Local and intermediate options located close to (but not on or directly replicating) the alignment of the existing bridge crossing would serve a primarily local traffic function. This function (and traffic demand) would vary depending on location and connectivity. Operational issues which would need to be overcome for these options included:
 - Local Eastern Connection: connecting back to the Princes Highway (and to the Nowra CBD) via North and Junction Streets
 - Local Western Connection (and variants): connecting into the Nowra CBD street network
 - Intermediate Western Crossing: connecting to Illaroo Road via Yurunga Drive.
- It was recommended that both eastern options and the Intermediate Western Crossing did not meet the objectives of the project at that time and therefore did not appear to be feasible at that time.
- The possible future Western Route had issues meeting objectives in the short-medium term, with modelling carried out for the study indicating that this option would only attract a small volume of traffic in 2016. Despite this the study suggested that this option could meet objectives in the long term
- Although most (feasible) options relieved capacity issues on the bridge itself, generally only relatively minor relief was provided to the Princes Highway south of the bridge through Nowra
- Existing capacity issues on the bridge and its immediate surrounds could be partially relieved by intersection improvements at the Princes Highway | Illaroo Road and Princes Highway | Bridge Road intersections.

Following the 2004 study, a stakeholder consultation workshop was held to present the results. The following feedback was provided:

- The then RTA advised that traffic on the highway would be expected to continue to grow at around three per cent per annum, due to road network upgrades and land use developments
- Department of Environment and Conservation suggested that ‘the Nowra Bomaderry Structure Plan should look at establishing other retail centres to eliminate travel need across the bridge’
- Department of Infrastructure, Planning and Natural Resources noted that:
 - The likelihood of feeder roads being flooded in minor events at a proposed crossing site would make any option (affected by such events) difficult to promote
 - ‘The main driving issue for a second crossing appears to be the need to address the local traffic congestion’.
- Shoalhaven City Council provided the following feedback:
 - An extension of the existing rail line has been considered but would not be expected to provide value for money; it would be expensive and result only in a marginal decrease in traffic volumes on any river crossing(s)
 - Transport planning workshops as part of the Nowra Bomaderry Structure Plan were

scheduled which would consider the traffic impacts of further land releases in the area; further work should consider these impacts

- 'The origin-destination study completed in September 2003 has shown that approximately 50 per cent of traffic on the bridge is local, approximately 44 per cent is regional and only five-six per cent is direct through traffic. Therefore a bypass would not solve the problem at this time'
 - The capacity and operation of intersections in the vicinity of the bridge needs to be considered
 - 'There are three strategic corridors in the Nowra Bomaderry Structure Plan and there would be a major impact on the CBD by bringing traffic in to the Highway from the west'
 - 'Illaroo Rd has 16,000 vehicles per day so the capacity of Illaroo Rd is an issue. There are other issues with usage and the feeder roads and these would need to be addressed. Improved river crossing capacity may exacerbate this problem'
 - 'Nowra Fair attracts 8,000 to 9,000 vehicles per day therefore the establishment of other retail centres would not accomplish a lot. Also major employment centres are the attractors but there is no guarantee that people will live where they work, and is generally not the case. This information could be used to improve counter flow if people are crossing paths from home to work'.
- SMEC also noted that public transport amenity should be considered during the development of solutions.

Specifically the Feasibility Study recommended the following next steps:

- Investigate and develop solutions to improve the capacity of the intersections at each end of the bridge to provide short-medium term improvement
- Investigate a long-term crossing option in conjunction with a full route analysis; supported by detailed studies including specific traffic analyses (see identified gaps in knowledge).

Identified gaps in knowledge

The Feasibility Study recommended that solutions around the existing bridges appeared to be preferable. However for this study further analysis would need to be carried out, particularly on options not located near the Princes Highway.

Further traffic analysis is needed to address the limitations of the strategic modelling. In particular:

- Basic assumptions were made on defining links to the crossing points and the characteristics of these links
- The 2016 model used an urban consolidation land use scenario that assumed all growth would occur within the existing urban area, which is only one of three land use patterns being used by Shoalhaven City Council for the Nowra Bomaderry 2016 analysis
- The analysis may not have included all the other improvements to the network that may be made prior to 2016
- The decision on the most appropriate crossing location is part of a strategy for the network over the next 30 years and this analysis simply used a snapshot of a single year (2016) mid-term in the 30 year time frame

The key risk associated with the Feasibility Study is the accuracy of future year modelling. In traffic and transport terms the feasibility of options was based primarily on the volumes of traffic that were forecast to use each option. Improvements to traffic modelling that have occurred over time could produce different results to the historical modelling. Supplementary data collection and traffic modelling carried out is described in Section 4.3.

Princes Highway Shoalhaven River Crossing – Interchange Study

(SMEC on behalf of RTA, June 2005)

This study (Interchange Study) followed the *Additional Shoalhaven River Crossing – Numbaa Island to Bangalee* study (Feasibility Study). It investigated options to improve the capacity of the existing bridge crossing and approaches, focussing on intersections between the Princes Highway and Bolong Road, Illaroo Road, and Bridge Road.

The study notes that in addition to existing congestion issues, the consideration of new bridge sites should also take into account the risks associated with the ongoing use of the existing southbound bridge, namely:

- Potential for traffic incidents due to low vertical clearances and narrow lanes
- Potential for lengthy road closures in the event of an accident. The truss structure is particularly vulnerable to impact and fire damage.

Considering the above, improvement options involving high capital expenditure were designed to be compatible with a new bridge next to the existing crossing. Various options were considered and assessed to estimate traffic volumes and patterns both with and without construction of the North Nowra – Bomaderry Link Road.

Study findings and recommendations

The Interchange Study described the existing road network conditions around the bridges. It is noted that existing constraints include:

- Capacity of the two-lane steel bridge for southbound traffic
- Northbound weaving movements on the bridge between Nowra and Bomaderry
- Road reserve width of Illaroo Road
- Pedestrian crossing of the highway at Bridge Road
- Insufficient queue storage for southbound traffic turning right from the Princes Highway to Bridge Road.

The Interchange Study included the use of SIDRA and Paramics micro-simulation traffic modelling. Modelling of existing conditions¹ noted that:

- The right turn from Bolong Road has limited capacity
- At Illaroo Road, the intersection is operating at full capacity in both peak periods due to the high traffic demand between North Nowra and Nowra CBD
- At the Princes Highway | Bridge Road intersection, the major turning movements are between the Princes Highway north (Shoalhaven Bridges) and Bridge Road (Nowra CBD). As a result queuing back on the Princes Highway in the southbound direction extends back onto the bridge during peak times, reducing its capacity.

The Interchange Study in 2005 concluded that:

- Grade-separated options would not substantially extend the life of the existing crossing southbound, because of the limitations on the capacity of the bridge
- There are short term intersection improvements on both sides that would give some relief to congestion and provide further increases in capacity if built with a new bridge

¹ Note that the existing road network (number of lanes, intersection control methods) is unchanged from the modelled configuration; ie no significant upgrades have been implemented since the study was completed.

- The construction of the North Nowra Link Road would extend the life of the Princes Highway | Illaroo Road intersection
- The highway capacity of the existing bridge arrangement would be reached by 2016.

The Interchange Study recommended the following short-term works should be investigated:

- Development of an at-grade solution at the Princes Highway | Illaroo Road intersection, compatible with a future upstream bridge
- A new junction south of Bridge Road that connects Hawthorn Avenue to the Princes Highway in the short-term, and potentially provides an additional connection to Nowra CBD in the future
- Longer-term recommendations including the construction of grade-separated interchanges were also included in the Interchange Study. The study conclusions suggest that the construction of a new bridge crossing at or around the existing bridge crossing – in combination with road network improvements on the bridge approaches – could be a feasible long-term solution.

Identified gaps in knowledge

The Interchange Study investigated options to improve the capacity of the existing bridge crossing and approaches, focusing on short-term solutions. Due to this, 2005 traffic flows (existing traffic flows at the time of study), were used to assess the performance of the options.. The Interchange Study did not provide a robust assessment of the performance of potential solutions based on future traffic volumes and patterns.

In addition, the assessment of options generally considered only the isolated performance of solutions using SIDRA. The compatibility and effects of individual solutions on the wider road network – particularly the Princes Highway corridor between Bolong Road and Bridge Road – was not assessed.

It is also important to note that this study focussed on solutions using the existing bridges. It did not include a quantitative analysis of any options which included the construction of new bridges or additional river crossing capacity.

Key limitations of the Interchange Study were caused by:

- A focus on road network operations assuming the existing southbound bridge continues in its current role, providing a southbound Shoalhaven River crossing
- An assessment of the performance of solutions based on existing (2005) traffic volumes and patterns, but no assessment of long-term performance
- A focus on the isolated performance of individual solutions, without considering the impacts of these solutions across the wider road network.

The findings of the Interchange Study could be used to demonstrate possible concepts, however the findings would need to be built on by further updated detailed assessments as the site option selection process progresses. The assessment of upgrades to the intersections is beyond the scope of this study, and will be addressed during the concept design phase.

2.4.4 Environment

The preliminary data review of available environmental information was carried out to identify known constraints and opportunities in the study area, identify what was unknown (information gaps) and identify what further data was required to inform a preliminary environmental investigation (PEI) of potential bridge sites. The review was limited to a desktop study of preliminary data supplied by Roads and Maritime, previous consultants, and Shoalhaven City Council.

For the purpose of the preliminary data review, the study area remained fairly broad and included the area downstream of the existing crossings to part of Pig Island, and upstream to an area near Mundamia Creek. It should be noted that the area around the western bypass corridor on the 2013 draft Shoalhaven City Council LEP was not carried out in the preliminary data collection and analysis phase. Desktop investigations were carried out in the supplementary data collection and analysis phase (see Chapter 4) once the western bypass was identified as a potential option.

Discussion of key constraints was generally restricted to areas which were likely to impact on the development of preliminary options. Where further definition was required, in order to undertake database searches or to provide further context of the environmental constraints, a conservative approach was applied and a broader study area with appropriate buffer distances was adopted (e.g. for flora and fauna and heritage database searches).

Environmental planning considerations

The preliminary data review focused on identifying constraints and opportunities for the development of river crossing options. The planning implications or approval pathways associated with those constraints were not considered. A review of applicable planning instruments and policies was carried out once site options had been defined (see Section 4.2).

As Roads and Maritime is a public authority, any future proposal would be assessed for approval under either Part 5 or Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Roads and Maritime or the Department of Planning and Environment would be the determining authority. While development consent from Council would not be required, relevant land use zones applicable under local planning instruments were considered in this review, as they indicated existing and future land use constraints.

Literature review and gap analysis

A desktop review was carried out for publically available and Roads and Maritime supplied information sources relevant to the study area. The documents and studies that were reviewed are listed below:

- Additional Shoalhaven River Crossing - Numbaa Island to Bangalee (SMEC, 2004)
- Draft Hydrological Review. Second Crossing of the Shoalhaven River - Feasibility Study. (SMEC, 2004)
- South Coast Regional Strategy (DoP, 2007)
- Nowra Bomaderry Structure Plan 2008 (Shoalhaven City Council, 2008), including the following background reports:
 - Threatened Biodiversity Survey and Assessment (Alison Hunt & Associates, 2008)
 - Riparian Corridor Objectives for Selected Streams in Nowra & Bomaderry (DIPNR, 2005)
 - Mapping of Riparian Lands Report (GHD, 2008).
- North Nowra to Bomaderry Link Road Options Study (AECOM, 2011) and North Nowra Link Road Concept Plan Environmental Assessment Report (JBA Planning, 2011)
- Shoalhaven City Council Local Environmental Plan 1985 and associated maps
- Shoalhaven City Council Draft Local Environmental Plan 2013 and associated maps.

Database sources utilised during the desktop review included:

- Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) Protected Matters Search Tool
- Atlas of NSW Wildlife
- Directory of Nationally Important Wetlands
- NSW Aboriginal Heritage Information Management System (AHIMS)
- Australian Heritage Database
- NSW State Heritage Register
- Roads and Traffic Authority (now Roads and Maritime) Heritage Register
- Shoalhaven City Council online web mapping application.

The review focused on key environmental issues considered to pose the greatest risk to developing potential bridge crossing options. Preliminary data collected and analysed for the following key environmental issues are discussed in subsequent pages:

- Land Use
- Flora and Fauna
- Heritage (Aboriginal and Non-Aboriginal)
- Visual Amenity
- Other issues (acid sulphate soils, coastal protection).

Land use

The *Shoalhaven Local Environmental Plan 1985* (SLEP 1985) identified land use zones adjacent to the Shoalhaven River, including zone objectives and permissible and prohibited development. Previous studies relating to river crossings had been carried out in respect of this SLEP, including the SMEC study (2004). However, the draft *Shoalhaven Local Environmental Plan 2013* (SLEP 2013) was also available and consideration of both LEPs was carried out, providing comparison where required, to identify zones that may provide greater constraint to the selection of a bridge crossing.

The majority of the study area is classified as urban area. The majority of land zoning within the study area is a mix of agricultural, recreation and environmental protection. Several residential uses are also located close to the Shoalhaven River within the Nowra urban area; however these are not directly next to the river. Residential development and existing service infrastructure (including transmission infrastructure, commercial retailers and the hospital) are considered to be the most constraining zones/uses to potential bridge options. Consideration of particular land use zonings were considered for both SLEP 1985 and SLEP 2013 as shown in Table 2-4 and Table 2-5, respectively. These are also illustrated in Figure 2-5 and Figure 2-6.

Other notable sensitive land uses from preliminary investigations are summarised in Table 2-6.

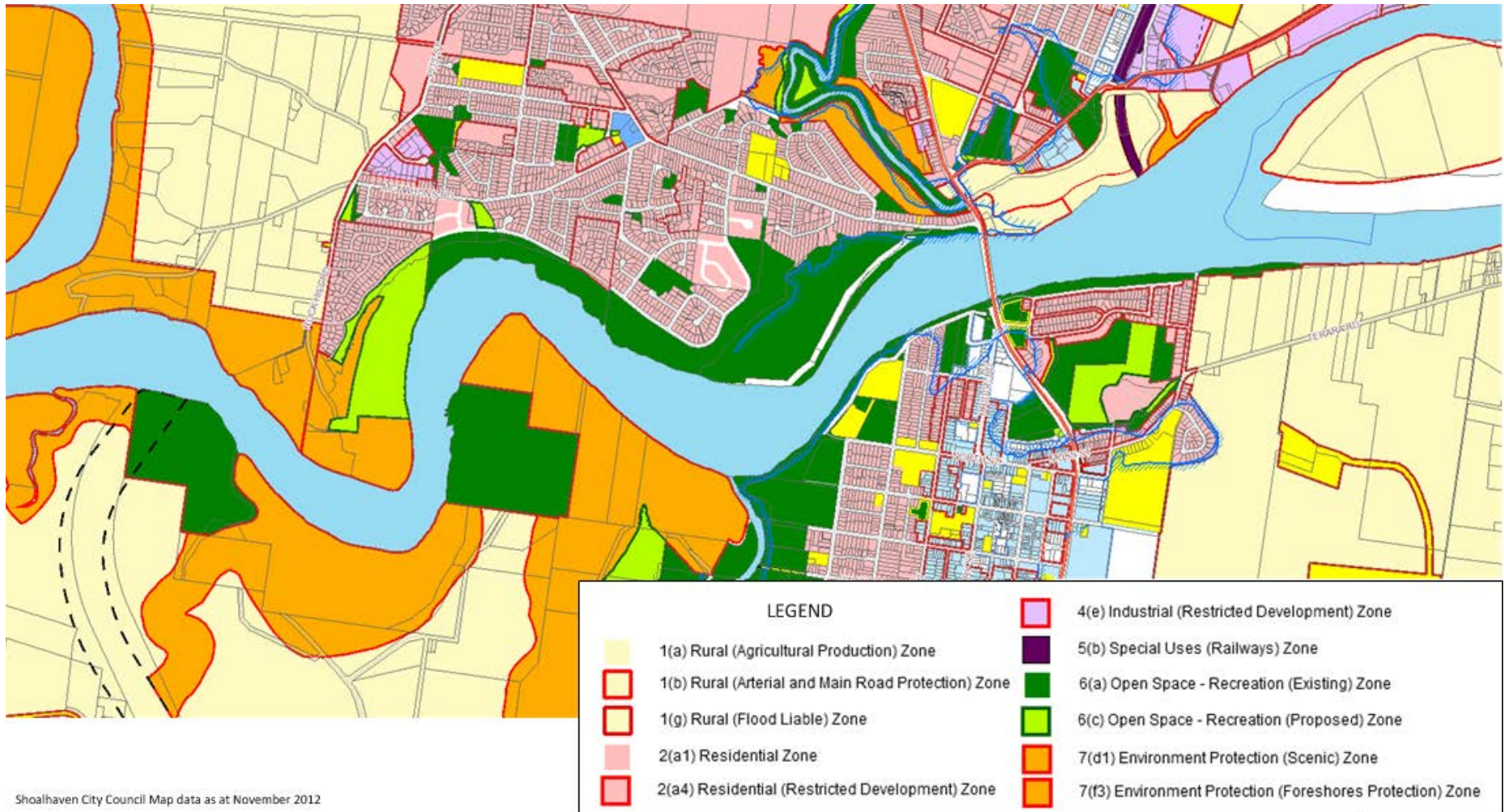
The Structure Plan 2008 also identified several land use areas for consideration, including prime crop and pasture land, and agricultural land (class 1, 2, 5 and 9). These are not strictly constraining to bridge options at this stage but are noted for future consideration.

Residential land use was considered a key constraint due to the limitations it places on development opportunity, associated amenity, and traffic flow-on impacts generated on existing residential uses, and potential sterilisation for future urban development.

Table 2-4 Zoning and Objectives of the Shoalhaven Local Environmental Plan 1985
(LEP in-force at the time of this preliminary assessment)

Land Use Zone	Objectives	Comment risk
1(a) Rural (Agricultural Production)	<ul style="list-style-type: none"> To conserve and maintain the productive potential of prime crop and pasture land To ensure that existing or potential agricultural land use is not jeopardised by non-agricultural land uses To conserve cultural landscapes. 	Relatively small parcel of land to the east of the existing bridge. Land is currently undeveloped and is unlikely to pose a significant risk to a new bridge crossing in this zone.
1(b) Rural (Arterial and Main Road Protection)	<ul style="list-style-type: none"> To minimise the direct and accumulative impact of development on the efficiency and safety of existing or proposed main and arterial roads To promote a high level of scenic quality adjacent to existing or proposed main or arterial roads To encourage, where possible, the use of existing or proposed side roads as an alternative to direct vehicular access to an existing or proposed main or arterial road. 	Relatively small parcel of land located directly adjacent (east) of the existing bridge. Any development works in proximity of this land use for the purposes of the bridge would not be constrained by the objectives of this zone.
1(g) Rural (Flood Liable)	<ul style="list-style-type: none"> To limit the erection of structures on land subject to periodic inundation To ensure that dwelling-houses are erected on land subject to periodic inundation only in conjunction with agricultural used to ensure that the effect of inundation is not increased through development To restrict development and how it is carried out so that its potential to have an adverse impact on site and off site on acid sulphate soils is reduced or eliminated To conserve and maintain the productive potential of prime crop and pasture land. 	This land use is primarily located east of the existing bridge, including Pig Island. Greater consideration would be required for design and construction works in this zone in terms of flooding and inundation.
2(a1) Residential	The objectives are to provide an environment primarily for detached housing and to ensure that the range of other development permitted in a residential area is compatible with the residential environment.	Located north and south of the River, most constraining in proximity to the existing bridge and less constraining upstream and downstream of the existing bridge. Residential land uses are considered a high risk constraint to designing potential bridge crossing options.
2 (a4) Residential (Restricted Development)	The objectives are to identify locations in existing urban areas with development problems where special consideration will be required before development can be approved.	Located either side of the River. Residential land uses are considered a high risk constraint to designing potential bridge crossing options.
4(e) Industrial (Restricted Development)	The objectives are to identify locations in existing industrial areas with development problems where special consideration will be required before development can be approved.	Located on the northern side of the River near Pig Island. Land is currently developed and is considered a high risk constraint to designing potential bridge crossing options.

Land Use Zone	Objectives	Comment risk
5(b) Special Uses (Railways)	The objectives are to identify land for railway purposes and to allow development authorised under the Government Railways Act 1912, and for certain other compatible land uses to be carried out with the consent of the council.	The existing rail corridor is located east of the existing bridge on the northern side of the River. While the infrastructure does not extend all the way to the River, a zoned easement exists. This easement is not considered a significant constraint.
6(a) Open Space – Recreation (Existing)	The objectives are to identify land where existing recreation facilities for the general use of the community are provided.	Located along the southern side of the River for the majority of the study area, and along the north side west of the existing bridge. This zoning is considered a low risk constraint to designing potential bridge crossing options.
6(c) Open Space – Recreation (Proposed)	The objectives are to identify land which will be required to be dedicated as public open space when the land is subdivided to provide for recreation for the general use of the community. The exact boundaries will be fixed at the time of subdivision.	Located far west of the existing bridge. This zoning is considered a low risk constraint to designing potential bridge crossing options.
7(d1) Environment Protection (Scenic)	<ul style="list-style-type: none"> To conserve and enhance scenic quality To protect natural and cultural features of the landscape which contribute to scenic value To ensure that development is integrated with the landscape values of the area. 	Located west/upstream of the existing bridge in large portions along the River banks and includes areas of dense vegetation. This zoning is considered a high risk to designing potential bridge crossing options.
7(f3) Environment Protection (Foreshores Protection)	<ul style="list-style-type: none"> To protect the foreshore environment and the visual amenity To protect water quality and the ecological values of estuaries and coastal streams. 	Located east of the existing bridge along the foreshore. This zoning is considered a medium risk constraint to designing potential bridge crossing options.



Shoalhaven City Council Map data as at November 2012

Figure 2-5 SLEP 1985 Zoning

Source: Shoalhaven City Council online webmapping, accessed 03/04/13

Table 2-5 Zoning and objectives of the Shoalhaven Local Environmental Plan 2013
(Draft LEP proposed at the time of this preliminary assessment)

Land Use Zone	Objectives	Comment/Risk
RU1 Primary Production	<ul style="list-style-type: none"> To encourage sustainable primary industry production by maintaining and enhancing the natural resource base To encourage diversity in primary industry enterprises and systems appropriate for the area To minimise the fragmentation and alienation of resource lands To minimise conflict between land uses within this zone and land uses within adjoining zones To conserve and maintain productive prime crop and pasture land To conserve and maintain the economic potential of the land for extractive industries. 	Located east of the existing bridge on both sides of the River and includes Pig Island. New zoning does not distinguish between road protection and flood liable zone as per SLEP 1985. Areas of this zone vary between developed and undeveloped land. It is considered this zoning presents a low to medium risk to potential bridge options.
R1 General Residential	<ul style="list-style-type: none"> To provide for the housing needs of the community To provide for a variety of housing types and densities To enable other land uses providing facilities or services to meet the day to day needs of residents To identify land suitable for future urban expansion 	Located either side of the River within the Nowra Urban Area. New zoning differentiates between housing density compared to SLEP1985. Residential land uses are considered a high risk constraint to designing potential bridge crossing options.
R2 Low Density Residential	<ul style="list-style-type: none"> To provide for the housing needs of the community within a low density residential environment To enable other land uses providing facilities or services to meet the day to day needs of residents To provide an environment primarily for detached housing and to ensure that other development is compatible with that environment. 	
R3 Medium Density Residential	<ul style="list-style-type: none"> To provide for the housing needs of the community within a medium density residential environment To provide a variety of housing types within a medium density residential environment To enable other land uses providing facilities or services to meet the day to day needs of residents To provide opportunities for the development of tourist and visitor accommodation where this does not conflict with the residential environment To provide for single dwelling houses as an ancillary, integral part of a medium density development that help maintain and enhance the residential amenity of the street. 	

Land Use Zone	Objectives	Comment/Risk
IN1 General Industrial	<ul style="list-style-type: none"> To provide a wide range of industrial and warehouse land uses To encourage employment opportunities To minimise any adverse effect of industry on other land uses To support and protect industrial land for industrial uses To allow diversity of industrial uses to the extent that new activities will not significantly detract from the operation of existing or proposed development To enable other land uses providing facilities or services to meet the day to day needs of workers in the area. 	Located on the northern side of the River near Pig Island. Land is currently developed and is considered a high risk constraint to designing potential bridge crossing options.
RE1 Public Recreation	<ul style="list-style-type: none"> To enable land to be used for public open space or recreational purposes To provide a range of recreational settings and activities and compatible land uses To protect and enhance the natural environment for recreational purposes. 	Formerly 6(a) under SLEP1985. Located along the southern side of the River for the majority of the study area, and along the north side west of the existing bridge. This zoning is considered low risk constraint to designing potential bridge crossing options.
E3 Environmental Management	<ul style="list-style-type: none"> To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values To provide for a limited range of development that supports those values To protect the natural and cultural features of the landscape, including coastal and foreshore areas, which contribute to scenic value and visual amenity To maintain the stability of coastal land forms and protect the water quality and ecological values of estuaries and coastal streams. 	Formerly 7(d1) under SLEP1985. Located west/upstream of the existing bridge in large portions along the River banks and includes areas of dense vegetation. This zoning is considered a high risk to designing potential bridge crossing options.
W2 Recreational Waterways	<ul style="list-style-type: none"> To protect the ecological, scenic and recreation values of recreational waterways To allow for water-based recreation and related uses To provide for sustainable fishing industries and recreational fishing. 	Shoalhaven River.
SP2 Infrastructure (Road)	<ul style="list-style-type: none"> To provide for infrastructure and related uses To prevent development that is not compatible with or that may detract from the provision of infrastructure. 	Main roads previously unzoned under SLEP1985 are now zoned under SLEP2013.
SP2 Infrastructure (Rail)		Formerly 5(b) under SLEP1985. The existing rail corridor is located east of the existing bridge on the northern side of the River. While the infrastructure does not extend all the way to the River, a zoned easement exists. This easement is not considered a significant constraint
B4 Mixed Use	<ul style="list-style-type: none"> To provide a mixture of compatible land uses To integrate suitable business, office, residential, retail and other development in accessible locations so as to maximise public transport patronage and encourage walking and cycling. 	SLEP2013 zoning suggest and expansion of mixed use in this area. Proposed development in this zone presents a medium-high risk constraint to designing potential bridge crossing options for this reason.

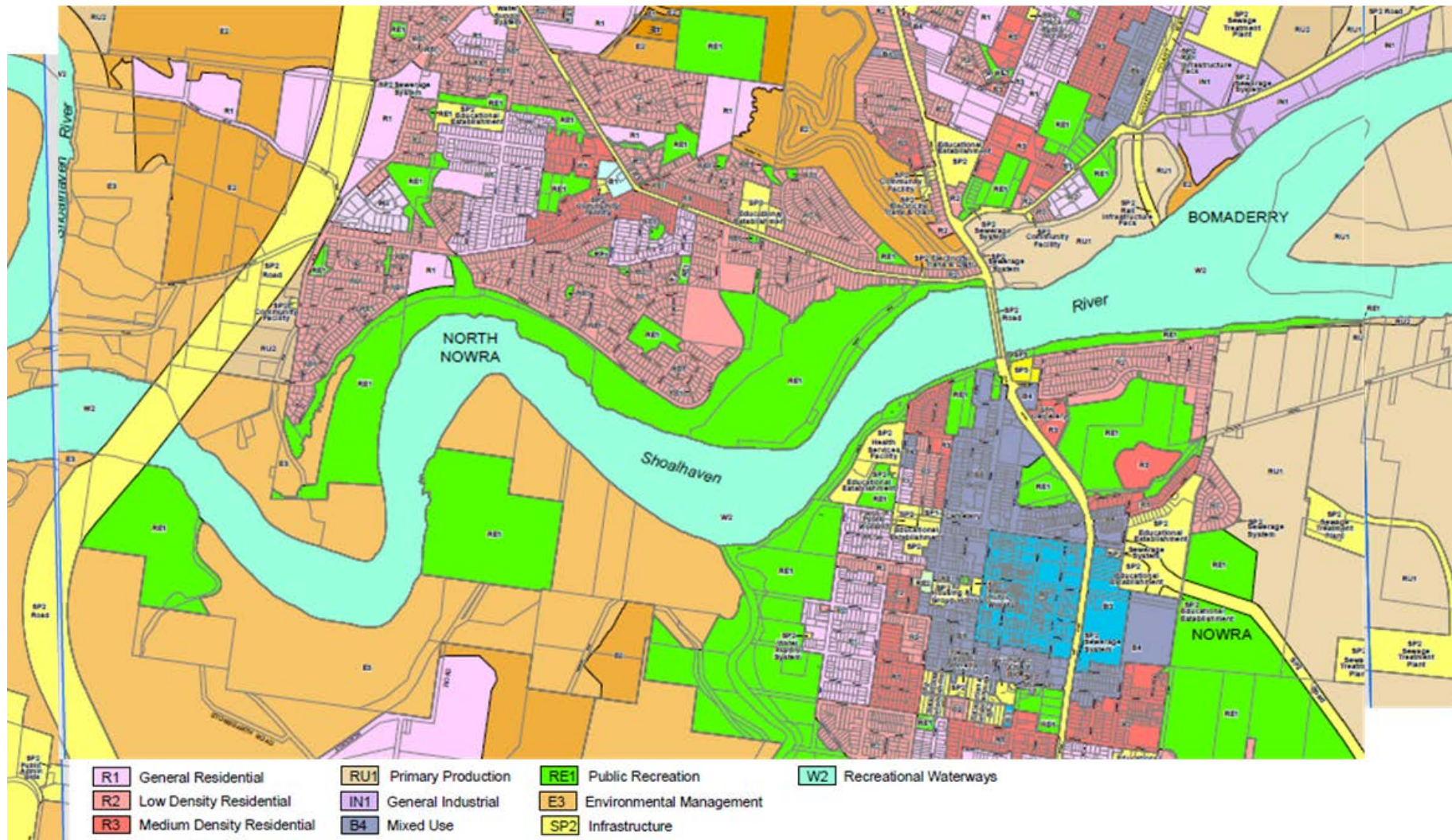


Figure 2-6 SLEP 2013 Zoning

Source: Shoalhaven City Council

Table 2-6 Other sensitive land uses for consideration

Location	Land Uses
Existing bridge – northern side	<ul style="list-style-type: none"> • Bomaderry Creek tributary • Agricultural properties • Low density residential housing
Existing bridge – southern side	<ul style="list-style-type: none"> • Commercial developments • Medium density residential housing • Open space/future development areas
Upstream – northern side	<ul style="list-style-type: none"> • Nowra Golf Course • Low and medium density residential housing • Dense riparian vegetation areas • Caravan Park
Upstream – southern side:	<ul style="list-style-type: none"> • Nowra Creek tributary • Open space along river banks • Dense vegetation
Downstream – northern side	<ul style="list-style-type: none"> • Some residential housing • Rural/agricultural areas (largely undeveloped) • Some industrial development (small scale)
Downstream – southern side	<ul style="list-style-type: none"> • Large rural/agricultural holdings • Some residential housing

Identified gaps in knowledge for land use

It was considered that there was sufficient existing land use information available. However, the extent of this information could not be fully applied until the site options were identified. The following was recommended for the progression of the options assessment.

- When determining site options, consideration of high risk areas identified in this review should be taken into account (i.e. residential areas, environmentally sensitive areas)
- More detailed investigation and interrogation of land use in specific areas should be carried out once site options have been identified. This would include a review of compatibility of land uses and potential for land use conflicts
- Land use should be included as a key risk in the development of criteria for the development and assessment of site options.

Flora and fauna

Several previous studies were carried out that highlighted flora and fauna issues. Of specific interest were the SMEC studies (2004) for potential crossing locations and the studies carried out for the Structure Plan (2008), including the Crams Road Investigation Area (part of the potential Nowra bypass corridor). These studies were largely limited to specific areas and as such were applied to this options assessment study more broadly and conservatively. The studies included both desktop and field investigations. It should be noted that where some of these assessments are dated, such as the SMEC study (2004), efforts were made to update existing data through current searches of available databases and drawing on more recent studies where relevant.

