Nowra Bridge Project

Review of environmental factors

Roads and Maritime Services | August 2018

NSW GOVERNMENT

Nowra Bridge Project

Review of Environmental Factors

Roads and Maritime Services | August 2018

Prepared by SMEC Australia Pty Ltd and Roads and Maritime Services

RMS.18.942
ISBN: 978-1-925797-58-9

Executive summary

The proposal

Roads and Maritime Services is proposing to construct a new bridge on the A1 Princes Highway over the Shoalhaven River at Nowra. The Nowra Bridge project (the proposal) includes a new four lane bridge to the west (upstream) of the existing bridge crossings and the removal of vehicular traffic from the existing southbound bridge. The proposal would also include the upgrade of about 1.6 kilometres of the Princes Highway in the vicinity of the bridge, as well as providing key intersection upgrades and modifications to the local road network. The proposal would improve access between North Nowra/Bomaderry and Nowra and the surrounding areas, improve southbound access for large freight vehicles, and improve traffic flows.

The proposal is to be carried out on behalf of Roads and Maritime and can be assessed under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The main features of the proposal include:

- Construction of a new bridge to the west (upstream) of the existing bridge crossings over the Shoalhaven River including:
  - Four northbound lanes including a dedicated left turn only lane from Bridge Road to Illaroo Road
  - A 3.5 metre wide shared use path on the western side of the bridge connecting the Illaroo Road intersection to the Bridge Road intersection
- Widening of the existing bridge over Bomaderry Creek
- Minor lane adjustments on the existing northbound bridge to convert it to three lanes of southbound traffic
- Removal of vehicular traffic and closure of the existing southbound bridge to undertake investigation, rehabilitation and repurposing work for adaptive reuse after opening of the new northbound bridge. As part of the proposal shared paths and maintenance access would be constructed up to the existing southbound bridge, and work to prevent unauthorised access would also be carried out. The rehabilitation and repurposing of the existing southbound bridge for adaptive reuse would be subject to a separate consultation and assessment process to this REF
- Upgrading of the Princes Highway to provide three northbound and three southbound lanes from the Bolong Road intersection through to about 75 metres north of the Moss Street intersection
- Widening of Illaroo Road over a distance of about 270 metres
- Upgrading of the Princes Highway and Illaroo Road intersection to provide:
  - Two southbound right turn lanes from the Princes Highway into Illaroo Road
  - Three dedicated right turn lanes and one dedicated left turn lane from Illaroo Road to Princes Highway
  - An acceleration and merge lane for northbound traffic turning from Princes Highway into Illaroo Road
- Upgrading of the Princes Highway and Bridge Road intersection to provide:
  - Two southbound right turn lanes from the Princes Highway into Bridge Road
  - One left turn lane from Bridge Road to the Princes Highway
- Local road adjustments including:
  - Closing the access between Pleasant Way and Princes Highway

  - Restricting turning movements at the intersection of Bridge Road and Scenic Drive
  - Construction of a new local road connecting Lyrebird Drive to the Princes Highway about 300 metres south of the existing Pleasant Way intersection
- Provision of pedestrian facilities at all intersections
- Dedicated off road shared paths and footpaths along the length of the proposal.
- Urban design and social amenity improvements, and landscaping including pedestrian links to the existing southbound bridge
- Relocation and/or protection of utility services
- Drainage and water quality management infrastructure along the road corridor
- Property works including acquisition, demolition, and adjustments to accesses
- Temporary ancillary facilities during construction including site offices, construction compounds, and stockpile sites.
- Be as comprehensive and measurable as possible

Need for the proposal

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 south of 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 network performance is poor and modelling has suggested that the existing arrangement would reach capacity by 2026.

The existing southbound bridge has restrictions for vehicles over 4.6 metres high and for higher mass limit (HML) vehicles. To travel south these vehicles require a police escort to travel over the existing northbound bridge resulting in traffic delays. Additionally, the southbound bridge is over 130 years old, is in poor condition and has substantial maintenance costs estimated at $35 million over the next 50 years.

Roads and Maritime is proposing to construct an additional bridge crossing over the Shoalhaven River to:

- Remove barriers to freight, particularly over height and HML vehicles
- Address current poor bridge condition and reduce ongoing maintenance and major rehabilitation obligations
- Improve local and regional network connectivity for motor traffic
- Improve journey reliability, particularly during holiday seasons.

Proposal objectives

The primary and secondary objectives of the proposal are to:

- Reduce crash rates on the Princes Highway between Bolong Road and Bridge Road
- Support future traffic growth accessing the Princes Highway associated with planned land use in the Nowra Bomaderry area
- Provide southbound access for over height vehicles and HML vehicles on the Princes Highway across the Shoalhaven River
- Reduce delays and queuing on the Princes Highway between Bolong Road and Bridge Road

- Enable safe and efficient maintenance activities on the Shoalhaven River crossings without causing extended delays to the road network
- Provide the best benefit to our customers
- Deliver the proposal within an acceptable timeframe
- Deliver the proposal within budget
- Prioritise the safety of our workers and customers
- Minimise environmental impact
- Deliver a proposal that fits sensitively with the built, natural and community environment.

Alternatives and options considered

Alternatives and options for the Nowra Bridge proposal were considered through a comprehensive multi-staged identification and assessment process. This also included a comprehensive investigation into options for the future of the existing southbound bridge.

Identification and analysis of strategic alternatives

Strategic alternatives were considered to address the current network performance and safety issues including:

- Do minimum (maintain the existing southbound bridge)
- Demolish and replace the existing southbound bridge
- A new bridge next to the existing bridges
- A bypass of Nowra
- Provision for future rail
- A ‘double deck’ bridge
- A tunnel.

These were evaluated against criteria covering the proposal objectives, engineering design and constructability, traffic performance, and minimising environmental impacts. From the strategic alternatives, five route options were identified and taken forward for further development and consideration. The future of the existing southbound bridge was also taken forward to separately consider available options.

Identification and assessment of route options

The following five options were developed to consider the location of the new bridge:

- Option A – western bypass alignment
- Option B – immediately west (upstream)
- Option C – existing southbound alignment
- Option D – immediately east (downstream)
- Option E – eastern potential rail option.

A value management workshop was held in May 2015 which resulted in the following recommendations:

- 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 as a contingency in the event that a design solution for Option B could not be achieved
- Roads and Maritime should ensure the project addresses traffic concerns at the intersections at Bolong Road, Illaroo Road and Bridge Road.

A new bridge immediately to the west (upstream) of the existing bridges was selected as the route option that would best meet the evaluation criteria.

Identification and analysis of intersection and network options

After the selection of Option B as the preferred route option, potential intersection and network options were developed. A total of 19 potential intersection options were compiled in consultation with Shoalhaven City Council and other key stakeholders, focusing on the section of the Princes Highway between the Bolong Road and Bridge Road intersections. The analysis considered two options identified in the Nowra Bomaderry Structure Plan (NBSP), including a realigned western bridge under Illaroo Road connecting at Bolong Road.

The following six representative intersection options were shortlisted for further investigation:

- Option 1: New four lane bridge, no intersection upgrades
- Option 2: New three lane bridge, at grade intersection upgrades
- Option 3: New four lane bridge, at grade intersection upgrades
- Option 4: New four lane bridge, grade separation on southern approach
- Option 5: New four lane bridge and mix of at grade and grade separated upgrades (NBSP)
- Option 6: New four lane bridge, grade separation on both approaches.

Option 3 was identified as the preferred intersection and network option based on a multi-criteria assessment process which took into consideration the traffic performance, heritage, environment, property, land use and maintenance aspects of each option. Option 3 was considered to provide the best balance of potential benefits against potential impacts.

Preferred option

The preferred option is a new four lane bridge to the west (upstream) of the existing northbound bridge, with upgrades of key intersections to the immediate north and south of the new bridge. The proposal is considered to be the most cost-effective option to address the project objectives and community expectations, while reducing as much as possible impacts to the community and property owners, and ensuring that long term planning for the Princes Highway is not compromised.

The Preferred Route Option Report (Roads and Maritime, February 2018) was placed on display between 19 February and 23 March 2018 to enable the community to have their say. Roads and Maritime have used the feedback to further refine project design and develop the environmental assessment.

Future of the existing southbound bridge

The existing southbound bridge is the only intact American pin-jointed ‘Whipple’ truss bridge in NSW that has historically been used for road traffic. There are only three known bridges of this type in Australia.

Seven options were investigated for the existing southbound bridge, consisting of retain and maintain, retain and transfer, partial demolition, partial demolition with relocation of spans, full demolition with relocation of spans, full demolition and deferral. This informed consultation carried out in 2014, where Roads and Maritime engaged with the community about the future of the existing

southbound bridge through public information sessions, surveys and submissions. This showed an overwhelming response to retain the existing southbound bridge in some form.

A specialist heritage assessment was undertaken considering the technical and aesthetic significance of the existing structure. Based on its recommendation it was decided to retain the existing bridge and adapt it for future reuse.

Statutory and planning framework

The proponent and determining authority for the proposal is Roads and Maritime under clause 94 of State Environmental Planning Policy (Infrastructure) 2007 which provides that the proposal may be carried out without the need for development consent. The proposal is therefore subject to assessment and determination under Division 5.1 of the EP&A Act.

Community and stakeholder consultation

The following stakeholders were consulted before and during the preparation of the REF:

- Shoalhaven City Council
- Potentially affected property owners
- Residents of Nowra, North Nowra and Bomaderry
- Community groups
- Business owners including transport providers
- Utility service providers
- Aboriginal stakeholders.

Key issues raised by the community during the consultation include:

- Need for a bypass
- The proposal will not do much to ease congestion, especially during peak holiday seasons
- There are too many sets of traffic lights which affects efficient movement of traffic, and the proposal is adding a further set
- Grade separated interchanges should be provided at Illaroo Road and Bridge Road instead of the proposed at grade arrangements
- Provide a dedicated left-hand turn from Illaroo Road to the Princes Highway
- Need for the railway line to be extended
- The old bridge should be removed and replaced with a new four-lane bridge
- Construction impacts, especially to Illaroo Road.

Environmental impacts

The proposal would result in the following main environmental impacts.

Traffic and transport

During construction, about 270 public car parking spaces would be temporarily impacted. There would be a temporary increase in travel times as a result of speed limit restrictions, traffic detours, heavy construction vehicle traffic, altered property access arrangements and potential delays to bus timetables.

When completed, the proposal would improve travel times for vehicles travelling in all directions compared to the Do Minimum. Additional benefits include the removal of restrictions for southbound overheight and HML vehicles, reduced risk of crashes and improved pedestrian and cyclist safety.

Noise and vibration

The majority of construction work would be undertaken during standard construction hours. However, some works outside standard construction hours would be required for specific construction activities to minimise disruptions to traffic flow in the area.

Construction of the proposal during standard construction hours would exceed the highly noise affected level of 75 decibels at 180 receivers due to their proximity to the works. Measures in the Roads and Maritime *Construction Noise and Vibration Guideline* (2016) would be implemented to minimise construction noise impacts.

When completed, the proposal would change traffic noise through the removal of vehicles from the existing southbound bridge and the transfer of northbound traffic to the new bridge. There would also be a change in local traffic related to the closure of Pleasant Way.

Maximum noise levels for residences within the study area are not predicted to noticeably increase as a result of the proposal. The number of maximum noise level events per night for residences are not predicted to increase as a result of the proposal.

A total of 24 residential receivers would qualify for consideration of noise mitigation where reasonable and feasible. The noise and vibration assessment recommends a noise barrier adjacent to the southbound lanes of the Princes Highway, south of Graham Lodge. The noise barrier assessment recommended a barrier height of 5.5 metres would provide effective noise mitigation at up to 12 receivers. The location and extent of any noise barrier would be refined during detailed design in consultation with affected property owners. All other sensitive receivers are setback far enough from the proposal that they do not trigger consideration of noise mitigation.

Aboriginal heritage

The proposal would directly impact up to seven Aboriginal sites and partially impact one State Heritage Registered site, Graham Lodge, which has identified Aboriginal cultural values.

The seven directly impacted sites comprise:

- Three artefact scatters of low archaeological significance
- Two artefact scatters of moderate archaeological significance
- One artefact scatter of high archaeological significance
- One habitation site/artefact scatter of high archaeological significance.

An Aboriginal heritage impact permit would be sought for the proposal area. Surface collection and salvage of the sites of moderate to high archaeological significance would be carried out prior to relevant impacts occurring.

Non-Aboriginal heritage

The proposal would impact seven non-Aboriginal heritage items. The proposal would have a major impact on the locally listed Captain Cook Bicentennial Memorial resulting in a permanent reduction in the item's heritage curtilage and requiring relocation of the pavilion structure itself. The proposal would result in moderate impacts to two locally significant timber federation residences and gardens, 'Lynburn' and 'Illowra'. The proposal would result in a minor impact to the curtilage of the state listed Graham Lodge but would not impact any built heritage.

Cessation of the existing southbound bridge as the main transportation route across the Shoalhaven River would result in a minor indirect impact to the heritage values of this item. The rehabilitation and repurposing of the existing southbound bridge for adaptive reuse would be subject to a separate consultation and assessment process to this REF.

A range of safeguards and management measures have been identified to mitigate impacts to non-Aboriginal heritage. These include preparation of archival recordings for the Captain Cook Bicentennial Memorial, the Nowra Bridge over the Shoalhaven River, 'Lynburn', and 'Illowra' prior to impacts occurring.

Landscape character and visual impact

The proposal would have a high to moderate impact on views in and around the study area. The urban design for the proposal has been carried out with reference to a set of design objectives specifically developed for the proposal, and reflecting the visual amenity values of the local area. These have been used to develop mitigation and management measures that would minimise the impacts of the proposal.

The existing southbound bridge would be retained and maintained, generally maintaining the existing amenity values for the area.

Flooding and hydrology

The new northbound bridge and associated intersection upgrades at Bridge Road and Illaroo Road would achieve flood immunity for the 10 per cent, five per cent, two per cent and one per cent annual exceedance probability (AEP) flood events. Sections of Scenic Drive and Hyam Street are already affected in large flood events and the extent of impacts in these areas would increase slightly with the increase in flood levels.

Flood levels for the one per cent AEP event upstream of the new northbound bridge would increase in the order of 0.1-0.2 metres. The building floor levels for 29 properties along Mandalay Avenue, Hyam Street and Scenic Drive have been surveyed to better characterise the change in flood risk in this area. Currently, two properties are predicted to experience inundation above floor level in the two per cent AEP event, while four additional properties are predicted to be inundated above floor level in the one per cent AEP event. The predicted change in flood level as a result of the proposal would not increase the number of properties predicted to experience inundation above floor level in both the two and one per cent AEP events. Buildings that currently experience inundation would experience an increase in flood level of 0.1 to 0.2 metres. No flooding was predicted at any of these properties for the 10 per cent or five per cent AEP events.

Up to 12 properties that were previously not affected by the one and two per cent AEP flood events are predicted to be impacted by flood water that is below the surveyed floor level.

Property and land use

The proposal has been designed to minimise the need for property acquisitions. Where possible the proposal utilises the existing road corridor however nine households and two businesses would need to be acquired to accommodate the wider footprint required to achieve the road upgrade, improve traffic performance and provide the associated infrastructure such as pedestrian and cycle paths.

During the detailed design stage, Roads and Maritime would consult with affected landowners to finalise the scope and design of property adjustment infrastructure. The acquisition of property would be undertaken in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*,

the NSW Government Land Acquisition Reform 2016 and the Roads and Maritime Land Acquisition Information Guide (Roads and Maritime, 2014).

Socio-economic

The proposal would have both positive and negative socio-economic impacts that would occur during construction and operation. When completed, the proposal is expected to provide a range of socio-economic benefits for both the local and broader community including improvements in road safety, traffic flow, freight transport, and public transport reliability.

Construction activities would affect amenity associated with noise and dust emissions from construction sites. The removal of roadside vegetation would be a substantial change to the local landscape, and this impact would be offset through implementation of an Urban Design and Landscape Plan.

North Nowra Rotary Park and Moorhouse Park would be closed to the public for the duration of construction. Sections of Greys Beach Reserve would also be closed at times during construction. Off-street parking would be closed at several locations for the duration of construction, including the informal parking area at the Shoalhaven Entertainment Centre and Visitors Centre, which would potentially have an impact on patronage at this facility.

Water-based activities associated with construction of the new bridge may require the restriction of watercraft movements for short periods, however, the navigational channel of the Shoalhaven River in the proposal area would be maintained during construction.

Biodiversity

The proposal would result in:

- Clearing of up to 2.18 hectares of native vegetation, including 0.09 hectares of the endangered ecological community Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Removal of 19 Magenta Lilly Pilly (*Syzygium paniculatum*) plants which are listed as endangered under the *Biodiversity Conservation Act 2016*
- Impacts on up to 0.09 hectares of seagrass (*Zostera muelleri*), which is a Type 1 key fish habitat under the *Fisheries Management Act 1994*.

The proposal is not likely to significantly impact threatened species or ecological communities or their habitats, within the meaning of the *Threatened Species Conservation Act 1994* or the *Fisheries Management Act 1994* and therefore a Species Impact Statement or Biodiversity Development Assessment Report is not required.

The proposal is not likely to significantly impact threatened species, ecological communities or migratory species, within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*.

Biodiversity impacts would be minimised though avoidance during design with residual impacts managed through the implementation of management and mitigation measures. Any offsetting requirements related to impacts on seagrass would be carried out in accordance with the Department of Primary Industries *Policy and guidelines for fish habitat conservation and management* (DPI 2013) and relevant conditions attached to any approval under the *Fisheries Management Act 1994*.

How will the likely impacts be managed?

This REF identifies comprehensive mitigation and management measures that would be implemented to avoid, manage, mitigate, offset and/or monitor impacts during construction and operation of the proposal. These include best practice environmental planning and management techniques, including but not limited to:

- A construction environmental management plan to coordinate construction activities and manage potential impacts
- A noise and vibration management plan prepared in accordance with the Construction Noise and Vibration Guideline (Roads and Maritime 2016) to minimise construction noise impacts
- An erosion and sedimentation control plan to minimise water quality impacts
- Silt curtains and in-stream construction techniques that reduce the potential for release of sediment to the surrounding environment
- Permanent operational water quality controls, comprising stormwater treatment and spill containment facilities, to collect and treat stormwater runoff water prior to discharge and to manage large spills of hazardous substances.

During detailed design and construction planning, some impacts identified in this REF may be further reduced.

Justification and conclusion

The proposal is considered to be consistent with a number of relevant strategies and plan including:

- The NSW State Priorities
- NSW Future Transport Strategy
- NSW Freight and Ports Strategy
- Illawarra Regional Transport Plan
- Illawarra – Shoalhaven Regional Plan
- Nowra Bomaderry Structure Plan
- Princes Highway Corridor Strategy.

The Princes Highway is the main north-south transport corridor linking Sydney and Wollongong to the NSW South Coast and north-eastern Victoria. The proposal is considered to be important to the region with positive social and economic impacts.

Implementation of the proposal would:

- Improve travel times for vehicles travelling in all directions compared to the do minimum, even for the forecast projections for 2046
- Remove constraints to overheight and HML vehicles currently associated with the existing southbound bridge
- Reduce congestion and improve travel times for northbound and southbound traffic
- Reduce traffic delays at the Bolong Road, Illaroo Road and Bridge Road intersections with the Princes Highway
- Reduce crashes
- Improve pedestrian and cyclist safety through the provision of off-road shared paths that would provide connections to existing active transport routes
- Improve reliability and travel times of bus services.

Though environmental impacts would occur, they can be effectively mitigated with the application of safeguards outlined within this REF.

The benefits of the proposal are considered to outweigh the expected impacts on the environment. The environmental impacts for the proposal are not likely to be significant and therefore the preparation of an environmental impact statement and approval from the Minister for Planning under Division 5.2 of the EP&A Act are not required.

Display of the review of environmental factors

This REF is on display for comment between **27 August 2018** and **28 September 2018**. You can access the REF documents in the following ways:

Internet

The REF will be available on the Roads and Maritime Services website at: http://www.rms.nsw.gov.au/NowraBridge

Display

The REF is on display at the following locations:

- Shoalhaven City Council, Nowra
- Nowra Library, Nowra
- TAFE NSW, Bomaderry

Community information sessions

Community information sessions will be held at the following times and locations. A formal presentation will not be given so please drop in at any time:

Nowra School of Arts
Berry Street, Nowra
Saturday 1 September, 11am – 3pm;
Thursday 6 September, 4pm – 8pm

Stocklands Nowra
60 East Street, Nowra
Thursday 13 September, 4pm – 8pm

North Nowra Shops
Illaroo Road, North Nowra
Saturday 8 September, 11am – 3pm
Wednesday 12 September, 11am – 3pm.

How can I make a submission?

Roads and Maritime is seeking feedback on the environmental assessment documents until **Friday 28 September 2018**. All submissions made during the display period will be addressed by Roads and Maritime with responses published in a submissions report.

Written submissions should be sent to Roads and Maritime and can be emailed or mailed to:

Email: NowraBridgeProject@rms.nsw.gov.au

Mail: Nowra Bridge Project,

Roads and Maritime Services,

PO Box 477 Wollongong NSW 2500

What happens next?

Roads and Maritime will collect feedback from the REF display period and prepare a submissions report. All submissions made during the display period will be responded to by Roads and Maritime and addressed in the submissions report.

Feedback from this display period will help to further refine the design of the new bridge and intersection upgrades. The community will be kept informed during this process.

After this, Roads and Maritime would proceed with detailed design and tenders would be called for construction.

For further information, please contact Roads and Maritime Services Project Development Manager Dan McClure on 1800 331 713 or email to NowraBridgeProject@rms.nsw.gov.au.

Contents

Tables

Figures

Appendices

1. Introduction

1.1 Proposal identification

Roads and Maritime Services (Roads and Maritime) proposes to construct a new bridge on the A1 Princes Highway over the Shoalhaven River at Nowra (the proposal). The proposal includes the construction of a new four lane bridge to the west (upstream) of the existing bridge crossings and the removal of vehicular traffic from the existing southbound bridge. The proposal would also include the upgrade of about 1.6 kilometres of the Princes Highway in the vicinity of the bridge, as well as providing key intersection upgrades and modifications to the local road network. The proposal would improve access to Nowra and the surrounding areas, improve southbound access for large freight vehicles, and improve traffic flows.

The main features of the proposal include:

- Construction of a new bridge to the west (upstream) of the existing bridge crossings over the Shoalhaven River including:
  - Four northbound lanes including a dedicated left turn only lane from Bridge Road to Illaroo Road
  - A 3.5 metre wide shared use path on the western side of the bridge connecting the Illaroo Road intersection to the Bridge Road intersection
- Widening of the existing bridge over Bomaderry Creek
- Minor lane adjustments on the existing northbound bridge to convert it to three lanes of southbound traffic
- Removal of vehicular traffic and closure of the existing southbound bridge to undertake investigation, rehabilitation and repurposing work for adaptive reuse following opening of the new northbound bridge. As part of the proposal, shared paths and maintenance access would be constructed up to the existing southbound bridge and work to prevent unauthorised access would also be carried out. The rehabilitation and repurposing of the existing southbound bridge for adaptive reuse would be subject to a separate consultation and assessment process to this REF
- Upgrading of the Princes Highway to provide three northbound and three southbound lanes from the Bolong Road intersection through to about 75 metres north of the Moss Street intersection
- Widening of Illaroo Road over a distance of about 270 metres
- Upgrading of the Princes Highway and Illaroo Road intersection to provide:
  - Two southbound right turn lanes from the Princes Highway into Illaroo Road
  - Three dedicated right turn lanes and one dedicated left turn lane from Illaroo Road to Princes Highway
  - An acceleration and merge lane for northbound traffic turning into Illaroo Road from Princes Highway
- Upgrading of the Princes Highway and Bridge Road intersection to provide:
  - Two southbound right turn lanes from the Princes Highway into Bridge Road
  - One left turn lane from Bridge Road to the Princes Highway
- Local road adjustments including:
  - Closing the access between Pleasant Way and Princes Highway
  - Restricting turning movements at the intersection of Bridge Road and Scenic Drive

  - Construction of a new local road connecting Lyrebird Drive to the Princes Highway about 300 metres south of the existing Pleasant Way intersection
- Provision of pedestrian facilities at all intersections
- Dedicated off road shared paths and footpaths along the length of the proposal.
- Urban design and social amenity improvements, and landscaping including pedestrian links to the existing southbound bridge
- Relocation and/or protection of utility services
- Drainage and water quality management infrastructure along the road corridor
- Property works including acquisition, demolition, and adjustments to accesses
- Temporary ancillary facilities during construction including site offices, construction compounds, and stockpile sites.

The location of the proposal is shown in Figure 1-1. Chapter 3 describes the proposal in more detail.

1.1.1 Proposal background

The Princes Highway is the main north-south regional road 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. It connects Nowra with important commercial centres in the region, and the local towns of Bomaderry and North Nowra. 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 current crossing of the Shoalhaven River at Nowra comprises two independent bridges. The southbound bridge has two lanes while the northbound bridge has three lanes. The southbound bridge was constructed in 1880 and is historically significant as a regional landmark because of its unique iron truss design. This bridge carried two-way traffic until a concrete box girder bridge was constructed to the west of it in 1980.

The existing southbound bridge is 130 years old and requires costly maintenance due to its age. A recent condition assessment of the bridge 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. If Roads and Maritime was to address only the tasks identified in the recent assessment at once, it has been estimated a full closure of the bridge for around 12-18 months would be required. As there is no feasible alternative route, any extended closure of the southbound bridge during daily peak times would represent an unreasonable and unacceptable delay on the network.

In addition, the existing southbound bridge restricts the movement of higher mass limit (HML) heavy vehicles that have been reconfigured to carry more weight than normal, and vehicles higher than 4.6 metres. Any collision with the structure would require a prolonged closure of the bridge, presenting a risk and inconvenience to road users.

A new bridge crossing could address these issues associated with the current twin-bridge arrangement and provide an opportunity to improve conditions at this crossing.

Figure 1-1: Location of the proposal

1.1.2 Proposal location and setting

The proposal is located on the Princes Highway in Nowra NSW within the Shoalhaven local government area (LGA), about 120 kilometres south of Sydney and 40 kilometres south-west of Kiama. The bridge is proposed to be built immediately upstream of the existing northbound bridge over the Shoalhaven River.

The land to the north of the Shoalhaven River is primarily residential, with a golf course to the west of the existing bridges and a restaurant and agricultural land to the east. The land immediately to the south of the Shoalhaven River is used for tourism and recreation and includes a motel (currently closed), caravan park, sailing club, and public aquatic centre. The land to the south of the river includes the Willows Caravan Park and restaurants such as the Wharf Road Restaurant and Bar, and Thai Riverside Restaurant.

The Nowra town centre, to the south of the proposal, contains local and regional facilities and services including supermarkets, retail, financial and medical services.

There are 13 non-Aboriginal heritage items located within the proposal study area. All 13 items are listed on the Shoalhaven Local Environment Plan 2014 (LEP). One of these items, Graham Lodge, is also listed on the State Heritage Register (SHR). Another item, Nowra Bridge over the Shoalhaven River, is also listed on the Roads and Maritime Section 170 Heritage and Conservation Register (s170) as having significance at a State level for its historic value, its landmark aesthetic qualities, and its ability to contribute to research questions relating to the construction of Whipple truss bridges.

The Shoalhaven River and its tributary Bomaderry Creek are the two main waterways within the proposal area. The Shoalhaven River at Nowra is a wide, tidal river that is popular for recreational and commercial activities as well as the fishing and aquaculture industries. The Shoalhaven River is a major community resource and hosts a range of recreational activities such as kayaking, swimming, and river cruises, and also commercial activities such as fishing, charters, and hire operations. A number of inshore commercial vessels operate within the estuary itself, including houseboats, hire and drive craft, and small tinnies.

The following access points to the river are located within 400 metres of the proposal:

- Nowra Wharf - two boat ramps located on the south side of the river, east of the existing bridges on Wharf Road, used by the Nowra Sailing Club.
- Shoalhaven Rowing Club, club house and ramp at Paringa Park, on the south side of the river, west of the existing bridges
- Greys Beach - public ramps and wharves at the eastern end of Riverbank Reserve on the north side of the river, west of the existing bridges.

Greys Beach is a popular boat ramp facility, with parking for 100 vehicles and trailers. The adjacent waterway is one of the more heavily trafficked sections of the river (NSW Maritime, 2009).

Bomaderry Creek flows west to east through the project area, crossing under the Princes Highway between the Bolong Road and Illaroo Road intersections before joining the Shoalhaven River about 800 metres downstream of the existing southbound bridge.

The Shoalhaven River provides a variety of habitats including mud flats, seagrass, mangroves, and estuarine which may be used by threatened species. The river is considered to provide key fish habitat as defined by the NSW DPI Fisheries and is classified as a Type 1 highly sensitive key fish habitat and Class 1 major fish habitat in accordance with criteria outlined in the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013).

Two native vegetation communities exist in the proposal study area:

- Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion
- Northern South-East Corner Bioregion and Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South-East Corner Bioregion (containing the endangered ecological community (EEC) Swamp Paperbark-Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion).

In addition, several mixed native and exotic vegetation communities exist throughout the proposal study area.

The proposal study area occurs on Nowra Sandstone and an undifferentiated geological formation comprising medium to coarse grain quartz sandstones, minor siltstones and conglomerate beds.

The Shoalhaven landscape is associated with the river bed, banks and undulating terrace surfaces, active floodplain with levees and backwater swamps on alluvium. Levees are moderate deep prairie soils, terraces red earths and Yellow and Red Podzolic Soils. The floodplains consist of alluvial soils and Gleyed Podzolic Soils.

1.2 Purpose of the report

This review of environmental factors (REF) has been prepared by SMEC Australia Pty Ltd on behalf of Roads and Maritime. For the purpose of these works, Roads and Maritime is the proponent and a determining authority under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of the REF is to describe the proposal, to document the likely impacts of the proposal on the environment, and to detail mitigation and management measures to be implemented.

The description of the proposed work and assessment of associated environmental impacts has been undertaken in the context of clause 228 of the Environmental Planning and Assessment Regulation 2000, the factors in Is an EIS Required? Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979 (Is an EIS required? guidelines) (DUAP, 1995/1996), Roads and Related Facilities EIS Guideline (DUAP 1996), the *Biodiversity Conservation Act 2016* (BC Act), the *Fisheries Management Act 1994* (FM Act), and the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In doing so, the REF helps to fulfil the requirements of:

- Section 5.5 of the EP&A Act including that Roads and Maritime examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity
- The strategic assessment approval granted by the Federal Government under the EPBC Act in September 2015, with respect to the impacts of Roads and Maritime's road activities on nationally listed threatened species, ecological communities and migratory species.

The findings of the REF would be considered when assessing:

- Whether the proposal is likely to have a significant impact on the environment and therefore the necessity for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning under Division 5.2 of the EP&A Act

- The significance of any impact on threatened species as defined by the BC Act and/or FM Act, in Section 1.7 of the EP&A Act and therefore the requirement for a Species Impact Statement or a Biodiversity Development Assessment Report
- The significance of any impact on nationally listed biodiversity matters under the EPBC Act, including whether there is a real possibility that the activity may threaten long-term survival of these matters, and whether offsets are required and able to be secured
- The potential for the proposal to significantly impact any other matters of national environmental significance or Commonwealth land and the need, subject to the EPBC Act strategic assessment approval, to make a referral to the Australian Government Department of the Environment and Energy for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.

2. Need and options considered

2.1 Strategic need for the proposal

2.1.1 NSW State Priorities

NSW State Priorities: Making it Happen (State Priorities) replaces NSW 2021: A plan to make NSW Number One. It sets out 12 Premier's priorities and 18 state priorities, which include improving road travel reliability (Building Infrastructure) and reducing road fatalities (Safer Communities).

The proposal is relevant to the state priority of 'Building Infrastructure' to address increasing demand on infrastructure with 30 per cent more car trips over the next 15 years and creating liveable communities where the need for smart, connected and resilient infrastructure has been identified.

The proposal would contribute to improving travels times within the Nowra region, improve safety for pedestrians, cyclists and motorists, provide for the safe maintenance of the existing southbound bridge, improve local connectivity and improve through traffic efficiency.

2.1.2 State infrastructure Strategy

First things first – the State Infrastructure Strategy (Infrastructure NSW, 2012) was the NSW Government's 20-year strategy to set out infrastructure projects and initiatives priorities. It identified strategies and new commitments for transport, water, energy, health and social infrastructure. The strategy recognised that transport links, particularly the road network in regional areas such as the section of the proposal, provide important economic connections through facilitating employment and the movement of goods and services.

The State Infrastructure Strategy Update 2014 (Infrastructure NSW, 2014), was prepared by Infrastructure NSW at the direction of the Premier to guide how proceeds from the Rebuilding NSW initiative could be spent. The 2014 Update made recommendations for the next round of critical infrastructure for NSW.

The NSW State Infrastructure Strategy 2018–2038: Building Momentum (Infrastructure NSW, 2018) is the latest iteration of the strategy and builds on the NSW Government's major long-term infrastructure plans over the last seven years. The strategy sets out the government's priorities through to 2038, and combined with the Future Transport Strategy 2056, the Greater Sydney Region Plan and the Regional Development Framework, brings together infrastructure investment and land-use planning for NSW's cities and regions.

The proposal is consistent with two of the three Regional Development Programs identified in the Regional Development Framework, in providing quality infrastructure regional NSW, and supporting growth in regional centres. The proposal would facilitate improvement of regional freight routes by eliminating the weight and height limitations imposed on heavy vehicles by the existing southbound bridge.

2.1.3 NSW Future Transport Strategy 2056

The Future Transport Strategy 2056 (Transport for NSW, March 2018) (Future Transport) is an update of the NSW Long Term Transport Master Plan (Transport for NSW, 2012a) (Transport

Master Plan). Future Transport sets the 40 year vision, directions and outcomes framework for customer mobility in NSW, which will guide transport investment over the longer term.

Future Transport is delivered through the Services and Infrastructure Plans and supporting plans including:

- Greater Sydney Services and Infrastructure Plan
- Regional NSW Services and Infrastructure Plan
- NSW Draft Freight and Ports Plan (as detailed in Section 2.1.5.)
- Road Safety Plan 2021
- Draft Tourism and Transport Plan.

An aim of the strategy is to improve safety and performance where customers are provided with efficient, safe and secure travel. The proposal would reduce crash rates and queuing on the Princes Highway between Bolong Road and Bridge Road, reduce delays, and enable the safe and efficient maintenance activities on the existing southbound bridge without causing extended delays to the road network. The proposal would improve freight movements and access to the South Coast of NSW through the provision for overheight vehicles and HML vehicles on the Princes Highway across the Shoalhaven River.

The proposal also aligns with the sustainability outcomes of the strategy in its retention of the existing southbound bridge and improving pedestrian and cycle connectivity and access to the foreshore.

2.1.4 NSW Freight and Ports Strategy

The NSW Freight and Ports Strategy (TfNSW 2013) details how the NSW Government will provide an efficient network and a framework for managing growth. It highlights a range of tasks that will improve freight movement on the network.

The proposal contributes to the delivery of a freight network which efficiently supports the projected growth of the NSW economy by removing the current restriction to HML vehicles and heavy vehicles over 4.6 m high on the existing southbound bridge. This would allow heavy vehicles to use the Princes Highway to transport freight across the Shoalhaven River.

2.1.5 Draft NSW Freight and Ports Plan

The draft NSW Freight and Ports Plan (NSW Government, 2017a) supports Transport for NSW's Future Transport 2056 Strategy and provides direction to business and industry for managing and investing in freight into the future.

The freight industry plays a vital role in the movement of $200 billion a year in goods across the state. Increased demands for Australian exports internationally, combined with the economic boom in NSW, means that freight volumes are forecasted to double in the Greater Sydney area in the next 40 years and grow by a quarter in regional NSW.

The proposal aligns with the priority action areas under the plan by providing southbound access for overheight vehicles and HML vehicles on the Princes Highway across the Shoalhaven River. The removal of the freight vehicle restrictions would result in improved freight movements and access to the South Coast of NSW.

2.1.6 Princes Highway Corridor Strategy

The Princes Highway Corridor Strategy (NSW Government 2016) outlines the vision for the Princes Highway between Yallah, near Port Kembla and the Victorian border over 20 years. The corridor extends for 422 kilometres and passes through five local government areas.

The proposal would meet the following objectives in the strategy:

- Provide freight access for Performance Based Standards (PBS) class 2(B) vehicles south to BTU Road in South Nowra, and to allow PBS class 2(A) vehicles on the reminder of the corridor
- Manage through and local traffic issues for major urban centres along the corridor, particularly at Nowra
- Recognise the corridor as having national importance linking Port Kembla to Jervis Bay by providing improved access for HML vehicles
- Support public transport connectivity between the Lower Illawarra and the South Coast by improving traffic flow through Nowra
- Manage the road network so that it provides for reliable travel during peak traffic periods (including holiday peak periods) and road incidents, particularly through the urban centres of Nowra
- Balance the demand of local and through traffic with urban amenity in high pedestrian and vehicle conflict areas at Nowra
- Improve pedestrian facilities in Nowra on the Princes Highway.

The proposal aligns with the visions of the strategy by:

- Removal of the constraints for overheight and higher mass limit vehicles
- Provision of four northbound and three southbound lanes and at grade intersection upgrades of Bolong Road and Illaroo Road
- Reducing delays and queuing on the Princes Highway between Bolong Road and Bridge Road
- Improving highway travel time and reducing network delay
- Improving safety and reducing the risk of crashes on the Princes Highway in Nowra by reducing traffic queuing and increasing traffic lane width on the southbound bridge crossing
- Decommissioning the existing southbound bridge for use by vehicle traffic to allow maintenance work to be carried out under safer conditions and without traffic disruptions.
- The proposal is consistent with the above vision of the strategy by improving road safety and enhancing traffic efficiency (including for freight) on the Princes Highway.

2.1.7 Illawarra Regional Transport Plan

The Illawarra Regional Transport Plan (TfNSW 2016) builds upon the priorities of the NSW Long Term Master Plan within the region. It takes the direction from the Master Plan and provides more detail for the issues specific to the region.

The proposal is consistent with the following actions:

- Continue investment in the Illawarra road network
- Improve road safety by reducing delays and queuing on the Princes Highway between Bolong Road and Bridge Road
- Reduce crash rates on the Princes Highway between Bolong Road and Bridge Road

- Support future traffic growth on the Princes Highway associated with planned land use in the Nowra Bomaderry area
- Provide southbound access for overheight and HML vehicles on the Princes Highway across the Shoalhaven River
- Enable safe and efficient maintenance activities on the Shoalhaven River crossings without causing extended delays to the road network.

2.1.8 Illawarra-Shoalhaven Regional Plan

The Illawarra – Shoalhaven Regional Plan (NSW Government 2015) provides the strategic policy, planning and decision-making framework to guide the region to sustainable growth over the next 20 years. The Plan aligns the regional economic outcomes to infrastructure investments, so that State funding is aligned with priorities and opportunities that support regional growth. Growth in the area is expected to increase from 60,400 in 2016 to 463,150 by 2036, leading to the need of about 35,400 new homes. This would increase traffic and congestion in the region.

The Plan has a balance between improving access to jobs, services and transport in existing urban areas, and designing new urban areas to support sustainability and healthy communities. One of the key principles of the plan is to improve infrastructure coordination. The infrastructure context in this Regional Plan is drawn from the NSW State Infrastructure Strategy, NSW Long Term Transport Master Plan, Illawarra Regional Transport Plan, and NSW Freight and Ports Strategy. The Plan states that the NSW Government would continue to work with infrastructure providers to coordinate delivery of infrastructure, such as the proposal, that meets community needs.

The proposal is consistent with the Plan as it would support improved connectivity and contribute to reducing congestion in the Nowra Bomaderry area.

2.1.9 Nowra Bomaderry Structure Plan

The Nowra Bomaderry Structure Plan (Shoalhaven City Council 2008) examines the transport infrastructure in Nowra Bomaderry and identifies opportunities for improvements on the Princes Highway and existing bridges in terms of traffic and transport. The Princes Highway is the single north-south road linking these urban areas. Congestion on the existing bridge over the Shoalhaven River has led to it being described as the ‘Achilles heel’ of the of the Nowra Bomaderry road network.

The proposal supports the objectives of the plan through:

- Providing for improved efficiency, and the safe and convenient movement of people and goods through the local road network, particularly along the Princes Highway crossing the Shoalhaven River
- Improving pedestrian and cyclist routes with good connectivity to the local and main road network
- Ensuring that the amenity of surrounding living areas is not unacceptably affected by the operation of urban infrastructure, particularly in terms of noise and visual impact
- Meeting future traffic demands and reducing congestion by providing additional lane capacity across the Shoalhaven River.

The Structure Plan notes that to address congestion, it is likely that three additional Shoalhaven River crossings may be required by 2036. The proposal is consistent with this vision by providing additional lane capacity across the Shoalhaven River for future traffic demands.

2.1.10 Shoalhaven River Estuary Management Plan

The Shoalhaven River Estuary Management Plan (Shoalhaven City Council 2008) recommends a program of strategic actions for the sustainable management of the estuary. The Estuary Management Plan provides a strategy for local implementation of the standards and targets established by the NSW Natural Resources Commission and subregional targets established in the Southern Rivers Catchment Action Plan.

The main objective is 'to manage the estuary to best maintain the overall value of the system (taking into account natural, social, cultural and economic values), but to also recognise the special character of local areas, (e.g. for conservation, or recreation or aquaculture), to ensure the correct balance of values for sustainability at the local level'. The design of the proposal is consistent with the objectives of the plan.

The plan notes that the existing southbound bridge is listed on the Australian Heritage Database. Impacts as a result of development on significant cultural heritage places is listed as an unacceptable risk in the Plan and one of the objectives of the plan is 'to protect significant heritage features and landscapes'. The proposal ensures that this objective is met by retaining the historic bridge and providing an urban design that fits in with the landscape.

2.2 Existing infrastructure

2.2.1 Princes Highway

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 south of 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 Fridays and during holiday periods.

The proposal is located on the Princes Highway around 120 kilometres south of Sydney and 40 kilometres south-west of Kiama. The existing river crossings are key components of the regional and local transport network, being the only road linking urban centres on the either side of the Shoalhaven River. More specifically, they provide a critical link for the residents of Bomaderry and North Nowra to access the commercial centre of Nowra. Shoalhaven City Council's strategic planning typically refers to 'Nowra Bomaderry' as one cohesive settlement.

The Princes Highway has a posted speed limit of 70 km/h through the proposal study area. The highway generally provides a four lane median divided highway with two traffic lanes in each direction with additional lanes for turning at intersections. The lanes are typically 3.5 metres wide with a median width of two metres. The Princes Highway is drained by an existing pit and pipe network generally discharging directly to the Shoalhaven River when within 250 metres of the waterway.

The Shoalhaven River crossing has two separate bridges about 340 metres in length. The existing southbound bridge provides two traffic lanes, each about 2.9 metres wide. The existing northbound bridge provides two traffic lanes and a left turn lane only to Illaroo Road, each about 3.0 metres wide. Restrictions apply to the existing southbound bridge for overheight and HML heavy vehicles.

This section of the highway experiences seasonal traffic fluctuations and the network performance is poor. Traffic modelling has indicated that the existing arrangement would reach capacity by 2026. The existing traffic and transport environment are discussed in more detail in Section 6.1.

The Princes Highway corridor is connected to the local road network at three signalised intersections at Bolong Road, Illaroo Road and Bridge Road/Pleasant Way.

Princes Highway / Bolong Road intersection

This is a signalised T-intersection located about 300 metres north of the Shoalhaven River. Bolong Road is classified as a regional road, and is the main route to Shoalhaven Heads. It provides an alternative route (known locally as the 'Sandtrack') to the Princes Highway for light vehicles (vehicles less than 4.5 tonnes) to towns north of Nowra including Gerroa and Gerringong. Bolong Road is used by bus services and also provides heavy vehicle access (including for B-Doubles) to the Bomaderry industrial area.

The intersection currently provides for the following vehicle movements:

- Two left turn lanes from Bolong Road to the Princes Highway
- One right turn lane from Bolong Road to the Princes Highway, connecting to a short merge lane on the northbound carriageway
- One left turn via a slip lane to Bolong Road from the Princes Highway southbound
- Two right turn lanes to Bolong Road from the Princes Highway northbound
- Two through lanes on both carriageways on the Princes Highway.

Princes Highway / Illaroo Road intersection

This is a signalised T-intersection located about 50 metres north of the Shoalhaven River. Illaroo Road has two lanes in both directions, and provides a key link between the Princes Highway and the suburbs of North Nowra and Bangalee located north of the Shoalhaven River. Local bus services run along this road.

The intersection currently provides for the following vehicle movements:

- One left turn lane from Illaroo Road to the Princes Highway, shared with a right turn lane
- Two right turn lanes (one shared) from Illaroo Road to the Princes Highway
- One right turn to Illaroo Road from the Princes Highway southbound
- Dedicated left turn lane from the Princes Highway northbound to Illaroo Road
- Two through lanes on both carriageways on the Princes Highway.

Princes Highway / Bridge Road / Pleasant Way intersection

This is a signalised intersection located around 150 metres south of the Shoalhaven River. Bridge Road is the primary point of access for traffic travelling between the Nowra town centre and the northern side of the Shoalhaven River. It provides access to Shoalhaven Entertainment and Visitors Centre, Nowra town centre and emergency vehicle access to Shoalhaven District Memorial Hospital.

Pleasant Way is a local road that provides access to the Shoalhaven River foreshore, accommodation and residences east of the Princes Highway.

The intersection currently provides for the following vehicle movements:

- Left turn from the Princes Highway to Pleasant Way via a short slip lane
- Left turn from Pleasant Way to the Princes Highway southbound
- Two right turn lanes from the Princes Highway southbound to Bridge Road, with two lanes continuing along Bridge Road to Hyam Street

- Two through lanes on the Princes Highway southbound
- Left turn to Bridge Road from the Princes Highway northbound via a slip lane
- Left turn from Bridge Road to Princes Highway; this lane continues across the existing northbound bridge and becomes the dedicated left turn lane to Illaroo Road.

Bomaderry Creek bridge

The Bomaderry Creek bridge is located on the Princes Highway between Illaroo Road and Bolong Road. The bridge comprises two independent bridges that are about 48 metres in length. The bridge carries six lanes of traffic and has a pedestrian footpath along each edge of the bridge. The bridge superstructure consists of three spans supported by end abutments and concrete piers. The existing bridge does not meet current design standards; this would be addressed in the design for the widened bridge.

Local roads

The following local roads are located in the proposal study area:

- Illaroo Road
- Bridge Road
- Scenic Drive
- Pleasant Way
- Hawthorn Avenue
- Lyrebird Drive
- Wharf Road
- Moss Street
- Fairway Drive.

Further details relating to the individual roads are provided in Section 6.1.2.

2.2.2 Shoalhaven River crossing

The Shoalhaven River crossing comprises two independent bridges. The existing southbound bridge has two lanes and is a constraint to overheight and HML vehicles. The existing northbound bridge has three lanes with one lane being a dedicated left turn lane between Bridge Road and Illaroo Road. There is a gap of about seven metres between the two bridges.

Traffic modelling has shown that during peak periods the Shoalhaven River crossing is operating at or close to capacity. Traffic counts taken in December 2017 identified 51,300 vehicles using the crossing on weekdays. The modelling has also forecast traffic to grow at an average rate of 1.7 per cent annually based on 2014 traffic volumes.

Existing southbound bridge

The existing southbound bridge is an iron truss bridge built between 1879 and 1880, and was opened to traffic in August 1881. It is described as a ‘Whipple pin-jointed truss’ and is the only bridge of this design still in use in NSW.

The southbound bridge is listed as having State significance on the Roads and Maritime Section 170 Heritage and Conservation Register. The listing states the bridge has significance because:

- It is the only American pin-jointed Whipple truss in service in NSW

- It has been an important item of infrastructure in the history of NSW for over 130 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 NSW
- It is associated with the famous American civil engineer and specialist bridge designer, C Shaler Smith.

The bridge is an important feature of Nowra and the local community identified strongly with the bridge through its design, character and historical significance.

The bridge has an overall length of 341 metres, consisting of eight wrought iron trusses, with a northern end truss span of 56 metres and seven truss spans of 38.5 metres. The bridge is 5.8 metres wide between kerbs with a 1.3 metre wide footpath attached to the eastern side. Stormwater drains from the bridge deck directly into the Shoalhaven River. Eight piers support the bridge structure.

During the AM peak period, the bridge carries up to 2400 vehicles per hour, which equates to 1200 vehicles per lane. Relevant Austroads guidelines note that the capacity of roads in urban environments is generally between 1100-1200 vehicles per lane, which confirms the existing southbound bridge currently operates at capacity during peak hours.

The bridge is configured for two lanes of traffic however, due to the truss structure, vehicles over 4.6 metres high and HML vehicles cannot use it. To travel south these vehicles use the northbound bridge under a police escort. This occurs about once a week, which impacts traffic and has resourcing implications for the local police. Vehicles between 4.3 metres and 4.6 metres high are restricted to movements within the centre of the bridge to avoid hitting the truss structure and occupy both lanes.

Oversize vehicles also present a high risk of damage to the iron truss structure from potential collisions. These could potentially require the bridge to be closed to all traffic for an extended period until repaired. A major collision last happened in 1997 resulting in the bridge being closed to all heavy vehicles and reduced to one lane for five months (AECOM, 2014).

The bridge requires regular maintenance with a large number of tasks required in the short to medium term to allow continued safe operation. Maintenance activities completed from the river do not affect traffic, however maintenance activities on the bridge deck cannot be undertaken while the bridge is open to traffic. During these activities, the bridge would need to be closed to traffic for an extended period of time in order to complete this work with southbound traffic diverted to the existing northbound bridge. This contraflow arrangement would result in extensive delays during the AM and PM peak periods.

Some maintenance may be carried out at night as traffic volumes drop to less than a quarter of the daily peak volumes, and it is reasonable to close the southbound bridge for limited night shift hours. However, some of the larger and more complex works identified in the asset assessment would not be able to carried out under nightshift conditions due to time restrictions.

In general, the ongoing maintenance ‘whole of life’ costs are higher for an aging iron truss bridge structure compared to a modern cost effective structure. If Roads and Maritime was to address only the works identified in the recent assessment, it has been estimated a full closure of the bridge for around 12-18 months would be required (AECOM, 2014). There is no feasible alternative route (the nearest is the Hume Highway) and this would represent an unreasonable and unacceptable delay on the Princes Highway.

In addition to the maintenance works described above, major refurbishment would be required on the bridge to accommodate future traffic projections.

Existing northbound bridge

The existing northbound bridge is a concrete box girder bridge built in 1980 to relieve the congestion on the existing southbound bridge. The bridge has an overall length of 360 metres, consisting of 10 spans supported on nine piers. Spans 2-8 are each 38.5 metres in length; span 1 (at the northern abutment) is 32.9 metres in length, and spans 9 and 10 have lengths of 31.5 metres and 25.9 metres respectively. The bridge is 9.2 metres wide between kerbs with a 1.8 metre wide shared path on the western side. Stormwater drains through scuppers in the bridge deck directly into the Shoalhaven River.

The bridge is configured for three lanes of northbound traffic with one lane being a dedicated left turn lane between Bridge Road and Illaroo Road. The bridge carries about 2400 vehicles during the PM peak hour, equivalent to 800 vehicles per lane. This is less than the 1100-1200 vehicles per lane capacity specified in relevant Austroads guidelines.

2.3 Proposal objectives and development criteria

2.3.1 Proposal objectives

The primary objectives of the proposal include:

- Reduce crash rates on the Princes Highway between Bolong Road and Bridge Road
- Support future traffic growth accessing the Princes Highway associated with planned land use in the Nowra Bomaderry area
- Provide southbound access for overheight vehicles and HML vehicles on the Princes Highway across the Shoalhaven River
- Reduce delays and queuing on the Princes Highway between Bolong Road and Bridge Road
- Enable safe and efficient maintenance activities on the Shoalhaven River crossings without causing extended delays to the road network.

Roads and Maritime has also worked to achieve high quality proposal outcomes across customer service, time management, budget, environmental and work health and safety. These factors are fundamental to enable the design development, options evaluation and option selection for the proposal, and are reflected and described in Table 2-1.

Table 2-1: Secondary proposal objectives

Secondary proposal objectives	Description
Provide the best benefit to our customers	Nowra Bridge serves a wide variety of customers with a diverse set of requirements. The proposal is to investigate these requirements and identify a preferred option which provides the best balance and overall benefit to our customers, the community and stakeholders.
Delivering the proposal within an acceptable timeframe	To provide a proposal that can be completed within a short term timeframe.

Secondary proposal objectives	Description
Delivering the proposal within budget	To deliver a sustainable and innovative solution which achieves the proposal objectives and presents good value for money.
Prioritising the safety of our workers and our customers	The safety of our people and our customers is to be a priority during the planning, construction and operational phases.
Minimise environmental impact	To identify a proposal that best balances the overall environmental impact.
Deliver a proposal which fits sensitively with the built, natural and community environment	The existing southbound bridge is an important landmark within the local and regional context of Nowra and the south coast of NSW. Options were identified and developed appreciating its heritage significance and its role as the original bridge crossing of the Shoalhaven River.

2.3.2 Development criteria

The development criteria for the proposal comprise the following:

- Improve safety for pedestrians, cyclists and motorists
- Provide for safe maintenance of the existing southbound bridge
- Improve local connectivity
- Improve through traffic efficiency
- Provide for safe construction while minimising impact on traffic movement
- Minimise impact on major public utilities
- 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 on river users
- Minimise impacts on biodiversity
- Minimise impact on Aboriginal heritage
- Minimise impact on non-Aboriginal heritage
- Ease of managing flooding implications on the bridges and approaches
- Effective management of operational noise impacts.

2.3.3 Urban design objectives

Urban design objectives for the proposal include:

- 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
- Respecting the integrity of the heritage-listed existing southbound bridge
- 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.

2.4 Alternatives and options considered

This section details the development of strategic alternatives and options, and the process undertaken for selection of the preferred option.

2.4.1 Methodology for selection of preferred option

Alternatives and options for the Nowra Bridge proposal were considered in a multi staged identification and assessment process.

Stage 1 – Identification of strategic alternatives

As a precursor to identifying potential strategic alternatives for a new river crossing, a preliminary data review was carried out. This included a review of:

- Existing technical reports including traffic studies
- Early environmental and geotechnical investigations
- Examining the findings of community consultation carried out.

A full list of the documents reviewed is provided in Appendix A to the *Nowra Bridge Project Site Options Development Report* (Roads and Maritime, 2014).

Further discussion on the strategic alternatives identification process is given in Section 2.4.2.

Stage 2 – Analysis of strategic alternatives

The seven strategic alternatives were assessed against a list of criteria expressed as a series of questions to rule out any alternatives that were not feasible for engineering or environmental reasons.

Five strategic alternatives were considered suitable for further development and were carried forward to Stage 3 as route options.

Further discussion on the analysis and selection of strategic alternatives is provided in Section 2.4.3.

Stage 3 – Identified route options

From the evaluation of strategic alternatives, five route options for a new bridge crossing were defined for a detailed options assessment.

Further discussion on the identified route options is provided in Section 2.4.4.

Stage 4 – Preferred route option selection

The assessment of the five route options was informed by other activities. These activities included:

- Preparation of a preliminary environmental investigation (PEI) to identify potential opportunities and environmental constraints
- Additional traffic investigations were undertaken to determine the capacity and efficiency of the existing network, and each of the five potential route options
- A preliminary landscape character and visual impact assessment, drawing upon work carried out previously by Council in developing the Shoalhaven River Estuary Management Plan (Shoalhaven City Council, 2008)
- The development of preliminary concept designs, strategic costs estimates for the five route options, and the early identification of construction issues.

This stage of the options evaluation process involved a Value Management workshop that brought together technical experts and key project stakeholders to consider the information that had been gathered through Stages 1 to 3 and using a structured evaluation process, recommend a preferred route.

The evaluation process involved:

- Developing a common understanding by all participants of the work undertaken to date on the Nowra Bridge Project
- Reviewing the five route options
- Evaluating of each route option against assessment criteria developed by the workshop participants
- Recommending a preferred route option(s) to progress the project.

After the workshop, Roads and Maritime engaged further with the community to discuss the outcomes of the workshop and to seek feedback on the recommended option.

The five route options were then subject to a further critical evaluation drawing on the outputs of the additional technical studies, the outcomes of the value management workshop, and feedback obtained through the community and stakeholder consultation process, with particular emphasis placed on testing the robustness of the recommended option.

Further discussion on the selection of the preferred route option is provided in Section 2.4.5.

Stage 5 – Intersection and network options development

During the initial stages of the project, three main issues were identified with the existing river crossings, one of these being capacity issues due to high traffic volumes during peak times. This triggered further investigations including traffic modelling and site observations of intersection performance to better understand the network performance. These studies identified a large number of potential intersection options to the north and south of the existing bridge crossings, including a number of different configurations of intersection options.

A series of workshops were held between late 2014 and 2015 to consider the intersection options identified by Roads and Maritime and select those suitable for further assessment. An options workshop held on 25 August 2015 confirmed a total of 19 different intersection options, resulting in up to 39 possible network configurations. Specific network capacity requirements, such as the number of lanes required, were not considered at this stage.

Further traffic modelling was then carried out to assess the performance of these intersection options. This work identified that similar intersection options resulted in comparable improvements to intersection performance. The traffic modelling also identified that certain combinations of intersection options on the northern and southern sides were incompatible, as they introduced weave, merge and queuing issues that are inefficient, unsafe and do not presently exist in the network.

Further discussion on the identification and development of intersection and network options is provided in Section 2.4.6.

Stage 6 – Preferred intersection and network option selection

A shortlist of six network options was developed from the identified intersection options. Prior to the assessment of the six network options, selection criteria were developed. These included traffic efficiency performance (drawing on traffic modelling carried out for each option) and environmental impacts. A workshop was held on 20 November 2015 to carry out a multi-criteria assessment to evaluate the six network options and select a preferred network option.

Further discussion on selection of the preferred intersection and network option is provided in Section 2.4.7.

Stage 7 – Analysis and confirmation of the preferred network option

Once the preferred network option was identified a series of further investigations were undertaken to test the feasibility of the option. This included:

- Assessing potential design and constructability issues
- Sensitivity testing of the traffic modelling that had been previously completed by challenging a number of its assumptions.

Further discussion on analysis and confirmation of the preferred option is provided in Section 2.4.8.

Stage 8 – Future of the existing southbound bridge

After the announcement of the preferred location for a new bridge in 2014, the future of the existing southbound bridge was subject to extensive investigation. This was completed in parallel with Stages 5 to 7. A number of options to retain or demolish the bridge were considered.

Assessment and evaluation of options involved multiple reviews by internal and independent external experts considering:

- The heritage significance of the bridge, and Roads and Maritime Services' obligations under the *Heritage Act 1977*
- Expectations of the community and stakeholders
- Anticipated maintenance activities and costs necessary to retain the bridge in its current location
- Estimated costs associated with any demolition or relocation works.

Further discussion on the development and assessment of options for the future use of the existing southbound bridge is provided in Sections 2.4.9 and 2.4.10.

2.4.2 Identified strategic alternatives

Roads and Maritime reviewed preliminary data to inform the identification of strategic alternatives. During the review it was identified that any alternatives that were considered would need to address traffic and transport efficiency on the Princes Highway.

Key documentation reviewed included:

- Additional Shoalhaven River Crossing, Nambaa Island to Bangalee (SMEC Australia, 2004)
- Princes Highway Shoalhaven River Crossing Interchange Study (SMEC Australia, 2005)
- Nowra Bomaderry Structure Plan (Shoalhaven City Council, 2006)
- Drawings and design information from the existing concrete box girder bridge built in 1980.
- Draft Nowra CBD Master Plan Strategic Direction (2011)
- Shoalhaven Riverfront Gateway Masterplan Study Report (2010)
- South Coast Transport Study (2000)
- Nowra CBD Transport Strategy (2003).

Environmental and geotechnical investigations focused on a desktop analysis and a review of existing literature across broad study areas. The findings were used to identify environmental constraints within the study area. The review identified that more targeted investigations would be needed for all alternatives around the existing river crossings.

Community consultation commenced in 2013 and involved conversations with the community including the need for the project and potential new river crossings. There was a strong response from the community that Roads and Maritime further investigate a bypass and consider alternatives that could cater for rail.

A wide range of strategic alternatives were identified during the preliminary data review and are described below.

Do minimum- maintenance of the existing southbound bridge

The ‘do minimum’ alternative would include retention of the existing southbound bridge at its current location and the required level of maintenance undertaken to ensure it remained in a serviceable state. This alternative would not increase the number of lanes on the Princes Highway or include improvements to the intersections either side of the bridge.

Demolition and replacement of the existing southbound bridge

This alternative would include the demolition of the existing southbound bridge and rebuilding a new bridge on the same alignment.

A new bridge next to the existing bridges

This alternative would include construction of a new bridge crossing over the Shoalhaven River in the vicinity of the existing bridge crossings and considers alternatives to the west (upstream) and east (downstream).

A bypass of Nowra

This alternative would include construction of a new bridge as part of a bypass of the Bomaderry and Nowra townships including bypassing the existing bridge crossings of the Shoalhaven River. Alternatives to the east and west of the townships were considered identified for further analysis.

Provision for future rail

This alternative would involve constructing a new bridge east (downstream) of the existing southbound bridge that could potentially allow for a future rail extension across the Shoalhaven River.

A 'double deck' bridge

The double deck bridge alternative considers two sub alternatives. The first is construction of a new double deck bridge to east and reserving one deck for vehicular traffic and the other for a future rail extension across the Shoalhaven River. The second sub alternative is construction of an additional deck to one of the existing bridges.

A tunnel

This alternative would involve constructing a bored or immersed tube tunned under the Shoalhaven River instead of a new bridge. The tunnel would be located far enough away so it would not impact on the piles and footings of the existing bridge crossings.

2.4.3 Analysis of strategic alternatives

Evaluation of the seven strategic alternatives was undertaken to rule out any alternatives that were not feasible for engineering or environmental reasons. A list of criteria, expressed as a series of questions were developed to assess the strategic alternatives. These included:

- Does the alternative meet the primary proposal objectives?
- Is the alterative feasible in terms of engineering design and constructability?
- Is the alternative feasible in terms of traffic performance?
- Does the alternative demonstrate that it can minimise environmental impact?

If an alternative failed on any of the above criteria, it was discarded unless there was a notable reason to keep it on the shortlist. Alternatives were considered to fail against the criteria if the impacts were considered to be unacceptable or the impacts could not be minimised, either through design refinement or mitigation measures, to an acceptable level.

The assessment process was completed using the descriptors given in Table 2-2.

Table 2-2: Strategic alternative assessment descriptors

Key	Description
✓	Alternative cannot be eliminated as impacts are either considered likely to be acceptable; or could potentially be reduced to acceptable levels through design refinements
Δ	Alternative is considered to require significant design refinements to eliminate or reduce impacts to an acceptable level but cannot be eliminated at this stage
×	Alternative fails against criterion and should be eliminated.

Assessment of the strategic alternatives against the above criteria is described below.

Do minimum – maintenance of the existing southbound bridge

The assessment of the do minimum alternative is given in Table 2-3.

Table 2-3: Assessment of do minimum alternative

Shortlisting criterion	Outcome
Does the alternative meet the primary proposal objectives?	✗
Is the alternative feasible in terms of engineering design and constructability?	✓
Is the alternative feasible in terms of traffic performance?	✗
Does the alternative demonstrate that it can minimise environmental impacts?	✓

It was noted during the assessment that:

- Proposal objectives – the alternative would not meet any of the proposal objectives
- Worker and road user safety – previous work carried out on the existing southbound bridge during temporary full and partial closures had identified unacceptable safety risks for workers and road users was no longer considered appropriate
- Traffic efficiency – Maintenance activities on the existing southbound bridge would require the closure of the bridge and the temporary diversion of traffic onto the existing three lane northbound bridge, resulting in unacceptable congestion during normal week day peak periods.

The do minimum alternative was not considered for further assessment based on the above assessment.

Demolition and replacement of the existing southbound bridge

The assessment of the demolition and replacement of the existing southbound bridge on its current alignment is given in Table 2-4.

Table 2-4: Assessment of demolition and replacement alternative

Shortlisting criterion	Outcome
Does the alternative meet the primary proposal objectives?	✓
Is the alternative feasible in terms of engineering design and constructability?	Δ
Is the alternative feasible in terms of traffic performance?	Δ
Does the alternative demonstrate that it can minimise environmental impacts?	Δ

It was noted during the assessment that:

- Proposal objectives – a new bridge would meet all the proposal objectives once completed
- Engineering feasibility – placing a new bridge along the existing alignment increases the complexity of the design and construction due to the location of the existing bridge foundations in the river
- Traffic efficiency – work to demolish the existing southbound bridge and construct a new bridge would require the temporary diversion of traffic onto the existing three lane northbound bridge, for about five years during demolition and construction, however the new bridge would provide opportunities to increase traffic capacity once construction was completed

- Environmental impacts – the alternative would reduce the potential environmental and property impacts on the approaches to the existing bridges however there would be heritage impacts due to the removal of the existing southbound bridge.

The demolition and replacement of the existing southbound bridge on its current alignment was retained for further development and assessment as Option C.

A new bridge next to the existing bridges

The assessment of the alternative to build a new bridge next to the existing crossings is given in Table 2-5. The assessment considered alternatives immediately to the west (upstream) and east (downstream).

Table 2-5: Assessment of new bridge next to the existing bridges alternative

Shortlisting criterion	Outcome
Does the alternative meet the primary proposal objectives?	✓
Is the alternative feasible in terms of engineering design and constructability?	✓
Is the alternative feasible in terms of traffic performance?	✓
Does the alternative demonstrate that it can minimise environmental impacts?	Δ

It was noted during the assessment that:

- Traffic efficiency – historical traffic studies reviewed during Stage 1 identified that the greater the distance a new bridge was from the existing Princes Highway, the less traffic it would attract. Options close to the existing crossings also provide greater opportunities to upgrade the intersections on the existing bridge approaches
- Environmental impacts – the alternative to the east was considered to have a slightly higher environmental impact due to its impact to views from the existing southbound bridge and potential to impact non-Aboriginal heritage on the northern and southern approach.

Both the western and eastern alternatives were retained for further development and became route Option B to the west (upstream), and route Option D to the east (downstream) respectively.

A bypass of Nowra

The assessment of bypass alternatives to the east and west is given in Table 2-6.

Table 2-6: Assessment of bypass alternatives

Shortlisting criterion	West	East
Does the alternative meet the primary proposal objectives?	Δ	Δ
Is the alternative feasible in terms of engineering design and constructability?	✓	×
Is the alternative feasible in terms of traffic performance?	✓	✓

Shortlisting criterion	West	East
Does the alternative demonstrate that it can minimise environmental impacts?	✓	Δ

It was noted during the assessment that:

- Proposal objectives – the bypass alternatives would meet most of the proposal objectives but would not reduce delays and queuing between Bolong Road and Bridge Roads, particularly if the existing southbound bridge reached the end of its useful life and was decommissioned
- Community alternatives - a range of bypass routes were suggested by the community and other stakeholders, including one main option to the west of the existing crossings identified in the Shoalhaven LEP, and numerous other options to the east of the existing crossings from Pig Island to as far east as Shoalhaven Heads
- Land use and planning - at the time of consideration no corridor for a possible eastern bypass of Nowra Bomaderry had been identified. The western bypass option was identified in the Shoalhaven LEP at the time of the assessment and was considered to be consistent with the long term land use plans of Shoalhaven City Council
- Traffic efficiency – historical traffic studies reviewed in Stage 1 identified that the majority of traffic crossing the Shoalhaven River includes an origin, destination, or both within the Nowra Bomaderry area and would not divert to a bypass
- Engineering feasibility (east) – Bypass alternatives to the east were considered unfeasible due to considerably longer bridge length required to cross the Shoalhaven River and flood plain. Any impediment to flood waters was considered likely to have adverse hydrological impacts to surrounding properties
- Engineering feasibility (west) – a bypass to the west is likely to have more favourable geotechnical conditions than the eastern alternatives
- Environmental impacts – Bypass alternatives to the east or west were considered to have the potential for high environmental impacts due to the greenfields nature of construction and socio-economic implications of bypasses.

The eastern bypass option was not considered for further development based on the above assessment. The western bypass alternative was retained for further development and assessment as Option A.

Provision for future rail

The assessment of the eastern rail alternative is given in Table 2-7.

Table 2-7: Assessment of the eastern rail alternative

Shortlisting criterion	Outcome
Does the alternative meet the primary proposal objectives?	Δ
Is the alternative feasible in terms of engineering design and constructability?	Δ
Is the alternative feasible in terms of traffic performance?	✓
Does the alternative demonstrate that it can minimise environmental impacts?	Δ

It was noted during the assessment that:

- Proposal objectives – the alternative would meet most of the proposal objectives but would not necessarily reduce delays and queuing between Bolong Road and Bridge Roads
- Engineering feasibility –a multi modal bridge would significantly increase the complexity of the design and construction of the new bridge and approaches
- Community alternatives - there was considerable community interest in an option that could cater for a future rail extension of the South Coast Rail line across the Shoalhaven River into Nowra and potentially further down the south coast
- Value for money – the alternative presents potential cost benefits by coordinating multi modal transport needs into a single piece of infrastructure that would offset additional construction costs.

The future rail alternative was retained for further development and assessment as Option E.

A tunnel

The assessment of the tunnel alternative is given in Table 2-8.

Table 2-8: Assessment of the tunnel alternative

Shortlisting criterion	Outcome
Does the alternative meet the primary proposal objectives?	✓
Is the alternative feasible in terms of engineering design and constructability?	×
Is the alternative feasible in terms of traffic performance?	Δ
Does the alternative demonstrate that it can minimise environmental impacts?	Δ

It was noted during the assessment that:

- Engineering feasibility – 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 on either side of the river and would likely restrict access to the local road network at Bolong Road, Illaroo Road and Bridge Road
- Maintenance costs – the length of the tunnel would also introduce additional construction and maintenance costs with complicated ventilation and fire retardant systems, and could introduce additional construction and operational issues in tying back to the Princes Highway
- Value for money - a tunnel was not considered a cost effective alternative compared to the available above ground alternatives
- Environmental impacts – a tunnel was considered to have high potential for significant environmental impacts.

The tunnel alternative was not considered further based on the above assessment.

A 'double deck' bridge

The assessment of the 'double deck' bridge option is given in Table 2-9.

Table 2-9: Assessment of ‘double deck’ bridge option

Shortlisting criterion	Outcome
Does the alternative meet the primary proposal objectives?	✓
Is the alternative feasible in terms of engineering design and constructability?	×
Is the alternative feasible in terms of traffic performance?	Δ
Does the alternative demonstrate that it can minimise environmental impacts?	✓

It was noted during the assessment that:

- Engineering feasibility - any ‘add on’ alternative to the existing bridges would be difficult to design and have substantial construction challenges under traffic. Neither of the existing bridges were designed to carry the additional weight of another deck and traffic
- Value for money - building a new ‘double deck’ bridge next to existing bridges would introduce construction difficulties and costs with little additional benefits
- Traffic efficiency – building a new or add on double deck bridge would require complex intersections either side of the bridge to maintain connections with the local road network.

Based on the above assessment and identified issues the ‘double deck’ alternative was not considered further.

Preferred strategic alternatives

Five route options were identified from the strategic alternatives analysis and were progressed to the next stage as Options A to E for further development and assessment and are described in Section 2.4.4.

2.4.4 Identified route options

The strategic alternatives analysis process identified five potential route options for a new bridge crossing. The five options, from west to east, were designated Option A to Option E and the key features of each are described as follows.

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 as identified in the Shoalhaven LEP and is shown in Figure 2-1.

Option B – immediately west (upstream)

Option B would involve construction of a new bridge immediately west (upstream) of the existing northbound bridge

Option C – existing southbound alignment

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

Option D – immediately east (downstream)

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

Option E – eastern potential rail option

Option E would involve construction of a new bridge further east (downstream) of the existing southbound bridge. This option could potentially allow for a future rail extension across the Shoalhaven River.

The indicative alignments of Options B to E are given in Figure 2-2.

2.4.5 Analysis of route options

Evaluation of the five route options was carried out at a Value Management workshop. Prior to holding the workshop, a number of investigations were completed to inform the process as follows.

Preliminary environmental investigation

A PEI was undertaken to identify environmental constraints likely to occur within the study area. The outcomes of the investigation were used to build on the findings from the preliminary data review and identify potential opportunities and environmental constraints.

The PEI identified the following key environmental constraints that were used to differentiate between the five route options:

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

A full discussion of the PEI findings is provided in Section 4.2 of the *Nowra Bridge Project Site Options Development Report* (Roads and Maritime, 2014).

Traffic modelling

The preliminary data review identified the need to better understand the existing and future traffic capacity and efficiencies for the options. Further traffic assessments were carried out to:

- Confirm the existing network performance
- Validate previous Origin-Destination studies
- Identify future traffic growth rates
- Test the options (including the ‘do nothing’ option) to find out which options could effectively accommodate forecast travel demand.

The analysis noted the following:

- 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 would provide an appropriate, well-balanced bridge crossing solution

Figure 2-1: Option A – western bypass alignment

Figure 2-2: Options B, C, D, E – Shoalhaven River crossing

- 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 following stages of project development to further assess and demonstrate the effective operation of the preferred route option, adjacent intersections and the surrounding road network.

Preliminary landscape character and visual impact assessment

A preliminary assessment was carried out in accordance with Roads and Maritimes' Environmental Impact Assessment Guidance Note – Guidelines for Landscape Character and Visual Impact Assessment (Roads and Maritime, 2013) for the three identified key landscape character units, with the findings as follows:

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

The assessment concluded that an additional crossing point in either the Shoalhaven alluvial or Shoalhaven canyon landscape zones, when considered against the overall project and urban design objectives, would be likely to have high to moderate landscape character and visual impacts. It also noted that effort should be made to reduce the visual impacts of a new structure on the existing heritage items in the transition zone.

Review of design and constructability issues

This activity was carried out through a workshop process involving a range of technical specialists from Roads and Maritime and the construction industry. The workshop was supported by a site visit with construction industry experts also attending.

The workshop identified appropriate assessment criteria to compare the five route options which included:

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

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. A summary of the assessment results is provided in Table 2-10.

Table 2-10: Design and constructability review assessment results

Criterion	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 compared 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 has greatest perceived impacts compared to other options

No judgement was made on the best overall option as the scope of the workshop was limited to design and constructability issues only.

The key findings of the review are summarised in Table 2-11.

Table 2-11: Review findings

Option	Review findings
Option A – western bypass alignment	The 'greenfields' nature of this option could provide better opportunities for ease of construction and mitigation of risks. However the scale of this 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 this option is also estimated to be at least ten times greater than the least expensive options.
Option B – immediately west (upstream)	This option could potentially affect slightly fewer properties than some of the other options; however unresolved land claims 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 lends itself well to an incrementally launched bridge. This would be one of the least expensive options.
Option C – existing southbound alignment	This option would make use of the existing Princes Highway corridor and would largely avoid surrounding properties. However this option would require the demolition of the existing southbound bridge. This would introduce additional construction issues and risks including the

Option	Review findings
	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 this option is estimated to be about 1.5 times greater than the least expensive options.
Option D – immediately east (downstream)	This option 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, however if 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, introducing a risk of destabilising the bridge during construction. This would be one of the least expensive options.
Option E – eastern potential rail option	The semi 'greenfields' nature of this option 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. This option would likely require long complicated bridge structures constructed on soft ground in flood plain areas and would have potential settlement and embankment stability issues. Depending on the chosen alignment, the cost of this option is estimated to be between three and five times greater than the least expensive options.

Value Management workshop

A Value Management workshop was held on 22 May 2015. Participants included Roads and Maritime project team members, technical specialists, key stakeholders from government and non-government agencies, businesses/chambers of commerce, and other stakeholders including two community representatives. The following table lists the criteria used to assess options.

Table 2-12: Value Management workshop option assessment criteria

Criterion type	Criteria
Functional	• Improve safety for pedestrians, cyclists and motorists • Enable safe and efficient maintenance of the existing southbound bridge • Improve local connectivity • Improve through traffic efficiency • Enable construction under existing and forecast traffic conditions
Socio-economic	• Best fits with existing and future planning • Minimise changes to visual and landscape character • Minimise traffic disruption during construction

Criterion type	Criteria
	• Minimise direct impacts to properties and businesses
Environmental	• Minimise impacts on biodiversity • Minimise impacts on Aboriginal heritage • Minimise impacts on non-Aboriginal heritage • Minimise flood impacts on the bridges, approaches and surrounding low lying areas

The workshop also included an assessment of relative costs and value for each option.

The workshop resulted in the following recommendations:

- 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 (downstream) 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 concerns at the intersections at Bolong Road, Illaroo Road and Bridge Road.

Community and stakeholder consultation

After the Value Management workshop, Roads and Maritime engaged further with the community to discuss the outcomes of the workshop and to seek feedback for the recommended option. The key issues raised by the community were:

- Clear support and understanding for the need of a new crossing immediately to the west of the existing crossings
- Many community members suggested that a long term plan to bypass Nowra should be considered in the future to accommodate growth in the area
- The majority of responses received supported the decision to focus planning on Option B; however, it was noted that there was still some level of support for all options
- Many people expressed the view that the project should address traffic issues at the intersections of Bolong Road, Illaroo Road and Bridge Road / Pleasant Way
- Desire for a rail component to be incorporated into any future river crossing
- The new crossing should make better provision for pedestrians and cyclists than the existing bridges
- Urban growth in the Nowra area should be considered when planning a new river crossing.

Preferred route option

A new bridge immediately to the west (upstream) of the existing crossings (Option B) was identified as the preferred route option.

2.4.6 Identified intersection and network options

After the selection of the preferred route option potential intersection and network options were developed from the strategic design development work.

A list of 19 potential intersection options was compiled in consultation with Shoalhaven City Council and other key stakeholders and focussed on the section of Princes Highway between Bolong Road and Bridge Road intersections.

Table 2-13, Table 2-14and Table 2-15provide schematic figures for each of the 19 options developed.

Table 2-13: Northern intersection and network options examined

Option N1:At grade intersection upgrades at Bolong Road and Illaroo Road	Option N2: Rationalisation of Bolong Road and Illaroo Road at grade, with Illaroo Road closure	Option N3: Replace Illaroo Road right turn southbound with flyover (v1)	Option N4: Replace Bolong right turn eastbound with flyover
			
Option N5: Rationalisation of Bolong Road and Illaroo Road with grade separation	Option N6: Replace Illaroo Road right turn southbound with flyover (v2)	Option N7: Replace Bolong Road right turn eastbound and Illaroo Road right turn southbound with flyovers	Option N8: Rationalisation of Bolong Road and Illaroo Road at grade, with Bolong Road closure
			

Table 2-14: Southern intersection and network options examined

Option S1a: At grade intersection upgrades at Bridge Road and Pleasant Way	Option S1b: Stagger T intersections, with Pleasant Way relocation	Option S2: Stagger T intersections, with Bridge Road relocation	Option S3: Replace Princes Highway right turn westbound with underpass (v1)
			
Option S4: Replace Princes Highway right turn westbound with overpass	**Option S5: Bridge Road and Pleasant Way relocation with grade separation**	**Option S6: Relocate and replace Princes Highway right turn westbound with flyover**	**Option S7: Replace Princes right turn westbound with underpass (v2)**
			

Table 2-15: Southern network and intersection option S8

Option S8: Relocate and replace Pleasant Way with grade separation, plus Bridge Road left in/out.


In addition to the above options, two further options identified in Shoalhaven City Council's Structure Plan (W1a, W1b) comprising a realigned western bridge under Illaroo Road connecting at Bolong Road were also considered.

As previously noted in Section 2.4.1, further traffic modelling was carried out after the workshop on 25 August 2015 to assess the performance of the 19 intersection options. The traffic modelling identified that certain combinations of intersection options on the northern and southern sides were incompatible, as they introduced inefficient and unsafe weave, merge and queuing issues that do not currently exist in the network. This was particularly the case for the network options which combined grade separation on the northern approach with at grade options on the southern approach. While this option provided benefits to the local road network, the option had the highest level of congestion on the Princes Highway compared to the other network options that were modelled.

The modelling also noted the following:

- Grade separation on the southern approach would generally result in similar benefits with and without a grade separation on the northern approach
- Grade separation on the southern approach would provide benefits mostly to the highway
- Grade separation on the northern approach would improve the local network with less benefit to the highway
- At grade treatments could function adequately for about 20 years before any grade separation might be necessary, however this is only the case if a four lanes northbound crossing is provided with additional lanes on the intersection approaches.

Six representative network options were shortlisted for further traffic modelling and assessment. The six network options consisted of:

- Option 1: New four lane bridge, no intersection upgrades
- Option 2: New three lane bridge, at grade intersection upgrades
- Option 3, New four lane bridge, at grade intersection upgrades (initially included
- Option 4: New four lane bridge, grade separation on southern approach

- Option 5: Nowra Bomaderry Structure Plan which includes a new four lane bridge and mix of at grade and grade separated upgrades
- Option 6: New four lane bridge, grade separation on both approaches.

The six shortlisted network options were established as functional representations of potential networks and based on the assumption that further design development would be required to establish the precise location and makeup of the bridge and intersection upgrades.

Option 3 initially included access to Pleasant Way.

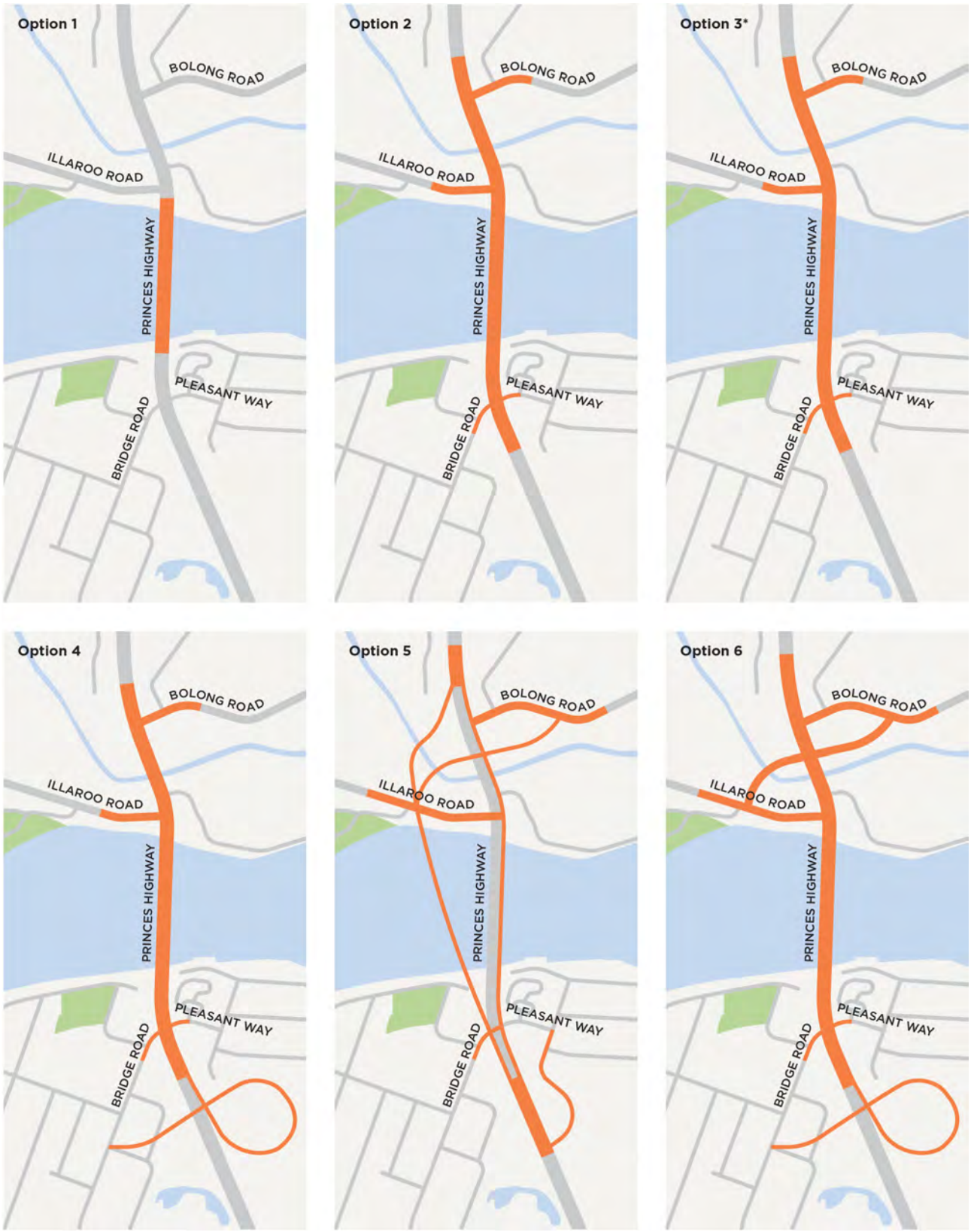

Figure 2-3: Shortlisted representative network options

2.4.7 Analysis of intersection and network options

The six representative network options were evaluated using the results from further traffic modelling and a multi criteria assessment process which took into consideration the heritage, environmental, property, land use and maintenance aspects of each option.

Traffic modelling

The traffic modelling assessment identified the benefits and constraints of each network option and assessed the performance outputs which included:

- Princes Highway trip times
- Vehicles on network
- Travel speed and level of service (LoS)
- Annual network vehicle hours travelled (VHT).

The traffic modelling used 2014 traffic data and a growth rate of 2.7 per cent which was considered an upper limit to account for substantial increases in development within the area.

Princes Highway trip times

The average travel time on the Princes Highway during the peak one hour modelled periods was assessed from the traffic model. The results indicate that the best performing option was Option 6, with Options 4 and 5 also performing well up to 2039. Options 2 and 3 performed worse than Options 4 and 5, while Option 1 and the base case (do minimum) performed poorly.

All options were predicted to perform poorly in 2044 in relation to trip times on the Princes Highway.

Table 2-16: Princes Highway southbound trip times

Year	Base	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
AM trip times							
2014	03:10	02:39	02:39	02:40	02:36	02:45	02:35
2024	07:40	02:53	02:45	02:45	02:40	02:54	02:38
2034	16:55	07:37	03:15	03:10	02:52	03:11	02:47
2039	21:04	13:05	06:19	06:27	03:41	03:57	03:11
2044	23:49	18:33	11:29	11:18	08:36	09:28	07:30
PM trip times							
2014	03:11	02:43	02:40	02:39	02:38	02:43	02:32
2024	09:23	02:53	02:43	02:43	02:38	02:50	02:35
2034	22:35	10:22	03:03	03:00	02:55	03:10	02:42
2039	24:12	15:23	05:35	05:35	05:32	06:50	04:25
2044	26:13	19:48	11:08	11:23	11:02	11:58	09:23

Table 2-17: Princes Highway northbound trip times

Year	Base	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
AM trip times							
2014	02:57	03:20	03:21	03:21	03:00	02:23	02:26
2024	03:06	03:26	03:26	03:26	03:06	02:24	02:28
2034	06:07	06:09	06:21	03:58	03:18	02:27	02:35
2039	08:34	09:49	09:31	04:11	03:28	02:29	02:44
2044	13:22	13:47	14:10	05:25	03:39	02:32	02:48
PM trip times							
2014	03:08	03:04	03:04	03:04	03:03	02:23	02:35
2024	08:44	03:09	03:20	03:13	03:14	02:25	02:38
2034	18:53	07:41	06:42	03:33	03:34	02:31	02:54
2039	22:42	13:52	13:19	03:50	03:49	02:40	03:10
2044	25:04	17:44	17:07	04:35	04:32	05:01	04:00

Vehicles on network

The vehicles on network output indicates how well each option can process the traffic demand with the lower the number of vehicles on the network generally indicating a higher level of efficiency. The vehicles on network outputs (refer Table 2-18) show Option 6 is the best performing option, with Options 3 to 5 being slightly less efficient.

Table 2-18: AM and PM vehicles on network

Year	Base	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
AM Vehicles on network							
2014	279	271	258	260	250	216	251
2024	703	419	330	327	325	287	315
2034	879	797	660	501	467	441	445
2039	919	809	952	758	637	677	601
2044	877	806	980	992	890	780	836
PM Vehicles on network							
2014	332	283	291	288	287	249	281
2024	869	415	415	399	412	322	369
2034	967	878	725	574	563	464	495
2039	927	880	878	741	712	773	573
2044	932	879	985	973	883	869	752

Travel speed and level of service

Average travel speeds on the Princes Highway northbound and southbound were calculated based on the travel time outputs from the future year traffic models. The results generally align with the trip times above, however they demonstrate the level of service on the Princes Highway, for the majority of options, will return to existing levels by 2034 to 2039.

The criteria for level of service based on a free flow travel speed (FFS) of 70 km/h is shown in the following table.

Table 2-19: Level of service criteria for average speeds on urban arterial roads

LoS	Criteria (% of FFS)	Average Speed
A	>85%	> 60 km/h
B	67% to 85%	47 km/h to 60 km/h
C	50% to 67%	35 km/h to 47 km/h
D	40% to 50%	28 km/h to 35 km/h
E	30% to 40%	21 km/h to 28 km/h
F	0% to 30%	0 km/h to 21 km/h

Table 2-20: Princes Highway southbound travel speeds and level of service

Year	Base		Option 1		Option 2		Option 3		Option 4		Option 5		Option 6	
	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS
AM Average Travel Speed and Level of Service														
2014	43	C	60	B	59	B	59	B	62	A	55	B	62	A
2024	13	F	51	B	55	B	55	B	59	B	50	B	60	A
2034	5	F	13	F	41	C	43	C	51	B	43	C	54	B
2039	4	F	7	F	16	F	16	F	34	D	30	D	43	C
2044	4	F	5	F	8	F	8	F	11	F	10	F	13	F
PM Average Travel Speed and Level of Service														
2014	43	C	57	B	59	B	59	B	60	A	57	B	65	A
2024	10	F	51	B	57	B	57	B	60	B	52	B	62	A
2034	4	F	9	F	46	C	47	B	50	B	43	C	57	B
2039	4	F	6	F	19	F	19	F	19	F	15	F	26	E
2044	3	F	4	F	8	F	8	F	8	F	8	F	10	F

Table 2-21: Princes Highway northbound travel speed and level of service

Year	Base		Option 1		Option 2		Option 3		Option 4		Option 5		Option 6	
	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS	Average Speed (km/h)	LOS
AM Average Travel Speed and Level of Service														
2014	49	B	39	C	39	C	39	C	47	B	74	A	70	A
2024	44	C	38	C	38	C	38	C	45	C	73	A	69	A
2034	17	F	17	F	16	F	30	D	40	C	70	A	62	A
2039	11	F	9	F	10	F	28	E	37	C	67	A	56	B
2044	7	F	6	F	6	F	20	F	34	D	65	A	54	B
PM Average Travel Speed and Level of Service														
2014	44	C	46	C	45	C	46	C	46	C	74	A	63	A
2024	11	F	43	C	39	C	42	C	42	C	71	A	60	A
2034	5	F	13	F	15	F	36	C	35	C	66	A	50	B
2039	4	F	6	F	7	F	32	D	32	D	59	B	43	C
2044	3	F	5	F	5	F	25	E	25	E	22	E	30	D

Annual vehicle hours travelled

To summarise the options analysis the AM and PM vehicle hours travelled (VHT) were calculated to determine annual VHT results. Annual VHT is considered a good indicator of network performance as it takes into account the performance of the local road as well as the Princes Highway. The annual VHT results indicated that Options 3 to 6 were the better performing options with only marginal differences occurring between these options beyond 2039.

Table 2-22: Annual vehicle hours travelled

Year	Base	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
2014	1,178,732	1,100,110	1,095,809	1,093,464	1,083,556	925,528	1,051,502
2024	3,190,272	1,657,031	1,482,580	1,466,796	1,454,675	1,255,764	1,400,466
2034	9,114,535	4,531,592	3,107,044	2,124,142	2,042,494	1,794,843	1,943,949
2039	12,520,439	7,845,403	5,468,967	3,404,700	3,017,962	3,056,222	2,749,999
2044	16,496,553	12,963,023	8,928,997	5,934,387	5,257,653	5,434,857	4,856,649

Key findings

The key findings of the traffic modelling were:

- The performance of the existing network is poor. There is insufficient capacity for the right turn demand into Bridge Road from the Princes Highway during the morning peak period. This results in queues extending up the Princes Highway and affects the Illaroo Road intersection
- Providing a new three lane northbound bridge without upgrades to the Bridge Road and Illaroo Road intersections results in minimal improvements. These results do not improve if an additional northbound lane is provided on the new bridge
- Providing intersection upgrades and a three lane northbound bridge performs well up to about 2029
- Intersection upgrades and a four lane northbound bridge improves performance up to about 2039
- Grade separated options perform only marginally better than the best performing at grade option
- Some grade separated options introduce weave, merge or queuing issues that do not currently exist.

Multi-criteria assessment

A multi-criteria assessment process was adopted to evaluate the six network options. A workshop was held on 20 November 2015 involving Roads and Maritime project team members covered the following:

- A review of available information
- Agreement of assessment criteria
- Identification of any significant issue(s) that could exclude a particular option
- Assessment using a qualitative performance matrix process.

The workshop participants rated each shortlisted option relative to each other against the agreed criteria. The chosen criteria used for the option assessment is summarised in Table 2-23. No weightings were applied to the assessment criteria.

Table 2-23: Assessment criteria

Criterion	Description
Traffic efficiency improvements	The potential traffic efficiency improvements in terms of travel time on the Princes Highway and reduced delay on local roads for each option was considered.
Heritage	Non-Aboriginal heritage items were identified in different locations within the study area. Heritage buildings, such as Graham Lodge were considered likely to be impacted by grade separated options on the north and south. The study area was recognised as having a high potential of Aboriginal heritage however it was considered that any impacts would likely be common to all options.
Environment	An area of high conservation value was identified to the north of Bolong Road, with potential conservation value identified along creek line vegetation near Bomaderry Creek.
Residential property	Impacts to residential property were considered likely across all options. Options involving grade separation were considered likely to impact existing residential properties.
Sensitive property and future land use	Impacts to sensitive property were considered likely across all options. Options involving grade separation to the south were considered likely to impact businesses and land identified by Shoalhaven City Council as having the potential to develop in the future.
Work health and safety and whole of life maintenance	The scale and associated risks of different options was considered sufficient to differentiate between the options.

Other criteria that were identified but considered not to provide differentiation between the options included:

- Road safety
- Design
- Urban design including access to the waterfront and pedestrian connectivity
- Utility relocation.

The results of the multi-criteria assessment performed by the workshop participants are presented in Table 2-24.

Table 2-24: Performance matrix for multi-criteria assessment

Option	Highway travel time	Network VHT	Heritage	Environment	Residential Property	Property and land use	Maintenance
1	Not assessed due to poor traffic performance						
2	Not assessed due to poor traffic performance						
3	✓	✓	✓✓	✓	×	✓	✓
4	✓✓	✓✓	✓	×	×	×	×
5	✓✓	✓✓	××	××	×	××	××
6	✓✓	✓✓	×	×	×	××	××

Key ✓✓: Better, ✓: Good, ×: Poor, ××: Worst

Preferred intersection and network option

Option 3 was considered the preferred option based on the multi-criteria assessment. This option provides the best balance of potential benefits versus potential impacts.

2.4.8 Analysis and confirmation of the preferred option

Growth rate review

It was identified the compounding growth rate of 2.7 per cent per annum could be considered conservative and overstate the future traffic demand in the region. The adopted 2.7 per cent growth rate is considered to be based on aspirational forecast land use in 2039. Historical traffic data for the Princes Highway from permanent count stations 07.051 (190m south of Illaroo Road) and 07.800 (north of Rose Valley Road) over the last two decades indicate growth rates of 1.7 per cent and 1.2 per cent respectively. The traffic modelling was reassessed using lower growth rates of 1.1 per cent and 1.7 per cent which confirmed Options 3 to 6 are the better performing options.

A traffic growth rate of 1.7 per cent was ultimately adopted by Roads and Maritime for the Princes Highway for subsequent traffic modelling of the preferred option.

Preferred option review

After completion of the 20 per cent concept design of the preferred option, a review was undertaken to assess the overall performance and ease of construction of the option. An independent constructability review of the preferred option concluded that although the preferred option would have a number of challenges, such as managing traffic around Illaroo Road and the relocation of utilities during construction, it is still considered feasible.

As part of the preferred option review, two additional options were also evaluated and included:

- Option A: The preferred option of a new bridge immediately west (upstream) and at grade intersection treatments

- Option B: A new bridge on the same alignment as the preferred option and realigning Illaroo Road to Bolong Road intersection
- Option C: A new bridge with constant horizontal curve immediately east (downstream) of the current crossings and at grade intersection treatments.

A workshop held on the 21 September 2017 involving Roads and Maritime project team members considered each option with the aim to identify aspects of the design which would prevent the preferred option from progressing, as well as any benefits the alternative options had over the preferred option.

The options were evaluated against the following considerations:

- Project objectives
- Traffic efficiency
- Design
- Constructability
- WHS / Safety
- Heritage impacts
- Environmental impacts
- Property impacts
- Utilities
- Value for money

The workshop participants concluded a new bridge to the west (upstream) with at grade intersection upgrades remained the preferred option for further development.

2.4.9 Identified options for the existing southbound bridge

Roads and Maritime considered seven options for the existing southbound bridge. The identified options are summarised in Table 2-25.

Table 2-25: Identified options for the existing southbound bridge

Option	Description
Retain and maintain options	Retaining the bridge assumes Roads and Maritime would continue to maintain it to a standard that would ensure structural integrity and satisfy heritage requirements. This could involve adaptive re-use or closure of the bridge to public access.
Retain and transfer options	This option assumes that the structural integrity and heritage management requirements are satisfied. Roads and Maritime could seek to transfer responsibility for the asset to another party.
Partial demolition options	Partial demolition of the bridge would retain one or both of the spans immediately adjacent the shorelines. Partial demolition could potentially allow public access to the shoreline span(s).
Partial demolition options with relocation of spans	Partial demolition of the bridge would result in one or more of the central spans relocated within the local area for posterity. One or both of the spans immediately adjacent the shorelines would be retained and could be accessible to the public.
Full demolition options with relocation of spans	Demolition of the bridge with one or more of the central spans relocated within the local area for posterity
Full demolition	Complete removal of the bridge
Deferral	Deferral of the decision could be a temporary measure until a longer term decision is made.

2.4.10 Analysis of options for the existing southbound bridge

Analysis of options for the existing southbound bridge took into consideration maintenance requirements of retaining the existing southbound bridge, demolition methodology, historical significance of the bridge and community and stakeholder feedback.

Retention options

Analysis of retention options took into consideration the activities necessary to maintain the existing southbound bridge for adaptive reuse. Required maintenance activities would include:

- Repainting of all truss elements
- Tightening or replacement of any loose, damaged or corroded truss elements
- Inspection and maintenance or replacement of pin joints
- Removal and replacement of the deck attachment system
- Maintenance of expansion bearings
- Pier strengthening
- Remediation of footings.

At the time of the assessment it was estimated that retaining the existing southbound bridge would have a maintenance cost in the order of $35 million over the next 50 years.

Demolition options

Demolition of the bridge would likely include:

- Removing any heavy components such as the deck and some supporting structures which would not impact on the structural integrity of the truss itself
- Removal of other non-structural components such as utilities and footways by truck or barge
- Demolition of the truss either by removal as a complete unit using cranes and barges, or by dismantling after supporting the truss via temporary structures
- Archiving and recording heritage aspects of the bridge as it was demolished or dismantled.

At the time of the assessment it was estimated that the demolition costs would be about $18 million.

Historical significance

The existing southbound bridge is the only intact American pin-jointed 'Whipple' truss bridge in NSW that has historically been used for road traffic. There are only three known American pin-jointed 'Whipple' truss bridges in Australia.

A specialist assessment against the NSW heritage assessment criteria identified that the bridge has significance for its historic value, its landmark aesthetic qualities, its ability to contribute to research questions relating to the construction of 'Whipple' truss bridges in Australia, its rarity, and its representativeness.

The bridge is currently listed on the Roads and Maritime S170 Register. Roads and Maritime has a responsibility under Section 170A of the *Heritage Act 1977* to maintain the bridge in accordance with the State Owned Heritage Management Principles.

These principles state that management of redundant heritage assets should be planned and executed so as to conserve the item's heritage significance. A specialist heritage assessment has been undertaken and it was determined that the retention and adaptive re-use with heritage interpretation would help in retaining the technical and aesthetic significance of the structure.

The historical significance of existing southbound bridge is discussed further in Section 6.4 and the Statement of Heritage Impact (Appendix F).

Community and stakeholder feedback

In 2014, Roads and Maritime spoke to the community about the future of the existing southbound bridge. As part of the consultation activities Roads and Maritime:

- Spoke to over 1,850 people at pop up kiosks in Stockland Nowra, at the Shoalhaven River Festival and at two information sessions
- Received 38 written submissions
- Received about 676 online survey submissions.

The results of the community engagement activities indicated strong support for retaining the existing southbound bridge due to it engineering heritage and community value. Conversations with the community, written submissions and feedback from an online survey showed an overwhelming response to retain the existing southbound bridge in some form. There was a small proportion of the community that wanted to see the bridge removed completely and money instead spent on other projects in the region.

Written submissions were received from Office of Environment and Heritage (OEH), National Trust of Australia, and Engineers Australia. All of these bodies referred to the historic significance of the

existing southbound bridge and voiced their opposition to any options that would see it demolished or relocated.

Independent assessment of options

Roads and Maritime engaged an independent specialist to review all investigations completed to date relating to the future of the existing southbound bridge. The independent assessment confirmed the Roads and Maritime position that the existing southbound bridge is operationally unsuitable for the current and future demands of the Princes Highway, and that once a new bridge crossing is constructed the existing southbound bridge should then be closed to vehicular traffic.

The independent review assessed the heritage value of the existing southbound bridge and the community impacts associated with its removal as being significant. It also considered adaptive reuse to be viable in the medium term and did not consider the long term life costs and annual maintenance cost to be excessive in order to preserve the social and heritage value of the bridge.

Preferred option

Retention of the existing southbound bridge was identified as the preferred option. In doing so Roads and Maritime proposes:

- The existing southbound bridge be retained and maintained for adaptive reuse, such as a pedestrian and cyclist path, but be closed to vehicular traffic
- The design for a new bridge should cater for pedestrian and cyclists as the existing southbound bridge may not be a reliable alternative indefinitely
- The existing southbound bridge should continue to be inspected annually or at such times deemed necessary to assess the ongoing viability of retention of the structure into the future
- The estimated costs associated with restoring the existing southbound bridge as per the requirements of the Heritage Act should be included as part of the Nowra Bridge project.

2.5 Preferred option

Based on the outcomes of an extensive options analysis that involved consulting with stakeholders at key stages and considered a range of issues including traffic performance, road and urban design , constructability , environmental and heritage constraints, whole of life maintenance, work health safety, construction costs and value for money; the proposed preferred option for the Nowra Bridge Project is:

- A new river crossing upstream immediately to the west of the existing Princes Highway bridge crossings, providing four northbound lanes including a new shared path, and a dedicated continuous slip lane between Bridge Road and Illaroo Road
- The existing northbound bridge be converted to carry southbound, non-pedestrian traffic, increasing the southbound through capacity from two to three lanes
- At grade intersection upgrades at the intersections of Bolong Road and Illaroo Road, including provision for three northbound and southbound through lanes on the Princes Highway
- Conversion of Bridge Road to a three-leg intersection and construction of a new local road connection further south on the Princes Highway with all turning movements catered for
- The existing southbound bridge be retained and maintained for adaptive reuse, such as a pedestrian and cyclist path, but be closed to vehicular traffic (with the design and assessment of the adaptive reuse being addressed through a separate assessment.

This proposal is considered to be the most cost-effective option to address the project objectives and community expectations, while reducing as much as possible impacts to the community and property owners, and while ensuring that long term planning for the Princes Highway is not compromised.

2.6 Design refinements

2.6.1 New northbound bridge type

Roads and Maritime identified three bridge type options to construct a new northbound bridge given the proposal's context. The bridge types identified are summarised in Table 2-26.

Table 2-26: Bridge types

Bridge type	Description
Pre-cast concrete beam	The pre-cast concrete beam option consists of precast girders spanning about 38 metres between the more numerous, but least bulky piers. The pre-cast concrete beam arrangement limits the cantilevers of the bridge deck from the girder making the arrangement typically less elegant than the other options considered. The pre-cast concrete girder option is typically constructed using precast girders manufactured offsite. The precast girders are then lifted into place onto the piers and headstocks.
Post-tensioned concrete box girder – constant depth	A concrete box girder allows span lengths generally up to 60 metres between generally less bulky piers. The result is a structure which provides good visual permeability and generous deck cantilevers to provide an elegant structure. The concrete box girder bridge is typically constructed using the incrementally launched technique, which involves building the bridge deck segments in a casting yard located behind one bridge abutment. Each segment is then joined to the segment previously built, with the whole structure then pushed forward a distance equal to the length of the segment. The process is then repeated until the bridge is in its final position.
Post-tensioned concrete box girder – variable depth	The concrete variable depth (haunched) girder enables long span lengths which would enable the number of more bulky piers to be reduced and allow through views. The concrete haunched girder is typically constructed using the balanced cantilever technique. The method consists of building the bridge in segments which are concreted into travelling formwork. Construction begins at each pier with segments built outward and continuing until a joining midpoint is reached and a balanced pair is closed.

The three bridge types were evaluated against the three key issues (refer Table 2-27). Alignment was not considered to be a differentiator due to the proposed straight flat geometry of the new northbound bridge in order to provide a cohesive grouping of bridges with the existing two.

The following key urban design principles were also noted:

- This is a highly visible bridge across a wide river

- There are long distance views through the structure from the foreshore (looking east and west)
- The longitudinal alignment in relation to the adjacent (1980s) bridge
- Pier shapes and position need to correlate.

Table 2-27: Bridge form options analysis

Option	Urban design	Hydrology	Bridge deck drainage
Pre-cast concrete beam	Poor visual appearance. Bulky appearance. Piers would correlate with existing bridges.	Assumed matching spacing and sizing of bridge piers with existing bridges (nine piers in river). No adverse hydrological outcomes.	Strip drains on bridge would be ineffective. Would need to consider shoulders up to 3m in width.
Post-tensioned concrete box girder – constant depth	Provides clean lines and elegant elevation. Piers would correlate with existing bridges.	Assumed matching spacing and sizing for bridge piers with existing bridges (nine piers in river). No adverse hydrological outcomes.	Strip drain possible but likely maintenance issues
Post-tensioned concrete box girder – variable depth	Acceptable visual appearance but bridge piers do not correlate in terms of position with existing bridges.	Longer pier spacing (five piers in river) and larger than current piers. Greater obstruction of waterway and likely worse hydrological outcomes. More modelling would be required to confirm this.	Sufficient depth in girders for drainage infrastructure Drainage infrastructure would be more accessible Wide shoulder (approx. 2.5 m) required to prevent water pooling between scuppers from entering travel lanes

Subsequent to the initial evaluation of bridge options, a bridge option and Value Management workshop was held on 7 February 2018. The objectives of the workshop were to:

- Obtain a common understanding of the proposal and the work undertaken to date on the bridge types
- Review the bridge type options being considered and evaluate them against agreed assessment criteria
- Recommend a preferred option(s) to progress the project.

The workshop commenced with a review of the proposal objectives and identification of other matters important for the proposal to consider. The key assumptions for the proposal were also shared from various perspectives.

Using this information, draft assessment criteria (developed prior to the workshop) were discussed and refined. These criteria were then weighted based on their relative importance for evaluation of the bridge type options.

The three bridge type options were then presented, together with their key features, advantages, disadvantages, issues and risks. Each option was discussed to ensure a common understanding of

their differences, opportunities and constraints for later evaluation. The options were then qualitatively evaluated against the assessment criteria as well as discussing their relative cost estimates.

At the completion of the workshop, it was concluded:

- Option 2 was recommended as the preferred bridge type based on the workshop assessment.
- Option 1 should be retained to provide flexibility in the event that the project was to be procured via a Design and Construct delivery approach
- If Option 1 proceeds as the preferred bridge type, then there will be a need to resolve the drainage on the bridge deck which impacts on the overall width of the bridge.

2.6.2 Bomaderry Creek bridge

The bridge option and Value Management workshop held on 7 February 2018 also considered options for the upgrade of Bomaderry Creek bridge located between Bolong Road and Illaroo Road.

Options for Bomaderry Creek bridge included:

- Option 1 – Demolish the existing bridge and construct a new crossing
- Option 2 – Widening the existing structure
- Option 3 – Construction of a new bridge adjacent to the existing bridge.

These options were reviewed and discussed by the workshop group which then drew conclusions as a result of their deliberations.

At the completion of the workshop, it was concluded:

- Option 2 was recommended as the preferred option, with the widening to occur on the western side of the bridge
- Option 1 should be progressed to allow for flexibility in the event that procurement would be via a Design and Construct delivery approach
- Option 3 would likely form part of the staged construction of Option 1, should Option 1 be the preferred option of the contractor.

2.6.3 Illaroo Road intersection

During the display of the preferred option in February 2018, a strong community and stakeholder response was received regarding the proposed configuration of the Illaroo Road and Princes Highway intersection. The key issues included:

- A dedicated left turn lane should be provided to reduce delays caused by queued traffic turning right to head south across the Shoalhaven River
- The current left turn slip lane for northbound Princes Highway traffic entering Illaroo Road should be maintained. The preferred option displayed to the community required this movement to give way to vehicles turning right from the Princes Highway.

As such, the above designs refinements were investigated. It was identified through traffic modelling that the traffic efficiency of the intersection would be improved by providing a dedicated left turn lane and three dedicated right turn lanes on the Illaroo Road approach to the Princes Highway.

To maintain the current left turn slip lane for northbound traffic into Illaroo Road, an acceleration lane allowing traffic to merge prior to Fairway Drive was investigated. It was considered that an acceleration lane designed to the project design speed of 70 km/h (60 km/h posted) for Illaroo Road

would introduce road safety concerns at the Fairway Drive intersection and impact additional residential properties. As a result, a design based on a lower but more likely operating speed allowed the merge lane to be included in the concept design which will end prior to Fairway Drive.

2.6.4 New local road connection

During the display of the preferred option, a strong community and stakeholder response was received regarding the proposed set of additional traffic signals on the Princes Highway at the proposed new local road connection south of Bridge Road. The key issues raised by the community during the consultation period included:

- An additional set of traffic lights at the new local road connection combined with the existing traffic lights would reduce traffic efficiency along this section of the Princes Highway
- Concerns over the number of traffic lights on the Princes Highway within Nowra
- Due to the number of traffic lights, improvements to traffic light phasing between Bolong Road and Moss Street would be required
- There is a need to reduce the number of traffic lights between Bolong Road and Kalandar Street.

As such, removal of the traffic signals from the new local road connection was investigated. It was identified through traffic surveys and modelling that the right turn demand is low and can be accommodated by the existing local road network and Moss Street intersection. The new local road connection would be retained to provide left turn movements to and from the Princes Highway and access to the urban area and foreshore precinct east of the Princes Highway.

Removal of the right turn facility at the new local road connection for northbound traffic on the Princes Highway would require traffic to be redirected via Moss Street, Ferry Lane and Riverview Drive to the eastern foreshore precinct, resulting in longer trip times and distances for these journeys.

3. Description of the proposal

3.1 The proposal

Roads and Maritime proposes to construct a new bridge over the Shoalhaven River at Nowra. The proposal would include the upgrade of about 1.6 kilometres of the Princes Highway from about 150 metres north of the Bolong Road intersection to about 75 metres north of the Moss Street intersection. The new bridge over the Shoalhaven River would be about 360 metres long, and would provide four lanes for northbound traffic and a shared path for cyclists and pedestrians.

Key features of the proposal would include:

- Construction of a new bridge to the west (upstream) of the existing bridge crossings over the Shoalhaven River including:
  - Four northbound lanes including a dedicated left turn only lane from Bridge Road to Illaroo Road
  - A 3.5 metre wide shared use path on the western side of the bridge connecting the Illaroo Road intersection to the Bridge Road intersection
- Widening of the existing bridge over Bomaderry Creek
- Minor lane adjustments on the existing northbound bridge to convert it to three lanes of southbound traffic
- Removal of vehicular traffic and closure of the existing southbound bridge to undertake investigation, rehabilitation and repurposing work for adaptive reuse following opening of the new northbound bridge. As part of the proposal, shared paths and maintenance access would be constructed up to the existing southbound bridge and work to prevent unauthorised access would also be carried out. The rehabilitation and repurposing of the existing southbound bridge for adaptive reuse would be subject to a separate consultation and assessment process to this REF
- Upgrading of the Princes Highway to provide three northbound and three southbound lanes from the Bolong Road intersection through to about 75 metres north of the Moss Street intersection
- Widening of Illaroo Road over a distance of about 270 metres
- Upgrading of the Princes Highway and Illaroo Road intersection to provide:
  - Two southbound right turn lanes from the Princes Highway into Illaroo Road
  - Three dedicated right turn lanes and one dedicated left turn lane from Illaroo Road to Princes Highway
  - An acceleration and merge lane for northbound traffic turning into Illaroo Road from Princes Highway
- Upgrading of the Princes Highway and Bridge Road intersection to provide:
  - Two southbound right turn lanes from the Princes Highway into Bridge Road
  - One left turn lane from Bridge Road to the Princes Highway
- Local road adjustments including:
  - Closing the access between Pleasant Way and Princes Highway
  - Restricting turning movements at the intersection of Bridge Road and Scenic Drive
  - Construction of a new local road connecting Lyrebird Drive to the Princes Highway about 300 metres south of the existing Pleasant Way intersection

- Provision of pedestrian facilities at all intersections
- Dedicated off road shared paths and footpaths along the length of the proposal.
- Urban design and social amenity improvements, and landscaping including pedestrian links to the existing southbound bridge
- Relocation and/or protection of utility services
- Drainage and water quality management infrastructure along the road corridor
- Property works including acquisition, demolition, and adjustments to accesses
- Temporary ancillary facilities during construction including site offices, construction compounds, and stockpile sites.

The key features of the proposal are shown in Figure 3-1 and Figure 3-2.

The proposal description presented in this REF represents the concept design for the proposal. Sufficient flexibility has been provided in the concept design to allow for refinements during detailed design or in response to any submissions received after the exhibition of this REF or to minimise environmental impacts. The final design may therefore vary from the concept design described in this chapter.

3.2 Design

A description of the overall proposal design is provided in the following sections.

3.2.1 Design criteria

The proposal has been designed to address relevant standards and applications including:

- Guide to Road Design (Austroads, 2015), including Roads and Maritime Supplements
- AS 1742.2:2009 Manual of Uniform Traffic Control Devices, as amended by Roads and maritime Supplement (Roads and Maritime, 2013)
- Roads and Maritime Delineation Manual (Roads and Maritime, 2012)
- Roads and Maritime NSW Speed Zone Guidelines (RTA, 2011)
- Beyond the Pavement – Roads and Traffic Authority of NSW urban design policy, procedures and design principles (RTA, 2009)
- Austroads Guide and Commentary Series (Austroads, 2009)
- Austroads Design Vehicles and Turning path Templates (Austroads, 2009)
- Road Safety Audit Manual and Checklist (RTA, 2005).

The bridge guidelines and standards used in the design of the proposal include the following:

- Roads and Maritime Bridge Technical Direction Manual (Roads and Maritime, 2017)
- Roads and Maritime Standard Bridge Drawings (Roads and Maritime, 2017)
- AS 5100:2017 Bridge Design Code (Standards Australia, 2017)
- Roads and Maritime Bridgeworks QA Specifications
- Bridge Aesthetics: Design guidelines to improve the appearance of bridges in NSW (Roads and Maritime Services, 2012)
- Austroads Guide to Bridge Technology – Part 2 Materials (Austroads, 2009)

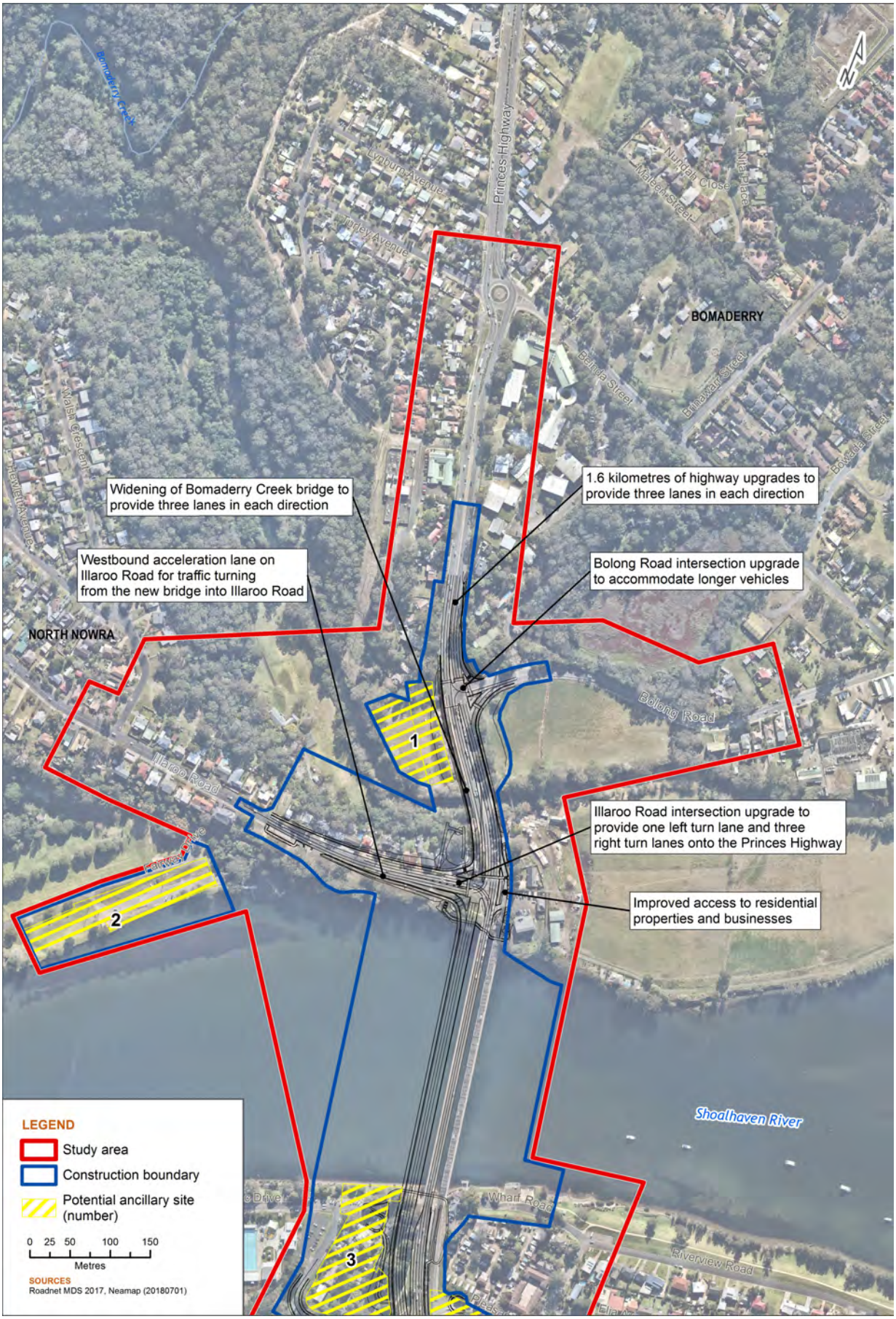

Figure 3-1: Key features of the proposal – North

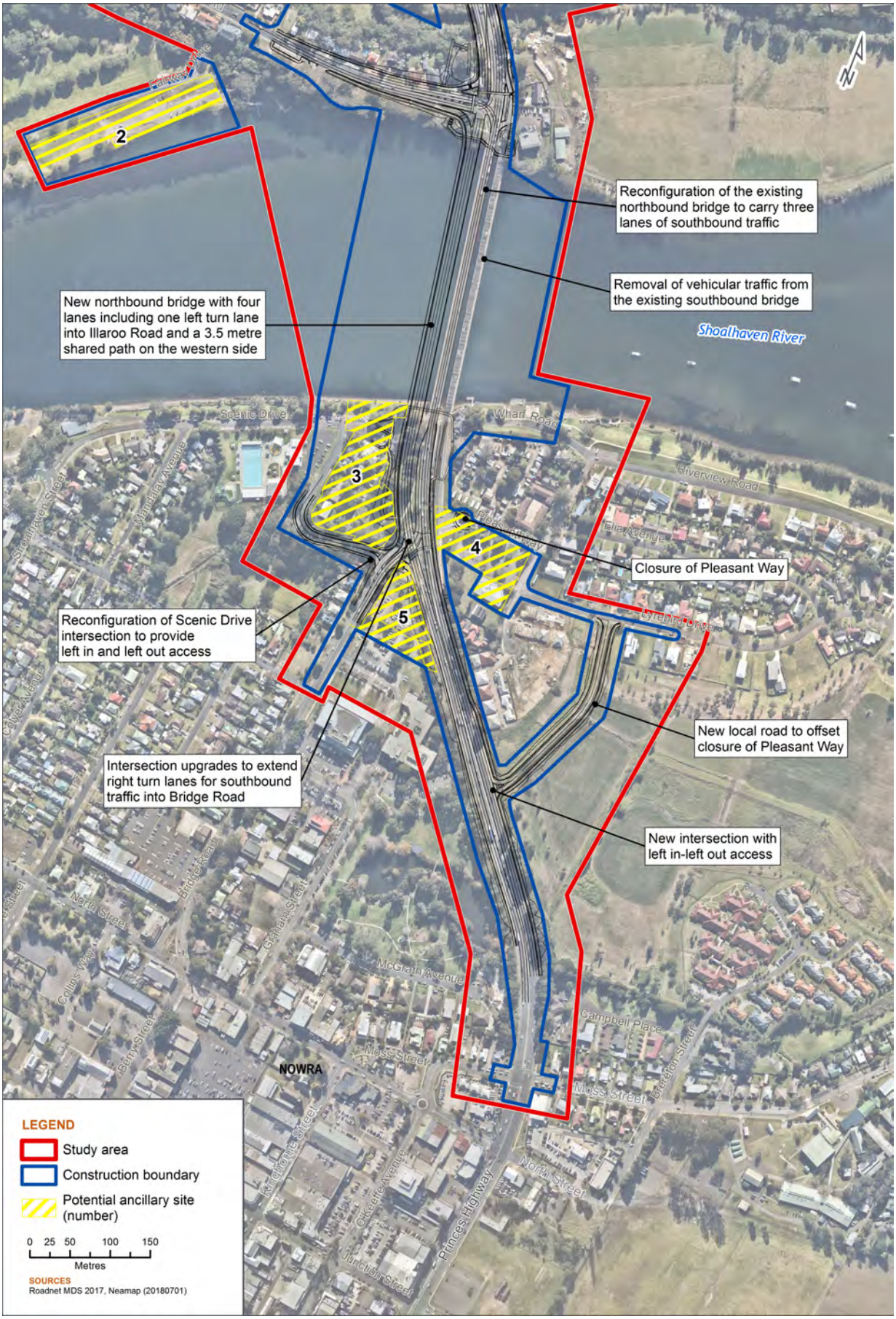

Figure 3-2: Key features of the proposal – South

- Austroads Guide to Bridge Technology – Part 3 Typical Superstructures, Substructures and Components (Austroads, 2009)
- Austroads Guide to Bridge Technology – Part 6 Bridge Construction (Austroads, 2009)
- AS 2159:2009 Piling – Design and Installation (Standards Australia, 2009).

A full list of guidelines, standards and other references used in development of the concept design for the proposal is provided in the 80 per cent concept design report (Arup, 2018a).

The design criteria for the proposal are detailed in Table 3-1.

Table 3-1: Design criteria

Design element	Criteria
Carriageway	Single carriageway, three lanes in each direction
Design speed	80 km/h for Princes Highway (posted speed: 70 km/h) 60 km/h for local roads (posted speed: 50 km/h)
Design vehicle	B-Double (27.5 metres)
Width of lanes	Typically 3.5 metres
Median/verge width	2.0 metres minimum
Shoulder width	Typically two 1.0 metre hard shoulders
Grade	0.63 - 2.8% on Princes Highway 7% maximum on Illaroo Road Existing northbound bridge has no longitudinal grade and 3 % crossfall on the bridge deck.
Safety barriers	W beam system at the top of the large fill embankment on the western side of Princes Highway on the southern approach to the new northbound bridge.
Shared use paths	Shared path on the existing northbound and southbound bridges to be closed at project completion. New northbound bridge would have a 2.5 m wide (3.5 m wide including clearances) shared path on the western side of the bridge. Proposed intersections provide equivalent crossing facilities; crossing to remain a single movement. Footpaths reinstated where required.
Batter slopes	Fill batters 1V:3H maximum, not traversable by cars. Where height is greater than 1 m, a safety barrier would be required where the batter is in the clear zone. Cut batters 1V:2H maximum.
Swept path design vehicles	Bolong Road: B-Double Illaroo Road/Bridge Road/New local road connection: 12.5 m rigid
Minimum stopping sight distance	In accordance with the prescribed design guidelines using a reaction time of 1.5 s.
Horizontal curves	Curve radii of 300 metres and 280 metres, design speed 80 km/hr without exceeding 5 % superelevation.

Design element	Criteria
Ship impact	ULS impact loads on bridge due to collision by barge 14.7 MN parallel and 7.35 MN perpendicular to pier, applied to navigational piers (piers 1-9) Note: parallel and perpendicular loads are not applied at the same time (AASHTO)
Design load	Design to AS 5100.2-2017 Design traffic loading consists of SM1600 and HLP400 design vehicles Braking force AS5100.2 CL 7.8.2

3.2.2 Engineering and other constraints

The principal engineering constraints for the proposal are:

- The existing bridge across Bomaderry Creek was designed to engineering standards that have since been superseded
- Proximity of Illaroo Road intersection to the river bank and resulting constraints on position and level of Illaroo Road intersection
- Minimising changes to the existing flooding regime, particularly with regard to increased impacts on properties and buildings
- Level difference between realigned Princes Highway and tie in point on Illaroo Road
- Minimising impacts on residential and commercial properties, including driveway access
- Variability in ground conditions, particularly with regard to bridges
- Vertical alignment of the proposed new bridge, and the impact of this on drainage of the new bridge deck
- Need to match navigational clearance of existing northbound bridge
- Capacity of the intersections for an at grade configuration, and the need for provision of turning pockets and auxiliary lanes
- Proximity of Bridge Road/Scenic Drive intersection to the realigned Princes Highway and the effect of this on the vertical alignment of Scenic Drive
- Large amount of underground services that would be affected by the proposed works, particularly where deep excavation is proposed along Illaroo Road
- The navigation clearance envelope is 28.5 metres wide between the pile-cap faces for spans two to eight and 21.5 metres for span nine and a minimum 7.3 metres high vertical clearance from mean high water spring level (there are no required navigational clearances for Bomaderry Creek).

Other constraints for the proposal include:

- The proximity of the northern bridge abutment to an area of Aboriginal cultural heritage sensitivity
- The boat ramp and car/trailer parking area at Greys Beach are heavily patronised which is likely to influence the manner of use of the Fairway Drive ancillary area.

3.2.3 Major design features

The major design features of the proposal are described in the following sections and are shown in Figure 3-3, Figure 3-4 and Figure 3-5.

New northbound bridge

The new northbound bridge would have four lanes of northbound traffic with one being a dedicated continuous left turn slip lane between Bridge Road and Illaroo Road. The new bridge would be on the western side of the existing bridges with sufficient clearance to allow maintenance tasks to be completed. Two options for the superstructure of the new bridge are under consideration, these being a concrete box girder and a pre-cast concrete beam.

The overall length of the bridge deck would be about 363 metres, spanning over nine piers between north and south abutments. The typical span would be about 38.5 metres, with shorter spans nearing the abutments.

The overall width of the bridge would typically be about 21 metres to accommodate four 3.5 metre traffic lanes, two 1.0 metre shoulders, and a 3.5 metre shared path on the western side of the bridge. The bridge would widen at Span 1 towards the northern abutment to a width of about 25 metres to accommodate the left turn into Illaroo Road. Medium performance level barriers with twin rails would be provided either side of the traffic lanes.

The bridge piers would generally consist of piles driven into the river bed and bedrock, a pile cap which would be visible at the base of the pier, and the piers which support the superstructure on the pile caps.

Existing northbound bridge

The existing northbound bridge would be converted to carry southbound traffic, increasing the southbound through traffic capacity from two to three lanes. Minimal work is proposed and would be limited to resurfacing and line marking works to accommodate southbound traffic. The shared path would be closed once traffic is moved onto the new northbound bridge.

Existing southbound bridge

It is proposed to retain the existing southbound bridge, close it to vehicular traffic, and maintain it for adaptive reuse following opening of the new northbound bridge. The rehabilitation and repurposing of the existing southbound bridge for adaptive reuse would be subject to a separate consultation and assessment process.

Shared paths and maintenance access would be constructed up to the existing southbound bridge and works to prevent unauthorised access would also be carried out as part of the proposal.

Bomaderry Creek bridge

Works on the Bomaderry Creek bridge would involve demolition of the existing footpaths and widening of the structure on both sides. The widened bridge would have a deck length of about 48 metres spanning over two piers between the north and south abutments. This would provide six 3.5 metre traffic lanes, two 1.0 metre shoulders, and two 2.5 metre shared paths.

Princes Highway upgrade

The upgrade to the Princes Highway provides for three lanes in each direction, 3.5 metres in width, separated by a median, and with additional lanes provided at intersections for turning traffic. The width of the median would vary to accommodate additional turning lanes and pedestrian crossings.