Protected and high conservation areas

There are several Nature Reserves in the locality but these are not located within the study area. There are no World Heritage Properties, National Heritage Places, Wetlands of International Significance or Commonwealth Marine Areas within the study area or locality. There is therefore no constraint posed by protected areas to potential bridge crossing options.

The former Department of Environment and Climate Change (DECC) (now Department of Planning and Environment, Office of Environment and Heritage, OEH) mapped areas of high conservation

value throughout the Shoalhaven Region. This mapping shows that within the study area the Shoalhaven River is a proposed habitat corridor with adjacent migratory wader habitat to be conserved. As the corridor extends along the length of the river within the study area, it is unlikely to differentiate potential options. While the habitat corridor was not considered to pose a significant constraint to site options development, once site options were defined, supplementary data collection was required to determine the varying habitat values at those locations (see Section 4.2).

Wetlands, estuarine vegetation and riparian corridors

There are no wetlands designated under *State Environmental Planning Policy 14 - Coastal Wetlands* (SEPP14) within the study area. However, the Shoalhaven/Crookhaven Estuary is listed as a Nationally Important Wetland. This does not constrain potential crossing options at the preliminary phase but required consideration of potential impacts on the wetland when site options were defined.

Mapping obtained for the Shoalhaven and Crookhaven estuaries (see Figure 2-7) indicates that seagrass is present in the vicinity of Pig Island and along the edges of the Shoalhaven River in proximity to the existing bridge. Seagrass is a sensitive vegetation community and provides valuable aquatic habitat and nursery areas for fish. Seagrass presents a high risk constraint to site options due to its high ecological value, sensitivity to disturbance, its rarity in location so far upstream, and likely community profile.



Figure 2-7 Estuarine vegetation of the Shoalhaven River

Source: former Department of Natural Resources, 2007

Figure 2-8 shows that much of the study area to the west of the existing bridge has also been identified as being of riparian conservation value, including several tributaries of the Shoalhaven River classified as Category 1: Environmental Corridor which aims to maintain connectivity between the riparian corridor and key destinations (e.g. bottom and top of catchment, wetlands and large nodes of vegetation). This is unlikely to constrain the identification of site options, but would require consideration in the supplementary data collection and analysis phase when determining potential impacts of each site option.

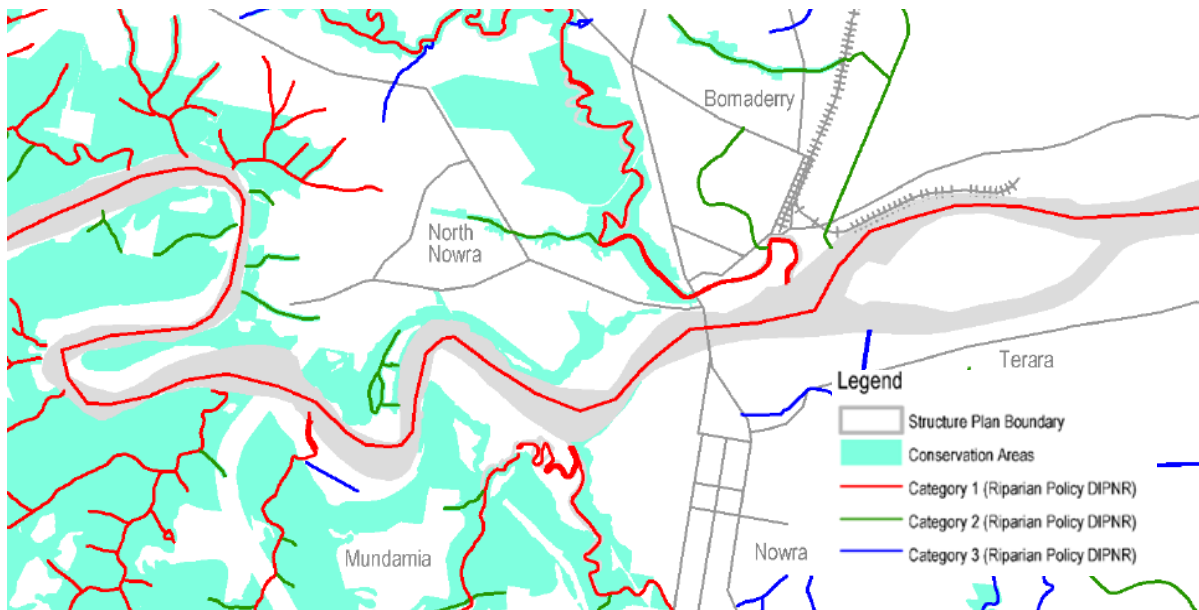


Figure 2-8 Riparian corridors

Source: Nowra Bomaderry Structure Plan, 2008

Vegetation communities

The Structure Plan 2008 listed 24 different vegetation communities identified as occurring in the Nowra Bomaderry area. Of these, five are relevant to site options within the study area (i.e. along the Shoalhaven River Corridor) as shown in Figure 2-11, being:

- Spotted Gum – Blackbutt Forest (MAC-PIL)
- Blackbutt Forest – Grey Gum (PIL-PUN). This community has not been recorded in such large stands elsewhere in the region and was recommended for reservation as part of the Structure Plan 2008
- Grey Gum-Stringybark Woodland-Open Woodland (PUN-AGG). This community partly contains most of the rare plant species in this area
- Freshwater Wetlands (JUN-FRH)
- Scribbly Gum-Bloodwood Woodland/Open Woodland (SCL-GUM).

Endangered ecological communities

One Endangered Ecological Community (EEC) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) has the potential to occur in the study area (based on a 10km search area), the Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion. Seventeen EECs were also identified under the NSW *Threatened Species Conservation Act 1997* (TSC Act). Alison Hunt & Associates (2008) suggested these communities comprise around 30% of all EECs listed under the TSC Act for the Sydney – south coast and tablelands region. Previous studies did not confirm the presence of any EECs in proximity or within the study area but have indicated that they may be present. The Structure Plan 2008 identified the presence of threatened communities within the study area (immediately north of the existing bridge and pockets west) however these were not clearly described and not enough detail was provided to confirm their occurrence (see Figure 2-10).

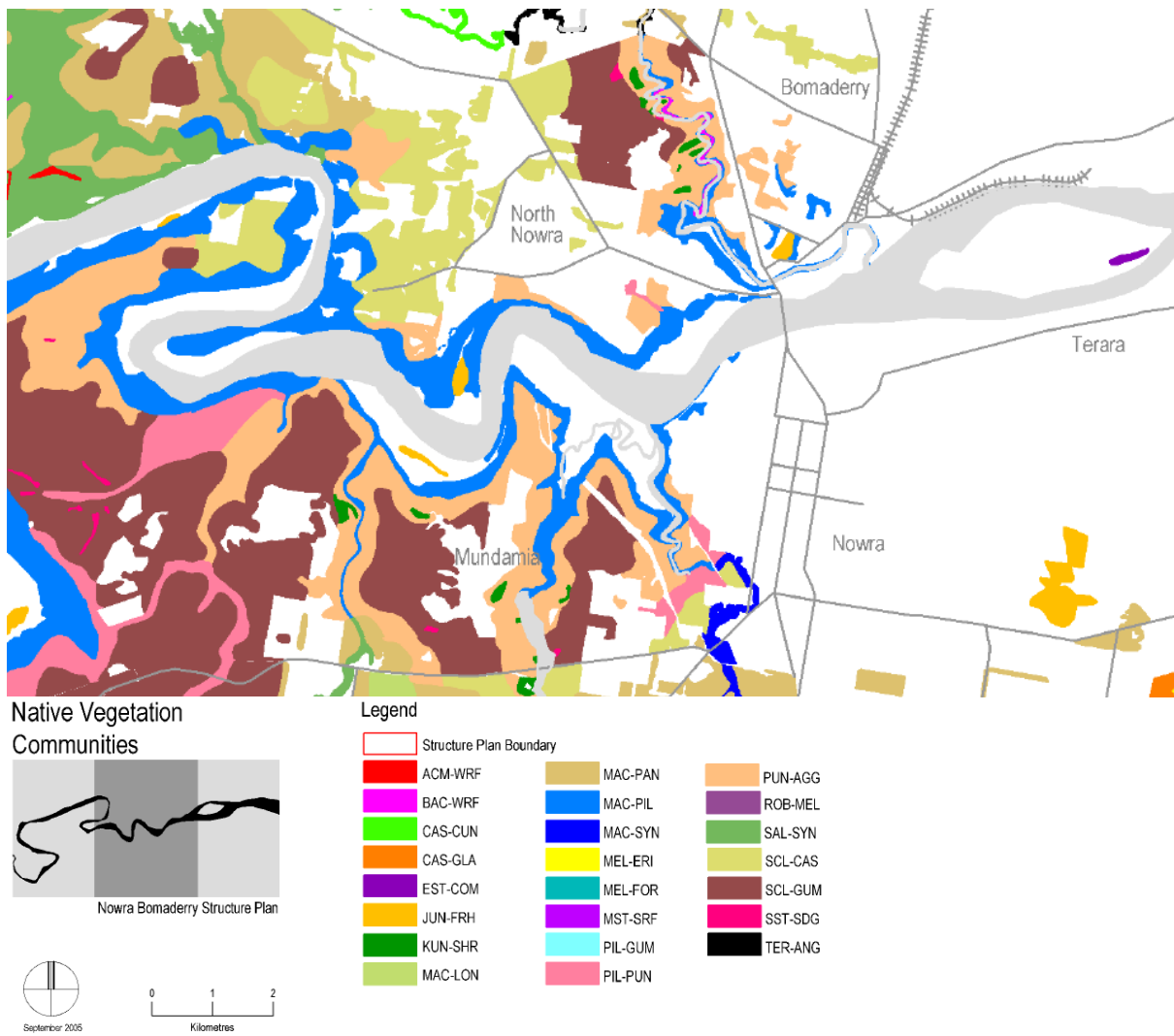


Figure 2-9 Native Vegetation Communities

Source: Nowra Bomaderry Structure Plan, 2008

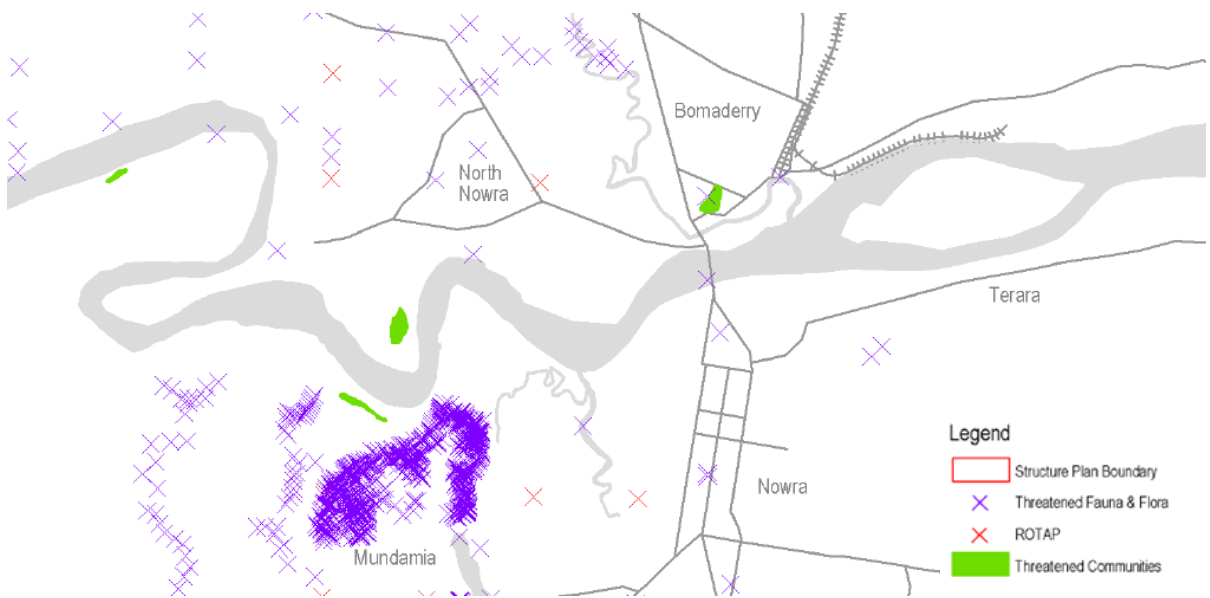


Figure 2-10 Threatened communities, flora and fauna

Source: Nowra Bomaderry Structure Plan, 2008

The South Coast - Illawarra Vegetation Integration (SCIVI) Project of 2006 aimed to integrate many previous vegetation classification and mapping works to produce a single regional classification and map, plus information on regional conservation status of vegetation types. Based on SCIVI data available within the study area and supported by the NSW Wildlife Atlas database search, it was considered that for the study area three vegetation community types had potential relationships to EECs listed under the TSC Act. These are shown in Table 2-7.

Table 2-7 Potential EECs present within the study area

Corresponding Map Unit Name	EEC listed under the TSC Act
South Coast Lowland Swamp Woodland	Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion
Estuarine Fringe Forest	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions
Floodplain Swamp Forest	River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (incorporating the previously listed Sydney Coastal River-flat Forest)

Table Note: It should be noted that the inferred relationships are indicative only. The legal definitions of EECs are provided by the Final Determinations under the respective Acts and decisions relating to whether any particular area of vegetation constitutes a TEC should be based on field inspection and comparison with the Final Determination (Source: Tozer et al. 2010).

Threatened species

A search of the EPBC Act Protected Matters Search Tool identified fifty three EPBC Act listed species that have the potential to occur in the study area, including 8 birds, 3 fish, 5 frogs, 9 mammals and 6 reptiles, and 22 plant species.

A search of the NSW Wildlife Atlas identified several species listed as either vulnerable or endangered under the NSW *Threatened Species Conservation Act 1997* (TSC Act). Within a 10km radius of the study area, the search identified 48 birds, 5 frogs, 23 mammals and 2 reptiles, and 59 plant species.

Mapping showed several records within the study area see Figure 2-11). These records tended to be localised in the dense vegetation to the west of the existing bridge (southern side of the River) and immediately west of the existing bridge on both the northern and southern side in urban area. Along the river mapping indicated that records were primarily birds and mammals, and flora records were primarily limited to pockets of dense vegetation to the far west of the existing bridge, concentrated along riparian corridors of southern tributaries. It is important to note that the absence of records in an area does not imply the absence of a species, but may rather reflect limited survey effort or reporting of sightings.

The occurrence of threatened species presented a high risk constraint to selecting site options as some species are extremely restricted in their distribution with occurrences limited to a few known sites, e.g. the endangered Nowra heath myrtle *Triplarina nowraensis* (Alison Hunt & Associates, 2008). However, as specific sites of threatened species cannot be determined at this desktop level, as records are indicative, there was low confidence in the ability to inform site options. Options west of the existing bridge are more likely to encounter threatened species and rare or threatened plant species. This is largely due to the undisturbed nature of this area and large intact stands of vegetation.

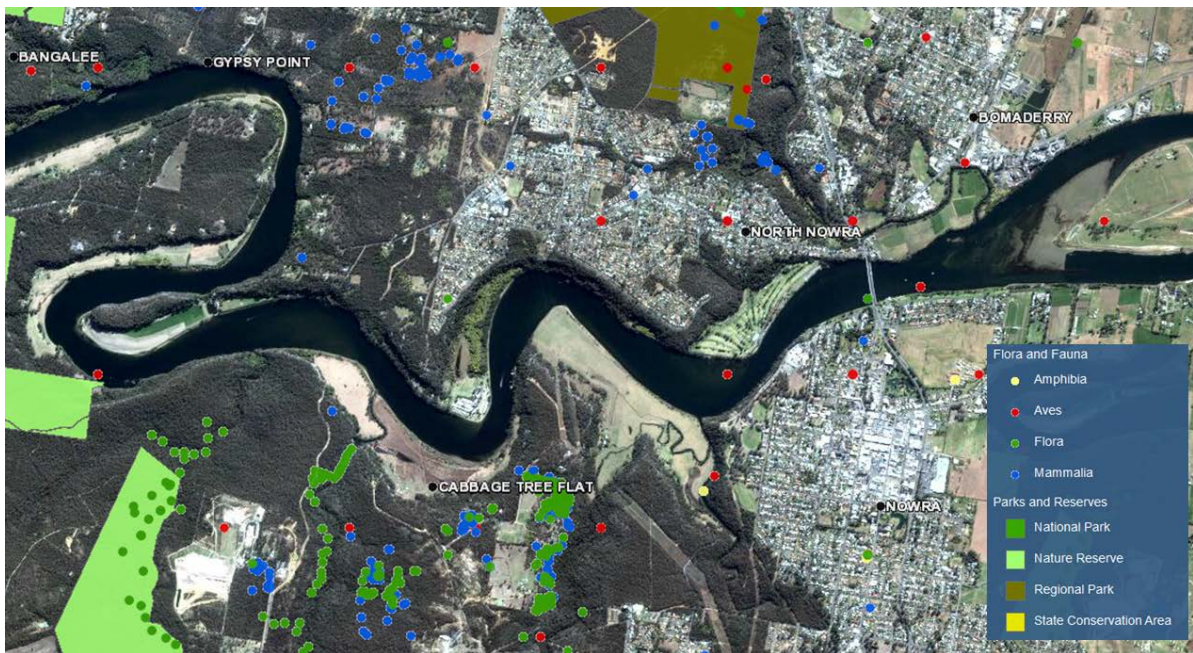


Figure 2-11 Threatened species

Source: NSW Atlas of Wildlife, 2013

Koala

State Environmental Planning Policy 44 – Koala Habitat Protection (SEPP 44) applies within the Shoalhaven Local Government Area (LGA). Areas in the vicinity of the study area have been identified as qualifying as potential Core Koala Habitat. However, there have been no known koala or core habitat records that would constrain site options, with the nearest record located greater than 2km south of the River. No records have been identified within the dense vegetation to the far west of the existing bridge. While not a constraint to identifying site options, potential for the presence of koala or koala habitat will require consideration in future assessment of a preferred option and potential areas of high koala likelihood should be avoided. In addition, since previous studies have been carried out, the koala has been listed as vulnerable on the EPBC Act. Any action that could have a significant impact on koalas or their habitat may trigger the requirement for an EPBC Act referral to the Commonwealth Department Environment (DoE) and require Commonwealth approval.

Identified gaps in knowledge for flora and fauna

- While ground-truthed information was available for other sites in the area, there was limited ground-truthed information for the River Corridor and its immediate surrounds relevant to this site options study. Previous investigations and desktop information had identified records of species and limited data on habitat. These studies also occurred in discrete locations as part of other proposed developments (such as the Nowra Link Road and proposed residential development areas identified in the Structure Plan). The information provided by these assessments indicated likely species but could not confirm the presence of any species outside the area studied
- The OEH Vegetation Information System (VIS) holds the most recent information resulting from the re-classification of vegetation as part of the NSW Vegetation Classification & Assessment (NSWVCA) project which was developed by the Royal Botanic Gardens and Domain Trust in 1999. VIS Classification builds on the NSWVCA and contains the NSW Master Plant Community Type Classification (PCT) that has been established as the NSW standard community level vegetation classification for use in site based planning processes and standardised vegetation mapping. The PCT classification is designed to be the NSW standard for community-level vegetation mapping. However, the PCT classification is relatively immature and will need to undergo further refinement before all communities are

defined to a minimum standard needed for vegetation mapping. Many plant communities, particularly on the east coast, are still poorly defined. The classification is being upgraded in this area (OEH, 2013)

- Native vegetation of Southeast NSW (including Shoalhaven LGA) has been covered by various works including Tozer et al (2010) which aim to classify floristic assemblages at a level of detail appropriate for the discrimination of Threatened Ecological Communities and other vegetation units referred to in government legislation. Data resulting from these studies, based on the SCIVI Project, is available and has been used for this site options study. The SCIVI data is considered most reliable for this area. However, this is yet to be incorporated into the VIS
- It is considered the information relating to the presence of threatened species is not robust enough to confidently inform site options at this stage. However, a broad assessment of habitat condition within the study area could build upon the existing information and provide more confidence around areas more likely to contain threatened species and subsequently advise site options
- The absence of records in an area does not imply the absence of a species, but may rather reflect limited survey effort or reporting of sightings. Some studies indicate the presence of some threatened fauna such as the Large-footed Myotis which is known to roost close to water in caves, stormwater systems, buildings, under bridges and in dense foliage. It can be assumed these would occur in the study area. An assessment of likelihood for this species and other species was carried out in the supplementary data collection stage
- Strategic documents (such as the Structure Plan) have suggested that biodiversity corridors and other sensitive vegetation stands should be conserved. The status of implementation for these areas requires further investigation
- Maps included in this review are broad and are often indicative. More detailed and refined maps (including obtaining GIS data where required) can be carried out in the supplementary data collection stage
- Further detailed desktop assessment is required once site options are defined. This can list species known to occur or rate the likelihood of a species to occur at more discrete locations for both threatened flora and fauna. Additional desktop assessment would include the collating of better quality mapping and data
- Additional limited survey effort is needed to support further detailed desktop assessment and confidence around likelihood of occurrence. To be conservative for the level of detail required to inform options assessment the survey would focus on a broad habitat assessment and vegetation mapping rather than targeted surveys. This assessment would also consider the potential for Core Koala Habitat.

Heritage

Aboriginal heritage

A search of the Aboriginal Heritage Information Management System (AHIMS) was carried out for the study area and its surrounds on Thursday 4 April 2013. AHIMS contains details of Aboriginal objects, places and other heritage values across NSW.

The results are consistent with previous studies (such as SMEC, 2004) which indicated the presence of sites along watercourses, particularly in association with sandstone outcropping suitable for rockshelters (ie Bomaderry Creek and Cabbage Tree Creek) (see Figure 2-12). Watercourses are typically associated with items of moderate to high indigenous heritage significance. Most of the registered Aboriginal heritage sites are located to the west of the existing bridge. Sites located within 500m of the river are also considered to pose the greatest risk or constraint to the identification of site options. These are listed in Table 2-8. Based on the results of the AHIMS search and preliminary landform assessment, locations west of the existing bridge (i.e. creeks, undisturbed areas) are considered constrained by potentially high archaeological sensitivity.

Table 2-8 Summary of key AHIMS listed sites (within 500m of the Shoalhaven River)

Site Type	Site IDs	Count
Artefact Scatter	52-5-0306	1
Burial	52-5-0258	1
Grinding Groove	52-5-0023, 52-5-0024, 52-5-0030, 52-5-0084	4
Rockshelter	52-5-0029, 52-5-0387, 52-5-0388, 52-5-0035, 52-5-0557, 52-5-0558, 52-5-0086, 52-5-0087, 52-5-0088, 52-5-0089, 52-5-0090	11
Rockshelter with Art	52-5-0017, 52-5-0022, 52-5-0025, 52-5-0026, 52-5-0028, 52-5-0036	6

Note: Some sites included in the AHIMS results include some error in the accuracy of coordinates and are therefore indicative and would require ground-truthing or correction.

Predictive sensitivity modelling for the study area could be carried out to identify areas of high potential which should be avoided. Once site options have been identified, ground-truthing and field surveys would be required to provide confident assessment of the defined options.

It is also important to note that Pig Island (also known as Burraga Island) was subject of a native title claim by the Jerrungarugh Aboriginal People in 1995. However, the claim was dismissed. Pig Island was sold to a private entity in 2011.

An Aboriginal land claim (No. 26124) also exists over a small parcel of land near the existing bridge. The implications of this claim cannot be determined at this stage and would require further investigation should an option be likely to impact this land, the uncertainty around this results in greater inherent risks.



Figure 2-12 AHIMS search results for study area and surrounds

Non-Aboriginal heritage

The SMEC (2004) study investigated Non-Aboriginal heritage along the river frontage of the Shoalhaven River and consulted the State Heritage Register and Regional Environmental Plan. A revised and more comprehensive search of Non-Aboriginal heritage databases was also carried out and the following registers were consulted:

- World Heritage List (WHL)
- Commonwealth Heritage List (CHL)
- National Heritage List (NHL)
- National Trust
- Register of the National Estate (Non-Statutory) (RNE)
- NSW Heritage Act - State Heritage Register (SHR)
- Heritage Act – Section 170 NSW State Agency Heritage Register
- Illawarra Regional Environmental Plan No 1
- Shoalhaven Draft Local Environmental Plan 2013.

The search identified several items located within around 250m of the Shoalhaven River (within the study area) which would pose constraints to the development of options. The items considered to be of greatest risk/constraint are summarised in Table 2-9. It should be noted that the existing southbound bridge is listed under local, State and Commonwealth registers. Mapping is available for local listings under the draft SLEP 2013 and has been provided in Figure 2-13. These listings are the same as those listed in the current SLEP 1985.



Figure 2-13 Heritage items listed under draft SLEP 2013

Table 2-9 Non-Aboriginal heritage items within 250m of the Shoalhaven River within the study area

Item Name	Register listed under	Legal status
Commonwealth listings		
Graham Lodge and Family Cemetery	National Trust	Registered
Nowra Road Bridge	Register of the National Estate (Non-Statutory) (RNE)	Registered
Nowra South African War Memorial		Indicative Place
Nowra Soldiers Memorial		Indicative Place
Bomaderry Creek Gorge		Registered
Mill Bank House and associated buildings		Indicative Place
State listings		
Bomaderry Railway Station and Yard Group	NSW Heritage Act - State Heritage Register (SHR)	Registered
Graham Lodge		Registered
Bomaderry Aboriginal Children's Home		Registered
Nowra Bridge over the Shoalhaven River	Heritage Act – s. 170 NSW State Agency Heritage Register	Registered
Local listings		
Bomaderry Railway Station and Yard Group	<i>Illawarra Regional Environmental Plan No 1</i>	Registered
Graham Lodge		Registered
Old Nowra Bridge		Registered
Terara House		Registered
Terara Public School		Registered
Bomaderry Railway Station Group, including: Nowra Bomaderry Railway Station and "original bar holder", Bomaderry Stationmaster's House, Bomaderry Railway Siding Group (including turntable, weighbridge, goods crane, and water pump)	<i>Shoalhaven Draft Local Environmental Plan 2013 (Draft SLEP)</i>	Registered
Graham Family Cemetery		Registered
Graham Lodge (former Greenhills Estate Homestead) and grounds		Registered
"Shoalhaven River Bridge" – Victorian Wrought Iron Bridge		Registered
Ben's Walk, including: Suspension Bridge, Aboriginal Art Sites		Registered
"The Old House" – Weatherboard Residence and Well		Registered
"Terara Lodge" – (former Wesleyan Parsonage)		Registered
"Rose Cottage" – (formerly Pooley's Store)		Registered
"Ayrton House" – (former CBC Bank)		Registered
"Solway House" – Late Victorian Brick Residence and Store		Registered
Terara Heritage Conservation Area		Registered

The old iron truss bridge is listed under the Heritage Act – section 170 NSW State Agency Heritage Register.

As part of the listing under the statement of significance, the bridge has significance because:

- It has been an important item of infrastructure in the history of New South Wales for over 120 years
- It is a technically sophisticated bridge structure and unique for its time
- It has strong aesthetic lines despite its lightweight appearance
- It contributed significantly to the social and commercial development of the South Coast District of New South Wales
- It is associated with the famous American civil engineer and specialist bridge designer, C Shaler Smith.

The listing also states the below further comments:

- The Bridge has high historical significance because it is the only American pin-jointed 'Whipple' truss in service in New South Wales. At 309m overall it was the largest bridge project in New South Wales prior to the 1889 Hawkesbury River Railway Bridge. It significantly helped open up the Illawarra and South Coast districts. It was designed by the former American civil engineer and specialist bridge engineer, C Shaler Smith.
- The bridge exhibits the technical excellence of its design, as all of the structural detail are clearly visible. In the context of its landscape it is visually attractive and has strong aesthetic lines. Unlike most bridges, it is particularly striking to those who use the bridge because it is such a long bridge and users are enveloped in the truss.
- The bridge is valued by locals and tourists as it is a major crossing of the Shoalhaven River. The bridge contributed significantly to the social and commercial development of the South Coast district of New South Wales.
- The bridge has high technical significance because it is the only American pin-jointed 'Whipple' truss in service in New South Wales. Also unique was the use of steel, imported from the USA, some 14 years ahead of its general use in New South Wales. It is a rare example of this type of bridge in New South Wales.
- It is a fine representative example of a 'Whipple' truss bridge.

Identified gaps in knowledge for heritage

- The AHIMS database is known for its many inaccurate listings. Ground truthing of all sites will be required to improve location confidence
- Some Aboriginal sites listed in AHIMS are restricted. These records would need to be investigated further to determine their location
- Heritage survey coverage within the Nowra area has been limited. Additional Aboriginal archaeological sites including sub-surface finds are likely to be present within the study area particularly in those areas associated with watercourses
- Non-Aboriginal heritage is generally well known within the study area with comprehensive information available for each item. However additional items may be present in the study area that are yet to be officially registered
- A sensitivity analysis mapping exercise should be carried out to identify sensitivities around creek lines and other areas likely to be classified as high, moderate and low archaeological significance. This could be carried out to provide greater confidence in existing information and previous studies
- Further detailed desktop assessment of known sites and values once options are defined. This will need to be supplemented by field surveys to ground-truth existing records and to

search for any new finds.

Visual amenity

Opportunities and constraints relating to visual amenity are largely discussed within the Structure Plan and SLEP 1985. The SMEC study (2004) also considered visual amenity in assessing preliminary options.

The Structure Plan notes that open space is an important component of the overall 'amenity' of an area and that the value placed on proximity to open space is often reflected in residential land values. Specific areas relevant to the study area are described in Table 2-10. Several land zonings under SLEP 1985 and draft SLEP 2013 identify the importance of conserving scenic value in their objectives (see Table 2-4 and Table 2-5).

The Structure Plan also notes that all practicable measures should be taken to avoid taking open space land away from potentially sustainable, viable agricultural use, and that the visual integrity of the significant areas of scenic value need to be maintained. The development of this land should be regarded as a 'last resort' (Section 8.3.2 of the Structure Plan, 2008).

Table 2-10 Scenic value and amenity

Locality/Area	Reason for visual/scenic value
Shoalhaven River Corridor (and associated tributaries)	Maintains open space along the corridor which is considered an important component of the overall amenity of the area. The river itself is a visual asset.
Pastoral landscapes east of existing bridge (including Pig Island)	Pastoral landscape considered primary character contributors to Nowra Bomaderry's sense of place and important assets for tourism. The pastoral landscape also contains a number of significant heritage places.

The SMEC study (2004) noted that some locations for crossing options would have major visual impacts. These impacts alluded more specifically to bridge height and design and its intrusiveness on the surrounding environment which is a key visual factor. Similar impacts and settings will apply to any site options identified as a result of this current strategic site options study.

Co-locating with the existing bridge crossing may have a lesser relative impact as the existing amenity is already exposed to such a structure. However, there are more receivers exposed in this location as opposed to the upstream environment where there is minimal development and large dense areas of vegetation. Conversely, upstream crossing options would be likely to have a major visual impact (clearing, lack of development) as it is inconsistent with the surrounding environment. While it is considered that visual amenity is a key issue for such a large structure, it is difficult to be categorised as a clear options constraint at this stage. Further consideration will be required once site options have been defined.

Identified gaps in knowledge

- The Structure Plan 2008 outlined that development options relating to the expansion of Nowra Bomaderry were assessed against a number of criteria, which included: 'protection of pastoral landscapes and areas of high scenic value'. Other 'areas of high scenic value' are not specified
- A number of development constraints exist relating to maintenance of view corridors to pastoral areas from potential new developments within Nowra Bomaderry – it is not possible to discern whether or not bridge design would be affected by these constraints
- Consultation with Council to clarify potential constraints and confirm other 'areas of high scenic value'
- Visual analysis of site options once identified.

Other constraints

State Environmental Planning Policy 71 – Coastal Protection (SEPP 71)

The study area is located within the Coastal Zone as prescribed by SEPP 71. Land directly adjacent to the Shoalhaven River and its tributaries is also classified as sensitive coastal locations.

Consideration of implications within the coastal zone would be required at later stages once defined options have been determined.

Other considerations

Key issues such as soils and geology and flooding and hydrology are also considered high risk constraints to site options. However, these are covered in subsequent sections and should be referred to for further detail.