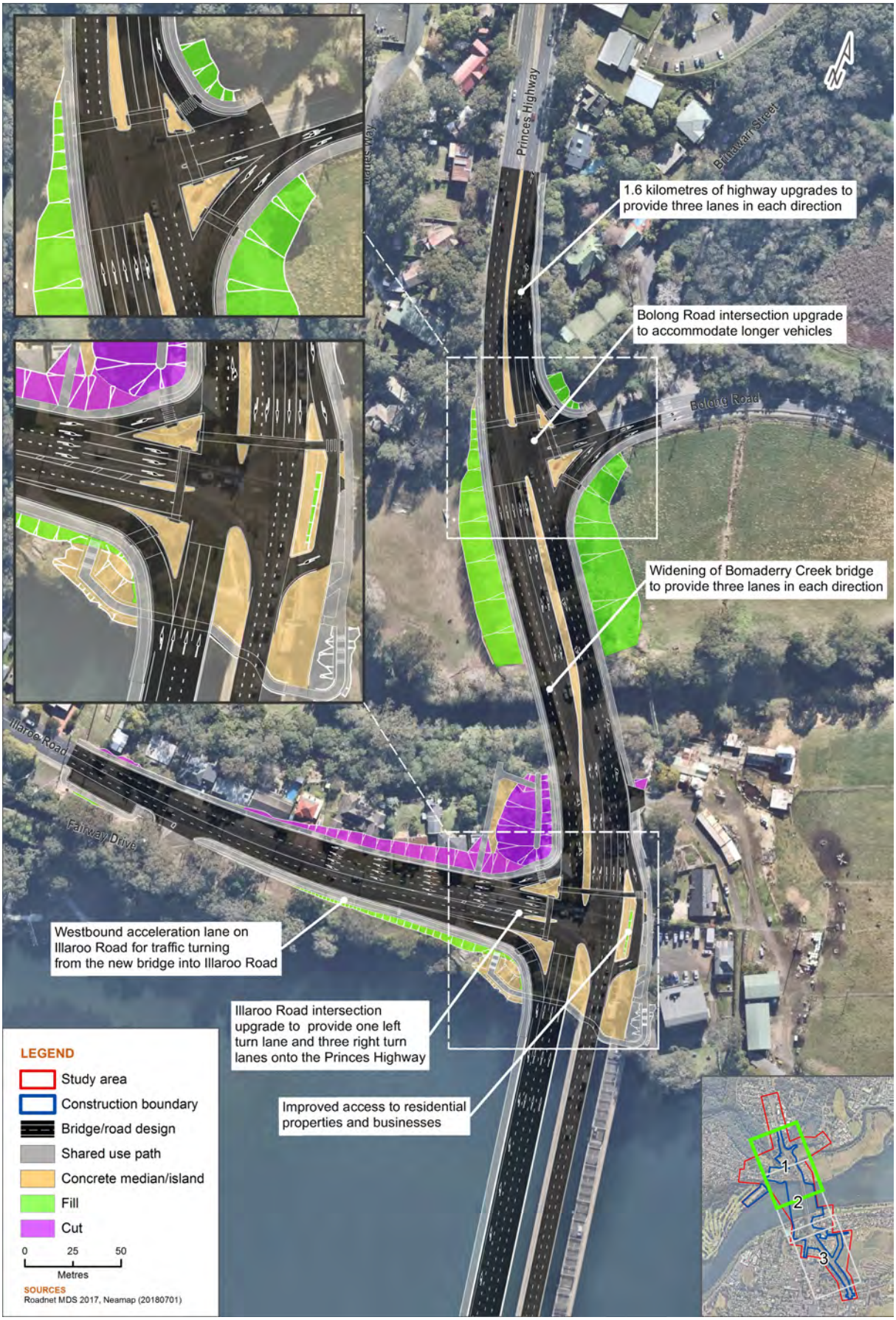

Figure 3-3: Major design features – North

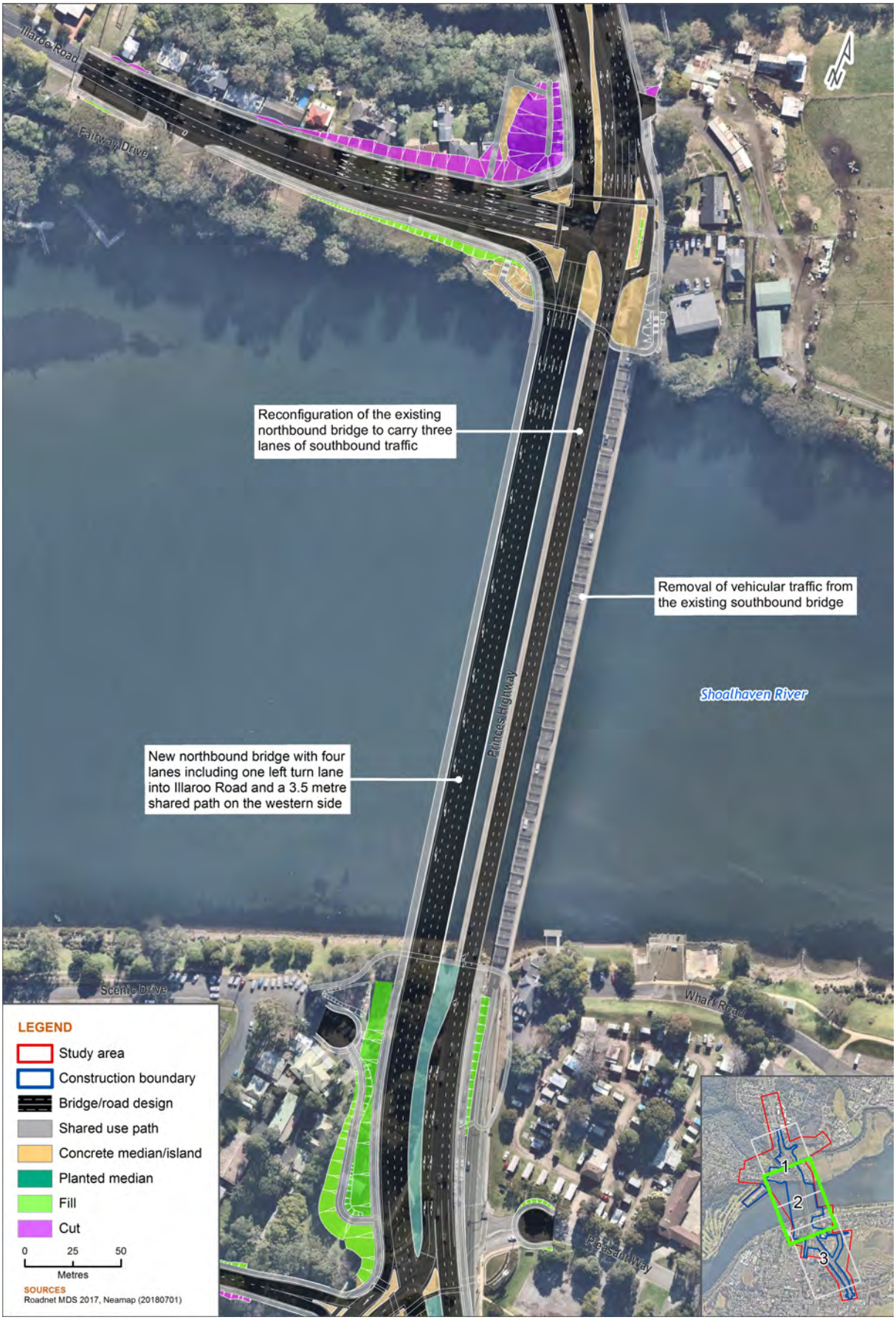

Figure 3-4: Major design features – Shoalhaven River

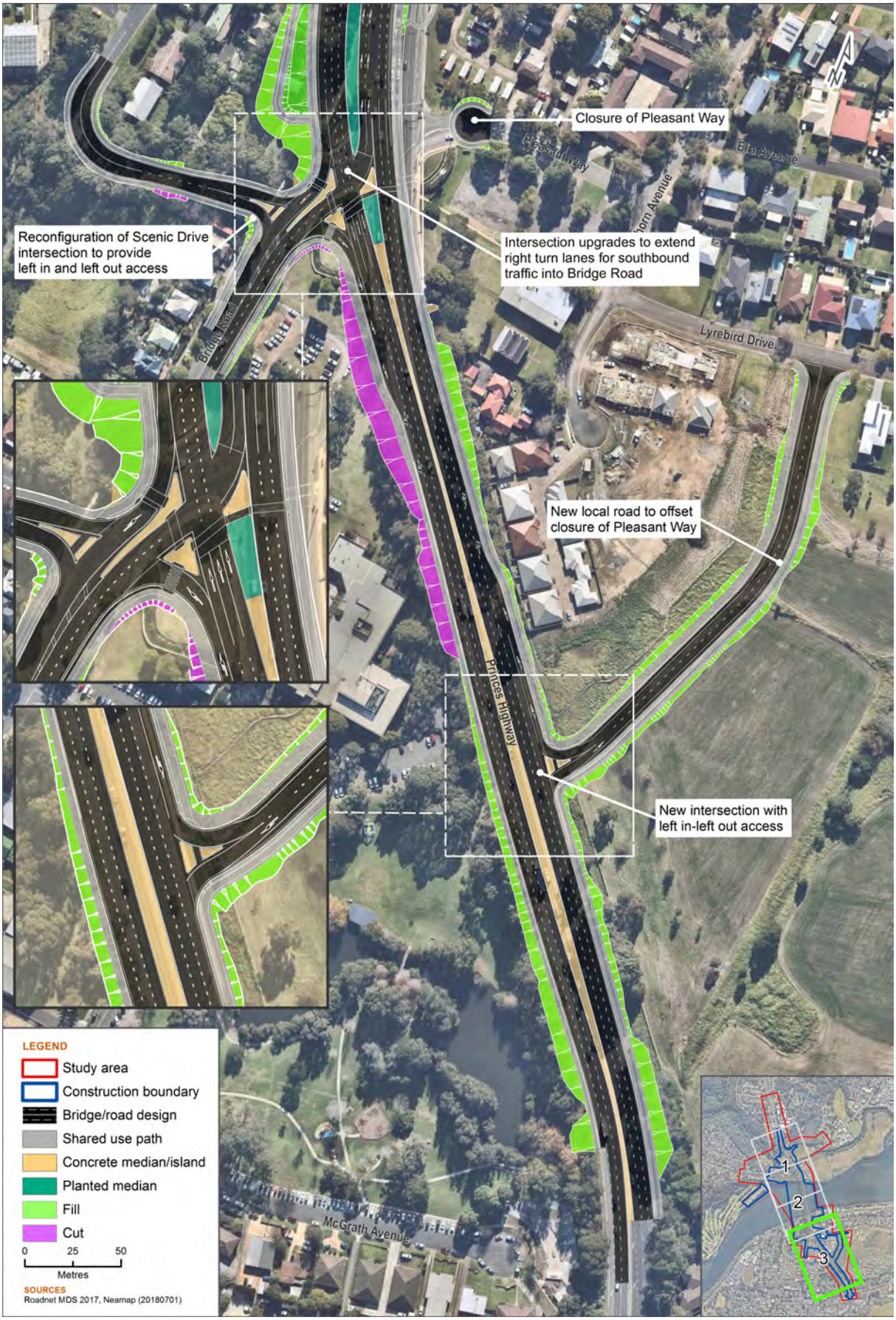

Figure 3-5: Major design features – South

Additional lanes would be provided as follows:

- A northbound left turn slip lane into Bolong Road
- Two right turn lanes from the Princes Highway to Bolong Road providing 105 metres and 110 metres of storage, and a deceleration length of 70 metres
- Two right turn lanes from the Princes Highway to Illaroo Road providing 60 metres of storage and a deceleration length of 70 metres
- Two right turn lanes from the Princes Highway to Bridge Road providing 60 metres storage and a deceleration length of 70 metres
- A left turn slip lane into the new local road connection
- A northbound left turn lane to Bridge Road providing a 70 metre lane and 130 metre long merge taper.

All intersections are currently controlled by traffic lights and this would remain unchanged. The phasing of traffic light operations would be coordinated and optimised for the intersections within and outside of the proposal area.

A new pedestrian crossing would be provided at the Bolong Road intersection and would allow pedestrians to safely cross the highway under the traffic signals.

Cross sections of the upgraded highway to the north of Illaroo Road and north of Bridge Road are shown in Figure 3-6 and Figure 3-7 respectively.

Local road adjustments

The concept design for the local road intersection upgrades provides:

- Bolong Road: Minor at grade works at the Bolong Road intersection would be carried out to accommodate larger truck movements from Bolong Road to the Princes Highway
- Illaroo Road: Illaroo Road would be widened over a distance of about 270 metres to provide three dedicated right turn lanes and one dedicated left turn lane to the Princes Highway, and a westbound acceleration lane for northbound traffic turning off the Princes Highway
- Pleasant Way: Pleasant Way to be closed and alternative access provided via a new intersection about 300 metres to the south connecting Princes Highway to Lyrebird Drive (new local road connection); access would be restricted to left in, left out
- Bridge Road/Scenic Drive: Access to/from Scenic Drive restricted to left in, left out.

Shared use paths

The proposal provides for pedestrian and cyclist access and connectivity via shared use paths that extend along the length of the proposal.

The new northbound bridge would include a 3.5 metre wide shared use path on the western side to improve connectivity between Nowra and North Nowra. The existing 2.5 metre shared use path on the southern side of Illaroo Road would be reconstructed to tie into the shared use path on the bridge. This shared use path would also continue south along the Princes Highway to Bridge Road.

A shared use path would be provided on the south eastern side of the highway from the Shoalhaven River south to Moss Street. This would connect to the existing shared path that runs along the southern bank of the Shoalhaven River.

Figure 3-6: Princes Highway cross section north of Illaroo Road intersection (looking south)

Figure 3-7: Princes Highway cross section north of Bridge Road intersection (looking south)

On the northern side of the Shoalhaven River, a path would be provided beneath the bridges connecting the path on the southern side of Illaroo Road to the path on the eastern side of the highway extending to Bolong Road.

The existing shared use path on the southern side of Bolong Road would be reconstructed to tie into the shared use path at the northern extent of works.

Drainage

The existing stormwater system for the Princes Highway and local roads would be upgraded to allow for stormwater runoff to be captured from any additional paved areas, the new northbound bridge, and the widened Bomaderry Creek bridge. The works would involve the construction of new kerbs, stormwater pits, new pipework and connections into the existing stormwater system.

Stormwater runoff would be collected from the new northbound bridge by outlets draining to drainage pipework. This would discharge to a water quality treatment device to reduce suspended solids and nutrients (Total Nitrogen, Total Phosphorus) prior to discharge.

Widening of Bomaderry Creek bridge would include reconfiguration of the bridge drainage. Pavement runoff from the bridge deck would be captured as gutter flow against the kerb and conveyed to a piped network where it would be directed to a discharge point near the intersection of Princes Highway and Bolong Road, about 100 metres to the north of Bomaderry Creek. Discharge to the natural surface at this location is considered to provide substantial opportunity for water quality treatment of the pavement runoff.

The drainage design would be considered further during detailed design and would seek to meet the water quality objectives recommended in the Operation Water Quality Assessment (refer Appendix G).

3.3 Construction activities

The construction boundary for the proposal (refer Figures 3-1 and 3-2) for the proposal includes areas for construction activities. These include:

- Ancillary facilities
- Indicative construction sediment basins
- Areas required for land and river access
- In-stream construction areas.

The boat ramp and northern foreshore area west of the existing bridges at Greys Beach may be used as a temporary ancillary facility, and access to the boat ramp and foreshore area may be restricted at times during construction. The southern foreshore area immediately west of the existing northbound bridge would be the main ancillary facility for the construction of the new bridge, and access to this area would be restricted for the duration of the works.

3.3.1 Work methodology

Construction activities would be carried out in accordance with a construction environmental management plan (CEMP) to ensure work complies with Roads and Maritime's commitments and legislative requirements. Detailed work methodologies would be identified by the construction

contractor. The proposal is anticipated to involve the following general construction methodology and sequencing:

- Site establishment and early works
- Utility works
- Building demolition
- Earthworks and drainage
- Bridge approaches
- Bridge construction
- Pavement construction
- Landscaping, finishing works and site rehabilitation.

Site establishment and early works

Site establishment and early works would consist of:

- Site survey, geotechnical and other investigations
- Property adjustment works including relocation of fences and boundary features
- Installation of architectural noise treatments to identified properties
- Installation of initial environmental controls including erosion and sediment controls and pollution management measures
- Minor earthworks to establish temporary construction roads, access points, level areas for site compounds, and sediment basins
- Minor vegetation clearing and grubbing works
- Establishment of site compounds and ancillary facilities
- Installation of temporary traffic controls and line marking
- Temporary closure of Scenic Drive at Bridge Road and detour put in place for the duration of the construction.

Utility works

Many utilities are located within the construction footprint and would require relocation or protection prior to construction commencement. Utility works would be undertaken concurrently with early works where possible and may be undertaken by service providers.

Utility works would include:

- Excavation of trenches, underboring, installation of services pits along the new utility routes
- Installation of bedding material and new utilities within trenches
- Installation of overhead services and associated support structures
- Testing and cutover of utilities into new infrastructure
- Decommissioning and removal of redundant utilities where required.

The number and type of utilities requiring relocation are discussed further in Section 3.5.

Building demolition

Demolition as part of the proposal would include houses, commercial properties, water pump stations, public toilets, septic tanks, and other Shoalhaven City Council infrastructure. Demolition

would be undertaken in compliance with AS2601: The demolition of structures (AS 2601) with any asbestos managed and removed by an appropriately licensed contractor.

Demolition activities would generally include:

- Identification and removal of asbestos (if required)
- Removal of fittings and other reusable elements
- Demolition of buildings and structures
- Sorting and temporary storage of demolition material into recyclable and waste components
- Loading and transporting recyclable and waste material to a licensed facility.

Earthworks and drainage

Earthworks activities would include:

- Vegetation clearing and grubbing
- Stripping, stockpiling and management of topsoil for reuse
- Removal, stockpiling and management of spoil and unsuitable material
- Excavate and fill to the road formation levels, including excavations for embankments and cuttings, movement of materials along the alignment from cuttings to fill embankment areas, and boxing out the new pavement
- Excess spoil would be used to flatten road side batters within the extents of the proposal where possible; where this is not possible, excess spoil would be disposed of to a suitably licensed facility
- Construction of road drainage structures including drainage lines, pits, and subsoil drains.

Bridge approaches

Land based structural works would be required for the bridge approaches, including retaining walls, stabilised embankments and bridge approach slabs. Typical construction activities would include:

- Ground preparation including minor earthworks
- Bored piling to provide foundation to support structural elements where required due to ground conditions
- For cast in-situ elements, erection of formwork, placement of steel reinforcing and pouring concrete
- For pre-cast elements, lifting, placing and securing precast components
- Stitching, joining and other similar processes to join structural elements together
- Backfilling and compaction of engineered fill or concrete
- Installation of the road layers including sub-base, base and surfacing layer as well as sub-surface drainage.

Bridge construction

New northbound bridge

Construction of the new northbound bridge would generally comprise:

- Carry out cut earthworks at the abutment locations
- Construct abutment piles
- Construct abutments

- Backfill / complete approach work
- Construct crane pads as required
- Cast concrete deck
- Install barrier and road surface wearing course.

There are two bridge type options for the proposed new northbound bridge. The general work methodologies and sequences for each bridge type are outlined as follows. An alternative bridge type or construction methodology may be identified by the contractor during detailed design.

Incrementally launched concrete box girder bridge option

Land-based construction activities associated with the new bridge would include construction of the abutments on the northern and southern banks to the west of the existing northbound bridge, and the casting and launching of the bridge superstructure.

Construction of the abutments would include:

- Importation of fill (local fill won from the proposal construction sites would be used where possible, although additional general and select imported fill is likely to be required)
- Completion of earthworks to create temporary level working platforms
- Installation of piles at abutment locations by boring to the required depth, placing a steel reinforcement cage in the hole then placing concrete in each pile
- Construction of the abutment walls and retaining structures for the bridge approaches including placement of beams
- Backfilling and compaction of engineered fill.

The incrementally launched method involves constructing the bridge superstructure progressively in segments on land and pushing the superstructure across the river and piers using hydraulic jacks. Superstructure segments would be cast on-site within a purpose built temporary concrete casting yard facility located behind the southern bridge abutment.

A casting bed would be created in the casting yard using formwork. Steel reinforcing for the bridge would also be installed in the formwork and once complete, concrete would be pumped into the formwork. The concrete would be allowed to set and cure.

The segment would then be joined to the already completed sections of the superstructure and then the whole superstructure would be pushed over the bridge piers and river using hydraulic jacks. This process would be repeated until the superstructure spans between the two abutments.

Finishing works on the bridge superstructure would include:

- Installing bearings on the piers and abutments to connect the bridge superstructure to the substructure
- Post-tensioning the bridge superstructure (tensioning cables inserted through the segments to hold them together)
- Installing precast or cast in situ concrete barriers
- Placing an asphalt road pavement surface
- Installing other road furniture such as lighting, signs and safety rails
- Line marking and other minor works.

Water-based construction associated with the proposal would include construction of nine piers in the Shoalhaven River (these being aligned with the piers of the existing northbound bridge) and

installation of scour protection below the water line. One or more barges would be used to provide working platforms for water-based construction activities.

Activities associated with pier construction would include:

- Installing piles at pier locations to the required depth by bored piling methods. A steel case would be driven to the required depth and the pile bored within this tube. A steel reinforcing cage would then be placed in the steel casing and the concrete poured into the pile. Works would be undertaken from barges moored at the pier locations
- Installing pile caps and pier columns using a combination of precast or cast in-situ methods.

As with the land-based components, the construction methods would be either based on precast or cast in-situ concrete components. If precast methods are used, the components of the pile caps or pier columns would be cast at an appropriately licensed off-site facility, before being transported to the intended location. The components would be lifted into place by a crane(s) sited on a barge(s). Cast in-situ methods for construction of the pile caps and pier columns would involve installation of formwork or precast concrete shells supported by a temporary scaffold system, and fixing of steel reinforcement into which concrete would be poured from barges.

Barges would be moored in suitable locations to facilitate the piling and installation of the piers and headstocks. Access to the Shoalhaven River to transport construction materials to the barges is expected to be from the launch site located on the southern side of the river to the west of the highway via a temporary jetty, from the boat ramps located off Fairway Drive on the northern side of the river, or from the boat ramp off Wharf Road on the southern side of the river.

Pre-cast concrete beam bridge option

Land-based construction of the northern and southern bridge abutments would be the same as for the incrementally launched bridge type.

To achieve production efficiencies, it would be most cost-effective to fabricate the concrete beams at an off-site casting yard and then transport them to the construction site. The beams would be 37.5 metres long so would require transportation using oversized vehicles along designated haulage routes and under appropriate traffic management.

The most practicable and safest land-based method to construct the bridge would be to use a launching truss. This is an engineered frame that is designed to move longitudinally along the alignment of a bridge and provide the mechanism to lift bridge segments into position. These trusses are fabricated from structural steel and the rigidity of the design primarily depends on both the span of the bridge (distance between the piers) and the mass of the segment being lifted.

The truss is designed with ‘feet’ that are jacked onto specific locations of the structure and these feet, once engaged, take the weight of the truss and allow it to ‘walk’ forward in a longitudinal plane. This self-propelling ability makes a launching truss ideal to use for the erection of long bridges as it minimises the support equipment required on site, like cranes and scaffold. Alternative construction methodologies may be identified by the contractor.

Water-based construction of the nine piers for the pre-cast concrete beam bridge would be the same as for the incrementally launched concrete box girder bridge.

A crane(s) would be used to lift in the concrete beams from barges. The bridge girders would be lifted directly onto the abutments and pier headstocks once the bridge bearings had been constructed. Temporary bracing may be required between the girders.

The deck would be poured, which may require temporary formwork supported directly from the bridge girders. The bridge deck and barrier kerbs would typically be constructed from reinforced cast in-situ concrete. Alternatively, precast units may be used for the barrier kerbs.

Finishing works for the pre-cast concrete beam bridge would be similar to those required for an incrementally launched bridge except for the post-tensioning of the superstructure.

Bomaderry Creek bridge

Widening of Bomaderry Creek bridge would generally comprise:

- Installation of environmental and traffic management controls
- Demolition of part of the existing headstocks at the pier and abutments followed by reinforcement of the existing headstocks to make them continuous with the widened headstocks
- Construction of new piles for the widened section to the west
- Demolition of the part of the deck slab and removal of concrete girders on either side of the bridge
- Placement of new concrete girders on the eastern and western sides
- Casting of remaining portions of the bridge deck
- Relocation of the median and line marking
- Removal of temporary works and site clean-up.

Pavement construction

Pavement construction would be required to tie the bridge approaches into the existing highway and local roads. Works would include:

- Removing areas of redundant pavement
- Installation of new kerb and gutter including driveway crossings where required
- Construction of new pavement, including placing and compacting select fill, sub-base and asphalt wearing surface
- Tying in footpaths, shared use paths, and pedestrian crossing facilities.

Landscaping, finishing works and site rehabilitation

Landscaping, finishing works and site rehabilitation would consist of:

- Installation of safety barrier systems, street lighting, fencing and roadside furniture
- Line marking and raised road markers
- Sign posting
- Rehabilitation of disturbed areas and landscaping in accordance with the urban design and landscape plan
- Works to prevent unauthorised access to the existing southbound bridge after removal of traffic
- Site clean-up and management of all surplus waste materials.

3.3.2 Construction hours and duration

It is anticipated that construction would commence in early 2021 with the new bridge targeted for opening to traffic in 2024.

Construction hours would be in accordance with the standard construction working hours as defined in the *Interim Construction Noise Guideline* (ICNG) (DECC 2009b):

- Monday to Friday: 7 am to 6 pm
- Saturday: 8 am to 1 pm
- Sundays and public holidays: no work.

In accordance with the Construction Noise and Vibration Guidelines (Roads and Maritime 2016), activities with impulsive or tonal noise emissions would be carried out only within the following hours:

- Monday to Friday: 8 am to 5 pm
- Saturday: 9 am to 1 pm
- Sundays and public holidays: no work.

Work with impulsive or tonal noise emissions would be carried out in continuous blocks not exceeding three hours each with a minimum respite of at least one hour between each block.

Under the ICNG, there are five categories of work that can be carried out outside the recommended standard hours, as follows:

- Delivery of oversized plant or structures, where police or other authorities have determined that special transport arrangements are required
- Emergency work, to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair works, where disruption to essential services and/or safety considerations do not allow work within standard hours
- Public infrastructure work that would shorten the duration of a project and are supported by the affected community
- Work where a proponent demonstrates and justifies the need to operate outside the standard hours.

It is anticipated that works would need to be carried out outside of standard construction hours, such as where works would interrupt the operation of the Princes Highway, involve utility relocations, or delivery and placement of pre-cast concrete bridge elements. Any out of hours works would be undertaken in accordance with the Construction Noise and Vibration Guidelines (Roads and Maritime, 2016).

Should an environment protection licence be required, any conditions relating to construction hours would also be adhered to.

3.3.3 Plant and equipment

A range of plant and equipment would be used during construction of the proposal. The final equipment and plant requirements would be identified by the construction contractor. An indicative list of plant and equipment likely to be used for each construction phase is provided in Table 3-2.

Table 3-2: Indicative construction plant and equipment

Construction phase	Plant and equipment
Site establishment and early works	Fences, portable sheds, portable toilets, road base and fuel storage tanks. Trucks, cranes, excavators, elevated work platform vehicle, backhoes, trenchers and small clearing equipment. Four-wheel drive vehicles, drillers.
Utility works	Trucks, light vehicles, cranes, excavators, elevated work platform vehicle, directional drilling rigs, backhoes, trenchers and small equipment.
Demolition	Trucks, bulldozers, scrapers, graders, excavators, backhoes, mulcher and small equipment
Earthworks	Trucks, bulldozers, excavators, scrapers, graders, water carts, compactors, rollers, blasting equipment, rock crushing equipment, and elevated work platform vehicle.
Drainage	Concrete pumps, cranes, excavators, trucks, trenching equipment, shoring equipment, small equipment. Materials include precast concrete pipes and pits, concrete, formworks.
Bridge construction	Excavators, rigid and articulated trucks, drilling rigs and pile boring machines, cranes, water carts, concrete trucks, generators, concrete pumps, welding equipment, suction dredge, cutting rods, hydraulic jacks, launching trusses/ moving gantries, barges and temporary jetties, small watercraft.
Pavement construction	Graders, backhoes, trucks, water carts, vibratory compactors, trenching equipment, concrete agitator trucks, bitumen sprayers, material transfer vehicle, asphalt pavers, vibratory rollers and rubber-tyre rollers.
Finishing and landscaping	Milling machines, piling machines, concrete pumps, cranes, welding equipment, trucks, rollers, road marking machine, concrete trucks, generators, oxy-cutting equipment, sprayers, light vehicles
Removal of ancillary facilities	Generators, trucks, cranes, light vehicles.

3.3.4 Earthworks

The estimated quantities of materials associated with the earthworks are provided in Table 3-3. It is estimated that the proposal would result in about 30,300 cubic metres of cut material north of the bridge abutment and about 9000 cubic metres of cut material south of the bridge abutment. The proposal would require about 14,900 cubic metres of fill material north of the bridge abutment and about 21,200 cubic metres of fill material south of the bridge abutment. The cut volumes do not include top soil removal or existing pavement removal.

The final earthwork requirements and sources of materials would be confirmed during detail design.

Table 3-3: Earthworks balance

Design element	Volume (m^3)
Material from excavations (cut)	39,300
Material required for embankments and revised road alignments (fill)	202,000
Total surplus of cut to fill	3,200

3.3.5 Source and quantity of materials

About 8000 cubic metres of concrete and 17,300 cubic metres of asphalt would be required for the proposal. Materials would be sourced from appropriately licensed commercial suppliers in nearby areas. None of the materials proposed to be used are considered to be in short supply. The quantities of materials required for the construction of the proposal would be refined during the detailed design phase.

Typical waste materials would include unsuitable cut material, unsuitable topsoil material, asphalt, concrete, demolition materials and vegetation. Surplus material unable to be used on-site or on adjacent projects would be classified in accordance with the NSW EPA *Waste Classification Guidelines* (EPA 2014) and disposed of to an approved materials recycling or waste disposal facility.

The volume of water that would be required during construction is unknown at this stage. This would depend on material sources and methodologies applied by the contractor. Water would be obtained from the town water supply.

3.3.6 Traffic management and access

Road closures

Temporary closures of roads may be required during construction, and would be determined by the construction contractor. As far as practicable, these would be scheduled to cause minimal disruption to local traffic and residents.

Temporary lane closures

A minimum of two lanes in each direction of the Princes Highway would be maintained where possible during construction. An exception would be during night works where the number of lanes may be reduced. Suitable traffic control measures would be employed for working under live traffic conditions.

Property access

All property access would be maintained during construction. Any required adjustments to accesses would be discussed with landowners/occupiers to determine any specific access requirements and alternatives available.

Pedestrian access

Pedestrian access would be diverted around work sites and alternative safe access provided. Pedestrian access along the foreshore under the existing bridges would be restricted during construction.

Construction traffic

Construction traffic movements would be related to light and heavy vehicles transporting materials to and from the site and additional movements in the vicinity to and from ancillary sites associated with deliveries and work force movements.

The peak heavy vehicle movements are expected during the earthworks and concrete pouring stages of construction.

Construction traffic impacts are discussed in Section 6.1.

Parking

The following existing public car parking areas may be temporarily impacted during stages of the construction period.

- Public off-street car park adjacent to Fairway Drive (about 100 spaces)
- Public off-street car park off Illaroo Road serving North Nowra Rotary Park (about 14 spaces)
- On-street parking on the northern side of Scenic Drive, immediately west of the Princes Highway (about five spaces) and at the northern end of Scenic Drive at the existing cul-de-sac (about 20 spaces)
- On-street parking on the western side of Bridge Road, south of Scenic Drive (about 10 spaces)
- The informal parking area to the north of the Shoalhaven Entertainment Centre (about 50 spaces)
- Public off-street car park adjacent to Pleasant Way and Graham Lodge (about 75 spaces).

Marine traffic and access

Construction of the new northbound bridge would require the use of boats, barges and other watercraft. Works would be undertaken within the proposal area to facilitate access from ancillary facilities to the Shoalhaven River.

Two locations have been identified for potential temporary moorings/jetties for construction barges and transfer of plant and materials:

- Shoalhaven River southern bank, located immediately west of the existing bridges
- Fairway Drive, generally occupying the area of the existing car park and part of Riverbank Reserve to the west.

In addition to the above two locations, the Wharf Road boat ramp may also be used to gain access to/from the river, and for transfer of materials.

The navigational channel of the Shoalhaven River in the proposal study area would be maintained through construction. Should there be a need to temporarily restrict watercraft movement during certain activities, the community would be notified in advance, and any restrictions would be in accordance with applicable Roads and Maritime requirements.

3.4 Ancillary facilities

A number of ancillary facilities would be required to support construction. Activities associated with the use of these sites would include:

- Site compounds incorporating site offices, car parking, amenity sheds, workshops and storage of construction materials and plant

- Temporary mooring facilities for barges
- Areas for the delivery and storage of bridge structural elements
- Areas for capturing and treating water from construction areas
- Stockpile sites for materials, spoil and cleared vegetation.

A launch site for the incrementally launched bridge option would also be required, and is proposed to be located at the southern bridge abutment. This site would include:

- A casting bed, including an adjustable formwork mould for casting the bridge segments, a laydown area(s) and space for required item of construction equipment
- A launch pad, including a paved area, various supports and guides to hold the superstructure and hydraulic jacks
- A small tower crane to move segments and other construction elements
- Areas to receive concrete deliveries and to store other materials and plant.

Five potential sites have been identified for ancillary facilities that would be used for construction compounds, plant/equipment storage, and temporary storage/stockpiling of construction materials. These are located principally in areas that maximise the use of available land or existing infrastructure, and minimise the amount of site preparation for use (such as clearing of vegetation).

The five sites are:

1. Bomaderry Creek, located on the eastern side of the Princes Highway between Bomaderry Creek and the Bolong Road intersection
2. Fairway Drive, generally occupying the area of the existing car park and a small area of adjacent cleared land to the southwest of the car park
3. Shoalhaven River southern bank, located immediately west of the Princes Highway on the southern side of the river
4. Pleasant Way, generally comprising the existing car park bounded by the Princes Highway, Pleasant Way, Hawthorn Avenue, and Graham Lodge
5. Bridge Road, located on the triangle of land to the south of Bridge Road intersection bounded by Bridge Road, the Princes Highway and the car park to the north of the Shoalhaven Entertainment Centre.

These sites are further described and evaluated against the site assessment criteria in Table 3-4. The locations of the five sites are shown in Figure 3-8. Sites that are not owned by Roads and Maritime would be acquired or leased during construction pending agreement between the landowner and Roads and Maritime.

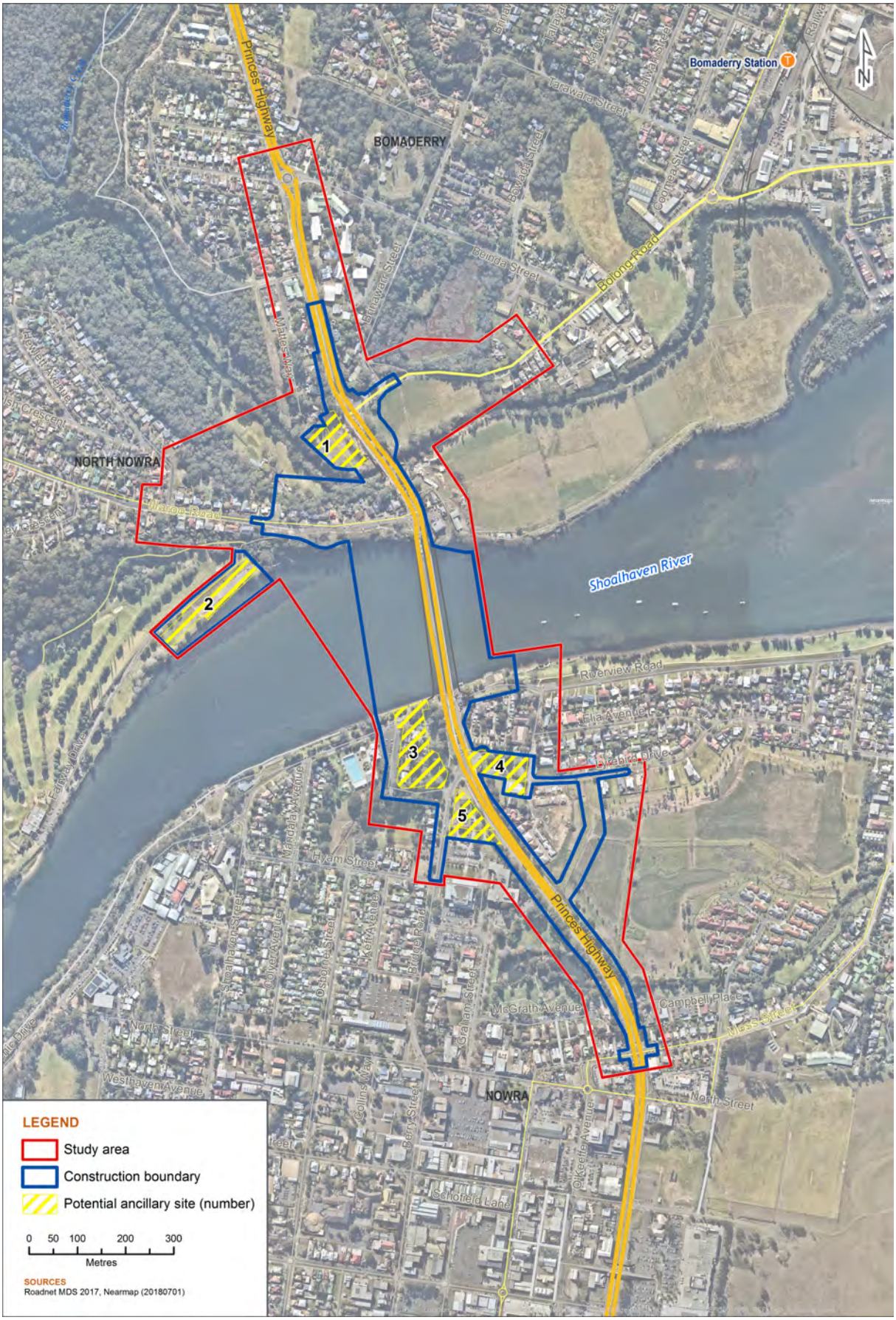

Figure 3-8: Potential ancillary sites

Should the need for additional ancillary facilities sites be identified during detailed design and construction planning, the positioning of additional sites would be undertaken considering the following site assessment criteria:

- Operational during a flood event and avoid or minimise impacts to surrounding properties
- More than 40 metres from a watercourse
- More than 50 metres from residential dwellings
- In previously disturbed areas that do not require the clearing of native vegetation
- Outside the drip line of trees
- On relatively level ground
- Away from areas of heritage value.

The positioning of any additional ancillary facilities would aim to meet all of the above criteria. However, due to the nature of the proposal area and the surrounding environment, this may not be possible. Consultation with the Roads and Maritime Environment Manager would be carried out to confirm the suitability of any additional ancillary facilities and whether any additional environmental controls or assessment would be required.

Table 3-4: Ancillary sites, indicative use, and compliance with location criteria

Location context	Indicative use	Compliance with location criteria
1. Bomaderry Creek site The Bomaderry Creek site is predominantly cleared land with vegetation lining Bomaderry Creek and the Princes Highway. The site is opposite Bolong Road on the western side of the Princes Highway and the construction area. Access to the site would be directly from the Princes Highway. Residences along Mattes Way are located directly to the north of the site.	Temporary office and workers amenity buildings, construction plant and materials storage Some clearing of vegetation is expected to be required	The site is located less than 40 metres from a watercourse and less than 50 metres from residential dwellings. The site falls within the local heritage item 'Lynburn' Timber Federation Residence and Garden land parcel. No structures would impacted by the temporary site. The site falls within Aboriginal heritage area Nowra Bridge 8 that will result in a direct impact and total loss of value requiring an Aboriginal heritage impact permit and targeted salvage. Potential impacts on heritage are discussed in Section 6.3 and Section 6.4.
2. Fairway Drive site The Fairway Drive site consists of paved and grassed areas directly adjacent to the Shoalhaven River. Site access is from Fairway Drive off Illaroo Road. Scattered trees exist adjacent to the Shoalhaven River. The golf course is north west of the site and residential properties are present north of the site along Illaroo Road.	Temporary materials and plant storage Temporary barge mooring and loading facilities Use of this site would be managed to minimise impacts on boat ramp users; access to the boat ramp may need to be restricted at times for safety reasons but would avoid periods of high usage as far as practicable No clearing of vegetation is expected to be required	The site complies with most of the site assessment criteria however the site is located less than 40 metres from a watercourse.
3. Shoalhaven River southern bank site The site is located immediately west of the Princes Highway on the southern side of the Shoalhaven River, and broadly comprises the area between the river, the highway and Scenic Drive.	Main compound site on southern side of river which would be used for fabrication and launching of an incrementally launched concrete box girder bridge. Temporary materials and plant storage Temporary barge mooring and loading facilities	The site is located less than 40 metres from a watercourse and less than 50 metres from residential dwellings. The site is generally flood immune up to the five per cent AEP event (depth of inundation about 0.06 metres).

Location context	Indicative use	Compliance with location criteria
The site contains two commercial properties: the Dish and the Spoon Café, and the Riverhaven Motel. The Captain Cook Bicentennial Memorial is located within the site. The M&M Guesthouse, identified as having potential local heritage value is also located within this site. Nowra Aquatic Park is located to the west of the site.	Part of the site would be acquired for the proposal, with the remainder leased for the construction period. Use of this site would require removal of existing structures.	Use of the site will result in the physical impact to the locally heritage listed Captain Cook Bicentennial Memorial and potential heritage item, M&M Guesthouse. The potential impacts to heritage are discussed in Section 6.4. While use of the site would require clearing of vegetation, most of this would relate to the permanent works.
4. Pleasant Way site The Pleasant Way site is located immediately east of the highway between Pleasant Way and Hawthorn Avenue. It is on the northern part of the Graham Lodge property; the affected area consists of cleared land, grassed areas and pavement with scattered vegetation, and the vacant commercial building (former Nowra Steakhouse & Café). The East Willows Van Park is located to the north of the site with residential properties to the east. The site is accessed by Pleasant Way and Hawthorn Avenue.	Materials and plant storage Access to construction areas on the eastern side of the Princes Highway Former information centre building may be leased for use during the construction period The site is located within the heritage curtilage of Graham Lodge; as such use of the site would be managed to minimise impacts on heritage values.	The site is located less than 50 metres from residential dwellings. The proposal would involve works within the heritage curtilage of State heritage listed item Graham Lodge that involves the use of the existing carpark and hardstand area. The impacts would be temporary and not result in permanent changes or a reduction of the item's heritage curtilage. Graham Lodge also has identified Aboriginal heritage cultural values. Potential impacts on heritage are discussed in Section 6.3 and Section 6.4.
5. Bridge Road site The Bridge Road site consists of a car parking lot and mostly cleared land with scattered vegetation. The site can be accessed from Bridge Road. Residential dwellings are to the west and the Entertainment Centre falls to the south of the site.	Materials and plant storage Access to construction areas on western side of Princes Highway Vegetation within the design footprint would be cleared, and removal of other vegetation would be minimised where practicable	The site is located less than 50 metres from residential dwellings. The site contains an Aboriginal heritage site (Site 1) which would be directly impacted. Potential impacts to heritage are discussed in Section 6.3. Flooding issues existing in the Harry Sawkins Park area located south of the site.

3.5 Public utility adjustments

The concept design has given consideration to:

- Existing service pit locations and connecting services
- Allowable minimum cover
- Surcharge loads.

Services that would be impacted include:

- Shoalhaven City Council sewer and water supply
- One septic tank
- Drainage infrastructure
- Overhead and underground power (low voltage and high voltage)
- Gas
- Critical and high integrity communications cables.

Services likely to be affected include Endeavour Energy, Shoalhaven City Council Telstra, RMS, Jemena, Telstra, NBN Co, Optus, Pipe Networks, Soul (TPG) and AARNet (many sharing Telstra ducts). There is also an overhead Variable Message Sign within the proposed location of works which contains an overheight detection system for southbound traffic that would be decommissioned after construction.

Utility relocations would be designed and constructed in accordance with the respective utility providers' requirements. Further consultation would be undertaken during the detailed design and construction planning stage of the proposal.

3.6 Property acquisition

The proposal would require the full or partial acquisition of a number of properties, and the temporary leasing of properties for construction (see Figure 3-9) as follows:

- 16 properties to be fully acquired
- 25 properties to be partially acquired
- 18 properties to be fully or partially leased.

The extent of property acquisition would be refined and confirmed during detailed design, and in consultation with the affected property owners. Property acquisition would be undertaken in accordance with Roads and Maritime's Land Acquisition Information Guide 2014 and the *Land Acquisition (Just Terms Compensation) Act 1991*. Property adjustment plans would be developed in consultation with the relevant property owner.

Properties proposed to be fully or partially acquired, or leased are listed in Table 3-5.

Some properties may be subject to Aboriginal land claims and these are discussed in Section 6.7.2.

Table 3-5: Proposed property acquisition and leases

Area ID	Description	Total area (m^2)	Acquisition type	Current owner	Lot and DP	Land use zone (LEP)
1	Private dwelling – 1 Illaroo Road	924	Full acquisition	Private	Lot 1 DP13492	R2
2	Private dwelling – 3 Illaroo Road	743	Full acquisition	Private	Lot 2 DP13492	R2
3	Private dwelling – 5 Illaroo Road	780	Full acquisition	Private	Lot 3 DP13492	R2
4	Private dwelling – 7 Illaroo Road	810	Full acquisition	Private	Lot B DP375637	R2
4A	Private dwelling – 7 Illaroo Road	74	Full acquisition	Private	Lot 2 DP 210952	R2
5	Private dwelling – 9 Illaroo Road	737	Full acquisition	Private	Lot 1 DP210952	R2
6	Private dwelling – 11 Illaroo Road	1476	Full acquisition	Private	Lot 4 DP13492	R2
7	Private dwelling – 15 Illaroo Road	654	Full acquisition	Private	Lot 5 DP 13492	R2
8	Private dwelling – 17 Illaroo Road	911	Full acquisition	Private	Lot 1 DP119928	R2
9	Private Dwelling – 125 Brinawarr Street ('Illowra')	461	Partial acquisition	Private	Lot 2 DP792770	R2
9A	Private Dwelling – 125 Brinawarr Street ('Illowra')	288	Lease for construction	Private	Lot 2 DP792770	R2
10	Vacant land north of Bolong Road intersection	215	Partial acquisition	Council	Lot 1 DP397062	RE1
11	Farmland east of the Princes Highway, north of Bomaderry Creek	3378	Partial acquisition	Private	Lot 221 DP1182436	RU1
11A	Farmland east of the Princes Highway, south of Bomaderry Creek	189	Partial acquisition	Private	Lot 221 DP1182436	RU1

Area ID	Description	Total area (m^2)	Acquisition type	Current owner	Lot and DP	Land use zone (LEP)
11B	Farmland east of the Princes Highway, south of Bomaderry Creek	29	Partial acquisition	Private	Lot 221 DP1182436	RU1
11C	Farmland east of the Princes Highway, south of Bomaderry Creek	443	Utility easement	Private	Lot 221 DP1182436	RU1
11D	Farmland east of the Princes Highway, south of Bomaderry Creek	103	Utility easement/Lease for construction	Private	Lot 221 DP1182436	RU1
12	Private dwelling - 13 Mattes Way ('Lynburn')	3980	Partial acquisition	Private	Lot 23 DP793122	R2/E2
12A	Private dwelling - 13 Mattes Way ('Lynburn')	3372	Lease for construction	Private	Lot 23 DP793122	R2/E2
13	Vacant land adjacent to Bomaderry Creek	1241	Partial acquisition	Crown	Lot 7322 DP1163457	E2
13A	Vacant land adjacent to Bomaderry Creek	5882	Lease for construction	Crown	Lot 7322 DP1163457	E2
14	Sewerage infrastructure	23	Partial acquisition	Council	Lot 1 DP569158	RU1/SP2
14A	Sewerage infrastructure	82	Lease for construction	Council	Lot 1 DP569158	RU1/SP2
15	Private dwelling - 476 Princes Highway	150	Utility easement	Private	Lot 1 DP 601330	RU1
16	Perfect Catch Fish n Chips	325	Partial acquisition	Private	Lot A DP386575	RU1
16A	Perfect Catch Fish n Chips	137	Utility easement	Private	Lot A DP386575	RU1
17	Vacant land adjacent to Bomaderry Creek	5091	Partial acquisition	Crown	Lot 7324 DP1163457	E2
18	Land south of Illaroo Road adjacent to Shoalhaven River	3554	Partial acquisition	Crown	Lot 7302 DP1164490	RE1

Area ID	Description	Total area (m^2)	Acquisition type	Current owner	Lot and DP	Land use zone (LEP)
18A	Land south of Illaroo Road adjacent to Shoalhaven River	4760	Lease for construction	Crown	Lot 7302 DP1164490	RE1
18B	Land south of Illaroo Road adjacent to Shoalhaven River	11780	Lease for construction	Crown	Lot 7302 DP1164490	RE1
19	Land south of Illaroo Road	870	Partial acquisition	Crown	Lot 1 DP438034	RE1
20	Land on the Shoalhaven River southern foreshore	328	Lease for construction	Crown	Lot 370 DP755952	SP2
21	Land on the Shoalhaven River southern foreshore	3661	Partial acquisition	Crown	Lot 7325 DP1166966	RE1
22	Land on the Shoalhaven River southern foreshore	439	Full acquisition	Council	Lot 1 DP1176373	RE1
23	Land on the Shoalhaven River southern foreshore	414	Full acquisition	Council	Lot 1 DP1127316	RE1
24	Land on the Shoalhaven River southern foreshore	909	Full acquisition	Crown	Lot 7038 DP1107416	RE1
25	Former Riverhaven Motel – 1 Scenic Drive	343	Partial acquisition	Private	Lot 1 DP624434	B4
25A	Former Riverhaven Motel – 1 Scenic Drive	6481	Lease for construction	Private	Lot 1 DP624434	B4
26	Land on the Shoalhaven River southern foreshore	1852	Full acquisition	Council	Lot 5 DP252460	RE1
26A	Land on the Shoalhaven River southern foreshore	721	Lease for construction	Council	Lot 5 DP252460	RE1

Area ID	Description	Total area (m^2)	Acquisition type	Current owner	Lot and DP	Land use zone (LEP)
27	Vacant lot on corner of Princes Highway and Bridge Road	919	Full acquisition	Council	Lot 6 DP813461	B4
28	Vacant lot on corner of Princes Highway and Bridge Road	420	Partial acquisition	Council	Lot 5 DP5813461	B4
28A	Vacant lot on corner of Princes Highway and Bridge Road	422	Lease for construction	Council	Lot 5 DP5813461	B4
29	Vacant lot on corner of Princes Highway and Bridge Road	365	Partial acquisition	Council	Lot 1 DP194884	B4
29A	Vacant lot on corner of Princes Highway and Bridge Road	1307	Lease for construction	Council	Lot 1 DP194884	B4
30	Vacant lot on corner of Princes Highway and Bridge Road	732	Partial acquisition	Council	Lot 5 DP112482	B4
30A	Vacant lot on corner of Princes Highway and Bridge Road	1041	Lease for construction	Council	Lot 5 DP112482	B4
31	Vacant lot on corner of Princes Highway and Bridge Road	918	Lease for construction	Council	Lot A DP158942	B4
32	Vacant lot on corner of Princes Highway and Bridge Road	121	Lease for construction	Council	Lot B DP158942	B4
33	Former tourist information centre and carpark	4742	Lease for construction	Council	Lot 1 DP1010062	B4
34	Vacant lot - 60 Lyrebird Drive	831	Full acquisition	Private	Lot 64 DP1198691	R2
35	Vacant lot - 11 Hawthorn Avenue	2197	Partial acquisition	Private	Lot 1002 DP1233127	R3

Area ID	Description	Total area (m^2)	Acquisition type	Current owner	Lot and DP	Land use zone (LEP)
36	26 Hawthorn Avenue	549	Partial acquisition	Private	Lot 1001 DP1233127	R3
37	Vacant lot	2157	Partial acquisition	Council	Lot 8 DP809132	RE1
38	Vacant lot	4476	Full acquisition	Council	Lot 3 DP625514	RE1
39	Vacant lot	439	Partial acquisition	Council	Lot 100 DP1071707	RE1
40	Shoalhaven City Council (local government chambers)	1215	Partial acquisition	Council	Lot 51 DP209295	B4/RE1
41	Harry Sawkins Park	293	Partial acquisition	Council	Lot 52 DP209295	B4/RE1
42	Harry Sawkins Park	451	Partial acquisition	Council	Lot 5 DP208897	RE1
43	Harry Sawkins Park	509	Partial acquisition	Council	Lot 2 DP802068	RE1
44	Fairway Drive adjacent to Greys Beach	1981	Lease for construction	Crown	Lot 7303 DP1164490	RE1

Figure 3-9: Proposed property acquisition – North

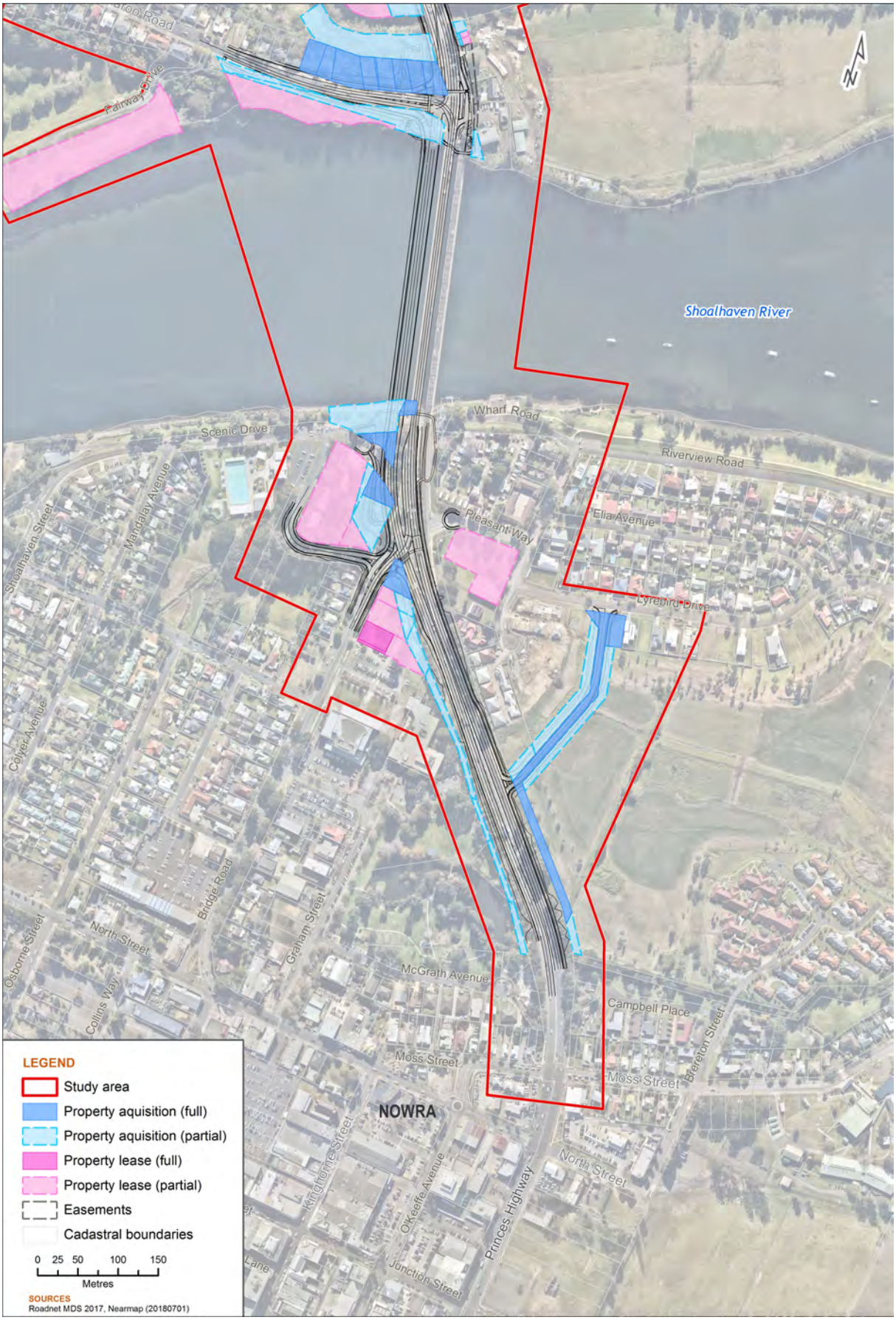

Figure 3-10: Proposed property acquisition – South

4. Statutory and planning framework

4.1 Environmental Planning and Assessment Act 1979

4.1.1 State Environmental Planning Policies

State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across the State. Clause 94 of the ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent.

As the proposal is for a new bridge and road upgrade, and is to be carried out on behalf of Roads and Maritime, it can be assessed under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Development consent from Shoalhaven City Council is not required.

The proposal is not located on land reserved under the *National Parks and Wildlife Act 1974*, does not trigger designated development under State Environmental Planning Policy (Coastal Management) 2018 and does not affect land or development regulated by State Environmental Planning Policy (State and Regional Development) 2011 or State Environmental Planning Policy (Major Development) 2005.

Part 2 of the ISEPP contains provisions for public authorities to consult with local councils and other public authorities prior to the commencement of certain types of development. Consultation, including consultation as required by the ISEPP (where applicable), is discussed in Chapter 5 of this REF.

State Environmental Planning Policy (Coastal Management) 2018

State Environmental Planning Policy (Coastal Management) 2018 (Coastal Management SEPP) commenced on 3 April 2018. It aims to promote an integrated and coordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the *Coastal Management Act 2016*. The Coastal Management SEPP consolidates and consequently repeals SEPP 14 (Coastal Wetlands), SEPP 26 (Littoral Rainforests) and SEPP 71 (Coastal Protection).

The proposal is located on land mapped as ‘coastal environment area’ and ‘coastal use area’. Development consent within this area must be in accordance with clause 13 of the Coastal Management SEPP, which includes consideration by the consent authority that the proposal will not cause adverse impacts to coastal processes, water quality of a marine estate, Aboriginal heritage and that the proposal incorporates water sensitive urban design (refer Table 4-1, Table 4-2).

As the proposal is not designated development under the Coastal Management SEPP and is development without consent under clause 94 of the ISEPP, consent is not required from Shoalhaven City Council; therefore the requirements of clause 13 do not apply to the proposal. However, the proposal would be broadly consistent with the objectives of each area.

Table 4-1: Considerations for development within the coastal environment area

Clause 13(1) matter	Comment
a) The integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment	The proposal will result in: • Clearing of up to 2.18 hectares of native vegetation, including 0.09 hectares of the endangered ecological community Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions • Removal of 19 Magenta Lilly Pilly (*Syzygium paniculatum*) plants which are listed as endangered under the *Biodiversity Conservation Act 2016* • Impacts on up to 0.09 hectares of seagrass (*Zostera muelleri*), which is a Type 1 key fish habitat under the *Fisheries Management Act 1994*. The proposal is not likely to significantly impact threatened species, ecological communities or migratory species. The proposal includes water quality treatment devices to manage stormwater runoff from the new northbound bridge. Operation of the proposal is not likely lead to a significant change in water quality within the Shoalhaven River or Bomaderry Creek. Potential impacts are discussed in detail in Sections 6.9 and 6.10.
b) Coastal environmental values and natural coastal processes	The proposal is located inland from the coast and is considered unlikely to affect related values or natural coastal processes. The principal factor for consideration is disruption to sediment transport down the river to the coast, and the proposal is considered unlikely to have a material effect on this. Consideration of potential impacts on coastal processes is provided in Section 6.6 of this REF.
c) The water quality of the marine estate (within the meaning of the *Marine Estate Management Act 2014),* in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1	The proposal includes water quality treatment devices to manage stormwater runoff from the new northbound bridge. Operation of the proposal is not likely lead to a significant change in water quality within the Shoalhaven River or Bomaderry Creek. The proposal would not affect any of the lakes identified in Schedule 1 to this Act. This is discussed in Section 6.10.
d) Marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms	The proposal will result in: • Clearing of up to 2.18 hectares of native vegetation, including 0.09 hectares of the endangered ecological community Swamp Oak Floodplain Forest of the New South Wales North

Clause 13(1) matter	Comment
	Coast, Sydney Basin and South East Corner Bioregions • Removal of 19 Magenta Lilly Pilly (*Syzygium paniculatum*) plants which are listed as endangered under the *Biodiversity Conservation Act 2016* • Impacts on up to 0.09 hectares of seagrass (*Zostera muelleri*), which is a Type 1 key fish habitat under the *Fisheries Management Act 1994*. The assessment found that the proposal is not likely to significantly impact threatened species, ecological communities or migratory species. A water quality treatment swale and basin will be constructed to manage stormwater runoff from the proposal. Operation of the proposal is not likely lead to a significant change in water quality within the Shoalhaven River or Bomaderry Creek. This is discussed in detail in Section 6.10.
e) Existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability	Access to some areas of public open space on the Shoalhaven River foreshore would be temporarily restricted/reduced during construction. A traffic management plan would be developed as a part of the construction environmental management plan to address any temporary impacts. Opportunities to provide new and improved access during operation have been incorporated into the proposal and will be further investigated during the detailed design. The proposal would improve conditions for pedestrians and cyclists by providing a range of improvements to the existing network and facilities. Urban design issues and visual amenity are discussed in detail in Section 6.5. A comprehensive range of measures have been identified to mitigate and manage any potential impacts.
f) Aboriginal cultural heritage, practices and places	Seven Aboriginal sites would be impacted by the proposal. Prior to construction, collection of artefacts and targeted salvage would be required in accordance with an Aboriginal Heritage Impact Permit. The ongoing operation and maintenance of the proposal would not result in potential impacts to Aboriginal heritage. A Heritage Interpretation Strategy would be prepared and implemented for the proposal that would address the cultural significance of the affected sites. Potential impacts and mitigation are discussed in detail in Section 6.3.
g) The use of the surf zone	The proposal sits outside the surf zone.

Table 4-2: Considerations for development within the coastal use area

Clause 14(1)(a) matter	Comment
i) Existing, safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability	Access to some areas of public open space on the Shoalhaven River foreshore would be temporarily restricted/reduced during construction. A traffic management plan would be developed as a part of the construction environmental management plan to address any temporary impacts. Opportunities to provide new and improved access during operation have been incorporated into the proposal and will be further investigated during the detailed design. The proposal would improve conditions for pedestrians and cyclists by providing a range of improvements to the existing network and facilities. Urban design issues and visual amenity are discussed in detail in Section 6.5. A comprehensive range of measures have been identified to mitigate and manage any potential impacts
ii) Overshadowing, wind funnelling and the loss of views from public places to foreshores	The new northbound bridge would have associated shadowing impacts and these have been considered in the landscape character and visual impact assessment carried out for the proposal. Visual impacts associated with the construction of the proposal are directly associated with vegetation clearing, erection of a new bridge and the presence of plant and equipment. Construction works would be clearly viewed from the Shoalhaven River, adjacent banks and foreshore areas. Visual impacts during construction would be temporary in nature and standard construction safeguards and management measures would be adopted to minimise these impacts. The proposal would have an impact on landscape character. Works would be occurring within or directly adjacent to an existing road corridor, and would impact most landscape character zones to some degree. Particularly in highly visible areas adjacent to the Shoalhaven River the landscape character would be impacted for motorists, cyclists, local residents and tourists. Potential impacts are discussed further in Section 6.5.
iii) The visual amenity and scenic qualities of the coast, including coastal headlands,	The environmental assessment has included assessment of the impacts of the proposal on visual amenity, including along the Shoalhaven River foreshores. The proposal includes measures to replace and enhance visual amenity values affected by the proposal.
iv) Aboriginal cultural heritage, practices and places	Seven Aboriginal sites would be impacted by the proposal. Prior to construction, collection of artefacts and targeted salvage would be required in accordance with an Aboriginal Heritage Impact Permit. The ongoing operation and maintenance of the proposal would not result in potential impacts to Aboriginal heritage.

Clause 14(1)(a) matter	Comment
	A Heritage Interpretation Strategy would be prepared and implemented for the proposal that would address the cultural significance of the affected sites. Potential impacts and mitigation are discussed in detail in Section 6.3.
v) Cultural and built environment heritage	The environmental assessment carried out for the proposal has included preparation of a Statement of Heritage Impact for non-Aboriginal cultural and built heritage. Construction of the proposal would result in a direct impact to non-Aboriginal heritage. Potential impacts and mitigation are discussed in detail in Section 6.4.

4.1.2 Local Environmental Plans

Shoalhaven Local Environmental Plan 2014

The proposal is located within the Shoalhaven LGA. The relevant local environmental planning instrument under the EP&A Act is the Shoalhaven LEP 2014.

The Shoalhaven LEP identifies land use zones adjacent to the Shoalhaven River, including zone objectives and permissible and prohibited development. Land use zones over the Proposal area are: RE1 Public Recreation, R2 Low Density Residential, SP2 Infrastructure, B4 Mixed Use, and RU1 Primary Production. Table 4-3 provides a brief summary of how the proposal would be consistent with the objectives of each of these zones. Zonings are also shown on Figure 4-1.

Impacts on land use are discussed in Section 6.7. Roads are permissible with development consent under all of the other zonings however as identified in Section 4.1.1, clause 94 of the ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent. The proposal is therefore permitted without consent from Shoalhaven City Council. The proposal would however be broadly consistent with the objectives for the other zones. Local heritage impacts are discussed in Section 6.4.

Shoalhaven City Council has been consulted on the proposal and would continue to be consulted throughout the proposal development and construction.

Table 4-3: Land use zonings affected by the proposal

Land use zoning	Objectives	Proposal consistency
RE1 Public Recreation	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.	The proposal would slightly reduce the amount of public recreation land available in along banks of the Shoalhaven River. The design has sought to minimise the footprint by staying as close as possible to the existing bridges and road corridor where possible. The proposal would include a shared path on the new bridge.

Land use zoning	Objectives	Proposal consistency
R2 Low Density Residential	To provide for the housing needs of the community within a low density residential environment. To enable other land uses that provide 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.	The proposal would improve traffic conditions including safety and accessibility for residents for crossing the Shoalhaven River. The provision of a shared path along the length of the proposal would provide safer pedestrian and cyclist movement. The capacity of the proposal has been designed to meet the needs of future generations and to minimise the loss of vegetation and biodiversity. An Urban Design and Landscape Plan would be prepared to minimise impacts on amenity.
SP2 Infrastructure	To provide for infrastructure and related uses. To prevent development that is not compatible with or that may detract from the provision of infrastructure.	The proposal comprises road infrastructure.
B4 Mixed Use	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.	The proposal would be consistent with the objectives of this zone as the proposal is for a road. The proposal is also going to improve pedestrian access during operation. It is likely to also improve the overall uses within this zone by improved road access and travel time.
RU1 Primary Production	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 within this zone for extractive industries.	The proposal would be consistent with the objectives of this zone as the proposal is for a road. The proposal is also going to improve freight access southbound on the Princes Highway during operation. It is likely to also improve the overall uses within this zone by improved road access, travel time and removal of HML and height restrictions for vehicles.

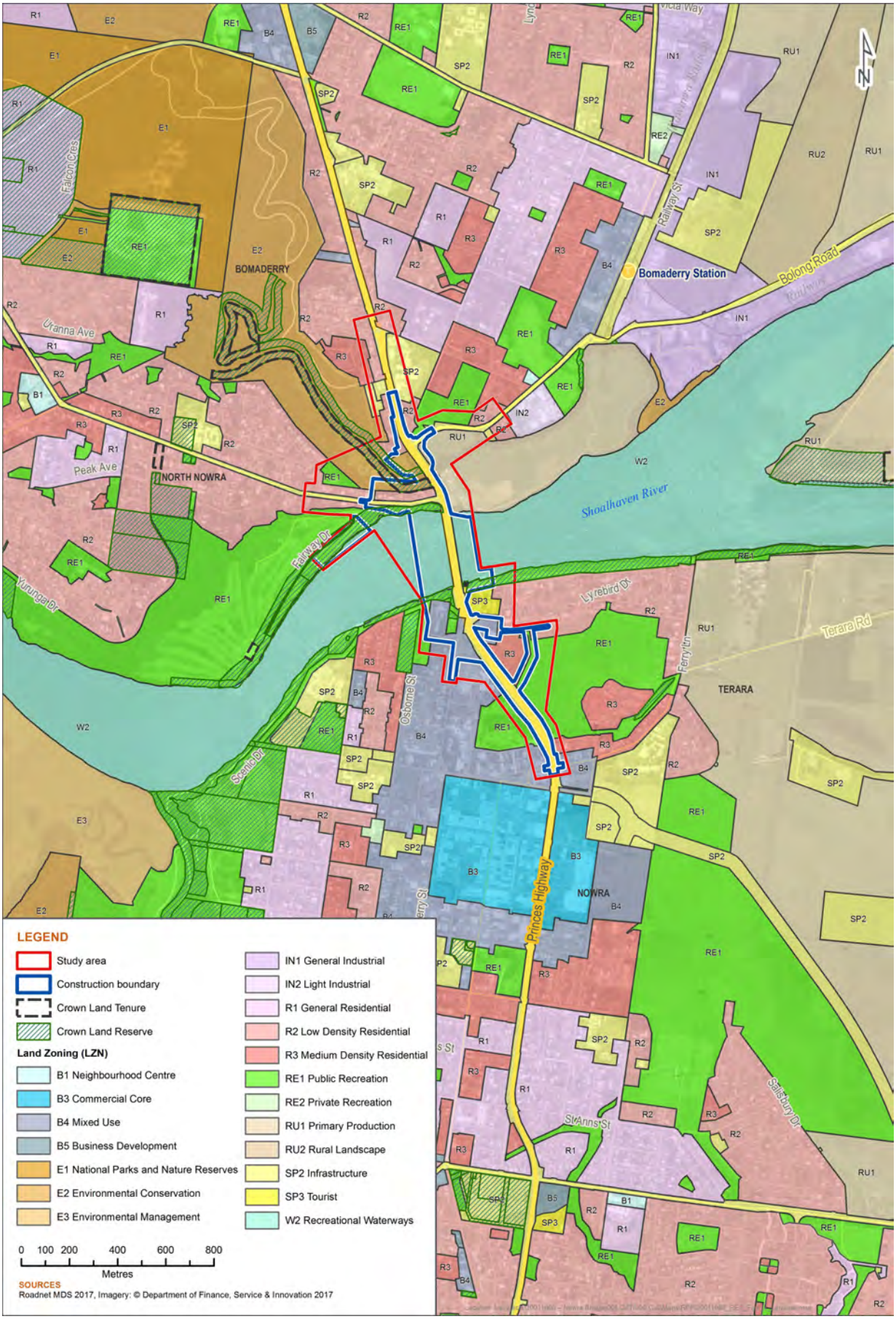

Figure 4-1: Local area zonings

Shoalhaven Local Environmental Plan 1985

The Shoalhaven LEP 1985 is still in effect and applies to land identified as 'Deferred Matter' in the LEP 2014. There are no areas of 'Deferred Matter' within the study area.

4.2 Other relevant NSW legislation

4.2.1 Coastal Management Act 2016

The objective of the *Coastal Management Act 2016* (CM Act) is to manage the coastal environment in a manner consistent with the principles of ecologically sustainable development for the social, cultural and economic well-being of the people of NSW.

The CM Act divides the coastal zone into four coastal management areas. The proposal is located in a 'coastal environment area' and 'coastal use area'.

The management objectives for the coastal environment area are:

a) to protect and enhance the coastal environmental values and natural processes of coastal waters, estuaries, coastal lakes and coastal lagoons, and enhance natural character, scenic value, biological diversity and ecosystem integrity,

b) to reduce threats to and improve the resilience of coastal waters, estuaries, coastal lakes and coastal lagoons, including in response to climate change,

c) to maintain and improve water quality and estuary health,

d) to support the social and cultural values of coastal waters, estuaries, coastal lakes and coastal lagoons,

e) to maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place,

f) to maintain and, where practicable, improve public access, amenity and use of beaches, foreshores, headlands and rock platforms.

The management objectives for the coastal use area are as follows:

a) to protect and enhance the scenic, social and cultural values of the coast by ensuring that:

    i. the type, bulk, scale and size of development is appropriate for the location and natural scenic quality of the coast, and

    ii. adverse impacts of development on cultural and built environment heritage are avoided or mitigated, and

    iii. urban design, including water sensitive urban design, is supported and incorporated into development activities, and

    iv. adequate public open space is provided, including for recreational activities and associated infrastructure, and

    v. the use of the surf zone is considered,

b) to accommodate both urbanised and natural stretches of coastline.

The four coastal management areas are defined in the Act as part of the Coastal Management SEPP. This legislation establishes clear outcome-orientated management objectives for each area to ensure councils apply appropriate management tools and development controls. As the proposal is not designated development under the Coastal Management SEPP and is development without consent under the cl 94 of the ISEPP, consent is not required from Shoalhaven City Council.

4.2.2 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) and its supporting regulations commenced on 25 August 2017. The BC Act repeals the *Threatened Species Conservation Act 1995* (TSC Act) along with other natural resource management legislation including sections of the National Parks and Wildlife Act 1979 (NPW Act). The BC Act sets out the environmental impact assessment framework for threatened species and ecological communities for Division 5.1 activities (among other types of development).

However, the transitional provisions of the Biodiversity Conservation (Savings and Transitional) Regulation 2017 apply to the proposal as the environmental impact assessment of the activity began under Division 5.1 of the EP&A Act before the commencement of the new Act and is pending assessment under Division 5.1 (Section 29(1a)). The proposal has been assessed in accordance with the TSC Act.

The outcomes of the biodiversity assessment conducted for the proposal are documented in Section 6.9. The proposal would not have a significant impact on threatened species or ecological communities or critical habitat.

4.2.3 Threatened Species Conservation Act 1995

The TSC Act was repealed by the NSW BC Act which came into effect on 25 August 2017. This REF and the associated Biodiversity Assessment Report (BAR) were substantially commenced prior to that date; consequently, in accordance with clause 29 of the Biodiversity Conservation (Savings and Transitional) Regulation 2017, Roads and Maritime elects to continue to apply the former planning provisions.

The TSC Act was prepared to protect threatened species, populations and ecological communities and their habitat in NSW. Under the TSC Act, if threatened species, populations, ecological communities or their habitat may be impacted by the proposal, an assessment of significance of the impact must be undertaken, in accordance with section 5A of the EP&A Act. The TSC Act also lists key threatening processes (KTPs), which are matters that threaten the survival or evolutionary development of a species, population or ecological community.

The potential impacts of the proposal on threatened species are discussed in Section 6.9 of this REF and the BAR provided in Appendix D.

The assessment has identified a number of likely and potential impacts on biodiversity and these are considered in the BAR and in Section 6.9 of this REF.

The proposal is not expected to significantly impact on threatened species and consequently a Species Impact Statement (SIS) is not required.

4.2.4 Biosecurity Act 2015

The *Biosecurity Act 2015* repeals the *Noxious Weeds Act 1993* and provides for a coordinated approach to the removal and control of scheduled noxious weeds across the NSW. No permits or approvals are required under this Act, but it is the responsibility of Roads and Maritime to provide for

the removal and proper disposal of any listed weeds found within the proposal site. Noxious weeds are discussed, and management measures proposed in Section 6.9 of this REF.

4.2.5 National Parks and Wildlife Act 1974

The NPW Act is the primary statute for management of Aboriginal cultural heritage in New South Wales. Items of Aboriginal heritage (Aboriginal objects) or Aboriginal places (declared under section 84) are protected and regulated under the NPW Act.

Under the Act, an Aboriginal object is defined as 'any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains'. As such, Aboriginal objects are confined to physical evidence and are commonly referred to as Aboriginal sites.

Aboriginal objects are protected under section 86 of the Act. It is an offence to harm or desecrate an Aboriginal object, either knowingly (section 86(1)) or unknowingly (section 86(2)). There are offences and penalties relating to the harm to, or desecration of, an Aboriginal object or declared Aboriginal place. Harm includes to destroy, deface, damage or move.

The proposal would impact up to eight known Aboriginal sites. An Aboriginal Heritage Impact Permit (AHIP) application would be lodged for the proposal and a targeted archaeological salvage would be required for sites assessed as demonstrating moderate and high archaeological significance.

Potential impacts on Aboriginal heritage are discussed in Section 6.3 of this REF.

4.2.6 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) regulates activities which may result in pollution impacts (eg land, air, water and noise pollution). Part 3.2 of the POEO Act requires an Environment Protection Licence (EPL) for scheduled development work and to carry out scheduled activities as identified in Schedule 1 of the POEO Act.

The following scheduled activities potentially apply to the proposal:

- Road construction if it results in four or more traffic lanes (not including bicycle lanes or lanes used for entry or exit), where the road is classified or proposed to be classified as a main road for at least three kilometres of its length in the metropolitan area, and for at least five kilometres in any other area
- Extractive activities, where excavation required for the proposal is greater than 30,000 tonnes per year
- Cement or lime handling, meaning the handling of cement, fly ash, powdered lime (other than agricultural lime) or any other similar dry cement products.

Based on the 80 per cent concept design, it is estimated that the cut requirements for the overall proposal would be about 30,300 cubic metres of cut material north of the bridge abutment and about 9000 cubic metres of cut material south of the bridge abutment. Schedule 1, Part 1, Premises-based activities, clause 19 Extractive activities of the POEO Act may apply if the proposal requires the extraction, processing or storage of more than 30,000 tonnes per year of extractive materials. Based on the concept design an EPL would be required for the proposal in this regard, and this would be confirmed during detailed design when cut requirements are refined.

The proposal would not meet the criteria for road construction or cement or lime handling.

Further, section 120 of the POEO Act prohibits the pollution of waters. The construction contractor and Roads and Maritime are obliged to notify the EPA if a pollution incident occurs that causes or threatens material harm to the environment. The proposal would implement the proper mitigation measures to ensure that no pollution enters the Shoalhaven River or Bomaderry Creek during construction. These are discussed in Section 6.10.

4.2.7 Roads Act 1993

The *Roads Act 1993* (Roads Act) objects are to govern the use and access to public roads, manage opening and closing of public roads as well as providing classification of roads and identifying the functions of road authorities.

Under section 78 of the Roads Act, Roads and Maritime may construct a bridge across navigational waters. However, before construction, a notice must be placed in the local newspaper allowing for any submissions to be made by any person (section 79).

The proposal includes works to tie in to local roads. Approval from Shoalhaven City Council would be required for any such works as the relevant approval authority for works related to these roads.

4.2.8 Heritage Act 1977

The *Heritage Act 1977* (Heritage Act) function is to conserve the State's cultural heritage, and promote public awareness of places, objects, and provides for the conservation of environmental heritage items in NSW.

Under section 139 of the Heritage Act, an approval would be required prior to the disturbance or excavation of land if the proposal would, or is likely to result in, disturbance to a relic.

The proposal would result in a minor physical impact to Graham Lodge (SHR, LEP 389), a major physical and visual impact to the locally listed Captain Cook Bicentennial Memorial (LEP No. 338), a moderate physical and visual impact to the locally listed 'Lynburn' (LEP No. 130) and a minor physical impact and visual impact to the existing southbound bridge (s170).

The cessation of the existing southbound bridge as a transport route across the Shoalhaven River would result in an indirect impact to the heritage values of this item.

Further discussion on non-Aboriginal heritage is provided in Section 6.4 of this REF.

4.2.9 Fisheries Management Act 1994

The objects of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. The threatened species, population and ecological communities listed in the FM Act, and that are known or are likely to occur within the area would be subject to the consideration under section 1.7 of the EP&A Act and in accordance with Threatened Species Assessment Guidelines (DECC 2007), and if relevant, completion of a SIS . The proposed bridge alignment would impact about 0.09 hectares of seagrass and further discussion on aquatic biodiversity is provided in Section 6.9 of this REF.

Based on the proposed construction methodology, the proposal would require an approval or require notice to be given to the Minister for Primary Industry under the FM Act in relation to:

- Works that involve dredging or reclamation work (section 199)
- Works that harm or disturb marine vegetation, such as seagrasses (section 205).

The proposal would not result in blocking fish passage therefore not triggering an approval under section 219 (works that would block fish passage, including temporary blockage during construction).

4.2.10 Water Management Act 2000

The object of the *Water Management Act 2000* is the sustainable and integrated management of the state's water for the benefit of both present and future generations. Under the Act the following approvals are required for certain activities or works:

- A water access licence under section 56
- A water use approval under section 89
- A water management work approval under section 90(2); a water supply work approval authorises its holder to construct and use a specified water supply work at a specified location
- An aquifer interference approval under section 91(3).

Approvals under the *Water Management Act 2000* are not expected to be required for this proposal. As a public authority, Roads and Maritime is exempt from requiring an approval for an aquifer interference approval under clause 38 of the Water Management (General) Regulation 2011.

4.2.11 Crown Land Management Act 2016

Part of the REF proposal is located on Crown land which occurs along both sides of the Shoalhaven River. This land is administered under the *Crown Land Management Act 2016* (CLM Act).

Under section 5.21(1), the Minister for Primary Industries may, through a licence, 'authorise the use or occupation of Crown land for the purposes that the Minister thinks fit'.

In accordance with the CLM Act, a licence is required to occupy areas of Crown land. A licence would be sought after consultation with the DPI (Crown Lands Division).

4.3 Commonwealth legislation

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) a referral is required to the Australian Government for proposed actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land. These are discussed in Chapter 6 and Appendix A. Chapter 6 considers potential impacts on issues such as biodiversity, socio-economic, Aboriginal heritage, Non-Aboriginal heritage, pollution and cumulative impacts. Appendix A addresses the factors to be considered and provides an overview of the proposal's impacts.

A referral is not required for proposed road activities that may affect nationally listed threatened species, endangered ecological communities and migratory species. This is because requirements for considering impacts to these biodiversity matters are the subject of a strategic assessment approval granted under the EPBC Act by the Australian Government in September 2015.

Potential impacts on these biodiversity matters are also considered as part of Section 6.9 of the REF and Appendix D.

4.4 Confirmation of statutory position

The proposal is categorised as development for the purpose of a road and/or road infrastructure facilities and is being carried out by or on behalf of a public authority. Under clause 94 of the ISEPP the proposal is permissible without consent. The proposal is not State significant infrastructure or State significant development. The proposal can be assessed under Division 5.1 of the EP&A Act.

Roads and Maritime is a determining authority for the proposal. This REF fulfils Roads and Maritime's obligation under section 5.5 of the EP&A Act including to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

5. Consultation

5.1 Consultation strategy

A Community and Stakeholder Communication Plan has been prepared for the proposal in accordance with the Roads and Maritime *Community Involvement Practice Notes and Resources Manual: A resource manual for staff* (RTA, 2010). The Plan identifies activities for the consultation process involving Roads and Maritime, other relevant government agencies, organisations, community representatives and residents.

The objective of the Plan is to inform key stakeholders, immediate residents and businesses, road users and the broader community of the proposal to build a new bridge west of the existing northbound bridge. A number of communication tools have been used to inform the local and broader community, key stakeholders, local and state government including Members of Parliament. These included:

- A dedicated project website, telephone line and email address
- Meetings and briefings
- Online 'Have your say' surveys
- Community information sessions
- Media coverage
- Print and digital communication materials such as flyers, community updates, postcards
- Road signage using portable variable message signs.

The engagement objectives are to:

- Engage and inform key stakeholders and the community about the Nowra Bridge Project planning process and timeframes, proposed concept design and environmental impact assessment
- Consult with stakeholders and community during the concept design, environmental assessment and formal exhibition phases of the project
- Incorporate local participation into project planning decisions and outcomes
- Generate awareness of opportunities for feedback, accessible project information and timely problem solving.

5.2 Community involvement

Consultation for the Nowra Bridge Project with the community and stakeholders commenced in late 2012 and is ongoing. To date, there have been four major rounds of consultation carried for the proposal summarised as follows.

Options for a new crossing, November 2013

In late 2013, the community were invited to register their interest, submit ideas for the project and provide feedback on the future of the existing southbound bridge. Five community sessions were held in Nowra during this round of consultation as follows:

- Saturday 30 November 2013, 10.30am to 1.30pm (Nowra School of Arts)

- Thursday 5 December 2013, 5pm to 8pm (Nowra School of Arts)
- Thursday 12 December 2013, 5pm to 8pm (Nowra School of Arts)
- Saturday 7 December 2013, 10.30am to 1.30pm (Nowra Showground Pavilion).

Key issues raised during this round of consultation included:

- Suggestions for options including a new bridge, bypass of Nowra, widening of the existing bridges, inclusion of a rail component and options for the surrounding road network
- The project needs to address the current congestion and include intersection upgrades to increase capacity and improve road safety
- The environment and impacts to local amenity, air quality and sensitive noise receivers such as the nearby retirement village and caravan park should be considered
- Concerns about maintaining the existing southbound bridge for traffic including increasing maintenance costs, fear of collapse, and risk of damage from overheight vehicles
- The existing southbound bridge is valued for its heritage and landscape value
- Concerns around property acquisitions if a new bridge is to be built next to the exiting bridges
- The project should recognise and ensure consistency with local planning strategies.

Announcement of the preferred location for a new bridge, June 2014

In June 2014, Roads and Maritime invited the community to provide feedback on the preferred location for a new bridge. Roads and Maritime received 456 online survey responses during the consultation period, the majority of which were aware of and supported a new bridge to the west (upstream). However, it was noted there was a level of support for all options considered.

Community information sessions were held at Stockland Nowra and were attended by 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 was also required for the future to accommodate growth in the area.

Key issues raised during this round of consultation 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 southbound 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.

Future of the existing southbound bridge, October 2014

In 2014, the community was invited to provide feedback on options for the existing southbound bridge between 15 October and 19 December 2014. During the consultation period, Roads and Maritime received 38 written submissions, 676 online survey responses and six suggestions on Facebook.

Nine community sessions were held in Nowra during the consultation period:

- Saturday 25 and Sunday 26 October 2014 (Shoalhaven River Festival)
- Wednesday 12 November 2014, 5pm to 7.30pm (North Nowra Community Centre)
- Saturday 22 November 2014, 10am to 1pm (Nowra School of Arts)
- Tuesday 4, Thursday 6, Saturday 8, Tuesday 11 and Friday 14 November 2014 (Stockland Nowra)

Around 1850 people attended across the nine sessions. A summary of the key issues raised during the consultation period included:

- There was support for all options, most people who spoke thought the bridge should be retained in some form. Those with strong connections to the historical significance of the bridge thought the bridge should be retained and conserved in its current location. Many who felt a personal connection with the bridge were more open to options that involved relocation in additional to use in its current location
- Popular suggestions for the future use of the bridge included a shared path/cycleway, pop-up cafes, markets or other entertainment uses such as festivals or fun runs. Transport related suggestions included using the old bridge for light traffic, incident management or seasonal peak holiday traffic, or for a future rail extension across the Shoalhaven River into Nowra
- A small proportion of the community wanted to see the bridge removed completely. Some people initially supported retention of the bridge adjusted their position once they became aware of the possible maintenance costs of the different options
- There were members of the community who stated a preference that the money that might be spend maintaining the old bridge would be better spent on additional Princes Highway or local road upgrades, or other infrastructure within the area.

Announcement of the preferred option, February 2018

The community was invited to provide feedback on the preferred option between 19 February 2018 and 23 March 2018. During the preferred option display, Roads and Maritime received 84 written submissions and 250 online and written survey responses. Of the written submissions received, on submission was received from Shoalhaven City Council and 83 submissions were received from community members, interest groups, transport providers, local businesses and government agencies.

Five drop-in community sessions were held in Nowra during the consultation period:

- Thursday 1 March 2018, 11am to 3pm (Stockland Nowra)
- Saturday 3 March 2018, 11am to 3pm (Stockland Nowra)
- Thursday 8 March 2018, 11am to 3pm (North Nowra Shops)
- Saturday 10 March 2018, 11am to 3pm (North Nowra Shops)
- Saturday 17 March 2018, 10am to 1pm (Nowra School of Arts).

A total of 630 people attended across the five sessions.

All feedback received during the preferred option consultation period has helped the project team refine the proposal. A summary of the key issues raised during the preferred option consultation period and where they are addressed in the REF is provided in Table 5 1.

Table 5-1: Summary of issues raised by the community members and groups during 2018 consultation

Group	Issue raised	Response / where addressed in REF
Community members Community groups Shoalhaven City Council	Provide a dedicated left-hand turn from Illaroo Road onto the Princes Highway	• The proposal would provide three dedicated right turn lanes and on dedicated left slip lane for traffic turning onto the Princes Highway from Illaroo Road • Section 2.4 of this REF discusses the design refinements to the preferred option and Section 6.1 of this REF details the traffic and transport assessment.
Community members Community groups Shoalhaven City Council	Include an acceleration lane on Illaroo Road for the left turn from the Princes Highway	• The proposal would provide an acceleration lane on Illaroo Road for northbound traffic turning left from the Princes Highway into Illaroo Road • Section 2.4 of this REF discusses the design refinements to the preferred option and Section 6.1 of this REF details the traffic and transport assessment.
Community members Community groups	A bypass would be a better option, providing a long term solution, addressing freight, tourists and economic growth	• The need for a bypass has been extensively examined and the traffic modelling has shown this would not address the local traffic demands in the area. Building a new bridge now would not preclude the future planning of a bypass if/when traffic demand is reached • Section 2.4 this REF discusses the alternative options considered, including the option of a bypass.
Community members Community groups Local businesses Shoalhaven City Council	Need for a flyover / grade separated intersections	• Flyovers, or grade separation of traffic, have been investigated as part of the options development and assessment process. It was identified that these would provide a small benefit to intersection performance but this would have greater property and environmental impacts • Section 2.4 of this REF discusses the alternative options considered, including grade separation.
Community members	The number of traffic lights on the Princes Highway increases congestion through Nowra	• The proposal does not include the addition or removal of traffic lights on the Princes Highway • The new local road connection south of Bridge Road would be limited to left in and left out movements. Right turn movements for northbound traffic would be provided at Moss Street intersection • Movement of vehicles through intersections is managed during traffic lights to provide equitable access for local traffic and through traffic

Group	Issue raised	Response / where addressed in REF
		• Traffic light operations would be coordinated and optimised • Removing traffic lights and replacing these with roundabouts would add further traffic delays and queueing, as roundabouts provide less control to manage traffic movements at intersections. Without traffic lights in place it would become very difficult for vehicles to access the Princes Highway during peak periods from local roads • Section 2.4 of this REF discusses the alternative options considered and Section 6.1 of this REF details the traffic and transport assessment.
Community members Community groups Local businesses Shoalhaven City Council	The proposal would not ease congestion especially during peak holiday seasons	• Historical traffic data and Shoalhaven City Council's strategic model were reviewed to determine the appropriate growth rates for the future traffic demands on the road network in the vicinity of the project. The traffic model considers future land use changes in the surrounding area that would influence the volume of traffic on the road network, and takes into account future development sites and general population growth • The proposal would include changes to Bolong Road, Illaroo Road and Bridge Road intersections, including additional lanes to increase capacity • Traffic modelling carried out for the proposal has identified that the efficiency of operation of these intersections would be improved • Section 2.4 of this REF discusses the alternative options considered and Section 6.1 of this REF details the traffic and transport assessment.
Community members Community groups Local businesses	Changes to the local road network	• It is proposed that Pleasant Way would be closed to traffic, with alternative access to the area to the east of the highway provided via a new local road connection about 300 metres south of the current Pleasant Way intersection • Section 2.4 of this REF discusses the alternative options considered and Section 6.1 of this REF details the traffic and transport assessment.
Community members Community groups	Future use of the existing south bound bridge	• The existing southbound bridge has insufficient capacity, constraints for heavy vehicles and increasing maintenance costs. The investigations carried out for the project have identified that these issues would be effectively addressed through provision of a new bridge with additional capacity • Through previous consultation for the proposal, the community has expressed a strong desire to retain the existing southbound bridge. In view of this, and in recognition of the

Group	Issue raised	Response / where addressed in REF
		heritage significance of the bridge, Roads and Maritime has committed to the ongoing maintenance of the bridge, and to carry out further consultation into options for adaptive reuse. Adaptive reuse of the existing southbound bridge would be subject to a separate assessment and determination process • Sections 2.4.9 and 2.4.10 of this REF discusses the options associated with retaining the existing southbound bridge and Section 6.4 addresses the heritage significance of the existing southbound bridge.
Community members Community groups	Adequate provision for pedestrian access / shared access	• Allowance for pedestrian and cyclist access has been made in the design. A shared path would be provided on the new northbound bridge • Access to the shared path on the existing northbound bridge would be removed • Roads and Maritime would investigate the adaptive reuse of the existing southbound bridge for a shared path which would be subject to a separate consultation and assessment process • Impacts associated with pedestrian access and shared paths are discussed in Section 6.1 (traffic and transport assessment), Section 6.5 (landscape character and visual impact assessment) and Section 6.8 (socio-economic assessment).
Community members Community groups Local businesses Shoalhaven City Council	Incorporate access to the Shoalhaven River foreshore	• Roads and Maritime will continue to work with Council and other stakeholders to support local access and to integrate proposal with the River Foreshore Master Plan • Section 6.5 of this REF addresses the landscape and visual impact and Section 6.8 addresses the social impacts associated with foreshore access.
Community members Shoalhaven City Council	Visual appearance of the bridge	• The new bridge would have four traffic lanes, a shared path for pedestrians and cyclists and closely match the height of the existing northbound bridge • The piers of the new and existing northbound bridge would match the existing bridges to maintain the current navigational channels and reduce hydrological impacts • The proposal has been developed in accordance with best practice urban design principles • An urban design strategy has been developed for the proposal which would be aligned with the urban design principles of the other Princes Highway upgrade projects

Group	Issue raised	Response / where addressed in REF
		• Urban design objectives for the proposal are outlined in Section 2.3.3. Urban design principles for the new northbound bridge are discussed in Section 2.6.1. Section 6.5 of this REF details the landscape character and visual impact assessment and Section 6.4 details the non-Aboriginal heritage impacts.
Community members Community groups	Extension of the railway service	• Options that could potentially cater for a future extension of the South Coast Line have been investigated as part of the options development and assessment process • At this stage, TfNSW has no plans to extend the South Coast Line to the south • Section 2.4 of this REF discusses the alternative options considered.
Community members	Alternative options presented	• Bypass options to the east of Nowra are documented in the Nowra Bridge Project Site Options Development Report, prepared in 2016. A key constraint for eastern bypass options is the Shoalhaven River floodplain which would likely require a bridge about 1500 metres in length and an elevated viaduct or roadway for about three kilometres to provide the necessary level of flood immunity • Section 2.4 of this REF discusses the alternative options.
Community members Shoalhaven City Council	Consultation process	• The environmental assessment is placed on public display later in 2018 with the opportunity to provide comment • A submissions report would be prepared summarising the issues raised and a response provided • Ongoing and future consultation is described in Section 5.6 of this REF.
Community members Community groups	Impacts (including noise, construction, property, heritage and other environmental)	• Environmental impacts are assessed in Chapter 6 of this REF.

5.3 Aboriginal community involvement

An Aboriginal heritage assessment has been carried out for the proposal in accordance with the Procedure for Aboriginal Cultural Heritage Consultation and Investigations (PACHCI) (Roads and Maritime, 2011).

Consultation with Aboriginal stakeholders for the proposal has been carried out in accordance with the PACHCI. The Nowra Local Aboriginal Land Council (LALC) was consulted during planning stages of proposal. In accordance with PACHCI Stage 2 the Nowra LALC was invited to participate in the archaeological survey. An archaeological field survey of the study area was undertaken with two representatives of the Nowra LALC on 22 June and 31 August 2017.

An archaeological survey and assessment of the proposal was undertaken in accordance with Stage 3 Procedure for Aboriginal Cultural Heritage Consultation and Investigation guidelines (PACHCI) (Roads and Maritime, 2011), and the Office of Environment and Heritage (OEH, formerly Department of Environment, Climate Change & Water [DECCW]) Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (Code of Practice) (Department of Environment Climate Change and Water [DECCW] 2010a).

The assessment included a desktop investigation, archaeological survey, test pit excavations and cultural heritage assessment within the study area. The results of the Aboriginal heritage investigations are summarised in Section 6.3 and the Cultural Heritage Assessment Report (CHAR) prepared by Artefact Heritage Services in Appendix E.

Table 5-2: Summary of Roads and Maritime Procedures for Aboriginal Cultural Heritage Consultation and Investigation

Stage	Description
1	Initial Roads and Maritime assessment
2	Site survey and further assessment
3	Formal consultation and preparation of a cultural heritage assessment report
4	Implement environmental impact assessment recommendations

The following table summarises issues communicated to Roads and Maritime through the Aboriginal Focus Groups or through formal submissions to Roads and Maritime during formal consultation periods.

Table 5-3: Issues raised through Aboriginal community consultation

Group	Issue	Response / where addressed in REF
AFG	Concern regarding potential impacts to rock shelters including vibration impacts to rock shelters in close proximity to the works. Clarification of which rock shelter would be directly impacted by the proposal and proposed mitigation.	An Aboriginal Heritage Management Plan will be prepared and implemented to minimise impacts during construction. Potential vibration impacts to rock shelters and proposed mitigation measures are addressed in Section 6.2 of this REF. Potential impacts to rock shelters and proposed mitigation measures are discussed in Section 6.3 and Appendix E of this REF.

Group	Issue	Response / where addressed in REF
AFG, Registered Aboriginal Party	Long term management of artefacts is important and Registered Aboriginal Parties (RAP's) would prefer recovered artefacts be re-buried on Country or displayed in an appropriate area within the study area. Artefacts with educational value should be kept at a keeping place so that artefacts are accessible.	Arrangements for the long term management of recovered artefacts would be determined in accordance with the recommendations of RAPs and OEH. Refer to Section 6.3 and Appendix E of this REF.
AFG, Registered Aboriginal Party	Options for a Heritage Interpretation Plan for the project, including the option of interpretive signage, plaques, and naming of the bridge	An Aboriginal Heritage Interpretation Strategy will be prepared in consultation with RAPs. Refer to Section 6.3.4 and Appendix E of this REF.
AFG, Registered Aboriginal Party	Options for monitoring areas of high significance during construction. Monitoring impacts to soils at areas with moderate significance.	Roads and Maritime has a no monitoring policy. An Aboriginal Heritage Management Plan will be prepared and implemented to minimise impacts during construction. Refer to Section 6.3.4 and Appendix E of this REF.

5.4 ISEPP consultation

Clauses 13 to 16 of the ISEPP specify the requirements for consultation with councils and other public authorities for infrastructure development carried out by or on behalf of a public authority.

A review of the proposal against clauses 13 to 16 was undertaken (refer Appendix B) to determine the need for any ISEPP consultation. The review found that the following consultation was required with Shoalhaven City Council, due to:

- Potential substantial impact on the stormwater management services (clause 13(1)(a))
- Installation of a temporary structure on, or the enclosing of, a public place that is under a council's management or control that is likely to cause a disruption to pedestrian or vehicular traffic that is not minor or inconsequential (clause 13(1)(e))
- Excavation that is not minor or inconsequential of the surface of, or a footpath adjacent to, a road for which a council is the roads authority under the Roads Act 1993 (clause 13(1)(f))
- More than a minor or inconsequential impacts on local heritage items (clause 14)
- Impact on flood-liable land (clause 15).

An ISEPP consultation letter was issued to Shoalhaven City Council on 25 May 2018 and formal responses received on 14 and 15 June 2018. Issues that have been raised as a result of this consultation are outlined in Table 5-4.

Table 5-4: Issues raised by Shoalhaven City Council

Issue raised	Response / where addressed in REF
Requesting Council review the final Statement of Heritage Impact (SOHI) for adequacy and mitigation measures	A SOHI has been prepared for the proposal and is provided in Appendix F. A copy of the SOHI will be sent to Council. Non-Aboriginal heritage is discussed in Section 6.4 of the REF.
Requesting Roads and Maritime to consult with Council regarding possible relocation of the Captain Cook Bicentennial Memorial. Advising that the flood boat is undergoing restoration	Consultation with Council regarding the memorial is a recommendation of the SOHI and Roads and Maritime would continue to consult with Council regarding its relocation.
Noting significant trees at the entrance / foreground and view lines of 'Lynburn'.	Construction of the northern approaches to the new bridge would result in an encroachment on the eastern extent of the heritage curtilage of 'Lynburn' resulting in removal of plantings and vegetation that borders the Princes Highway. Refer to Section 6.4 of the REF and Appendix F
Requesting development of an interpretation strategy for the old bridge	A heritage interpretation strategy would be prepared to include the history, associations and significance of the existing southbound bridge. Refer to Section 6.4 of the REF and Appendix F
Identifying a potential heritage item, the M&M Guesthouse.	The potential heritage item has been identified in the SOHI and recommendations for further investigations to explore the relocation of the buildings in consultation with Shoalhaven City Council. Refer to Section 6.4 of the REF.
Identifying Nowra Sailing Club, which was burnt down in 2017, as a heritage item. Advising Council has prepared a heritage assessment relating to maritime archaeology.	The SOHI assesses a heritage item known as the 'Inter-war Weatherboard Building and Timber Wharf' (otherwise known as the Nowra Sailing Club) and potential impacts on maritime archaeology has been included. Refer to Section 6.4 of the REF.
The construction footprint and potential ancillary sites impacts on land owned or managed by Council. This may impact Council's work on the Nowra Riverfront Precinct.	The construction footprint would be minimised as far as practicable. The Landscape Character and Visual Impact Assessment has taken into account Council's work on the Nowra Riverfront Precinct and the Socio-economic and property impact assessment has addressed the property and recreational impacts of the proposal. Refer to Sections 6.7 and 6.8 of the REF.
Recommending the intersection of Scenic Drive and Bridge Road be closed, subject to consultation with NSW Ambulance and Shoalhaven District Memorial Hospital	The proposal does not include permanent closure of the Bridge Road and Scenic Drive intersection.

Issue raised	Response / where addressed in REF
Concern over the 0.2 m increase in flood levels and that the affected property owners are consulted. Concerns about the impacts of flood waters on Gateway Park and questions of the effect on flood patterns from the new local road connection. Recommending consultation with landowners on Bridge Road who have been identified has having increased flood affectation.	Roads and Maritime has conducted surveys to establish existing floor levels of flood affected properties to enable the full extent of impacts to be assessed. Refer Flooding and Hydrology Assessment in Appendix H and Section 6.6 of the REF.
Recommend Roads and Maritime consult with ambulance services to determine if impacts during 1% AEP would affect access.	Ongoing consultation would be conducted with Ambulance NSW. Hydrology and flooding are discussed in Section 6.6 of the REF.
Advising that the potential ancillary sites at the Greys Beach Carpark and the Council Administrative Building / Shoalhaven Entertainment Centre, are unsuitable.	Ongoing consultation is required to identify other potential sites. Ancillary sites are identified in Section 3.4 of the REF.
The Greys Beach site is being master planned and some works have been undertaken on boat ramps, access ways, and car parking.	The proposal is likely to impact the Greys Beach Reserve during construction as the area has been identified as an ancillary site. The impact would depend upon final construction staging and activities planned for the site. Refer Sections 6.1 and 6.8 of the REF.
The Pleasant Way ancillary site should only be considered if the intersection south is constructed and operational in the initial stages.	Early staging of the new local road connection would be considered during detailed design. Refer Sections 3.3 and 3.4 of the REF
Pedestrian / shared pathways should be extended to an overpass linking the east and west over the Princes Highway, redesign of the existing bridge underpass, and improved facilities on the existing southbound bridge.	Pedestrian overpasses are not being considered as part of this project. East/west pedestrian links would be improved by upgrading pedestrian underpasses on the northern and southern foreshores as well as improving pedestrian links at the existing intersections. The rehabilitation and repurposing of the existing southbound bridge for adaptive reuse would be subject to a separate consultation and assessment process.
The impact on the Nowra Steakhouse business within the old Visitor Information Centre should be assessed	The Socio-economic impact assessment (Appendix L) addresses the impact of the proposal on businesses and notes that the Nowra Steakhouse is currently closed and out of operation. The impacts on the property are addressed in Appendix L and Section 6.8 of the REF.
Need to assess the impact on staff parking on the old Civic Centre site.	Ongoing consultation will be conducted with Council regarding this site.

Issue raised	Response / where addressed in REF
Issues around Pleasant Way, alternative access to the highway, and impact on the Visitor Information Centre.	The proposal would close Pleasant Way at the Princes Highway. Alternative access to the former Visitor Information Centre site would be provided by the new local road connection south of Bridge Road. Refer Appendix L and Section 6.8 of the REF for impacts on businesses and property.
The road identified through Gateway Park does not show detail on exactly its position or access and egress from surrounding streets. There would potentially be large impacts on Council social infrastructure.	Ongoing consultation would be conducted with Council regarding this site.
Expressing concern about the potential loss of a park and playground in Moorhouse Park.	Ongoing consultation will be conducted with Council regarding this site.
Advising Council planning and investments in several parks and reserves including Greys Beach, Scenic Drive/Mavromattes Reserve, Paringa Park / Rowing Club, the Rowing Club, and Gateway Park.	Noted. Refer Sections 6.7 and 6.8 of the REF.
Water and sewer relocation designs to be undertaken by external designers. Council do not have a pre-qualified list of consultants.	Utilities are discussed in Section 3.5 of the REF.

5.5 Government agency and stakeholder involvement

Various government agencies and stakeholders have been consulted about the proposal, including:

- NSW Office of Environment and Heritage
- NSW Police
- Fire and Rescue NSW
- Ambulance NSW
- Shoalhaven City Council
- Shoalhaven District Memorial Hospital
- Nowra Private Hospital
- National Trust of Australia
- Shoalhaven Historical Society
- Shoalhaven Business Chamber
- Bus operators.

The following table outlines the issues raised by stakeholders and how Roads and Maritime is proposing to address these issues.

Table 5-5: Issues raised through government agency and stakeholder consultation

Agency/Stakeholder	Issue raised	Response / where addressed in REF
Shoalhaven City Council	Prefers grade separated intersections at Bolong Road and Bridge Road and bring forward the planning and construction of a bypass in the medium term.	Grade separation of traffic has been investigated as part of the options development and assessment process. It was identified that this would provide a small benefit to intersection performance but would have greater property and environmental impacts. Refer to Section 2.4.
	Upgrades bring forward need for three traffic lanes in each direction between Bomaderry and South Nowra.	The proposal provides three lanes in each direction between Bolong Road and Moss Street. Refer Section 2.4 and Chapter 3.
	Confirmation that the left slip lane out of Bridge Road is maintained.	The left slip lane will be maintained. Refer to Chapter 3.
	Investigate opportunity to incorporate a pedestrian refuge on Bridge Road, south of Scenic Drive.	Works in this location would be limited to tying in the new works with the existing section of Bridge Road. Refer to Section 3.2.
	Traffic signals should be provided at the intersection of Illaroo Road and Fairway Drive.	No traffic signals are proposed at this location. Refer to Section 2.4.
	Request for ongoing consultation during detailed design.	Further consultation would be undertaken with Council. Refer to Section 5.6.
	Requesting confirmation that the State will continue to own and maintain the existing southbound bridge.	Roads and Maritime will continue to be responsible for the existing southbound bridge.
National Trust	Supports to proposal to retain the existing southbound bridge for adaptive reuse, such as a pedestrian or cycle pathway.	Noted.
	Recommends the Conservation Management Plan be updated to include need for annual inspection and maintenance.	The rehabilitation and repurposing of the existing southbound bridge for adaptive reuse would be subject to a separate consultation and assessment process to this REF. Refer to Section 6.4.
	Recommends interpretive signage for the bridge.	The rehabilitation and repurposing of the existing southbound bridge

Agency/Stakeholder	Issue raised	Response / where addressed in REF
		for adaptive reuse would be subject to a separate consultation and assessment process to this REF. Refer to Section 6.4.
	Recommends ownership of existing southbound bridge remain with Roads and Maritime.	Roads and Maritime will continue to be responsible for the existing southbound bridge.
Shoalhaven Historical Society	Supports the retention of the existing southbound bridge.	Noted.
	Concerns about potential for vibration impacts on Graham Lodge.	The REF has identified the potential for temporary impacts to occur during construction. Refer to Sections 6.2 and 6.4.
	Concerns about potential for subsidence of graves at the Graham Family Cemetery.	The proposal does not involve any works that would directly affect the physical fabric or encroach upon the curtilage of the Graham Family Cemetery. Refer to Section 6.4.
	Concerns about potential for physical and visual impacts on Illowra and Lynburn.	The REF has identified impacts to the curtilage of 'Illowra' and 'Lynburn', including the loss of existing vegetation. Refer to Sections 6.4 and 6.5.
	Suggestions regarding the potential repurposing of the existing southbound bridge.	The rehabilitation and repurposing of the existing southbound bridge for adaptive reuse would be subject to a separate consultation and assessment process to this REF.
Nowra CBD Business Chamber	Prefers a bypass because the proposal does not adequately address traffic issues at Illaroo, Bridge and Bolong Roads.	Bypass options were identified, however, this would require long bridges and viaducts to provide for flood immunity. Refer to Section 2.4.
Shoalhaven Business Chamber	Questioning traffic modelling assumptions and travel times. The proposal is insufficient to handle future traffic demands.	Historical traffic data and Council's strategic traffic model was reviewed to determine the appropriate growth rates for further traffic demands on the road network. Refer to Sections 2.4 and 6.1.
	Preference for grade separated intersections at Bolong, Illaroo and Bridge Roads.	Grade separation of traffic has been investigated as part of the options development and assessment process. It was

Agency/Stakeholder	Issue raised	Response / where addressed in REF
		identified that this would provide a small benefit to intersection performance but would have greater property and environmental impacts. Refer to Section 2.4.
	Retain slip road at Pleasant Way to provide access to the river area.	It is proposed that Pleasant Way would be closed to traffic with alternative access being provided via a new local road connection about 300 metres south of the current Pleasant Way intersection. Refer to Section 2.4.
Shoal Bus	Questioning traffic modelling and preferring a larger study area from North Bomaderry to South Nowra	Historical traffic data and Council's strategic traffic model was reviewed to determine the appropriate growth rates for further traffic demands on the road network. Refer to Sections 2.4 and 6.1.
	Offering suggestions for North Nowra Link Road, a new bridge and eastern arterial road.	Roads and Maritime has carried out a comprehensive analysis of options including those noted. Further details are provided in Section 2.4. Roads and Maritime has also considered the cumulative impacts of the proposal and local road projects (refer Section 6.15).

5.6 Ongoing or future consultation

Roads and Maritime would continue to consult with the community, Shoalhaven City Council and relevant stakeholders during detailed design and construction of the proposal.

5.6.1 Consultation during the public display of the REF

The REF would be placed on public display and comments invited. A range of consultation activities would be undertaken in accordance with the consultation strategy and include:

- Stakeholder, Shoalhaven City Council and government agencies briefings
- Meetings with directly affected property owners
- Communication materials
- Community information sessions
- Door knocks/letter box drops

- Website updates.

After public display, submissions would be collated and a submissions report prepared to address issues raised in submissions. The submissions report would be made available to the public via the Roads and Maritime website. The community would be kept informed of any major design changes made to address concerns raised in submissions.

5.6.2 Consultation during construction

After the REF display period and continuing into the construction phase of proposal, Roads and Maritime would continue to identify and manage issues of interest or concern to the community and other stakeholders. The aims of ongoing communications and consultation are to provide the community with:

- Accurate and accessible information regarding the processes and activities associated with the proposal
- Information in a timely manner
- Appropriate avenues for providing comment or raising concerns, and to ensure they are aware of the avenues
- A high level of responsiveness to their issues and concerns throughout development and delivery of the proposal.

After determination, the community would continue to be updated about the progress of construction and provided notification of any road closures or night works in advance of the works occurring.

To effectively manage consultation during the construction stage of the proposal a Community and Stakeholder Engagement Plan would be developed and implemented by the construction contractor.

6. Environmental assessment

6.1 Traffic and transport

A traffic and transport assessment has been prepared for the proposal by Arup Pty Ltd. A copy of the assessment is provided in Appendix C and is summarised in the following sections.

6.1.1 Methodology

The traffic and transport assessment has been prepared in accordance with:

- Roads and Maritime Traffic Modelling Guidelines, February 2013 Version 1.0
- Highway Capacity Manual (HCM, 2016)
- Guide to Traffic Generating Developments, Version 2.2 Roads and Maritime, October 2002
- Austroads Guide to Traffic Engineering Practice.

The assessment was undertaken by:

- Collation of previous traffic data collected and modelling of the area for 2014 (current traffic volumes), 2026, 2036, 2046
- Understanding of the existing transport networks
- Modelling of future traffic growth
- Assess future traffic performance against current performance
- Understanding construction activities, staging and associated impacts
- Development of management and safeguard measures to mitigate the impacts.

The key assumptions for the modelling included:

- In the do minimum scenario there were no changes made to the existing road network layout
- All existing pedestrian crossings on slip lanes were converted to traffic lights
- All options were modelled with all existing pedestrian crossings in place and assumed to run in every cycle
- An additional scenario was modelled which considered the inclusion of all possible pedestrian movements. Pedestrian movements were assumed to run every cycle. These changes involved the addition of the following pedestrian crossings controlled by traffic lights:
  - Princes Highway/Bolong Road (north and south approaches)
  - Princes Highway/Illaroo Road (south approach)
  - Princes Highway/Bridge Road (north approach)
- All current permitted turning movements at intersections have been retained, although they may be provided at separate intersections
- Heavy vehicle demand was determined based on the surveyed traffic data collected for the study.

For areas which experience highly seasonal traffic fluctuations, such as the Princes Highway at Nowra, adopting the 100th highest annual hour of traffic flow as the target design hour is the preferred methodology according to Austroads guidelines.

As such, intersection count surveys were undertaken on 14 March 2014 to assess peak hour traffic flow across the study area. The specific date was selected by Roads and Maritime in consultation with Shoalhaven City Council as it occurred within the shoulder peak period, had the highest daily traffic flows and was considered to be representative of the 100th highest hour for the area.

SIDRA intersection modelling was carried out to assess the performance of key intersections in the proposal. The existing intersection performance was assessed for the following factors at each intersection:

- Degree of saturation (DoS)
- Level of Service (LoS)
- Maximum queue length (in metres).

Six scenarios have been modelled for the proposal, these being for the years 2026, 2036 and 2046 without the proposal (do minimum scenario) and with the proposal.

6.1.2 Existing environment

Road network

Princes Highway

The Princes Highway at Nowra forms part of the main-north-south transport corridor that connects Sydney to north east Victoria via the coast.

Within the proposal study area, the Princes Highway comprises dual carriageway with a minimum of two lanes in each direction and localised widening for turning traffic at intersections. All key intersections in the study area are controlled by traffic signals.

Shoalhaven River bridges

The Shoalhaven River crossing has two independent bridges that are about 350 metres in length. The existing southbound bridge has two lanes and is a constraint to overheight and HML vehicles. The existing northbound bridge has three lanes, with one lane being a dedicated left turn lane to Illaroo Road.

The *Nowra Key Road Projects Strategic Overview Report* (Shoalhaven City Council, 2017) identifies the replacement of the existing southbound bridge over the Shoalhaven River as a key project.

Bomaderry Creek bridge

The Bomaderry Creek crossing comprises two independent bridges that are about 48 metres in length. There are two lanes southbound and three lanes northbound and a shared path provided on each side.

Bolong Road

Bolong Road is a regional road located north of the Shoalhaven River and provides access to locations east of the Princes Highway via a signalised T-intersection. The road is predominantly a single lane in each direction with additional lanes provided at intersections for turning movements. It is the main route to Shoalhaven Heads and provides an alternative route to towns north of Nowra including Gerroa and Gerringong. Bolong Road is used by bus services and it also provides heavy vehicle access (including B-Doubles) to the Bomaderry industrial area.

Key local roads

The following local roads are located in the proposal study area:

- Illaroo Road
  - Key link between the Princes Highway and the suburbs of North Nowra and Bangalee located north of the Shoalhaven River
  - Generally two lanes in each direction
  - Signalised T-intersection with the Princes Highway at the northern end of the Shoalhaven River crossing
  - Used by local bus services
- Bridge Road
  - A local road extending from a signalised T-intersection with Princes Highway on the southern side of the Shoalhaven River
  - Main connection to the Nowra Town Centre, Shoalhaven Entertainment and Visitors Centre, emergency vehicle access to Shoalhaven District Memorial hospital
  - Comprises one northbound lane and two southbound lanes from the Princes Highway to Hyam Street, where it is then becomes one lane in each direction and kerbside parking
  - Provides left turn only travelling northbound from Bridge Road onto the Princes Highway
- Pleasant Way
  - Local road that provides access to the Shoalhaven River foreshore, accommodation and residences east of the Princes Highway
  - Signalised intersection at the Princes Highway
  - Unmarked one lane each way
- Scenic Drive
  - Local road west of the bridge on the southern side of the Shoalhaven River
  - Scenic Drive forms an unsignalised intersection with Bridge Road immediately south of the Princes Highway and Bridge Road intersection.
  - Generally one lane in each direction
  - Used by bus services and provides access to the river foreshore, Nowra Aquatic Park and an alternative route to the Shoalhaven District Memorial Hospital
- Hawthorn Avenue
  - Local street providing direct access to residences and a connection to the river foreshore
- Lyrebird Drive
  - Local street providing access to residential dwellings on the eastern side of Princes Highway
  - One way each direction providing access to local residences and businesses
- Wharf Road
  - Local street providing access to Nowra Sailing Club, boat ramp and wharf located on the southern foreshore adjacent to the existing southbound bridge
- Moss Street
  - Local road which forms a signalised crossroad with the Princes Highway at the southern extent of the proposal study area
  - Provides access to the Nowra town centre as well as the residential precincts to the east of the Princes Highway and the Nowra High School

- Fairway Drive
  - Local road with one lane in each direction on the northern side of the Shoalhaven River. South of Illaroo Road and provides access to the Greys Beach public boat ramp and Nowra Golf and Recreation Club.

Intersections

The key intersections within the study area are listed in Table 6-1.

Table 6-1: Key intersections in the study area

Intersection	Current control
Princes Highway / Bolong Road	Traffic signals
Princes Highway / Illaroo Road	Traffic signals
Illaroo Road / Fairway Drive	Unsignalised
Princes Highway / Bridge Road / Pleasant Way	Traffic signals
Bridge Road / Scenic Drive	Unsignalised
Princes Highway / Moss Street	Traffic signals

Speed limits

The Princes Highway speed limit within the study area is 70 km/h. Illaroo Road and Bolong Road both have posted speed limits of 60 km/h, while a 50 km/h speed limit is in place on local roads. There are no school zones within the proposal study area.

Current traffic volumes

Based on traffic counts undertaken in November 2017, Table 6-2 provides a summary of the existing two-way weekday daily traffic flows at different locations within the study area.

Table 6-2: Existing traffic volumes

Road	Existing two-way weekday daily traffic volumes
State and regional road network	
Princes Highway south of Bolong Road	37,900
Princes Highway across Shoalhaven River	51,300
Princes Highway south of Bridge Road	42,500
Bolong Road	15,300
Local road network	
Illaroo Road	17,600
Bridge Road	13,100
Pleasant Way	1,500

The Roads and Maritime permanent counter provided traffic data for the Princes Highway at the Shoalhaven River crossing for 2016 and includes the peak summer and Easter seasonal periods. From this data the following is noted:

- The average daily weekday traffic on this section of road is about 51,300 vehicles, and ranges between 50,700 vehicles per day in low season and 53,500 vehicles per day in high season
- High season for traffic appears to run from September through to March with lower volumes generally experienced between April and August
- Public holiday traffic is substantially lower than average daily weekday traffic with about 39,000 vehicles per day
- The AM peak accounts for about 24 per cent of daily traffic movements with about 12,800 vehicle movements (41 per cent of which is travelling northbound and 59 per cent is travelling southbound)
- The PM peak accounts for about 30 per cent of daily traffic movements with about 15,500 vehicles movements (55 per cent of which is travelling northbound and 45 per cent is travelling southbound)
- During 2016 on average, daily traffic on Fridays was about 11 per cent higher than the average daily movements for Monday to Thursday.

Heavy vehicle constraints

There are a number of constraints to heavy vehicle freight traffic movement through the study area. The freight vehicle movements are summarised as follows:

- The Princes Highway and Bolong Road are approved for use by heavy vehicles up to 25 metres and 26 metre B-doubles. The Shoalhaven River crossing provides no current constraint to these vehicles
- There are prohibitions of some HML vehicles on the existing southbound bridge
- The Princes Highway is a 4.6 metre high vehicle route north of the Shoalhaven River crossings. Height restrictions exist across the river and further south
- Vehicles with a height clearance between 4.3 metres and 4.6 metres travelling southbound must occupy both lanes and travel down the centre of the existing southbound bridge to prevent striking the truss structure
- No freight vehicles are approved for operation on Illaroo Road, Bridge Road or Pleasant Way.

Public transport

Public transport within the area consists of both rail and bus networks.

Bomaderry Station is located about two kilometres north-east of Nowra town centre. Bomaderry is the last station on the South Coast Rail Line and has services to Kiama via Berry and Gerringong. At Kiama, passengers may change trains for services to Wollongong and Sydney. In July 2017, Transport for NSW introduced a new trial bus service running between Bomaderry and Kiama train stations aimed at improving connecting services between the two stations.

The Princes Highway is a key corridor for all bus services in the region as it connects Nowra town centre to other regional centres. There are several bus operators that provide services through Nowra, including Nowra Coaches, Shoal Bus and Kennedy's Bus and Coaches. These operators all service Nowra Bus Terminal located on Stewart Place in the town centre.

Public transport services in the area are summarised in Table 6-3.

Table 6-3: Rail and bus services between Bomaderry Station and Kiama Station

Mode	Direction	Number of daily services	Frequency
Train	Bomaderry Station to Kiama Station	13	Peak: About every 45 minutes Off Peak: hourly
	Kiama Station to Bomaderry Station	14	
Bus (Route 737)	Bomaderry Station to Kiama Station	6	Every couple of hours, inconsistent throughout the day. Weekday services only.
	Kiama Station to Bomaderry Station	5	Every couple of hours, inconsistent throughout the day. Weekday services only.

Pedestrian and cyclist network

There are shared paths for pedestrians and cyclists on the east side of the existing southbound bridge and the west side of the existing northbound bridge. These shared paths do not meet the recommended width for a shared path of 2.5 metres, based on Austroads design guidelines. These shared paths connect to other shared paths along Bolong Road, providing access to the Bomaderry residential area, and along Illaroo Road, providing access to the North Nowra residential area. Footpaths are provided along the majority of streets within the Nowra town centre.

Pedestrian crossings are provided at the following intersections

- Bolong Road:
  - provides for crossing of Bolong Road via zebra crossing (southbound left turn lane) and traffic lights
- Illaroo Road:
  - provides for crossing of Princes Highway under traffic lights; located on northern side of intersection
  - provides for crossing of Illaroo Road via traffic lights and zebra crossing (northbound left turn lane)
- Bridge Road / Pleasant Way:
  - provides for crossing Bridge Road / Pleasant Way under traffic lights
  - provides for crossing of Princes Highway under traffic lights on southern side of intersection.

The next pedestrian crossing to the south is at the Moss Street intersection.

The Shoalhaven Bike Plan (Shoalhaven City Council, 2013) identifies a number of proposed improvements to the bicycle network serving the LGA, including locations within the proposal study area.

Maritime environment

The Shoalhaven Estuary Safe Boating Plan 2009-2013 (NSW Maritime, 2009) identifies the use of Shoalhaven River around Nowra Bridge as moderate to high. Common types of usage in the area

are fishing, sailing, rowing, kayaking, swimming, river cruises as well as commercial activities such as charters and hire operations. The Nowra Sailing Club has two boat ramp facilities at the wharf on the south side of the Shoalhaven River located off Wharf Road. There are about five spaces for cars with trailers and another five parking spaces for cars on Wharf Road.

On the northern side of the bridge, Grey's Beach boat ramp is located off Fairway Drive, accessed via Illaroo Road, where there is an unmarked unsealed gravel area for cars and trailers to park, and public toilet facilities.

There is a current maximum navigational clearance of 7.3 metres for all maritime vessels under the existing bridge. There are nine piers across the river for the bridge which are about 35 to 40 metres apart. There is a four knot speed limit for vessels in the area.

Parking

The study area contains a mix of on-street car parking and off-street formal car parks. The majority of parking available is unrestricted parking (i.e. no time limits) however in the Nowra CBD a number of on and off street car parking areas are subject to time limits of between five minutes and three hours.

There is a total of 661 off street car parking spaces available at eight parking areas including Illaroo Road (Rotary Park), Greys Beach boat ramp, Nowra Golf and Recreation Club, Nowra Aquatic Park, Pleasant Way near Graham Lodge, Shoalhaven Entertainment Centre, Shoalhaven City Council (staff and visitors), and Shoalhaven City Council overflow grass parking area.

On-street parking is available on several roads providing a total of 290 spaces. Within the study area, on street parking is not permitted on the Princes Highway, Illaroo Road, Fairway Drive, Bolong Road and Wharf Road.

Performance of existing road network

The existing road network performance has been assessed against the LoS rating. LoS is a common measure of effectiveness adopted for transport related studies and determines the operational conditions and efficiency of a roadway or intersection. The definition of LoS generally describes the operating conditions in terms of speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience, and road safety. There are six levels of services, A to F, with LoS A representing optimum operating conditions (free flow) and LoS F the poorest conditions (forced or breakdown in flow), as shown in Table 6-4.

Table 6-4: Level of Service description

LoS	Description
A-C	Considered to represent good to acceptable levels of service. Where traffic is still within the limits of stable flow with most vehicles being able to travel at the desired speed.
D	Still within capacity. Close to the limit of stable flow with desired speed and manoeuvring restricted. Small increases in traffic flows could cause operational problems.
E	Traffic volumes are close to capacity and queuing and delays can be considered significant.
F	Traffic flows generally exceed capacity and / or average delays are significant for the type of intersection or road. Or where a particular movement would experience a degree of saturation (volume over capacity) over 1.0.

Another common measure of intersection performance is the DoS, which provides an overall measure of the capability of the intersection to accommodate additional traffic. A DoS of 1.0 indicates that an intersection is operating at capacity.

Capacity of existing bridges

During the AM peak period the existing southbound bridge carries up to 2400 vehicles per hour, which equates to 1200 vehicles per lane. Relevant Austroads guidelines notes that the capacity of roads in urban environments is generally between 1100 to1200 vehicles per lane (which confirms the existing southbound bridge currently operates at capacity during peak hours). Therefore irrespective of the capacity of the intersections either side of the bridge, the existing bridge design is insufficient to accommodate current traffic flows.

The existing three lane northbound bridge carries about 2400 vehicles during the PM peak hour, – equivalent to 800 vehicles per lane. This is less than the capacity specified in Austroads.

Capacity of intersections

The existing operation of key intersections in the study area is provided in the following table.

Table 6-5: Existing intersection operation

Intersection	Approach	AM peak			PM peak		
		DoS	LoS	Max queue (m)	DoS	LoS	Max queue (m)
Princes Highway / Bolong Road	Princes Highway (N)	0.73	B	177	0.73	B	157
	Bolong Road (E)	0.47	C	115	0.68	D	142
	Princes Highway (S)	0.27	A	39	0.50	A	911
	Total	**0.73**	**B**	**177**	**0.73**	**B**	**157**
Princes Highway / Illaroo Road	Princes Highway (N)	0.84	D	94	0.79	A	108
	Princes Highway (S)	0.64	B	118	0.93	B	366
	Illaroo Road (W)	0.95	F	294	0.81	E	168
	Total	**0.95**	**E**	**294**	**0.93**	**B**	**366**
Princes Highway / Bridge Road	Princes Highway (N)	0.97	E	296	0.96	E	263
	Pleasant Way (E)	0.01	A	1	0.02	A	1
	Princes Highway (S)	0.88	D	14	0.93	C	146
	Bridge Road (W)	0.24	A	17	0.53	A	55
	Total	**0.97**	**E**	**296**	**0.96**	**D**	**263**

Operation of the key intersections in Table 6-5 can be summarised as follows:

- The Princes Highway / Bolong Road intersection generally operates at an acceptable LoS during the AM and PM peak hours. Long queues can develop at the northern approach of the intersection for vehicles travelling south towards the Nowra CBD
- During the morning peak, the Princes Highway / Illaroo Road intersection operates with a poor LoS and is nearing its operational capacity. The Illaroo Road approach is particularly poor, operating at a LoS of F, and significant delays are experienced. The intersection generally operates at a higher level of service during the afternoon peak period
- The Princes Highway / Bridge Road intersection currently operates close to capacity during the AM and PM peak periods. A particular issue is the delays experienced for vehicles travelling over the existing southbound bridge during the morning peak and turning right into Bridge Road, with long delays often experienced due to the high traffic volumes and only two southbound lanes available over the bridge to accommodate both through traffic and turning traffic.

Crashes

A review of crashes within the proposal study area between 2012 and 2016 found that:

- There were 52 crashes, with 62 per cent of crashes occurring along the Princes Highway at or within 50 metres of an intersection
- There was one fatality recorded due to a fatal head on (not overtaking) collision on the Princes Highway between Bolong Road and Illaroo Road. One crash involving a pedestrian occurred at the intersection of Bridge Road and the Princes Highway while the pedestrian was crossing at the intersection
- The most common crash type was rear end crashes with 23 incidents recorded which accounted for 44 per cent of all crashes. These were located predominantly along the Princes Highway
- Along the bridges there were nine crashes, eight of these incidents being rear end collisions and one incident due to a lane change manoeuvre
- Over half of the crashes occurred at key intersections.

6.1.3 Potential impacts

Construction

Potential impacts to traffic and transport during construction include:

- Temporary increases to travel times to road users including vehicle and cyclists due to:
  - Speed limit restrictions within construction zones
  - Diversions around areas of works that are located or impinge on existing road and footpath carriageway
  - Increased traffic on surrounding road network from heavy construction vehicles and light vehicle movements for workforce and small deliveries
- Altered property access arrangements
- Altered access to the local road network
- Removal of some local road connections
- Possible delays in bus timetables due to temporary traffic control measures
- Temporary loss of parking during construction works.

Traffic

Construction of the proposal would generate between 300 and 410 construction vehicle movements per day. The distribution of these movements on the road network would depend on the following:

- Stage of work
- Home destinations of the workforce
- Source of imported material
- Destination of exported material.

Table 6-6 presents construction traffic vehicle movements per day (vpd) relative to daily traffic movements on individual roads in the vicinity of the construction works. This assessment has assumed that vehicles would be split equally between the approaching site via Princes Highway north, Princes Highway south and Bolong Road.

Table 6-6: Construction traffic movements on surrounding roads

Road	**Existing average daily traffic flow (vpd)**	**Average construction period**		**Peak construction period**	
		Construction traffic (vpd)	Per cent increase	Construction traffic (vpd)	Per cent increase
State and regional road network					
Princes Highway south of Bolong Road	37,900	198	0.5	271	0.7
Princes Highway across Shoalhaven River	51,300	150	0.3	205	0.4
Princes Highway south of Bridge Road	42,500	99	0.2	135	0.3
Bolong Road	15,300	150	1.0	205	1.3
Local roads					
Illaroo Road	17,600	60	0.3	82	0.5
Bridge Road	13,100	45	0.3	62	0.5
Pleasant Way	1,500	45	3.0	62	4.1
Scenic Drive	Unknown, likely less than 1000	15	-	21	-
Fairway Drive	Unknown, likely less than 1000	15	-	21	-

This assessment indicated that daily traffic movements would increase slightly and would not affect the performance of the local and regional roads. A minimum of two lanes in each direction of the Princes Highway would be maintained where possible during construction. It may be necessary to

temporarily reduce the number of lanes available on the Princes Highway during approved night works to undertake some construction activities.

Haulage or traffic movements along the Princes Highway would also be required during construction. Traffic management plans and construction staging would be progressively developed and refined during construction in order to facilitate the safe and efficient movement of traffic through and around the proposal study area and ancillary sites.

Planning for construction works during peak holiday periods would be minimised to reduce potential impacts to traffic and transport.

Business and property

Where property access or parking would be restricted, consultation would be undertaken with the affected property owners and temporary access or parking arrangements would be developed.

Properties that would potentially have access impacts include:

- Perfect Catch Seafoods & Takeaway, 480 Princes Highway
- Residential and agricultural properties east of the Princes Highway (Numbers 474A, 476 and 480)
- Number 521 Princes Highway
- Numbers 19, 21 Illaroo Road
- Thai Riverside Restaurant, 27 Bridge Road
- Numbers 29, 31 Bridge Road
- Exit from the Shoalhaven Entertainment Centre spill over car park (opposite 27 Bridge Road)
- East Willows Van Park, 1 Pleasant Way
- Pleasant Way River Lodge, 9 Pleasant Way
- Wharf Road Restaurant and Bar, 10 Wharf Road
- Nowra Aquatic Park, 20 Scenic Drive.

Public transport

The existing routes of the five bus routes would not change during construction. At times buses may experience delays due to the reduced road capacity during construction works. The construction may impact some existing bus stops in both directions on Bridge Road (near Scenic Drive) and the southbound bus stop on the Princes Highway (immediately south of Pleasant Way). To ensure the safety of bus passengers and allow for the efficient movement of buses away from the construction areas, these bus stops would be temporarily relocated during the works. The details of the relocation (including expected timing) would be detailed in the traffic management plan to be prepared prior to construction.

Pedestrian and cyclist access

The existing pedestrian and cyclist crossings of the Shoalhaven River would be maintained during the construction period. Where pedestrian crossing are provided at traffic light controlled intersections, formal crossings would be maintained where possible throughout the works. To facilitate the intersection upgrade works and widening of Princes Highway, there would potentially be locations where pedestrians and cyclists are temporarily directed to the other side of the road due to necessary temporary footpath closures. The pedestrian paths underneath the existing bridges (on both sides of the river) would need to be closed at times during the construction period.

Maritime

Maritime traffic under the existing bridges would be maintained during construction with at least one span remaining open at all times. The construction of the new bridge would result in additional maritime traffic, with barges required to move personnel, materials and plant at times. A temporary jetty would be required and would potentially be located on the south side of the river, west of the existing northbound bridge adjacent to the main bridge construction site.

A second temporary jetty may be located adjacent to the Fairway Drive ancillary site to reduce impacts on users of the nearby boat ramp. The boat ramp and wharf at the Nowra Sailing Club may also be used for access to and from the river during construction, which may require temporary short term closures and cause disruptions for other users.

The use of maritime vessels and the need to access construction areas on the water would introduce temporary impediments into the river for recreational and commercial boat operators. However, it is not anticipated that these would have a major impact on commercial and recreational watercraft movements. It may be necessary to implement specific measures during water-based construction activities to maintain safe passage and boating conditions such as exclusion zones around construction locations in the river. The need for these and the nature of them would be developed by the construction contractor in consultation with Roads and Maritime, and other relevant stakeholders.

Parking

Where practicable, public parking would be maintained. Due to the requirement for ancillary sites and work areas, some existing public car parking areas would be impacted during construction. These are as follows:

- Existing parking at North Nowra Rotary Park, Illaroo Road (about 14 spaces)
- Existing public off-street car park adjacent to Fairway Drive (about 100 spaces)
- Existing on-street parking on the northern side of Scenic Drive, west of the Princes Highway (about 20 spaces)
- Existing on-street parking on Bridge Road northbound (about 10 spaces)
- Existing informal parking area to the north of the Shoalhaven Entertainment Centre (about 50 spaces)
- Existing public off-street car park adjacent to Pleasant Way and Graham Lodge (about 75 spaces).

These impacts would only be for defined periods during construction, with not all spaces necessarily closed for the duration of construction. Consideration of impacts on amenity is provided in Section 6.8.3.

Operation

Once constructed, the proposal has the potential to impact traffic and transport in a number of ways including:

- Improve travel times for vehicles travelling in all directions compared to the do minimum, even for the forecast projections for 2046
- Remove constraints for overheight and HML vehicles
- Improve congestion and reduce travel times across the Shoalhaven River
- Reduce delays at key intersections
- Reduce crashes

- Increase pedestrian and cyclist safety
- Improve traffic flow and improve road safety
- Improve reliability and travel times of bus services
- Improve active transport throughout the study area.

Future traffic growth

Historical traffic data and Shoalhaven City Council's strategic (TRACKS) traffic model were reviewed to determine the appropriate growth rates for the future traffic demands on the road network in the vicinity of the proposal.

The model considers potential for future land use changes in the surrounding area that would influence the volume of traffic. Traffic growth forecasts are summarised in Table 6-7.

Table 6-7: Traffic projections

Location	Traffic projections
Nowra Bridge	Historical traffic growth rates on the Princes Highway north of the proposal study area at Gerringong and at the Shoalhaven River bridge are 1.2 and 1.7 per cent respectively. A rate of 1.7 per cent per annum was adopted for the analysis. The selected growth rate is consistent with the rate used in the Princes Highway Corridor Strategy for the Princes Highway between Gerringong and Fall Creek.
Illaroo Road	A rate of 2.3 per cent per annum was adopted for the analysis and assumes significant level of urban development occurring in the area.
All other roads	A rate of 1.7 per cent per annum was adopted for the analysis.

Intersection performance

Princes Highway / Bolong Road

The proposal would provide additional capacity at the Princes Highway / Bolong Road intersection. Traffic modelling forecasts that this intersection would continue to perform at LoS C or better until 2046, as shown in Table 6-8. This is due to the additional capacity provided on the Princes Highway by widening the road from two lanes to three lanes in each direction.

Table 6-8: Intersection performance: Princes Highway / Bolong Road

Approach	AM peak			PM peak		
	DoS	LoS	Max queue (m)	DoS	LoS	Max queue (m)
2026 – do minimum						
Princes Hwy (N)	0.76	A	34	0.90	A	112
Princes Hwy (S)	0.47	A	71	0.99	B	188
Bolong Rd (E)	1.18	F	664	1.60	F	1396
Total	**1.18**	**F**	**664**	**1.60**	**F**	**1396**
2026 – with proposal						
Princes Hwy (N)	0.58	A	79	0.68	A	106

Approach	AM peak			PM peak		
	DoS	LoS	Max queue (m)	DoS	LoS	Max queue (m)
Princes Hwy (S)	0.58	A	65	0.84	A	123
Bolong Rd (E)	0.50	B	102	0.52	B	109
Total	**0.58**	**A**	**102**	**0.84**	**A**	**123**
2036 – do minimum						
Princes Hwy (N)	1.03	F	868	1.07	F	1172
Princes Hwy (S)	0.45	A	68	0.94	B	153
Bolong Rd (E)	1.41	F	1147	1.69	F	1569
Total	**1.41**	**F**	**1147**	**1.69**	**F**	**1569**
2036 – with proposal						
Princes Hwy (N)	0.67	A	94	0.81	A	162
Princes Hwy (S)	0.67	A	74	0.92	A	146
Bolong Rd (E)	0.57	C	115	0.56	B	117
Total	**0.67**	**A**	**115**	**0.92**	**B**	**162**
2046 – do minimum						
Princes Hwy (N)	1.19	F	1939	1.24	F	2451
Princes Hwy (S)	0.44	A	66	1.14	F	359
Bolong Rd (E)	1.49	F	1328	1.77	F	1732
Total	**1.49**	**F**	**1939**	**1.77**	**F**	**2451**
2046 – with proposal						
Princes Hwy (N)	0.75	A	121	0.98	D	529
Princes Hwy (S)	0.75	A	83	0.93	D	226
Bolong Rd (E)	0.61	C	126	0.57	B	169
Total	**0.745**	**A**	**126**	**0.98**	**C**	**529**

Princes Highway / Illaroo Road

The proposal would provide considerable enhancement of capacity at the intersection of the Princes Highway and Illaroo Road. Traffic modelling forecasts that this would result in an improvement of intersection performance from the current LoS F to LoS B or better until 2046 in the peak hour periods (refer able 6-9). This is due to the significant increase in capacity at the intersection with an additional right and left turning lane provided on Illaroo Road and three through lanes on the Princes Highway. However, on Illaroo Road, while there would be improved performance, by 2046 this would have deteriorated particularly for the PM peak when the LoS would be similar to current levels.