Noise and traffic impacts are also considered key issues. However, they are not considered key constraints to the development of site options at this stage. Future assessment of options will be required once these have been clearly defined.

Summary of key environmental constraints and recommendations

The key risks identified as part of this review of environmental constraints are summarised in Table 2-11. It is anticipated that following further desktop investigation, based on the recommendations presented, a series of risk-based constraint maps (traffic light) were developed which informed the options assessment process to ensure that environmental constraints are considered during options assessment.

Table 2-11 Further work required for options assessment

Constraint	Description	Consideration for options identification	Recommended next steps
Land Use	Both sides of the Shoalhaven River around the existing bridges represent a largely constrained area due to the developed and populated nature of the Nowra urban area. While residential development is also located east of the existing bridge, it is generally less dense, containing a mix of rural and industrial land uses. Residential land uses, environmentally sensitive areas, and established industrial and mixed use areas pose the greatest constraint to potential siting of bridge crossing options.	Need to avoid residential land uses where possible.	<ul style="list-style-type: none"> Undertake more detailed investigation and interrogation of land use in specific areas once potential options have been identified (including review of potential for land use conflicts). Develop land use criteria to inform development and assessment of preliminary options.
Flora and Fauna	There are several native vegetation communities across the study area which contains known records of threatened flora and fauna. These records tend to be more concentrated to the west of the existing bridge, largely within large areas of intact vegetation, along the riparian corridor, and sporadically through the developed urban area of Nowra.	Need to conserve significant vegetation and fauna habitat, particularly where there is potential for threatened species with restricted occurrence. Need to avoid causing fragmentation of large vegetation communities that currently provide biodiversity corridors (riparian and terrestrial).	<ul style="list-style-type: none"> Further detailed desktop assessment once options are defined (including habitat-based likelihood assessment). Supplementary field surveys of key constrained areas identified during likelihood assessment. Develop ecological criteria to inform development and assessment of preliminary options.

Constraint	Description	Consideration for options identification	Recommended next steps
Heritage	There are several known indigenous sites located west of the existing bridge that would be constraining to potential options. There are numerous Non-Aboriginal heritage sites located throughout the study area. The Shoalhaven Bridge is listed on several heritage registers.	Need to conserve indigenous heritage sites (primarily through avoidance). Need to conserve values associated with Non-Aboriginal heritage sites.	<ul style="list-style-type: none"> Undertake a sensitivity analysis mapping exercise to predict areas of high, moderate and low archaeological significance. Further detailed desktop assessment and undertake field surveys. Develop criteria to inform assessment of preliminary options.
Visual	The Shoalhaven River itself is a visual asset as well as its foreshore and open space areas. Pastoral landscapes are located to the east of the existing bridge.	Generally not well defined enough to inform options at this stage. However, future assessment of defined options would need to minimise visual impact to sensitive receivers and intrusiveness on environment.	<ul style="list-style-type: none"> Consultation with Council and community to discern potential constraints and confirm areas of high scenic value. Visual analysis of preliminary options once identified.

2.4.5 Hydrology

Flooding assessment

Shoalhaven River overview

The Shoalhaven River drains the sixth largest catchment of the NSW coastal rivers. The catchment area is 7,250 square kilometres, extending as far west as Braidwood and within 50 kilometres of Cooma to the south. The river is over 300km long. Catchment landuse is predominantly agricultural in the upper areas, intact natural vegetation through the Morton National Park in the central region, and predominantly agricultural floodplains east of Nowra.

The Shoalhaven River has two entrances at the Pacific Ocean. The southern entrance at Crookhaven is open to the ocean. The northern entrance at Shoalhaven Heads is usually closed by a naturally accreting sandbank. During very high flows this sandbank is overtopped and eroded to allow discharge to the ocean. Shoalhaven City Council operates the Shoalhaven River Entrance Management Plan (November 2006) to manage flood risk and mitigation actions at the entrances.

Available data

The most relevant existing flood related studies to inform the bridge site options assessment is the Shoalhaven City Council:

- Lower Shoalhaven River Flood Study (1990)
- Floodplain Risk Management Study (2008)
- Floodplain Risk Management Plan (2008)
- Climate Change Assessment (2011).

These four documents were sequentially prepared in accordance with NSW Government's Floodplain Development Manual.

Numerical modelling with the WBNM hydrology model and the CELLS hydraulic model were utilised in these studies. Both models were originally developed between 1986 and 1988 and were calibrated

and validated to the available historic data dating back to the 1860's. As such they provide a good description and prediction of the flood risk in the Lower Shoalhaven River. The water level results from these models are combined with recently flown airborne laser survey (ALS) data to produce the Council adopted flood extents mapping.

The potential implications of climate change on flood water levels in the Lower Shoalhaven River were recently assessed in 2011. The potential effects of climate change are outlined in Table 2-12. The assessment concluded that increased sea levels have less than 0.1m impact at the current crossings.

The tidal limit of the river is approximately 48 kilometres upstream of the entrance. To support the NSW Government's Metropolitan Water Plan 2006, the University of NSW Water Research Laboratory established a one-dimensional hydrodynamic and salt dispersion RMA model of the Shoalhaven estuary. The results are reported in the paper "Saline Dynamics of the Shoalhaven River (unknown date)." This model may be of some use to inform ecological or hydraulic assessments. Manly Hydraulics Laboratory (MHL) operates a number of water level gauges on the Shoalhaven River. Relevant gauges are located at Grady's Caravan Park (since 2006), Nowra Bridge (since July 1990), Terara (since August 2001) and Hay Street (since 2002).

Table 2-12 Peak levels of major floods (Adapted from WMAwater 2008, 2011)

Location	Historical Events (mAHD*)				Design Events (mAHD)				
	1860	1870	1974	1978	5%	2%	1%	0.5%	Extreme
Nowra Bridge	5.5m	6.55m	4.9m	5.3m	5.3m	5.8m	6.3m	6.8m	8.9m
Estimated AEP at Nowra Bridge	3%	0.7%	8%	5%					
Estimated ARI at Nowra Bridge	30 years	150 years	12 years	20 years					
Nowra Bridge 10% rainfall increase					5.5m	6.0m	6.6m	N/A	N/A
Nowra Bridge 20% rainfall increase					5.7m	6.2m	6.8m	N/A	N/A
Nowra Bridge 30% rainfall increase					5.8m	6.4m	7.0m	N/A	N/A

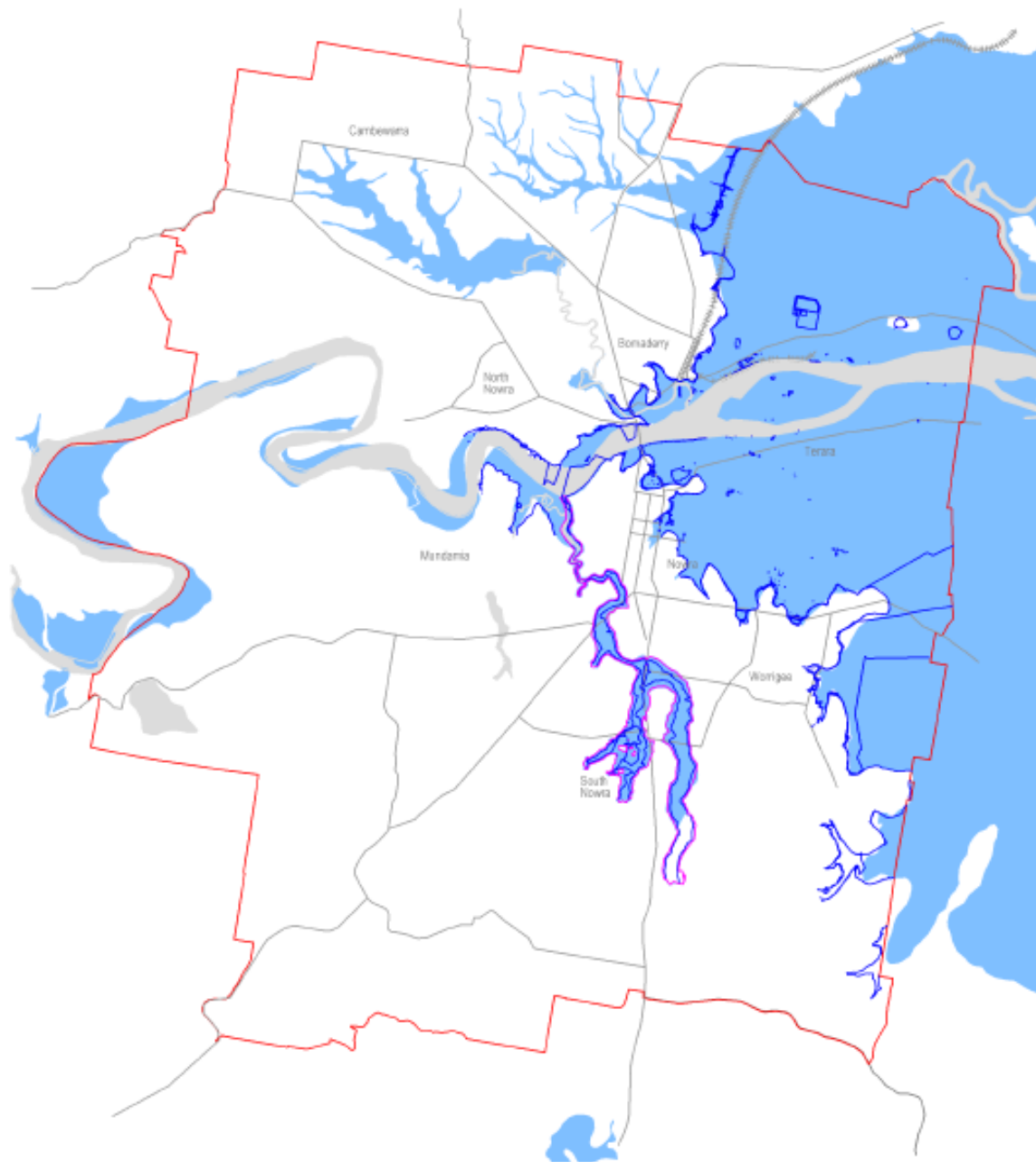
Table Notes: mAHD refers to metres above the Australian Height Datum
AEP - annual exceedance probability
ARI - average recurrence interval

Suitability of existing data for site options assessment

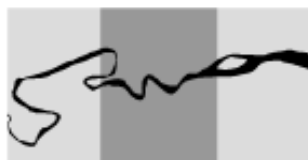
The existing data provided a detailed understanding of the existing flood behaviour, flows and water levels and potential changes due to climate change. The existing WBNM hydrologic model supporting these findings is appropriate and still relevant, despite being developed in the late 1980's.

The existing pseudo two dimensional CELLS hydraulic model would not be an appropriate tool to assess changes to the flood regime resulting from a new bridge. The model is not of a suitable structure or resolution to model the impacts from local changes such as piers that may alter the flood characteristics. Where construction is proposed in the floodplain areas, an updated hydraulic model would be required to design and assess the impacts of the works.

The level of impact assessment required would depend on the extent of likely flood impacts, together with the sensitivity of the impacted area. General advice on assessment of flood implications for specific bridge crossing locations is provided below. Figure 2-14 highlights the extensive flood plain developing immediately downstream of the existing bridge crossing location.



Flooding

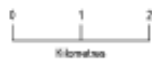


Legend

- Structure Plan Boundary
- Flood Prone Land (Concept Plan)
- PMF (Browns/Nowra Creek Flood Study)
- 1 in 100 year Flood Line (Browns/Nowra Creek Flood Study)
- 1 in 100 year Flood Line (North Shoalhaven River Flood Study)



September 2005



Map 6.3

Figure 2-14 Shoalhaven River flooding profile

Source: Nowra Bomaderry Structure Plan, 2008

Locations east (downstream) of Nowra Bridge

The Lower Shoalhaven River floodplain extends from immediately downstream of the existing Nowra Bridge to the river entrance. Widespread flooding characterises the area. Due to the wide, flat nature of the floodplain, any impediment to flood flows across this floodplain could have significant flood impacts. These impacts would be felt at properties and structures already sensitive to flooding. Mitigation of the impacts would be difficult and potentially expensive.

In order to quantitatively assess the impacts and potential mitigation measures in this area, a high-resolution two-dimensional hydraulic model would need to be developed. This task would require a significant amount of time and effort, including ground survey. The existing CELLS hydraulic model is not of a suitable structure or resolution for this assessment.

New bridge locations downstream of the existing crossings present the highest risk of changing flood behaviour.

Locations at Nowra Bridge

A new bridge at the existing crossing location has the potential to create flood impacts at properties and structures sensitive to flooding. Of significant note in this area is the Terara Levee immediately downstream, and the potential Shoalhaven Gateway development immediately upstream. Future development of the Gateway site would likely involve the filling of land to prevent flooding. If the proposed bridge were to increase flood levels upstream, this would impact fill levels for the design of structures within the development.

Additional piers in the waterway would create some localised flood impacts. Depending on the orientation and location of the proposed piers, qualitative assessment of the relative impacts could be calculated using head loss formula or one dimensional model, rather than establishing a full two dimensional hydraulic model.

Should the proposed southern embankment be located within the floodplain, then some hydraulic modelling assessment may be required to adequately understand implications for the upstream development area. The existing CELLS hydraulic model is not of a suitable structure or resolution to inform this assessment and a new model would be required.

New bridge locations at the existing crossings present the least risk of changing flood behaviour.

Locations west (upstream) of Nowra Bridge

The Shoalhaven River is typically deeply incised upstream of the existing Nowra Bridge. Structures in this area could have considerable flood impacts on both velocity and water level. The existing CELLS model is not of sufficient structure or resolution to design and assess works in this area. Therefore, quantitative assessment of these impacts would require development of a more detailed, two dimensional hydraulic model, incorporating ground and bathymetric survey. Implications of impacts are unknown and this would need to be quantified and reported on during the environmental assessment phase.

New bridge locations upstream of the existing crossings present a significant risk of changing flood behaviour.

Summary

Sufficient information to qualitatively or relatively assess flood impacts for alternative site options was available to inform the assessment of site options. Quantification of the flood impacts for the preferred option would require detailed hydraulic modelling at a later stage.

2.4.6 Utility infrastructure

In the context of identifying a new bridge crossing site, utility infrastructure is not generally considered a constraint to be avoided. Rather, it is assumed that utility infrastructure can be adjusted to suit and the consideration becomes one of the costs to capital works and network outages. One exception to this is the Eastern Gas Pipeline, discussed further in the sections following.

To inform bridge site selection and assessment, the main utility assets of interest are those:

- Clustered around the existing bridge crossing site
- Running parallel with the river
- Crossing the river independent of the existing bridge crossing site.

Utility information was gathered from three initial sources:

- The Background Report of the Structure Plan as prepared by Shoalhaven City Council in 2006
- An enquiry to Shoalwater
- A Dial Before You Dig (DBYD) request on 18 March 2013 for the area surrounding the Princes Highway current crossing of Shoalhaven River.

The DBYD request automatically notified the following service providers:

- Endeavour Energy
- Jemena Gas Nowra
- Optus and/or Uecomm, NSW
- Roads and Maritime Services
- Soul Australia Communication
- Telstra NSW, South.

These sources provided a comprehensive understanding of the existing utilities in the study area which tracks from Pig Island in the east to the western bypass in the west. Following is a description of each service provider's assets in the area with a discussion regarding constraints to the selection of a new crossing site.

Water

Water is provided by Shoalwater, a division of Shoalhaven City Council. Water is sourced from the Shoalhaven River at the Burrier Pumping Station approximately 30km west of Nowra. From there it is pumped to two treatment plants, Bamarang and Flatrock, both west of Nowra.

According to the reticulation plans supplied by Shoalwater, both treated and untreated mains cross on the existing concrete box girder bridge. One of these mains supplies untreated water to the Shoalhaven Paper Mill. The other provides treated water to Bomaderry. On the northern river bank mains generally track the road network along Illaroo and Bolong Roads. On the southern river bank there is a mains track along the river and through the Nowra CBD. A second main crosses the river, but not on structure, at Cabbage Tree Flat to service North Nowra and Cambewarra.

Shoalwater makes mention of upgrades of major trunk mains to service growth areas in the Structure Plan. It is unlikely that these will impact the selection of possible bridge crossings.

Figure 2-15 from the Structure Plan indicates the significant water mains in the area of interest.

Waste water

Waste water is also provided and maintained by Shoalwater. According to the Structure Plan, all wastewater from north of the river, except North Nowra, is treated at the Bomaderry Treatment Plant. North Nowra is serviced by the Nowra Treatment Plant on the southern side of the river. This seems contradictory to the reticulation plans which show a 50mm 'private rising main' crossing the bridge from a toilet block as the only line crossing the concrete box girder bridge. This contradiction can be clarified with Shoalwater at a later stage in the study.

The waste water services in the area comprise gravity and pressurised mains, and include a number of pump stations. Figure 2-16 from the Structure Plan indicates the extent of the wastewater network in the area of interest.

While modifications to the wastewater network are likely based on any new configurations of the crossing, it is unlikely that it will be a major factor influencing the decisions about possible future bridge sites.

Electricity

As noted in the Structure Plan, electricity is supplied by Integral Energy from Dapto Bulk Supply Point. There is a 132kv and three 33kv crossings of the Shoalhaven River none of which are around the existing bridge crossings. The twin 132kv feeders pass through the western edge of North Nowra and cross the river above ground towards West Nowra. The 33kv lines cross in three locations, one is west of the 132kv lines, one is approximately 800m west of the current Princes Highway crossing of Shoalhaven River, and one is to the east near Pig Island. Figure 2-17 from the Structure Plan indicates this network.

For the low voltage supply, Endeavour Energy has supplied their 'low risk' electrical lines within the area of the existing bridge as part of the DBYD request. There appears to be three spare ducts crossing the concrete box girder bridge and a low voltage circuit for the bridge lighting.

The thick brown line in Figure 2-18 indicates a ducted electrical feed, while the thinner orange line is a direct buried cable supplying low voltage electricity.

No additional information is required regarding the electrical supply network to inform the development of site options.

Gas

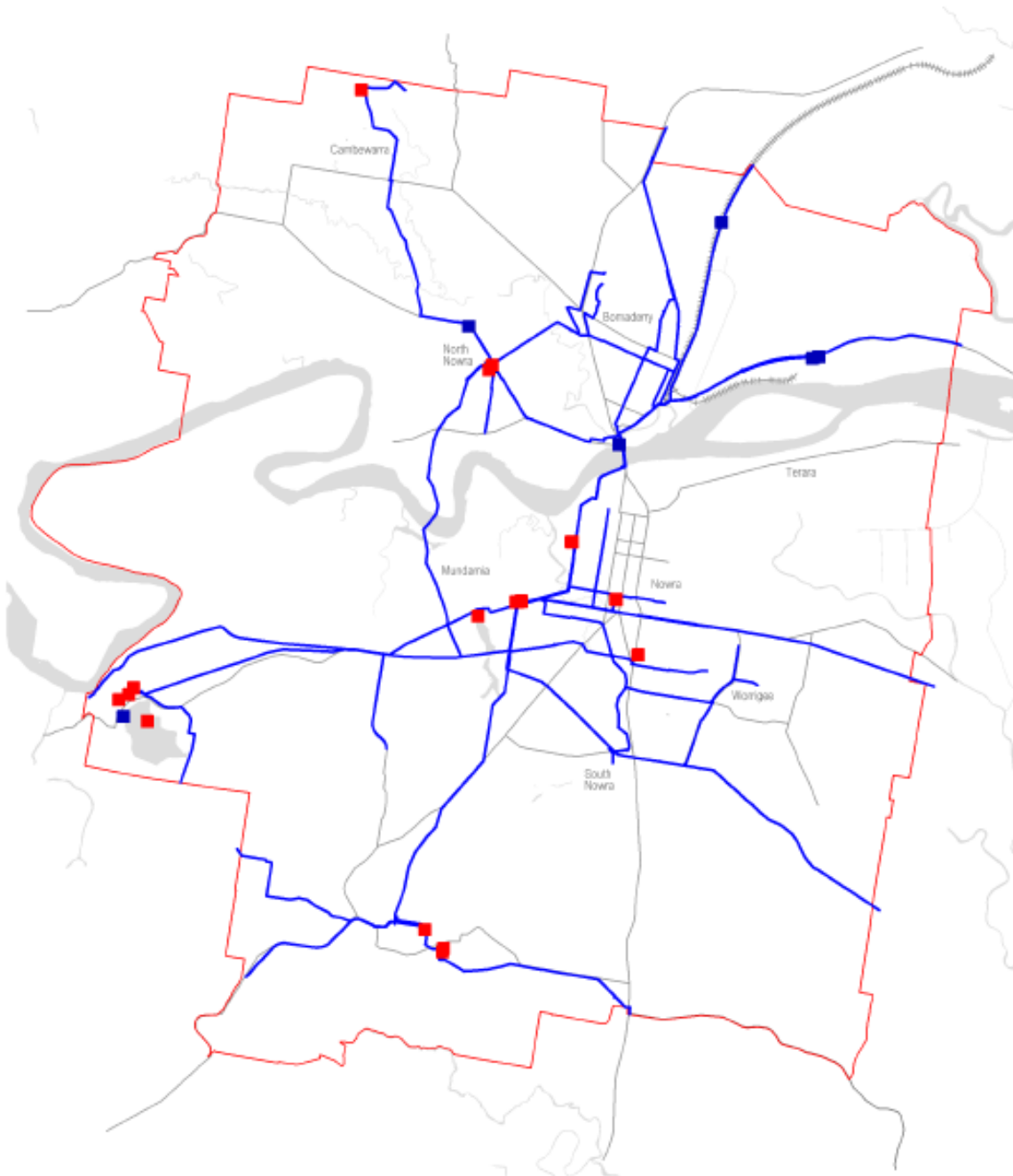
As noted in the Structure Plan, the Eastern Gas Pipeline traverses to the west of Nowra and Bomaderry urban areas. In places this main shares the same corridor as the 132kv transmission line. This main is generally best avoided or road crossings limited to those able to cross in fill embankment only. The proposed western bypass follows closely with this main and more information would be required regarding the nature of this interaction if this option was considered for further investigation.

Jemena has supplied information on gas lines from the DBYD request within the area of the current bridge crossings. These are minor gas services of around 75mm Nylon ducting. They have noted that there are only small diameter plastic distribution mains in the area. While these would need to be considered if changes are made in the area, they are of minor consequence. Figure 2-19 from the Structure Plan indicates the gas networks.

Communications

Information regarding communications assets was difficult to establish. Information obtained from DBYD indicates that significant optic fibre cables follow the highway alignment and the existing concrete box girder bridge. Details of interexchange networks had not been obtained at this preliminary stage.

Accurate details of communications assets are not required at this stage as their location will not influence the selection and assessment of potential crossing sites.



Water Supply Network



Nowra Bomaderry Structure Plan

Legend

- Structure Plan Boundary
- Water Trunk Mains
- Water Reservoirs
- Water Pumping Stations



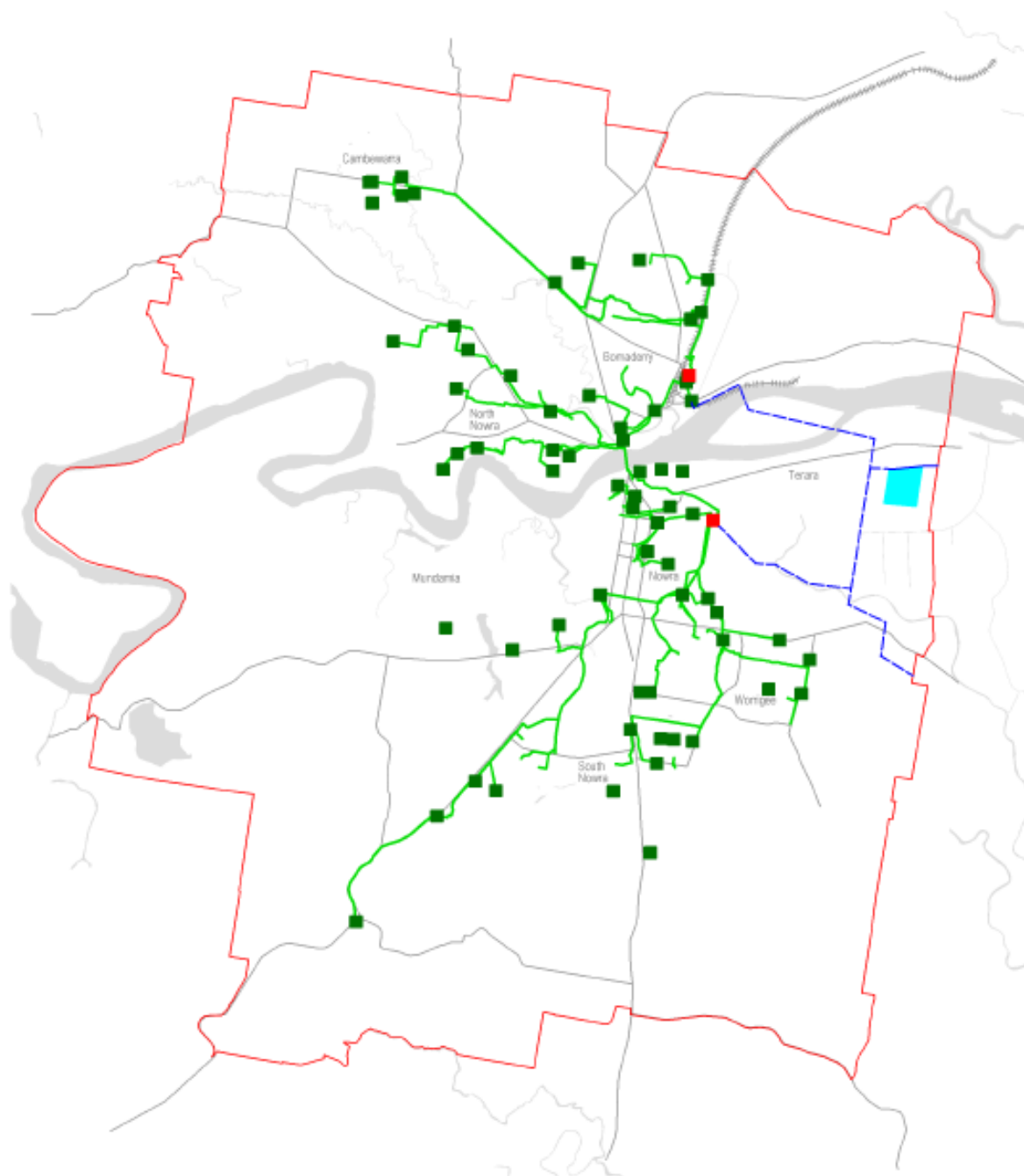
September 2006



Map 7.1

Figure 2-15 Water supply network

Source: Nowra Bomaderry Structure Plan, Adopted 2006

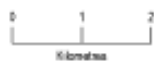


Waste Water Network
(including REMS)



Legend

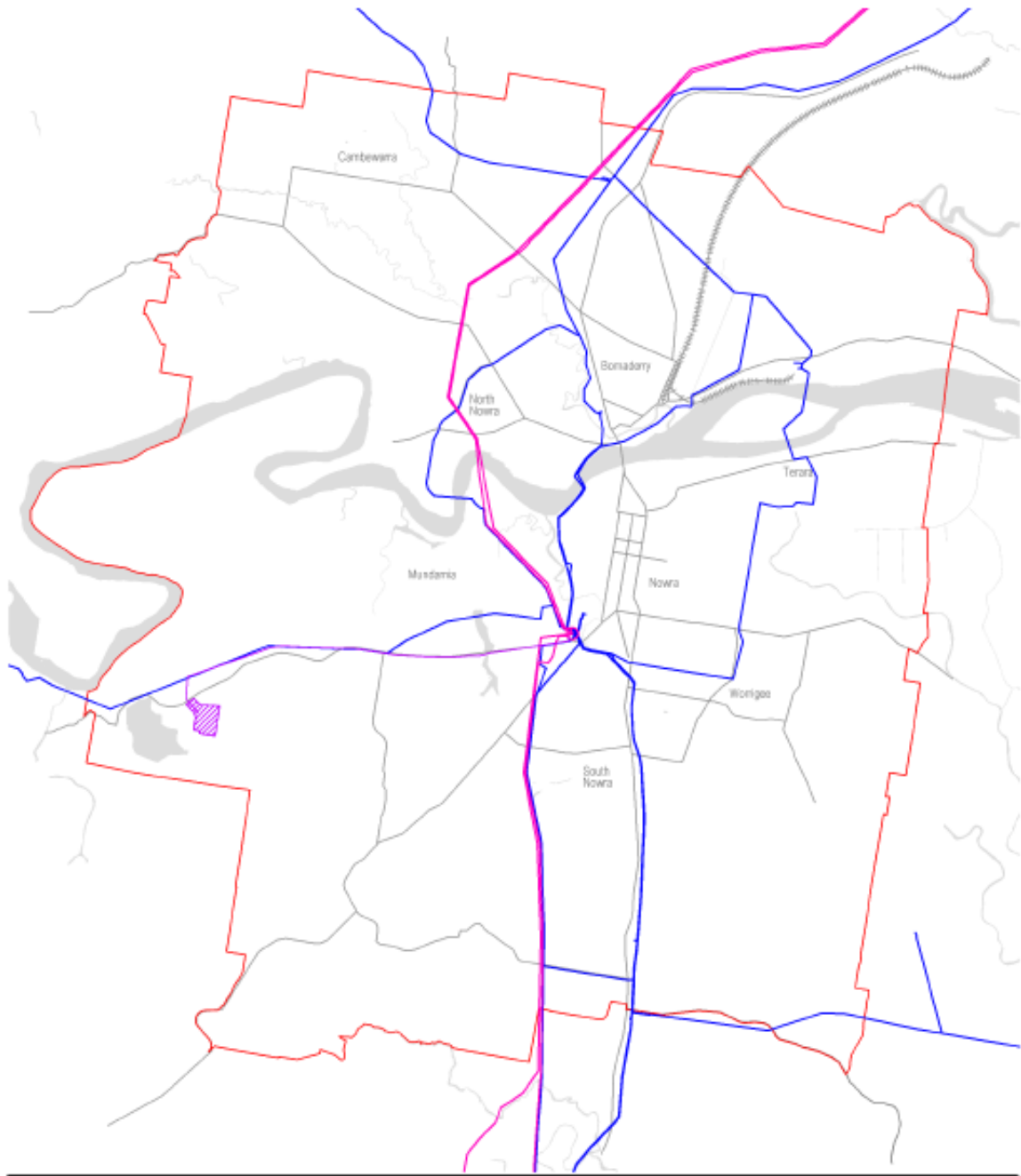
- Structure Plan Boundary
- Waste Water Trunk Mains
- Waste Water Pumping Stations
- Sewage Treatment Works
- REMS Stage 1a
- REMS Stage 1b
- REMS Dairy Farm