The proposal retains the existing pedestrian crossings on the northern and western approaches of the intersection. However, it does not include a pedestrian crossing on the southern approach as it would significantly reduce the overall efficiency of the intersection.

Table 6-9: Intersection performance: Princes Highway / Illaroo Road

Approach	AM peak			PM peak		
	DoS	LoS	Max queue (m)	DoS	LoS	Max queue (m)
2026 – do minimum						
Princes Hwy (N)	1.16	C	289	1.84	F	359
Princes Hwy (S)	0.61	A	65	0.79	A	39
Illaroo Rd (W)	1.40	F	1378	1.04	F	401
Total	**1.40**	**F**	**1378**	**1.84**	**F**	**401**
2026 – with proposal						
Princes Hwy (N)	0.57	A	34	0.78	A	45
Princes Hwy (S)	0.56	A	62	0.62	A	133
Illaroo Rd (W)	0.68	C	97	0.47	C	70
Total	**0.68**	**B**	**97**	**0.78**	**A**	**133**
2036 – do minimum						
Princes Hwy (N)	1.29	E	359	2.05	F	359
Princes Hwy (S)	0.64	A	72	0.79	A	37
Illaroo Rd (W)	1.63	F	2026	1.22	F	822
Total	**1.63**	**F**	**2026**	**2.05**	**F**	**822**
2036 – with proposal						
Princes Hwy (N)	0.68	A	43	0.67	A	50
Princes Hwy (S)	0.65	A	100	0.87	A	199
Illaroo Rd (W)	0.71	C	113	0.63	D	90
Total	**0.71**	**B**	**113**	**0.87**	**A**	**199**
2046 – do minimum						
Princes Hwy (N)	1.25	D	359	1.99	F	359
Princes Hwy (S)	0.66	A	79	0.91	A	118
Illaroo Rd (W)	1.87	F	2689	1.39	F	1284
Total	**1.87**	**F**	**2689**	**1.99**	**F**	**1284**
2046 – with proposal						
Princes Hwy (N)	0.73	A	49	0.79	A	85
Princes Hwy (S)	0.69	A	106	0.80	A	86
Illaroo Rd (W)	0.92	D	173	0.92	F	155
Total	**0.92**	**B**	**173**	**0.92**	**B**	**155**

Princes Highway / Bridge Road

The proposal would widen the Princes Highway providing an improvement in the operation of the intersection of Bridge Road and the Princes Highway from the existing AM Peak LoS E and PM peak LoS D. Traffic modelling forecasts that this intersection would perform at LoS B or better during all modelled years, as shown in Table 6-10.

Table 6-10: Intersection performance: Princes Highway / Bridge Road

Approach	AM peak			PM peak		
	DoS	LoS	Max queue (m)	DoS	LoS	Max queue (m)
2026 – do minimum						
Princes Hwy (N)	0.67	A	25	0.75	A	36
Pleasant Way (E)	0.28	F	11	0.30	F	12
Princes Hwy (S)	1.17	F	1037	1.25	F	1653
Bridge Rd (W)	0.29	A	22	1.09	F	1191
Total	**1.17**	**F**	**1037**	**1.25**	**F**	**1653**
2026 – with proposal						
Princes Hwy (N)	0.58	A	73	0.68	A	107
Pleasant Way (E)	-	-	-	-	-	-
Princes Hwy (S)	0.59	A	84	0.80	B	157
Bridge Rd (W)	0.37	A	64	0.68	A	152
Total	**0.59**	**A**	**84**	**0.80**	**A**	**157**
2036 – do minimum						
Princes Hwy (N)	0.72	A	32	0.82	A	52
Pleasant Way (E)	0.28	F	11	0.30	F	12
Princes Hwy (S)	1.32	F	1613	1.43	F	2506
Bridge Rd (W)	0.50	B	150	1.25	F	2077
Total	**1.32**	**F**	**1613**	**1.43**	**F**	**2506**
2036 – with proposal						
Princes Hwy (N)	0.71	A	114	0.72	A	45
Pleasant Way (E)	-	-	-	-	-	-
Princes Hwy (S)	0.67	A	103	0.87	B	205
Bridge Rd (W)	0.51	B	110	0.83	A	258
Total	**0.67**	**A**	**114**	**0.87**	**A**	**258**

Approach	AM peak			PM peak		
	DoS	LoS	Max queue (m)	DoS	LoS	Max queue (m)
2046 – do minimum						
Princes Hwy (N)	0.71	A	29	0.79	A	45
Pleasant Way (E)	0.28	F	11	0.30	F	12
Princes Hwy (S)	1.48	F	2265	1.61	F	3362
Bridge Rd (W)	0.37	A	31	0.82	A	165
Total	**1.48**	**F**	**2265**	**1.61**	**F**	**3362**
2046 – with proposal						
Princes Hwy (N)	0.79	A	145	0.91	A	283
Pleasant Way (E)	-	-	-	-	-	-
Princes Hwy (S)	0.77	B	132	0.91	B	324
Bridge Rd (W)	0.56	A	127	0.85	A	338
Total	**0.79**	**A**	**145**	**0.91**	**B**	**338**

Overall road network performance

The performance of the overall Princes Highway corridor, including side roads, was estimated with and without the proposal for the base case and for 2026, 2036, and 2046 traffic volumes. The performance of the network was evaluated using estimates of the following measures:

- Vehicle Kilometres Travelled (VKT), which is the sum of all distances travelled by vehicles during the peak hour. Trends in VKT growth can infer the potential for the different road networks to accommodate the projected demands. A lower VKT indicates a shorter travel distance
- Vehicle Hours Travelled (VHT) by all vehicles within the model, calculated using the average trip time for each traffic movement and multiplying this by the total traffic demands. A lower VHT indicates a greater ability of the network to accommodate the modelled demand
- Average travel time (minutes) spent by vehicles within the road network. Calculated as VHT divided by total travel demand across the model. The greater the average travel time, the more significant the traffic congestion and delays
- Blocked vehicles, the number of unreleased vehicles. The greater the number of unreleased vehicles, the more significant the traffic congestion and delays in the model.

A summary of these results is provided in Table 6-11 and described in further detail in the following sections.

The analysis demonstrates:

- The traffic modelling indicates that without the proposal (the do minimum scenario), there would be little capacity in the network to accommodate additional traffic. In contrast, the proposal would provide additional capacity to meet forecast traffic growth up to 2036
- The modelling indicates that VHT levels in 2036 are similar to existing levels under the proposal in both the AM and PM peak hours, with VHT increasing in 2046 due to higher volumes of traffic on the road network

- The traffic modelling indicates that during the AM peak, the proposal would improve travel times for motorists by 250 per cent by 2046 when compared with the do minimum scenario for the same period. This is reflective of the inability of the existing road network to accommodate future traffic flows in the area. A similar improvement is forecast in the PM peak hour
- The number of blocked vehicles at the end of each modelled period (both AM and PM) indicates that without the proposal (the do minimum scenario) there would be substantial numbers of unreleased vehicles, indicating the current network cannot accommodate the projected travel demand. The proposal accommodates the travel demand well into 2046, with relatively few unreleased vehicles at the end of model simulation compared to the do minimum scenario.

Table 6-11: Summary of overall road network performance

Scenario		Base case	2026		2036		2046	
			Do Minimum	Proposal	Do Minimum	Proposal	Do Minimum	Proposal
AM peak hour	VKT (km)	7411	8434	9272	8660	10,578	8623	11,566
	VHT (hours)	296	490	234	771	299	1087	422
	Avg travel time (mins)	4.0	5.4	2.6	7.4	2.9	9.3	3.6
	Blocked vehicles	274	1214	0	2672	0	4734	94
PM peak hour	VKT (km)	8189	8990	10,969	9019	12,392	9279	13,721
	VHT (hours)	393	612	282	1132	369	1442	538
	Avg travel time (mins)	4.5	5.7	2.6	9.3	3.0	10.5	3.9
	Blocked vehicles	1062	2212	0	4536	0	6262	0

Local road traffic impacts

The proposal would result in some small changes to traffic flows on local roads within the study area, as summarised below:

- A significant reduction in traffic volumes on Pleasant Way due to the closure of the access point to the Princes Highway as part of the proposal
- Increase in traffic volumes on sections of Lyrebird Drive and Hawthorn Avenue. This is associated with the proposed road connection from the Princes Highway which connects with these two existing local roads
- Increase in traffic volumes on Hyam Street as a result of the Scenic Drive / Bridge Road intersection reverting to a left in, left out arrangement as part of the proposal. Vehicles would therefore not be able to turn right into Scenic Drive from Bridge Road and would instead use Hyam Street
- A reduction in traffic volumes on Scenic Drive as a result of the Scenic Drive / Bridge Road intersection reverting to a left in, left out arrangement.

Heavy vehicles

The proposal would remove the existing constraints to HML vehicles allowing them to travel south over the Shoalhaven River. Other restrictions on the height and length of heavy vehicles caused by the existing southbound bridge would also be removed, allowing freight vehicles to access locations south of Nowra without having to detour or compromise vehicle size. The need for vehicles with a clearance height between 4.3 metres and 4.6 metres to travel in the centre of the bridge, and which is presently a source of traffic delays, would also be removed.

The removal of these restrictions would see an increase in the proportion of heavy vehicles on the Princes Highway that are HML, however, the increase is not expected to be significant as there are still height and weight restrictions at other locations south of the proposal. The proposal would provide increased productivity for the freight industry due to use of HML vehicles, reduced travel times, and improved journey reliability across the Shoalhaven River.

Pedestrians and cyclists

The proposal would improve conditions for pedestrians and cyclists by providing improvements to the existing network and facilities. The 3.5 metre wide shared use path on the western side of the new northbound bridge would connect into shared paths at Illaroo Road and Bridge Road intersections.

The proposal would improve east-west connections across the Princes Highway for pedestrians and cyclist by providing additional controlled crossings at the Bolong Road intersection. The shared path underpasses at the northern and southern foreshores would be upgraded as part of the proposal to make them safer and more accessible.

The proposal also provides for a shared path on the eastern side of the highway on both sides of the river. The path is aligned to connect to the existing southbound bridge after any future decision regarding adaptive reuse for the bridge.

Public transport

Improved traffic performance at the intersections along the Princes Highway would reduce travel times and improve journey reliability for bus services in the study area. The proposal would maintain all existing bus stops and shelters within the study area.

Maritime environment

The proposal would not change navigability for watercraft during operation. The bridge pier configuration would generally match that of the existing northbound bridge (noting that the existing southbound bridge has a lesser vertical clearance). This would provide a navigational clearance of about 28 metres between the pile cap faces for spans 2-8 and about 21 metres for span 9, and a maximum 7.3 metre vertical clearance from mean spring high water level.

Parking

The proposal would impact the existing off-street car park fronting Illaroo Road which services North Nowra Rotary Park. This car park currently contains 12 spaces and is proposed to be relocated to the west along Illaroo Road where a like for like replacement would be provided resulting in no net impact.

No other parking areas (either on-street parking or off-street car parks) would be impacted by the proposal after the completion of construction.

Impact on road safety

The proposal would improve congestion and travel times across the bridge and reduce delays at the intersections. This would also result in a reduction in crashes occurring within the study area, which have been largely attributed to congestion at the intersections adjacent to the Shoalhaven River crossing.

The proposal would also contribute to improved pedestrian safety through inclusion of a new crossing across the Princes Highway at the Bolong Road intersection. The inclusion of the shared path on the eastern side of the highway and on the new northbound bridge would provide an alternative travel option for cyclists, also contributing to improved safety.

6.1.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Traffic and transport	A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Roads and Maritime *Traffic Control at Work Sites Manual* (RTA, 2010) and *QA Specification G10 Control of Traffic* (Roads and Maritime, 2008). The TMP will include: • Confirmation of haulage routes • Measures to maintain access to local roads and properties • Site specific traffic control measures (including signage) to manage and regulate traffic movement • Measures to maintain pedestrian and cyclist access • Requirements and methods to consult and inform the local community of impacts on the local road network • Access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads • A response plan for any construction traffic incident • Consideration of other developments that may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic	Construction Contactor	Pre-construction	Section 4.8 of QA *G36 Environment Protection*

Impact	Environmental safeguards	Responsibility	Timing	Reference
	• Monitoring, review and amendment mechanisms.			
Traffic and transport	Undertake consultation with local and regional bus companies prior to and during construction.	Construction Contactor	Pre-construction / Construction	Project specific control
Traffic and transport	Undertake consultation with Shoalhaven City Council regarding potential impacts to parking during construction and operation.	Roads and Maritime	Pre-construction	Project specific control
Traffic and transport	Undertake consultation with emergency services and Shoalhaven District Memorial Hospital before and during construction to confirm any diversions during construction.	Construction Contactor	Pre-construction / Construction	Project specific control
Traffic and transport	Undertake consultation with property owners regarding changes to access arrangements. Targeted notification to affected residents and businesses will be conducted prior to the completion of altered local road connections, where road closures and detours are proposed.	Construction Contactor	Pre-construction / Construction	Project specific control
Traffic and transport	Notifications will be issued to the local community regarding changes to pedestrian and cycle path access, diversions or alternative routes and any proposed changes to parking.	Construction Contactor	Pre-construction / Construction	Project specific control
Traffic and transport	Schedule partial road closures to avoid peak holiday periods.	Construction Contactor	Construction	Project specific control
Traffic and transport	Provide advance notification to the community where impacts to on-street and off-street parking is unavoidable.	Construction Contactor	Construction	Project specific control
Traffic and transport	Obtain a Road Occupancy Licence where required.	Construction Contactor	Pre-construction / Construction	Project specific control

6.2 Noise and vibration

A noise and vibration assessment has been prepared for the proposal by Renzo Tonin & Associates. The assessment is provided in Appendix D and is summarised in the following sections.

6.2.1 Methodology

The noise and vibration assessment was prepared in accordance with the following guidelines:

- Road Noise Policy (RNP) (DECCW 2011)
- Noise Criteria Guideline (NCG) (Roads and Maritime 2014a)
- Noise Mitigation Guideline (NMG) (Roads and Maritime 2014b)
- Interim Construction Noise Guideline (ICNG) (DECC 2009b)
- Construction Noise and Vibration Guideline (CNVG) (Roads and Maritime 2016)
- Construction Noise Strategy (Transport for NSW 2012a)
- Assessing Vibration: A Technical Guideline (DEC 2006)
- DIN 4150, Part 3: Structural Vibration in Buildings – Effects on Structures (German Standard, 1999).

6.2.2 Existing environment

Noise monitoring

Long term noise monitoring was undertaken to quantify ambient noise levels within the study and in proximity to the construction footprint. Noise monitoring was carried out between 7 and 18 December 2017 at five locations (refer Figure 6-1) to determine background noise levels and existing traffic noise on the Princes Highway. All noise monitoring activities were undertaken and processed in accordance with the Industrial Noise Policy (EPA 2000). Further details of the noise monitoring methodology are provided in Appendix D.

Construction noise assessment

Noise impacts on sensitive receivers from construction activities during and outside recommended standard construction hours have been assessed. A quantitative assessment was carried out as there are many potentially impacted receivers and the construction duration would be longer than three weeks. The assessment provides a detailed analysis of the noise levels at each sensitive receiver location and compares them with the relevant construction noise management levels.

To assess the impact of construction noise on sensitive receivers, construction stages, the expected equipment and plant to be used in each of the stages and the locations of their use was identified. This information was used in a noise model to identify maximum construction noise levels experienced at each sensitive receiver for each stage of construction.

Table 6-12: Indicative construction staging and general activities

Key activity	Description of activity
Early works	
Establishment of the site compounds ancillary sites	Includes site buildings, car parking, and designation of materials storage and laydown areas. The initial actions would involve the construction of site access and egress points.
Temporary and permanent fencing	Specific fencing including silt/sediment fences to prevent sediment reaching watercourses and higher security fences at compounds or where additional security of the works is required.
Construction of water quality basins and temporary construction basins	Installation of temporary construction water quality basins. These would be installed as soon as possible during early works stages.
Pre-earthworks drainage	Constructed at the top of cutting slopes or toe of embankments where required by the design to prevent surface or ground water entering the works. These drains would also be used during construction to divert surface runoff to the construction water quality basins.
Site clearance and demolition	Site clearance including the following tasks: isolation and diversion of live services, demolition of buildings, removal of any pipelines, vegetation clearance.
Main construction works	
Bulk earthworks	Formation of road alignment. Excavation of soil and rock, hammering/rock breaking, drilling, loading, haulage, compaction of fill areas, grading.
Drainage infrastructure	Excavation of trenches and pits. Delivery and placement of precast pipes and pits; filling and compacting.
Paving/asphalting (including concrete sawing)	Delivery of raw materials, placement of surface material, saw cutting.
Bridge works	Piling, casting, concrete pours, placement of pre-cast elements.
Finishing works	
Road furniture installation	Signposting and line marking.
Removal of compounds	Removal of site cabins and restoration of site compound area.

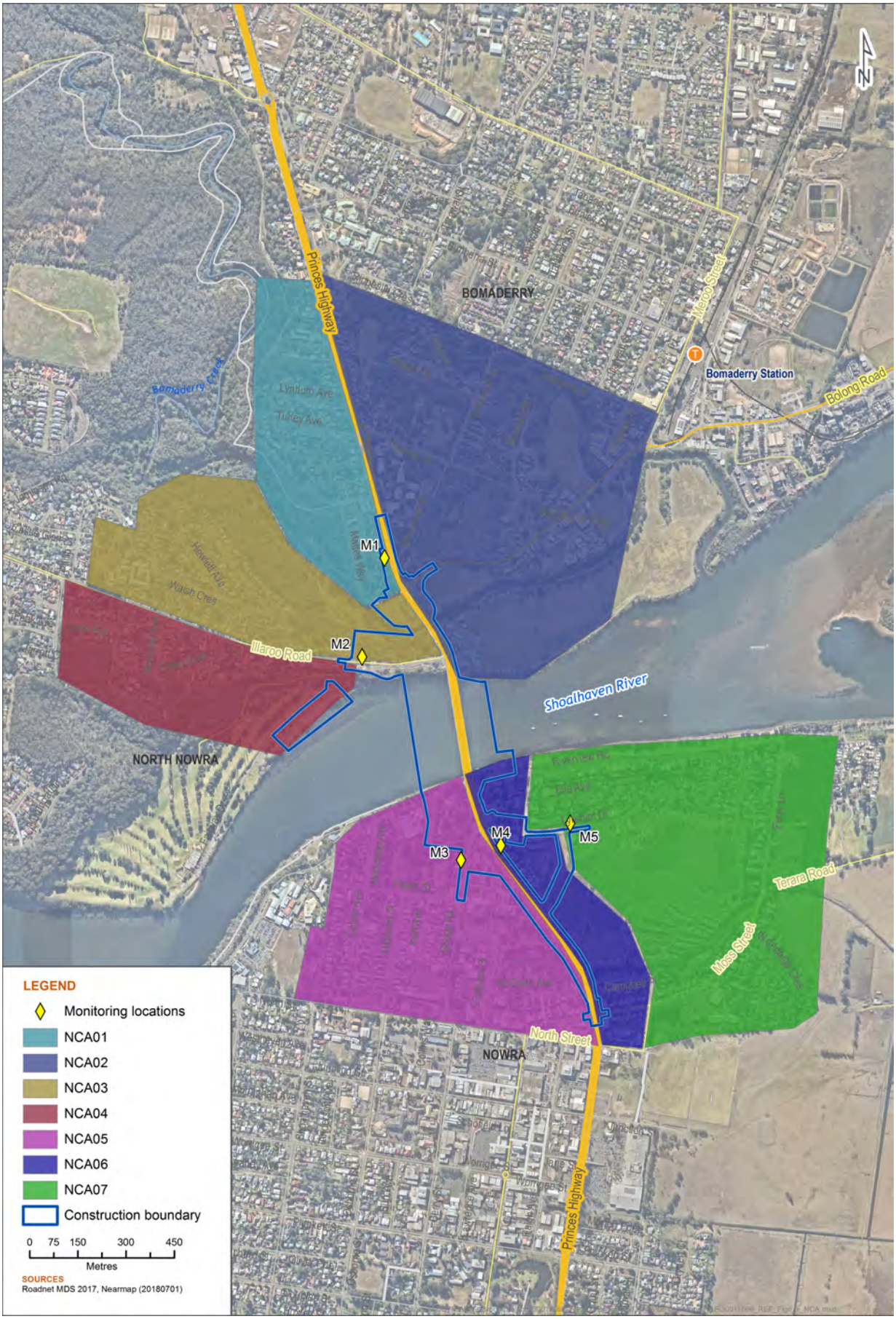

Figure 6-1: Noise Catchment Areas and noise monitoring locations

The following stages would have potential to occur concurrently and noise impacts from these concurrent activities have also been predicted including:

- Site establishment and utilities relocation (standard hours works)
- Bridge construction, construction of bridge approaches and concrete batching facility
- Finishing, landscaping and removal of compounds.

Further details on construction stages and the plant and equipment assumed to be used in each stage are provided in Appendix D. Each of the stages were modelled for both day and night-time periods. Plant and equipment for each stage were assumed to be operating simultaneously and the activity sound power level based on the CNVG was used in the construction model. This provides a worst-case scenario as it is unlikely that all construction equipment would be operating at any one time.

Operational noise assessment

The methodology for the operational noise assessment involved:

- Establish the noise study area in accordance with the Roads and Maritime CNVG
- Establish transition zones between new and road redevelopment segments and between the overall proposal and existing roads
- Daytime, based on existing measured 2017 traffic and road alignment for model validation purposes
- Night-time, based on existing measured 2017 traffic and road alignment for model validation purposes
- Daytime based on 2022 ‘No build’ scenario
- Night-time based on 2022 ‘No build’ scenario
- Daytime based on 2032 ‘No build’ scenario
- Night-time based on 2032 ‘No build’ scenario
- Daytime based on 2022 with 'Build’ scenario
- Night-time based on 2022 with 'Build’ scenario
- Daytime based on 2032 with 'Build’ scenario
- Night-time based on 2032 with 'Build’ scenario
- Develop a traffic noise model to predict the existing level of road traffic noise for the current year
- Determine the noise predictions based on the model for the following operational scenarios:
  - Assess the result of the above modelling against noise criteria to determine any resulting increases in road traffic noise at nearby receivers
  - Identification of sensitive receivers which requires consideration of noise mitigation due to impacts from the proposal.

Further details on the noise model and traffic inputs can be found in Appendix D.

6.2.3 Criteria

Construction noise criteria

The construction noise management levels (NMLs) for the proposal have been developed in accordance with:

- Interim Construction Noise Guideline (ICNG) (DECC, 2009b)

- Construction Noise and Vibration Guideline (CNVG) (Roads and Maritime, 2016).

For work during recommended standard construction hours:

- The 'noise affected level' represents the point above which there may be some community reaction to noise; the noise affected level is calculated by adding 10 dB(A) to the rating background level (RBL)
- The 'highly noise affected level' represents the point above which there may be strong community reaction to noise; the ICNG specifies that the highly noise affected level is 75 dB(A).

For any work outside recommended standard construction hours:

- A strong justification would typically be required for works outside the standard construction hours
- The proponent should apply all feasible and reasonable work practices to meet the noise affected level
- Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

For work outside standard construction hours, the construction noise management level is calculated by adding 5 dB(A) to the RBL. The noise management level for sleep disturbance is based on a maximum internal noise level of 55 dB(A) L_{Amax} as recommended by the RNP and a 10 dB(A) reduction in noise from outside the building. The RNP acknowledges that one or two noise events per night with maximum external noise levels of 75-80 dB(A) are unlikely to substantially affect health and wellbeing. The proposal-specific construction NMLs are provided in Table 6-13.

Table 6-13: Specific construction noise management levels

NCA	Logger ID	L_{A90} RBL			Noise management level $L_{Aeq(15min)}$		
					Standard hours (RBL+10dB)	Extended/out-of-hours work (OOHW) (RBL+5 dB)	
		Day	Evening	Night	Day	Evening	Night
NCA01	M1	62	56	35	72	61	40
NCA02	M1	62	56	35	72	61	40
NCA03	M2	52	46	31	62	51	36
NCA04	M2	52	46	31	62	51	36
NCA05	M3	51	46	34	61	51	39
NCA06	M4	57	53	36	67	58	41
NCA07	M5	39	38	31	49	43	36

Construction vibration

Human comfort criteria

Human comfort vibration criteria have been determined including consideration of Assessing Vibration: A Technical Guideline and British Standard (BS) 6472 – 1992, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz) which is recognised by the Environment

Protection Authority as the preferred standard for assessing 'human comfort' in relation to potential vibration impacts. Typically, construction activities generate ground vibration of an intermittent nature. Intermittent vibration is assessed using the vibration dose value. Acceptable values of vibration dose are presented in Table 6-14.

Table 6-14: Human comfort intermittent vibration limits (BS 6472-1992)

Receiver type	Period	Intermittent vibration dose value ($m/s^{1.75}$)	
		Preferred value	Maximum value
Residential	Day (7am to 10pm)	0.2	0.4
Residential	Night (10pm to 7am)	0.13	0.26
Offices, schools, educational institutes and places of worship	When in use	0.4	0.8

Humans are capable of detecting vibration at levels which are well below those that could cause damage to a building. The degrees of perception for humans are shown in Table 6-15.

Table 6-15: Guidance on effects of vibration levels for human comfort (BS 5228.2-2009)

Vibration level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.3 mm/s	Vibration might be just perceptible in residential environments
1.0 mm/s	It is likely that vibration at this level in residential environments would cause complaints, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure

Structural damage criteria

Table 6-16 presents the German Standard DIN 4150-3:1999 Structural Vibration – Part 3: Effects of vibration on structures minimum safe levels of vibration at different frequencies for commercial and residential buildings. Based on DIN 4150-3, a measured value exceeding those listed in Table 6-16 '…does not necessarily lead to damage; should they be significantly exceeded, however, further investigations are necessary.'

Table 6-16: Guidelines values for short term vibration on structures

Type of structure	Guideline values for velocity (mm/s)		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]
Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
Structures that, because of their particular sensitivity to vibration, cannot be classified above and are of great intrinsic value (eg listed buildings under preservation order).	3	3 to 8	8 to 10

1 Note: At frequencies above 100 Hz the values given in this column may be used as minimum values

Operational noise

Road Noise Policy and noise criteria guidelines

The RNP provides traffic noise assessment criteria for residential receivers and sensitive land uses near new roads and redevelopments of existing arterial roads. The NCG provides guidance on how to apply the RNP. The target levels should aim to be achieved 10 years after the overall proposal opening. The RNP and NCG road traffic noise assessment criteria are presented in Table 6-17.

Table 6-17: NCG assessment criteria for residential land uses for arterial and sub-arterial road developments

Type of road development	Assessment criteria (external) (dB(A))	
	Day (7 am to 10 pm)	Night (10 pm to 7 am)
Existing residences affected by noise from new arterial road corridors	$L_{Aeq(15hr)}$ 55 (external)	$L_{Aeq(9hr)}$ 50 (external)
Existing residences affected by noise from redevelopment of an existing arterial road	$L_{Aeq(15hr)}$ 60 (external)	$L_{Aeq(9hr)}$ 55 (external)
Existing residences affected by both new roads and the redevelopment of existing arterial/sub-arterial roads in a Transition Zone	$L_{Aeq(15hr)}$ 55-60 (external)	$L_{Aeq(9hr)}$ 50-55 (external)
Existing residences affected by increases in traffic noise of 12dBA or more from new arterial/sub-arterial roads	$L_{Aeq(15hr)}$ 42-55 (external)	$L_{Aeq(9hr)}$ 42-50 (external)
Existing residences affected by increases in traffic noise of 12dBA or more from redevelopment of existing arterial/sub arterial roads	Between $L_{Aeq(15hr)}$ 42-60 (external)	Between $L_{Aeq(9hr)}$ 42-55 (external)

Where residences are exposed to both new and existing roads, the NCG provides transition zone criteria. In this instance the proportion of noise from each road is used to establish transition zone

criteria. The overall proposal consists of both new and redeveloped road segments, with transition zones on the Princes Highway on the northern and southern ends of the new bridge. Noise criteria for residences exposed to noise from roads in the transition zone would be between the new and redeveloped NCG noise criteria.

Where existing noise levels are above the criteria, the RNP relative increase criterion is used. The relative increase criteria is exceeded if the 'build option' noise levels increase by more than 12 dB(A) above the 'no-build option' noise levels. A detailed list of the criteria for each individual receiver is provided in Appendix D.

Sleep disturbance

Maximum noise levels generated by road traffic noise have the potential to cause disturbance to sleep. Maximum noise levels from the proposal have been assessed qualitatively for their potential to disturb sleep. The effect of traffic noise on sleep is discussed in Section 5.4 of the RNP. From the research on sleep disturbance to date, the RNP concludes that:

- L_{Amax} (the maximum A-weighted noise level) internal noise levels below 50-55 dB(A) are unlikely to awaken people from sleep (corresponding to around 60-65 dB(A) externally)
- One or two noise events per night, with maximum internal noise levels of 65-70 dB(A) (corresponding to around 75-80 dB(A) externally), are not likely to affect health and wellbeing significantly.

According to the RNP, triggers for and effects of sleep disturbance from exposure to intermittent noise such as noise from road traffic are still being studied, and there appears to be insufficient evidence to set new indicators for potential sleep disturbance due to road traffic noise. The cause of most maximum noise emissions from the proposal would be from heavy vehicles travelling along the proposal during the night time period. The highest maximum noise levels would typically be during compression braking events where heavy vehicles would reduce speeds to negotiate curves in the road, descending down road gradients or changes in posted speed limits.

6.2.4 Potential impacts

Construction

Works within recommended standard construction hours

Table 6-18 presents the number of residential receivers that would experience exceedances above the NML for the respective NCA. Exceedances are predicted for every NCA for most construction activities along the main alignment due to the close proximity of surrounding receivers. Bulk earthworks and pavement works would cause the largest impacts. Receivers in NCA07 would also experience exceedances associated with finishing and landscaping works.

Up to 720 receivers are predicted to be impacted during the pavement works, with up to 180 of these receivers predicted to be highly noise-affected. Noise levels at the nearest affected residences in all NCAs are predicted to be between 85-99 dB(A) and other sensitive receivers predicted to be up to 102 dB(A).

Table 6-18: Predicted number of exceedances, standard hours

Stage	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	OSR
	NML (dB(A))							
	72	72	62	62	61	67	49	-
Site establishment (including establishment of ancillary sites)	5	4	32	24	114	34	257	37
Main compounds	0	0	0	0	1	0	19	0
Utilities relocations	2	0	13	6	4	25	165	16
Building removal	0	2	9	5	44	0	57	16
Earthworks and drainage	8	8	37	19	128	57	278	78
Construction of bridge approaches	0	0	0	0	1	0	43	0
Bridge construction	0	2	6	3	43	3	205	14
Pavement construction	8	12	67	27	157	64	278	107
Finishing and landscaping	8	6	37	18	122	55	278	67
Removal of compounds	1	0	10	12	52	25	176	23

Noise levels are generally dominated by high noise generating plant and equipment with each specific construction activity. The construction plant and equipment that generate the most high noise impacts are road and concrete saws, excavators with rock breaker attachment, pavement laying and road milling machines. These high noise impacts would be for a brief period of time for individual residences as the construction works move along the main alignment. Individual residences would only experience the predicted noise levels while the works are occurring directly outside the residence.

Works outside recommended standard construction hours

Works outside recommended standard working hours would result in exceedances of NMLs at a larger number of sensitive receivers as the NMLs in the evening and night time are lower than those in the day time. The most likely activities that would occur outside standard working hours would be utility relocation and pavement construction to tie in the new approaches to the Princes Highway and works associated with bridge construction activities, particularly for Bomaderry Creek bridge. Works outside recommended standard construction hours may also be required for specific construction activities to minimise disruptions to traffic flow in the area.

Up to 1406 residences are predicted to exceed the construction noise criteria during the out of hours evening period (refer Table 6-19). Up to 174 receivers are predicted to be more than 25 dB(A) above the NML during the pavement works.

Table 6-19: Predicted number of exceedances, evening out-of-hours

Stage	Number of exceedances 25 dB(A) or greater above NML							
	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	OSR
Site establishment (including establishment of ancillary facilities)	0	0	11	7	5	12	36	1
Utilities relocations	0	0	5	1	0	2	0	0
Building removal	0	0	2	0	0	0	0	0
Earthworks and drainage	1	0	11	2	6	26	55	3
Pavement construction	2	0	12	5	22	29	101	3
Finishing and landscaping	1	0	9	1	5	19	51	1
Removal of ancillary sites	0	0	0	0	2	0	15	0

Up to 1191 residences are predicted to exceed the construction noise criteria during the out-of-hours night period (refer Table 6-20). Up to 533 receivers are predicted to be more than 25 dB(A) above the NML during the pavement works.

Table 6-20: Predicted number of exceedances, night out-of-hours

Stage	Number of exceedances 25 dB(A) or greater above NML							
	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	OSR
Site establishment (including establishment of ancillary facilities)	8	13	38	24	87	35	67	1
Main compounds	0	0	0	1	0	0	0	0
Utilities relocations	5	3	14	7	2	28	12	
Building removal	0	2	11	5	24	0	0	0
Earthworks and drainage	8	29	48	20	103	61	145	3
Construction of bridge approach	0	2	0	0	0	0	0	0
Bridge construction	1	3	11	4	9	4	29	
Pavement construction	16	55	75	33	135	64	216	3

Stage	Number of exceedances 25 dB(A) or greater above NML							
	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	OSR
Finishing and landscaping	8	23	47	20	97	59	138	1
Removal of compounds	0	0	0	0	2	0	15	0

Sleep disturbance

Construction activities that would be carried out during the night time period would generally be associated with works where it would be unsafe to carry them out close to live traffic or which would cause major traffic disruptions. These activities would have potential to cause sleep disturbance. Maximum noise levels have been predicted using the out of hours works and is presented in Table 6-21.

Table 6-21: Sleep disturbance, predicted range of noise levels

Stage		NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07
		NML (dB(A))						
		50	50	46	46	49	51	46
Site establishment (including establishment of ancillary sites)	Min	43	43	*47*	46	*55*	*55*	46
	Max	*87*	*83*	*97*	*90*	*91*	*90*	*90*
Main compounds	Min	36	36	40	39	48	46	40
	Max	*66*	*57*	*65*	*71*	*71*	*69*	*70*
Utilities relocations	Min	34	33	38	37	45	54	41
	Max	*75*	*72*	*85*	*79*	*69*	*84*	*64*
Building removal	Min	41	40	44	42	52	47	38
	Max	*68*	*79*	*98*	*74*	*77*	*67*	*62*
Earthworks and drainage	Min	46	45	49	48	59	66	53
	Max	*92*	*84*	*97*	*90*	*98*	*95*	*95*
Construction of bridge approaches	Min	34	32	36	34	42	40	34
	Max	*61*	*71*	*64*	*59*	*65*	*66*	*62*
Bridge construction	Min	48	47	*50*	*48*	*56*	*52*	*48*
	Max	*71*	*83*	*77*	*72*	*72*	*76*	*73*
Pavement construction	Min	49	48	*52*	*51*	*60*	*68*	*56*
	Max	*93*	*85*	*98*	*92*	*99*	*96*	*96*
	Min	46	45	*49*	*48*	*57*	*64*	*52*

Stage		NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07
		NML (dB(A))						
		50	50	46	46	49	51	46
Finishing and landscaping	Max	*88*	*80*	*93*	*87*	*94*	*91*	*91*
Removal of compounds	Min	40	40	45	43	*52*	*52*	45
	Max	*76*	*67*	*74*	*78*	*85*	*82*	*84*

Note: Italic text indicates exceedance of the sleep disturbance NML

Construction traffic noise

Based on the potential ancillary sites presented in Section 3.4, most construction-related traffic would access the ancillary sites from Princes Highway, Illaroo Road or Bridge Road (with the exception of the site at Greys Beach). Based on the existing traffic volumes, Table 6-22 lists the estimated number of heavy vehicle movements to limit the total traffic noise (including construction related traffic) to within 2 dB(A) of existing noise levels.

Table 6-22: Construction traffic volumes

Road	Allowable construction heavy vehicle movements (two-way) per hour	
	Day (7am to 10 pm)	Night (10pm to 7am)
Princes Highway	300	30
Illaroo Road	100	16
Bridge Road	80	8

Vibration

Site-specific minimum working distances for vibration significant plant items must be measured on site where plant and equipment is likely to operate close to or within the minimum working distances for cosmetic damage. Table 6-23 presents the number of buildings for each NCA within the minimum working distances for structural damage and human response. The assessment is based on the most vibration intensive piece of equipment that could potentially be used on the works (large vibratory roller with a minimum working distance of 25 metres). To be conservative, it is assumed that the roller could operate anywhere within the work area.

Table 6-23: Potential vibration impacts

NCA	Number of buildings within minimum working distances	
	Structural damage (25 m)	Human response (100 m)
01	6	8
02	2	7
03	6	11

NCA	Number of buildings within minimum working distances	
	Structural damage (25 m)	Human response (100 m)
04	1	6
05	2	7
06	17	44
07	7	34
OSR	15	33
Total	**56**	**150**

Heritage listed structures

Table 6-24 lists heritage items in close proximity to construction activities which could be potentially impacted by vibration. The Captain Cook Bicentennial Memorial is located within the footprint of an embankment next to the realigned northbound lanes, and would potentially be relocated prior to construction. Accordingly, no monitoring is recommended with respect to this item.

Table 6-24: Heritage listed structures

Item name	LEP no	Estimated distance from works (m)	Vibration monitoring
Captain Cook Bicentennial Memorial	338	5	No
Federation brick and asbestos tile residence	123	250	No
Graham Family Cemetery	369	20	Yes
Graham Lodge	389	30	Yes
Greenleaves – Federation Queen Anne style residence	122	400	No
Illowra	136	20	Yes
Inter-war weatherboard building and timber wharf	407	25	Yes
Kilsyth residence	331	20	Yes
Late Victorian weatherboard cottage	337	150	No
Late Victorian weatherboard residence	376	150	No
Lynburn residence	130	30	Yes
Shoalhaven River Bridge	402	25	Yes
Uuna Cottage	332	25	Yes

Sandstone rock shelter

The Aboriginal heritage investigations identified a rock shelter on the northern side of the Shoalhaven River to the west of the existing northbound bridge. Given the close proximity to the works, including main alignment and bridge works, there is potential for high vibration generating equipment such as rock breakers, pad rollers and impact piling to cause damage to these structures.

Group 3 of the DIN standard provides vibration criteria for buildings that have intrinsic value and this should be used as an initial screening test for the rock shelter. However, given that the rock shelter is not a built structure, the vibration criteria may be unduly conservative. Vibration monitoring should be carried out during periods where high vibration plant and equipment are operating to determine appropriate site-specific vibration levels for the rock shelter.

Operation

The proposal would remove access to the Princes Highway from the existing Pleasant Way, resulting in traffic being diverted onto the new local road and Lyrebird Drive. This would increase traffic flows for these two roads and decrease traffic on the existing Pleasant Way. For all other remaining roads, traffic volumes would remain the same in both the 'Build' and 'No Build' scenarios.

Table 6-25 summarises the number of receivers that exceed the traffic noise criteria and qualify for consideration of noise mitigation before any road corridor treatments such as quieter pavement or noise barriers are implemented. A total of 24 residential receivers would qualify for consideration of noise mitigation. All other sensitive receivers are setback far enough from the proposal that they do not trigger consideration of noise mitigation.

Table 6-25: Summary of receivers that qualify for consideration of noise mitigation (pre-mitigation)

NCA	Number of receivers that qualify for consideration of noise mitigation (pre-mitigation)
01	2
02	2
03	5
04	0
05	1
06	14
07	0
Other sensitive receivers	0
Total:	**24**

The NMG provides a methodology in relation to determining and recommending acoustic treatments for road projects. Once noise has been minimised by feasible and reasonable methods during the corridor planning and road design stages, receivers with residual exceedances of the NCG criteria are assessed to determine if they qualify for consideration of additional noise mitigation.

For receivers that qualify for consideration of noise mitigation measures, potential noise mitigation measures are identified, in the order of preference for application given in the NMG:

1. Quieter pavement surfaces
2. Noise mounds
3. Noise walls
4. At-property treatments.

The priority of mitigation measures recognises the importance of providing protection to both outside recreational areas and internal levels, and also the degree of visual impact. For it to be considered reasonable to provide quieter pavement surfaces, noise mounds and noise walls, there needs to be four or more closely spaced receivers that qualify for consideration of noise mitigation.

Quieter pavement surfaces

Provision of low noise pavement as a potential noise mitigation option was investigated but discounted for the following reasons:

- There are several intersections (Bolong Road, Illaroo Road, Bridge Road, new local road) along the Princes Highway where accelerating and decelerating traffic would occur
- High shear stresses are experienced by pavement surfaces at intersections from vehicle braking, accelerating and turning movements. Open graded asphalt is not recommended for use at heavily trafficked intersections due to its relatively low shear resistance and potential for oil droppings to soften the binder and fill the voids, reducing its noise absorbing ability
- Adopting short sections of open graded asphalt surfacing is not considered practical due to the close proximity of intersections along the Princes Highway which introduce unnecessary complications and safety risks. A consistent dense grade asphalt surface is considered more favourable for its durability and better resistance to shear stress.

Noise barriers

A review of the concept design identified that a barrier could be an effective mitigation solution for residences in NCA06 adjacent to the Princes Highway. The assessment noted the following matters with regard to a barrier:

- A maximum barrier height of eight metres would achieve the required insertion loss of more than 10 dB(A)
- A design barrier height of 5.5 metres would achieve the required insertion loss of more than 10 dB(A)
- Three of the five receivers exceeding the NCG criteria with the design barrier height of 5.5 metres are double storey dwellings.
- A barrier of eight metres provides minimal benefit over the design barrier height of 5.5 metres
- A barrier height of 5.5 metres would provide effective noise mitigation at up to 12 receivers (10 properties) to comply with NCG criteria
- The location and extents of any noise barrier should be further considered during detailed design.

At-property treatments.

At-property noise mitigation may replace at-road mitigation, subject to a reasonable and feasible assessment, in the following circumstances:

- Isolated single residences or isolated groups of closely spaced residences

- Where the affected community expresses a preference for at-property treatment and the cost is less than a combination of a barrier and at-property treatment
- Where noise barriers cannot achieve the level of noise reduction required
- Where the only applicable noise criteria are internal (e.g. places of worship, hospitals or schools and childcare facilities where play areas meet external criteria)
- Where other noise mitigation measures have been shown not to be feasible or reasonable.

Table 6-26 summarises the number of properties within each NCA that remain above the NCG criteria after implementation of noise barriers, and therefore trigger for consideration of at-property treatment. The level of exceedance for the number of properties is shown in five categories, which are detailed in the Roads and Maritime's At-Receiver Noise Treatment Guideline.

Table 6-26: Summary of receivers that qualify for consideration of noise mitigation (post-mitigation)

NCA	Exceedance of NCG criteria					
	0-5 dB	6-8 dB	9-11 dB	12-14 dB	>14 dB	Total
01	0	1	0	1	0	**2**
02	0	1	1	0	0	**2**
03	0	1	1	3	0	**5**
04	0	0	0	0	0	**0**
05	1	0	0	0	0	**1**
06	5	0	0	0	0	**5**
07	0	0	0	0	0	**0**
Total:	**6**	**3**	**2**	**4**	**0**	**15**

Post-construction noise monitoring would also be undertaken in accordance with Roads and Maritime's NMG and Section 6 of the Noise Model Validation Guideline. The monitoring would be undertaken after proposal opening to identify the effectiveness of the operational noise mitigation measures. Where noise levels exceed predictions beyond acceptable tolerances, all further feasible and reasonable measures would be considered.

6.2.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Construction noise and vibration	A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the Interim Construction Noise Guideline (ICNG) (DECC, 2009) and identify:	Construction Contractor	Detailed design / pre-construction	Section 4.6 of QA *G36 Environment Protection*

Impact	Environmental safeguards	Responsibility	Timing	Reference
	• All potential significant noise and vibration generating activities associated with the activity • Feasible and reasonable mitigation measures to be implemented, taking into account Beyond the Pavement: urban design policy, process and principles (Roads and Maritime, 2014) • A monitoring program to assess performance against relevant noise and vibration criteria • Arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • Contingency measures to be implemented in the event of non-compliance with noise and vibration criteria.			
Construction noise	Where feasible, use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; and consideration of site topography when situating plant.	Construction Contractor	Construction	Project specific control
Construction noise and vibration	All sensitive receivers likely to be affected will be notified of construction impacts at least seven calendar days prior to the commencement of any works that may generate noise levels above the Noise Management Level or high vibration impacts. The notification will provide details of: • The project • The construction period and construction hours	Construction Contractor	Pre-construction	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
	• Contact information for project management staff • Complaint and incident reporting • How to obtain further information.			
Out of hours work	Out of hours works will be carried out in accordance with the *Construction Noise and Vibration Guideline* (Roads and Maritime 2016).	Construction Contractor	Construction	Project specific control
Works with high noise levels	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise levels should be scheduled during less sensitive time periods, such as after 8.00 am and before 6.00 pm.	Construction Contractor	Construction	Project specific control
Construction respite periods	High noise generating activities near receivers should be carried out in blocks that do not exceed three hours each, with a minimum respite period of one hour between each block. The duration of each block of work and respite should be flexible to accommodate the usage and amenity at nearby receivers. Unless negotiated with the community with consultation documented and approved by Roads and Maritime Project Manager or permitted under the licence there should be no more than: • Two consecutive evenings or nights per week • Three evenings or nights per week • Six evenings or nights per month. For night work these periods of work should be separated by not less than one week.	Construction Contractor	Construction	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
Construction noise and vibration	Shield stationary noise sources such as pumps, compressors, fans, etc. Stationary noise sources should be enclosed or shielded where feasible and reasonable while ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.	Construction Contractor	Construction	Project specific control
Damage to structures	Attended vibration monitoring should be undertaken at sensitive receivers during works with potential for vibration to cause structural damage and human response in order to confirm appropriate site-specific minimum working distances. Site-specific minimum working distances should be determined whenever significant vibration generating plant will be working close to or within the recommended minimum working distances listed in Appendix D.	Construction Contractor	Construction	Project specific control
Damage to structures	Dilapidation surveys will be conducted at all residential and other vibration sensitive receivers within 50 metres of the construction site.	Construction Contractor	Pre-construction	Project specific control
Construction vibration	Notification of residences potentially affected by vibration by letterbox drop will be carried out for all occupied buildings within 100 metres of the construction site.	Construction Contractor	Pre-construction / Construction	Project specific control
Potential damage to heritage listed structures	Attended vibration monitoring will be carried out during periods where construction plant and equipment are operating within the minimum working distance for the heritage listed structures identified in Table 6-24 of this REF	Construction Contractor	Pre-construction / Construction	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
Potential damage to rock shelters	Vibration monitoring will be carried out during periods where high vibration plant and equipment are operating in close proximity to the rock shelters to determine appropriate site-specific vibration levels.	Construction Contractor	Construction	Project specific control
Operational noise mitigation	Operational noise mitigation requirements will be reviewed during detailed design. At-property treatments will be agreed upon and implemented in consultation with property owners	Roads and Maritime / Designer	Detailed design	Project specific control
Operational noise mitigation	Where practical, operational noise treatments will be implemented at the start of the construction period.	Construction Contractor	Pre-construction	Project specific control
Operational noise	Post construction noise monitoring will be undertaken in accordance with Noise Criteria Guideline (Roads and Maritime 2016) and Noise Mitigation Guideline (Roads and Maritime 2016) within 2-12 months of proposal completion, at selected representative locations along the proposal route.	Roads and Maritime	Post-construction	Project specific control

6.3 Aboriginal heritage

An Aboriginal Cultural Heritage Assessment (CHAR) has been prepared by Artefact Heritage Services and is presented in Appendix E and summarised in the following sections.

6.3.1 Methodology

An Aboriginal cultural heritage assessment and associated consultation was undertaken in accordance with the following guidelines:

- Roads and Maritime Services Procedure for Aboriginal Cultural Heritage Consultation and Investigation (Roads and Maritime 2011) (PACHCI)
- Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (Code of Practice) (Department of Environment Climate Change and Water [DECCW] 2010a)
- Guide to investigating, assessing, and reporting on Aboriginal Cultural Heritage in NSW (OEH 2011)
- Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (DECCW 2010)

The assessment included a desktop investigation, archaeological survey, test excavations and cultural heritage assessment within the study area.

Desktop assessment

An extensive search of the Aboriginal Heritage Information Management Systems (AHIMS) was undertaken on 13 June 2018 for the study area with an approximate buffer of 2.5 kilometres in each direction. The purpose of the buffer was to provide a local context as no sites had been previously recorded within the study area.

Survey and test excavations

Archaeological surveys were undertaken on 22 June 2017 and 31 August 2017 in accordance with PACHCI Stage 2. The survey identified five Aboriginal sites and five areas of potential archaeological deposit (PAD). It was recommended that test excavations be conducted within the areas of PAD to be impacted, in order to determine the extent and nature of any archaeological deposit and to assess archaeological significance.

Test excavations under the Code of Practice were conducted at four of the PADs (PADs 1, 2, 4, and 5). As the Code of Practice requires that test excavations cannot occur within 50 metres of a rock shelter, test excavations of PAD 3 were undertaken in accordance with an AHIP approved by OEH. The test excavation program was carried out across 13 days between 12 March and 6 April 2018.

Cultural heritage assessment

The cultural heritage assessment involved a desktop assessment, database searches, consultation undertaken during survey and test excavation, Aboriginal Focus Group consultation, and interviews with two Aboriginal knowledge holders.

The assessment of cultural heritage significance was undertaken in accordance with reference to the Burra Charter (Australia ICOMOS 2013) and the Heritage Office guidelines (2001).

Additional investigations

During the investigations, two additional areas were identified due to changes in the study area:

1. Fairway Drive ancillary site and land to the south of Lyrebird Drive – an additional archaeological survey was conducted during the test excavation program.
2. A small addition to the Fairway Drive ancillary site – a PACHCI stage 1 assessment was conducted which found that the extension was unlikely to harm known Aboriginal objects or places and does not contain landscapes features that indicate the presence of Aboriginal objects. As such, no further assessment was required.

6.3.2 Existing environment

Archaeological heritage

Ethnohistoric and historical context

Aboriginal people have lived in the Illawarra region for at least 20,000 years (Lampert, 1971). The Shoalhaven River has strong spiritual meaning as well as Coolangatta Mountain, Cambewarra Mountain and Pulpit Rock. There are two creation/dreaming stories for the Shoalhaven River and other stories that connect the Shoalhaven River with the Devils Hands rock art site at Mundamia, three and half kilometres west of the study area.

The study area is the border between the Wodi Wodi and the Wandandian people. The Wodi Wodi were recorded as speaking Dharawal.

After the arrival of Governor Macquarie in1810, the Illawarra area was opened to the cedar getters in 1814–16. By 1840 Alexander Berry had acquired 40,000 acres in the area. A number of Aboriginal people lived and worked in Berry's Coolangatta until the 1880s when the estate was subdivided and the Aboriginal inhabitants were moved to the Roseby Park mission station on the coast east of Nowra. Aboriginal heritage items that have most likely survived include the flaked tools shaped from stone sources embedded in the local sandstone conglomerate, river cobbles transported in the Shoalhaven River or materials obtain through trade during travel.

The historical and archaeological context are described in detail in Appendix E.

Desktop searches

The AHIMS database search identified 69 registered Aboriginal heritage sites within an area of 2.5 kilometres of the study area. The majority of sites are stone artefacts mostly located on sandstone geology eroded by the Bomaderry Creek. Other sites include grinding grooves, art sites, a few modified trees, and one burial site in the alluvial sands. One AHIMS registered site, an artefact site, is located with the updated study area. The site also features a rock shelter and deposit.

Evidence of contact between early settlers and Aboriginal people has been found during archaeological excavations at Graham Lodge, an item listed on the State Heritage Register. While not registered on AHIMS, Graham Lodge is a place with Aboriginal heritage significance. Archaeological surveys undertaken in accordance with the PACHCI Stage 2 recorded five Aboriginal sites and five areas of PAD within the study area These are presented in the following table.

Table 6-27: Summary of sites and PADS registered as a result of survey

AHIMS ID	Site name	Site type
52-5-0852	Nowra Bridge 1	Artefact scatter
52-5-0853	Nowra Bridge 2*	Artefact scatter
52-5-0855	Nowra Bridge 3*	Artefact scatter
52-5-0857	Nowra Bridge 4*	Scarred Tree
52-5-0856	Nowra Bridge 5*	Artefact scatter
52-5-0859	Nowra Bridge PAD 1	Potential Archaeological Deposit
52-5-0860	Nowra Bridge PAD 2	Potential Archaeological Deposit
52-5-0861	Nowra Bridge PAD 3 Cliff & Rockshelter Complex	Potential Archaeological Deposit
52-5-0858	Nowra Bridge PAD 4	Potential Archaeological Deposit
52-5-0854	Nowra Bridge PAD 5	Potential Archaeological Deposit

*Associated with Nowra Bridge PAD 3 Cliff & Rockshelter Complex (AHIMS ID 52-5-0861)

Test excavations

The test excavation identified Aboriginal objects at all five PADs. The test excavation identified five additional Aboriginal sites:

- Two artefacts at Nowra Bridge 6 (AHIMS ID 52-5-0872)
- Artefact scatter at Nowra Bridge 7 (AHIMS ID 52-5-0875)
- Artefact scatter at Nowra Bridge 8 (AHIMS ID 52-5-0876)
- Artefact scatter at Nowra Bridge 9 (AHIMS ID 52-5-0873)
- Artefact scatter at Nowra Bridge 10 (AHIMS ID 52-5-0873).

After the test excavations, one Aboriginal site, Nowra Bridge 3 (AHIMS ID 52-5-0855) and two PADs, Nowra Bridge PAD 1 (AHIMS ID 52-5-0859) and Nowra Bridge PAD 2 (AHIMS ID 52-5-0860) were deregistered. Two previously recorded Aboriginal sites, Nowra Bridge 1 (AHIMS ID 52-5-0852) and Nowra Bridge 2 (AHIMS ID 52-5-0853) were updated as well as three PADs, Nowra Bridge PAD 3 Cliff & Rockshelter Complex (AHIMS ID 52-5-0861), Nowra Bridge PAD 4 (AHIMS ID 52-5-0858), and Nowra Bridge PAD 5 (AHIMS ID 52-5-0854).

Additional archaeological survey was conducted during the test excavation program due to changes in the study area. One newly identified Aboriginal site (Nowra Bridge 11 (AHIMS ID 52-5-0878)) was identified. One previously registered site, Nowra (AHIMS ID 52-5-0086), was found to be located within the updated study area. Based on the description and early date of recording it is likely that Nowra (AHIMS ID 52-5-0086) is the same site as Nowra Bridge 11 (AHIMS ID 52-5-0878). A site card update to Nowra (AHIMS ID 52-5-0086) has been submitted.

During background research for the cultural assessment it was established that Graham Lodge (State Heritage Register [SHR] No. 01699) is located within the southeast portion of the study area and was found to include Aboriginal objects and evidence of early European contact. Graham Lodge had not been previously registered as an Aboriginal site on the AHIMS.

Table 6-28 summarises the new and updated Aboriginal sites and PADs located in the study area.

Table 6-28: Assessment areas and associated artefacts

TA	Previously identified sites	Updated site	Newly identified sites	Deregistered sites
TA01	Nowra Bridge PAD 1 (AHIMS ID 52-5-0859), Nowra Bridge 1 (AHIMS ID 52-5-0852)	Nowra Bridge 1 (AHIMS ID 52-5-0852)		Nowra Bridge PAD 1 (AHIMS ID 52-5-0859)
TA02	Nowra Bridge PAD 2 (AHIMS ID 52-5-0853)		Nowra Bridge 6 (AHIMS ID 52-5-0872)	Nowra Bridge PAD 2 (AHIMS ID 52-5-0853)
TA03	Nowra Bridge PAD 3 Cliff & Rockshelter Complex (AHIMS ID 52-5-0861), Nowra Bridge 2 (AHIMS ID 52-5-0853), Nowra Bridge 3 (AHIMS ID 52-5-0855)	Nowra Bridge 2 (AHIMS ID 52-5-0853), Nowra Bridge PAD 3 Cliff & Rockshelter Complex (AHIMS ID 52-5-0861)		Nowra Bridge 3 (AHIMS ID 52-5-0855)
TA04	Nowra Bridge PAD 3 Cliff & Rockshelter Complex (AHIMS ID 52-5-0861)		Nowra Bridge 7 (AHIMS ID 52-5-0875)	
TA05	Nowra Bridge PAD 4 (AHIMS ID 52-5-0858)		Nowra Bridge 8 (AHIMS ID 52-5-0876)	
TA06	Nowra Bridge PAD 4 (AHIMS ID 52-5-0858)	Nowra Bridge PAD 4 (AHIMS ID 52-5-0858)	Nowra Bridge 9 (AHIMS ID 52-5-0873)	
TA07	Nowra Bridge PAD 5 (AHIMS ID 52-5-0854)	Nowra Bridge PAD 5 (AHIMS ID 52-5-0854)	Nowra Bridge 10 (AHIMS ID 52-5-0873)	
	Nowra (AHIMS ID 52-5-0086)		Nowra Bridge 11 (AHIMS ID 52-5-0878)	Nowra (AHIMS ID 52-5-0086)
			Graham Lodge (AHIMS ID 52-5-0879)	
	Nowra Bridge 4 (AHIMS ID 52-5-0857)			
	Nowra Bridge 5 (AHIMS ID 52-5-0856)			

All sites within the study area were found to be highly disturbed and low concentrations observed across the study area.

Aboriginal cultural heritage assessment

Nowra is currently home to a number of Aboriginal families with strong connection to Country including Nowra – Bomaderry and out towards the coast for many Aboriginal people. There is association, either through grandparents, parents or themselves, with the Bomaderry Aboriginal Children's Home located just to the northeast of the study area at 59 Beinda Street, Bomaderry.

Spiritually, the traditional connection to Country is strengthened through Dreaming or Creation stories associated with prominent topographic features such as the Shoalhaven River and Bomaderry Creek. Physically, the traditional connection to Country is evidenced through the numerous and diverse archaeological site types and complexes recorded through the area such as rock shelters with art and deposit and stone arrangements. These sites likely reflect the strong religious, social and cultural networks operating in the region.

Cultural values for the study area include:

- Bomaderry Aboriginal Children's Home (1908-1988):
  - Place of social significance provides tangible evidence where the lives of Aboriginal people were controlled by the Government with the assistance of Christian missionaries
  - The home has strong social significance for former residences, families and communities from whom children were removed
- Dharawal-Cabbage Tree Palm (*Livistona australis*):
  - Social/religious totem – significant local item
  - Possibly where the Tharawal language derives its name
  - The new growth of the tree could be used for food and heart of the trunk for medicinal purposes
  - Leaves used for shelter and fibre for string, rope and fishing lines
- Shoalhaven River and Bomaderry Creek:
  - Waterways providing resources for past and present Aboriginal populations
  - Water resource for food, shelter, transport and occupation. Trees used for spears, shields, bush tucker and firewood
  - The Shoalhaven River features in Dreaming/Creation stories
- Nowra:
  - Place where Aboriginal people presently live and work
  - About six per cent of the total population of Nowra and Bomaderry identify as Indigenous Australians
- Graham Lodge:
  - Evidence of Aboriginal contact with early settlers
  - Significance for the archaeological potential associated with the 'Greenhills' estate, including remnants from the demolished cottages and sheds recorded in historic paintings
- Archaeological sites:
  - Records of Aboriginal occupation including rock shelters with art, occupation deposit, axe grinding grooves, stone arrangements, middens and burials.

Significance assessment

Social significance

The study area would have been used as a travel route, fishing, camping, food resources, preparation of tools and weapons and was a good fresh water source. The natural landscape provides spiritual and economic basis for survival.

Interviews with knowledge holders indicate a strong social connection to the study area.

Historical significance

During the early 1800s the growth of the cedar industry along the Shoalhaven River resulted in conflict with the local Aboriginal people.

In the late 1880s Aboriginal people lived and worked on Berry's Coolangatta Estate, once the estate was subdivided the Aboriginal who lived on the estate were moved to the Roseby Park mission station. Graham Lodge provides historical significance due to its history of contact between European and Aboriginal people.

The study area is considered to have a high historical significance.

Aesthetic significance

The study area is considered to have a moderate aesthetic significance due to the creek and native vegetation.

Scientific significance assessment

The study area contains Aboriginal sites with significance from high to low. A summary of significance is presented in Table 6-29. All sites have social and cultural significance to the Aboriginal community.

The remainder of the study area has no scientific or aesthetic value. There is a high historical value for the area as there is strong documented history of Aboriginal people in the area.

Table 6-29: Summary of the archaeological significance

Site name (AHIMS ID)	Research potential	Representativeness	Rarity	Education potential	Overall significance assessment
Nowra Bridge 1 (AHIMS ID 52-5-0852)	Low	Low	Low	Low	Low
Nowra Bridge 2 (AHIMS ID 52-5-0853)	High	Moderate	High	High	High
Nowra Bridge 4 (AHIMS ID 52-5-0857)	High	Moderate	Moderate	High	High
Nowra Bridge 5 (AHIMS ID 52-5-0856)	High	Moderate	Moderate	High	High

Site name (AHIMS ID)	Research potential	Representativeness	Rarity	Education potential	Overall significance assessment
Nowra Bridge 6 (AHIMS ID 52-5-0872)	Low	Low	Low	Low	Low
Nowra Bridge 7 (AHIMS ID 52-5-0875)	High	Moderate	Moderate	High	High
Nowra Bridge 8 (AHIMS ID 52-5-0876)	Moderate	Moderate	Moderate	Low	Moderate
Nowra Bridge 9 (AHIMS ID 52-5-0874)	Moderate	Moderate	Moderate	Low	Moderate
Nowra Bridge 10 (AHIMS ID 52-5-0873)	Low	Low	Low	Low	Low
Nowra Bridge 11 (AHIMS ID 52-5-0873)	High	Moderate	Moderate	High	High
Graham Lodge (AHIMS ID 52-5-0878)	High	Moderate	High	High	High
Nowra Bridge PAD 3 Cliff & Rockshelter Complex (AHIMS ID 52-5-0861)	Unknown	Unknown	Unknown	Unknown	Unknown
Nowra Bridge PAD 4 (AHIMS ID 52-5-0858)	Unknown	Unknown	Unknown	Unknown	Unknown
Nowra Bridge PAD 5 (AHIMS ID 52-5-0854)	Unknown	Unknown	Unknown	Unknown	Unknown

6.3.3 Potential impacts

Construction

Aboriginal sites and PADs

There are nine Aboriginal sites and three areas of PAD within the proposal study area. The proposal would directly impact seven Aboriginal sites and partially impact one State Heritage Registered site, Graham Lodge, which has identified Aboriginal cultural values. The proposal would not impact Nowra Bridge 4 (AHIMS ID 52-5-0857), Nowra Bridge 5 (AHIMS ID 52-5-0856), Nowra Bridge

PAD 3 Cliff & Rockshelter Complex (AHIMS ID 52-5-0861), Nowra Bridge PAD 4 (AHIMS ID 52-5-0858), or Nowra Bridge PAD 5 (AHIMS ID 52-5-0854). All other sites would be impacted to some degree by construction and associated works. The impacts are outlined in Table 6-30.

Table 6-30: Impact assessment

Site name (AHIMS ID)	Type of harm	Degree of harm	Consequence of harm
Nowra Bridge 1 (AHIMS ID 52-5-0852)	Direct	Total	Total loss of value
Nowra Bridge 2 (AHIMS ID 52-5-0853)	Direct	Total	Total loss of value
Nowra Bridge 4 (AHIMS ID 52-5-0857)	None	None	No loss of value
Nowra Bridge 5 (AHIMS ID 52-5-0856)	None	None	No loss of value
Nowra Bridge 6 (AHIMS ID 52-5-0872)	Direct	Total	Total loss of value
Nowra Bridge 7 (AHIMS ID 52-5-0875)	Direct	Total	Total loss of value
Nowra Bridge 8 (AHIMS ID 52-5-0876)	Direct	Total	Total loss of value
Nowra Bridge 9 (AHIMS ID 52-5-0874)	Direct	Total	Total loss of value
Nowra Bridge 10 (AHIMS ID 52-5-0873)	Direct	Total	Total loss of value
Nowra Bridge 11 (AHIMS ID 52-5-0878)	None	None	No loss of value
Nowra Bridge PAD 3 Cliff & Rockshelter Complex (AHIMS ID 52-5-0861)	None	None	No loss of value
Nowra Bridge PAD 4 (AHIMS ID 52-5-0858)	None	None	Partial loss of value
Nowra Bridge PAD 5 (AHIMS ID 52-5-0854)	None	None	No loss of value
Graham Lodge (SHR No 01699) / Graham Lodge (AHIMS ID 52-5-0879)	Direct	Partial	Partial loss of value

The archaeological significance of sites that would be impacted by the proposal are as follows:

- Sites Nowra Bridge 1 (AHIMS ID 52-5-0852), Nowra Bridge 6 (AHIMS ID 52-5-0872), and Nowra Bridge 10 (AHIMS ID 52-5-0873) have been assessed as having low archaeological significance
- Nowra Bridge 8 (AHIMS ID 52-5-0876) and Nowra Bridge 9 (AHIMS ID 52-5-0874) have been assessed as having moderate archaeological significance
- Sites Nowra Bridge 2 (AHIMS ID 52-5-0853) and Nowra Bridge 7 (AHIMS ID 52-5-0875) have been assessed as having high archaeological significance.

Prior to construction, the collection of surface artefacts across Nowra Bridge 1 (AHIMS ID 52-5-0852) and Nowra Bridge 2 (AHIMS ID 52-5-0853) would be required. Targeted salvage would be required for Nowra Bridge 2 (AHIMS ID 52-5-0853), Nowra Bridge 7 (AHIMS ID 52-5-0875), Nowra Bridge 8 (AHIMS ID 52-5-0876), and Nowra Bridge 9 (AHIMS ID 52-5-0874). Collection of artefacts and targeted salvage would be required in accordance with an AHIP.

Graham Lodge (SHR No. 01699)

The proposal involves works within the heritage curtilage of the SHR listed Graham Lodge. The existing carpark and hardstand area located at the northern portion of the item are proposed for the location of an ancillary construction site. The area could possibly be used for the storage and movement of equipment and machinery, removal of vegetation and localised earthworks.

Operation

No impacts to Aboriginal heritage would occur during the operation of the proposal.