Map 7.3

Figure 2-16 Waste water network

Source: Nowra Bomaderry Structure Plan, Adopted 2006

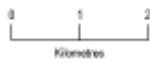


Electricity Network



Legend

- ▬ Structure Plan Boundary
- ▬ 132kV Electricity Line
- ▬ 33kV Electricity Line



Map 7.4

Figure 2-17 Electricity network

Source: Nowra Bomaderry Structure Plan, Adopted 2006

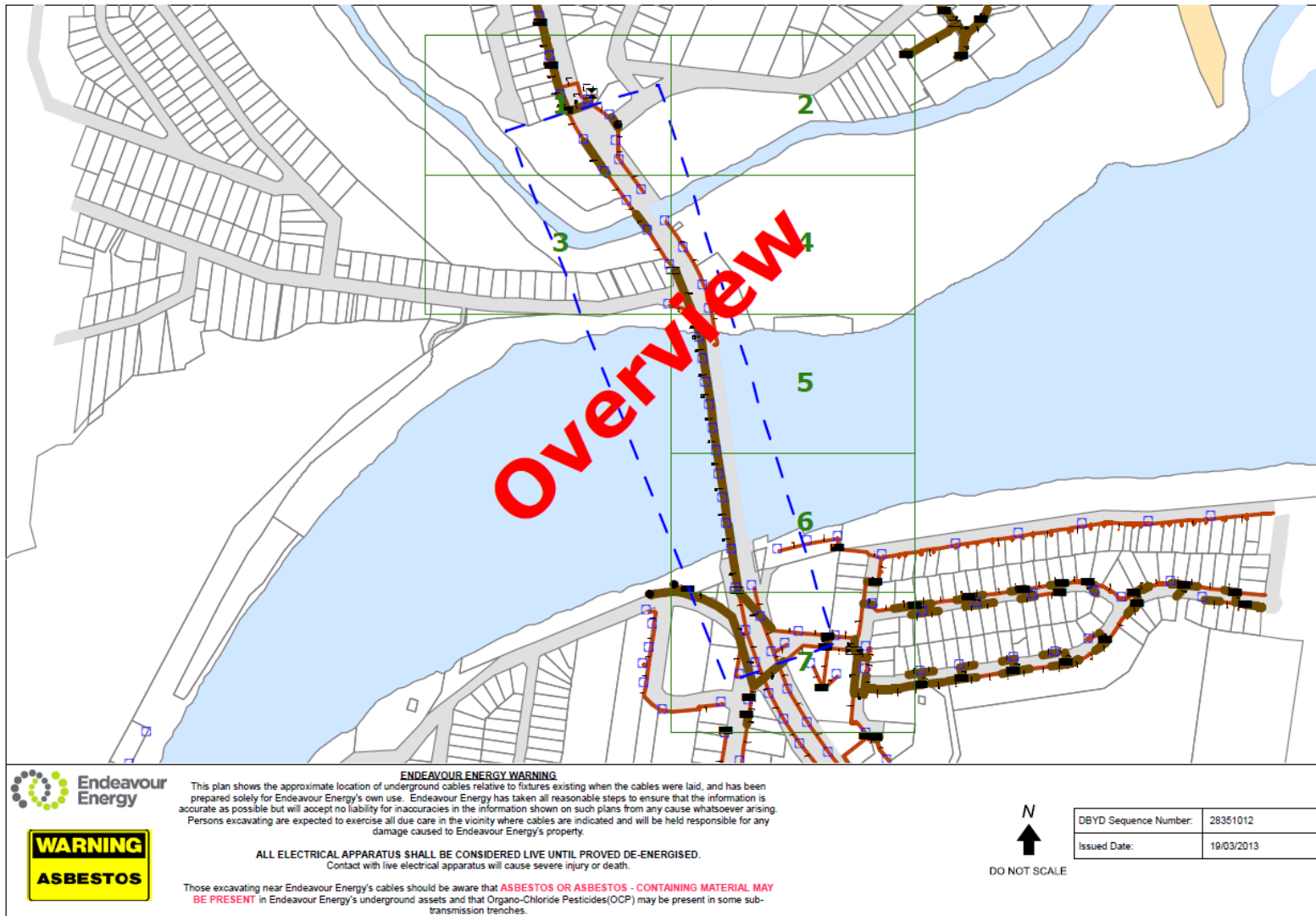
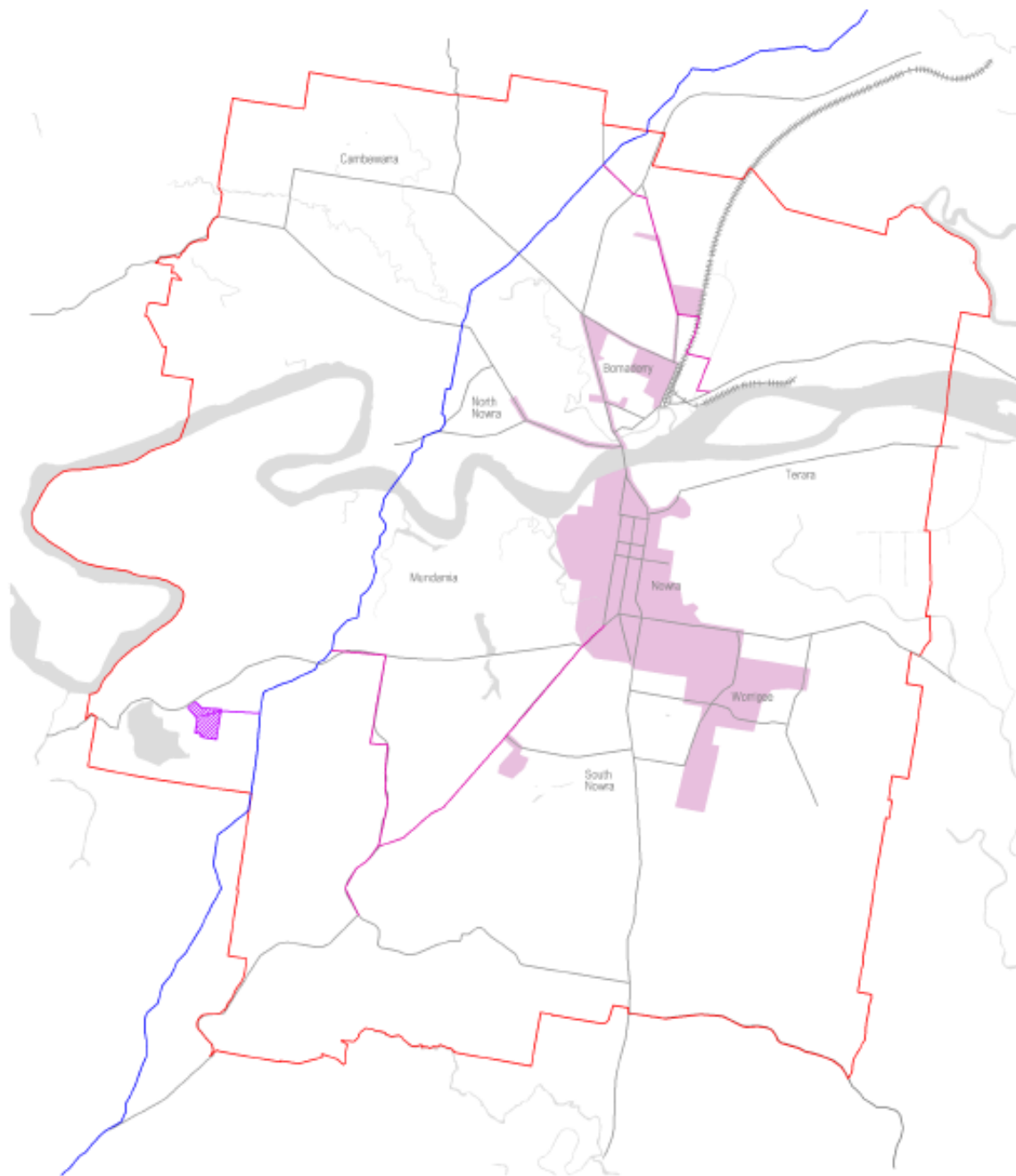


Figure 2-18 Endeavour Energy low voltage network







Source: DBYD



Gas Network

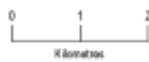


Legend

-  Structure Plan Boundary
-  Eastern Gas Pipeline
-  Gas Mains
-  Reticulated Gas Distribution Network
-  Proposed Power Station Gas Supply
-  Proposed Gas Turbine Power Station Bamarang



September 2006



Map 7.5

Figure 2-19 Gas network

Source: Nowra Bomaderry Structure Plan, Adopted 2006

2.4.7 Geotechnical

To enable potential bridge crossing sites to be evaluated against geotechnical conditions, an understanding of the key geotechnical issues and their risks was required. Information was required in the areas of:

- Landform
- Geology
- Acid sulphate soils
- Sub-soil profile.

The purpose of this review was to identify known information about the study area, identify what was unknown (information gaps), and identify what further information was required to inform a strategic assessment of potential site options. The review of geotechnical conditions was limited to a desktop study of existing and available information, information supplied by Roads and Maritime Services (and previous studies carried out by consultants and Shoalhaven City Council.

Literature review and gap analysis

A number of general references are available and were reviewed. The reviewed documents include:

- Department of Main Roads New South Wales, Work as Executed Drawings - State Highway No. 1 Bridge over Shoalhaven River at Nowra, 1980
- Geological Survey of New South Wales, Wollongong, 1:250,000 Series Geological Series Sheet SI 56-9, Second Edition, 1966
- Main Roads, New Bridges and Deviation at Nowra, June 1979
- New South Wales Natural Resource Atlas, <http://nratlas.nsw.gov.au/http://nratlas.nsw.gov.au/>, accessed March 2013
- Skycam aerial photographs of the study area, 2006
- SMEC, Additional Shoalhaven River Crossing, Nambaa Island to Bangalee, 2004.

Landform

A review of map contours indicates that Nowra and the surrounding urbanised areas have developed on the western edge of the Shoalhaven coastal flood plain. The existing crossings are also located on the edge of this flood plain.

The Structure Plan describes the significant topographical features of the area as:

- Cambewarra Escarpment, which in turn forms part of the Illawarra Escarpment
- Coolangatta Mountain to the east of Bomaderry
- Nowra Hill to the south of Nowra
- The Shoalhaven gorge, which has been incised by the Shoalhaven River and extends westwards from the Shoalhaven bridge for approximately 15 kilometres
- Secondary waterways including: Nowra and Bomaderry creeks, which have both incised to a sandstone formation creating secondary topographical features.

The landform of the area in relation to the road network is shown on Figure 2-20, also from the Structure Plan.



Figure 2-20 Landform

Source: Nowra Bomaderry Structure Plan, Adopted 2006

Geology

The 1:250,000 Wollongong geological map is shown in Figure 2-21.

The surface geological unit on either side of the Shoalhaven River upstream of the existing bridges belongs to the Permian aged Nowra Sandstone formation, which forms part of the Shoalhaven Group and is typically made of quartz sandstone.

The surface geological unit downstream of the existing bridges is Quaternary aged alluvium, typically made of gravel, swamp deposits and sand dunes.

The existing bridge crossings are located on the transition between the sandstone and alluvium units.



Figure 2-21 Wollongong geological units

Source Wollongong 1:250,000 geological map

Acid sulphate soils

The potential for acid sulphate soils (ASS) in the study area is shown on Figure 2-22 and varies from high to low probability in-stream and seaward of the existing bridge and to no known occurrence or extremely low probability inland or west of the existing bridge. The potential for ASS is not strictly considered a constraint to developing site options. However, this will require consideration once site options are determined and field sampling is proposed.

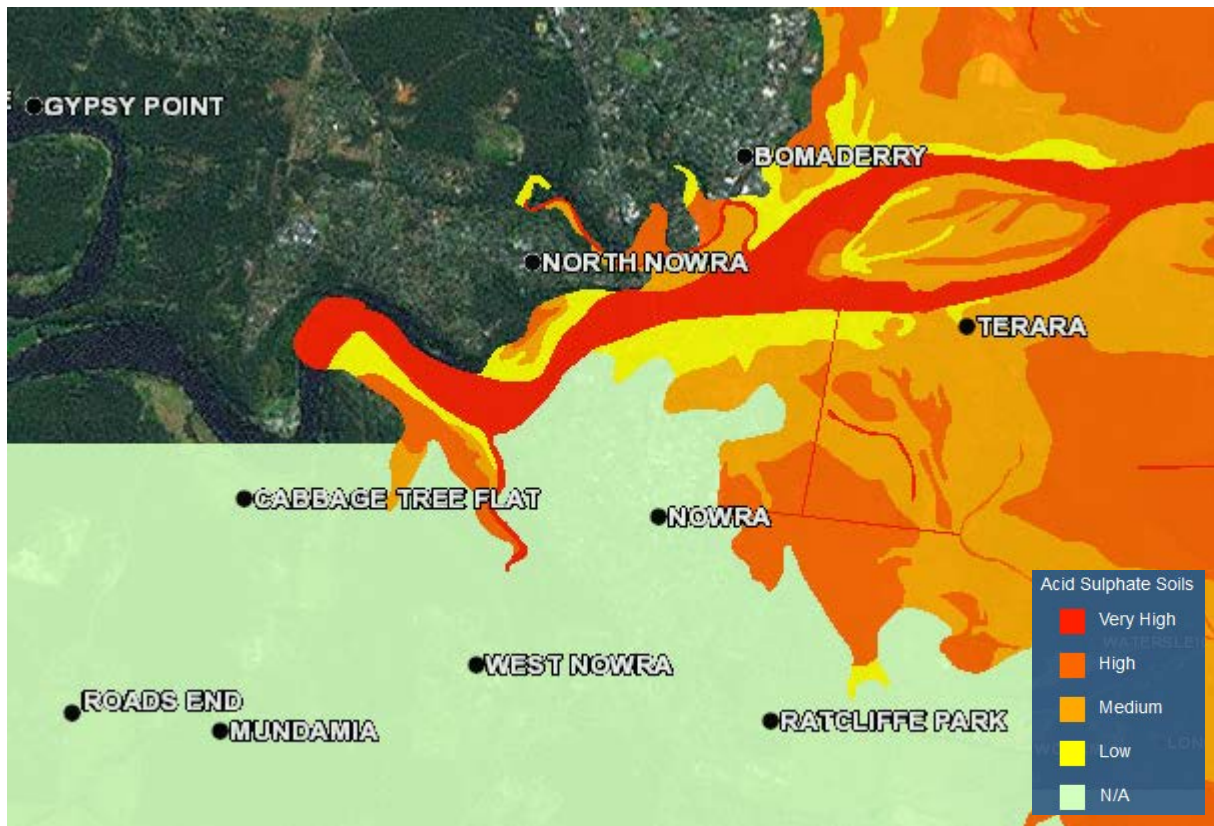


Figure 2-22 Acid Sulphate Soils Mapping

Source: NSW Atlas of Acid Sulphate Soils

Subsoil profile

The Natural Resource Atlas identifies a number of water bores constructed in the Nowra and Bomaderry region. Driller's logs are available for some of these water bores, and provide some indication of subsurface material.

Driller's logs from bores at the Nowra swimming pool, near the south side of the river, approximately 200m upstream of the existing bridges, indicate rock at a depth of three metres. Rock was also indicated at three metre depth in a domestic bore drilled in Nowra town. Rock was not noted in the bores drilled to depth between Four metres and six metres at the Shoalhaven Starches plant, approximately 1.5km downstream of the existing bridges.

The Work as Executed drawings of the existing 1980 concrete bridge show that the northern abutment and most northern bridge pier are supported by groups of cast in-situ reinforced concrete piles. The remaining bridge piers and the south abutment are supported by groups of driven steel tubular piles. The drawings include the subsurface profile of boreholes drilled at the foundation locations and indicate that the piles are embedded into sandstone (suggested to be Nowra Sandstone).

The drawings indicate that the alluvium overlying the sandstone is generally sandy with interbedded layers of sand, clay, gravel and mud. Due to the variable nature and generally low strength of these materials, the alluvium is considered inadequate as a founding stratum for the bridge foundations. The thickness of alluvium through the river channel is variable.

The construction records suggest that competent sandstone may be found at around 20 metres below the existing bridge deck (RL -11) at the northern abutment, but drops away significantly in the river channel. It is also relatively deep at the southern abutment.

On the basis of the assessed information, it was concluded that the existing bridges are situated near a boundary of relatively shallow sandstone (upstream) and deep alluvium (downstream). This

conclusion is supported by the generally flat, low lying landscape downstream of the bridges in comparison with the relatively higher, more undulating landscape upstream.

For the preliminary assessment it was considered that founding conditions upstream of the bridges would be more favourable than downstream, and in view of the depth of piles for the existing bridges, there could be a significant increase in foundation costs if a new bridge were constructed downstream of the existing bridges.

This degree of information and inference is considered suitable for the purpose of identifying and assessing site options.

Further work required for options assessment

Depending on the level of information required for the selection of a preferred site option, there may be value in undertaking additional site investigation to inform site options assessment.

It is at least recommended that further investigations be carried out to provide greater certainty of the bedrock profile during development of the preferred site option.

Such investigations could include:

- Geological mapping of the area around the existing bridges, and at targeted locations up and down stream
- Seismic reflection and/or refraction, and electromagnetic and bathymetric survey of the river bed at targeted locations from a vessel in order to determine the depth to river bed and rock across the river channel, and to identify underground services and obstructions (e.g. car bodies).

3 Development of site options

3.1 Option identification process

Potential site options were identified following review of the preliminary data review (see Chapter 2) including community consultation held in late 2013. It was necessary to select site options at this point to ensure that the supplementary data collection and analysis (see Chapter 4) acquired enough information to perform an adequate assessment of the site options.

The preliminary data review stage included:

- A review of technical studies including traffic
- Early environmental and geotechnical investigations
- Community consultation.

The technical studies mostly focused on fixing traffic congestion around the bridges. Although the studies reviewed were not recent, and mostly assumed the existing southbound bridge would still be in use, the findings were still considered relevant. It became apparent during review of these investigations that any potential option would need to ensure traffic and transport efficiency on the Princes Highway for the future.

The environmental and geotechnical investigations focused on desktop analysis and a review of existing literature in broad study areas. This was used to identify high risk constraints within the study area to help identify potential site options. It was recommended that more targeted investigations would be needed on any option around the existing crossings so that they could be differentiated.

Community consultation involved conversations with the community including the need for the project and potential site locations. There was a strong indication from the community for Roads and Maritime to take the opportunity to further investigate a bypass option and an option that could potentially cater for rail.

A more detailed summary of the findings from the preliminary data collection and analysis stage can be found in Chapter 2.

3.2 Options considered for assessment

After the preliminary data review stage, five options were selected for site options assessment. However, many more alternatives options were initially considered. The following chapters describe the options and all alternatives considered.

3.2.1 Maintain the existing southbound bridge

Planned closures of the existing southbound bridge would allow the necessary maintenance works to take place; however there would be issues with the loss of traffic capacity during peak periods if all traffic was forced to use the one bridge. Initial assessments concluded that during peak hour there would be unacceptable delays to the Nowra Bomaderry road network if the river crossing capacity was reduced to three lanes.

Around 46,500 vehicles cross the Shoalhaven River on an average day. These high traffic volumes prevent the closure of the bridge during the day as it would cause unacceptable delays on the Nowra Bomaderry road network during AM and PM peak periods. This is due to the reduction of lane capacity from five lanes in either direction to three. Early assessments concluded that no closures of the southbound bridge should be planned during peak periods.

Building a new bridge across the Shoalhaven River would be a large and expensive project. Alternatives that could allow the old southbound bridge to continue to carry traffic without the need to build a new bridge were considered. These alternatives included:

- The use of temporary 'Bailey' bridges to carry traffic while the existing southbound bridge is closed and repaired
- The partial closure of the existing southbound bridge to a single traffic lane during maintenance work
- Night time restrictions, closing the existing southbound bridge to allow maintenance work overnight when traffic volumes are less
- Increasing the number of lanes on the existing concrete bridge so that the existing southbound bridge could be closed for maintenance.

Roads and Maritime has investigated the use of temporary 'Bailey' bridges on other projects, such as the maintenance of the Hampden Bridge in Kangaroo Valley. While these temporary bridges may be practical for short periods of time or with low traffic volumes and shorter bridge spans. After assessment, the project team felt that a temporary 'Bailey' bridge was not an appropriate solution as it could:

- Introduce unsatisfactory safety risks to the travelling public in the event of an incident
- Be difficult to manage any incidents that happen on the temporary structure
- Require similar property acquisition to building a new bridge
- Become comparable in cost to building a new bridge if needed for an extended period.

Due to the width of the existing southbound bridge, partial lane closures would not improve the ability of maintenance crews to work. This set up is also still likely to result in traffic congestion if carried out in peak periods. Previous work carried out on the bridge during partial traffic closures has identified unacceptable safety risks for works crews and the travelling public and is no longer considered appropriate.

Night closures have also been used in the past for maintenance work on the existing southbound bridge. Night closures are an inefficient way of completing maintenance work as the majority of allocated time is spent setting up and packing up, leaving very little time for actual maintenance work. An early assessment of the work necessary on the existing bridge suggests that if the work was carried out during night closures, the work may need to occur continuously. Some work cannot be carried out at all under nightshift conditions as there is simply not enough time to complete the task before the bridge needs to re-open for peak morning traffic.

Narrowing the three lanes on the existing northbound concrete bridge and removing the pedestrian pathway has been raised as an alternative, as it was suggested it may allow for a fourth lane on the concrete bridge. However, this would require reducing the lane widths to less than acceptable standards. Early assessments indicate the bridge is not structurally designed to deal with the loads from four lanes of traffic. This alternative would also require reduction of the northbound lanes from three to two and would potentially remove the exclusive lane for left turn movements between Bridge Road and Illaroo Road. This alternative would also remove the southbound right turn storage currently available into Bridge Road, which would intensify southbound queues.

Even if a practical maintenance solution could be found to allow continued safe operation of the southbound iron truss bridge, the issues of traffic congestion and freight restrictions especially for overheight vehicles would still remain. Through the early stages of project development, this study concluded that any feasible options to improve conditions on the Princes Highway at the crossing of the Shoalhaven River require the construction of a new bridge.

It should be noted there is no immediate risk to the travelling public. A recent assessment of the condition of the bridge assessed the iron truss bridge to be structurally sound, but requiring major refurbishment in the short to medium term to continue to operate safely.

3.2.2 Options next to the existing bridges

Historical traffic studies have identified that the further away a new bridge is from the existing Princes Highway, the less traffic it would attract. Therefore options close to the existing bridges were considered as feasible for site options assessment. It would also be practical for any new bridge to be located near the existing Princes Highway as it could potentially tie in more efficiently to the existing road network.

Options either side of the existing bridges were identified and these became Option B to the west (upstream) and Option D to the east (downstream).

3.2.3 Demolish and replace the old southbound bridge

Demolishing the existing southbound bridge and rebuilding a new bridge on the same alignment was considered. This option would reduce the potential impact on property either side of the existing bridges.

The perceived benefits of this option were considered important enough for it to be considered for site options assessment. This option became Option C.

3.2.4 Bypass Nowra

There was strong support from the community and other stakeholders for a Nowra bypass. The Princes Highway through Nowra Bomaderry experiences traffic congestion during daily commuter peaks, on weekends and during holiday periods. It was felt by some that a bypass would address the wider issue of traffic congestion along the Princes Highway.

A range of bypass routes were suggested, including one main option to the west on the Draft 2013 Shoalhaven Local Environment Plan (SLEP) and many options to the east from Pig Island to as far east as Shoalhaven Heads.

There currently is no corridor identified for a possible eastern bypass of Nowra Bomaderry. It was not considered feasible for such an option to be further assessed compared to other available options.

The western option identified on the SLEP was considered to be the most appropriate option for further assessment. This option is consistent with the long term land use plans of Shoalhaven City Council and was included for site options assessment as Option A.

3.2.5 Provide for future rail

There was considerable interest from the community that the Nowra Bridge project should consider an option that could cater for a future rail extension across the Shoalhaven River. It was felt that this option would provide infrastructure that could in future be used to extend the South Coast Rail line into Nowra and potentially further down the NSW south coast. Some members of the community were of the belief that an option catering for rail would accelerate any plans for a rail extension into Nowra.

The option was considered as having the potential to integrate longer term and multi modal transport needs into a single piece of infrastructure, with potential cost benefits from coordinating with future rail. The option was included for site options assessment, and was considered as Option E.

3.2.6 'Double deck' bridge

A small number of requests were received to investigate a 'double deck' bridge. Variations on this idea included reserving one of the decks for a future rail extension across the Shoalhaven River, or configuring one of the decks for local traffic to access the local roads at Illaroo Road, Bolong Road and Bridge Road.

Any 'add on' option to the existing bridges would be difficult to design and have construction difficulties under traffic. Neither of the existing bridges was designed to carry the additional weight of

another deck or the weight of the additional traffic that would occur under a 'double deck' option.

Building a new 'double deck' bridge next to existing bridges would introduce construction difficulties and costs with little additional benefits. This option could not be seriously considered compared to other available options.

3.2.7 Tunnel

A small number of requests were received from the community to investigate a bored or immersed tube tunnel under the Shoalhaven River instead of a new bridge.

A tunnel at this location would need to be built far enough away from the existing crossing so that it would not impact the piles and footings of the existing bridges. Due to the depth of the Shoalhaven River at this location it would not be able to resurface for some distance either side of the river and is likely to restrict access to the local road network at Bolong Road, Illaroo Road and Bridge Road. A tunnel of this length would also introduce additional construction and maintenance costs with complicated ventilation and fire retardant systems, and may introduce additional complications to tie back to the Princes Highway.

A tunnel was not considered a cost effective or practical option compared to the available above ground options.

3.3 Overview of options

As described above, five potential site options worthy of further investigation were selected for supplementary data collection, analysis, and evaluation.

The five options from west to east were designated Option A to Option E and are described below.

Option A – western bypass alignment

Option A would involve construction of a new bridge as part of a potential future western bypass of Nowra. This option would follow an alignment that skirts to the west of Nowra Bomaderry identified in the Shoalhaven Local Environmental Plan (SLEP).

Given limitations to on-site investigation, the assessment of constraints and opportunities associated with this option has been based on desktop analyses.

Option B – immediately west (upstream)

Option B would involve construction of a new bridge immediately west (upstream) of the existing northbound concrete box girder bridge at the Princes Highway.

Option C – existing southbound alignment

Option C would involve construction of a new bridge on the alignment of the existing southbound bridge at the Princes Highway. This option would require demolition of the existing southbound iron truss bridge, after which a new bridge would be built on the old alignment.

Option D – immediately east (downstream)

Option D would involve construction of a new bridge immediately east (downstream) of the existing southbound bridge at the Princes Highway.

Option E – eastern potential rail option

Option E would involve construction of an eastern option, with a new bridge downstream of the existing southbound bridge. This option could potentially allow for a future rail extension across the Shoalhaven River.

Figure 3-1 shows indicative locations for the five potential site options.

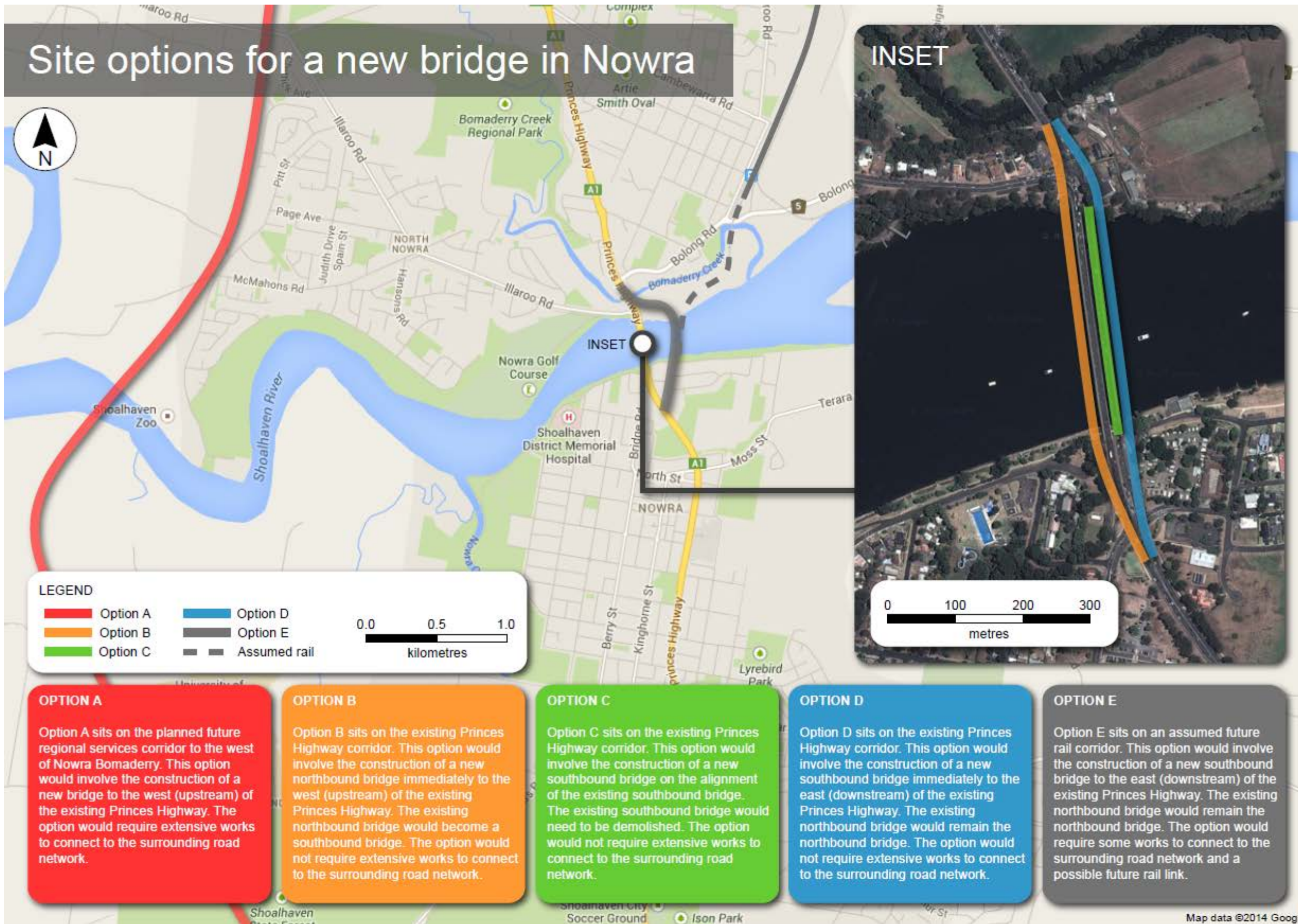


Figure 3-1 Indicative locations for the five site options

4 Supplementary data collection and analysis

4.1 Introduction

A number of key environmental, engineering and economic issues influence the location and design of the preferred site option. Therefore, a further data collection and analysis phase was required to supplement the existing background material summarised in Chapter 2. The objective of the supplementary data collection and analysis phase was to provide a comprehensive understanding of the functional, socio-economic and environmental constraints and opportunities for the five potential site options and to inform the value management process outlined in Chapter 5.

The main supplementary technical areas are listed below, with further details provided in subsequent sections:

- Preliminary environmental investigation (PEI)
- Traffic assessment
- Visual and landscape character
- Design and construction considerations.

4.2 Preliminary environmental investigation (PEI)

A preliminary environmental investigation (PEI) was carried out to complete a broad scale assessment of the five potential site options. The aim was to build on the findings from the preliminary data review phase (See Section 2.4.4) to identify potential opportunities and environmental constraints that may influence the selection and development of a recommended site option for a new bridge.

A broad study area was considered for each option within Nowra as exact alignments for each option were not known. For the purposes of the PEI, the study area for options within Nowra (Options B, C, D and E) have been combined and referred to as the 'Nowra study area'. For Option A, the study area reflects the corridor identified by Shoalhaven City Council within its Local Environmental Plan. This study area is referred to as the 'Option A study area'.

Given that the analysis is focused on a broad study extent for Options A to E, as opposed to a refined bridge corridor, the analysis focused on key environmental issues that are considered likely to provide a robust basis for comparing and evaluating the five site options. These issues are listed below with further details on specific investigations and findings for each area provided in subsequent sections:

- Biodiversity
- Aboriginal heritage
- Non-Aboriginal heritage
- Land use and property
- Socio-economic
- Contamination.

4.2.1 Biodiversity

A strategic environmental review of the ecological constraints of the study areas was carried out by Eco Logical Australia Pty Ltd (ELA), and involved:

- Ten kilometre radius searches of the following databases:
 - Office of Environment and Heritage (OEH) BioNet Atlas of NSW Wildlife

- Department of the Environment (DE) Protected Matters Search Tool
- Industry and Investment NSW Threatened and Protected Species viewer for threatened fish species.
- Assessments of the likelihood of occurrence for endangered ecological communities (EEC), threatened and migratory species identified from the database searches
- Review of available literature to assist in identifying ecological constraints
- Analysis of vegetation mapping for the South Coast – Illawarra Vegetation Integration (SCIVI) vegetation community, previous threatened species search results, and aerial photography. Results were used to tailor field surveys for Nowra study area (Options B, C, D and E)
- Rapid assessment of the Nowra study area to validate vegetation mapping and identify potential areas of habitat for threatened species. Field surveys were conducted over two days (21 and 24 February 2014) by two ecologists. Due to the scale of the Option A study area, assessment of this option was limited to desktop analysis only
- Criteria were used to determine areas of high to negligible ecological constraint.

Existing environment

Threatened species

Database searches identified 39 threatened flora species and 23 threatened ecological communities within a 10 kilometre radius of the study areas (OEH, 2014; DE, 2014). One EEC listed under the EPBC Act was identified from a 10 kilometre radius database search. A total of 130 threatened or migratory fauna species were identified from the Protected Matters Search Tool (EPBC) database search. A list of species that are likely to occur or are known to occur within each study area is provided in Appendix B.

Flora

A total of 143 flora species were identified during field surveys of the Nowra study area. A species list is provided in Appendix B, and includes 92 native flora species and 51 exotic species. Of the exotic species recorded during field surveys, ten are listed as noxious within the Shoalhaven LGA under the *Noxious Weeds Act 1993*. Five species are also listed as Weeds of National Significance (WoNS).

Fauna and fauna habitat

A total of 37 bird species were recorded during the field surveys including three species listed under the Threatened Species Conservation (TSC) or EPBC Acts:

- *Lophoictinia isura* (Square-tailed Kite) (vulnerable under the TSC Act)
- *Ardea ibis* (Cattle Egret) (migratory species under the EPBC Act)
- *Ardea modesta* (Eastern) (Great Egret) (migratory species under the EPBC Act).

Both study areas also provide suitable habitat for a number of other threatened fauna species which may occur; however, these were not recorded during the field surveys. An assessment of the likelihood of occurrence for each species is provided in Appendix B.

For the purpose of *State Environmental Planning Policy 44 – Koala Habitat Protection*, the presence of core koala habitat within the Nowra study area was considered unlikely, due to the urban nature of these study areas. Given the characteristics of the Option A study area and proximity to recent koala records, it is possible that core koala habitat may occur within the as yet unsurveyed Option A study area.

One wetland listed under the *State Environmental Planning Policy 14 – Coastal Wetlands* and the *Environment Protection and Biodiversity Conservation Act 1999* (as a Wetland of National Significance), is located at the mouth of the Shoalhaven and Crookhaven Estuary. Although this

wetland is located about five kilometres east of the proposed options, disturbance to the foreshores of the Shoalhaven River may impact the wetland (for example as a result of sedimentation, or changes to flood patterns).

Vegetation communities

Broad-scale vegetation mapping of the south coast (SCIVI) was conducted by Tozer et al. (2006). A total of seven vegetation communities were mapped within the Nowra study area. The SCIVI data layer did not map fragmented or modified habitats. There are large areas of fragmented and modified habitat located within the study areas including the riparian areas of the Shoalhaven River and Bomaderry Creek. Validation of threatened vegetation communities, condition and extent was carried out during the field surveys of Nowra study area.

Four native vegetation communities were identified by ELA during field surveys of Nowra study area, of which three are listed as EECs under the TSC Act:

- Southeast Floodplain Wetlands (EEC)
- South Coast Lowland Swamp Woodland (EEC)
- Floodplain Swamp Forest (EEC)
- Currumbene-Batemans Lowlands Forest.

Results from the field assessment identified discrepancies in the SCIVI mapping. In particular the EECs, Southeast Floodplain Wetlands and Floodplain Swamp Forest identified in the field had not been mapped as vegetation communities by SCIVI.

Although seagrass meadows were not included in the SCIVI mapping data layer, these have previously been mapped at Pig Island and the north-eastern shallows of the Shoalhaven Bridge (Roads and Maritime, 2013). During field surveys, seagrass meadows were observed within shallow water under Shoalhaven Bridge extending downstream and within parts of Bomaderry Creek. Scattered patches of *Aegiceras corniculatum* (River Mangrove) occur on the along the southern foreshore of the Shoalhaven River.

SCIVI mapping identified nine vegetation communities as occurring within a one kilometre buffer of the Option A study area. Two of these communities are listed as EECs. The one kilometre buffer includes large tracts of intact native vegetation with minimal disturbance. There is a high probability that these areas may provide suitable habitat for threatened flora and fauna species.

Assessment

The ecological constraints within each study area were classed as high, medium or low-negligible, based on the ecological attributes that have been confirm by field investigations or by a desktop review.

Areas corresponding to each class of constraint for each study area are shown in Figure 4-1 and Figure 4-2.

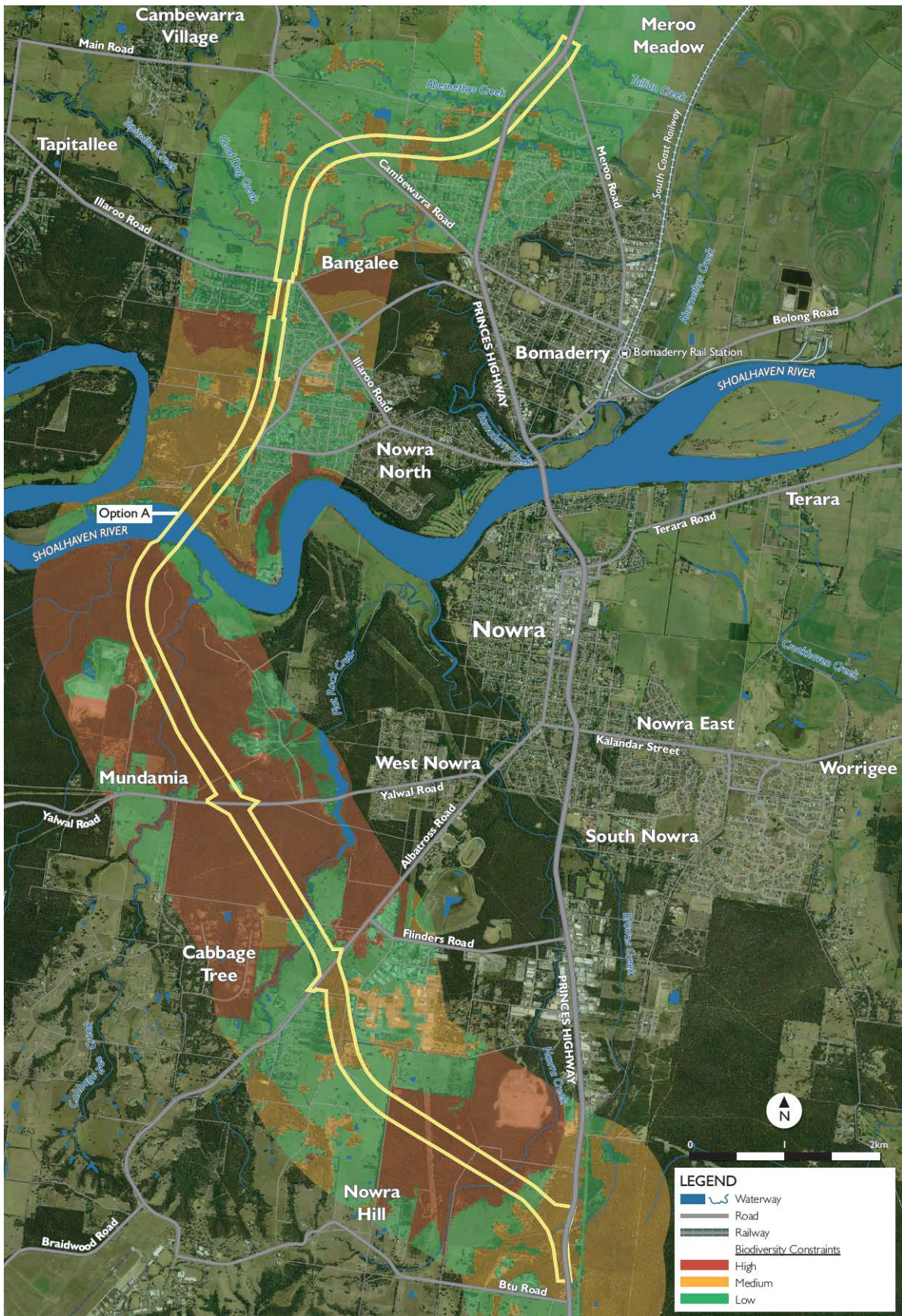


Figure 4-1 Biodiversity constraints (Option A study area)



Figure 4-2 Biodiversity constraints (Nowra study area)

Nine vegetation communities were identified as occurring within a one kilometre buffer of the Option A study area, two of which are listed as EECs. The one kilometre buffer includes large tracts of intact native vegetation with minimal disturbance. There is a high probability that these areas may provide suitable habitat for threatened flora and fauna species.

Option A study area has the potential to contain a greater number (diversity) and abundance of threatened species that are known, likely or have the potential to occur, when compared to the Nowra study area. Option A is located within a long-term infrastructure corridor that has been protected by Shoalhaven City Council, but would require a much larger footprint when compared to the other proposed options because of the connections to the Princes Highway that would be required to the north and south of Nowra. Other ecological issues associated with the Option A study area include the potential for fragmentation of highly vegetated areas of habitat, and potential for road mortality.

The majority of the Nowra study area is of low or negligible ecological constraint, consisting of exotic vegetation or modified habitats in urban and rural landscapes, with minimal potential habitat for threatened fauna.

One area of high ecological constraint was identified within the Nowra study area. This area is located north of Bolong Road and east of the existing Princes Highway (see Figure 4-2). Areas of medium ecological constraint are largely associated with riparian vegetation associated with Bomaderry Creek, the Shoalhaven River foreshore, and areas of open space (see Figure 4-2). The impacts on areas of high and medium constraint would be dependent on the alignment and the required connections to the Princes Highway. Because Option C is on the existing alignment it would have the least impact on high and medium constraints.

Areas corresponding to each class of constraint are provided within Table 4-1 and shown in Figure 4-2.

Table 4-1 Nowra study area constraints and attributes

Constraint class	Attributes
High	<ul style="list-style-type: none"> • One patch of vegetation (north of Bolong Road and east of Princes Highway) which contains high species diversity and habitat values in a small area, and is generally in good condition • Represents a patch with two EECs and an established indigenous revegetated buffer to the wetland: <ul style="list-style-type: none"> ○ Freshwater Wetlands on Coastal Floodplains (EEC) ○ South Coast Lowland Swamp Woodland (EEC). • Vegetation has connectivity values with adjoining vegetation to the north and habitat values • This patch also supports potential habitat for threatened bird species such as waders and may also support foraging and roosting habitats for the Grey-headed Flying-fox and microchiropteran bats for which there are nearby records.
Moderate	<ul style="list-style-type: none"> • Contains highly disturbed and fragmented EEC vegetation (Floodplain Swamp Forest) and one common community (Currumbene-Batemans Lowlands Forest). This vegetation also functions as a creek bank stabiliser and riparian corridor habitat • An area of open grassland (south of the Shoalhaven River and immediately east of the Princes Highway) contains depressions which are likely to fill with water after rainfall and provide potential habitat for the endangered Green and Golden Bell Frog, for which there are nearby records.
Low - negligible	<ul style="list-style-type: none"> • Includes exotic or modified habitats which may contain suitable foraging habitat for threatened or migratory fauna species such as Egrets, Square-tailed Kite and Grey-headed Flying Fox • Modified or exotic vegetation includes - landscaped park, urban planted trees and agricultural paddocks.

Opportunities to avoid impacts to biodiversity would depend largely on the design of connections to the existing road network. Development of designs for potential alignments should seek to minimise impacts on vegetation communities and potential habitats as far as practicable.

Design of crossings should explore opportunities to remove abutments or structures within riparian areas to minimise impacts on these areas. Impacts to seagrass and aquatic ecological values should be avoided or minimised in the development of route alignments for the bridge crossing.

Next steps

Additional assessments, including targeted threatened species assessments, would be required to confirm the presence of threatened flora or fauna species during the concept design phase.

Existing bridge structures may support threatened microbats. As no targeted surveys were conducted and access to the underside of the bridges is difficult, it is unknown whether microbats were present under these existing structures. The presence of microbats should be confirmed through targeted survey during the concept design phase, if relevant.

Following the selection of a preferred alignment, potential impacts on the downstream wetland would need to be considered in environmental assessment documentation.

4.2.2 Aboriginal heritage

A combination of desktop investigations and visual inspections were carried out during preparation of the Aboriginal heritage due diligence assessment. Information regarding the presence of known and potential Aboriginal heritage within the study areas of Options A to E was obtained from:

- A search of the Aboriginal Heritage Information Management System (AHIMS) database register was obtained from OEH on 4 April 2013, which was updated on 5 March 2014 and again on 14 March 2014 to capture all five study areas. The final search area encompassed the study areas of Options A to E within a rectangle measuring 13.7 kilometres by 12 kilometres
- A search of the National Native Title Tribunal, the Australian Heritage Database and the NSW State Heritage Register
- Desktop review of accessible previous Aboriginal heritage reports relevant to the area
- Visual inspection of identified Aboriginal heritage items within the Nowra study area was carried out on 24 February 2014. This inspection involved a general assessment of areas of archaeological potential as well as a targeted inspection of the five registered AHIMS sites identified within the study areas. Due to the scale of Option A, assessment of this study area was limited to desktop analysis only
- This preliminary assessment aligns with Stage 1 of Roads and Maritime's Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI) and did not take into account cultural values. Cultural values can only be derived through consultation with Registered Aboriginal Parties (associated with Stage 3 of the PACHCI). As such, constraints discussed herein relate to impacts to archaeological (scientific) values.

Existing environment

Cultural background

Options A to E are located within the traditional lands of the Wandandian and Wodi Wodi people, with the Shoalhaven River having historically provided the boundary for their separate areas according to tribal boundary data (Tindale, 1974). The area is part of the south coast region administered by the Nowra Local Aboriginal Land Council (NLALC) (New South Wales Aboriginal Land Council, 2009). In addition, the Tharawal Local Aboriginal Land Council describes its boundaries as "from the south side of Botany Bay, around Port Hacking to the north of the Shoalhaven River (Nowra) and extending inland west to Campbelltown and Camden" (Tharawal Local Aboriginal Land Council, 2014),

stemming back to the Wodi Wodi people.

As of March 2014 the National Native Title Tribunal has no native title applications listed for the Nowra area (National Native Title Tribunal, 2014). A search of the Australian Heritage Database and the NSW State Heritage Register did not identify any further potential Aboriginal heritage constraints for the project.

AHIMS data

A search of OEH's AHIMS database identified a total of 119 previously recorded sites within the search area. One of these sites has since been deleted from the AHIMS database, bringing the total number of valid sites within the search area to 118. [REDACTED]

Isolated artefacts were the dominant site type within the search area, followed by artefact scatters, rockshelters and rockshelters with art. A breakdown of AHIMS site types is provided in Appendix B. Of the 118 sites, a total of five previously recorded sites were identified as occurring – either wholly or partially – within the bounds of, or in close proximity to, the Nowra study area, and 24 within or close proximity to the Option A study area. These counts are based on coordinates provided by the AHIMS register, which may be erroneous. The five sites could not be re-located during the field inspection.

Other heritage registers

A search of the Australian Heritage Database and the NSW State Heritage Inventory identified one Aboriginal heritage item, the Bomaderry Aboriginal Children's Home. This item is outside the study areas for all five options, but is considered in Section 4.2.2.

Previous Aboriginal archaeological investigations

Past studies in the area have identified rockshelters within the steep escarpments of the Nowra Sandstone areas, including a rockshelter with art site [REDACTED] identified by Bindon in his 1976 thesis which may not be currently included on the AHIMS database. [REDACTED]

While potentially located within Option A study area, ground-truthing of this site and those listed in Appendix B would be required in order to confirm potential impacts to Aboriginal heritage within this area.

Areas of archaeological potential

Proximity to water sources is an indicative factor for past Aboriginal pathways and areas of habitation. As such, areas within 200 metres of the Shoalhaven River and 100 metres of named creeks (including Bomaderry Creek) were assessed as having archaeological sensitivity and the potential to contain Aboriginal subsurface deposits. Areas of sandstone outcrops and escarpments were also identified as having potential to contain additional rockshelter sites, and areas of mature vegetation to contain modified trees. Areas of archaeological potential are shown on Figure 4-4 and Figure 4-5.

The level of archaeological sensitivity within the 200 metre and 100 metre riparian bands would depend on the depth of past impacts within these areas. The presence or absence of subsurface deposits can only be confirmed through archaeological testing.

Much of the Shoalhaven River foreshore has been significantly impacted by development, including agriculture and the construction of urban infrastructure. In highly developed areas such as Bomaderry and central Nowra, it was considered likely that development within foreshore areas would have disturbed Aboriginal deposits. The estimated depth of disturbance in agricultural areas further east and west of Nowra is about 30 centimetres. It was considered unlikely for subsurface deposits below this depth to have been impacted.

The banks of Bomaderry Creek have been less impacted by development, with the primary sources of disturbance being vegetation clearance and the construction of walking tracks.



Figure 4-4 Areas of archaeological potential (Option A)



Figure 4-5 Areas of archaeological potential (Nowra study area)

Assessment

Areas that are considered to have archaeological potential in the Option A study area and the Nowra study area are identified in Figure 4-4 and Figure 4-5 respectively.

The Option A study area covers the largest area of all proposed options and contains multiple sensitive landforms including escarpment areas, areas of mature vegetation, and the banks of the following watercourses: Shoalhaven River; Tapitallee Creek; Cabbage Tree Creek; Flat Rock Creek; Tullian Creek and Nowra Creek. Based on the underlying geology and the previous recordings of rockshelter sites, including Devil's Hands, indicate that previously unidentified rockshelters may be present in the escarpment areas. The presence of mature vegetation stands also suggests the possibility for modified trees.

For these reasons, Option A study area is the most constrained, in terms of potential for impacts to Aboriginal heritage.

The Nowra study area contains a relatively low number of registered AHIMS sites and areas of archaeological sensitivity, compared to Option A study area.

Areas around the creek banks of the Shoalhaven River and Bomaderry Creek, as well as the confluence of these two watercourses, are the most constrained. Despite farming and grazing activities in these areas, there is potential for deeper in situ archaeological deposits to still be present. There is also the potential for the study area to contain an AHIMS site, which could not be relocated during the site inspection. North western zones of the study area, specifically the escarpment areas either side of Bomaderry Creek, also have the potential to contain previously registered AHIMS sites and are considered to be a constraint within this study area.

Options B, C, D and E may present an opportunity to minimise potential impacts to Aboriginal archaeological sites, noting that eastern areas of the study area do contain a greater potential for Aboriginal heritage impacts.

Next steps

- In order to minimise impacts to Aboriginal archaeology, the following should be considered during development, design and selection of a preferred alignment:
 - Avoidance of escarpment areas, where the previously registered rockshelter sites are likely to occur
 - Minimising ground disturbance within areas of archaeological sensitivity (e.g. in proximity to water courses)
 - Limiting ground disturbance to areas with the highest levels of past disturbance.

Both study areas have the potential to impact Aboriginal cultural heritage, including registered AHIMS sites and previously unidentified Aboriginal objects. However, in order to accurately assess impacts, further survey is required to verify the condition and content of sites, as well as their location in relation to the five proposed options.

Based on the process outlined in the PACHCI and the OEH Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (NSW Department of Environment Climate Change & Water, 2010), it is advised that further investigation is required to inform development, design and selection of a preferred alignment. This includes consultation with key Aboriginal stakeholders be carried out in accordance with Stage 2 of the PACHCI.

4.2.3 Non-Aboriginal heritage

A combination of desktop investigations and visual inspections were carried out during preparation of the Non-Aboriginal heritage due diligence assessment. Information regarding the presence of known and potential Non-Aboriginal heritage within the study areas of Options A to E was obtained from:

- Searches of relevant heritage inventories and registers (carried out on 20 February 2014), including:
 - World Heritage List
 - National Heritage List
 - Commonwealth Heritage List
 - Register of the National Estate (non-statutory)
 - NSW State Heritage Register
 - NSW State Heritage Inventory
 - Section 170 (S170) registers including those maintained by Roads and Maritime and Transport for NSW
 - Shoalhaven Environmental Plan 2014
 - National Trust of NSW (non-statutory).
- Searches encompassed a 300 metre buffer around the combined study areas of Options A to E. The 300 metre buffer was included in order to capture Non-Aboriginal heritage items within the vicinity of the proposed options, for the purpose of identifying those that would potentially be susceptible to indirect impacts
- Desktop review of accessible previous Non-Aboriginal heritage reports relevant to the area
- Visual inspection of identified Non-Aboriginal heritage items within the Nowra study area was carried out on 24 February 2014. The purpose of this inspection was to identify the current condition of listed items and verify their location in relation to the proposed options.

At the time of the original desktop analysis, the *Shoalhaven Local Environmental Plan 1985* (SLEP 1985) had not been repealed. This assessment has since been updated to reflect the recently made *Shoalhaven Local Environmental Plan 2014* (SLEP 2014), which has repealed the SLEP 1985.

Existing environment

Searches of heritage inventories identified a total of 16 Non-Aboriginal heritage items listed under the LEP 2014 as occurring within a 300 metre buffer of Options A to E study areas. Of these 16 items, 13 were identified as being contained either wholly or partially within the Nowra study area. No listed Non-Aboriginal heritage items were identified within the Option A study area.

One of the 13 items located within the Nowra study area, item I340 (Former Numbaa Red Cedar Flood Boat and Captain Cook Bicentennial Memorial), has been moved and is no longer located within this area. As a result, there are only 12 listed Non-Aboriginal heritage items located within the Nowra study area. These 12 items are shown in Figure 4-6. Further detail on the significance of identified listed Non-Aboriginal heritage items is provided in Appendix B.

During the visual inspection, listed Non-Aboriginal heritage items were largely found to correspond to their past recording descriptions and photographs, with minor alterations noted for some items. The majority of items were listed as being of local significance with the exception of two items which are listed in the LEP 2014 as being of State significance, being I135 (Bomaderry Railway Station and Yard Group) and I389 (Graham Lodge). These items are also listed on the NSW State Heritage Register. Item I369 (Graham Family Cemetery) is listed in the LEP 2014 as being of local significance, but is included in the curtilage of the State significant I389 (Graham Lodge).



Figure 4-6 Non-Aboriginal heritage constraints (Nowra study area)

Item I402 (Shoalhaven River Bridge/Nowra Bridge over the Shoalhaven River) is described as being of State significance in the Roads and Maritime S170 Register, but is not a listed item under the NSW State Heritage Register. Roads and Maritime has a statutory requirement to maintain assets listed on the S170 Register, in accordance with the requirements of S170 (A) of the Act and the State Agency Heritage Guide (2005),

In addition to items listed under the LEP 2014, five other items were identified during the visual inspection. These items were noted as having potential for local significance as features within the contemporary Nowra landscape. These additional items are shown in Figure 4-6 and described in Appendix B.

Assessment

State heritage items are considered to present a greater constraint to the development of options than items of local significance. Listing on the State Heritage Register means that the item is of particular importance for the whole of NSW.

As shown in Figure 4-6, listed Non-Aboriginal heritage items have been identified within the Nowra study area. There were no listed heritage items identified within the Option A study area. Items are generally concentrated immediately east and west of the Princes Highway and within the vicinity of Bomaderry Station.

Given the absence of no listed Non-Aboriginal heritage items within the Option A study area, Option A may present an opportunity to avoid loss of Non-Aboriginal heritage items or values within the Nowra Bomaderry area. However, it should be noted that further investigation is required to confirm Non-Aboriginal heritage values within the Option A study area.

A number of Non-Aboriginal heritage items of local significance are located immediately adjacent to the existing Princes Highway. The design of connections to the Princes Highway, and local road network north and south of the Shoalhaven River should consider alignment designs to avoid or minimise impacts to the curtilage of these items.

'Graham Lodge and nearby Graham Family Cemetery' (LEP 2014 I389, NSW State Heritage Register SHR #01699) is a listed State Heritage item and is located to the immediate east of the Princes Highway. The presence of this item would be a high constraint to the alignment of a new crossing. Given its location to the east of the Princes Highway, this may be a greater constraint for Options D and E.

Option C would involve the demolition of the existing iron truss bridge (LEP 2014 I402, Roads and Maritime S170 Register Item #4301658). Although not listed on the NSW State Heritage Register, the existing bridge is identified as having Non-Aboriginal heritage values that are of State significance. The demolition of the existing iron truss bridge would result in a loss of State-significant heritage value. Should Option C be pursued, a future impact assessment would need to demonstrate that all reasonable and feasible options for retention and repurposing of the bridge had been explored.

Options A, B, D and E would involve opportunities for retention and re-purposing of the existing iron truss bridge. Re-purposing of the existing bridge would allow for project objectives to be met and the heritage value of this item to be maintained. The ongoing function and maintenance of the existing bridge would need to be explored, should these options progress further for consideration. It should be noted that a decision on the future of the existing southbound bridge has not been made, and demolition could occur under any of the Options A, B, D or E.

Although Options B, D and E avoid direct impacts to the existing iron truss bridge (LEP 2014 I402, Roads and Maritime S170 Register Item #4301658), these options involve the construction of a new bridge adjacent to the existing double crossing. Construction of a new bridge either upstream or downstream of the existing double crossing has the potential to impede views of the 'strong aesthetic lines' of the existing iron truss bridge that contribute to its heritage significance.

The locally listed heritage item 'Inter-war Weatherboard Building and Timber Wharf' (Draft LEP 2013 I407) would be a constraint to any option that would require abutment works immediately east of the

existing double crossing. This would be more likely for Options C, D and E.

Railway line extension works associated with Option E may extend into the area occupied by Bomaderry Station. The station is recognised as being of State significance, and is listed under the NSW State Heritage Register (Draft LEP 2013 I135, NSW State Heritage Register SHR #01090). Development of a design for Option E would need to consider impacts to the heritage values of the station.

4.2.4 Land use and property

The land use and property investigation of the Options A to E study areas involved a combination of desktop investigation, review of local planning instruments, and field observation.

At the time of the original desktop analysis, the *Shoalhaven Local Environmental Plan 1985* (SLEP 1985) had not been repealed. This assessment has since been updated to reflect the recently made *Shoalhaven Local Environmental Plan 2014* (SLEP 2014), which has repealed the SLEP 1985.

A site visit was carried out on 13 February 2014, the purpose of which was to verify existing land uses and identify potential constraints and opportunities.

Existing environment

Situated within primarily urban landscapes, the Nowra study area covers a wide variety of land use including industrial, residential, commercial and recreational. The Option A study area extends west of the Nowra Bomaderry area, across an area of less varied land use (primarily bushland and agriculture).

North of the existing crossing, land use consists of residential areas interspersed with community uses. A large area of vegetated open space surrounds Bomaderry Creek to the west of the Princes Highway, through which recreational walking tracks have been established. A smaller bridge on the Princes Highway crosses Bomaderry Creek north of the existing Shoalhaven River crossing. To the east of the Princes Highway, land is occupied by a mixture of commercial, industrial and residential uses. An isolated agricultural property (lucerne production and cattle) spans the northern bank of the Shoalhaven River, south of Bolong Road. The existing rail corridor for the South Coast Rail Line terminates immediately south of Bomaderry Station, located at the eastern extent of the Nowra study area.

Much of the area south of the existing crossing is occupied by the Nowra commercial centre, comprising a mixture of commercial and community land uses. Towards the southern bank of the Shoalhaven River, recreational, residential and commercial (tourism) land uses dominate the foreshore. To the east of the Princes Highway, a large residential area on the southern bank of the Shoalhaven River is bordered to the south by land formerly belonging to the Graham Estate. The Graham Family cemetery occupies a small area within this otherwise vacant area of open space. A section of this open space has been zoned for potential medium density residential development.

Land use zoning

Land use in the Nowra Bomaderry area is currently governed by land use zones as mapped and defined within the LEP 2014. This includes low and medium density residential, public recreational, environmental conservation, and infrastructure zones (for example, educational or tourist uses). The development controls imposed by these local planning instruments would not apply to a future proposal, due to the provisions of *State Environmental Planning Policy – Infrastructure 2007*. As such, for the purpose of this assessment, land use zones under the LEP 2014 have been considered only in cases where they are deemed to present notable constraints or opportunities within the study areas. Following selection of a preferred alignment, environmental assessment of the project would include consideration of the project's consistency with the objectives of each land use zone within the project footprint.

Assessment

Land uses within the Option A and Nowra study areas vary in terms of their sensitivity to impacts. Sensitive land uses include community facilities, low density residential areas, areas designated for public recreation, and agricultural land. Specific sensitive land uses are shown on Figure 4-7 and Figure 4-8.

Option A would involve construction of a western bypass, traversing large tracts of bushland and agricultural properties to the west of the existing crossing. Construction of Option A would require the removal of large areas of native vegetation, and may lead to fragmentation and/or severance of rural and environmental land uses. However, clause 7.21 of the LEP 2014 would limit potential constraints posed by future development to a future bypass. Where Option A meets the existing Princes Highway north and south of the Shoalhaven River, there is also potential for acquisition and fragmentation impacts in urban and residential areas.

Potential land use constraints relevant to the Nowra study area include:

- Impacts to sensitive land uses north of the existing crossing, residential areas, open space east of the Princes Highway, and areas of public open space associated with Bomaderry Creek and the northern foreshore (Options B, C, D and E)
- Loss and/or fragmentation of recreational, business and tourist land uses along the southern foreshore area, east and west of the existing crossing (Options B, C, D and E). Option E would potentially involve the greatest level of impact to these land uses, given the need to deviate away from the current crossing location
- Impacts to sensitive land uses adjacent to the Princes Highway, south of the existing crossing (Options B, C, D and E). These include tourist and recreation facilities within the vicinity of the foreshore, Shoalhaven City Council offices, Graham Estate homestead, Harry Sawkins Park, Town Park, and a range of businesses including several restaurants and a caravan park
- Smaller residential lots are clustered north-west and south-west of the existing crossings. Depending on the footprint required for connections to the Princes Highway and the local road network, a number of full and partial property acquisitions may be required.

Due to its extension further east of the existing double crossing that the other proposed options, Option E is uniquely constrained by sensitive land uses within this area. This includes the increased potential fragmentation of, or loss of continuity and isolation between, residential communities and recreational areas on the southern bank of the Shoalhaven River, east of the existing crossing. Other potential constraints would be the potential loss/fragmentation of the agricultural land on the northern bank of the Shoalhaven River, or the loss of land zoned for potential future medium residential development, immediately east of the Princes Highway, south of the existing crossing.

Existing utility networks have been identified throughout the Nowra Bomaderry area, including electricity, gas, water supply, communications and wastewater. Land uses associated with these services including transmission easements, pipelines, and other associated infrastructure, may constrain options. However, it is assumed that utility infrastructure would generally be adjusted to suit the preferred alignment.

Sensitive land uses should be considered during the development, design and selection of a preferred route alignment to avoid or minimise potential impacts such as acquisition, fragmentation and sterilisation. Option C presents the greatest opportunity to avoid impacts to foreshore land uses within the Nowra Bomaderry area and to limit residual or sterilised land.