6.3.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Aboriginal heritage	An Aboriginal Heritage Management Plan (AHMP) will be prepared in accordance with the Procedure for Aboriginal cultural heritage consultation and investigation (Roads and Maritime, 2012) and Standard Management Procedure - Unexpected Heritage Items (Roads and Maritime, 2015) and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented for managing impacts on Aboriginal heritage. The AHMP will be prepared in consultation with all relevant Aboriginal groups.	Construction Contractor	Pre-construction	Section 4.9 of QA *G36 Environment Protection*
Unexpected finds	The *Standard Management Procedure - Unexpected Heritage Items* (Roads and Maritime, 2015) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Roads and Maritime does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of	Construction Contractor	Construction	Section 4.9 of QA *G36 Environment Protection*

Impact	Environmental safeguards	Responsibility	Timing	Reference
	that Procedure have been satisfied.			
AHIP	An Aboriginal heritage impact permit (AHIP) will be sought for the overall proposal area, including Nowra Bridge 1 (AHIMS ID 52-5-0852), Nowra Bridge 2 (AHIMS ID 52-5-0853), Nowra Bridge 6 (AHIMS ID 52-5-0872), Nowra Bridge 7 (AHIMS ID 52-5-0875), Nowra Bridge 8 (AHIMS ID 52-5-0876), Nowra Bridge 9 (AHIMS ID 52-5-0874), and Nowra Bridge 10 (AHIMS ID 52-5-0873). Collection of surface artefacts and salvage excavations will be completed prior to any activities (including pre-construction activities) which may harm Aboriginal objects at these locations.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)
Aboriginal heritage	Where possible, all subsurface impact to Graham Lodge Aboriginal Artefact Scatter (AHIMS ID 52-5-0879) will be avoided. Where impacts are unavoidable, salvage excavations will be undertaken in accordance with an AHIP and a Section 60 permit.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction / Construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)
Aboriginal heritage	Collection of surface artefacts across Nowra Bridge 1 (AHIMS ID 52-5-0852) and Nowra Bridge 2 (AHIMS ID 52-5-0853) will be conducted prior to construction, in accordance with an AHIP.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction / Construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)
Aboriginal heritage	Targeted salvage excavation will be conducted within Nowra Bridge 2 (AHIMS ID 52-5-0853), Nowra Bridge 7 (AHIMS ID 52-5-0875),	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction / Construction	Cultural Heritage Assessment Report (CHAR),

Impact	Environmental safeguards	Responsibility	Timing	Reference
	Nowra Bridge 8 (AHIMS ID 52-5-0876), and Nowra Bridge 9 (AHIMS ID 52-5-0874) prior to construction in accordance with an AHIP.			Artefact Heritage Services, 2018)
Aboriginal heritage	Long term arrangements for the management of excavated artefacts, such as reburial or a keeping place, will be determined in accordance with the recommendations of registered Aboriginal stakeholders and OEH.	Roads and Maritime / Construction Contractor	Pre-construction / Construction / Post construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)
Aboriginal heritage	Prepare and implement a Heritage Interpretation Strategy that addresses the cultural significance of the proposal location within the Dharawal landscape and archaeological finds from the study area. Develop the strategy in consultation with the Registered Aboriginal Parties.	Roads and Maritime / Construction Contractor	Pre-construction / Construction / Post construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)
Aboriginal heritage	Maintain ongoing consultation with the Registered Aboriginal Parties during detailed design and construction.	Roads and Maritime / Construction Contractor	Pre-construction / Construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)

6.4 Non-Aboriginal heritage

A Statement of Heritage Impact (SOHI) has been prepared by Artefact Heritage Services for the proposal. The assessment is provided in Appendix F and is summarised in the following sections.

6.4.1 Methodology

The SOHI was completed to assess the potential impacts on non-Aboriginal heritage values as a result of the proposal.

The assessment included:

- Identification of listed heritage items and potential archaeological remains within the study area
- An overview of the historical development of the study area
- Assessment of significance of heritage items and potential archaeological remains within the study area
- Assessment of impact of the proposal on identified heritage items and potential archaeological remains within the study area
- Recommendations on appropriate management and mitigation measures in line with statutory requirements.

The SOHI was prepared with reference to the following:

- Statements of Heritage Impact in NSW Heritage Manual (NSW Heritage Office, 2002)
- Burra Charter 2013: Australia ICOMOS Charter for Places of Cultural Significance (Australia ICOMOS, 2013).

The following existing literature was also identified:

- Nowra Truss Bridge: Phase 1 Conservation Management Plan (Artefact Heritage, 2015)
- Graham Lodge Precinct, Nowra: Conservation Management Plan (Freemans Architects, 2000)
- Archaeological Assessment of Greenhills, Nowra, NSW (Heritage Archaeology, 2000).

6.4.2 Existing environment

Historical context

Europeans first explored the Shoalhaven region in the late 1790s and later surveyed in 1805. The cedar getters were the first European occupants of the region who logged trees in the area from at least 1811. In December 1812, the first recorded cargo of cedar was brought from the Shoalhaven River to Sydney. The timber industry grew in the area with the exploitation of cedar along the local rivers and creeks.

Settlement of the region was governed by the ease of access. The northern banks of the Shoalhaven River were easily accessed from the Berry to Bomaderry Road, and via Bomaderry Creek. However, the southern bank of the river, where Nowra was established, was difficult to reach by water.

In 1822, Alexander Berry and Edward Wollstoncraft were jointly granted 10,000 acres named ‘Coolloomagatta’. Berry slowly acquired additional land and established his station at the foot of Mount Coolangatta (east of the Nowra Bridge). The northern portion of one of Berry’s grants that sat along the Shoalhaven River, now falls at the southern approach to the Nowra Bridge and the majority of land surrounding it.

The Berry estates were subdivided in 1889 and many of the tenant farmers were able to buy their portions of land. A number of fine residences were built during this period. Prominent Sydney architect Howard Joseland designed ‘Lynburn’, a fine Federation residence, overlooking Bomaderry Creek.

South of the Shoalhaven River, early settlement was concentrated along the river banks and associated with larger land grants to the east than the west.

William Graham, a Scottish convict, was released in 1826 and soon after began acquiring land around the Shoalhaven River. The area was known as Greenhills. Greenhills extended along the southern bank of the Shoalhaven River (near today’s Bridge Road), to the Nowra to Bomaderry ferry road (today’s Ferry Lane). The first Graham homestead was established in the 1840s in an area near the extant Graham Lodge residence.

Settlement south of the river was slow and came much later than that to the north in today’s Bomaderry. The land associated with Nowra was reserved in the early 19th century and surveyed by Thomas Mann as the ‘village of Nowra’ in 1852. Nowra is the only Government planned town in Shoalhaven.

Early communication to the Shoalhaven area was reliant on the Shoalhaven River. Alexander Berry funded the construction of the road between Bomaderry to Berry. Numbaa Council later took over ownership of roads in the area. In 1920, the roads were upgraded and consolidated, creating the Main South Road and the Princes Highway. The river crossing remained an issue until 1881 when the Shoalhaven River Bridge (now the Nowra Bridge) was built.

Construction of the existing southbound bridge

The planning for the construction of a bridge over the Shoalhaven River began in 1876. Prominent Pittsburgh born bridge builder ‘C Shaler Smith Engr’ designed the bridge and for the time, the construction and planning of the bridge was considered a significant engineering feat due to difficulties in stabilising footings into the deep and rocky riverbed.

American based Edge Moor Iron Works Company designed and built the truss bridge, reflecting the American tradition of using large pins at the joints of each diagonal, a practice that significantly reduced assembly and erection times.

At completion and at a length over 309 metres, it was the longest bridge funded by the then Public Works Department. In 1881, the truss bridge was opened with over 6000 people attending the opening ceremony. The bridge acted as a ‘unifying entity’, bringing north and south Shoalhaven together ‘economically, politically and socially’ (Shoalhaven Historical Society, 2014). The construction of the bridge decreased traffic on the ferries and moved development away from Ferry Lane and townships to the east. The increased rail and road based traffic primarily from the north resulted in increasing subdivisions.

By 1893 Nowra began to grow due to the railway link from Bomaderry to Kiama. Nowra became a destination in the broader area as well as a centre for dairy production and trade (Peter Freeman Pty Ltd, 2000). Pastoral and agricultural activities also prospered at this time (Peter Freeman Pty Ltd, 2003).

Listed heritage items

There are 13 heritage items located within the study area. All 13 items are listed on the Shoalhaven LEP. One of these items, Graham Lodge, is also listed on the State Heritage Register (SHR). Another item, Nowra Bridge over the Shoalhaven River, is also listed on the Roads and Maritime

Section 170 Heritage and Conservation Register (s170) and on the non-statutory Register of National Estate. There is one potential heritage item, the M&M Guesthouse, within the study area.

The locations of heritage items are shown in Figure 6-3 and Figure 6-4, and are summarised in Table 6-31.

No sites within or near the study area are included on the Commonwealth Heritage List or the National Heritage List.

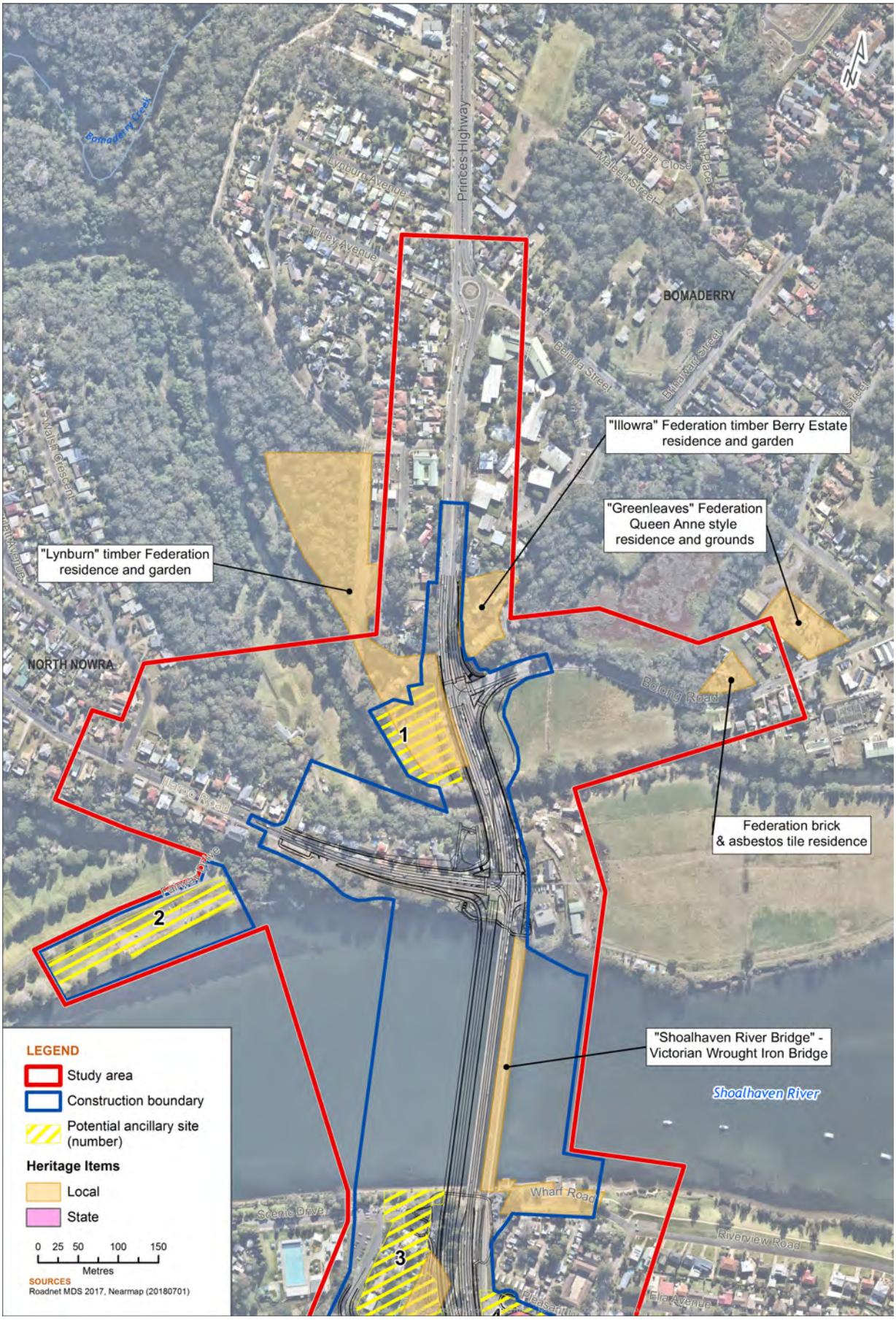

Figure 6-2: Non-Aboriginal heritage within the study area – North

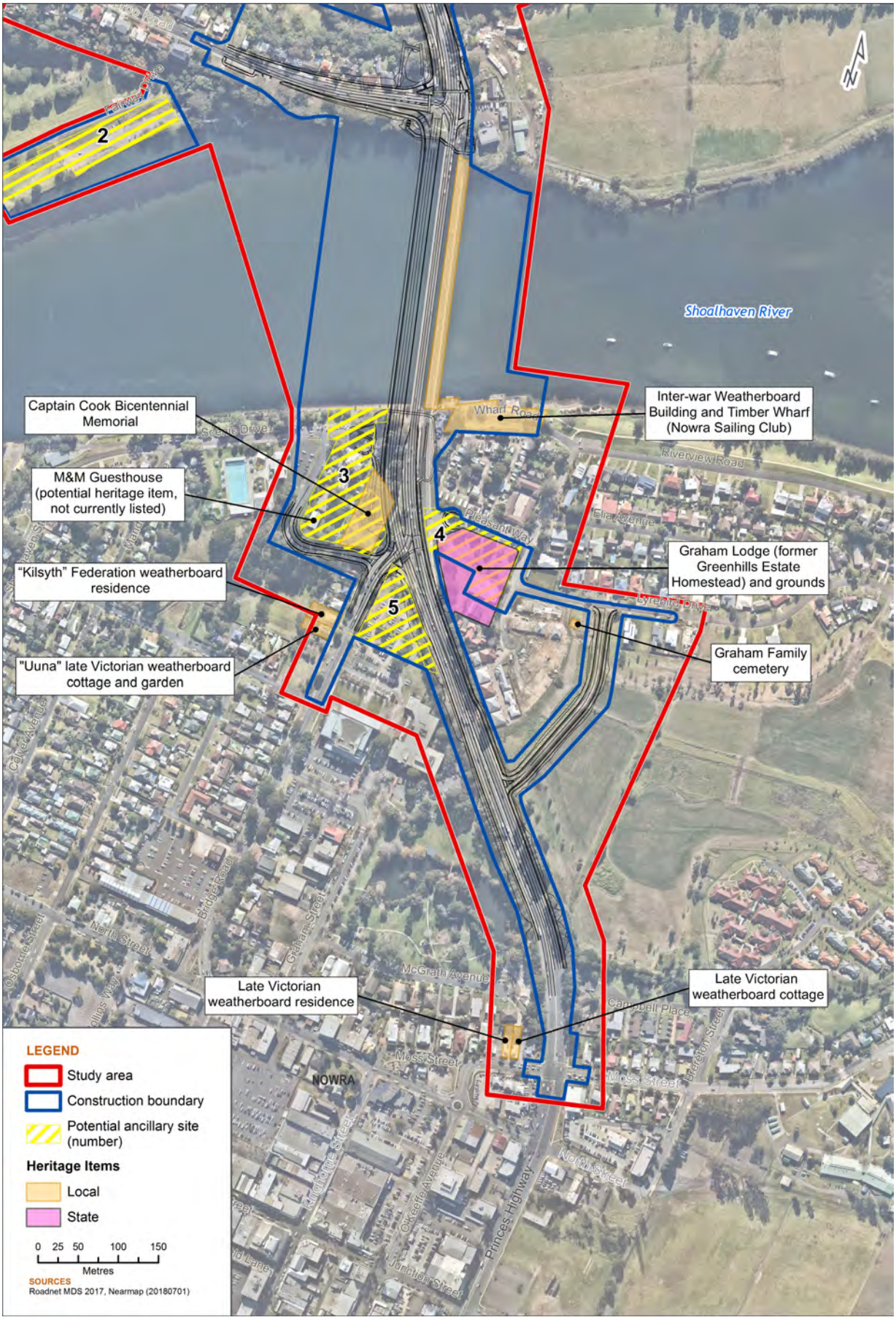

Figure 6-3: Non-Aboriginal heritage within the study area – South

Table 6-31: Non-Aboriginal heritage items within the study area

Site name	Description	Listing	Listing significance
Graham Lodge (former Greenhills Estate and Homestead) and grounds 10 Pleasant Way, Nowra	Graham Lodge is a large two-storey residence constructed in 1860-1861. Designed in the Victorian Georgian style with Victorian Regency influences, the residence is located near the south bank of the Shoalhaven River to the north-east of Nowra's town centre, and is near the Princes Highway by-pass. The building is constructed of locally fired rendered bricks on sandstone footings with a double hipped slate roof. Styled with symmetrical ordering and harmonic proportioned windows and doors, the residence features an upper verandah roof with striped corrugated iron roofing, cast iron verandah posts, iron lace brackets and wrought iron balustrade. Graham Lodge is significant for its aesthetic quality as a substantial nineteenth century Victorian Georgian residence still overlooking much of its original pastoral landholdings and for its potential to expand historical understanding of early European settlement patterns and interactions with Aboriginal people. The site has significance particularly for the archaeological potential associated with the 'Greenhills' estate, including remnants from the demolished cottages and sheds recorded in historic paintings, evidence of both pre- and post-contact Aboriginal artefacts, and evidence of early Chinese market gardens.	SHR No. 01699 LEP Item No. 389	State
Nowra Bridge over the Shoalhaven River Princes Highway, Nowra	The Nowra truss bridge (originally known as the Shoalhaven Bridge) was designed by the prominent engineer C. Shaler Smith, considered one of the premier bridge designers in the post-Civil War period, and was officially opened in 1881. Establishment of a bridge in the locality resulted in increased subdivisions and development, and refocused development on the southern side of the river from Terara to Nowra in the west. In 1981, the bridge was upgraded with a new concrete bridge constructed immediately upstream (west) to carry northbound traffic, and a pedestrian walkway was attached to the truss bridge's eastern elevation. The truss bridge over the Shoalhaven River is a nine span bridge consisting of seven wrought iron 'Whipple' truss spans with overhead bracing supported on pairs of cast iron cylindrical piers, with an overall length of 340 metres. The	Roads and Maritime s170 Register No. 4301658 LEP Item No. 402 Register of the National Estate ID 15932	State

Site name	Description	Listing	Listing significance
	bridge features decorative elements including circular cast iron rosettes. The downstream face of the bridge supports a pedestrian walkway installed in 1981. At present, the bridge carries two southbound traffic lanes of the Princes Highway, with northbound traffic carried on the northbound concrete bridge immediately to the west that was completed in 1981. The truss bridge is a rare example of an early truss bridge that is connected with the early development of the township of Nowra, and is demonstrative of a period of expansion throughout the Shoalhaven region in the late nineteenth century. It was originally designed to carry a double railway track, however the lines were never extended beyond Bomaderry Station. Today it carries the Princes Highway across the Shoalhaven River and is considered a gateway to Nowra town centre. The truss bridge was the longest bridge in New South Wales prior to the construction of the 1889 Hawkesbury River Railway Bridge, and it is the earliest example of a Whipple Truss bridge in New South Wales.		
‘Greenleaves’ – Federation Queen Anne style residence and grounds 59 Bolong Road, Bomaderry	Originally called ‘Flawcraig’ and later renamed ‘Greenleaves’, this residence was built around 1895 by the Berry Estate and designed by leading Sydney architect Howard Joseland. Constructed of local materials, ‘Greenleaves’ is a fine, slightly asymmetrical Federation Queen Anne style house of face brick on sandstone foundations and a complex slate roof. Decorative elements, including ornate brick chimneys, verandah posts and brackets add interest to the surrounding streetscape, which is accentuated by the property’s generous grounds.	LEP Item No. 122	Local
Federation brick and asbestos tile residence 67 Bolong Road, Bomaderry	Constructed in 1915, this single storey brick and asbestos cement tile house is designed in the late Federation style. Once part of the Berry Estate landholding, this parcel of land was subdivided after the death of David Berry. The residence has an asymmetrical plan form with projecting gabled bays on two sides below the main hipped roof, and features decorative design features including terracotta ridge tiles, gable finials and coloured glass.	LEP Item No. 123	Local

Site name	Description	Listing	Listing significance
‘Lynburn’ – timber Federation residence and garden Mattes Way, Bomaderry	Designed by leading Sydney architect Howard Joseland, who was commissioned to design several fine buildings on the Berry Estate in the late 19th century, ‘Lynburn’ was built by George Muller and completed in 1895. An ornate Federation residence, the weatherboard residence features two front gabled projections, a skillion verandah and complex slate roof with terracotta ridge capping and unusual timber decoration to gable ends. Despite a fire that occurred in 1981, the exterior of the residence has been sensitively restored and the interior remains largely intact featuring several marble fireplaces and original lathe and plaster ceilings. The grounds of the property contain several mature trees. Road widening associated with previous upgrading of the Princes Highway slightly reduced the garden, and resulted in the removal of several mature spotted gum trees and reconstruction of the entry gates.	LEP Item No. 130	Local
‘Illowra’ – Federation timber Berry Estate residence and garden 125 Brinawarr Street, Bomaderry	Designed by leading Sydney architect Howard Joseland, ‘Illowra’ was built in 1906 for Mark F. Morton as part of the Berry Estate. The large Federation residence, which features an attic storey, is constructed of weatherboard with tall chimneys in rendered brick and a complex high-pitched jerkin-head roof. The residence is largely concealed from the surrounding streetscape, with plantings and the property fencing concealing the house from view from Princes Highway, Bolong Road and Brinawarr Street.	LEP Item No. 136	Local
‘Kilsyth’ – Federation weatherboard residence 33 Bridge Road, Nowra	Built in circa 1929 by Bruce Lumsden, ‘Kilsyth’ is a single storey Inter-War California Bungalow style residence. Constructed of weatherboard with a corrugated iron roof, the house features axially centred gables facing the street with fibro and batten infill and louvered vent. Making a significant contribution to the surrounding streetscape, the item remains as one of the few unmodified examples of its kind in Nowra.	LEP Item No. 331	Local
‘Uuna’ – late Victorian weatherboard cottage and garden 35 Bridge Road, Nowra	Built by 1895, ‘Uuna’ is a single storey late Victorian shiplap weatherboard cottage featuring a complex hipped iron roof. The gable facing Bridge Road features decorative bargeboard and a finial, and the front verandah with a bullnose iron roof features iron-lace fringing and brackets. The building’s	LEP Item No. 332	Local

Site name	Description	Listing	Listing significance
	unusual form and roof shape, along with its well landscaped garden, contributes to the character and quality of the surrounding streetscape.		
Captain Cook Bicentennial Memorial Bridge Road, Nowra	In 1970, the Shoalhaven Council received a grant of $3500 to construct a modern boathouse as part of the Captain Cook Bicentennial celebrations. The pavilion to house a restored flood boat was completed later in 1970 and was designed by Sydney Architect Michael Tomaszewski. The monument is a late-20th century period shell concrete structure that is reminiscent of 1960s architecture, externally painted white and painted light blue internally. At the time of this assessment, the flood boat was not present within the pavilion memorial and Shoalhaven Council has advised that it is undergoing restoration work with a view to putting it back on public display.	LEP Item No. 338	Local
Graham Family Cemetery Lyrebird Drive, Nowra	The Graham Family Cemetery comprises a small private cemetery that marks the final resting place of the Graham family, a prominent family in the Nowra region. The cemetery is located on low ground about 400 metres south from the Shoalhaven River. Four surviving monuments remain, which are oriented east. The cemetery is overlooked by and retains significant historic sightlines with Graham Lodge.	LEP Item No. 369	Local
Late Victorian weatherboard residence 29 Moss Street, Nowra	Constructed circa 1900, the item is an Italianate asymmetrical plan form cottage that is common from the late Victorian and Federation periods. The weatherboard cottage features a hipped galvanised iron roof and projecting gabled bay. The hipped verandah to the front of the house is roofed with flat corrugated iron sheeting with timber posts and brackets. A picket fence defines the street boundary of the property	LEP Item No. 376	Local
Late Victorian weatherboard cottage 31 Moss Street, Nowra	Erected circa 1900, this item is a late Victorian example of the Italianate asymmetrical plan form cottage. The weatherboard cottage with a hipped galvanised iron roof and projecting gabled bay and bullnose bay window and verandah to front with timber posts and brackets. The projecting bay features decorative bargeboards and a finial. A picket fence defines the street boundary of the property.	LEP Item No. 377	Local

Site name	Description	Listing	Listing significance
Inter-war weatherboard building and timber wharf (Nowra Sailing Club) Wharf Road, Nowra	Constructed in 1930, the Nowra Sailing Club was a typical Inter-War Federation style timber framed building of the 1920s, located directly above the Shoalhaven River. The timber framed building featured a simple gabled roof structure of galvanised iron, and was supported on a brick sub-floor structure. The associated timber piled wharf has been progressively replaced over time with the present combination of piles and fill. At the time of the site visit for the preparation of this report, it appears the weatherboard building had been demolished from the site, although the timber wharf structure still remains. A maritime assessment provided by Shoalhaven City Council has found that archaeological remains apart from the structural remains of the footings are unlikely to be present within the river and banks due to water movement and scouring. The wharf footings would be defined as 'works' and would not fall under the relics provisions of the Heritage Act.	LEP Item No. 407	Local
M&M Guesthouse (former 'Culburra House') near Moorhouse Park, Nowra	Originally named "Culburra House", the single storey weatherboard building was built in the early 1920s. "Culburra House" was designed in the Californian Bungalow style and was one of the earliest buildings at Culburra Beach. Between 1953 and 1954 it was dismantled and relocated to its present location as the Riverhaven Guest Hotel. The building has retained its significant values since its relocation to Nowra during the development of the region during the mid-twentieth century.	Unlisted	Local

Archaeological potential

The study area remained rural in nature from the time of early land grants until after the construction of the bridge in 1881. It wasn't until the late 1800s and early 1900s that significant subdivision and development was undertaken with the growth of Nowra and Bomaderry.

Review of historical plans, maps and photos indicate that there are unlikely to have been substantial structures within the construction area that would have left an archaeological signature, other than those identified below. Any archaeological remains within the majority of the construction area would either be related to later development and unlikely to have research potential, related to the agricultural use of the area and would be ephemeral with their location unpredictable, or would relate to infrastructure such as former road surfaces or drainage, which are unlikely to meet the threshold of local significance and would be classified as works under the NSW Heritage Act.

Around 50 metres east of the existing southbound bridge on the northern shoreline of the Shoalhaven River there are remains of the wharf constructed for coasting steamers in the late19th century and associated stores maybe located within the construction footprint. This area is proposed as a construction compound site.

Historical photographs indicate the wharf was of timber construction with sandstone embankments to the shoreline. The potential for intact archaeological remains associated with the former wharf are low, and may include pier pilings, post holes, brick or stone footings.

The remains of outbuildings associated with Graham Lodge and the original Greenhills property are likely to be located within the Graham Lodge SHR curtilage. Previous archaeological investigations uncovered archaeological relics on the ground surface and sub-surface area in the vicinity of SHR listed residence. Archaeological remains associated with early Graham Lodge outbuildings and cottages may include post holes, fence lines, brick or stone footings, refuse pits and occupation deposits.

Areas of archaeological potential are shown in Figure 6-5 and a summary of the archaeological potential within the study area is provided in Table 6-32.

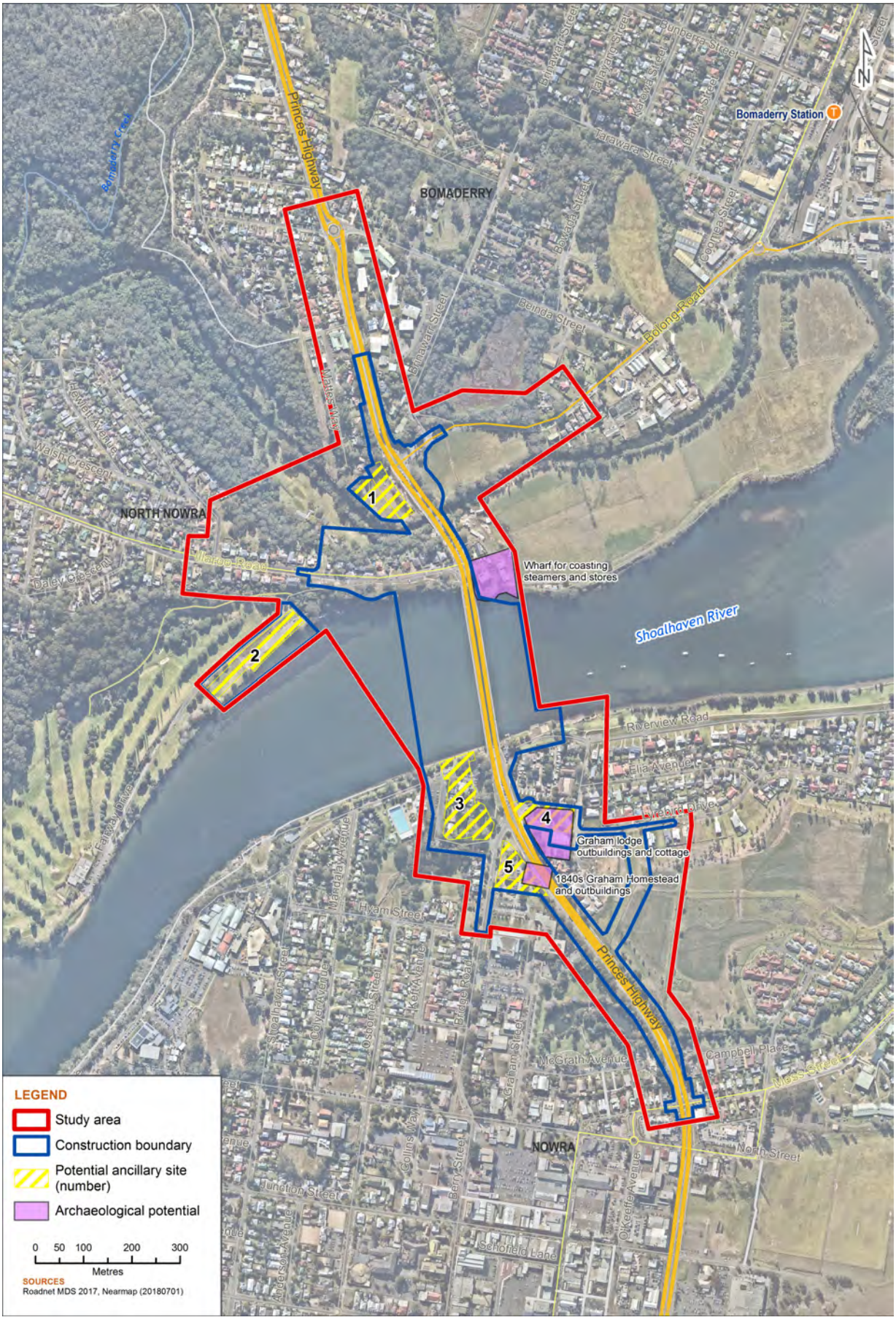

Figure 6-4: Archaeological potential within the study area

Table 6-32: Summary of archaeological significance and potential

Heritage item	Description	Disturbance	Significance	Potential
Wharf for coasting steamers and stores	Site of a former wharf recorded as early as 1892 used for coasting steamers and associated stores located to the east of the existing southbound bridge on the northern shoreline of the Shoalhaven River. Wharf appears to have been of timber construction with sandstone embankment to the shoreline, and associated stores as simple weatherboard structures.	Moderate	Local (works)	Low
Graham Lodge outbuildings and cottages (within SHR curtilage)	Outbuildings and cottages associated with SHR listed Graham Lodge. Structures depicted in 1877 historical painting of the area. Possible that an area along the verge to Hawthorn Avenue adjacent to the carpark area in the northern portion of the site contains archaeological relics. Buildings ranging from brick or timber construction. Several timber slab cottages with brick chimneys.	Low-Moderate	Local/State (as assessed in CMP)	High

6.4.3 Potential impacts

Construction

The proposal would result in a minor, moderate or major impact to the following six non-Aboriginal heritage items:

- Graham Lodge (SHR No. 01699, LEP No. 389)
- Captain Cook Bicentennial Memorial (LEP No. 338)
- 'Lynburn' (LEP No. 130)
- 'Illowra' (LEP No. 136)
- Graham Family Cemetery (LEP No. 369)
- Nowra Bridge over the Shoalhaven River (SHR No. 4301658, Roads and Maritime s170 No. 4301658, LEP No. 402).

The proposal would impact a potential heritage item known as the M&M Guesthouse, which is located to the rear of the former Riverhaven Motel near Moorhouse Park. At present, the proposal would result in the removal of all buildings on the site resulting in a major physical and visual impact to the potential heritage item. The M&M Guesthouse was relocated to its current location from Culburra and has been assessed as having local heritage significance.

Existing southbound bridge (Nowra Bridge over the Shoalhaven River)

While the proposal would result in a minor physical impact and visual impact to the Nowra truss bridge, it is noted that termination of its historic use as the main transportation route across the Shoalhaven would result in an indirect impact to the heritage values of this item. The changed use of the truss bridge would be balanced by positive heritage outcomes. The proposal allows for the bridge's retention and has been designed to site new development upstream (west) of the existing bridges. This complies with the CMP 2015 (Artefact Heritage), which outlines the importance of maintaining the setting and character of the bridge's eastern elevation. Potential conversion of the truss bridge in the future for pedestrian and cyclist use would also offer an opportunity to remove non-original elements including the 1980s pedestrian walkway, road signs and guardrails, and would safeguard the bridge's ongoing use, maintenance and longevity.

Adaptive reuse of the existing southbound bridge would be subject to a separate assessment and determination process. The impacts on known heritage items in the study area are detailed in the following table.

Table 6-33: Impacts on known non-Aboriginal heritage items

Heritage item	Physical impact	Visual impact	Overall impact	Discussion
Graham Lodge	Minor	Negligible	Minor	The proposal would involve works within the heritage curtilage that includes the use of the existing carpark and hardstand area. The impacts would be temporary and not result in permanent changes or a reduction of the item's heritage curtilage.
Captain Cook Bicentennial Memorial	Major	Major	Major	The proposal would result in construction activities that would have a localised physical impact to the Captain Cook Bicentennial Memorial. The proposed southern approach to a new bridge would occupy a significant portion of the item's heritage curtilage, and associated embankments would occur over the top of the current location of the 1970s pavilion structure. This would result in a permanent reduction in the item's heritage curtilage and would require relocation of the pavilion structure itself.
Nowra Bridge over the Shoalhaven River	Negative	Minor	Minor	The proposal would involve negligible physical impact to the truss bridge. The construction of a new bridge immediately upstream (west) of the existing bridges and removal of traffic from the truss bridge would result in termination of the truss bridge's historic use as the major transportation route in the region across the Shoalhaven River. It is noted the use of the truss bridge has previously been impacted by the construction of the northbound concrete bridge, which at present carries all northbound traffic across the river. The bridge has also been previously adapted for pedestrian use in the 1980s, involving the attached walkway on the eastern side of the bridge.
'Lynburn' – timber Federation residence and garden	Moderate	Moderate	Moderate	Construction of the northern approaches to the proposed new Nowra bridge and upgrades to the Bolong Road intersection would result in encroachment upon the eastern extent of the heritage curtilage of 'Lynburn'. This would result in a small permanent reduction in the item's heritage curtilage by up to 20 metres and removal of plantings and vegetation that borders the Princes Highway in this locality. The proposal would also potentially result in the establishment of an associated construction compound that would temporarily occupy additional space within the southern and eastern portion of the curtilage. This would potentially result in further removal of vegetation within the curtilage.
'Illowra' – Federation timber Berry Estate	Minor	Moderate	Moderate	Construction of approaches to the proposed new bridge would result in a minor encroachment upon the western extent of the heritage curtilage of 'Illowra' along Princes Highway, by about three metres. This would potentially result in removal of vegetation, excavation and earthworks within the heritage item's curtilage. Construction activities

Heritage item	Physical impact	Visual impact	Overall impact	Discussion
residence and garden				would be undertaken within 25 metres of the residence and, as such, the proposal could potentially result in indirect physical impact by way of vibration.
Graham Family Cemetery	Neutral	Minor	Minor	The proposal does not involve any works that would directly affect the physical fabric or encroach upon the heritage curtilage of the Graham Family Cemetery (which is part of the SHR curtilage of Graham Lodge). Construction activities would be undertaken within 25 metres of the cemetery and, as such, the proposal could potentially result in an indirect physical impact by way of vibration.
Inter-war Weatherboard Building and Timber Wharf	Minor	Minor	Minor	Potential establishment of an associated construction compound across almost entirety of the 'Inter-war Weatherboard Building and Timber Wharf heritage item. The impacts are temporary in nature and would not result in a reduction of the item's heritage curtilage. There is the potential of indirect physical impact by way of vibration to the wharf.
'Kilsyth' – Federation weatherboard residence	Neutral	Negligible	Negligible	The proposal does not involve any work that would directly affect the physical fabric or encroach upon the heritage curtilage of 'Kilsyth. Construction activities would be undertaken within 25 metres of the residence and, as such, the proposal could potentially result in indirect physical impact by way of vibration. There is potential for impact from work vibrations.
'Uuna' – late Victorian weatherboard cottage and garden	Neutral	Negligible	Negligible	The proposal does not involve any work that would directly affect the physical fabric or encroach upon the heritage curtilage of 'Uuna'. Construction activities would be undertaken within 25 metres of the residence and, as such, the proposal could potentially result in indirect physical impact by way of vibration. The proposal would result in a neutral physical impact to 'Uuna'. There is potential for impact from work vibrations.
'Greenleaves' – Federation Queen Anne style residence and grounds	Neutral	Neutral	Neutral	The proposal does not involve any work that would directly affect the physical fabric or encroach upon the heritage curtilage of the 'Greenleaves' residence or grounds. As construction activities are located more than 25 metres away, vibration impact to this heritage item is not anticipated. The proposal would result in a neutral physical impact to 'Greenleaves'.

Heritage item	Physical impact	Visual impact	Overall impact	Discussion
Federation brick and asbestos tile residence	Neutral	Neutral	Neutral	The proposal does not involve any work that would directly affect the physical fabric or encroach upon the curtilage of the 'Federation Brick and Asbestos Tile Residence' heritage item. As construction activities are located more than 25 metres away, vibration impact to this heritage item is not anticipated. The proposal would result in a neutral physical impact to 'Federation Brick and Asbestos Tile Residence'.
Late Victorian weatherboard residence	Neutral	Negligible	Negligible	The proposal does not involve any work that would directly affect the physical fabric or encroach upon the heritage curtilage of the 'Late Victorian weatherboard residence'. As construction activities are located more than 25 metres away, vibration impact to this heritage item is not anticipated. The proposal would result in a neutral physical impact to the 'Late Victorian weatherboard residence' heritage item.
Late Victorian weatherboard cottage	Neutral	Negligible	Negligible	The proposal does not involve any work that would directly affect the physical fabric or encroach upon the heritage curtilage of the 'Late Victorian weatherboard cottage'. As construction activities are located more than 25 metres away, vibration impact to this heritage item is not anticipated. The proposal would result in a neutral physical impact to the 'Late Victorian weatherboard cottage' heritage item.

The proposal includes a potential construction compound in the location of a potential heritage item, the M&M Guesthouse (former 'Culburra House'), which is located to the rear of the present Riverhaven Motel near Moorhouse Park. The proposal would result in the removal of all buildings on the site. This would result in a major physical and visual impact to the unlisted heritage item M&M Guesthouse, which has been assessed as being of local significance. Given that the building has been previously moved from its original location at Culburra Beach, relocation of this item is not considered to diminish its significant values.

Archaeological impact assessment

There is a moderate-high potential for archaeological remains within the SHR curtilage of Graham Lodge. This includes the previously identified area of potential along the verge between Hawthorn Avenue and the existing carpark.

Due to previous disturbance there is nil to low potential for the remains of the original Graham Lodge 1840s cottage to be located within the construction footprint area.

The location of the former stores and wharf has low potential for locally significant archaeological remains (works) and is outside the proposed impact area.

Significant archaeological remains are not expected within the remainder of the study area due to the rural and agricultural use until the late 19th century.

Operation

Operation of the proposal would result in positive heritage outcomes for the existing southbound bridge due to the retention of the structure, maintenance operations, potential removal of non-significant fabric, and long term reduction in vibration levels.

Statement of heritage impact

The SOHI is summarised in Table 6-34.

Table 6-34: Summary of archaeological potential and significance

Development	Discussion
What aspects of the proposal respect or enhance the heritage significance of the study area?	The proposal has been developed, where possible, to minimise direct impact on nearby heritage items, including the retention of the existing southbound bridge (Roads and Maritime s170 Register No. 4301658, LEP Item No. 402), which has previously been assessed as being of State significance. Impacts to other LEP items have been minimised by design. The proposal would result in positive heritage outcomes for the existing southbound bridge. In addition to allowing for the retention of the bridge, the siting of the proposed new northbound bridge has been developed to the west of the existing bridges. This would minimise impacts to the existing southbound bridge and is in keeping with the policies contained in the CMP 2015, which outline the requirement to maintain the area to the east of the bridge and around the two ends of the bridge as being free from any new constructions.
What aspects of the proposal could have a detrimental impact on the heritage	The change in use of the existing southbound bridge, and encroachment upon the heritage curtilages of several heritage items as a result of the proposal would not respect or enhance the heritage significance of these items and the surrounding cultural landscape of the Shoalhaven, and would potentially involve a range of physical and visual impacts.

Development	Discussion
significance of the study area?	The proposed new northbound bridge and subsequent decommissioning of the existing southbound bridge from vehicle use would result in an indirect impact to the historical use of the bridge as the main transportation route across the Shoalhaven since its construction over 130 years ago. It is noted, however, that the proposal allows for the retention of the existing southbound bridge into the future and allows for its historical, associative, aesthetic, research potential, rarity and representativeness heritage values to be conserved and interpreted. The alignment of the southern approaches to the new northbound bridge would result in significant incursions to the Captain Cook Bicentennial Memorial (LEP Item No. 338), and would potentially necessitate relocation or removal of the 1970s pavilion structure. Changes to this feature and reduction of its heritage curtilage would result in a major direct and major indirect impact. Encroachment upon the eastern boundary of 'Lynburn' (LEP Item No. 130) to construct the northern approaches to a new bridge and associated construction compounds would alter the setting and cultural landscape of this item by way of removal of vegetation and reduction of the curtilage of the adjoining paddock between the main residence and Bomaderry Creek. The proposal would result in a moderate physical impact and visual impact to 'Lynburn'. The location of a proposed construction compound adjacent to Moorhouse Park would require excavations and works that would result in a major physical and visual impact to the potential heritage item 'M&M Guesthouse' (former "Culburra House"). It is noted that the item has been relocated previously from its original location in Culburra Beach, and relocation from its present location would not diminish its identified heritage significance. Avoidance of the Graham Lodge curtilage has reduced the potential for impact to archaeological remains. Relevant archaeological permits, management measures and procedures would be required to be employed in the event that unexpected finds are encountered during the proposed work.
Have more sympathetic options been considered and discounted?	Development of the proposal has involved a complex and ongoing process that has explored numerous design options for the proposal. This process has negotiated constraints and opportunities and input from various stakeholders in order to reach the current proposal that meets the key objectives. Three options were considered for the truss bridge: • Retention – the truss bridge would be repaired and maintained; potentially refitted for a variety of different uses • Relocation (whole or in parts) – the truss bridge would be removed and relocated • Removal – complete removal of the whole truss bridge, only to be considered if no other feasible option can be found. For the proposal, Roads and Maritime has drawn upon the review by an independent external specialist of all investigations completed to date relating to the future of the old southbound truss bridge. The independent assessment confirmed that the old bridge is operationally unsuitable for the current and future demands of the Princes Highway,

Development	Discussion
	and that once a new bridge crossing is constructed the old bridge should then be closed to vehicular traffic. The independent assessment assigned substantial weight to the potential heritage value of the existing southbound bridge and considers the community impacts of any option that does not retain the bridge in its current location. The independent assessment also estimates a marginal cost differential in the first 10 years to retain the existing southbound bridge for adaptive reuse, and also considers that option to be viable in the medium term. Based on this analysis, the proposal involves retention and adaptive reuse of the existing southbound bridge, and a proposed new northbound bridge immediately upstream of the existing northbound bridge. Several options were considered for the location of the proposed new northbound bridge, which are outlined in the REF. Based on the results of multiple options assessment exercises including consideration of the benefits for light and heavy vehicles, design and urban design issues, constructability and utilities challenges, environmental and heritage priorities, whole of life maintenance and work health safety, as well as relative construction costs and value for money; and after consulting with key stakeholders, the proposal was selected as the preferred option.

6.4.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Non-Aboriginal heritage	A Non-Aboriginal Heritage Management Plan (NAHMP) will be prepared and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented to avoid and mitigate impacts to Non-Aboriginal heritage. The NAHMP will include • Provisions to appropriately protect and manage significant fabric during the proposed. • Provision of a heritage induction for all workers being carried out prior to commencement of works. • The induction will include values of the sites, avoidance procedure, and contacts (site manager, Road and Maritime environment officer) for reporting unexpected archaeological finds, or	Construction Contractor	Detailed design / Pre-construction	Section 4.10 of QA G36 Environment Protection

Impact	Environmental safeguards	Responsibility	Timing	Reference
	inadvertent impact to heritage items.			
Non-Aboriginal heritage	*The Standard Management Procedure - Unexpected Heritage Items* (Roads and Maritime, 2015) will be followed in the event that any unexpected heritage items, archaeological remains or potential relics of Non-Aboriginal origin are encountered. Work will only re-commence once the requirements of that Procedure have been satisfied.	Construction Contractor	Detailed design / Pre-construction	Section 4.10 of QA G36 Environment Protection
Non-Aboriginal heritage	Where practicable, impacts to Graham Lodge and curtilage should be avoided. Should subsurface works which may impact significant archaeological remains with Graham Lodge are unavoidable and justifiable, an Archaeological Research Design will be prepared to support a section 60 application.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
Non-Aboriginal heritage	Determine a suitable location for relocation of the pavilion structure associated with the Captain Cook Bicentennial Memorial, in consultation with Shoalhaven City Council.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
Non-Aboriginal heritage	Where practicable, investigate opportunities to minimise impacts to the curtilage of 'Lynburn' (LEP No.130). The screening vegetation will be retained where possible or replanted after construction to minimise visual impact.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction / Post construction	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
Non-Aboriginal heritage	A heritage interpretation strategy will be prepared including an interpretation of archaeological remains should any be uncovered. The interpretation strategy will include the history, associations and significance of the existing southbound bridge, interpretive signage, panels or displays at the entry points to the bridge or at locations along its span.	Roads and Maritime	Detailed design	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018

Impact	Environmental safeguards	Responsibility	Timing	Reference
Non-Aboriginal heritage	An archival recording will be prepared for the Captain Cook Bicentennial Memorial, the Nowra Bridge over the Shoalhaven River, 'Illowra', 'Lynburn' and the potential unlisted heritage item 'M&M Guesthouse' prior to impacts occurring. The archival recording will be prepared in accordance with Photographic Recording of Heritage Items Using Film or Digital Capture (Heritage Council 2006).	Roads and Maritime	Detailed design / Pre-construction	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
Non-Aboriginal heritage	Wherever possible, natural screening adjacent to heritage items along the Princes Highway will be retained. This particularly relates to vegetation within the LEP listed 'Lynburn' heritage item (LEP No. 130) and Captain Cook Bicentennial Memorial heritage item (LEP No. 338). Where impact to vegetation cannot be avoided new plantings will be considered.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction / Post construction	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
Non-Aboriginal heritage	Consider options for relocation of the unlisted potential heritage item 'M&M Guesthouse' in consultation with Shoalhaven Council.	Roads and Maritime	Prior to detailed design	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018

6.5 Landscape character and visual impacts

A landscape and visual impact assessment has been prepared by Spackman Mossop and Michaels. The assessment is provided in Appendix G and summarised in the following sections.

6.5.1 Methodology

The methodology used to undertake the landscape character and visual impact assessment involved:

- Reviewing existing data and reports for the area
- Undertaking a site inspection to identify views, visual catchments, sensitive sight lines
- Reviewing and contributing to the concept design
- Evaluating the characteristics of the site considering land uses, heritage and conservation areas, scenic views, recreational areas and landform.
- Determining sensitivity levels
- Identifying key urban design objectives and principles
- Developing a concept strategic design plan
- Determining the visual exposure and preparing a visual envelop map showing the visual catchment area
- Identifying view points within the visual catchment that represent the varying site conditions and the proposal
- Assessing the visual impact by reviewing the sensitivity of the view points and the determining the magnitude of the impact (scale, character and distance) of the proposal on them
- Identifying safeguards and mitigation measures.

The landscape character and visual impact assessment has been prepared in accordance with Roads and Maritime guidelines including:

- Beyond the Pavement: Urban Design Policy, Procedures and Design Principles, Roads and Maritime, January 2014
- Bridge Aesthetics, Roads and Maritime, July 2012
- Landscape Design Guidelines, Roads and Maritime, April 2008
- Environmental Impact Assessment Practice Note: Guidelines for landscape character and visual impact No EIA-N04 v2.0 28 March 2013
- Guideline for Batter Surface Stabilisation using vegetation, Roads and Maritime, April 2015
- Biodiversity Guidelines, Protecting and Managing Biodiversity, Roads and Maritime, Sept 2011.

The assessment of landscape character involves the identification of different landscape character zones, providing description of their defining attributes and an assessment of the sensitivity and impact of the proposal on each zone.

The visual assessment requires the selection of a number of view points along the proposal. Each view point was provided a description, assessment of the sensitivity and impact of the proposal in terms of sensitivity and magnitude. An overall assessment is provided based on the landscape character and visual impact grading matrix, as detailed in Table 6-35.

Table 6-35: Landscape character and visual impact grading matrix

SENSITIVITY \ MAGNITUDE	High	Moderate	Low	Negligible
High	High	High-moderate	Moderate	Negligible
Moderate	High -moderate	Moderate	Moderate - low	Negligible
Low	Moderate	Moderate - low	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

6.5.2 Existing environment

Landscape context

Nowra is located within an area of highly scenic, natural bushland and pastoral landscape. The surrounding area includes state forests and national parks that contain dense native vegetation. The key natural landscapes include the Illawarra escarpment and Cambewarra Ranges which contribute to the scenic quality, providing attractive views from the road corridors and urban areas.

The Nowra township is laid out in grid pattern comprising predominantly single storey buildings. Open spaces areas are limited to Harry Sawkins Park and Marriot Park providing the only significant space. The foreshore area separates the built landscape of Nowra and the Shoalhaven River.

North Nowra is low to medium density consisting of single and two storey residential buildings. The area is separated from the river by open space consisting of the Nowra Golf Club and Rotary Park. North Nowra and Bomaderry are separated by the Bomaderry Creek Regional Park.

Bomaderry consists of various land uses including residential, industrial, commercial and retail. The centre of the suburb is located on Meroo Street near Bomaderry Railway Station.

Local destinations for the area include Nowra Golf Club, TAFE Illawarra, Shoalhaven Visitors Centre, East Willows Van Park and Nowra Aquatic Park.

The Shoalhaven River foreshore adjacent to Nowra consists of continuous open space that provides for recreational activities such as walking, cycling, children's play and picnicking.

Landscape setting

Nowra is located within the Shoalhaven coastal flood plain. The topography of the study area is primarily flat land that gently slopes towards the river. The Shoalhaven River and its tributaries Bomaderry Creek and Nowra Creek dominate the landscape and the area is subject to flooding.

The Shoalhaven River is the defining landscape feature for the area. It has a distinctive character defined by its wide sweeping form cutting through the alluvial floodplain. The flat topography of the area reinforces the river as a visual landmark. The river's edge has a natural scenic quality with some modified areas close to the existing northbound and southbound bridges including sandstone

retaining walls and grassed sloping levee banks. The Shoalhaven River and the area to the north-west are zoned Scenic Protection Areas under the Shoalhaven LEP 2014.

There are extensive areas of natural vegetation along the northwest side of the bridge and further east and west along the river. The existing twin bridges over the Shoalhaven River are the only structures that cross the Shoalhaven River in the locality, making it a prominent visual landmark. The existing bridges are highly visible from the Princes Highway approaches, river and foreshore areas. The existing southbound bridge is considered a rare example of the Whipple Truss bridge and listed on Roads and Maritime s170 heritage conservation register. Non-Aboriginal heritage is discussed in detailed in Section 6.4.

Only about 50 per cent of the native remnant vegetation remains within the Nowra-Bomaderry region. There are 24 vegetation communities that have been identified including rainforest, wetlands, shrub lands, Paperbark, Casuarina and Eucalypt forest and woodland. The foreshore area of the river contains scattered Paperbark, Swamp Oak and various reeds. Biodiversity is discussed in detail in Section 6.9.

Urban areas have been planted with exotic tree species such as Coral Trees, Maple, Figs, Araucarias, Camphor Laurels and Poplars that provide a dominant visual element to the streets.

The key elements of the natural setting include:

- Water systems – Shoalhaven River and Bomaderry Creek
- Floodplain
- Remnant native vegetation
- Open space running along the foreshore of the Shoalhaven River.

Other key elements include:

- The existing southbound State heritage significant bridge
- The existing northbound bridge
- Areas of archaeological significance such as the former ferry wharf.

Landscape character zones and key view points

Landscape character is defined by landform and vegetation, views and vistas, settlement pattern and built structures. The landscape character zones (LCZs) are a set of visual values that the shape the experience for motorists and viewers in the surrounding areas. There are six identified LCZs within the study area which are summarised in Table 6-36 and shown on Figure 6-6.

Table 6-36: Landscape character zones

LCZ	Description	Key attributes
1	Rural/Regional Park	Area east of Princes Highway between Shoalhaven River and Bolong Road and Bomaderry Creek and its associated vegetation corridor west of the Princes Highway Characterised by restaurants, rural land and associated buildings, dense vegetation associated with Bomaderry Regional Park and the Bomaderry Creek Walking Track.
2	Illaroo Road Residential	Area north of the Shoalhaven River and immediately west of the Princes Highway Characterised by residential dwellings, Bomaderry Creek and its vegetation corridor

LCZ	Description	Key attributes
		There is a sharp drop from Rotary Park to the river exposing a cliff face. A walkway is beneath both bridge structures provides connection to the eastern side of the bridge. Mature vegetation within Rotary Park screens the road and properties along Illaroo Road.
3	Shoalhaven River Waterbody	Predominant visual feature in the landscape with a distinctive character defined by its wide sweeping form cutting through the low-lying topography. Characterised by horizontal water plane, foreshore vegetation and distant views to the hills and ranges. The Shoalhaven River falls within the Scenic Protection Area in the Shoalhaven LEP 2014.
4	River Foreshore – South	Open space that runs along the southern river foreshore. The landform slopes towards the water's edge, with open lawn areas and clusters of mature trees dominating the character. Flood levees to the east of the bridge provide a ridgeline Bens Walk, an east-west pedestrian and cycle path is located on the flood levee and stretches the length of the character zone, passing beneath both existing bridge structures. Wharf Road Restaurant and Bar, as well as Shoalhaven River Cruise and a wakeboarding school are located immediately east of the bridge.
5	Nowra Town Entry	Area west of the Princes Highway between the southern extent of the proposal and Scenic Drive. Access to the town comes from either Bridge Road through the centre of this character zone or from the Princes Highway. Mix of single and two storey commercial buildings with a number of residential dwellings distributed throughout. The topography is relatively flat, with the land sloping gently towards the river. The vegetation contains informal plantings of single, avenue and clustered mature trees, many of which are mature Eucalyptus species over 20 metres tall. The open space and vegetation to the north of the character zone has a parkland character allowing views through to the river. The built form is generally set back from the Princes Highway. There are views to the corridor from a number of adjacent dwellings, however some of the mature vegetation currently screens sightlines.
6	Nowra Commercial/Tourism	East of the Princes Highway and runs from the southern extent of the proposal to Wharf Road. Primarily commercial and tourist uses with several residential dwellings to the south. Nowra Steakhouse and Café, East Willows Van Park and Pleasant Way River Lodge sit to the north of the character zone. The topography throughout the precinct is relatively flat, although the highway slopes up to higher ground on approach to the bridge. Vegetation within the character zone is comprised of a number of scattered trees throughout the campgrounds as well as a narrow avenue of trees lining the Princes Highway to the south.

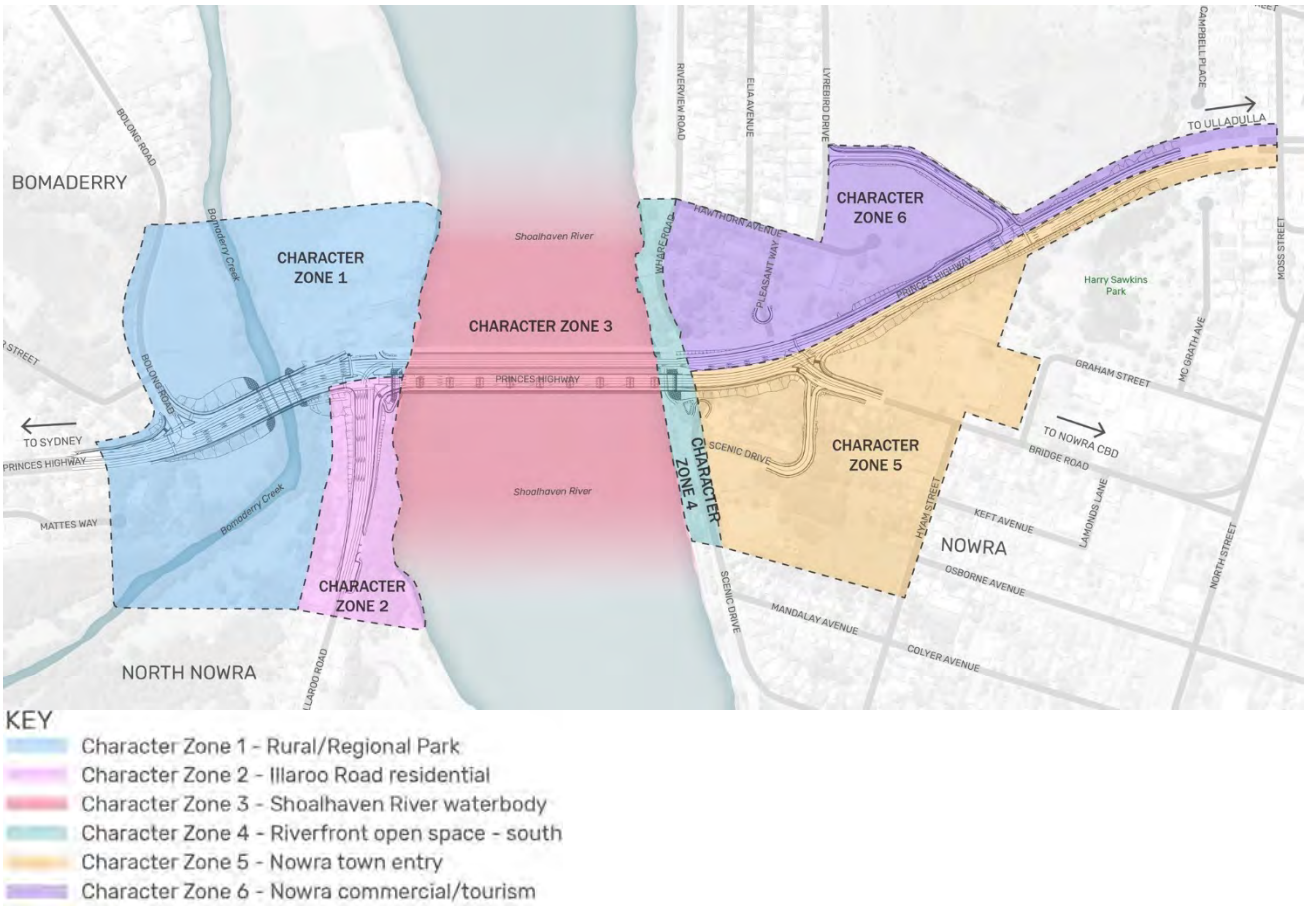

Figure 6-5: Landscape character zones

Ten key viewpoints have been identified; these are described in Table 6-37 and are shown on Figure 6-7.

Table 6-37: Key attributes of viewpoints

View point	Description	Key attributes
1	Looking south along the Princes Highway towards Bolong Road	The residential properties that face Mattes Way and Brinawarr Street are separated from the highway by a rear fence and cannot be seen from this view. There is a footpath on the left of view and a raised footpath on the right of view. The topography descends with the Princes Highway towards the Shoalhaven River. An avenue of mature vegetation lines the highway on either side of the road.
2	Looking south along the Princes Highway towards Illaroo Road	This view is from the Princes Highway looking southwest on approach to Nowra Bridge. The Illaroo Road intersection is in the foreground with the bridges in the background. The topography is flat. Rotary Park can be seen on the right of the view at the corner of Illaroo Road and the Princes Highway.

View point	Description	Key attributes
3	Looking east along Illaroo Road towards the Princes Highway	This view is from Illaroo Road looking east towards the Princes Highway and Illaroo Road intersection. The topography descends with Illaroo Road towards the Princes Highway. Residential dwellings can be seen on the left of view. Rotary Park with its established vegetation and pedestrian paths can be seen on the right of view.
4	Looking southeast from Rotary Park towards Nowra Bridge	This view is from Rotary Park looking southeast across the Shoalhaven River towards the bridges. The southern foreshore as well as both existing bridge structures are within view.
5	Looking northwest from the northern foreshore towards Nowra Bridge	This view is from the perspective of the people using the open space to the rear of the fish and chip shop on the northern river foreshore. The view addresses the existing southbound bridge in the foreground with the existing northbound bridge behind. Views are available across the river to the Wharf Road Restaurant and Bar, as well as through the bridge piers to the southern foreshore.
6	Looking northeast from the southern foreshore towards Nowra Bridge	This view is from the perspective of people using the open space on the southern river foreshore. It addresses foreground views of the proposal with the existing bridge structures behind.
7	Looking northwest from the southern foreshore towards Nowra Bridge	This view is from the perspective of pedestrians and cyclists on Bens Walk and the open space on the southern river foreshore looking northwest towards the existing southbound bridge.
8	Looking south from the Princes Highway towards Bridge Road Intersection	This view is from the perspective of pedestrians and cyclists looking southwest across the intersection onto Bridge Road. Mature vegetation fronting the former Riverhaven Motel is on the right of view and the open space fronting the Shoalhaven Council property is in the background.
9	Looking north from the corner of Bridge Road and the Princes Highway	This view is from the perspective of northbound motorists, pedestrians, and cyclists on approach to the northbound bridge. The existing bridges can be seen in the background. Established vegetation of the southern foreshore can be seen on the left of view, giving visual cues of the approach to the northbound bridge. Formal planting is seen in the foreground, indicating the town entry to Nowra from Bridge Road.
10	Looking north along the Princes Highway	This view is from the Princes Highway looking north along the highway corridor about 75 metres north of Moss Street. Established vegetation avenues are seen either side of the road. There is a footpath on the right of view, adjacent to the roadway.

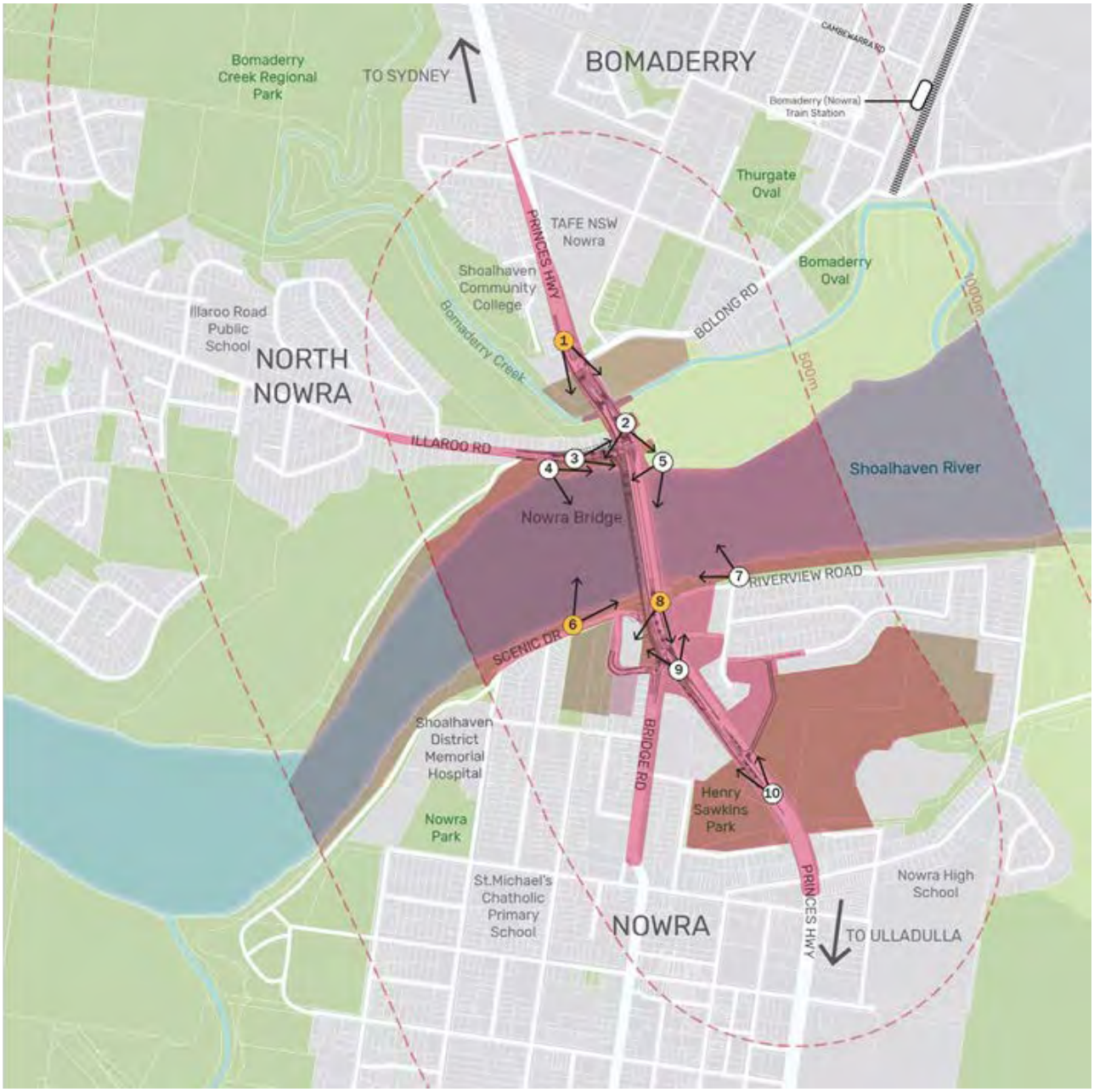

Figure 6-6: Key viewpoints

6.5.3 Potential impacts

Construction

Visual impacts associated with the construction of the proposal are directly associated with vegetation clearing, erection of the new bridge, intersection upgrade works and the presence of plant and equipment.

Construction works would be clearly viewed from the Shoalhaven River, adjacent banks and foreshore areas. Visual impacts during construction would be temporary in nature, and standard construction safeguards and management measures would be adopted to minimise these impacts.