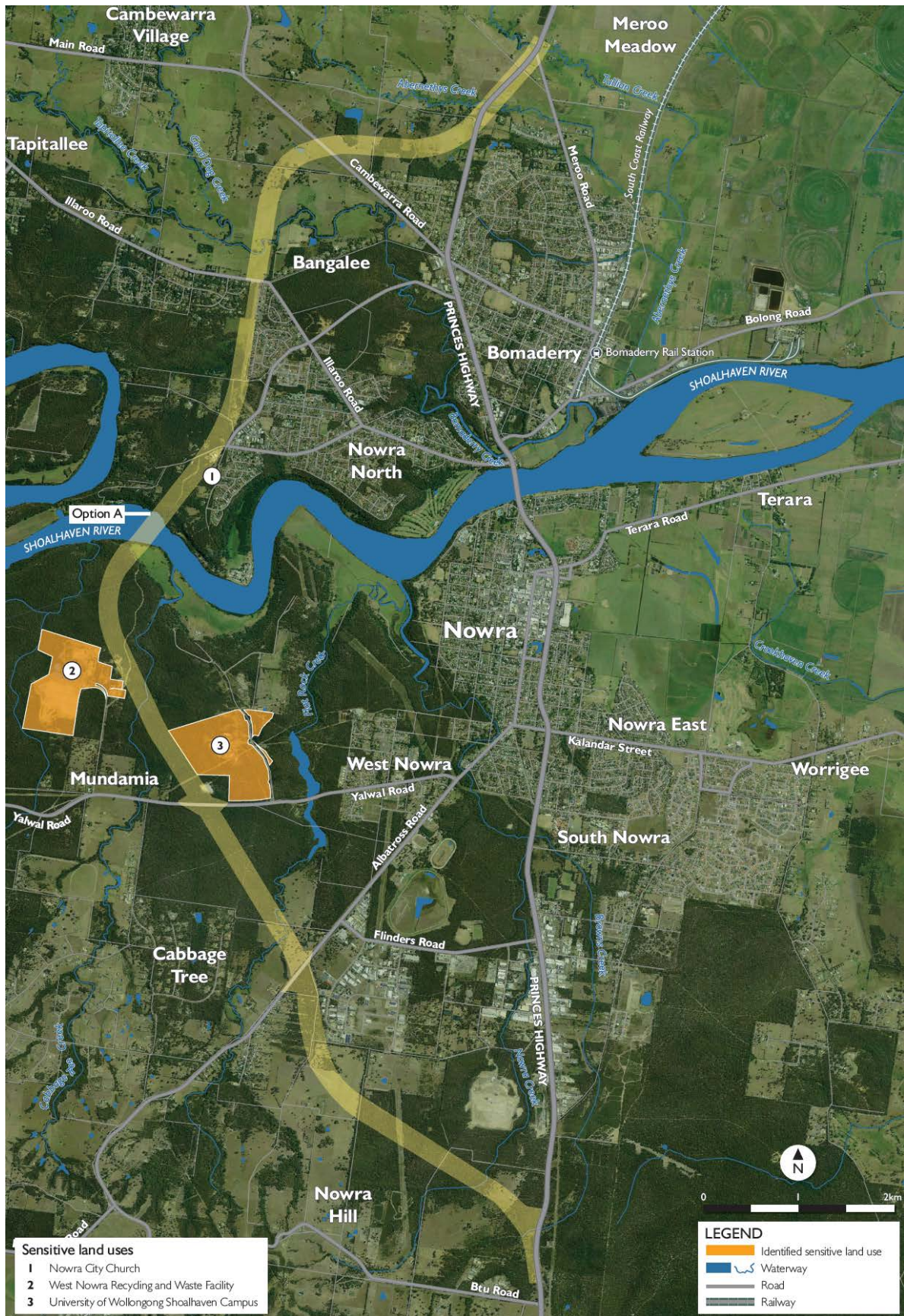


Figure 4-7 Sensitive land uses (Option A study area)



Figure 4-8 Sensitive land uses (Nowra study area)

Next steps

Sensitive land uses should be considered during the development, design and selection of a preferred option to avoid or minimise potential impacts such as acquisition and fragmentation. Further investigation should be carried out to determine current use, economic value, and agricultural quality of the property located north east of the existing crossing.

Following selection of a preferred alignment and development of a concept design, consultation with potentially affected landowners, residents and businesses should be carried out.

An assessment of land use impacts should be included in any future environmental assessment document specific to the preferred alignment.

4.2.5 Socio-economic

A desktop socioeconomic assessment was carried out to identify constraints and opportunities within the study areas of Options A to E. This included assessment of:

- Business and tourism activity within and in the vicinity of the study areas of Options A to E
- Potential social impacts associated with each proposed option, focusing primarily on community infrastructure
- Recommendations for further assessment and suggested evaluation criteria
- At the time of this assessment, information relating to travel time improvements or through traffic benefits/disadvantages was not known and is a limitation of this assessment.

Existing environment

All options are located within the Shoalhaven Local Government Area (LGA), which encompasses 4,530 square kilometres and was home to approximately 96,000 people in 2011 (ABS, 2012). Almost a quarter of the population of the Shoalhaven LGA is aged 65 years or older, indicating that this area may be favoured by retirees (ABS, 2012). Approximately five per cent of the Shoalhaven LGA population identifies as Indigenous which is higher than the New South Wales average of 2.5 per cent (ABS, 2012).

Population forecasts for the Shoalhaven LGA indicate modest growth of 1.1 per cent per year between 2011 and 2036 (NSW Department of Planning and Infrastructure, 2010). The majority of growth in Shoalhaven LGA is expected to be concentrated in the Nowra Bomaderry area, strengthening its role as the major residential, employment and administrative centre in the region (NSW Department of Planning, 2007).

As the administrative centre for the Shoalhaven region, Nowra provides primary facilities and services such as hospitals, emergency services, utilities and the Shoalhaven City Council offices. North Nowra and Bomaderry contain a number of smaller, secondary facilities and services that complement the services and facilities available in Nowra. Community infrastructure consists of several educational facilities (including the TAFE NSW Illawarra Campus and the University of Wollongong Shoalhaven Campus), places of worship, open space, community centres, sporting and recreational facilities, and clubs. The Shoalhaven River also plays an important role in sporting and recreation in the Nowra Bomaderry area.

Defence is an important industry in the Shoalhaven LGA with HMAS Albatross and HMAS Creswell located in Nowra and Jervis Bay respectively. Other key industries in the Shoalhaven LGA are retail, aged care, primary industry, manufacturing, tourism and agriculture. Retail, commercial and industrial businesses within Bomaderry are concentrated around Bomaderry Station, which is the last stop on the passenger railway line from Sydney. Retail development in Nowra is centred along the Princes Highway, particularly around the Stockland Nowra Shopping Centre.

The Shoalhaven LGA is a popular tourist destination and is the most visited area in NSW, outside of the Sydney region (TRA, 2012). Although tourism has historically been based around the beaches,

the south coast has also become known for its national parks and forests, historic villages and buildings.

Assessment

Socio-economic elements identified as potentially being sensitive to impacts of a future proposal include residential dwellings, businesses and tourism activities, agricultural activity and community facilities (see Figure 4-7 and Figure 4-8). These elements are identified as being important to the social and economic character of the region and present a high risk of constraint for the development, design and selection of a preferred alignment.

Option A study area represents the western bypass corridor identified by Shoalhaven Council that traverses large tracts of bushland and agricultural properties west of the Nowra Bomaderry area. The identification of the western bypass corridor in the Draft 2013 SLEP would limit the potential for future socio-economic constraints, but existing potential constraints relevant to Option A includes:

- Loss and/or fragmentation of productive agricultural land north and south of the Shoalhaven River in Meroo Meadow, Bangalee, Cabbage Tree and North Nowra
- Loss of residential dwellings in Bangalee and North Nowra, north of the Shoalhaven River and potential community severance due to divisions created by the bypass
- Impacts to community facilities including University of Wollongong Shoalhaven Campus in West Nowra and Nowra City Church in North Nowra
- Depending on the volume of traffic diverted to the bypass, a loss of passing trade for service-related businesses within the Nowra Bomaderry area (e.g. services stations and cafes).

Potential socio-economic constraints relevant to Nowra study area include:

- Potential impacts to community facilities north and south of the existing crossing including Shoalhaven Community College, TAFE NSW Illawarra Campus, Shoalhaven City Council Offices, and Shoalhaven Entertainment Centre (Options B, C and D)
- Impacts to recreational facilities along the southern foreshore area, east and west of the existing crossing, including pedestrian and cycle paths, recreational fishing areas, rowing sheds, Nowra Olympic Pool and Nowra Sailing Club (Options B, C, D and E)
- Impacts to businesses and tourism activities along foreshore areas east of the existing crossing including a caravan park, several businesses including restaurants, and a public wharf from which day cruises arrive and depart (Options D and E)
- Loss of residential dwellings on the southern and northern banks of the Shoalhaven River, east and west of the existing crossing (Options B, C, D and E)
- Loss and/or fragmentation of productive agricultural land on the northern bank of the Shoalhaven River, east of the existing crossing (Option D and E)
- Potential community severance on the southern bank of the Shoalhaven River, east of the existing crossing. Depending on the design of Option E, there is potential for residents to be separated from community and recreational facilities, or an isolated pocket of urban area to be created between the existing and future crossing.

Should residential development occur to the west of North Nowra, Option A may improve general connectivity between developments within the Nowra Bomaderry area.

Option C may present an opportunity to minimise socio-economic impacts, particularly within foreshore areas, as construction of the new bridge would occur on the alignment of the existing iron truss bridge, however, consideration should be given to the socioeconomic impacts of the demolition of the iron truss bridge.

The community within the Nowra Bomaderry area considers the existing iron truss bridge to have iconic value. Options A, B, D and E could be constructed and operated regardless of whether the southbound iron truss bridge is maintained or removed.

Next steps

Socially and economically sensitive areas should be considered during the development, design and selection of a preferred alignment to minimise potential impacts to community facilities, business and tourism activities. Following selection of a preferred alignment, preparation of a concept design should consider:

- Potential property boundary impacts to businesses and residential properties to minimise the potential impact to livelihood and community character
- Opportunities to minimise community severance, ensure local access to community facilities is maintained or enhanced, and minimise impacts to access to the Shoalhaven River for recreational purposes
- Opportunities to minimise impacts to businesses and productive agricultural land.

Following preparation of a concept design, a socio-economic impact assessment should be conducted in accordance with the Roads and Maritime Services Draft Socio-economic Assessment Practice Note.

4.2.6 Contamination

A contamination constraints assessment (CCA) was carried out for each study area to identify potential constraints and opportunities for the development, design and selection of a preferred option.

Key source material reviewed as part of the CCA to identify potential areas of environmental concern included:

- Current aerial photographs of each option
- Relevant online registers were carried out to identify areas of potential concern (from a contamination perspective) that may present constraints. Online searches included:
 - NSW EPA contaminated sites register
 - List of NSW contaminated sites notified to the EPA (last updated 14 February 2014)
 - Shoalhaven City Council website
 - NSW EPA POEO licence register
 - Australian Department of Defence Unexploded Ordnance (UXO) Contamination database (26 February 2014).
- A site inspection of the study areas of Options B, C, D and E was carried out on 12 February 2014
- Due to the scale of Option A, assessment of the Option A study area involved review of aerial photography and general land use only. No site inspection was conducted for the Option A study area as part of the contamination constraints assessment.

Existing environment

The Nowra study area is a predominantly urban environment, bordered by a mixture of residential, agricultural, commercial, and industrial land uses. Industrial land uses are primarily located in areas north east of the existing double crossing and include (but not limited to) service stations, automotive workshops and railway infrastructure.

Land use to the west of Nowra and Bomaderry, along the length of the Option A study area, is primarily agricultural (grazing) and bushland. The West Nowra Recycling and Waste Facility, a general solid waste (putrescible and non-putrescible) landfill, is also located immediately west of the Option A study area.

The desktop review and site inspection identified a number of known and potential sources of localised contamination and potentially contaminating activities within the study areas of Options A to E. Based on the results of this desktop review and site inspection, areas of environmental concern associated with high risk land use activities are identified in Figure 4-9.

Based on the findings of the CCA, areas of contamination risk have been identified in the northeast of the Nowra study area, and south-west of the Nowra study area (see Figure 4-9). The former Nowra Gasworks site, located outside of the Nowra study area, was identified in Council and NSW EPA searches. Contamination associated with the site has been subject to remediation work; however the potential remains for residual gasworks contamination to be present within the surrounding area. As such, the south-western extent of the Nowra study area is recognised as an area of environmental concern.

Additionally, a number of potentially contaminating land use industries were identified within the Bomaderry industrial lands, north-east of the existing double crossing, as well as a smaller commercial/industrial area located further west on Bolong Road. Due to the identified risk of contamination within these areas and the associated potential for contamination to be present in the areas that surround them, northern portions of the Nowra study area have been identified as areas of environmental concern.

Portions of the Option A and Nowra study areas, and land surrounding these study areas, are classified as 'Other – potential of UXO'. This indicates that there is potential for UXO or explosive ordnance fragments/components to be present. This risk is not specific to a particular area within the study areas of Options A to E and has been assigned a contamination risk category of 'low'.

Assessment

With the exception of the West Nowra Recycling and Waste Facility and the possible presence of UXO associated with historical Defence activities, specific areas of environmental concern were not identified for the Option A study area. Rather, contamination constraints were broadly assessed through an examination of land use within this area. As discussed earlier in this section, this area largely comprises agricultural properties and bushland.

The West Nowra Recycling and Waste Facility, located south of the Shoalhaven River immediately west of the Option A study area, was identified as a potentially constraining land use. The facility operates under EPL 5877 as a general solid waste (putrescible and non-putrescible) landfill. Should Option A proceed to the design stage, the location of the facility could constrain the development of an alignment due to potential for contamination to be present at this site. It should be noted that further assessment is needed to confirm potential contamination risks associated with Option A.

The findings of the CCA suggest that the possibility of study area Options B, C, D and E being subject to widespread contamination is low. As such, it is considered unlikely that contamination would significantly constrain development, design and selection of a preferred site option.

A number of areas of environmental concern have been identified and are detailed in Appendix B. Areas of environmental concern are generally concentrated around the Bomaderry industrial lands and the former Nowra Gasworks site, located northeast and southwest of the existing crossing, respectively (see Figure 4-9). These areas may require further assessment, including the review of records relating to the remediation of the site.

Due to its extension further north and east of the existing crossing than the other study areas; Option E is constrained to a greater extent than the other options within the Nowra study area by the areas of environmental concern identified around the Bomaderry industrial lands.

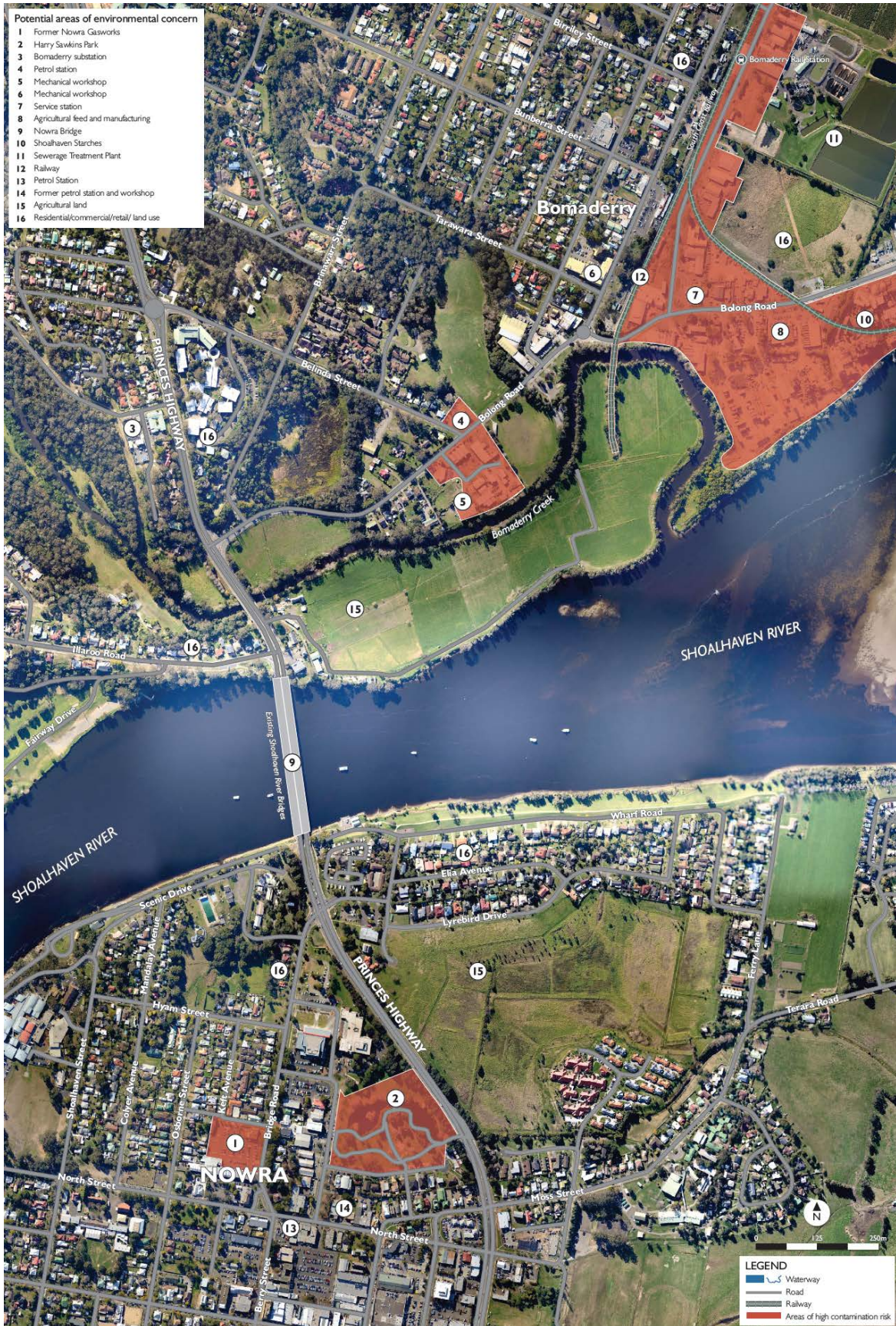


Figure 4-9 Areas of environmental concern (Nowra study area)

Next steps

The location and nature of identified areas of environmental concern (see Figure 4-9 and Appendix B) should be considered during the development, design and selection of a preferred route alignment to avoid or minimise potential for disturbance of contaminated material. The need for intrusive sampling should be evaluated to determine if it would assist in the route alignment design and evaluation.

4.3 Traffic assessment

4.3.1 Context

Findings from the preliminary traffic data review (see Section 2.4.3) identified the need to better understand the existing and future traffic capacity and efficiencies for the options.

As part of the supplementary data collection phase, additional traffic assessments were carried out to develop and compare traffic volumes, patterns and performance (capacity and efficiency) for existing conditions and each of the five potential site options.

More specifically traffic data was needed to:

- Confirm the existing traffic volumes and patterns and network performance
- Validate previous Origin-Destination studies
- Identify future traffic trends and demand for the options
- Test the options (including a 'do nothing' option) to find out which options could effectively accommodate forecast travel demand.

4.3.2 Existing traffic volumes and patterns

Existing traffic volumes are typically represented by Annual Average Daily Traffic (AADT), which is an average 24 hour figure taken from data recorded during a specific year. AADT recorded by Roads and Maritime during 2008 on the Princes Highway at the Shoalhaven River indicates that the highest peak travel demands in the area occurred on the first evening of a holiday period in a southbound direction and the last afternoon of a holiday period in a northbound direction.

As it is not appropriate to design for traffic volumes that happen for only limited hours per year, a 'design hour' must be selected on which to base planning and design. The design hour is usually chosen between the 30th and 100th highest recorded hour of the year. For the purpose of this traffic assessment, the following peak hour periods were considered to assess the operational performance of each option:

- Average one hour AM peak (7am–10am)
- Average one hour PM peak (3pm–6pm)
- 100th highest hour (100HH).

Table 4-2 provides a detailed overview of the northbound (NB) and southbound (SB) peak hour traffic demand crossing the Shoalhaven River during 2008.

- During weekday peak periods:
 - Northbound traffic peaked at 2280 vehicles per hour (10.5% of total AADT)
 - Southbound traffic peaked at 2450 vehicles per hour (11.2% of total AADT).
- During holiday periods:
 - 100HH northbound traffic peaked at 2370 vehicles per hour (10.9% of total AADT)
 - 100HH southbound traffic peaked at 2550 vehicles per hour (11.7% of total AADT).

Table 4-2 Shoalhaven River crossing weekday & holiday peak period directional traffic volumes (2008)

Location direction		AADT (vehicles / day)	Traffic volume (vehicles/hour (% AADT))				
			Weekday peaks		Holiday peaks		
			AM peak (7-10am)	PM peak (3-6pm)	100HH (SB peak)	100HH (NB peak)	100HH (Highest recorded)
Princes Highway - Shoalhaven River	NB	21,700	1400 (6.4%)	2280 (10.5%)	1400 (6.4%)	2370 (10.9%)	2580 (11.9%)
	SB	21,900	2450 (11.2%)	2020 (9.2%)	2550 (11.7%)	1800 (8.2%)	2710 (12.4%)

Source: Roads and Maritime Services traffic survey data (2008)

The average weekly traffic profile on the Princes Highway at the Shoalhaven River crossing from 2008 is illustrated in Figure 4-10. The profile clearly shows southbound traffic peaks during weekday mornings, and northbound traffic peaks during weekday afternoons. Two-way traffic during AM peak and PM peak reaches a similar total volume. The increase in southbound (and consequently two-way) traffic on Friday afternoons when compared to other weekdays illustrates the high level of recreational travel present in the area.

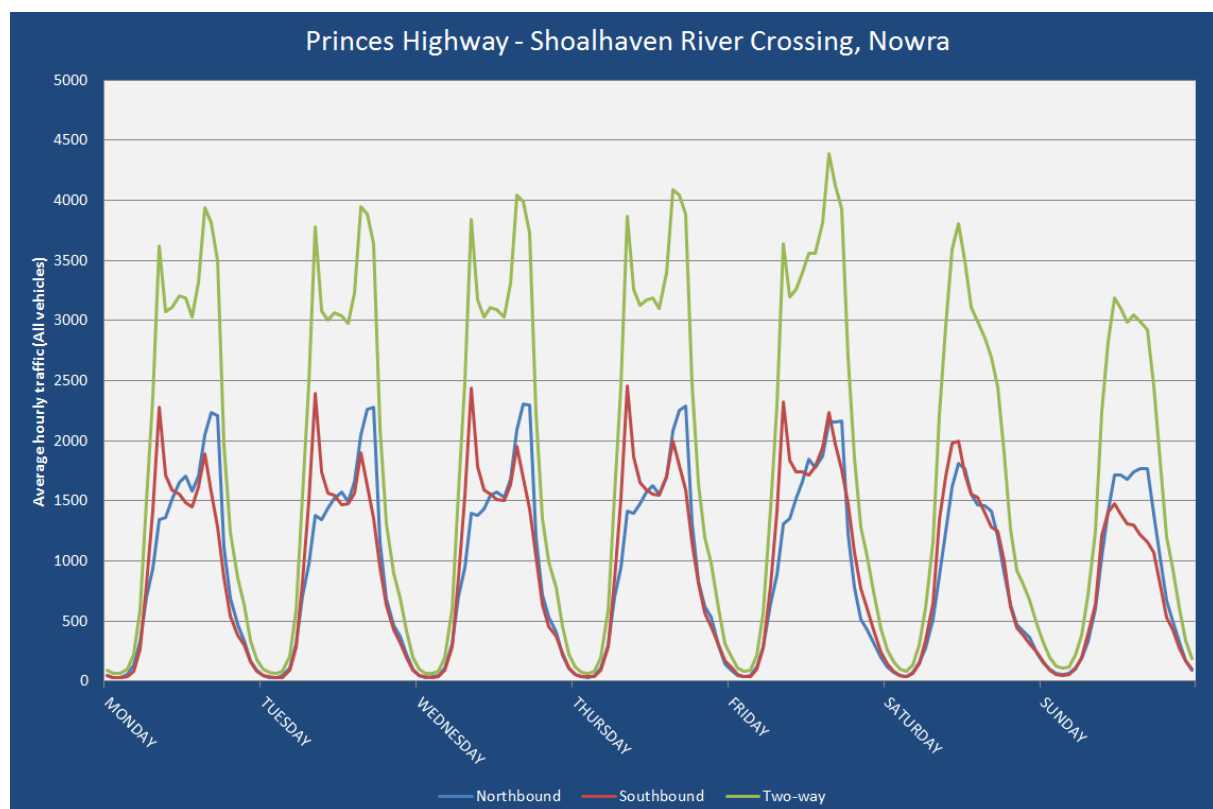


Figure 4-10 Weekly traffic profile: Princes Highway at the Shoalhaven River crossing (2008)

Source: Roads and Maritime Services traffic survey data

The weekly traffic profile shows:

- A steady increase in northbound traffic throughout the day, generally peaking at around 4pm-5pm before decreasing rapidly in the early evening
- Southbound traffic peaks in the morning between 8am-9am, although a second, smaller peak occurs in the afternoon between 3-4pm

- Weekend traffic peaks and overall volumes are generally lower than weekday traffic volumes.

More recent 2012-13 traffic survey data in the Nowra Bomaderry area is summarised in Table 4-3. North of Bolong Road, average daily traffic on the Princes Highway was 21,950 vehicles per day, with 13,700 vehicles using the alternative Bolong Road 'Sandtrack' route. This equates to a 62 per cent / 38 per cent split of average daily traffic using the Princes Highway and the 'Sandtrack' respectively.

Average daily traffic on Illaroo Road is around 15,500 vehicles per day, with a large proportion of this traffic crossing the Shoalhaven River. As a consequence, the Princes Highway crossing of the Shoalhaven River carries around 46,550 vehicles per day. To the south of the Shoalhaven River, average daily traffic on Bridge Road is around 13,800 vehicles. To the south of Bridge Road average daily traffic on the Princes Highway is around 34,600 vehicles.

The 2012/13 data shows around a 7 per cent increase in traffic volumes crossing the Shoalhaven River from 2008.

Table 4-3 Weekday peak period and daily traffic summary (2012-13)

Route	Location	Year	Two-way traffic				
			Weekday AM peak (veh/hr)	Weekday PM peak (veh/hr)	100HH (veh/hr)	AADT	
						Vehicles / day	% heavy vehicles
Princes Highway	North of Rose Valley Road	2012	1570	1850	2570	22,125	8.0%
	North of Cambewarra Rd	2013	865	950	1380	11,870	14.9%
	North of Bolong Road	2013	2050	2600	-	21,950	7.3%
	Shoalhaven River	2013	4100	4600	5250	46,550	6.5%
	South of Bridge Road	2013	2800	3350	-	34,600	3.7%
Bolong Road	East of Princes Highway	2013	1300	1400	-	13,700	6.1%
Illaroo Road	West of Princes Highway	2013	1650	1600	-	15,500	4.2%
Bridge Road	West of Princes Highway	2013	1150	1250	-	13,800	1.0%
Pleasant Way	East of Princes Highway	2013	70	125	-	1000	5.9%

Source: Roads and Maritime Services traffic survey data

4.3.3 Existing road network performance

Level of service (LoS) is a measure to determine the operational performance of a roadway or intersection. There are six levels of service ranging from LoS A to LoS F; with LoS A representing optimum operating conditions (free flow) and LoS F the poorest (forced or breakdown in flow). Generally once a roadway reaches LoS D it starts to be considered as approaching practical capacity, with capacity being exceeded once LoS F is reached.

The volume/capacity (V/C) ratio is a number commonly used to assess the operational performance of roadways with LoS used as the corresponding index. A summary of the LoS index (including specific colour coding to highlight/group the performance of each service level) is shown in Table 4-4.

Table 4-4 Level of service criteria for roadways and intersections

LoS	Volume/capacity (V/C)	Traffic signals roundabout	Give way stop signs
A	V/C < 0.60	Good operation	Good operation
B	V/C = 0.60-0.75	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	V/C = 0.75-0.90	Satisfactory	Satisfactory, but accident study required
D	V/C = 0.90-0.95	Operating near capacity	Near capacity and accident study required
E	V/C = 0.95-1.00	At capacity; at signals incidents would cause excessive delays	At capacity; requires other control mode
F	V/C > 1.00	Roundabouts require other control mode	At capacity; requires other control mode

Source: Guide to Traffic Generating Developments, RMS 2002

The roadway LoS for the existing Princes Highway northbound and southbound crossings of the Shoalhaven River, based on 2013 AM peak, PM peak and 100HH traffic volumes, are shown in Table 4-5.

Table 4-5 Roadway level of service (2013)

Location direction		AM peak hour (veh/h)		PM peak hour (veh/h)		100HH (veh/h)	
		Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS
Princes Highway – Shoalhaven River Crossings	Northbound	1500	A	2450	D	2550	D
	Southbound	2600	F	2150	F	2700	F

Source: AECOM based on Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis, 2009

The table indicates that the northbound crossing currently operates at LoS D or better during the three peak periods assessed. In comparison, the southbound crossing performs at unacceptable LoS F during the three peak periods. This is primarily due to the southbound crossing only having two traffic lanes compared to three traffic lanes on the northbound crossing.

This high level analysis indicates that the existing bridge crossing arrangement requires road capacity enhancements in the southbound direction.

The above analysis does not include the impacts of the intersections to the north and south of the bridges. The SMEC studies in 2004 and 2005 determined that these intersections contribute to traffic capacity issues across the Shoalhaven River. This has not been tested further at this stage, however roadside observations suggest that traffic queues from these intersections spill back onto the bridges and across the river, restricting the flow of traffic on the Princes Highway. Preliminary analysis suggests that any improvements from additional capacity on a new bridge would be enhanced further by improvements to these intersections. The potential benefits would need to be tested in detail during the concept development phase.

4.3.4 Origin-Destination analysis

The Nowra Bomaderry Structure Plan provides analysis of strategic traffic patterns, based on Origin-Destination (O-D) studies carried out in December 1994 and September 2003. A summary of the Structure Plan is provided in Chapter 2.4.3.

The Shoalhaven City Council Structure Plan indicates that around 85 to 90 per cent of trips which use the existing bridges to cross the Shoalhaven River have an origin or destination – or both – in the Nowra Bomaderry area. The majority of this travel demand is generated by the existing urban areas of Nowra, North Nowra, and Bomaderry.

Roads and Maritime and Shoalhaven City Council carried out a further O-D survey on Friday 25 October 2013. Key results of this survey are summarised in Figure 4-11. The results presented are based on first and last recorded stations. For example, if a vehicle was observed at Station 3, Station 11, and then Station 22, it was recorded as a trip from Station 3 (North of Nowra Bomaderry) to Station 22 (South of Nowra Bomaderry), and was not counted in the proportion of trips carried out from Station 3 to Station 11 only.

On Friday 25 October 2013:

- Between 5 and 12 per cent of traffic travelled between areas north of the Shoalhaven River – outside of the Nowra Bomaderry area – and south of the Nowra Bomaderry area
- Between 38 and 56 per cent of traffic travelled between areas north of the Shoalhaven River – outside of the Nowra Bomaderry area – and central Nowra
- Around 51-58 per cent of traffic contained within the Nowra Bomaderry area involved a river crossing movement, travelling between Bomaderry and North Nowra to Nowra CBD and immediate surrounds.

Overall the results of the October 2013 survey are consistent with previous O-D studies carried out in 1994 and 2003, confirming that during typical weekday conditions:

- A low proportion of traffic crossing the Shoalhaven River travels ‘through’ the Nowra Bomaderry area without stopping
- The majority of traffic crossing the Shoalhaven River includes an origin, destination, or both within the Nowra Bomaderry area.

It should be noted that the origins and destinations of traffic during holiday peaks differs substantially from typical weekday patterns. Some O-D studies have been conducted in 2014 to attempt to gather this information in more detail; however more work would need to be done to better understand these recreational peak volumes.

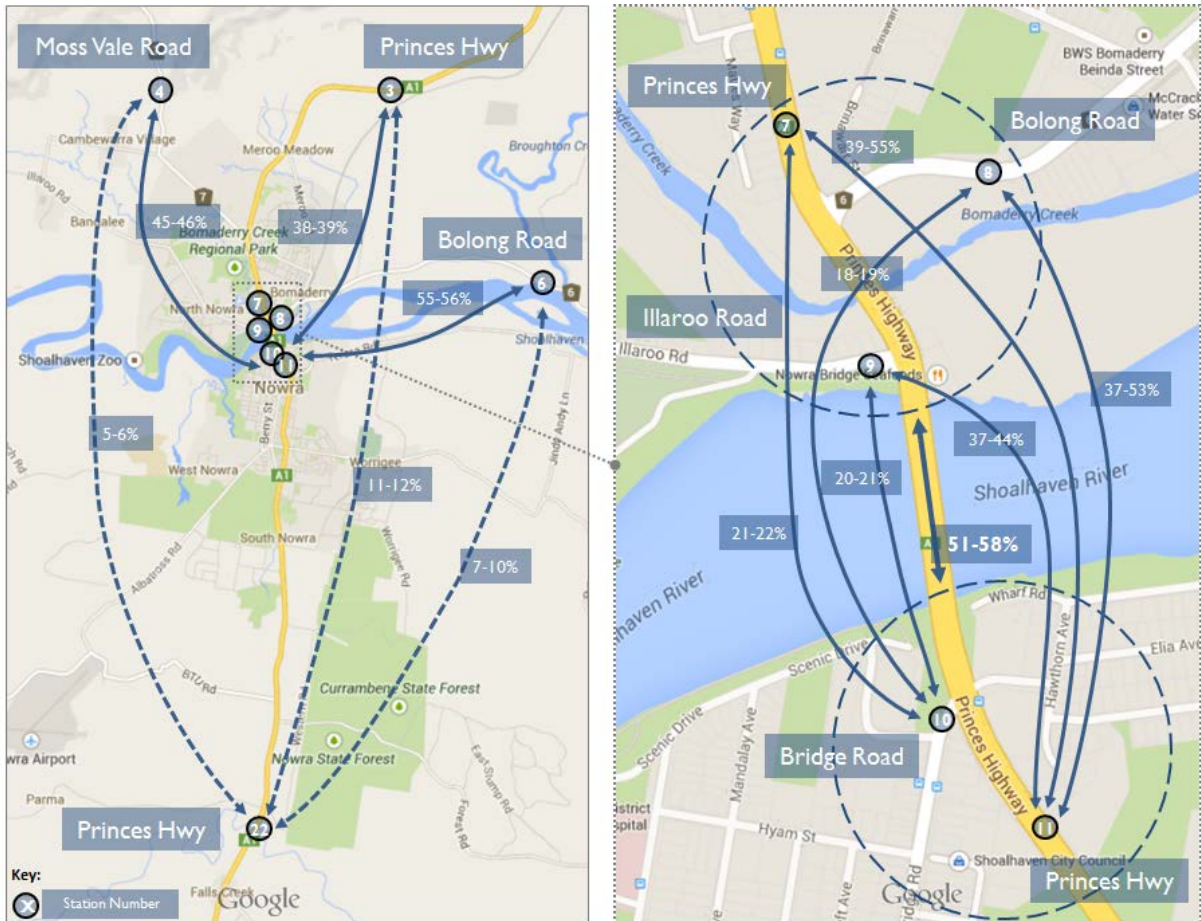


Figure 4-11 Origin-destination survey summary (First and last locations) October 2013

Source: AECOM, based on Skyhigh traffic survey data

4.3.5 Future traffic modelling (TRACKS)

The Shoalhaven City Council (SCC) 24 hour Nowra Bomaderry Transportation TRACKS Model (Nowra Bomaderry TRACKS Model) was used to carry out future year traffic modelling. Land use data in this model was updated in August 2013 and is believed to provide the most accurate representation of the future development of the Nowra Bomaderry area. The following two land use scenarios were selected to develop future year traffic volumes:

- 2016 short-term development
- 2036 long-term development.

In addition, the following road network options were modelled to determine the relative volume of travel demand for the potential site option scenarios:

- Base Case Option: the 'do nothing' option represents no upgrades or modifications to the existing road network and river crossing arrangements
- An option on the western bypass alignment (Option A), based on the following two interchange scenarios:
 - No intermediate interchanges in the Nowra Bomaderry area
 - Five intermediate interchanges consistent with the SCC Structure Plan.
- A new bridge option near the existing Princes Highway river crossing and associated improvements to the approaches (Options B, C, D and E).

The 2016 and 2036 future year daily traffic volumes resulting from the Nowra Bomaderry TRACKS Model are presented in Table 4-6 and indicate:

- Daily traffic volumes are forecast to increase from 46,550 vehicles in 2013 to 48,650 in 2016, which is an average growth rate of 1.5 per cent per annum. In the longer term, traffic volumes are predicted to increase to 62,650 in 2036
- In 2016, it is predicted that between 4.9 per cent and 11.2 per cent of total traffic crossing the river may use a western bypass option if it were available. Modelling of the long-term scenarios show a small increase for 2036 with traffic volumes predicted between 4200 and 9850 vehicles per day. This represents between 6.7 per cent and 15.7 per cent of total traffic crossing the river that may be prepared to use a western bypass. Up to 84 per cent of traffic crossing the Shoalhaven River is likely to continue to use the existing Princes Highway
- The proximity of Options B, C, D and E to the Princes Highway means that TRACKS estimates they would generate the same volumes and proportions of daily traffic as the base case option, as the Princes Highway would remain the only river crossing under these scenarios.

Table 4-6 Strategic TRACKS site options modelling – 2016 | 2036 daily traffic volume summary

Modelled Option Location		2013	2016		2036	
		Daily traffic volume	Daily traffic volume	Proportion of river crossing traffic	Daily traffic volume	Proportion of river crossing traffic
Base case 'do nothing' option		46,550	48,650	100%	62,650	100%
Option A	Western bypass with no intermediate interchanges	-	2400	4.9%	4200	6.7%
Option A	<i>Western bypass with intermediate interchanges</i>	-	<i>5450</i>	<i>11.2%</i>	<i>9850</i>	<i>15.7%</i>
Options B, C, D or E	New Princes Highway crossing and improvements at approaches	-	48,650	100%	62,650	100%

It should be noted that as the project progresses to the next phases of the *project development* stage, traffic forecasts will need to be developed and refined to a greater level of detail, including additional operational traffic modelling.

4.3.6 Site options capacity assessment

The roadway LoS for the base case 'do nothing' option and a new bridge option near the existing Princes Highway river crossing (with associated improvements to the approaches) are shown in Table 4-7. This analysis was based on 2016 and 2036 AM peak, PM peak and 100HH two-way traffic volumes.

It should be noted that the roadway capacity assessment of a new bridge near the existing Princes Highway river crossing assumes three southbound and three northbound traffic lanes would be available in future, and that there would be some form of upgrade to the intersections on the northern and southern approaches.

Option A was not assessed in Table 4-7 as the results of the TRACKS modelling indicate that option would not attract traffic volumes, even in the longer term timeframe (2036).

Table 4-7 Roadway level of service (2016 | 2036)

Location direction (number of lanes)		AM peak hour (veh/h)		PM peak hour (veh/h)		100HH (veh/h)	
		Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS
2016 future year							
Base case 'do nothing' option	Northbound (3)	1550	A	2550	D	2650	E
	Southbound (2)	2700	F	2250	F	2850	F
New Princes Highway crossing and improvements at approaches	Northbound (3)	1550	A	2550	B	2650	B
	Southbound (3)	2700	B	2250	A	2850	B
2036 future year							
Base case 'do nothing' option	Northbound (3)	2000	B	3300	F	3400	F
	Southbound (2)	3500	F	2900	F	3650	F
New Princes Highway crossing and improvements at approaches	Northbound (3)	2000	A	3300	C	3400	C
	Southbound (3)	3500	C	2900	B	3650	C

Source: AECOM based on Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis, 2009

The results presented in Table 4-7 indicate that the existing southbound bridge crossings will not provide sufficient operational traffic capacity to cope with forecast travel demand in future years. The 'base case' is estimated to perform at LoS F for both the short and long term time frames (2016 and 2036).

The results presented in Table 4-7 also indicate that a new bridge near the existing Princes Highway river crossing and improvements to the approaches could provide sufficient operational traffic capacity to cope with forecast travel demand in future years. In other words, an improvement to the network such as Option B, C, D or E would be estimated to perform no worse than LoS C even in the longer term (2036).

4.3.7 Observations

The following key points and observations should be noted:

- Based on the roadway capacity analysis carried out as part of the transport assessment, an option near the existing Princes Highway river crossing and associated improvements to the approaches appears to provide an appropriate, well-balanced bridge crossing solution
- Such an option would require at least three southbound traffic lanes and three northbound traffic lanes at the existing crossing location, and upgrades to the adjacent intersections.
- More detailed traffic modelling would be required in the next stages of project development to further assess and demonstrate the effective operation of the preferred site option, adjacent intersections and the surrounding road network.

4.4 Landscape and urban design

4.4.1 Context

Within the broader landscape context there are a number of key structuring elements that form part of the overall regional landscape experience. The scenic qualities of this area of the South Coast and Shoalhaven Region have been widely recognised and recorded. The holistic arrangement of the coastal dune landscape, the floodplains of the lower Shoalhaven River and Broughton Creek and the rolling pastoral landscape beneath the heavily forested escarpment, collectively comprise a unique and highly valued and visually engaging landscape.

As part of the broader landscape experience, the Shoalhaven River and the urban areas of Bomaderry and Nowra form the south western boundary of the Berry / Bolong Pastoral Landscape. The higher terrain of the lower Shoalhaven Gorge has been built out with urban development as this land provides flood immunity from the numerous drainages that descend from the escarpment and hills to the west and north west.

This river is a key defining landscape element, central to the landscape context and highly valued by the community. The value and importance of the Shoalhaven River is widely recognised and documented. To ensure the future sustainable management of the river the Shoalhaven City Council adopted the Shoalhaven River Estuary Management Plan (Shoalhaven City Council, 2008). As part of the study the team carried out a study of the primary views, vistas and general view sheds to and from the river.

Key findings included:

- Very few residential properties have direct view of the river, those with areas with views include:
 - Northern bank, filtered views from along Illaroo Road 15 – 18 residences
 - Southern bank, a small number of residences along the Scenic Drive
 - Riverview Road 36 -40 residences oriented with riverfront views.
- Generally there is a road between water's edge and private housing, maximising public access
- The nature of the river bank means that public access is restricted and focused to particular locations
- The river is experienced as a foreground to the backdrop of the hills and escarpment beyond in most cases. Two distinct features dominate these views:
 - Cambewarra Mountain to the north
 - Mt Coolangatta to the east.
- The experience of the landscape from the river transitions between the east and west sides of the existing bridge
- From the Shoalhaven River there are very few views of any urban related development.

4.4.2 Landscape character units

In order to assess landscape character and visual impacts, the study area was broken down into three landscape character units: two main landscape character units have been identified to the east and west of the existing river crossings, while a third character unit is described as the central transition point between the two. The landscape character units have been defined based on broadly similar characteristics or strongly defined spatial qualities; which are described below and illustrated in Figure 4-11:

Shoalhaven River - Canyon

Located to the west (on the Shoalhaven River) and north west (on Bomaderry Creek) of the existing bridge this landscape is distinguished by:

- Steep sandstone canyon edges to the waterways
- Flat floodplain on bends in the river (including the land occupied by the golf course and Cabbage Tree Creek to the west)
- Extensive remnant forest vegetation on the banks and slopes of the river and creek lines
- Urban related development is set well back from the riverfront due to access constraints and steepness of the terrain.

Shoalhaven River - Alluvial

Located to the east (on the Shoalhaven River) and north east (on Bomaderry Creek) of the existing bridge this landscape is distinguished by:

- Floodplain and very flat terrain
- Large tracts of agricultural and pastoral land forming a very open landscape
- A structured productive landscape with linear plantings
- Any remnant vegetation is chiefly restricted to the immediate river and creek banks
- Very little related urban related development (apart from some smaller industry) interfaces with the riverfront / edge due to the land being flood prone.

Shoalhaven River - Transition

The western edge of the canyon zone and eastern edge of the alluvial overlap to form a transitional zone, it is in this zone that the existing bridge crossings of the Shoalhaven River are located. This landscape is distinguished by:

- The last fingers of the sandstone landscape projecting along the riverbank merging with the start of the alluvial floodplain
- A narrowing of the river where the bank to bank distance of non-flood prone land is at its smallest.
- The river and creek interfaces are a combination of:
 - Agricultural land on the northern bank of the river enclosed by Bomaderry Creek
 - Narrow interface with residential development along Illaroo Road on the northern bank and Riverview Rd, Ella Ave and Lyrebird Road on the south side of the river just above the flood level
 - Narrow open space on the south bank and western side of the existing bridge.
- Vegetation is chiefly restricted to the immediate river and creek banks and edge of the river canyon west of the existing bridge.

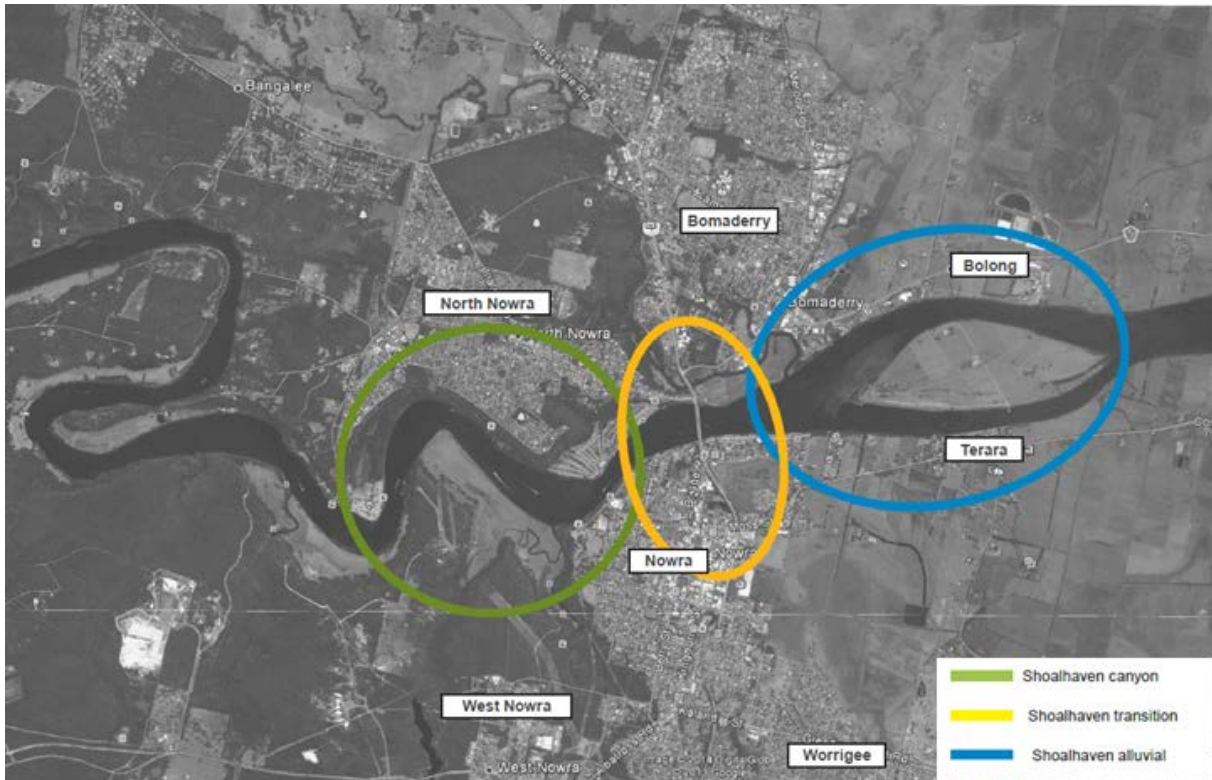


Figure 4-12 Landscape character units - relating to Shoalhaven River

4.4.3 Urban design objectives

Based on the site analysis, review of the existing planning and management reports and background studies the following urban design objectives have been identified to guide the further development of options for the additional crossing of the Shoalhaven River:

- Providing for safe and equitable connection between the northern and southern banks of the Shoalhaven River and over Bomaderry Creek
- Enhancing opportunities for connection between the growing urban areas of Nowra and Bomaderry / Nowra North
- Fits sensitively with the existing qualities and characteristics of the broader landscape and river setting
- Respects the integrity of the existing iron truss bridge, which is described as being of state significance in the Roads and Maritime S170 Register
- Reinforcing the strategies adopted as part of the Shoalhaven River Estuary management plan:
 - Protecting the long term natural landscape values of the Shoalhaven River
 - Protecting the long term recreational values of the Shoalhaven River
 - Reinforcing the objectives of the Nowra Bomaderry Structure Plan.
- Minimising the impacts on the functioning rural and agricultural landscape
- Locating infrastructure elements so as to minimise impacts to key vistas and views.

4.4.4 Preliminary landscape character and visual impact assessment

The assessment of the three key landscape character units based on Roads and Maritimes' Environmental Impact Assessment Guidance Note – Guidelines for Landscape Character and Visual Impact Assessment (RMS, 2013) was carried out for the three landscape character units. The findings were as follows:

- Shoalhaven Canyon: High to moderate impact
- Shoalhaven Alluvial: High to moderate impact
- Transition: Moderate to low impact.

4.4.5 Conclusions

The current planning framework (the Nowra Structure Plan – adopted 2010 and Shoalhaven Estuary Management Plan – adopted 2008) highlights the value of the Shoalhaven River as a natural, recreational and visual amenity. An additional crossing point in either the Shoalhaven alluvial or Shoalhaven canyon landscape zones, when considered against the overall project and urban design objectives, is likely to have high to moderate landscape character and visual impacts.

The local landform, topography and pattern and function of the urban fabric collectively reinforce that any additional crossing point should occur either immediately upstream / downstream of the existing crossings. Any consideration of a crossing point to the east (Shoalhaven alluvial) or west (Shoalhaven canyon) would require significant adjustments to the broader network and function of the whole Nowra Bomaderry area.

At the broad landscape character and visual impact level, an option within the transition zone would likely result in moderate to low landscape character and visual impacts. Efforts should be made to reduce the visual impacts of a new structure on the existing heritage items in the transition zone.

4.5 Design and construction considerations

A new bridge across the Shoalhaven River is likely to be challenging in terms of design and construction. The level of difficulty of these challenges will vary with some options potentially presenting more challenges than others.

It is appropriate in the early stages of development for any major road infrastructure project to carry out preliminary design and constructability reviews. Reviews at this stage in the project are an important and valuable part of the site options assessment process even though more detailed assessment of issues are not yet available. Future reviews on design and constructability are carried out throughout the entire life of a project.

An early review of design and constructability issues for the five identified options was carried out in early 2014. The constructability issues identified were considered significant enough to differentiate feasible and high risk options.

4.5.1 Preliminary concepts

Constructability reviews can be completed without the need for detailed design drawings. For most of the options being considered by the Nowra Bridge project, the design and constructability issues could be anticipated with minimal design detail.

However the constrained land use in the area around the existing Princes Highway corridor (Options B, C and D) meant that more detailed understanding of the potential design impacts would be needed. This was particularly the case for Option B (immediately upstream to the west) and Option D (immediately downstream to the east), as both have the potential to impact adjoining land uses and properties. Option C (on the alignment of the existing southbound bridge) was considered to have a relatively smaller potential impact on the adjoining properties and so additional design detail was not investigated.

Option E (potential rail option) was difficult to assess in detail beyond a strategic level as there were no plans available for a future rail corridor route across the Shoalhaven River.

Preliminary concept layouts were therefore prepared for Options B (see Figure 4-12) and D (see Figure 4-13) to better assess:

- Any potential issues that may rule out either option at the early stage
- The ability of each option to avoid adjoining properties
- The ability of each option to tie back into the existing road network.

For the purposes of comparative assessment designs for both Options B and D used the same configuration and cross section of the existing northbound concrete bridge.

A major consideration in the constructability assessment of each option was the preferred method of construction. Maritime authorities have indicated that a new bridge would need to have piers located alongside the existing bridge piers. This is for various reasons including management of water flow and sediment carry, ease and safety of marine navigation and flooding. The shortest spans for each bridge segment would be almost 40 metres long, which is a particularly difficult length of span to design, construct and place as a pre-cast unit, particularly over a river.

Incremental launching is a popular method that avoids difficulties associated with long spans. It is a method where a small unit of the bridge is constructed at one end and is pushed or 'launched' partway along the alignment. This is followed by the next unit and the next unit, until the entire length of the bridge has been 'launched'. At this stage incremental launching is the preferred method of construction.

Option B – immediately west (upstream)

The preliminary concept design drafted for Option B indicates that a design solution is achievable within the area available with only one property on the corner of the Princes Highway and Illaroo Road directly affected by the completed works. The green space on the southern bank would also be affected however this option could be designed to avoid the Riverhaven Motel site.

It should be noted that the area for construction will need to be larger than that needed for the completed works outlined in the preliminary design, as additional room will be needed for construction activities. This might mean more properties will be affected during construction on Illaroo Road, but still may not impact the Riverhaven Motel site. If adopted a more detailed assessment of construction methods and associated impacts will be completed as part of the project development process.

The preliminary concept design for Option B indicated that it is possible to tie in to the road network relatively quickly on both approaches. Assessment at this stage did not consider the constructability of potential intersection upgrades to the north and south of the bridge.

Option D – immediately east (downstream)

The preliminary concept design drafted for Option D indicates that a design solution is achievable within the area available and would affect one farm residence and one business on the northern bank and one restaurant, one caravan park and some green space on the southern bank.

A larger footprint for construction is also likely for Option D and will largely depend on the construction method used. If the incremental launching method is selected (preferred method) it may mean additional properties would be affected other than those identified above. If adopted a more detailed assessment of construction methods and associated impacts will be possible.

The preliminary concept design for Option D also indicates that it is possible to tie in to the road network relatively quickly on both approaches. However, if the incremental launching method of construction is chosen it might require the bridge to be moved some distance further east away from the two existing bridges.

The preliminary concept design exercise for Options B and D indicated that either option could fit within a constrained area, with varying levels of impact on the surrounding land use and properties.



Figure 4-13 Preliminary concept layout for Option B (upstream)



Figure 4-14 Preliminary concept layout for Option D (downstream)

4.5.2 Relative costs

It is appropriate that any cost estimates for construction at this early stage are considered as strategic due to the level of detail that is available. Estimated construction costs at such an early project stage include high levels of contingency to cater for 'unknowns' that may arise as the project progresses. Cost estimates often change due to better information as the project progresses and due to changing industry costs as time passes.

It is not appropriate at this early stage to attempt to accurately quantify the expected construction costs for each option. However a comparative assessment can be made of the estimated costs for each option. While the scale of the cost estimates may change over time, it is a fair assumption that the relativities between each option will remain similar over time.

Table 4-8 provides details of relative strategic cost estimates for the construction of each option. Of all the options considered for the Nowra Bridge project, the two options immediately upstream and downstream (Options B and D) were estimated to be the least expensive and were estimated to be essentially the same in terms of scale of cost. Fluctuations in costs due to the different quantities for each option (for example property acquisition) are considered to be minimal at this early stage.

The option on the alignment of the existing southbound bridge (Option C) was estimated to cost about 50 per cent more to construct compared to Option B or D. The main difference in cost for this option was the additional costs associated with the demolition of the existing southbound bridge. It would also need extensive traffic control measures during construction as a result of the temporarily reduced capacity across the river. Even if the demolition costs are not taken into account the traffic management issues would still result in considerable greater direct financial cost for Option C.

The option to the east that could possibly cater for future rail (Option E) was difficult to quantify as there are no plans for a future rail corridor route across the Shoalhaven River. A range of variations for sensitivity testing indicated a range of between three and five times the costs of Option B or D. It is likely that Option E would require extensive lengths of complicated bridge structure (viaduct) on the northern bank.

The option on the future western bypass corridor (Option A) was estimated to be the most expensive to construct. With extensive lengths of new road and existing road upgrades necessary to reconnect with the existing road network, Option A was estimated to cost at least 10 times more to construct than Option B or D. This factor could potentially be even higher.

Table 4-8 Indicative relative strategic cost estimates for construction

Option	Relative cost estimate
Option A – western bypass alignment	\$10X
Option B – immediately west (upstream)	\$X
Option C – existing southbound alignment	\$1.5X
Option D – immediately east (downstream)	\$X
Option E – eastern potential rail option	\$3–5X

4.5.3 Design and constructability review

A constructability issues assessment review was done in early 2014, involving both a site visit with construction industry experts as well as a workshop involving a range of technical specialists from Roads and Maritime Services and the construction industry. The workshop was run by an external facilitator and generally followed the format for value management workshops (see Appendix C). To avoid confusion with value management process in Chapter 5 the naming of this early stage constructability issues assessment workshop was referred to as a "workgroup meeting".

The *Roads and Maritime Services Constructability Panel Contract Schedule E3 Description of Services* was used to guide the workgroup meeting.

The workgroup meeting identified and defined appropriate assessment criteria (such as geotechnical, ease of construction, safety during construction and relative cost of construction) to compare the five options. Each option was then assessed against the criteria with the differences between the options discussed and noted. Where possible the best or worst option for each criteria was identified. However it was decided that no judgement would be made on the best option overall because the scope of the workgroup meeting was limited to constructability issues only.

The analysis was based on the information available, which at early stage does not include detailed design drawings. For options A and E ('greenfield' corridors in areas with minimal land use development) broad corridors were identified prior to the analysis and the constructability issues were assessed accordingly.

Options B, C and D ('brownfield' corridors in areas with existing land use development) had a greater level of detail than is often needed for early options consideration. The workgroup meeting participants were satisfied that the comparison of options was based on a satisfactory level of detail to enable a comparison of options.

The review focused on a range of issues, with the most attention paid to:

- Likelihood and potential impact of flooding during construction
- Potential difficulties associated with geotechnical subsurface and foundations
- An assessment of known utilities to be relocated
- Ease or difficulty of construction of each option
- Likely property impacts during construction
- Safety on worksite and to the travelling public during construction
- Maintenance of delivered infrastructure
- Disruption to traffic flow during construction
- Ease of demolition of southbound bridge (if necessary)
- General issues associated with construction activities.

Table 4-9 presents results from the preliminary design and constructability review, based on the above issues for each of the five site options.

Table 4-9 Indicative results of the preliminary design and constructability review

Consideration	Option A	Option B	Option C	Option D	Option E
Flooding	–	–	–	–	×
Geotechnical / foundations	✓	–	××	×	×
Utilities	–	×	××	×	✓
Construction ease	✓	–	××	–	×
Property impact	×	×	–	××	×
Safety	××	–	×	–	✓
Maintenance	××	–	✓	–	×
Traffic	–	–	××	–	–
Demolition	–	–	×	×	–
Construction activities	–	✓	×	–	–

- ✓ Option provides some perceived benefits relative to other options
- Option is mid-range or neutral in terms of benefits or impacts compared to other options
- × Option has some perceived impacts compared to other options

Option A – western bypass alignment

There is believed to be a boundary of relatively shallow sandstone upstream and deep alluvium downstream of the existing Princes Highway river crossings. Therefore all options upstream were considered to be at less risk of adverse flood impacts during construction compared to downstream options. Option A was therefore not considered to be a relative risk compared to other options.

Submarine geotechnical issues at the river crossing could be expected to be a relatively low risk for this option because of the relative shallow sandstone anticipated in these areas. Bridge foundations could be expected to be shallower (which is more favourable) than for downstream options.

Review of known utilities did not identify any utilities of significance that would impact greatly on Option A, however it was noted that Option A is reserved as a potential utilities corridor as well as future road.

Due to the ‘greenfields’ nature of Option A, it could potentially have a greater ease of construction than other options (particularly the Princes Highway corridor options) because it is less likely to be constrained by surrounding land uses. However the increased scale and uncertainty associated with much of the option increases the risk of unknown construction issues. This option would require the largest amount of earthworks of all five options, due to the extensive lengths of new road that would be required to connect the river crossing to the existing road network. The large quantity of earthworks required would potentially add issues associated with the balancing of cut and fill ratios, and there could be a risk of cut and fill areas being on opposite sides of the river creating issues during construction for transporting earthworks across the river.

Option A, like most options, is likely to have an impact on surrounding properties. While the ‘greenfields’ nature of the option reduces some of the impact, the increased scale of the project multiplies the number of properties that may be affected.

In terms of road safety during construction, Option A could be constructed and opened to traffic in a relatively safer manner than some other options. During construction the ‘greenfields’ nature of this option offers many opportunities to mitigate risks compared to the more constrained options near the Princes Highway. The opportunity to remove freight from the road network through Nowra could also be viewed as an operational road safety benefit. However the scale and multi-faceted nature of this option could result in a higher risk of construction hazards. This option could also pose a higher risk to recreational river users than the downstream options.

Option A would substantially increase the maintenance task after construction as there would be an substantial section of new road to be maintained as well as an additional bridge.

The constructability review did not identify any particular difficulties for maintaining traffic flow on the road network during construction of Option A.

Option A could be constructed and operated regardless of whether the southbound iron truss bridge is maintained or removed.

Option B – immediately west (upstream)

There is believed to be a boundary of relatively shallow sandstone upstream and deep alluvium downstream of the existing Princes Highway river crossings. Therefore all options upstream were considered to be at less risk of adverse flood impacts during construction compared to downstream options. Option B and the other Princes Highway corridor options were therefore not considered to be a high risk compared to the eastern most option.

Option B, as well as the other Princes Highway corridor options, would require relatively much less earthworks than Option A. At the river crossing, the relatively shallow sandstone could be expected to result in relatively less geotechnical issues for piles and footings compared to Options D and E.

Review of known utilities identified similar constraints for Option B compared to the other Princes Highway corridor options. However the site visit with constructability and construction industry experts identified potentially less utilities would require relocation or protection for this option than the other Princes Highway corridor options. Potential difficulties were identified with power lines on the northern approach and were common to all three of the Princes Highway corridor options.

Option B C and D, would be constrained by the surrounding land uses which has the potential to reduce the ease of construction. Of the three Princes Highway corridor options, Option B may have the least impact on the existing highway and travel lanes, and may provide more accessibility to the worksite during construction. Option B (or Option D) would not experience the same difficulties that are likely to be encountered by Option C.

Option B, like most options, is likely to have an impact on surrounding properties. There are likely to be a small number of properties affected on Illaroo Road, and there is an unresolved land claim on Crown land near Bridge Road.

In terms of road safety, Option B C and D should result in similar road safety conditions during construction and once opened to traffic. Option B may present some road safety risks during construction due to work near traffic on the northern side of the river.

Option B and the other Princes Highway corridor options would result in relatively minor changes to the maintenance task after construction.

The site visit with constructability and construction industry experts, and subsequent constructability review did not identify any particular difficulties for maintaining traffic flow on the road network during construction of Option B.

Option B could be constructed and operated regardless of whether the southbound iron truss bridge is maintained or removed.

The site visit with constructability and construction industry experts, and subsequent constructability review considered the general issues associated with construction activities for the Princes Highway corridor options. The length of spans between the piers that would be constructed are each about 40 metres long. These are long spans to design and construct as pre cast concrete units, particularly over a river. In these cases it may be preferable to adopt an incremental launch methodology for construction.

Incremental launching is a method where a small unit of the bridge is constructed at one end of the bridge, is pushed or 'launched' partway along the alignment, followed by the next unit and the next unit, each behind the preceding unit until the entire length of the bridge has been 'launched'. In such a case launching would need to occur from the southern side of the river, and compared to Options C and D, Option B would provide the best area for launch of the bridge.

Option C – existing southbound alignment

There is believed to be a boundary of relatively shallow sandstone upstream and deep alluvium downstream of the existing Princes Highway river crossings. Therefore all options upstream were considered to be at less risk of adverse flood impacts during construction compared to downstream options. Option C and the other Princes Highway corridor options were therefore not considered to be a high risk compared to the eastern most option.

Option C, as well as the other Princes Highway corridor options, would require relatively much less earthworks than Option A. At the river crossing, the relatively shallow sandstone could be expected to result in relatively less geotechnical issues for piles and footings compared to downstream options. However Option C would involve the removal of the existing southbound bridge and reconstruction on the same alignment, which would require piers to be constructed on top of the old southbound bridge foundations. To do so would most likely require submarine removal of the piers and footings, which would be a difficult and costly exercise. Constructing a new bridge making use of the old piers is not a safe design solution due to the age of the piers and would compromise the life span of what would otherwise be a long term infrastructure asset.

A review of known utilities identified similar constraints for Option C compared to the other Princes Highway corridor options. The site visit with constructability and construction industry experts identified potentially more utilities that would require relocation or protection than the other Princes Highway corridor options. Many utilities in the vicinity of the existing southbound bridge would need to be reviewed prior to demolition of the structure under Option C. Potential difficulties were identified with power lines on the northern approach and were common to all three of the Princes Highway corridor options.

Option C, like the other Princes Highway corridor options, would be constrained by the surrounding land uses which has the potential to reduce the ease of construction. Of the three Princes Highway corridor options, Option C would be the most difficult to construct. The demolition of the old southbound bridge in a constrained area would add complexity. The removal of the existing submarine footings so new piles and footings could be constructed would be difficult.

As Option C would exist mostly within the existing road corridor, there is potentially less impact on surrounding properties compared to the other options. However during construction there may be impacts on some surrounding properties due to demolition and construction activities.