Operation

Landscape character

The proposal would have a permanent impact on landscape character. Works would be occurring within or directly adjacent to an existing road corridor, and would impact most landscape character zones to some degree. Particularly in highly visible areas adjacent to the Shoalhaven River the landscape character would be impacted for motorists, cyclists, local residents and tourists. The impacts on each LCZ are summarised in Table 6-38. The sensitivity value refers to the qualities of the character zone, such as land use and vegetation.

Table 6-38: Impacts on landscape character zones

LCZ	Sensitivity	Magnitude	Landscape character impact
1 – Rural / Regional Park	Moderate: primarily open space with residential dwellings and commercial properties fronting the Princes Highway.	High: the proposal would increase the width of the Princes Highway on both the eastern and western sides, including the widening of Bomaderry Creek bridge. The widening and associated embankments would impact the character through the removal of an existing row of trees on the eastern side of the Princes Highway. Removal of trees from the western side of the highway would impact the screening of the road to and from nearby properties, as well as impacting on the drivers' experience travelling through this area.	High-moderate
2 - Illaroo Road Residential	High: predominantly residential. The built form faces the roadway and is setback a short distances with turfed front gardens and minimal screening. Rotary Park includes mature trees and provides views to and from the bridge.	High: the proposal would increase the width of Illaroo Road on the northern side requiring acquisition of a number of properties. The removal of the houses would change the character of the road as well as the residential precinct. The new northbound bridge and increased width of Illaroo Road would require the removal of a number of mature trees, impacting the existing character of the park.	High
3 – Shoalhaven River	High: highly visible from the foreshores and the river	Moderate: moderate on the upstream side and low on the downstream side of the bridges. The proposal would increase the scale of infrastructure on the river setting being particularly visible from the upstream side. The pier locations and the level of the bridge deck would mitigate the impacts, aligning with the existing northbound bridge.	High-moderate

LCZ	Sensitivity	Magnitude	Landscape character impact
4 – River Foreshore – South	High: predominantly open space with a number of commercial buildings to the east of the bridge. The large area of open space adjacent to the western side of the bridge has mature trees that provide a parkland character to the area, with clear views to and from the river and to and from the existing bridge.	Moderate: the new northbound bridge to the west of the existing bridges would increase the scale of infrastructure viewed from the southern foreshore. There would also be removal of a number of mature trees west of the existing bridge that contribute to the parkland character of the landscape zone. Ben's Walk would pass beneath an additional structure increasing the perceived separation of east from west. The additional bridge would impact on views to the bridge crossing from the western side. Views through to the north-eastern foreshore would be partially blocked by the additional piers. Views from the eastern side would be less affected, although the additional piers would similarly limit north-western foreshore views.	High - moderate
5 – Nowra Town Entry	High: this precinct is comprised of primarily civic and commercial properties. Roadside verges are narrow and predominantly planted with trees and shrubs. Screening of the road is dependant of this narrow avenue of planting.	High: the proposal would transform the landscape character through the removal of large areas of vegetation on the western side of the Princes Highway. The Captain Cook Bicentennial Memorial and the avenue of mature trees that screen the Princes Highway from Harry Sawkins Park and the Shoalhaven City Council building would be removed. As well, the proposal would remove mature trees near the Riverhaven Motel. This would materially change the character of the area resulting in a considerable increase in road width at the Princes Highway and Bridge Road intersection. Changes to the spatial quality of the area and impact on views for both motorists on the Princes Highway and also local roads including Bridge Road and new local road connection in LCZ6. The impact would reduce over time as the trees and shrubs mature.	High
6 – Nowra Commercial / Tourism	Moderate: predominantly commercial and tourism use, on relatively flat land below the highway. An avenue of vegetation screens a large area of	High: the increased width of the road due to additional traffic lanes, for both northbound and southbound traffic, as well as the upgrade of the Princes Highway and Bridge Road intersection, would increase the dominance of the road infrastructure on approach to the bridge.. The closing of Pleasant Way would provide an opportunity to provide a continuous pedestrian and cycle link from the existing southbound bridge to the Nowra CBD. The	High - moderate

LCZ	Sensitivity	Magnitude	Landscape character impact
	agricultural land to south.	proposed extensive planting would soften the extent of paving in this area and give visual cues to traffic approaching the bridge. The construction of a new local road connecting Lyrebird Drive to the Princes Highway would provide access to the precinct. The removal of a number of trees south of the intersection along the eastern side of the Princes Highway would reduce the amount of screening to nearby properties as well as the proposed regional park. The impact would reduce over time as the trees and shrubs mature.	

The introduction of the new bridge and intersection upgrades into the landscape would be consistent with the existing road and bridge infrastructure in the area. The new bridge is slightly outside the existing road corridor. As the proposed bridge would be located immediately next to the existing bridges and follow the same grade, views from surrounding properties, recreational users, and for tourists would still contain bridges. The bridge piers would be aligned with the existing southbound and northbound bridge piers which would also contribute to mitigating potential visual impacts.

The existing southbound bridge would be retained and maintained, generally maintaining the existing cultural heritage significance and heritage vistas for the area.

While the proposed new northbound bridge would be of a modern concrete construction, the visual focus of the existing southbound bridge would be maintained. While an additional bridge would be visually prominent, it would be consistent with the existing views for the area.

Post construction, the foreshore areas would be rehabilitated, and landscape design during detailed design would incorporate measures to reduce the new bridge's visual prominence in the area.

Visual impact

Table 6-39 provides a summary of the visual impacts at each of the key viewpoints. The proposal would have a high to moderate impact on views in and around the study area. The assessment has been carried out for both the concrete box girder and pre-cast concrete beam bridge options, and appropriate comment has been provided with regard to a specific option.

Table 6-39: Impacts on viewpoints

Viewpoint	Sensitivity	Magnitude	Visual impact
1 – Looking south along the Princes Highway toward Bolong Road	Moderate: southbound motorists approaching Nowra Bridge would experience this view. Despite the attractive and mature vegetation on either side of the	Moderate: due to increased pavement area and removal of vegetation. As part of the proposal the Princes Highway would be widened to include three northbound lanes and three southbound lanes. The works would include a wider median and reinstate the existing footway on the right of view. As	Moderate

Viewpoint	Sensitivity	Magnitude	Visual impact
	road, the sensitivity of the viewer is considered to be moderate due to their focus being on the road.	a result of earthworks, the existing avenue of mature trees would be removed on either side of the road. These trees would be reinstated. The trees would contribute to the character of this view, however these would take 10–15 years to mature.	
2 – Looking south along the Princes Highway toward Illaroo Road	Moderate: Southbound motorists from the Princes Highway experience this view. The bridge is within view, as well as Rotary Park. The view is amidst a busy interchange.	High: due to increased pavement, introduction of new northbound bridge and impact on Rotary Park. The proposal would realign the Princes Highway and Illaroo Road intersection. The Princes Highway would be widened to include three southbound lanes crossing the existing northbound bridge with two dedicated right turn lanes onto Illaroo Road. A new median would be introduced and a left slip lane to the Perfect Catch Seafoods & Takeaway property. The new northbound bridge would be introduced on the right of this view, impacting on Rotary Park as well as requiring the acquisition of properties on Illaroo Road.	High–moderate
3 – Looking east along Illaroo Road toward the Princes Highway	Moderate: Primarily local residents and motorists would experience this view. The proximity of the residential dwellings, as well as Rotary Park with its predominantly native species, establishes a park character.	High: due to increased road width, the introduction of the new northbound bridge and the impact on both Rotary Park and the properties on Illaroo Road. The proposal would widen Illaroo Road to provide three dedicated right turn lanes and one dedicated left turn lane from Illaroo Road to the Princes Highway. Two westbound lanes from the Princes Highway as well as a slip lane from the new northbound bridge would be provided. A three metre wide shared path on the western side of the new northbound bridge would continue west up Illaroo Road. It would be seen on the right of view. The proposal would require the acquisition and removal of a number of residences on the left of view. Native trees and large shrubs are proposed here to offset the loss of vegetation in Rotary Park. The new northbound bridge would be introduced on the right of view impacting on Rotary Park. A large area of the park including existing mature vegetation would be removed.	High–moderate
4 – Looking southeast from Rotary Park	High: Pedestrians and cyclists in Rotary Park experience this view.	High: The new northbound bridge would be constructed in front of the existing northbound bridge and would be highly	High

Viewpoint	Sensitivity	Magnitude	Visual impact
toward Nowra Bridge	Pedestrians have been assessed to have high sensitivity as their attention is generally focussed on the river and its surrounds for reasonably long periods of time and in the direction of the new northbound and existing southbound and northbound bridges.	visible from this location. All components of the bridge would be visible and would block the view to a large portion of the existing northbound bridge. This would also result in the loss of a number of trees on the southern bank of the river as well as the vegetation on the left of view. These trees would be replaced with similar species adjacent to the new northbound bridge. Due to the introduction of the new northbound bridge, and the impact on southern and northern foreshore the magnitude of these changes are therefore considered to be high.	
5 – Looking northwest from the northern foreshore toward Nowra Bridge	Moderate: Patrons of the fish and chip shop, as well as pedestrians have been assessed as having a moderate sensitivity. Despite their attention generally being focussed on the river, the existing bridge structures provide strong existing infrastructural elements within the view.	Moderate: The new northbound bridge would be constructed on the upstream side of the existing northbound bridge. From this view point, the new northbound bridge superstructure and barriers would be obscured by the both existing bridge structures. The elements of the bridge that would be visible include the piers and pile caps and part of the abutment on the southern foreshore. The new piers would limit views through to the southern foreshore. Due to the introduction of the new northbound bridge and the impact on southern foreshore views the magnitude of the changes are therefore considered to be moderate.	Moderate
6 – Looking north-east from the southern foreshore toward Nowra Bridge	High: Local pedestrians and tourists visit this public park to observe the panoramic views over the river and in particular the view of the existing bridge structures. These viewers have been assessed as having a high sensitivity as this view has a high cultural significance. The view of the existing southbound bridge would almost be entirely obstructed by the new northbound bridge.	Moderate: The new northbound bridge would be constructed in front of the existing southbound bridge and would be highly visible from this location. All components of the new northbound bridge would be visible and would block the view to a large portion of the existing concrete and historic bridges. The new piers would limit views through to the northern foreshore. Due to the introduction of the new northbound bridge and the impact on northern foreshore views, the magnitude of the changes are therefore considered to be moderate. The visual impact assessment for the Super-T design option varies from the incrementally launched option because of the contrasting and bulky pier design. The sensitivity remains high however the magnitude is potentially higher due to the	High–moderate

Viewpoint	Sensitivity	Magnitude	Visual impact
		piers bulky and contrasting form to the existing northbound bridge. While the magnitude does not change sufficiently to be rated as high, it is likely to have a higher visual impact than the incrementally launched option.	
7 – Looking north-west from the southern foreshore toward Nowra Bridge	High: Local pedestrians and tourists have been assessed as having a high sensitivity. Local pedestrians and tourists visit this public park to observe the panoramic views over the river and in particular the view of the existing bridge structures.	Low: The new northbound bridge would be constructed on the upstream side of the existing northbound bridge. The existing bridge structures from this location would obscure the new northbound bridge superstructure and barriers. The elements of the bridge that would be visible include the piers and pile caps and part of the abutment on the northern foreshore. Vegetation removed at the northern abutment would be seen. The new piers would limit views through to the northern foreshore. Due to the introduction of the new northbound bridge on the upstream side of the existing bridge structures and the impact on northern foreshore views the magnitude of the changes are therefore considered to be low.	Moderate
8 – Looking south-west from the Princes Highway toward Bridge Road intersection	Moderate: Pedestrians and cyclists looking across the Princes Highway and Bridge Road intersection looking southwest would experience this view. Despite the attractive established vegetation on the right of view, the sensitivity of the viewer is considered to be moderate due to their focus being on the road.	High: The intersection would be modified to a signalised T-intersection, closing the access to Pleasant Way. The intersection would increase in size with three southbound lanes and four northbound lanes, including a dedicated left turn only lane from Bridge Road to Illaroo Road. The intersection would also have two dedicated right turn lanes onto Bridge Road. To accommodate this, the majority of vegetation in the background would be removed. The vegetation in the foreground on the right would also be removed. The proposed alignment changes the spatial quality of this view to an expansive road corridor about 50 metres in width. These changes result in the magnitude being assessed as high.	High–moderate
9 – Looking north from the corner of Bridge Road and the Princes Highway	Moderate: This view is from the perspective of motorists, pedestrians, and cyclists travelling north. The view has been assessed to have a moderate sensitivity	High: The Princes Highway and Bridge Road intersection would be modified and realigned west to accommodate the alignment of the new northbound bridge. The existing northbound lanes on the right of view would undergo lane adjustments to convert it to three lanes of southbound	High–moderate

Viewpoint	Sensitivity	Magnitude	Visual impact
	due to the attractive established vegetation on approach to the bridge in a gateway setting.	traffic. Northbound traffic would use the new northbound bridge. This would require the removal of almost all of the mature vegetation on the left of the photo. The existing southbound lanes would be converted into a parkland character with a shared use path from the existing southbound bridge and feature planting near the roadside. These changes result in the magnitude being assessed as high.	
10 – Looking north along the Princes Highway	Moderate: Northbound motorists would experience this view. Despite the attractive established vegetation on either side of the road, the sensitivity of the viewer is considered to be moderate due to their focus being on the road.	High: The proposal would provide three northbound and three southbound lanes to about 75 metres north of Moss Street. The widening of the road would result in the removal of the avenue of trees that run both sides of the Princes Highway. These changes result in the magnitude being assessed as high.	High–moderate

The proposal has been assessed as having a high visual impact for viewers looking southeast from Rotary Park towards the bridges. The new northbound bridge would be highly visible from this location and would block the view to much of the existing northbound bridge. Construction of the bridge would require the removal of a number of trees on the both banks of the river. These trees would be replaced with similar species adjacent to the new northbound bridge but would take 10-15 years to reach maturity.

The visual impact of the proposal has been assessed as high-moderate in locations related to removal of established roadside vegetation and at intersections where the highway would be widened to accommodate additional turning lanes. There would be a similar high-moderate impact for viewers looking north-east from the southern foreshore toward Nowra Bridge, this being associated with the new northbound bridge which would introduce a new major built structure into the landscape.

6.5.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Landscape character and visual impact	An Urban Design and Landscape Plan (UDLP) will be prepared to inform detailed design and will form part of the CEMP. Development of the UDLP will draw on the Urban Design Report and Landscape and Visual Assessment prepared for the REF.	Construction Contractor	Detailed design / pre-construction	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
	The UDLP will present an integrated urban design for the project, providing practical detail on the application of design principles and objectives identified in the environmental assessment. The UDLP will include design treatments for: • Location and identification of existing vegetation and proposed landscaped areas, including species to be used • Built elements including retaining walls, bridges and noise walls • Pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings • Fixtures such as seating, lighting, fencing and signs • Details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • Procedures for monitoring and maintaining landscaped or rehabilitated areas. The UDLP will be prepared in accordance with relevant guidelines, including: • Beyond the Pavement urban design policy, process and principles (Roads and Maritime, 2014) • Landscape Guideline (RTA, 2008) • Bridge Aesthetics (Roads and Maritime 2012) • Noise Wall Design Guidelines (RTA, 2006) • Shotcrete Design Guideline (RTA, 2005).			

Impact	Environmental safeguards	Responsibility	Timing	Reference
Retention of existing vegetation	The proposal will be designed to avoid impact to prominent trees and vegetation communities as far as practicable. Water quality structures and drainage lines will be designed to avoid existing vegetation where practicable.	Designer	Detailed design	Project specific control
Bridge form	The proposed bridge design will aim to achieve a slender and less visually intrusive form and be visually harmonious with the existing bridges. Investigate opportunities to further streamline the appearance of the new northbound bridge, including aligning the edges of the piers with the outside faces of the girder.	Designer	Detailed design	Project specific control
Impacts on existing vegetation	Investigate introducing retaining walls in the following locations to provide the opportunity to retain existing tree plantings, improve the visual and pedestrian amenity, and reduce the scale of the highway: • Either side of the Princes Highway between Bolong Road and Bomaderry Creek bridge. • The new northbound bridge approach road • Either side of the Princes Highway south of the Bridge Road intersection	Designer	Detailed design	Landscape Character and Visual Impact Assessment
Impacts on vegetation	Consider the proposed drainage swale design and location to minimise cutting as well as provide additional space for planting near the corner of the Princes Highway and Illaroo Road	Designer	Detailed design	Landscape Character and Visual Impact Assessment
Impact on Rotary Park	Consider the proposed footpath alignment and stair design of the path beneath the bridge structures and in Rotary Park to better reflect its parkland setting	Designer	Detailed design	Landscape Character and Visual Impact Assessment

Impact	Environmental safeguards	Responsibility	Timing	Reference
Impacts on existing vegetation	Consider the alignment of the footpath on the north eastern corner of the existing southbound bridge, in consultation with adjacent land owners, to avoid impact to existing trees.	Designer	Detailed design	Landscape Character and Visual Impact Assessment
Active transport	Investigate the design of the entrance to properties on the north eastern corner of the existing southbound bridge to prioritise pedestrians and cyclists over vehicles and facilitate ease of travel.	Designer	Detailed design	Landscape Character and Visual Impact Assessment
Visual impact of piers	Consider the proposed pier designs to strengthen the complementary relationship between the proposed bridge piers and the piers of the existing northbound and southbound bridges. In particular, it will consider tapering the piers at their long elevation	Designer	Detailed design	Landscape Character and Visual Impact Assessment
Site restoration	Construction work sites and ancillary sites will be returned to at least their pre-construction state, unless otherwise detailed in the project design, once construction activities are complete or will be progressively remediated throughout the construction program where possible	Designer	Detailed design	Landscape Character and Visual Impact Assessment
Retention of existing vegetation	Existing trees to be retained within construction facilities areas will be identified, protected and maintained for the duration of the construction works	Designer	Detailed design	Landscape Character and Visual Impact Assessment
Light spill	Temporary lighting will be screened, diverted or minimised to avoid unnecessary light spill	Designer	Detailed design	Landscape Character and Visual Impact Assessment
Site restoration	Material used for temporary land reclamation will be removed once construction activities are complete.	Designer	Detailed design	Landscape Character and Visual Impact Assessment

6.6 Flooding and hydrology

A flooding and hydrology assessment has been prepared by Arup Pty Ltd. This is provided in Appendix H and has informed the following assessment.

6.6.1 Methodology

The methodology for the flooding and hydrology assessment involved:

- A desktop review of available information and previous studies for the study area was undertaken to inform the hydrology and flooding assessment
- A flooding and hydrology assessment using the one and two dimensional TUFLOW version 2013-12-AA-w64-IPD hydrodynamic model developed as part of the Shoalhaven River Flood Study
- An assessment to determine flood immunity of the proposed bridge and flood impact of the proposed concept design for nearby properties for the 10 per cent, five per cent, two per cent and one per cent AEP (Annual Exceedance Probability) events as well as the extreme event
- An assessment of flood impacts for the following two climate change scenarios:
  - 10 per cent increase in rainfall intensity of one per cent AEP and 0.4 metre sea level rise
  - 30 per cent increase in rainfall intensity of one per cent AEP and 0.9 metre sea level rise.

6.6.2 Existing environment

Surface water

Shoalhaven River catchment

The Shoalhaven River catchment is located in the NSW upper south coast and has an area of 7000 square kilometres. The Shoalhaven River has four main tributaries, the Mongarlowe, Corang, Endrick and Kangaroo Rivers, and is highly valued for its wild and scenic attributes. Other tributaries include the Ettrema, Boro, Reedy, Danjerra, Yalwal, Broughton, Broughton Mill and Yarrunga Creeks.

The catchment contains the major water storage of Tallowa Dam which is part of the Greater Sydney water supply system owned and operated by WaterNSW. Key water management issues in the catchment include:

- Water sharing with Greater Sydney
- Water quality, associated with pollution and weed growth
- Riverbank management, associated with rural development
- Environmental water, related to ensuring sufficient flows to maintain river health.

The Bomaderry Creek and Shoalhaven River topography results in high velocity flows and erosion in the upper reaches. In the lower reaches flow velocities are lower and the water spreads out over low lying land and the floodplain.

A review of river gauging station records indicated:

- Water level ranges between –0.1 metres and 3.8 metres Australian Height Datum (AHD) (maximum recorded) within Bomaderry Creek
- Water level ranges between –1.0 metre and 18 metres AHD (maximum recorded) within the Shoalhaven River.

Stormwater drainage

The existing southbound and northbound bridges do not have any formal drainage systems, and pavement drainage is discharged directly to the Shoalhaven River through scuppers built into the bridge decks.

Runoff from roads is collected via kerb and guttering and directed to Council's stormwater system.

Existing flood risk

The existing bridges over the Shoalhaven River and Bomaderry Creek are flood immune for the one per cent AEP event, however there is minor inundation of the highway (about 0.15 metre depth) in the area of Harry Sawkins Park (which also experiences inundation), and to the immediate north of Bomaderry Creek (about 0.55 metre depth).

In the one per cent AEP event, there is extensive flooding on the southern side of the Shoalhaven River to the east of the Princes Highway. There is also extensive inundation of the northern side of the river east of the highway associated with the Bomaderry Creek channel and floodplain.

The western end of Scenic Drive (at Moorhouse Park) is flood immune for flood events up to and including the five per cent AEP event; during larger flood events the area of inundation extends southwest to properties on the eastern side of Mandalay Avenue and across Hyam Street generally following an existing creek line.

Coastal processes

The proposal is about 15 kilometres from the mouth of the Shoalhaven River in Zone 2 of the Shoalhaven River Estuary Management Plan (Shoalhaven City Council, 2008). The river is tidal at the Princes Highway crossing with the tidal limit located about 31 kilometres further upstream near Burrier. At the coast, the river is a wave-dominated barrier estuary with an open entrance.

Relevant considerations with regard to potential impacts on coastal processes are:

- Tides and currents; the maximum record tidal range at Nowra is 1.91 metres with tidal currents anticipated to range from small to moderate
- Flood flows; flooding is a significant influence on the area, and the principal mechanism for the transport of sediment along the river channel.

6.6.3 Potential impacts

Construction

Potential impacts associated with the construction of the proposal include:

- Flooding of proposed construction sites/ancillary sites during major flood events resulting in loss and/or damage of plant and equipment
- Temporary changes to overland flow paths and existing drainage patterns, potentially resulting in localised flooding.

Localised flooding

During construction, impacts on hydrology would be associated with removal of sections of the existing stormwater management system, changes to local topography associated with excavation and fill activities, and changes to local drainage lines and overland flow paths. These impacts would generally be temporary in nature and restricted to specific locations. Appropriate measures would be required to avoid any nuisance flooding of roads, and to maintain safe traffic conditions.

Flooding of construction areas and ancillary sites

Given the proximity of the proposed main construction site and potential ancillary sites to both the Shoalhaven River and Bomaderry Creek, all sites are at risk of being impacted by flooding to varying degrees. The proposed main construction site on the southern side of the river to the west of the highway is generally flood immune up to the five per cent AEP event (depth of inundation about 0.06 metres), however the potential ancillary sites at Fairway Drive and opposite Bolong Road experience a greater depth of inundation (greater than one metre). These two sites are also inundated during a 10 per cent AEP flood event.

Flood events that occur during construction could inundate construction sites and ancillary sites resulting in damage to or loss of plant and equipment; other impacts could include erosion of exposed ground areas. These impacts are generally unavoidable and risk of flooding of these sites would need to be managed through appropriate work site planning and management responses via a project-specific flood management plan.

Operation

Changes to local drainage

The new bridge and local road upgrades would increase the impervious area of road pavement, conceptually leading to an increased volume of runoff. This would be collected via a piped system for the bridges, and kerb and guttering for roadways, and then being discharged. The increase in impervious area in the context of local and wider catchment areas would be minimal in relative terms and would not increase flooding.

The new local road connection from the Princes Highway to Lyrebird Drive would cross a minor drainage line in a low lying area that already experiences flooding. A small section of the local catchment would be located upstream of the new road, and suitably sized cross drainage would be required to covey flows across this connection. It is not expected that there would be any material change to drainage flow patterns or flood risk in this location due to the new road.

Changes to flow patterns

Construction of an additional bridge across the Shoalhaven River and widening of the bridge across Bomaderry Creek would not result in any substantial changes to flow patterns during periods of regular flow. The waterway cross sections for both bridges would not substantially change and would be similar to existing conditions. Appropriate scour protection would be provided to minimise the risk of any scour associated with both bridges, and no material impacts are anticipated in this regard.

Flooding

The new northbound bridge would have a similar waterway cross-sectional area to the existing northbound bridge to minimise changes in flooding behaviour and patterns. The soffit height of the new northbound bridge generally matches that of the existing northbound bridge and is higher than the soffit height for the existing southbound bridge. Peak flood levels upstream of the proposed new bridge are provided in the following table.

Table 6-40: Peak flood levels upstream of proposed bridge

Design flood event (AEP)	Peak flood level (mAHD)
10%	5.12
5%	5.66

Design flood event (AEP)	Peak flood level (mAHD)
2%	6.44
1%	6.87
0.05%	9.06
Extreme event	13.67

Flood levels for the one per cent AEP event upstream of the new bridge would increase in the order of 0.1-0.2 metres. The peak flood level changes in the one per cent AEP event as a result of the proposal are presented in Figure 6-8.

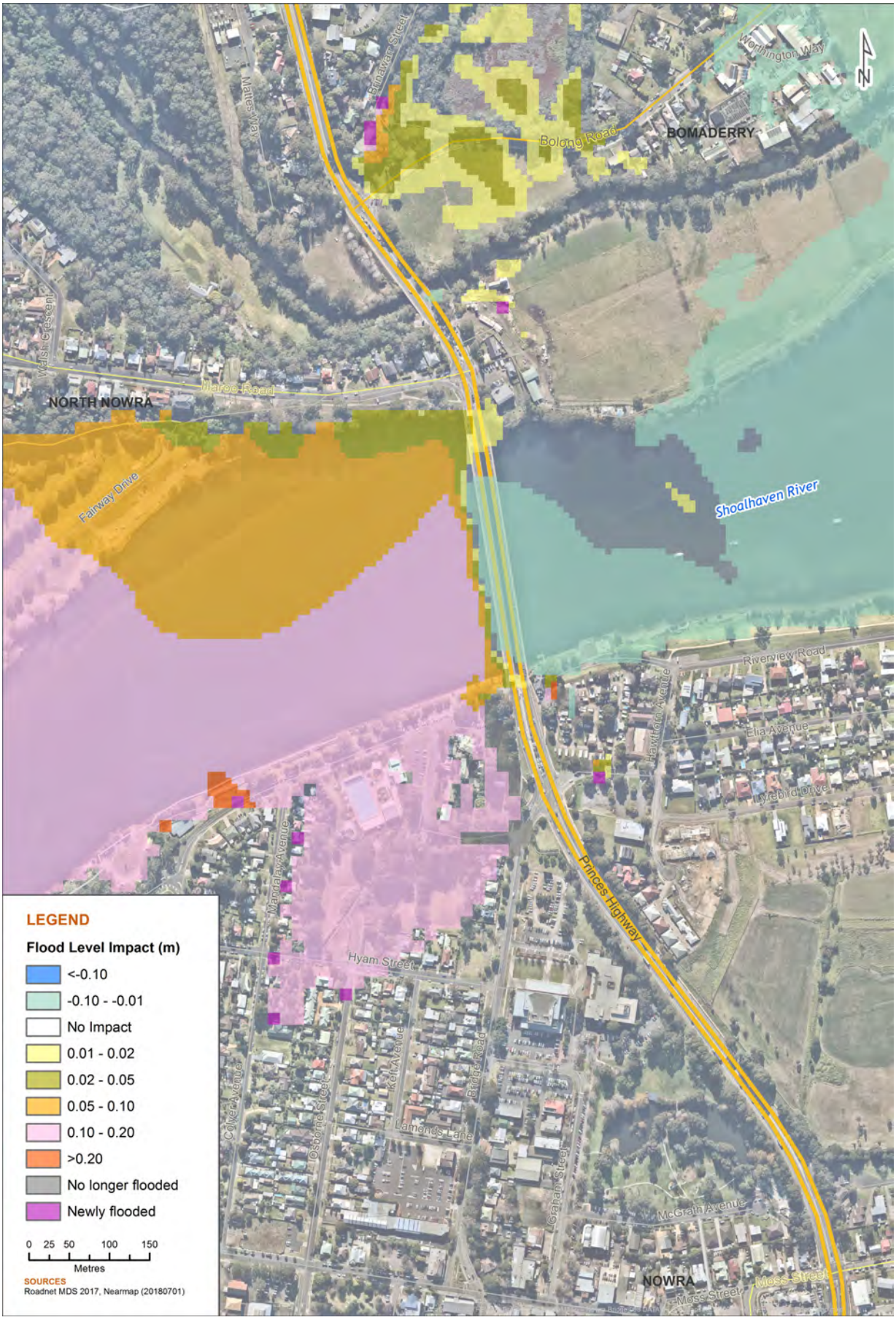

Figure 6-7: Changes in flood level for one per cent AEP flood event

Impacts on property

Surveys of building floor levels were completed for properties on Scenic Drive, Mandalay Avenue, Hyam Street and Bridge Road and have been reviewed with regard to increased flood levels. No buildings would be affected for the 10 per cent or five per cent AEP events. Potential flooding impacts for the two per cent and one per cent AEP events are summarised in Table 6-41. A number of properties where flood levels would not be above existing floor levels would, however, still experience inundation of parts of the property such as the rear of sections along Mandalay Avenue

Table 6-41: Assessment of potential flooding impact on building floor levels

Property	Floor level (mAHD)	2% AEP event flood level (m AHD)		1% AEP event flood level (m AHD)	
		Existing	Proposal	Existing	Proposal
1 Scenic Drive	5.51	5.88	6.10	6.59	6.70
1 Scenic Drive	5.52	5.91	6.09	6.57	6.68
1 Scenic Drive	5.25	5.83	5.99	6.55	6.7
12 Scenic Drive	6.38	5.89	6.02	6.54	6.71
1 Mandalay Avenue	6.99	5.89	6.02	6.56	6.71
3 Mandalay Avenue	7.22	Not affected	Not affected	Not affected	Not affected
5 Mandalay Avenue	7.65	Not affected	Not affected	Not affected	Not affected
7 Mandalay Avenue	7.72	Not affected	Not affected	Not affected	6.71
9 Mandalay Avenue	7.37	Not affected	Not affected	Not affected	Not affected
11 Mandalay Avenue	7.35	Not affected	6.01	6.54	6.71
13 Mandalay Avenue	7.35	5.85	6.01	6.54	6.71
15 Mandalay Avenue	6.96	5.85	6.01	6.54	6.71
17 Mandalay Avenue	7.08	5.85	6.01	6.54	6.71
19 Mandalay Avenue	6.93	Not affected	Not affected	6.54	6.71
21 Mandalay Avenue	7.13	Not affected	Not affected	Not affected	Not affected
8 Hyam Street	6.41	Not affected	Not affected	6.56	6.71
11 Hyam Street	7.24	5.87	6.03	6.56	6.71
13 Hyam Street	5.41	5.85	6.02	6.55	6.71
14 Hyam Street	7.06	5.86	6.02	6.56	6.71
16 Hyam Street	7.37	5.85	6.02	6.55	6.71
27 Hyam Street	6.31	Not affected	5.93	6.54	6.71
29 Hyam Street	6.27	Not affected	Not affected	6.54	6.71
31 Hyam Street	7.22	Not affected	Not affected	Not affected	Not affected

Property	Floor level (mAHD)	2% AEP event flood level (m AHD)		1% AEP event flood level (m AHD)	
		Existing	Proposal	Existing	Proposal
33 Hyam Street	7.74	Not affected	Not affected	Not affected	Not affected
35 Hyam Street	8.15	Not affected	Not affected	Not affected	Not affected
37 Hyam Street	9.08	Not affected	Not affected	Not affected	Not affected
27 Bridge Road	7.06	5.85	6.01	6.53	6.71
29 Bridge Road	7.16	5.85	6.01	6.53	6.71
31 Bridge Road	7.77	Not affected	Not affected	Not affected	Not affected
33 Bridge Road	8.08	Not affected	Not affected	Not affected	Not affected
35 Bridge Road	8.78	Not affected	Not affected	Not affected	Not affected

Access

The northern half of Scenic Drive is already affected by the existing two per cent AEP event and greater events with flood depths in the order of 0.6 metres at the northern end. While the proposal would increase flood levels in the order of 0.1-0.2 metres, access along this section of Scenic Drive is already affected in larger flood events, so there would not be any material change due to the proposal.

The section of Hyam Street between Mandalay Avenue to the east of Osborne Street is similarly flood affected in the larger flood events, with flooding associated with the drainage line that crosses under Hyam Street and runs through Nowra Aquatic Park. The modelling has indicated that flood levels in this locality would also increase by 0.1-0.2 metres. This may restrict vehicles from travelling along Hyam Street, however, alternative east-west routes are available, for example North Street and other parallel roads to the south.

There would be no other changes to access compared to the existing situation.

Utilities

The modelling did not identify any adverse peak flood velocity impacts for flood events up to and including the one per cent AEP event along the Shoalhaven River. The proposal is therefore not expected to cause an adverse impact to the stability of the river embankment, bridge structures or to increase scour potential. Accordingly, any utilities in these locations are not expected to be affected by the proposal.

Flooding due to climate change

An assessment of the potential flood impact due to climate change indicated that peak flood levels upstream are expected to increase by:

- 0.4 metres for a 10 per cent increase in rainfall intensity of one percent AEP and 0.4 metres sea level rise
- 1.3 metres for a 30 per cent increase in rainfall intensity of one percent AEP and 0.9 metres sea level rise
- Between 0.4 metres and 1.3 metres due to climate change.

The flood immunity of the new northbound bridge would not be impacted by climate change.

Coastal processes

The new northbound bridge would have minimal impact on coastal processes in view of it being of a similar size and form to the existing northbound bridge, and its distance from the coast. The proposal is not expected to have a material impact on tides and currents. As previously noted, there are not expected to be any adverse peak flood velocity impacts for flood events up to and including the one per cent AEP event along the Shoalhaven River. Accordingly, there are not expected to be any material changes to the sediment transport regime associated with the proposal.

6.6.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Hydrology	Temporary drainage structures will be designed and constructed in accordance with the Technical Guideline – Temporary Stormwater Drainage for Road Construction (Roads and Maritime 2011c).	Construction Contractor	Construction	Project specific control
Flooding	A flood management plan will be prepared that details the process for monitoring and mitigating flood risk. The plan will include: • Regular weather monitoring • Steps to be taken in the event of flood warning, including the removal or securing of loose material, plant, equipment, fuels, and chemicals	Construction Contractor	Pre-construction Construction	Project specific control

6.7 Property and land use

6.7.1 Existing environment

The overall proposal is located along and adjacent to the Princes Highway between Bolong Road and Moss Street within Bomaderry, North Nowra and Nowra. The land use to the north of the Shoalhaven River is primarily residential with open space, including a golf course to the west of the existing bridges, and a restaurant and agricultural land to the east.

South of the river, land use around the Princes Highway is a combination of open space, infrastructure, residential and administrative. With continued and possibly rapid development in the vicinity of the Bridge Road intersection, there may be changes to land use and zoning in Nowra. The majority of the open space along the river foreshores on both sides of the river is Crown land, managed by Council. Much of this land is vulnerable to flooding. There are several recreation and tourism businesses within or adjacent to the proposal area including restaurants and accommodation.

The Nowra town centre, to the south of the proposal, contains local and regional facilities and services including supermarkets, retail, financial and medical services.

Land use zonings are shown in Figure 4-1.

6.7.2 Potential impacts

Construction

Property

The proposal would require the acquisition and leasing of both public and private land. A summary of the proposed property acquisitions by land use type is provided in Table 6-42.

Details of the properties and the areas to be acquired are provided in Section 3.6.

Table 6-42: Summary of proposed acquisitions by land use type

Land use type	Number of properties	Total area (m^2)
Full acquisition		
Residential	9	4917
Commercial	1	919
Public recreation	5	8090
Partial acquisition		
Residential	4	7187
Commercial	6	3368
Public recreation	10	12,913
Primary production	3	3944
Environmental conservation	3	10,312

Land use type	Number of properties	Total area (m^2)
Infrastructure	1	23
Lease during construction		
Residential	2	3660
Commercial	7	14,911
Public recreation	4	19,242
Primary production	1	82
Environmental conservation	2	9254
Infrastructure	2	410
Utility easements		
Primary production	3	833

A total of nine residential lots would be fully acquired. Of these, eight are private dwellings on Illaroo Road which would reduce the number of properties in the area with views of the Shoalhaven River. The loss of one vacant residential lot on Lyrebird Drive would be minor as there are similar housing opportunities in the local area.

Four residential properties would require partial acquisition to allow for adjustments of the road corridor. Two of these are vacant lots located in Hawthorn Avenue and it is not anticipated that development on the land would be adversely affected by the partial acquisition. The partial acquisition of the other two residential properties, located in Bomaderry, is not expected to impact on the existing private dwellings. It is not anticipated that residents would need to be relocated as a result of the proposed partial property acquisitions.

The proposal does not require the full acquisition of any commercial zoned land or any land currently being used by a business. The proposal would require the partial acquisition of vacant land zoned for mixed use development on the corner of Princes Highway and Bridge Road and the informal car park at the Shoalhaven Entertainment Centre together with land adjacent to road reserve near the Shoalhaven City Council Chambers. Partial acquisition of land occupied by the former Riverhaven Motel (closed and out of operation) would also be required. The street frontage on the site occupied by the Perfect Catch Seafoods and Takeaway would require partial acquisition for a boundary adjustment but would not prevent the business from operating.

To enable construction, land zoned for mixed use development to the south-west of the existing bridges, would need to be leased for the duration of the construction. It is anticipated that construction would require the removal of all of the existing buildings on this land which is currently privately owned. This would impact existing businesses including the Dish and Spoon Café and the Waterways Swim School (office). The building occupied by the Nowra Steakhouse would also be potentially leased and used for the duration of the construction. Businesses at these properties would need to relocate prior to the commencement of construction. Business impacts are discussed in Section 6.8.3.

The following two parks/open spaces would be closed to the public for the duration of construction:

- North Nowra Rotary Park
- Moorhouse Park.

Both are used for passive recreation by locals and visitors, who would have to find alternative locations during construction.

A section of Harry Sawkins Park adjacent to the Princes Highway would be permanently acquired to accommodate the highway widening. The area to be acquired is currently covered with vegetation and consequently not used for active or passive recreation.

Sections of the Greys Beach Reserve, including sections of the boat ramp car park, and the Wharf Road waterfront park, including Nowra Wharf, may be required for short term periods at times throughout construction for activities such as boat loading for water based construction activities. This may result in a temporary reduction in the area available for public passive recreation or parking. Open space impacts are discussed further in Section 6.8.3.

The property adjustments proposed as part of the proposal would include works such as changed driveway connections as a result of changed road levels, road orientation, utility relocations, new fences or adjustments to retaining walls. The adjustments do not involve property acquisition and would not impact dwellings but would require work within private properties. These works would be of small scale and are a typical component of any road upgrade project. Impacts would be short term in nature and include noise, dust and temporary access changes. Table 6-43 provides a summary of property adjustments required for the proposal.

Table 6-43: Summary of property adjustments required for the proposal

Type of property	Number of properties requiring adjustments
Residential	7
Commercial	5
Heritage	1

A new driveway access is proposed for 521 Princes Highway. The existing driveway is accessed from the northbound lanes of the Princes Highway, between Illaroo Road and Bomaderry Creek bridge. Once the upgrade is constructed it would no longer be safe for this access to continue to be provided at the current location. Suitable new access arrangements would be developed in consultation with the property owners during detailed design.

Consultation has commenced with directly affected residents and property owners about potential impacts and the property acquisition process and opportunities. During detailed design, Roads and Maritime would further consult with landowners to refine and confirm the extent of property impacts. The acquisition of property would be undertaken in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, the NSW Government Land Acquisition Reform 2016 and the Roads and Maritime Land Acquisition Information Guide (Roads and Maritime, 2014).

Land use changes

Five potential sites have been identified for ancillary facilities that would be used for construction compounds, plant/equipment storage, and temporary storage/stockpiling of construction materials. These are located principally in areas that maximise the use of available land or existing infrastructure, and minimise the amount of site preparation for use (such as clearing of vegetation). These are shown in Figure 3-8.

These sites are indicative only and would be subject to detailed construction planning by the construction contractor. In the majority of cases, the proposal would temporarily change the land

use activity on the site, facilitated by the proposed demolition of structures on some sites. It is likely that noise generating activities would occur at times on these sites, including stockpiling, heavy vehicle movements and materials storage. These activities would have the potential to cause disturbance or annoyance to neighbouring residents, through noise, dust generation and additional traffic.

There would be changed land use on the northern side of Illaroo Road where eight residential dwellings would be acquired for the construction of the proposal. North Nowra Rotary Park would be closed for the duration of the construction.

Crown land

The proposal would require the permanent resumption of about 9000 square metres of Crown land. This land is largely along the foreshore of the Shoalhaven River and would become part of the road corridor and reserve. This would remove this land from Crown land holdings, and remove areas used for passive recreation for public enjoyment. Additional areas would be leased during construction and closed to the public. Property acquisition requirements are discussed in Section 3.6 and amenity and social infrastructure impacts are discussed further below.

Aboriginal land claims

There are several parcels of land within the study area that are subject to Aboriginal claims for Crown land under the NSW *Aboriginal Land Rights Act 1983* that would require acquisition. These are:

- Lot 7038 DP 1107416 (full acquisition)
- Lot 7302 DP 1164490 (partial acquisition)
- Lot 7325 DP 1166966 (partial acquisition).

In addition, the following parcels, which would be leased during construction, are also subject to an Aboriginal claim for Crown land:

- Lot 7302 DP 1164490
- Lot 7303 DP 1164490
- Lot 7325 DP 1166966.

There is a Native Title Claim for the South Coast area that would apply to reserves and vacant Crown land in the proposal area.

Further consultation would be undertaken by Roads and Maritime with Aboriginal claimants and the relevant NSW government departments to resolve the status and use of these properties.

Operation

Property

After the completion of construction, there would potentially be some parcels of land along the road corridor that may be suitable for reuse if not required for maintenance, landscaping or access. Roads and Maritime would examine these opportunities in more detail during detailed design, taking into consideration access, amenity and land use zoning.

Land use change

The creation of the new local road connection could have the potential to shape further land use changes and development in this area.

A section of the former southbound lanes of the Princes Highway south of the bridge would no longer be required for vehicle movements and would be incorporated into the landscaping strategy to provide additional planting. The urban design and landscape strategy is provided in Appendix G.

6.7.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Property acquisition and relocation issues	Roads and Maritime will continue to consult with directly affected property owners throughout the detail design phase.	Roads and Maritime	Detailed design	Project specific control
Property acquisition	All property acquisition will be carried out in accordance with the *Land Acquisition Information Guide* (Roads and Maritime, 2014b), the *Land Acquisition (Just Terms Compensation) Act 1991* and the NSW Government Land Acquisition Reform 2016.	Roads and Maritime	Detailed design, Pre-construction	Core standard safeguard PL1
Property acquisition	Acquisition of Crown land will be carried out in accordance with the *Crown Land Management Act 2016*.	Roads and Maritime	Detailed design, Pre-construction	Project specific control

6.8 Socio-economic

A socio-economic impact assessment (SEIA) has been prepared for the proposal. The assessment is provided in Appendix I and is summarised in the following sections.

6.8.1 Methodology

Preparation of the SEIA involved the following:

- Review of existing social policy and strategic planning information relevant to the study area as they relate to socio-economic, land use and property impacts
- Preparing a profile of demographic characteristics, community infrastructure, key industries and businesses, and recreational areas that may be influenced by the proposal
- Description of the regional context in which the proposal sits
- Characterisation of existing local amenity, such as noise and air quality
- Description of known community values from existing literature and outcomes of consultation undertaken for the proposal
- Analysis of stakeholder issues relating to potential social and economic impacts
- Identifying the scope of the likely changes and social and economic impacts that may occur as a result of the proposal
- Conducting an analysis of potential negative and positive impacts, both direct and indirect, during construction and operation
- Assessing the significance of the potential impacts by considering the sensitivity of the receptor and the magnitude of the proposed works using the methodology described in Section 2.5 of the SEIA
- Identifying safeguards and management measures to mitigate the impacts during construction and operation.

The SEIA has also been informed by the outcomes of various technical reports that have been prepared for the proposal. This includes the traffic and transport, noise and vibration, landscape and visual impacts, non-Aboriginal heritage, Aboriginal heritage and biodiversity impacts. In consideration of the results of the technical reports and the outcomes of consultation, a comprehensive assessment of construction and operational socio-economic impacts has been prepared in accordance with the Environmental Impact Assessment Practice Note – Socio-economic assessment (EIA-N05) (Roads and Maritime, 2013).

6.8.2 Existing environment

At the time of the 2016 census, the population of the SEIA study area, defined as the suburbs of Nowra, North Nowra and Bomaderry, was 21,648, representing 22 per cent of Shoalhaven LGA, which comprised 99,650 people. Between 2011 and 2016, the Shoalhaven LGA population experienced an average annual growth of 0.59 per cent, an increase of around 5,500 people. The estimated residential population in 2017 for the Shoalhaven LGA was 101,777.

Key statistical information relevant to socio-economic characteristics of the region and study area includes:

- In the study area the proportion of people under 14 years of age is about 18.3 per cent, about 1.4 per cent higher than the Shoalhaven LGA. The percentage of people aged 65 years and

older in the study area is about 23.1 per cent, about 3.3 per cent lower than the Shoalhaven LGA

- The percentage of Aboriginal and Torres Strait Islander People in the study area (about 8.7 per cent) is higher than the Shoalhaven LGA (about 5.5 per cent)
- Separate dwellings comprise about 73.3 per cent of housing stock in the study area, a higher proportion than the Shoalhaven LGA (about 64.6 per cent). Terrace and flat dwellings in the study area comprise about 15.5 per cent of the housing stock, considerably higher than the Shoalhaven LGA (about 6.9 per cent)
- About 69.3 per cent of residents in the study area drive a car as a method of travel to work. This is slightly higher than Shoalhaven LGA, about 68.5 per cent. About 5.8 per cent of residents in the study area travel to work via a passenger in a car in the study area compared 4.8 per cent in the Shoalhaven LGA. This shows the reliance of residents driving to work in the study area
- The median income of the study area of $965 per week is about 2.8 per cent lower than Shoalhaven LGA ($992)
- The key industries for employment in the study area are health care and social assistance, retail trade, accommodation and food services and public administration and safety.

Tourism

While tourism in the Shoalhaven as a whole is an important part of the economy, the immediate area is not generally considered a key tourism attraction, rather it is seen as a gateway to destinations further south, particularly along the coast. The road infrastructure constraints across the Shoalhaven River are seen as a bottleneck to further development of the tourism industry in the region (Shoalhaven City Council, 2006).

There are a number of tourist-related facilities in Nowra, reflecting its role as a regional centre. The following are located within 400 metres of the Princes Highway:

- The Guesthouse Motel, 1 Scenic Drive, Nowra (closed)
- Easts Willow Van Park, 1 Pleasant Way, Nowra
- Pleasant Way River Lodge, 9 Pleasant Way, Nowra
- Hawthorn River Retreat, Wharf Road, Nowra
- Bridge Cottage, Bridge Road, Nowra
- Illowra Guesthouse, Corner of Bolong Road and Princes Highway, Bomaderry
- Shoalhaven Visitor Centre, 42 Bridge Road, Nowra
- Shoalhaven Entertainment Centre, Bridge Road, Nowra.

An Iroquois Helicopter is located on the corner of Pleasant Way and the Princes Highway, adjacent to the heritage listed Graham Lodge. This iconic structure, also known as the ‘Helicopter on a stick’, has been greeting tourists and residents of Nowra since the early 2000s. The helicopter is on loan from the Naval Heritage Collection and recognises the local naval history in the area.

Social infrastructure

As an important regional centre, Nowra has substantial social infrastructure such as schools, libraries, and the services, activities and programs that operate within these facilities. Open spaces, parks, recreation areas and sporting fields that support sport, recreational and leisure uses are also included in this definition. Public services such as emergency services and police are also considered. As a major regional centre, Nowra contains a number of education facilities. Typically, catchment areas for childcare centres and primary schools are local in nature, primarily serving the

needs of the local community. Secondary schools are district level facilities as they often draw from a wider catchment.

The Shoalhaven River is a major community resource and hosts a range of recreational such as kayaking, swimming and river cruises and also commercial activities such as fishing, charters and hire operations. A number of inshore commercial vessels operate within the estuary itself, including houseboats, hire and drive craft and small tinnies. Those boats utilise both the Lower and Upper Shoalhaven.

The following access points to the river are located within 400 metres of the proposal:

- Nowra Wharf - two boat ramps located on the south side of the river, east of the bridge on Wharf Road, used by Nowra Sailing Club. The heritage listed Nowra Sailing Club building was destroyed by fire in June 2017
- Shoalhaven Rowing Club, club house and ramp at Paringa Park, on the south side of the river, west of the bridge
- Greys Beach - Public ramps and wharves at the eastern end of Riverbank Reserve on the north side of the river, west of the bridge.

6.8.3 Potential impacts

Construction

Social infrastructure

The potential impacts of the construction of the proposal on social infrastructure in the study area are detailed in Table 6-44.

Table 6-44: Construction impacts on social infrastructure within the study area

Name	Potential impacts
North Nowra Rotary Park	Construction activities to widen Illaroo Road would require the removal of the toilet block and visitor parking at eastern end of this narrow park located on the cliff top overlooking the Shoalhaven River and Nowra Bridge. The entire park would be closed for the duration of construction. This would have an impact for residents and visitors wanting to use the park. They would need to find alternative locations for passive recreation. The overall impact would be high.
Shoalhaven District Memorial Hospital	Traffic delays during construction may impact on the time required for travelling patients, families and emergency services to access this facility, unless appropriate mitigation measures are implemented. All access by highway traffic would be via Bridge Road and Hyam Street. This would have an impact for the majority of the construction period. The overall impact would be low.
Nowra Aquatic Park	Restrictions at Scenic Drive and Bridge Road would require southbound travelling visitors and staff to travel via Bridge Road, Hyam Street, Mandalay Avenue and then onto Scenic Drive, requiring a slightly longer travel time of up to five minutes. Dust, noise and vibration from both bridge and road works could potentially impact activities at the pool at times. There may potentially be temporary water quality impacts in the swimming

Name	Potential impacts
	pools if mitigation measures are not implemented. This would have an impact on visitors and staff at the park. The overall impact would be moderate.
Shoalhaven City Council, Shoalhaven Visitor Centre, Shoalhaven Entertainment Centre	Construction noise, vibration and air quality impacts would impact on visitors and staff. Some construction activities would exceed the relevant noise criteria and additional measures, including respite, may be required. Construction noise in the vicinity of the Council is likely to impact on staff, increasing stress and reduce productivity. Traffic delays would be expected for visitors and staff at times. Construction noise in the vicinity of the Entertainment Centre is likely to impact on concerts and functions at times, and may impact on the business operations at the Centre. Ancillary sites are proposed directly to the north of the Entertainment Centre which would have a visual amenity impact, as well as potentially reducing the functionality of the Visitors Centre for visitors. The ancillary site would remove the majority of parking at the Entertainment Centre and Visitor Centre which would impact on the operations at the centres. Increase in construction workers and traffic on Bridge Road could potentially impact on parking availability at the Council and Shoalhaven Entertainment Centre carparks. The proposal would have a high impact on staff, visitors and business operations at these facilities during construction.
Harry Sawkins Park	The proposal would permanently acquire a section of the park for the proposed road widening. This would require the removal of trees and shrubs that currently provide some screening of the park from the highway. The proposal would have a moderate impact on the park.
IRT Greenwell Gardens Care Centre	Potential noise, vibration and dust impacts would be experienced from the building of the new local road connection to the north of this facility. This would potentially have a low impact on residents and staff at the centre.
Moorhouse Park (including Bens Walk pedestrian path along the foreshore)	The proposal would permanently acquire a section of parkland for the piers for the new bridge. A section of the park, bounded by the Princes Highway, Scenic Drive, the former motel site and the cul-de-sac at the end of the road along the riverfront, is heritage listed. The heritage item, which is a concrete arch structure formerly housing a lifeboat, would be permanently removed. The site has formerly contained the Captain Cook Bicentennial Memorial, which has been removed by Council for restoration. Ancillary site 3 to the west of the bridge would require the temporary removal of a section of parkland for public use for the duration of construction, including removal of a children's playground. Roads and Maritime would explore opportunities to reinstate a new playground in the finished park during detailed design.

Name	Potential impacts
	There is potential for dust, noise and vibration impacts on park users. Through passage underneath the bridge would be closed for the duration of construction. Anecdotal evidence presented during community consultation has identified that there is potentially a time capsule buried in Moorhouse Park, potentially in the vicinity of the concrete arch structure. The proposal would have a high impact on the passive and active users of the park during construction.
Nowra Sailing Club and Shoalhaven Rowing Club (Paringa Park), Greys Beach Boat Ramp users	Sailing, rowing and other boating activities may be impacted by construction activities within the waterway, including but not limited to piling activities and overhead work. It is proposed to build a temporary jetty to the west of the existing bridges to support water based construction activities. These activities and the required exclusion zones, would potentially have some impacts on area of navigable water available at times for sailing activities. Parking availability at the ramp/wharf access points may also be limited at some times to facilitate on water construction activities. Water based recreation is extremely popular in the Shoalhaven and any impacts on these activities would not be popular with the local or regional communities. The Paringa Park/ Shoalhaven Rowing Club Precinct would not be impacted although marine activities would be impacted. Changed access to the facility due to the restriction of turning movements at Scenic Drive. The majority of vehicles travelling to the park would no longer be able to access it via Scenic Drive due to turning restrictions that would be permanently installed at the intersection with Bridge Road. A longer travel time would be required to access the Park via Hyam Road and Scenic Drive, a distance of around 1170 metres. The overall impact would be high.

Emergency services such as the Rural Fire Service, State Emergency Services and ambulances would potentially be affected by road construction works and traffic delays, with impacts potentially extending outside the study area if not managed appropriately.

Access and connectivity

During construction impacts are likely to result in changes to:

- Road network efficiency and connectivity
- Travel behaviour
- Public transport
- Pedestrian and cyclist connectivity
- Parking access and availability
- Maritime activities.

Changes in road network efficiency and connectivity would occur across the study area during construction. Traffic modifications, including road closures and diversions, or route alterations are

discussed in Section 6.1. Construction is expected to result in additional delays along the Princes Highway, Illaroo Road and Bridge Road which is likely to generate increased frustration for local road users and increased travel times for road users and bus services. Increased traffic delays during busy holiday periods are also likely to generate increased frustration for road users and local residents. The increased delays and congestion have the potential to incur greater travel costs for residents and visitors as well as greater service and delivery costs for businesses and social infrastructure. These temporary impacts are an unavoidable result of road upgrade projects.

Residents living north of the Shoalhaven River would continue to travel to Nowra for shopping, services and facilities. As there is no alternative to the Nowra bridge crossing, construction delays would be expected to impact on road users. Traffic shifts and changes to local access movements are likely to present anxiety and confusion to residents and road users unless appropriate measures are implemented. The closure of the existing Pleasant Way intersection with the Princes Highway and the relocation of a new intersection round 150 metres to the south is likely to cause some confusion, particularly for visitors to the tourist businesses located to the south east of the bridge.

Local, regional and interstate bus services that utilise the Princes Highway would be affected by traffic delays at times during construction. This could result in increased journey time for commuters and travellers. There are several bus stops located within the construction footprint of the proposal which may be temporarily relocated at times during construction.

Existing pedestrian and cyclist facilities along the road corridor would be maintained during construction. However, pedestrian access through the southern work site would be discouraged and an alternate pedestrian access around the site would be provided. It is likely that the pedestrian paths and bridge underpasses would need to be closed at times during construction to ensure user and worker safety. The proposal would potentially impact on cyclists who typically congregate at the Nowra Visitor Centre and those cyclists who use popular cycle routes identified in the Shoalhaven Bike Plan (2013):

- North Nowra – Bugong – Coolendel Lookout Loop along Illaroo Road
- Albatross Road Loop
- Main Road 92 Loop.

The proposal would impact on a number of public parking areas as identified in the following table.

Table 6-45: Summary of construction parking impacts

Location	No. of impacted spaces	Impact
North Nowra Rotary Park, Illaroo Road	14	These spaces would be removed for the duration of construction. As the entire park would be closed during construction, this impact would be low.
Greys Beach Reserve, Fairway Drive	100	It is expected that the parking area would be partially impacted at times during construction, and may occasionally need to be fully closed to public use. Given the popularity of the boat ramp for recreational water users, this would potentially have an impact for recreational water users. As far as practicable, high usage periods would be avoided and the overall impact would be moderate.

Location	No. of impacted spaces	Impact
Scenic Drive, on street parking adjacent to Moorhouse Park near the river	20	These spaces would be removed for the duration of construction. As Moorhouse Park would be closed during construction, this impact would be low.
Bridge Road, on street parking, northbound	10	These spaces would be removed for the duration of construction. This would impact on the small business that operate on Bridge Road that rely on on-street parking for clients resulting in a moderate impact.
Pleasant Way and Graham Lodge, off street parking	75	These spaces would be removed for the duration of construction. The Nowra Steakhouse business would be required to cease operation for the duration of construction. Roads and Maritime may choose to lease the building for additional ancillary facilities. This would have a high impact.
Shoalhaven Entertainment Centre and Visitor Centre car park	50	These spaces would be removed for the duration of construction. The proposal would have a high impact on the operations of the Entertainment and Visitor Centres during busy periods.

The amount of parking removed in the Nowra CBD, particularly at the Entertainment Centre and Visitor Centre as well as along Bridge Road would potentially have impacts on the viability of the directly affected businesses as well as flow on effects for the wider CBD.

The proposal would require all construction staff to park in allocated parking spaces only, to avoid any additional impact on parking areas utilised by local businesses, Council, Nowra Aquatic Park, the Shoalhaven Visitor Centre and the Shoalhaven Entertainment Centre.

Maritime activity

Construction of the new bridge would require the use of boats, barges and other marine vessels. Works would be undertaken within the construction footprint to facilitate access from the land based ancillary facilities to the works areas within the Shoalhaven River. The construction contractor would be responsible for detailed the construction work methodology and seeking any additional approvals or permits required. The following discussion provides a high level assessment of what may be undertaken.

Two locations have been identified for temporary moorings/jetties for construction barges and for transfer of plant and materials:

- Fairway Drive, adjacent to the Greys Beach boat ramp existing car park (Ancillary Site 2)
- Shoalhaven River southern bank, located immediately west of the Princes Highway on the southern side of the river (Ancillary Site 3).

There may be periods when the Nowra Wharf is also required for access to the waterway.

During the period when the bridge piers are being constructed, there would be one or more barges in the water at any one time, typically moored to one of the piers.

The navigational channel of the Shoalhaven River would be maintained through construction. Should there be a need to restrict marine vessels during certain activities, the community and river users would be notified in advance. It is expected that recreation and commercial activities could continue away from the immediate construction zone.

The proposed ancillary site at Greys Beach Reserve would potentially impact on car and trailer parking, depending on the final construction staging and construction activities that are planned for this site. As Greys Beach Wharf has been identified as an extremely popular area for recreational users, the proposal could have a substantial negative impact unless appropriate mitigation measures are implemented.

Access and connectivity

During construction of the proposal, changes to road, public transport, active transport and maritime activity are likely to occur as a result of:

- Establishment and use of ancillary sites
- Reduced speed limits around construction sites
- Increased heavy vehicle and construction machinery movements
- Temporary partial or complete closure of roads, intersections and/or accesses
- Construction work and barges within the river.

These are likely to result in changes to

- Road network efficiency and connectivity
- Travel behaviour
- Public transport
- Pedestrian and cyclist connectivity
- Parking access and availability
- Maritime activities.

Economy

The proposal would potentially have both positive effects and negative impacts on the local economy. The additional traffic delays and congestion that may arise at times during construction would have the potential to have some minor effect on businesses in and around Nowra, through increased travel costs and time, and customers electing to travel to another less congested location. The freight industry would continue to be similarly impacted, as the existing restrictions to southbound HML vehicles would continue until the new northbound bridge is completed and commissioned.

There are potential benefits to businesses in the locality during the construction phase. The proposal would generate a number of jobs. At the time of the 2016 Census, the construction industry generated nearly 4000 jobs in the Shoalhaven LGA, representing around 11 per cent of the total workforce.

Construction worker expenditure would benefit local services businesses near the study area, such as cafes and takeaways, and would also benefit those businesses which service the construction industry such as construction companies, suppliers and development consultants.

Business and industry

The majority of businesses located within 400 metres of the proposal are restaurants and cafes. Table 6-46 provides a summary of the construction impacts of the proposal on local businesses, including changes to access, as well as partial and full property impacts.

Table 6-46: Summary of potential construction impacts on local businesses

Business	Potential impact
Perfect Catch Seafoods & Takeaway, 480 Princes Highway, Bomaderry	Noise, vibration and air quality impacts. Traffic delays and changed access to the site for the final stage of the construction period when southbound traffic is moved to the existing northbound bridge and northbound traffic to the new bridge. Access (which is left in/left out only) would be via a dedicated slip lane which would make it safer for all users. Some loss of passing trade may be experienced at times during construction as a consequence of construction activities outside the business serving as a deterrent for patrons to stop. Altered business ambiance (character and atmosphere) due to alterations in noise and visual impacts, potentially affecting the ability to attract and retain customers. Strip acquisition adjacent to the highway to accommodate the road widening would not impact on operational land for the business. Overall, the proposal would have a moderate impact on the business during construction.
Thai Riverside – 27 Bridge Road, Nowra Casey Centre (vocational training) – 29 Bridge Road, Nowra Wholistic Health and Beauty Centre – 31 Bridge Road, Nowra	Temporary loss of on street parking (northbound on Bridge Road) for all three businesses. The Thai restaurant also has on-site off-street parking accessed off Scenic Drive. Access to this parking would be affected as a consequence of the restriction of the intersection to left-in left-out access only, requiring a longer travel time via Hyam Street and Scenic Drive for most patrons wishing to access the restaurant. Noise, vibration and air quality impacts. Traffic delays at times. Altered business ambiance (character and atmosphere) due to alterations in noise and visual impacts, potentially affecting the ability to attract and retain customers. Overall, the proposal would have a moderate impact on the businesses during construction.
The Dish and The Spoon Café, Waterways Swim School (office), 1 and 1A Scenic Drive, Nowra	Roads and Maritime proposes to lease this property and operations would cease. The business proprietors would need to relocate to new premises. The business owners may have difficulty in finding suitable alternative premises for their businesses especially the café which is likely to rely on passing trade. The proposal would have a high impact on these businesses.
Wharf Road Restaurant and Bar, 10 Wharf Road, Nowra	Advertising and directional signage on the property would be less visible once southbound traffic is shifted to the existing northbound bridge, reducing visibility to passing trade. Noise, vibration and air quality impacts.

Business	Potential impact
	Altered business ambiance (character and atmosphere) due to alterations in noise and visual impacts, potentially affecting the ability to attract and retain customers. Construction noise, vibration and air quality could potentially impact on the amenity for guests, particularly at outside areas such as decks and terraces. Overall, the proposal would have a moderate impact on this business.
Nowra Steakhouse and Café, 2/10 Pleasant Way, Nowra	The business operating at this location is open for dinner six nights per week. Roads and Maritime intends to lease the car park for ancillary purposes during construction. Roads and Maritime may decide to lease the building for office space if required. It is unlikely that the business could continue at this location during construction. Overall, the proposal would have a high impact on this business.
Businesses on the western side of Bridge Road, south of Hyam Street	While outside of the construction footprint, there is the potential that small businesses located in standalone buildings south of Hyam Street on Bridge Road may be impacted by noise, vibration and dust during construction as well as traffic delays. The proposal would have a low impact on businesses along Bridge Road outside of the construction area.

Due to the distance from the bridge crossings to the oyster leases downstream at Greenwell Point (around 15 kilometres), no impact on the aquaculture industry is expected.

Tourism

Congestion and increased travel times are expected on the Princes Highway at times during construction. This is likely to have an indirect impact on guests and staff of tourist facilities in the vicinity, as well as tour operators travelling through the area. Table 6-47 summarises the potential construction impacts on local tourism facilities.

Table 6-47: Summary of potential construction impacts on local tourism facilities

Business	Potential impact
The Riverhaven Motel, 1 Scenic Drive, Nowra (closed)	Roads and Maritime proposes to lease the property and demolish all buildings on the site. The existing buildings are in a state of disrepair and are not suitable for reuse during construction. The site would be used to accommodate construction activities, including but not limited to bridge staging, laydown areas, stockpiles and site offices. The motel currently has an approved DA for demolition. The proposed removal of the buildings as part of the proposal is expected to be a positive effect for the business owners.
Easts Willow Van Park, 1 Pleasant Way, Nowra	Location would be less visible to passing southbound traffic once traffic is shifted onto the existing northbound bridge. Southbound travelling guests and staff would need to travel further, via the new local road connection, to access the property.

Business	Potential impact
	Noise, vibration and air quality impacts. Some construction activities would exceed the criteria and additional measures, including respite, would be required. Traffic delays for staff and visitors would be experienced at times. It is likely that the construction noise impacts would serve as a deterrent to guests, which could be expected to impact on the business operations. Overall, the proposal would have a moderate impact on the van park.
Pleasant Way River Lodge, 9 Pleasant Way, Nowra	Location would be less visible to passing southbound traffic once traffic is shifted onto the existing northbound bridge. Southbound travelling guests and staff would need to travel further, via the local road connection, to access the property. Noise, vibration and air quality impacts. Some construction activities would exceed the criteria and additional measures, including respite, would be required. Traffic delays for staff and visitors would be experienced at times. It is likely that the construction noise impacts would serve as a deterrent to guests, which could be expected to impact on the business operations. Overall, the proposal would have a moderate impact on the motel.
Shoalhaven River Cruises	Southbound travelling guests and staff would need to travel further, via the new local road connection, to access the wharf. Construction activities within the waterway would potentially impact on cruise boat movements at times during construction, in order to manage safety for passengers and workers. Overall, the proposal would have a low impact on cruise operations.
Iroquois Helicopter	The site would be protected as a no-go area during construction, but would still be visible from the highway and local roads. No impacts are expected.
Illowra, Corner of Bolong Road and Princes Highway, Bomaderry	Strip acquisition along the property frontage with the Princes Highway to accommodate the proposed road widening. Loss of vegetation screening between the property and the highway. Noise, vibration and air quality impacts. Overall, the proposal would have a low impact on the guest house business.
Hawthorn River Retreat, Wharf Road, Nowra	Southbound travelling guests and staff would need to travel further, via the new local road connection, to access the property. Noise, vibration and air quality impacts. Some construction activities would exceed the criteria and additional measures, including respite, would be required. Traffic delays for staff and visitors would be experienced at times. It is likely that the construction noise impacts would serve as a deterrent to guests, which could be expected to impact on the business operations. Overall, the proposal would have a moderate impact on the guest house business.
Bridge Cottage, Bridge Road, Nowra	Noise, vibration and air quality impacts. Some construction activities would exceed the criteria and additional measures, including respite, would be required. Traffic delays for staff and visitors would be experienced at times.

Business	Potential impact
	It is likely that the construction noise impacts would serve as a deterrent to guests, which could be expected to impact on the business operations. Overall, the proposal would have a moderate impact on the guest house business.

Marine traffic access and the navigational channel of the Shoalhaven River would be maintained through construction. Should there be a need to restrict marine vessels during certain activities, the community would be notified.