In terms of road safety, Option C and the other Princes Highway corridor options should result in similar road safety conditions during construction and once opened to traffic. Option C would require demolition of the old southbound bridge. This would be a major activity with many associated risks to workers and the public.

Option C and the other Princes Highway corridor options would result in relatively minor changes to the maintenance task after construction. Option C would remove the maintenance task associated with the old southbound bridge after demolition.

Due to high traffic volumes, the new bridge would need to be constructed without removing any of the existing traffic capacity crossing the river, until construction has been completed. Therefore a new bridge near the existing bridges would need to be designed under the assumption that both of the existing bridges would, at least temporarily, remain in place. Option C would not allow for this, and there would be no means of relocating traffic during what would be several years of demolition and construction work.

The site visit with constructability and construction industry experts and the constructability review considered the general issues associated with construction activities for the Princes Highway corridor options. Compared to Options B and D, Option C would be the most difficult option in terms of contractor work space and construction vehicle access.

Option C would require the southbound iron truss bridge to be removed.

Option D – immediately east (downstream)

There is believed to be a boundary of relatively shallow sandstone upstream and deep alluvium downstream of the existing Princes Highway river crossings. Therefore all options upstream were considered to be at less risk of adverse flood impacts during construction compared to downstream options. Option D and the other Princes Highway corridor options were therefore not considered to be a high risk for flooding compared to the eastern most option.

Option D, as well as the other Princes Highway corridor options, would require relatively much less earthworks than Option A.

The relatively shallow sandstone is believed to transition at the location of the current southbound bridge to deep alluvium to the east. There is a risk that Option D could result in relatively more geotechnical issues for piles and footings compared to the upstream options.

Attempting to drive pile foundations so close to the existing southbound bridge structure could potentially interfere with its foundations which are over 130 years old. Therefore there is a high risk of destabilising the existing bridge during construction which will be expected to carry almost 25,000 vehicles per day until the new bridge is opened.

A review of known utilities identified similar constraints for Option D compared to the other Princes Highway corridor options. The site visit with constructability and construction industry experts identified potentially more utilities that would require relocation or protection than Option B, but potentially less than Option C. Difficulties were identified with power lines on the northern approach and were common to all three of the Princes Highway corridor options, however Option D would likely require relocation of high voltage power.

Option D, like the other Princes Highway corridor options, would be constrained by the surrounding land uses which has the potential to reduce the ease of construction. Compared to Option B, Option D may have more impact on the existing highway and travel lanes, and may have less accessibility to the worksite during construction. Option D (or Option B) would not experience the same difficulties that are likely to be encountered by Option C.

Option D, like most options, is likely to have an impact on surrounding properties. There are likely to be a number of properties and businesses affected on both sides of the river.

In terms of road safety, Option D and the other Princes Highway corridor options should result in similar road safety conditions during construction and once opened to traffic. Option D may present some road safety risks during construction due to work near traffic on the southern side of the river.

Option D and the other Princes Highway corridor options would result in relatively minor changes to the maintenance task after construction. Option D could present future maintenance difficulties for the old southbound bridge as it would ultimately be located between two concrete bridge structures and harder to access.

The site visit with constructability and construction industry experts, and subsequent constructability review did not identify any particular difficulties for maintaining traffic flow on the road network during construction of Option D.

Option D could be constructed and operated regardless of whether the southbound iron truss bridge is maintained or removed.

The site visit with constructability and construction industry experts and the constructability review considered the general issues associated with construction activities for the Princes Highway corridor

options. The length of spans between the piers that would be constructed are each about 40 metres long. These are long spans to design and construct as pre cast concrete units, particularly over a river. In these cases it may be preferable to adopt an incremental launch methodology for construction.

Incremental launching is a method where a small unit of the bridge is constructed at one end of the bridge, is pushed or 'launched' partway along the alignment, followed by the next unit and the next unit, each behind the preceding unit until the entire length of the bridge has been 'launched'. In such a case launching would need to occur from the southern side of the river. Compared to Option B, Option D would present difficulties for launch of the bridge due to the alignment of the Princes Highway curving to the east near Pleasant Way. Incremental launching requires an area to construct and launch the pre cast units. For Option D the area would need to extend south on a path that would be followed by the new bridge and this would conflict with the alignment of the Princes Highway. An incrementally launched bridge on Option D would need to be realigned and would then not run parallel to the existing bridges, would not tie in as neatly to the existing road network, and would potentially affect more properties. Option D (or Option B) would not experience the same difficulties that are likely to be encountered by Option C. Option D may provide more opportunity for contractor work space if the caravan park on the southern side of the river were acquired.

Option E – eastern potential rail option

Option E is situated within the anticipated boundary of deep alluvium downstream of the existing Princes Highway river crossings. Therefore Option E was considered to be at higher risk of adverse flood impacts during construction compared to the upstream options.

Option E would require relatively much less earthworks than Option A, however it would require extensive complicated bridge structures and footings because it is situated on soft ground associated with flood plains. It may also have potential settlement and embankment stability issues.

At the river crossing the submarine geotechnical conditions are expected to be within deep alluvium, which could be expected to result in relatively more geotechnical issues for piles and footings compared to upstream options.

A review of known utilities did not identify any utilities of significance that would impact greatly on Option E.

Due to the semi 'greenfields' nature of Option E, it could potentially have a greater ease of construction than other options (particularly the Princes Highway corridor options) as it is less likely to be constrained by surrounding land uses. However the uncertainty associated with much of the option (particularly the future rail component) increases the risk of unknown construction issues and earthworks would likely need to be fully imported.

Rail design specifications are different to roads and would likely govern the design in terms of horizontal and vertical alignments. The construction specifications for rail are also different to roads and could make for more complex approval processes. The necessary curvature of the bridge structures on the northern approach would be problematic, particularly if incremental launch was the preferred method of construction. If some pre cast spans were to be placed during construction as well as the use of incremental launching, the mixture of structure types and construction methods would increase construction cost and workplace hazards.

Option E, like most options, is likely to have an impact on surrounding properties. There are likely to be a number of properties affected on the southern side of the river, as well as the farm on the northern side of the river.

In terms of road safety, Option E could be constructed and opened to traffic in a relatively safer manner than some other options. During construction the semi 'greenfields' nature of this option may offer opportunities to mitigate risks compared to the more constrained options on the Princes Highway corridor. The construction of lengthy complicated bridge structures could introduce greater risks during construction and maintenance.

Option E would increase the maintenance task after construction due to additional lengthy viaduct structures.

The site visit with constructability and construction industry experts, and subsequent constructability review did not identify any particular difficulties for maintaining traffic flow on the road network during construction of Option E.

Option E could be constructed and operated regardless of whether the southbound iron truss bridge is maintained or removed .

4.5.4 Results

The preliminary design and constructability review identified several issues with each option that are considered significant enough to identify feasible and high risk options.

Option A – western bypass alignment

The ‘greenfields’ nature of Option A could provide better opportunities for ease of construction and mitigation of risks. However the scale of the option introduces greater exposure to potential risks and introduces construction issues that may not be present on the other smaller scale options. The cost of the option is also estimated to be at least ten times greater than the least expensive options.

Option B – immediately west (upstream)

Option B could potentially affect slightly less properties than some other options; however an unresolved land claim on Crown land would need to be resolved. This option does not appear to present any particular difficulties for maintaining traffic flow on the road network during construction, and the option lends itself well to an incrementally launched bridge. Option B is one of the least expensive options.

Option C – existing southbound alignment

Option C makes use of the existing Princes Highway corridor and would avoid surrounding properties. However the option requires the demolition of the existing southbound bridge. This introduces additional construction issues and risks including the difficulty of removing and replacing the 130 year old footings and traffic issues during the several years of demolition and construction work. The cost of the option is estimated to be about 50 per cent greater than the least expensive options.

Option D – immediately east (downstream)

Option D could potentially affect slightly more properties and businesses than some other options. This option does not appear to present any particular difficulties for maintaining traffic flow on the road network during construction. This option may present difficulties for constructing an incrementally launched bridge. This option could also potentially interfere with the load bearing foundations on the existing southbound bridge which is over 130 years old. There is risk of destabilising the existing bridge during construction which will be expected to carry almost 25,000 vehicles per day until the new bridge is opened. Option D is one of the least expensive options.

Option E – eastern potential rail option

The semi ‘greenfields’ nature of Option E could provide better opportunities for ease of construction and mitigation of risks. However the uncertainty associated with much of the option (particularly the future rail component) increases the risk of unknown construction issues, design issues and approvals. The option would also require extensive complicated bridge structures and footings that would likely need to be constructed on soft ground in flood plain with potential settlement and embankment stability issues. Depending on the chosen alignment the cost of the option is also estimated to be between three and five times greater than the least expensive options.

5 Value management process

5.1 Introduction

Value management is a development process used by Roads and Maritime to bring together technical experts and key project stakeholders to develop a way forward for large infrastructure projects.

For the Nowra Bridge project, a value management workshop was held on Thursday 22 May 2014 to help the project team assess the five site options identified during earlier planning stages. Refer to Appendix C for the Value Management Workshop Report which outlines the discussions, processes and recommendations of the workshop.

The focus of the workshop was to recommend a preferred location for a new bridge by assessing the options against agreed criteria. It did not focus on a decision around the future of the existing iron truss bridge or on the design and configuration of the new bridge or its approaches.

The objectives of the workshop were to:

- Obtain a common understanding of the work carried out to date on the Nowra Bridge project
- Review the five site options, evaluate them against agreed assessment criteria based on project objectives, and recommend a preferred option(s) to progress the project.

The 35 workshop participants included Roads and Maritime project team members, key study specialists, key stakeholders from government and non-government agencies, businesses/chambers of commerce and other stakeholders including two community representatives. A full list of participants can be found In Appendix C.

Community representation was an important part of the value management process. To select the representatives Roads and Maritime advertised for expressions of interest via:

- Newspaper advertisements in the South Coast Register and Nowra News
- Email communication to Nowra Bridge project stakeholder list
- Information on the project website
- Media release to local media outlets
- Flyer mailed out to all residents within the Nowra Bomaderry area.

Applications were open for two weeks and interested parties were asked to submit an application showing that they:

- Had an understanding of the Nowra Bridge project and community issues in the study area
- Were able to commit around two days over a two month period
- Were able to participate in the workshop with the aim of representing broader community interests and views and not personal opinion
- Were able to tolerate and respect differing viewpoints and interests that may be opposed to personal or local community position
- Did not own or live in a property that was potentially affected by any of the options.

Roads and Maritime received 20 applications which were assessed by a panel made up of two independent representatives from the Nowra area and the Roads and Maritime Project Manager. Participants were encouraged to fully participate in the workshop and were advised that the results of the value management workshop would be a recommendation, not a decision. The recommendation from the value management workshop would be just one of the inputs to be considered before a final

decision regarding a new river crossing would be made by the Minister for Roads and Freight.

5.2 Workshop activities

The workshop process built on the expertise of the participants to clarify the purpose of the project and what the project must achieve to be successful. Participants then agreed on the most appropriate criteria for the options to be assessed and weighted them in order of perceived importance.

5.2.1 Agreed assessment criteria

The criteria were grouped into three categories being functional, socio-economic and environmental. Below are the criteria agreed by the workshop participants in order of perceived importance for each category:

Functional criteria

- Improve safety for pedestrians, cyclists and motorists
- Allow easy maintenance of the existing southbound bridge
- Improve local connectivity
- Improve through traffic efficiency
- Easily constructed under existing and forecast traffic conditions
- Minimise impact on major public utilities.*

Socio-economic criteria

- Best fits with existing and future planning
- Minimise impact on urban business/service patronage
- Minimise changes to visual and landscape character
- Minimise direct impacts to properties
- Minimise traffic disruption during construction
- Minimise impacts to river users.*

Environmental criteria

- Minimise impact on biodiversity
- Minimise impact on Aboriginal heritage
- Minimise impact on Non-Aboriginal heritage
- Ease of managing flooding implications on the bridges and approaches
- Ease of managing the impact of new noise.*

* These criteria did not attract a weighting when using a paired comparison approach and were not used in the evaluation of options - see Appendix 2 in the *Nowra Bridge Value Management Report* (Appendix C).

5.2.2 Assessment of options

The five options were presented to the group and the opportunities and constraints based on the investigations carried out to date were discussed.

During the discussion for Option E it was explained to the group that this option would primarily allow for the potential integration of a future railway crossing. However, during early investigations and conversations with other NSW Government departments, there was some uncertainty around a future

rail strategy extending the line across the Shoalhaven River. The workshop group agreed that this option should not be pursued and as such, was not assessed.

Options A – D were assessed by three workshop focus groups. The below tables summarises how each option performed against the criteria and in relation to each other. They are ordered from best performing option to worst performing option for each of the criteria.

Functional criteria

Improve safety for pedestrians, cyclists and motorists	
B	Would improve safety equally the best
C	Would improve safety equally the best
D	Would improve safety equally the best
A	Performed the worst because it was considered too far from existing demand to have a considerable impact

Allow easy maintenance of existing southbound bridge	
C	Performed the best because the existing southbound bridge would be demolished and no maintenance would be required
B	Performed well because traffic could be removed off the existing southbound bridge to allow for maintenance
D	Performed slightly worse than B and C because although it could remove traffic off the existing southbound bridge to allow for maintenance, the bridge would be 'boxed in' and difficult to access
A	Performed the worst because it is too far away from the existing crossing to have a considerable impact on reducing traffic demand on the existing crossing

Improve local connectivity	
D	Performed the best subject to detailed investigation and improvements to the approach road intersections
B	Performed well with a minor difference to D and is also subject to detailed investigation and improvements to the approach road intersections
C	Performed poorly because there would be no change to the existing configuration
A	Performed the worst as a bypass does not address local connectivity around the Princes Highway and into the CBD

Improve through traffic efficiency	
A	Performed the best as it provides an alternative route for through traffic
B	Performed equal to C and D as they are all located on the current Princes Highway and any improvement to through traffic on the highway would be common to each
C	Performed equal to B and D as they are all located on the current Princes Highway and any improvement to through traffic on the highway would be common to each
D	Performed equal to B and C as they are all located on the current Princes Highway and any improvement to through traffic on the highway would be common to each

Easily constructed under existing and forecast traffic conditions

A	Performed the best as it can be completely constructed off line
B	Performed equal to D as it can be mostly built off line however there will be disruptions when connecting the bridge with the highway
D	Performed equal to B as it can be mostly built off line however there will be disruptions when connecting the bridge with the highway
C	Performed the worst as it would require major disruption to traffic flows and demolition of the existing southbound bridge

Socio-economic criteria**Best fits with existing and future planning**

B	Performed equal best with option D in terms of local short term needs and traffic planning and also provides the best opportunity for utilisation of the old iron truss bridge
D	Performed equal best with option B in terms of local short term needs and traffic planning
A	Performed well for the broader regional context in the future but does not provide for the short term need of the local community
C	Performed well when looking at the future foreshore planning however does not allow for increasing current and future capacity across the river

Minimise changes to visual and landscape character

B	Performed the best as it would be situated next to the concrete bridge and could be designed to complement it
D	Performed slightly worse than B because it “boxes in” the old iron truss bridge and could make it less visible
C	Performed poorly as it removes the iron truss bridge and its character is lost, however it performed better than option A because it consolidates the river crossing infrastructure at the current crossing
A	Performed the worst as it introduces a new infrastructure to a “greenfield” high quality landscape area

Minimise traffic disruption during construction

A	Performed the best as it can be completely constructed off line
B	Performed equal to D as it can be mostly built off line however there will be disruptions when connecting the bridge with the highway
D	Performed equal to B as it can be mostly built off line however there will be disruptions when connecting the bridge with the highway
C	Performed the worst as it would require major disruption to traffic flows and demolition of the existing southbound bridge

Minimise direct impacts to properties

C	Performs the best as it is on the current highway alignment and would impact no additional properties
B	Performed slightly better when compared to D as it has less potential property impacts
D	Performed slightly worse when compared to B as it has more potential property impacts
A	Performed the worst as it would have the greatest potential impact on property due to the extra amount of road needed to connect back to the highway

Environmental criteria

Minimise impact on biodiversity

C	Performed the best as it will be constructed within the existing footprint and in a disturbed corridor
B	Performed slightly worse than C and similar to D and can be constructed mostly within a disturbed corridor
D	Performed slightly worse than C and similar to B
A	Performed the worst due to the impact in an undisturbed land and river environment further upstream

Minimise impact on Aboriginal heritage

C	Performed the best as it will be constructed within the existing footprint and in a disturbed corridor
B	Performed slightly worse than C and similar to D and exists mostly within a disturbed corridor
D	Performed slightly worse than C and similar to B and exists mostly within a disturbed corridor
A	Performed the worst due to the impact in an undisturbed land and river environment further upstream. There are known and potential heritage sites within sensitive landforms in this area

Minimise impact on Non-Aboriginal heritage

A	Performed the best as there are no known heritage impacts or potential likely impacts
B	Performed worse than A because there is potential for impact on the flood boat shelter
D	Performed slightly worse than B and worse than A as there is a greater likelihood of impact on heritage items such as the wharf and Grahams Lodge. There is also a greater visual impact on the existing iron truss bridge than B
C	Performed the worst because it requires the demolition of the iron truss bridge which is on the Roads and Maritime Section 170 Heritage Register

Ease of managing flood implications on the bridges and approaches

A	Performed the best as a high level bridge can be constructed which is not constrained by the 1 in 100 year flood level. There is also no constraints with the number and location of the pylons
B	Performed slightly worse than A and equal to C and D as they are all affected by the 1 in 100 year flood level have limitations on the number and on location of pylons
C	Performed slightly worse than A and equal to B and D as they are all affected by the 1 in 100 year flood level have limitations on the number and on location of pylons
D	Performed slightly worse than A and equal to B and C as they are all affected by the 1 in 100 year flood level have limitations on the number and on location of pylons

Refer to the *Nowra Bridge Project Value Management Report* in Appendix C for a detailed explanation of how the criteria were ranked and weighted to come up with the assessment perspective.

5.2.3 Cost and value assessment

The group was presented with relative cost estimates for the four options. It was noted that the costs (at this stage) were indicative and could only be used for comparison purposes. Absolute value estimates for each option are likely to change as the project progresses. However the relative difference between the options can be assumed as unlikely to change as the project progresses.

A summary of performance of the options based on the assessment together with the relative strategic cost estimates was tabled in a Value Matrix so that the group could draw some conclusions as to which option provided best 'value for money'.

Table 5-1 presents the Value Matrix with the lowest cost estimate option shown as \$X and other options include a relative cost difference to \$X.

Table 5-1 Value matrix

Option	Assessment Perspective			
	Functional	Socio-economic	Environmental	Strategic Cost Estimates
Option A	4	4	4	\$10X
Option B	1	1	1	\$X
Option C	1	2	1	\$1.5X
Option D	1	2	1	\$X

5.3 Workshop outcomes and recommendations

By the end of the workshop, the participants recommended:

- Roads and Maritime should focus planning for a new river crossing immediately west (upstream) of the existing bridges (Option B)
- Roads and Maritime should further develop Option D (immediately east of the existing bridges) as a contingency in the event that a design solution for Option B cannot be achieved
- Roads and Maritime should ensure the project address traffic concerns at the intersections at Bolong Road, Illaroo Road and Bridge Road.

The working group asked that this recommendation be subject to Roads and Maritime sufficiently:

- Investigating potential impacts and improvements to traffic efficiency and north/south connectivity issues on the immediate approaches to the new bridge
- Carrying out further investigation into public utility impacts including additional costs
- Investigating fully the potential environmental, cultural and social impacts
- Working with Council to ensure the project can integrate with their long term strategic plans
- Clarifying the adjoining Aboriginal land claim issues
- Minimising the risk of disruption to road users during construction.

5.4 Post workshop community and stakeholder engagement

Roads and Maritime proactively engaged with the community to discuss the outcomes of the value management workshop and seek feedback for the recommended Option B.

Post workshop community engagement activities included:

- Project website updates
- Email notifications to registered stakeholders
- Media release
- Doorknocks to potentially affected residents and business owners
- Community flyer distributed to 14,500 residents and business owners in the Nowra and Bomaderry areas
- An online survey (450 responses)
- Six staffed community information stands at Stockland Nowra Shopping Centre:
 - Tuesday 27 May 2014 (around 120 conversations)
 - Thursday 29 May 2014 (around 180 conversations)
 - Saturday 31 May 2014 (around 270 conversations)
 - Monday 2 June 2014 (around 140 conversations)
 - Wednesday 4 June 2014 (around 130 conversations)
 - Friday 6 June 2014 (around 120 conversations).
- Meetings with key stakeholders and community interest groups
- Local school newsletter articles and Facebook posts.

5.4.1 Community feedback

Roads and Maritime received an overwhelmingly positive response from the community about the value management workshop recommendation to locate a new river crossing immediately west of the existing bridges (Option B).

During the six community information stands held at Stockland Nowra Shopping Centre, the Nowra Bridge project team discussed the workshop process and outcomes with over 950 community members.

Through conversations with the project team there was clear support and understanding for the need of a new crossing immediately to the west. Many community members suggested that a long term plan to bypass Nowra (either Option A or E) was also required for the future to accommodate growth in the area.

Almost all of the people who visited the stand felt that the project needed to address the congestion around the intersections on the bridge approaches.

The community were also invited to participate in an online survey to provide feedback about the workshop recommendations and identify any issues that they believed Roads and Maritime should consider during the next stage(s) of the project development process.

Roads and Maritime received a total of 450 responses, the majority of which were aware of and supported Option B. However, it is noted that there was some level of support for all options.

Other key issues that were raised by the survey and during the post workshop community and stakeholder engagement included:

- The project should address traffic issues at the intersections at Bolong Road, Illaroo Road and Bridge Road / Pleasant Way
- A rail component should be incorporated into any future river crossing

- The new crossing should make better provision for pedestrians and cyclists than the existing bridges
- The historic value of the existing iron truss bridge is important to the community and it should be retained for social use
- Maintenance costs are too high and the existing iron truss bridge should be removed
- Urban growth in the Nowra area should be considered when planning a new river crossing.

6 Preferred site option selection process

6.1 Selection approach

The aim of this site options study is to recommend the best location for a new bridge across the Shoalhaven River in Nowra. The recommendation would be used to focus future efforts on a safe and practical design solution at a preferred location. The recommended option must address the immediate issues associated with the existing southbound bridge and consider the possibility of addressing longer term transport issues.

This study has:

- Considered a number of technical areas from a wide range of specialists and agencies, including some studies that date back over a decade
- Engaged the community and stakeholders to identify the needs of the travelling public in Nowra Bomaderry, and to identify their views and ideas
- Completed an independently facilitated value management process that included representatives from NSW Government agencies, Shoalhaven City Council, as well as stakeholders from local business and the community.

The recommended preferred location for a new bridge across the Shoalhaven River was informed by these sources of information:

- Technical input from existing and supplementary data sources
- Feedback from the community at various stages throughout this study
- The recommendations of the value management process.

6.1.1 Technical input

Option A – western bypass alignment

This option aimed to address the immediate needs of the Nowra Bridge project as well as the longer term needs of the Nowra Bomaderry road network. It would involve the construction of a bridge on the future alignment of the western bypass identified on the Shoalhaven Local Environmental Plan (SLEP).

Traffic surveys and modelling have demonstrated that this option would not be an effective solution to removing traffic from the existing southbound bridge, and so would not adequately address the immediate issues.

Preliminary environmental investigations indicate that this option is potentially more likely to encounter ecological and Aboriginal heritage issues than other options; however it would not directly impact Non-Aboriginal heritage items such as the existing southbound bridge. The landscape character of the Shoalhaven River is also less suited to a bridge in this location.

This option would be of a far larger scale than the other options which could introduce greater exposure to design issues and property impacts. The increased scale of this option could also introduce greater exposure to construction issues and risks. The scale of the option including extensive lengths of new road and existing road upgrades necessary to reconnect with the existing road network, also means that the estimated cost for construction would be at least 10 times higher than the least expensive options.

Option B – immediately west (upstream)

This option (along with Option D) is one of two options that best meet the immediate needs of the Nowra Bridge project. This would involve constructing a bridge immediately west (upstream) alongside the existing northbound bridge.

Preliminary environmental investigations indicate that this option is unlikely to encounter the ecological and Aboriginal heritage issues that are expected for some other options, and it could be constructed regardless of whether the southbound bridge was retained or demolished. The landscape character of the Shoalhaven River is better suited to a bridge in this location than for some other options.

This option would affect relatively fewer properties than some other options; however an unresolved land claim on Crown land could affect access to the site. This option has relatively less constructability issues than some other options, and would be in a good location for an incremental launch method of construction.

This option (along with Option D) is one of the least expensive options.

Option C – existing southbound alignment

This option aimed to minimise the potential impact on surrounding land uses and future local road plans by constructing a new bridge within the existing Princes Highway road reserve.

The option would involve the demolition of the existing southbound bridge prior to construction of the new bridge. This would impact Non-Aboriginal heritage (the existing southbound bridge), and would also introduce constructability issues associated with the removal and replacement of the piers, piles and footings. The new bridge would need to be constructed without removing any of the existing traffic capacity crossing the river, and under this option there would be no means of relocating traffic during several years of demolition and construction work.

The option is estimated to cost about 50 per cent more to construct compared to the least expensive options, with the main difference being the additional costs associated with the demolition of the existing southbound bridge and the need for extensive traffic control measures during construction as a result of the temporarily reduced capacity across the river.

Option D – immediately east (downstream)

This option (along with Option B) best meets the immediate needs of the Nowra Bridge project. This would involve constructing a bridge immediately east (downstream) alongside the existing southbound bridge.

Preliminary environmental investigations indicate that this option is unlikely to encounter the ecological and Aboriginal heritage issues that are expected for some other options. It could be constructed regardless of whether the southbound bridge was retained or demolished, however it would to some degree impact Non-Aboriginal heritage items such as the existing southbound bridge. The landscape character of the Shoalhaven River is better suited to a bridge in this location than for other options.

This option would affect slightly more properties and businesses than some other options. This option has constructability issues and risks associated with its proximity to the 130 year old footings of the the existing southbound bridge. This option would also have difficulties with an incremental launch method of construction.

This option (along with Option B) is one of the least expensive options.

Option E – eastern potential rail option

This option aimed to provide an opportunity for a future rail extension across the Shoalhaven River between Bomaderry and Nowra. Despite genuine efforts between NSW Government agencies, it is not possible at this point in time to predict where a future rail link may go, or at what point in time that may happen.

This option would require extensive lengths of complicated bridge structures which would be difficult to design and construct to road and rail standards. It would introduce risks during construction and settlement issues on flood prone land with soft soils. It is at least three times more expensive than the least expensive options.

The uncertainty surrounding the future location of a rail corridor across the Shoalhaven River presents a great risk that this option could be built in the wrong place for future planning, or could be built in a location that impedes future planning.

6.1.2 Community feedback

Option A – western bypass alignment

Initial conversations with the community demonstrated a strong perception that traffic congestion is the primary issue to be addressed by the Nowra Bridge project, and that only a bypass of Nowra Bomaderry could address that issue. However upon presentation of the traffic survey and modelling results, the community was often receptive to the asset maintenance needs of the project and the realities about the unlikely traffic or asset maintenance benefits of a bypass in the short to medium term. This response was generally consistent across stakeholder groups and during community engagement throughout the course of this study.

This option was still a popular option as a long term traffic solution for the Nowra Bomaderry area.

Option B – immediately west (upstream)

Initial conversations with the community demonstrated a strong desire that traffic congestion at the intersections of Bolong Road, Illaroo Road and Bridge Road / Pleasant Way be addressed as part of any option on the Princes Highway corridor. When presented with a choice between either Option B or Option D, the community overwhelmingly supported Option B to the west. This was based on the benefits of reduced property impacts, reduced constructability risks and the potential to keep or reduce impacts on the existing southbound bridge.

Option C – existing southbound alignment

A small proportion of the community considered an option on the alignment of the existing southbound bridge to be preferable due to the reduced impacts on surrounding land use and properties. However these members of the community were understanding once presented with the difficulties of maintaining traffic flow during construction of this option.

Many members of the community rejected this option as it would require the demolition of the existing southbound bridge.

Option D – immediately east (downstream)

The community often discussed this option in comparison alongside Option B. Some members of the community initially assumed that a new southbound bridge would be constructed to the east alongside the existing southbound bridge. When presented with the results of the value management workshop and preliminary constructability review, these members of the community identified with the benefits of the alternative to the west. A common drawback raised with Option D was the impact the option would have on the existing southbound bridge.

Option E – eastern potential rail option

Initial conversations with the community identified interest in a project that could cater for future rail across the Shoalhaven River. There was a perception by some members of the community that providing a bridge for rail would accelerate plans to extend the rail line into Nowra and down the NSW south coast.

As the project progressed, most members of the community, while disappointed, appeared willing to accept that this option would be unlikely to accelerate future plans for a rail extension.

There is still strong support in the community for the rail line to be extended over the Shoalhaven River at some point in the future.

6.1.3 Value management workshop

Option A – western bypass alignment

This option was assessed at the value management workshop, but performed poorly when compared to the other options located around the existing Princes Highway corridor. This option was also estimated to cost at least ten times more than the least expensive options, and therefore was not recommended by the value management process.

Option B – immediately west (upstream)

This option was assessed at the value management workshop, and performed the best compared to all the options considered. This option (as well as Option D) was one of the least expensive options. Option B was recommended as the preferred option by the value management process, slightly ahead of Option D.

Option C – existing southbound alignment

This option was assessed at the value management workshop and performed relatively well compared to Options A and E, however it was outperformed by the other options around the existing Princes Highway corridor. This option was also estimated to cost about 50 per cent more than the least expensive options, and therefore was not recommended by the value management process.

Option D – immediately east (downstream)

This option was assessed at the value management workshop, and was ranked slightly lower than the recommended Option B. This option (as well as Option B) was one of the least expensive options. Option D was recommended as the preferred 'back up' option by the value management process, in the event that a suitable design solution cannot be found for Option B.

Option E – eastern potential rail option

By unanimous decision this option was not assessed in detail at the value management workshop due to the lack of certainty around planning for a future rail extension, and the associated risks in attempting to presume the most appropriate location. This option was also estimated to cost at least three times more than the least expensive options, and therefore was not recommended by the value management process.

6.2 Recommendation of a preferred option

6.2.1 Summary of assessment

The results of the technical studies and value management process demonstrated that to meet the project objectives, an option close to the existing Princes Highway river crossings would be needed. While some members of the community expressed a desire for a bypass option, this would not address the immediate needs of the project and must be considered as a longer term option.

An option to cater for rail could not be considered further due to lack of a future strategy for a rail

extension across the Shoalhaven River.

Of the options close to the existing Princes Highway river crossings, the results of the technical studies, value management and community consultation all demonstrate a preference for a new bridge immediately to the west of the existing bridges.

6.2.2 Recommended preferred option

Option B, which is immediately west (upstream) of the existing Princes Highway river crossings, is recommended as the preferred site for a new bridge across the Shoalhaven River. This site is recommended because:

- Option B would present less risk to the stability of the existing river crossings during construction activities, compared to the other Princes Highway options
- Option B is better suited to a preferred incremental launch construction methodology
- Option B would have relatively less property impacts
- Option B could be constructed and operated regardless of whether the southbound iron truss bridge is maintained or removed (at the time this report was written the future of the southbound bridge was yet to be decided)
- Option B has been well received by the community as the recommended preferred option
- Option B has been assessed at this early stage as being one of the options that would provide the best value for money.

This recommendation is subject to a list of issues to be resolved that were identified during the value management process.

It is also recommended that Roads and Maritime respond to the concerns of the community about traffic congestion in the area by attempting to find design solutions to improve traffic conditions at Bolong Road, Illaroo Road and Bridge Road / Pleasant Way.

6.3 The next steps

These recommendations will be provided to the NSW Government to inform a decision on the preferred location to focus planning for a new bridge crossing across the Shoalhaven River in Nowra.

Once a decision is made by the NSW Government, Roads and Maritime will be in a position to continue with project development. This will include concept design work and environmental assessment with a view to develop an approved project for future construction.

The community will continue to be engaged throughout the project development process, particularly on issues associated with traffic congestion in the area, and on the future of the existing southbound bridge.