Amenity and community

Amenity impacts include any factors that affect the ability of a resident, visitor or business owner to enjoy their home and daily activities, for example, noise, vibration, detrimental changes to views or changes to air quality. A project could improve amenity in some locations while being reduced in other locations. The local community values their visual amenity of the Shoalhaven River, the natural environment and access to community facilities and services. Access to employment opportunities is also highly valued.

As described in Section 6.2, construction activities would generate considerable noise, with the highest noise exceedances generally experienced at buildings and social infrastructure closest to construction areas and ancillary facilities. There are likely to be periods when construction noise impacts are substantial for residents, businesses and users of open space and recreational areas.

High levels of construction noise at night may interrupt sleep patterns with consequential impacts upon health and well-being. Ongoing sleep disturbance may affect an individual's creativity, performance, memory, concentration, risk-taking behaviour and risk of accidents. This may have secondary effects on the socio-economic environment such as a reduction in employee productivity (affecting business operation and revenue) and student performance at school.

The proposal is prominently located around the Shoalhaven River which is a popular recreation area for a wide range of users, as well as on the edge of a busy town centre, which serves as both a local and regional centre for a wide range of community, business, service and educational needs. Construction compounds would be located adjacent to the Shoalhaven Visitor Centre and Entertainment Centre and prominently visible from the highway for all road users. The community have indicated their strong attachment to their local area and the medium to long term disruption caused by construction is likely to have negative consequences for the sense of community if appropriate management measures are not put into place.

Operation

Social infrastructure

Once operational, the proposal is expected to have a positive indirect effect on social infrastructure in the study area and the wider community through improved traffic flows and accessibility along the Princes Highway and the adjacent intersections. North Nowra Park and Moorhouse Park would be returned to public use, albeit with a reduction in size as a consequence of some strip acquisition to accommodate the upgraded roads and new bridge.

Pedestrian connections would be provided to the river foreshore areas from the shared paths on the bridges. Roads and Maritime would continue to consult with Shoalhaven City Council in relation to this matter.

Access and connectivity

Road network efficiency and connectivity

The upgrade of the Bolong Road, Illaroo Road and Bridge Road intersections and the proposed closure of the existing Pleasant Way intersection and relocation about 300 metres south to provide a new signalised intersection, is likely to improve congestion and travel times across the bridge and reduce delays at the intersections. This is also expected to reduce the incidence of crashes along the Princes Highway.

The proposal would provide:

- Additional through lanes and turning lanes northbound and southbound to improve traffic capacity
- Facilities for cyclists and pedestrians
- Changed access arrangements onto the new local road connection.

The proposal would result in improved traffic flow and more efficient travel times within the study area and across the region. Congestion has substantial socio-economic effects because it affects the ability of people to get to work, access educational activities, access recreational opportunities and spend time with their families and friends. The widening of the highway to three through lanes in either direction, in addition to turning lanes or slip lanes where required, would provide improved capacity for both through traffic and local traffic which would allow residents and business users to travel more efficiently to their destinations and spend less time held up in traffic.

The proposal is not expected to contribute to community severance as the highway has been in place for many years and already provides a substantial barrier within the community.

The existing constraints on HML vehicles would be removed and these vehicles would be able to use the new bridge to access locations further south of the Shoalhaven River without having to detour or compromising on heavy vehicle size. Due to the removal of height restrictions there may be an increase in HML vehicles using the corridor.

Travel behaviour

Traffic modelling carried out for the project has identified that the operation of the intersections at Illaroo Road, Bridge Road and Bolong Road would be improved. The movement of vehicles through intersections would be managed using traffic lights to provide equitable access for local traffic and through traffic.

The proposal would result in the relocation of the Pleasant Way intersection with the Princes Highway from the current location opposite Bridge Road. This would require a short additional travel time for southbound travellers wishing to access the area of Nowra to the east of the Princes Highway. It would also remove the direct east-west connection for residents and business users across the highway and to the Nowra town centre.

The restriction of the intersection between Scenic Drive and Bridge Road to left-in left-out only would require the majority of road users wishing to access the riverfront west of the bridges, or the Aquatic Park, to travel further via Hyam Street and Mandalay Avenue, a distance of around 870 metres.

Traffic shifts and changes to local access movements are likely to present anxiety and confusion to residents and road users unless appropriate measures are implemented. Potential impacts would be appropriately managed through implementation of the safeguards and mitigation measures.

Public transport

Generally, it is expected that the proposal would reduce overall travel times and improve congestion for public transport buses utilising the Princes Highway as a consequence of the proposed upgrade.

Pedestrians and cyclists

The completed upgrade would provide improved pedestrian and cycle connectivity along the Princes Highway between Bolong Road and Moss Street. It is proposed that the existing southbound bridge may be adapted for reuse as a dedicated pedestrian and cycle crossing. This would be a physically separated path, therefore significantly improving the safety and attractiveness of the active transport network. The new northbound bridge would also include a shared path (minimum three metres wide) to accommodate pedestrians and cyclists. This would be a significant improved when compared with the narrow shared path that currently exists on the existing northbound bridge (which would be retained in future). A new signalised pedestrian crossing is proposed at the northern approach to the intersection of the Princes Highway and Bolong Road, which would improve pedestrian accessibility and safety across the highway.

Economy

The expected improvements in reducing congestion as a consequence of the completed upgrade would have a flow on economic benefit to the local and regional economies, particularly through travel time savings, as well as vehicle operating cost savings, and accident cost savings.

The proposal would allow unconstrained southbound access for HML vehicles and over height vehicles, as well as increased capacity, which would contribute to productivity gains in freight transport and support the expected doubling of NSW freight task identified in the Princes Highway Corridor Strategy (Transport for NSW, 2013). Many industries are dependent on efficiency travel times for the transport of goods around the state and interstate. As it is the only coastal crossing of the Shoalhaven River, this would have regional benefits for the economy.

Bolong Road is also a key freight route to industrial properties within the area. Decreased travel times would result in positive economic effects to freight, commuter and tourist traffic travelling both within the proposal area and longer distance regional trips (originating from, ending within or passing through the proposal area.

Business and industry

Once the proposal is operational, it is expected that local businesses would benefit from shorter travel times and lower amounts of time lost in congestion. Due to the freight vehicle restrictions being removed, there would be benefits for local and regional businesses through improved travel times for freight and commercial vehicles accessing local businesses.

Decreases in travel times would increase the attractiveness of the local area to commercial business and industry; new business may choose to locate inside the local area to benefit from improved connectivity, whilst decreasing commuting times in the proposal area would potentially promote employment growth in the region, particularly in the employment area to the south of Nowra.

Businesses located to the east of the bridge along Wharf Road may have slightly lower visibility to passing trade as a consequence of road traffic shifting further west. Land use in the gateway area is likely to change substantially in the coming years and the proposed upgrade has the potential to improve the attractiveness of this area for future business growth.

The Thai Riverside Restaurant would be permanently impacted by the restriction of most turning movements into Scenic Drive, requiring the majority of patrons to travel longer via Hyam Street and Scenic Drive to access the off-street parking at the rear of the restaurant. This may deter some patrons from attending.

Overall the change to the existing operating environment for business and industry would be positive.

Tourism

Similar to the business and industry operational impacts noted, above, the tourism facilities in the vicinity of the proposal and tourism operators utilising the highway would benefit from reduced congestion and reduced travel times. The traffic modelling for the proposal has incorporated assumptions relating to the seasonal peak period improvements and shows travel demand being met up to and beyond the forecast year 2046.

Regionally, tourism on the NSW South Coast is expected to grow strongly over the next ten years. Once operational, the proposal would represent an additional link in the progressive upgrading of the Princes Highway on the NSW South Coast, improving the attractiveness of the region for increased tourism opportunities.

The proposal would support regional tourism through improved access to tourist attractions and destinations along the Princes Highway and in the wider Shoalhaven region. In particular, improved safety and travel time savings and reliability would facilitate safer and quicker access along the highway for visitors and tourists, resulting in beneficial impacts for tourism related businesses and destinations.

Overall the change to the existing operating environment for tourism operators would be positive.

Amenity and community

Once operational, the proposal would present a modern, upgraded road corridor consistent with the upgrades that have occurred to date along the Princes Highway. Upgrading the Princes Highway to three through lanes in each direction, in addition to intersection and local road upgrades and changes would change the visual appearance of the road corridor, as well as the provision of a third bridge crossing of the Shoalhaven River, increasing the dominance of road infrastructure through the community.

Noise amenity

As discussed in Section 6.2, the proposal has the potential to impact on environmental noise across the proposal study area. The assessment found that north of the river, traffic noise levels are not predicted to noticeably increase as a result of the proposal however these residences are currently exposed to high traffic noise levels that exceed the guidelines by more than 5 dB(A), and consequently a total of nine residential properties have been identified as eligible for consideration of additional noise mitigation.

South of the river, reconfiguration of traffic movements would shift the traffic noise levels experienced by properties, with traffic generally moving closer to the western side of the highway. A total of 24 properties have been identified as eligible for consideration of additional noise mitigation treatments. A combination of a potential noise barrier, in the vicinity of Graham Lodge, and/or at-property noise treatment at the 24 properties were identified as measures that would provide the most reasonable overall noise reduction across the affected community. Further development of the potential noise barrier design, taking into account the likely heritage, visual and social impacts of such a feature, would be undertaken during detailed design.

Air quality

The upgraded Princes Highway section would have a posted speed limit of 70 km/h. The proposal would increase the carrying capacity of the Princes Highway and in doing so would relieve existing congestion, alleviating frustration of local residents and business users. Vehicle emissions in general would still contribute to local air quality levels however generally it is expected that the proposal would generate a positive outcome for local air quality in peak periods.

Visual amenity

The proposal would change the landscape character and visual amenity due to the addition of the new northbound bridge across the Shoalhaven River and local road upgrades and the installation of new landscaping and urban design features.

These changes have the potential to change the sense of ownership by the community and a person's appreciation of their surroundings.

The proposal would result in an overall visual impact of high-moderate.

Overall the change from the existing amenity of the local environment would be moderate.

Community values, social wellbeing and sense of community

The community have indicated they value their relaxed lifestyle with close connections to the natural environment. The river and access to it are highly valued, and access to community facilities and services are important. However this relaxed lifestyle has been compromised in recent years by the traffic and congestion along the highway and at key intersections with local roads. Once completed it is expected that the proposal would align with the identified community values by improving access to employment and community facilities, road safety and community connectivity through the provision of improved pedestrian and cyclist facilities and safer intersections.

The loss of dwellings along a section of Illaroo Road would potentially reduce the opportunities for passive surveillance along this section of road, opposite a road reserve overlooking the river. However, overall the proposal would improve livability and amenity for residents and businesses within the study area and region, by improving travel times, and reducing delays and frustrations and by improving pedestrian and cyclist facilities.

As noted in Section 6.1 the proposal would provide the opportunity to improve connections for pedestrians and cyclists to the river foreshore and open up new opportunities for active transport use, such as the proposal to re-use the old southbound bridge as a dedicated pedestrian and cycle connection. It would also provide improved cross connections of the highway for pedestrians and cyclists. These improvements, along with the reduced congestion and improved travel times are all expected to improve the way in which the local community experiences their local environment, and to provide new infrastructure that can contribute to their sense of pride in their town.

6.8.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Project communications	A Community and Stakeholder Engagement Plan will be prepared and will include: • Procedures and mechanisms that will be implemented in response to the key social	Roads and Maritime	Detailed design / pre-construction	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
	impacts identified for the proposal. • Procedures and mechanisms that will be used to engage with affected landowners, business owners, and the wider community to identify potential access, parking, business visibility, and other impacts and develop appropriate management measures. • Procedures to keep the community informed about construction and any associated changes to conditions (eg detours or lane closures) such as through advertisements in local media and advisory notices or variable message signs • Procedure for the management of complaints and enquiries, including a contact name and number for complaints. The plan will be prepared in accordance with the Community Involvement and Communications Resource Manual (RTA, 2008).			
Impacts on council infrastructure	Roads and Maritime will continue to consult with Council regarding impacts to council infrastructure.	Roads and Maritime	Detailed design	Project specific control
Impacts on social infrastructure – maritime activities	At least one of the two boat ramps within the proposal area will be available to the public at all times. The public would be notified in advance of any access restrictions during construction.	Roads and Maritime, Construction Contractor	Detailed design, Construction	Project specific control
Impact on Greys Beach Reserve	Use of the Greys Beach Reserve site for temporary construction activities should be planned to consider peak usage periods of the river for recreational users.	Roads and Maritime, Construction Contractor	Detailed design, Construction	Project specific control
Impacts on social	Roads and Maritime will endeavour to identify the location of the time capsule in Moorhouse	Roads and Maritime	Detailed design	

Impact	Environmental safeguards	Responsibility	Timing	Reference
infrastructure – time capsule	Park and establish an appropriate salvage and/or relocation of this object, in consultation with Council and relevant community members.			
Impact on parking	Consultation will be carried out with Council to identify alternative parking arrangements to replace car parking lost during construction.	Roads and Maritime	Detailed design, Pre-construction	Project specific control
Impact on access to Shoalhaven River foreshore	The CEMP will include measures to ensure public access to the Shoalhaven River foreshore and pathways is maintained during construction, where possible given safety considerations.	Roads and Maritime, Construction Contractor	Detailed design, Construction	Project specific control
Construction staff parking	The construction contractor will provide suitable off-street parking to accommodate workers during construction. Construction vehicles would not occupy private parking including Nowra Aquatic Centre and Shoalhaven Entertainment Centre and Visitor Centre. The Construction TMP will include appropriate measures to prevent construction staff from utilising these public parking areas.	Construction Contractor	Pre-construction, Construction	Project specific control
Business and tourism impacts – operation	Existing businesses with authorised Tourist Attraction Signposting Assessment Committee (TASAC) approved signage will be consulted to develop revised signage if impacted by the proposal.	Roads and Maritime	Detailed design	Project specific control

6.9 Biodiversity

A BAR has been prepared for the proposal that covers both terrestrial and aquatic biodiversity. The BAR is provided in Appendix J and is summarised in the following sections.

6.9.1 Methodology

The BAR was prepared with reference to Roads and Maritime's Environmental impact assessment practice note: biodiversity assessment (EIA-N06) and meets the requirements of the EP&A Act. The assessment has been carried out in accordance with the Matters of National Environmental Significance: Significant impact guidelines 1.1. Environment Protection and Biodiversity Conservation Act 1999 (DoE, 2013).

The proposal has been assessed in accordance with the TSC Act through the transitional provisions of the Biodiversity Conservation (Savings and Transitional) Regulation 2017 as the environmental impact assessment of the proposal began under Division 5.1 of the EP&A Act before the commencement of the new Act and is pending assessment under Division 5.1 (refer Section 4.2.2).

The methodology for the biodiversity assessment prepared for this REF included the following activities:

- Background research:
  - A search of relevant databases to obtain records on all threatened species, populations, and ecological communities previously recorded within a 10 kilometre search area
  - A database search of additional listed areas of ecological importance, key habitat features, vegetation communities, and aquatic habitat
  - Spatial data sources were used in the initial assessment and preliminary investigations to delineate the study area
- Habitat assessment:
  - Assessment of the available habitat for each threatened species, population or community identified as known or potentially present through the database searches and review of past reports
  - Considered the likelihood of each species occurring in habitat of the study area based on recent records, known distribution and the likely availability and quality of suitable habitat
  - Water and sediment quality samples were obtained from sites along the proposed alignment and analysed
- Field surveys
  - Site specific vegetation surveys to revise and update the existing vegetation mapping
  - Field traverses were undertaken to assess any changes to habitat within the study area and any changes in potential to support threatened flora
  - Targeted threatened flora surveys were conducted in adherence to the NSW Guide to Surveying Threatened Plants (OEH, 2016) and the Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004
  - Aquatic ecology surveys were undertaken in general accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013)
- Assessment of potential impacts
- Provision of recommended mitigation measures.

Field surveys carried out for the assessment included:

- Field traverses and Targeted threatened flora surveys were carried out on 13-17 March 2017, 20-21 November 2017 and 3-4 April 2018
- Baseline and targeted threatened fauna and habitat surveys were carried out on 13-17 March 2017 and on 20-21 November 2017
- Aquatic ecology surveys conducted on 11 and 12 December 2017, coinciding with two low tides and one high tide, and 4 April 2018.

The field survey effort met the required guidelines but the following limitations are noted:

- Survey conditions for microchiropteran bats were slightly unfavourable due to significant rainfall
- Aquatic ecology surveys were only undertaken during one season (summer). While previous aquatic ecology assessments were referenced and, where appropriate, findings summarised within the BAR, it is important to note that aquatic ecological values display temporal and spatial variability.

6.9.2 Existing environment

General environment

The proposal study area is located within the Sydney Basin Bioregion in the Illawarra IBRA subregion, and occurs entirely within the Shoalhaven Alluvial Plain Mitchell landscape (V3). Most of the study area comprises undulating landforms associated with the Shoalhaven River and floodplain and Bomaderry Creek. The study area is predominantly cleared of native vegetation with current land uses including residential, commercial, and public recreation.

Terrestrial habitats within the study area have been modified by past and current land uses. Remaining areas of bushland occur within Rotary Park on the northern bank of the Shoalhaven River west of the highway, containing substantial fauna habitat features including several large sandstone overhangs. There is also riparian vegetation associated with Bomaderry Creek forming a corridor that runs northwest from the highway and connecting to Bomaderry Creek Regional Park. This corridor is known to host a number of threatened biota including Yellow-bellied Glider (*Petaurus australis)*, Powerful Owl (*Ninox strenua*) and Gang-gang Cockatoo (*Callocephalon fimbriatum)*. While the park is located close to the study area, the Princes Highway and Illaroo Road form a barrier to ground-dwelling fauna and those species sensitive to urban landscapes that may attempt to use it.

At the Princes Highway crossing, the Shoalhaven River is an open mature estuary. The river provides a variety of habitats including mud flats, seagrass, mangroves, and estuarine, many of which may be utilised by threatened species. The river is mapped as key fish habitat by NSW DPI Fisheries. In accordance with criteria identified in the Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013), the river is classified as a Type 1 highly sensitive key fish habitat and Class 1 major fish habitat.

There are no declared critical habitats present within the study area.

Plant community types

Two native vegetation communities exist in the proposal area, these being Spotted Gum-Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion and Swamp Paperbark-Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South-East Corner Bioregion. In addition, several mixed native and exotic vegetation communities exist throughout the study area. Key species of these communities were

also recorded. The vegetation communities occurring in the study area are shown in Figure 6-9. A full floristic list recorded from the study area is provided in Appendix J.

Summary profiles of the native vegetation communities recorded in the study area during the investigations for the proposal are provided in Table 6-48.

Table 6-48: Plant community types within the proposal study area

Plant community type (PCT)	Condition class	Threatened ecological community?	Area in proposal area (ha)	Area in indirect impact area (ha)	Area in study area (ha)
Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (1206)	Moderate/ Good	No	2.09	0.34	6.52
Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (1236)[1]	Poor	Yes	0.09	0.03	0.46
Planted Mixed Native	N/A	No	2.35	0.33	3.16
Exotic	N/A	No	1.11	0.25	2.01
Total			**5.6**	**0.95**	**12.15**

1 Contains the endangered ecological community Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Threatened ecological communities

There is only one ecological community within the study area listed as endangered under the TSC Act: Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. This occurs as the vegetation formation Swamp Paperbark-Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (refer Figure 6-9). This occurs as small remnants in poor condition that support mostly Swamp Oak, with the occasional Bangalay. The remnants were mapped around the boat ramp on the northern shore of the Shoalhaven River and to the east of the Princes Highway at the southernmost extent of the study area. The endangered ecological community (EEC) is bisected by a concrete roadway and the groundcover is highly modified, and mostly made up of exotic species.

Given the poor condition of the remnants, the EEC within the study area only meets the determination under the TSC Act and does not meet the determination of an EEC under the EPBC Act.

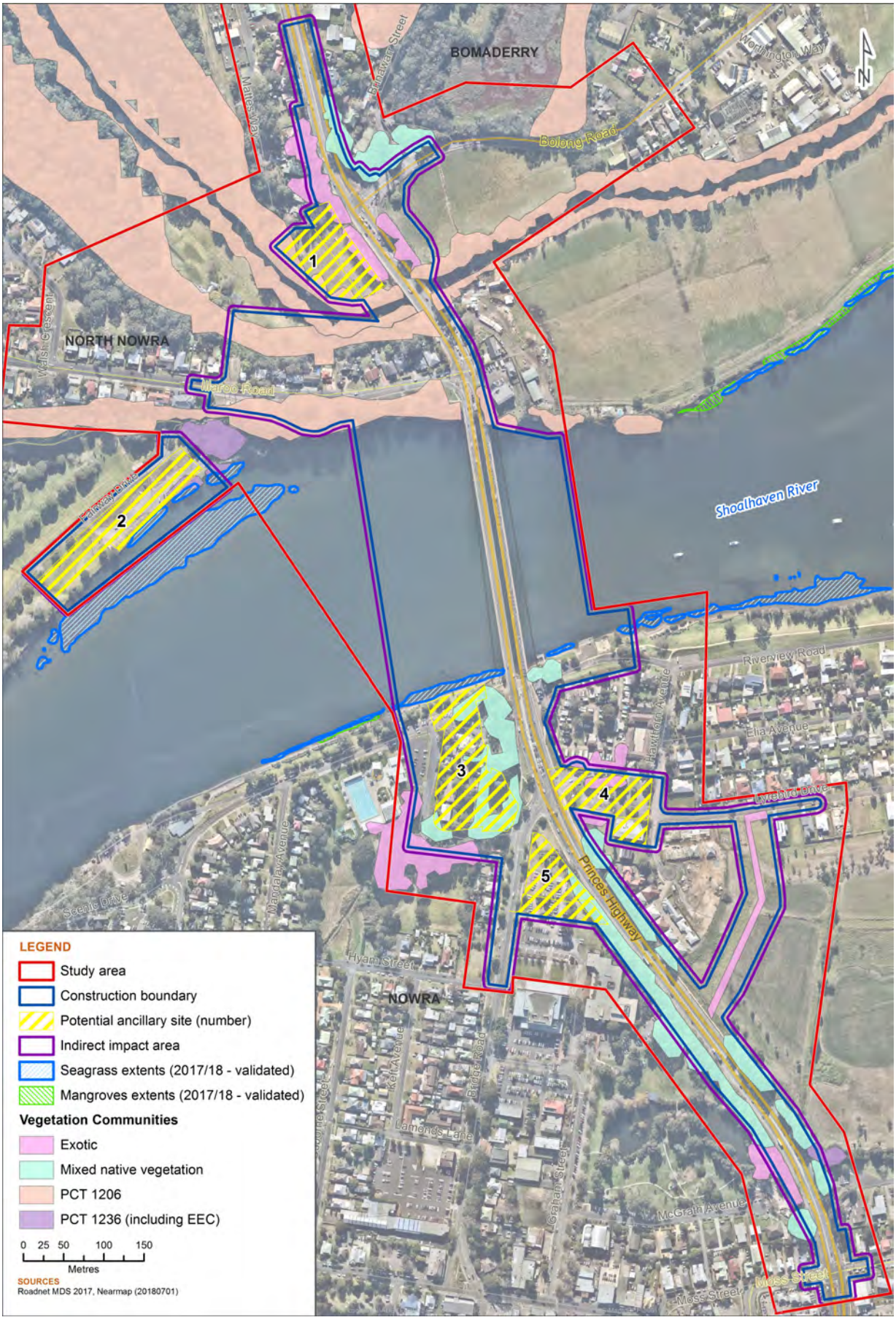

Figure 6-8: Vegetation communities

Other fauna habitats

The existing bridges at Bomaderry Creek and across the Shoalhaven River provide potential roosting habitat for microchiropteran bat species such as:

- Little Bentwing-bat (*Miniopterus australis*)
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)
- Southern Myotis (*Myotis macropus*).

Hollow-bearing trees were recorded at a very low density throughout the study area with only two hollow-bearing trees being found, both occurring in the south of the study area, accounting for one small (0-5 centimetre diameter) and three medium sized (5-10 centimetre diameter) hollows.

The following threatened fauna species may utilise the tree hollows in the study area:

- Gang-gang Cockatoo (*Callocephalon fimbriatum*)
- Little Lorikeet (*Glossopsitta pusilla*)
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
- Eastern Freetail-bat (*Mormopterus norfolkensis*)
- Southern Myotis (*Myotis macropus*)
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

Groundwater dependent ecosystems

One PCT within the study area has been identified as having potential groundwater interaction with one groundwater dependent ecosystem (GDE): Spotted Gum-Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion. The interaction is summarised in Table 6-49 and mapped in Figure 6-10.

Table 6-49: Groundwater dependent ecosystems mapped by BoM and Kuginis *et al*. (2012)

GDE type	GDE name	GDE probability	Landscape location	EEC
Vegetation	Currambene - Batemans Lowlands Forest	High	Deeply dissected sandstone plateaus	No

While the other PCT, Swamp Paperbark-Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion, is not mapped as having an association with any GDEs; it is likely to be sensitive to changes to groundwater.

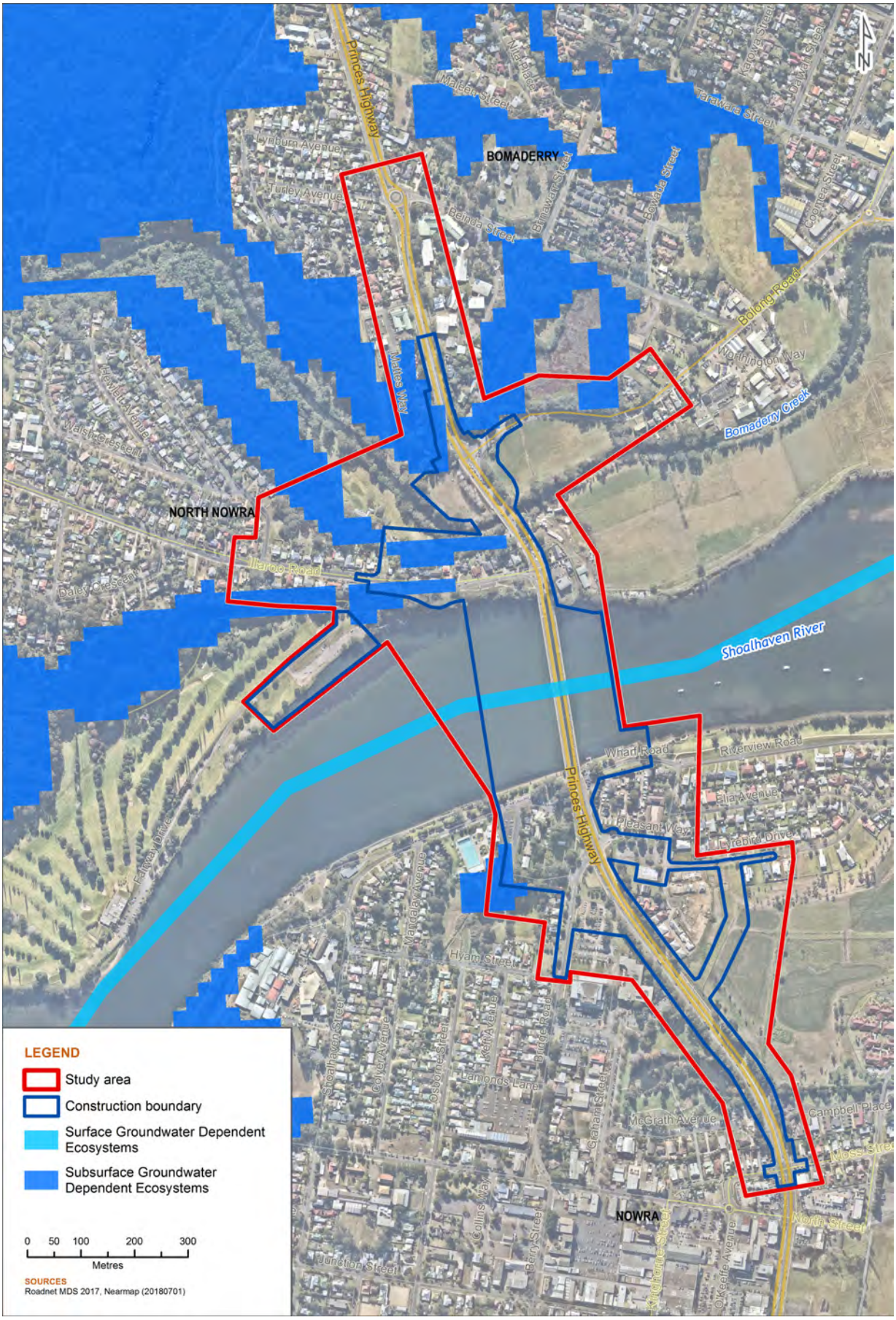

Figure 6-9: Groundwater dependent ecosystems

Threatened flora species and populations

A total of 11 threatened flora species were identified as potentially occurring in the locality (refer Table 6-50). An assessment of likelihood of occurrence was conducted for each of these to determine whether they had a low, moderate or high potential occurrence. The table also notes which species were recorded during surveys.

Table 6-50: Threatened flora species and populations

Scientific name	Common name	Status		Potential occurrence (Low, Moderate, High, Recorded)
		TSC Act	EPBC Act	
Acacia pubescens	Downy Wattle	V		Low
Cryptostylis hunteriana	Leafless Tongue-orchid	V		Low
Eucalyptus langleyi	Nowra Mallee	V	E	None
Genoplesium baueri	Bauer's Midge Orchid	E	E	Low
Hibbertia stricta subsp. *Furcatula*	(none)	E	-	None
Pterostylis gibbosa	Illawarra Greenhood	E	E	Moderate
Pterostylis vernalis	Spring Tiny Orchid	CE	CE	Low
Solanum celatum	(none)	E		Moderate
Syzygium paniculatum	Magenta Lilly Pilly	E	V	Recorded
Triplarina nowraensis	Nowra Heath Myrtle	E	E	Low
Zieria baeuerlenii	Bomaderry Zieria	E	E	Moderate

Four threatened flora species with known populations within a 10 kilometre search area of the locality were assessed as being moderately likely to occur in the study area. Only one of these, Magenta Lilly Pilly (*Syzygium paniculatum*), was found during field surveys (refer Figure 6-11). Nineteen individuals were recorded within the study area within a planted area of screening vegetation on the corner of the Princes Highway and Bolong Road. Given the individuals were likely planted as a screen between the Princes Highway and local residences, and that natural habitat is generally absent from the study area, it is highly unlikely that these individuals form part of a local, naturally occurring population.

AoS have been conducted for the four threatened flora species with a moderate to high potential to occur, and for those recorded. These are provided in Appendix J.

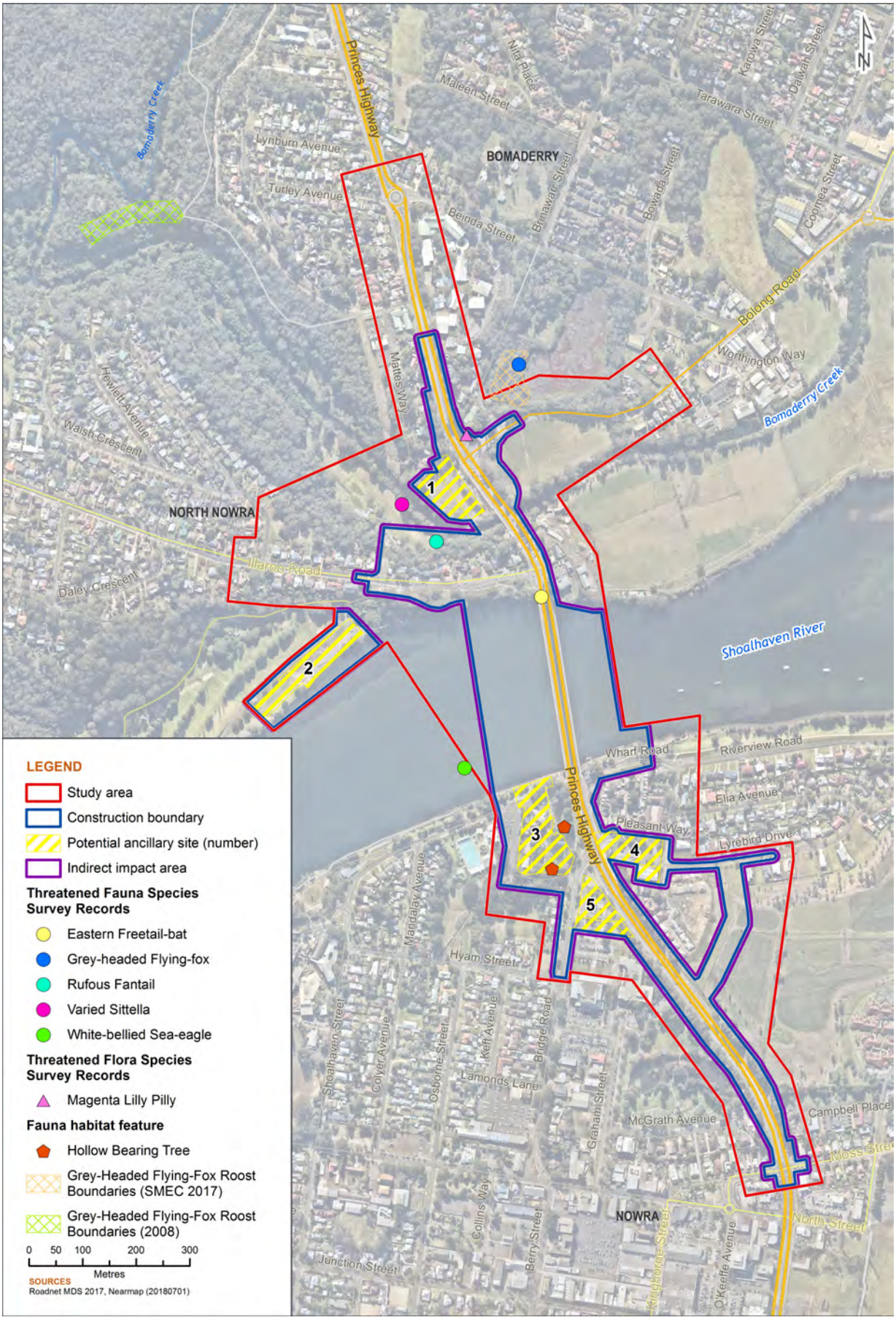

Figure 6-10: Threatened flora and fauna species recorded in the study area

Threatened fauna species and populations

Forty threatened fauna species were identified as potentially occurring in the locality (refer Table 6-51). An assessment of likelihood of occurrence was conducted for each of these to determine whether they had a low, moderate or high potential occurrence. The table also notes which species were recorded during surveys.

Table 6-51: Threatened fauna species and populations

Scientific name	Common name	Status		Potential occurrence (Low, Moderate, High, Recorded)
		TSC Act	EPBC Act	
Botaurus poiciloptilus	Australasian Bittern	E	-	Low
Arctocephalus pusillus doriferus	Australian Fur-Seal	V	-	Low
Ixobrychus flavicollis	Black Bittern	V	-	Low
Falco subniger	Black Falcon	V	-	Low
Burhinus grallarius	Bush Stone-curlew	E	-	Low
Artamus cyanopterus	Dusky Woodswallow	V	-	Low
Miniopterus schreibersii oceanensis	Eastern Bentwing-Bat	V	-	Moderate
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Moderate
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Recorded
Pandion cristatus	Eastern Osprey	V	-	Moderate
Cercartetus nanus	Eastern Pygmy-Possum	V	-	Low
Stictonetta naevosa	Freckled Duck	V	-	Low
Callocephalon fimbriatum	Gang-Gang Cockatoo	V	-	Low
Heleioporus australiacus	Giant Burrowing Frog	V	-	Low
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Moderate
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Moderate
Petauroides volans	Greater Glider		V	Low
Litoria aurea	Green and Golden Bell Frog	E	V	Moderate
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Recorded
Thinornis rubricollis	Hooded Plover	CE	V	Low
Phascolarctos cinereus	Koala	V	-	Low
Chalinolobus dwyeri	Large-eared Pied Bat	V	-	Low

Scientific name	Common name	Status		Potential occurrence (Low, Moderate, High, Recorded)
		TSC Act	EPBC Act	
Hieraaetus morphnoides	Little Eagle	V	-	Low
Glossopsitta pusilla	Little Lorikeet	V	-	Low
Tyto novaehollandiae	Masked Owl	V	-	Low
Ninox strenua	Powerful Owl	V	-	Moderate
Anthochaera phrygia	Regent Honeyeater	CE	CE	Low
Rhipidura rufifrons	Rufous Fantail	-	M	Recorded
Petroica boodang	Scarlet Robin	V	-	Low
Tyto tenebricosa	Sooty Owl	V	-	Low
Myotis macropus	Southern Myotis	V	-	High
Circus assimilis	Spotted Harrier	V	-	Low
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Low
Lophoictinia isura	Square-tailed Kite	V	-	Moderate
Petaurus norfolcensis	Squirrel Glider	V	-	Low
Daphoenositta chrysoptera	Varied Sittella	V	-	Recorded
Haliaeetus leucogaster	White-bellied Sea-eagle	V	-	Recorded
Epthianura albifrons	White-fronted Chat	V	-	Low
Petaurus australis	Yellow-bellied Glider	V	-	Moderate
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Moderate

Five threatened fauna species including one migratory species were recorded in the study area during surveys. These were the Eastern Freetail-bat (*Mormopterus norfolkensis*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Varied Sittella (*Daphoenositta chrysoptera*), White-bellied Sea-eagle (*Haliaeetus leucogaster*), and the migratory species Rufous Fantail (*Rhipidura rufifrons*) (refer Figure 6-11).

The Southern Myotis (*Myotis macropus*), was assessed to have a high potential to occur in the study area, however no individuals were recorded during survey. Ten other species were identified as having moderate potential to occur, including those that would use the study area only on a transient basis.

AoS have been conducted for the 16 threatened species with a moderate to high potential to occur, and for those recorded. These are provided in Appendix J.

Invasive species

Four priority weed species listed for the South East (DPI 2017) under the *Biosecurity Act 2015*, were identified in the study area. The class and duty associated with all plants and specific duties for the weed species identified in the study area are outlined in Table 6-52.

Table 6-52: Priority weeds listed for the Shoalhaven LGA identified within the study area

Weed	Duty
All plants	General biosecurity duty: • All plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.
Ground Asparagus (*Asparagus aethiopicus*)	Mandatory measure: • Must not be moved, imported into the State or sold • Exclusion zone: whole region excluding core infestation area of Eurobodalla, Kiama, Shellharbour, Wollongong and the Shoalhaven
Mother-of Millions (*Bryophyllum delagoense*)	Mandatory measure: • Must not be moved, imported into the State or sold
Lantana (*Lantana camara*)	Mandatory measure: • Must not be imported into the State or sold • Exclusion zone: whole region excluding core infestation area of Eurobodalla, Kiama, Shellharbour, Wollongong and the Shoalhaven local government area north of the Lantana Containment Line at 30’11”42S
African Olive (*Olea europaea* subsp. *Cuspidate*)	Mandatory measure: • Must not be imported into the State or sold

Five pest fauna species were identified during the field investigation:

- Common Myna (*Sturnus tristis*)
- Common Starling (*Sturnus vulgaris*)
- Red-whiskered Bulbul (*Pycnonotus jocosus*)
- Rock Dove (*Columba livia*)
- Spotted Dove (*Streptopelia chinensis*).

It is expected that other pest species would frequent the study area including the Red Fox (*Vulpes vulpes*), European Rabbit (*Oryctolagus cuniculus*), and Domestic Cat (*Felis catus*).

Aquatic habitat

The Shoalhaven River is classified as a Type 1, Class 1 waterway (Table 6-53), indicating that it contains highly sensitive key fish habitat and potential for threatened fauna species to occur. The

river also contains overhanging and emergent vegetation as well as tidal mudflats suitable for foraging, breeding and sheltering birds.

Table 6-53: Shoalhaven River classification

Classification	Characteristics of waterway
Type 1	Highly sensitive key fish habitat: • *Zostera* sp. beds of greater than 5 square metres in area • Wetlands listed in the Directory of Important Wetlands of Australia • Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two-dimensions, snags greater than 300 mm in diameter or three metres in length, or native aquatic plants • Any known or protected threatened species habitat or area of declared critical habitat under the FM Act.
Class 1	Major fish habitat: • Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.

The Shoalhaven River and estuary is recognised in the Directory of Important Wetlands of Australia. The listing extends from the river mouth upstream to Broughton Creek. The confluence of the Shoalhaven River and Broughton Creek is about 7.3 kilometres downstream of the proposal. It is considered the proposal would have low potential to impact on this section of the Shoalhaven River in view of other potential influences in this part of the catchment, and in upstream areas.

The water quality in the study area is considered to be good, based on monitoring carried out at a number of locations within the Shoalhaven River and Bomaderry. The following is noted:

- Temperature showed little variation within and between sites, with values typically ranging between 24.0 °C and 24.8 °C
- Surface dissolved oxygen concentrations ranged between 6.5 mg/L and 13.0 mg/L, which represents an approximate per cent saturation range of 60 to 130
- pH was neutral at all sites (the Bomaderry Creek site displayed a lower pH than all Shoalhaven River sites)
- Turbidity was generally good:
  - Concentrations at Shoalhaven River sites ranged between 0.1 NTU and 1.7 NTU
  - Turbidity in Bomaderry Creek was higher, ranging between 1.7 NTU and 2.7 NTU
- Metals (arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury), TPH, TRH, BTEX, TN, COD, and BOD, were all below analytical detection limits (and therefore ANZECC guidelines)
- Ammonia concentrations ranged between 4 µg N/L and 8 µg N/L (below the ANZECC guidelines for lowland rivers of 20 µg N/L)
- Nitrate concentrations were all below 10 µg N/L (below the ANZECC guidelines of 40 µg N/L)
- Total phosphorus concentrations ranged between 5 µg P/L and 10 µg P/L, and reactive phosphorus was 10 µg P/L or below 1 (below the ANZECC guidelines of 50 µg P/L)

- Reactive phosphorus was 10 µg P/L or below 1 (below the ANZECC guidelines of 20 µg P/L)
- Sediment particle size distribution indicates that the southern, shallower portion of the river is dominated by sand, while the deeper channel on the northern riverbank is dominated by fine particles
- Metals and metalloids, PAH, TPH, BTEX were all below sediment quality guidelines.

The historic dataset available (2000 to 2012) suggests that there were significant improvements in water quality in the Shoalhaven River from about 2010 onwards as all indicators improved from this time. This is likely to due to the implementation of improved stormwater and catchment management practices.

Aquatic flora

The aquatic flora recorded in the study area (refer Figure 6-1) consists of:

- Seagrass – *Zostera muelleri*
  - About 0.3 hectares
  - To the east and west of the southern end of the proposed and existing bridges
  - To the west of the boat ramp on the northern riverbank, adjacent to a proposed ancillary site
  - Constitute a Type 1 key fish habitat – *Zostera* sp. beds of greater than five square metres
- Mangroves
  - Small stands of the Grey Mangrove (*Avicennia marina*) occur to the west of the bridges along both the southern and northern riverbanks
  - More substantial stands occur about 50 metres to the east of the existing bridges on the northern riverbank and around the northwest edge of Pig Island
  - Not recorded directly under the proposed bridge alignment or other permanent infrastructure.

Aquatic fauna

A total of 23 threatened aquatic/marine fauna species were identified to potentially occur in the locality (Table 6-54). An assessment of likelihood of occurrence was conducted for each.

Table 6-54: Threatened aquatic and marine fauna

Scientific name	Common name	Status		Potential occurrence (Low, Moderate, High, Recorded)
		TSC Act or FM Act	EPBC Act	
Birds				
Diomedea epomophora epomophora	Southern Royal Albatross	-	V	Low
Diomedea epomophora sanfordi	Northern Royal Albatross	-	E	Low
Diomedea exulans antipodensis	Antipodean Albatross	V	V	Low
Diomedea exulans exulans	Tristan Albatross	-	E	Low
Diomedea exulans gibsoni	Gibson's Albatross	V	V	Low

Scientific name	Common name	Status		Potential occurrence (Low, Moderate, High, Recorded)
		TSC Act or FM Act	EPBC Act	
Diomedea exulans (sensulato)	Wandering Albatross	V	V	Low
Macronectes giganteus	Southern Giant Petrel	E	E	Low
Macronectes halli	Northern Giant Petrel	V	V	Low
Thalassarche bulleri	Pacific Albatross	-	V	Low
Thalassarche cauta cauta	Shy Albatross	V	V	Low
Thalassarche cauta salvini	Salvin's Albatross	-	V	Low
Thalassarche cauta steadi	White-capped Albatross	-	V	Low
Thalassarche eremita	Chatham Albatross	-	E	Low
Thalassarche melanophris	Black-browed Albatross	V	V	Low
Thalassarche impavida	Campbell Albatross	-	V	Low
Fish				
Epinephelus daemelii	Black Rock Cod	V	V	Low
Macquaria australasica	Macquarie Perch	E	E	Low
Prototroctes maraena	Australian Grayling	E	V	Recorded
Reptiles				
Caretta caretta	Loggerhead Turtle	E	E	Low
Chelonia mydas	Green Turtle	V	V	Low
Dermochelys coriacea	Leatherback Turtle	E	E	Low
Eretmochelys imbricata	Hawksbill Turtle	-	V	Low
Natator depressus	Flatback Turtle	-	V	Low

The Australian Grayling (*Prototroctes maraena*) was recorded within the study area during surveys carried out for the proposal. An AoS was carried out for this species and is provided in Appendix J. The Green Turtle (*Chelonia mydas)* has been previously recorded downstream of the study area but was identified as having low potential to occur. The remaining species were identified as having low potential to occur.

It is noted that several sygnathids (e.g. pipefish, sea horses) have the potential to occur in the Shoalhaven River, however, these are considered to primarily occur downstream of the study area. These are protected under the FM Act.

Matters of National Environmental Significance

Comment on Matters of National Environmental Significance relevant to the proposal is provided in the following table.

Table 6-55: Matters of National Environmental Significance in the study area

MNES	Present in study area	Comment
Threatened biodiversity	Magenta Lilly Pilly (*Syzygium paniculatum*) – vulnerable	Planted as a screen between the existing Princes Highway and adjacent residences. Natural habitat for the species was generally absent from the study area.
	Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable	Recorded during surveys in habitat adjoining the north section of the proposal
Migratory species	Rufous Fantail (*Rhipidura rufifrons*) – marine/migratory	Recorded within 100 metres of the study area during the fauna surveys

6.9.3 Potential impacts

Construction

Potential direct impacts of the proposal on biodiversity during construction would occur as a result of clearing and grubbing, earthworks, and general construction activities. These would include:

- Direct loss of or disturbance to 2.18 hectares of native vegetation, including 0.09 hectares of the endangered ecological community Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Direct loss of or disturbance to 3.36 hectares of non-native vegetation including gardens, street trees, weeds and paddocks leading to potential loss of food sources and habitat for fauna species
- Removal of 19 Magenta Lilly Pilly (*Syzygium paniculatum*) individuals
- Impacts on aquatic biodiversity
- Injury and mortality.

About 0.34 hectares of native vegetation would be indirectly impacted as a result of the proposal. Other potential indirect impacts on biodiversity during construction would include impacts resulting from:

- Changes in environmental conditions such as hydrology, drainage, noise, light and wind
- Changes in extent, size, shape and connectivity of native vegetation, exotic vegetation, and other areas of habitat
- Potential invasion and spread of weeds and diseases.

The potential impacts, both direct and indirect are discussed in more detail in the following sections.

Removal of vegetation

The proposal would result in the direct loss of, or disturbance to 2.18 hectares of native vegetation and 3.36 hectares of non-native vegetation

General impact to biodiversity could occur directly or indirectly because of the proposal through the following pathways:

- Direct loss of, or disturbance to, native vegetation. This may include threatened flora, threatened communities and their habitats
- Direct loss of, or disturbance to, non-native vegetation including gardens, street trees, weeds and paddocks
- Direct loss of, or disturbance to, terrestrial habitat for threatened and protected fauna including hollows, dead wood, food resources, roosting features, shelter and refugia
- Indirect impact due to changes in environmental conditions such as hydrology, drainage, noise, light and wind
- Indirect impact due to changes in extent, size, shape and connectivity of native vegetation, exotic vegetation, and other areas of habitat
- Indirect impact resulting from potential invasion and spread of weeds and diseases from edge effects, construction, operation and maintenance.

Table 6-56 summarises the direct and indirect impacts to native vegetation.

Table 6-56: Impacts on native vegetation

Plant community type (PCT)	Status		Proposal area[1] (ha)	Indirect Impacts (ha)	Percent cleared in CMA[2]
	TSC Act	EPBC Act			
Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion (1206)	N/A	N/A	2.09	0.34	15
Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (1236)	E[3]	N/A	0.09	0.03	32
Total			**2.18**	**0.34**	

1 Area to be cleared based on ground-truthed vegetation mapping within the study area

2 Based on the VIS classification database

3 E - Endangered

Table 6-57: Impacts on non-native vegetation

Plant community type (PCT)	Proposal area[1] (ha)	Indirect Impacts (ha)	Area (ha) in study area
Planted mixed vegetation	2.35	0.33	3.16
Exotic	1.11	0.25	2.01
Total	3.36	0.58	

1 Area to be cleared based on ground-truthed vegetation mapping within the study area

Removal of threatened fauna habitat

The primary impact of the proposal on threatened fauna habitat would be through clearing of native vegetation and the resulting loss of threatened species through the loss of individuals, extent and/or habitat. During construction, this would be as a direct result of machinery and personnel operating within the clearing boundary and includes the removal of, and disturbance to, vegetation due to site establishment, clearing and grubbing, earthworks and drainage. Direct loss of, or disturbance to, threatened fauna habitat through clearing of native vegetation is detailed in Table 6-56.

The vegetation within the construction area is an important food source for carnivorous or insectivorous fauna species such as Powerful Owl (*Ninox strenua*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*). All have either been recorded or have the potential to be present within the study and so may be impacted through the loss of foraging habitat and food resources.

Loss of, or disturbance to, native vegetation on the proposal area would largely conform to Clearing of Native Vegetation, a Key Threatening Process (KTP) listed on Schedule 3 of the TSC Act. Vegetation to be removed or modified, particularly native vegetation, would reduce or modify food resources in the study area and locality for numerous fauna species. The removed vegetation directly provides food resources to fauna species such as leaves, sap, wood, pollen, seeds and nectar to both vertebrate and invertebrate fauna species. Such plant food sources are directly important to threatened species that may utilise habitat in the study area such as Yellow-bellied Glider (*Petaurus australis*).

The existing bridge structures at Bomaderry Creek and across the Shoalhaven River provide potential roosting habitat for microchiropteran bat species such as the Little Bentwing-bat (*Miniopterus australis*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) and Southern Myotis (*Myotis macropus*). Hollow-bearing trees were recorded at very low density throughout the study area. Removal of hollow-bearing trees is listed as a KTP on Schedule 3 of the TSC Act.

Potential impacts to threatened fauna species are summarised in Table 6-58.

Table 6-58: Potential impacts to threatened fauna species and fauna habitat

Scientific name	Common name	Potential occurrence (Moderate, High, Recorded)	Significantly impacted by proposal?	Impact (ha)
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	Moderate	No	0
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Moderate	No	0
Mormopterus norfolkensis	Eastern Freetail-bat	Recorded	No	0
Pandion cristatus	Eastern Osprey	Moderate	No	0
Scoteanax rueppellii	Greater Broad-nosed Bat	Moderate	No	0
Litoria aurea	Green and Golden Bell Frog	Moderate	No	0

Scientific name	Common name	Potential occurrence (Moderate, High, Recorded)	Significantly impacted by proposal?	Impact (ha)
Pteropus poliocephalus	Grey-headed Flying-fox	Recorded	No	0
Ninox strenua	Powerful Owl	Moderate	No	0
Rhipidura rufifrons	Rufous Fantail	Recorded	No	0
Myotis macropus	Southern Myotis	High	No	0
Lophoictinia isura	Square-tailed Kite	Moderate	No	0
Daphoenositta chrysoptera	Varied Sittella	Recorded	No	0
Haliaeetus leucogaster	White-bellied Sea-eagle	Recorded	No	0
Petaurus australis	Yellow-bellied Glider	Moderate	No	0
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Moderate	No	0

Removal of threatened flora

The proposal would require clearing of vegetation within the construction boundary. This would lead to the removal of 19 individuals of Magenta Lilly Pilly (*Syzygium paniculatum*), a threatened flora species. These individuals were planted as part of screening vegetation and it is highly unlikely that they form part of a local, naturally occurring population.

Impacts on aquatic biodiversity

About 0.3 hectares of seagrass and 0.04 hectares of mangroves exists within the construction footprint. No mangroves were observed within the general alignment of the proposed new bridge and therefore no impact to mangroves is anticipated as a result of the proposal. The proposed bridge would impact about 0.03 hectares of seagrass (*Zostera muelleri)* on the southern riverbank. Up to 0.06 hectares of seagrass may be impacted by the temporary barge mooring and loading facilities on the southern riverbank and at Greys Beach. These seagrass beds constitute a Type 1 key fish habitat under the FM Act. As such, a permit under the FM Act would be required for the removal or disturbance of seagrass. The remainder of the alignment of the proposed new bridge is devoid of benthic habitat.

Indirect impacts to aquatic habitats may occur due to increased turbidity and sedimentation associated with the construction of the bridge piers within the Shoalhaven River. Activities such as piling and/or excavating (e.g., dredging), typically associated with bridge construction, would result in increases in turbidity and sedimentation. Based on the footprint area of each bridge pier, these impacts are expected to be temporary (short-term), minor and occur over a small spatial extent.

Light can also impact aquatic species, such as turtles and fish due to attraction and disorientation. Construction lighting may penetrate the aquatic environment, leading to attraction, avoidance or disorientation of aquatic fauna.

In aquatic species, increased noise can result in behavioural or physical impacts, depending on the noise levels. Construction of the bridge piers would result in increased underwater noise due to piling and/or dredging activities. Sensitive receptors, particularly whales, dolphin, and marine reptiles (except for the Green Turtle (*Chelonia mydas*)) are not known to occur within or near the study area. The Green Turtle has previously been recorded near the study area; however, sightings are extremely uncommon, therefore the probability of this species being observed during construction is low. As such, impacts on aquatic fauna from underwater noise are not anticipated.

The new bridge piers constitute an in-stream structure under the FM Act, and as such the proposal would require an approval or require notice to be given under the FM Act. The bridge piers are proposed to be aligned with those currently in place for the two existing bridges. The addition of a third set of piers may result in additional diversion of water flow; however, this is expected to be insignificant with respect to current conditions. As such, the new bridge piers are not likely to significantly alter the natural flow of the river. There would be no material impact to fish passage within the Shoalhaven River.

Major threatening processes for the Australian Grayling (*Prototroctes maraena*) include barriers to movement, river regulation, poor water quality, siltation, and introduced pests and diseases. The proposal is unlikely to result in any of these threatening processes. Changes in water quality and increased siltation may occur during construction of the bridge piers, however these are expected to be minor, short-term and over small spatial scales. Given the large home-range of the Australian Grayling, and lack of suitable spawning sites in the study area, it is unlikely that the proposal would adversely affect the life cycle of this species.

In summary, the proposal is unlikely to result in

- The temporary displacement of aquatic fauna
- Loss of riparian vegetation, or the removal or relocation of snags
- Obstruction of fish passage, including temporary in-stream structures and / or temporary diversions
- Acidification due to disturbance of acid sulfate soils
- Potential direct and indirect impacts on aquaculture, commercial or recreational fishing
- Impacts to wetlands.

The proposal has the potential to result in the following impacts to aquatic biodiversity during construction:

- Loss of up to 0.09 hectares of aquatic habitat (seagrass (*Zostera muelleri)*) – Type 1 key fish habitat)
- Potential indirect impact to 0.25 hectares of seagrass
- Installation of in-stream structures that may alter the natural flow regime of the river or stream
- Minor, short-term increases in turbidity and sedimentation during construction of the bridge piers
- Pollutants entering the waterway due to accidental spills.

Invasion and spread of weeds, pests, pathogens and disease

Mechanical vegetation removal, earthwork, increased human activity during construction and increased edge effects all have the potential to facilitate the spread of weeds within the study area and surrounding vegetation. The proposal may provide an opportunity to carry out weed control work and habitat enhancement after construction of the proposal in accordance with the *Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects* (RTA, 2011).

Five pest fauna species were identified during the field investigation and other pest species such as the Red Fox (*Vulpes vulpes*) would be expected to frequent the study area. The proposal is unlikely to increase the presence of pest species within the study area.

There is a risk that the construction activities could introduce, spread or exacerbate the plant diseases caused by Phytophthora dieback (*Phytophthora cinnamomi*) and Myrtle Rust (*Austropuccinia psidii*). These diseases are most likely introduced or spread through the importation or movement of soil, water and landscaping materials, either directly or through incidental attachment to machinery.

Fauna injury and mortality

Construction works that lead to the removal or disturbance of fauna or their habitats may lead to incidences of fauna injury or mortality through interactions with vehicles. It is possible that the level of risk would be altered during construction, particularly during habitat removal when fauna may be forced to move. Given the proposal would involve habitat clearing directly next to the existing roadway, this may result in an increase in individuals being injured or killed by vehicles in the short-term if they are required to cross the road more frequently to obtain resources.

Noise, light and vibration

The construction phase of the proposal would result in increased noise and vibration levels in the investigation area due to activities such as vegetation clearing, ground disturbance, machinery and vehicle movements, and human presence. Noise and vibration from construction activities may temporarily disturb and displace nocturnal fauna sheltering in habitat adjoining the construction footprint, and some fauna species. Some night works would be required during construction and lighting would be installed on the roadside. Construction lighting may also penetrate the aquatic environment, leading to attraction, avoidance or disorientation of aquatic fauna.

Construction of the bridge piers would result in increased underwater noise due to piling and/or dredging activities. Sensitive receptors, particularly whales, dolphin, and marine reptiles (except for the Green Turtle (*Chelonia mydas*)) are not known to occur within or near the study area. The Green Turtle has previously been recorded downstream of the study are; however, sightings are extremely uncommon, therefore the probability of this species being observed during construction is low. As such, impacts on aquatic fauna from underwater noise are not anticipated.

The temporary construction indirect impacts are expected to lead to increases in light, noise and vibration beyond the levels that are currently experienced by the local flora and fauna. These increases are not likely to be significant as the species are likely to be pre-disposed to handle the already urbanised area and are unlikely to suffer additional and significantly increased impacts beyond those that they are currently subject to.

Groundwater dependent ecosystems

One subsurface groundwater dependent ecosystem, Currambene-Batemans Lowlands Forest, is likely to be impacted as a result of the proposal. This GDE is associated with the clearing of 0.75 hectares of Spotted Gum-Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion. However, as the works are related to clearing of the vegetation on the surface, it is unlikely that the proposal would significantly alter the subsurface flows of this GDE.

Operation

Wildlife connectivity and habitat fragmentation

The proposal is likely to reduce the wildlife connectivity in the area through:

- Increased fragmentation of vegetation and increased edge effects resulting from the clearing of native vegetation
- Decreased connectivity between localities of endangered and/or critically endangered species
- Increased distance between vegetation on either side of the road from about 20 metres to about 40 metres as a result of the road upgrade. This increase in the gap between canopy trees may deter fauna from using the vegetation to forage and cross between habitat areas.

The study area is characterised by a landscape of small and disturbed patches of urban bushland that are heavily fragmented by the highway and cleared industrial and residential development. As such, the presence of these patches of remnant vegetation are considered to hold some local importance to the movement of species that are able to successfully move between them.

The proposal would result in a reduction of roadside native and exotic vegetation in the study area, contributing to increased habitat fragmentation.

Edge effects on adjacent native vegetation and habitat

The dominant weeds found within the study area are Ground Asparagus (*Asparagus aethiopicus)*, African Olive (*Olea europaea* subsp. *cuspidate)* and Lantana (*Lantana camara)*. These species are readily spread by existing dispersal factors such as birds and water.

Clearing and opening of new vegetation edges has the potential to facilitate the recruitment of these species and may facilitate the establishment of other weed species in native and exotic vegetation, outcompeting native flora and fauna species, and further reducing habitat values of these areas. Movement of machinery and equipment during construction would also be a likely vector of weed species seeds and other propagules through soil and mulch movement.

Fauna injury and mortality

It is possible that the proposal would increase the likelihood of vehicle strike in the long-term due to the extra width of the road corridor that would require any fauna attempting a crossing to be within the path of traffic for longer.

Noise, light and vibration

During operation, new street lighting for the widened road corridor would increase lighting to new edges of vegetation and habitat, and for species that travel across the widened road. These new environmental conditions in the remaining vegetation can promote the growth of different plants and altered structure (including weeds), allow invasion by pest animals specialising in edge habitats or change the behaviour of resident animals (Moenting and Morris, 2006). Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators, having a long-term impact on sensitive species.

During operation and maintenance of the proposal, noise from vehicular use is expected to increase within the proposal area as it facilitates traffic flow and future growth in traffic volumes.

The long term operational impacts are likely to lead to increases in light, noise and vibration beyond the levels that are currently experienced by the local flora and fauna. These increases are not likely to be significant as the species present in the already urbanised area are likely to be already pre-

disposed to handle this and are unlikely to suffer additional and significantly increased impacts beyond those that they are currently subject to.

Runoff

Runoff from the new bridge road surface would impact on water quality if pollutants (e.g., hydrocarbons, gross rubbish) enter the aquatic environment. The new bridge would be designed such that pavement runoff would be captured and conveyed to the land-based drainage network which provides for a level of treatment via bioretention.

Operational impacts associated with soil and water aspects such as contamination, acid sulfate soils, groundwater and management of hazardous substances are not considered significant and can be effectively minimised through additional investigation, the development and implementation of construction environmental management plan.

Conclusion on significance of impacts

The proposal is not likely to significantly impact threatened species or ecological communities or their habitats, within the meaning of the *Biodiversity Conservation Act 2016* or *Fisheries Management Act 1994* and therefore a Species Impact Statement or Biodiversity Development Assessment Report is not required.

The proposal is not likely to significantly impact threatened species, ecological communities or migratory species within the meaning of the EPBC Act.

6.9.4 Biodiversity offsets

Roads and Maritime is committed to offsetting impacts associated with the proposal in line with its biodiversity offsetting guidelines (Roads and Maritime, 2016) and in general accordance with the OEH principles for the use of biodiversity offsets in NSW.

Roads and Maritime would provide biodiversity offsets or, where offsets are not reasonable or feasible, supplementary measures for impacts that exceed the thresholds in the following table.

Table 6-59: Summary of the Roads and Maritime Services Biodiversity Offset Guidelines

Description of activity or impact	Consider offsets or supplementary measures
Activities in accordance with Roads and Maritime Services Environmental assessment procedure: Routine and Minor Works (RTA 2011)	No
Works on cleared land, plantations, exotic vegetation where there are no threatened species or habitat present	No
Works involving clearing of vegetation planted as part of a road corridor landscaping program (this includes where threatened species or species comprising listed ecological communities have been used for landscaping purposes)	No
Works involving clearing of national or NSW listed critically endangered ecological communities (CEEC)	Where there is any clearing of an CEEC in moderate to good condition

Description of activity or impact	Consider offsets or supplementary measures
Works involving clearing of nationally listed threatened ecological community (TEC) or nationally listed threatened species habitat	Where clearing >1 hectares of a TEC or habitat in moderate to good condition
Works involving clearing of a NSW listed endangered or vulnerable ecological community	Where clearing > 5 hectares or where the ecological community is subject to an SIS
Works involving clearing of NSW listed threatened species habitat where the species is a species credit species as defined in the OEH Threatened Species Profile Database (TSPD)	Where clearing > 1 hectares or where the species is the subject of an SIS
Works involving clearing of NSW listed threatened species habitat and the species is an ecosystem credit species as defined in OEH's Threatened Species Profile Database (TSPD)	Where clearing > 5 hectares or where the species is the subject of an SIS
Type 1 or Type 2 key fish habitats (as defined by NSW Fisheries)	Where there is any net loss of habitat

In accordance with the above thresholds, offsets would be required for the proposal for net loss of Type 1 key fish habitat (seagrass). Table 6-60 provides an assessment for offsetting of impacts of the proposal for vegetation communities. No offsets are required with regard to threatened species.

Table 6-60: Impacts on vegetation communities (ecosystem credits)

PCT Code	PCT Name	EEC	Area (ha)	Meets RMS Biodiversity Offsetting Guideline (2016) thresholds?
1206	Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion	No	2.09	No
1236	Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion	Yes	0.09	No
	Seagrass (*Zostera muelleri*) which constitutes Type 1 or Type 2 key fish habitat	No	0.09	Yes

Offsetting impacts on fish habitat

In accordance with the Roads and Maritime Guidelines for Biodiversity Offsets (v2.0), biodiversity offsets should be considered where there is any clearing of Type 1 or Type 2 key fish habitat (as defined by NSW DPI). As discussed, the area of seagrass within the construction footprint is classified as Type 1 key fish habitat. This aligns with NSW DPI Policy and Guidelines for Fish Habitat Conservation and Management (2013 update), which enforces a 'no net loss' of key fish habitat as a permanent condition of development approval.

If impacts (direct and indirect) to seagrass are unavoidable, they are to be offset by environmental compensation. This may require proponents to conduct habitat rehabilitation and/or provide environmental compensation. NSW DPI does not allow seagrass transplanting as an impact compensation measure. Therefore, if seagrass is likely to be impacted and cannot be avoided or minimised, financial compensation would be required.

The standard compensation rate is listed as $51/m^2, however, for seagrass and other Type I and II fish habitat, the DPI Policy requires an offset compensation ratio of 2:1. Therefore a nominal compensation amount of $102/m^2 is likely to apply. Habitat compensation (e.g., mangroves) may be negotiated as a component of the offset package in addition to financial compensation, and would be calculated on a minimum 2:1 basis for all key fish habitat types (Types 1-3). A greater compensation ratio may be required if opportunities for compensation are not available in the vicinity of, or of the type of, habitat that has been lost. The offset requirements would be provided by NSW DPI as a condition to a permit to harm marine vegetation.

6.9.5 Safeguards and management measures

Impact	Mitigation measures	Responsibility	Timing	Reference
General biodiversity	A Flora and Fauna Management Plan (FFMP) will be prepared as part of the CEMP. The FFMP will be prepared in accordance with the Roads and Maritime Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011) (Biodiversity Guidelines) and Section 4.8 of Roads and Maritime QA Specification G36 Environment Protection and G40 Clearing and Grubbing. The FFMP will include, but not be limited to: • Pre-clearing process • Management of unexpected species finds • Delineation of exclusion zones • Process for weed management • Process for pathogen management • Requirements set out in the *Landscape Guideline* (RTA, 2008).	Construction Contractor	Pre-construction	Project specific control
Removal of native vegetation	Native vegetation removal would be minimised through detailed design.	Designer	Detailed design	Project specific control

Impact	Mitigation measures	Responsibility	Timing	Reference
Impacts on fauna	Pre-clearing surveys will be undertaken in accordance with *Guide 1: Pre-clearing process* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Pre-construction	Project specific control
Removal of native vegetation	Vegetation removal will be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Construction	Project specific control
Removal of native vegetation	Native vegetation will be re-established in accordance with *Guide 3: Re-establishment of native vegetation* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Constriction / Post construction	Project specific control
Threatened flora and fauna	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) if threatened species and ecological communities, not assessed in the biodiversity assessment, are identified in the proposal site.	Construction Contractor	Construction	Project specific control
Removal of vegetation	A mulch management plan will be prepared in accordance with the mulch order 2016 under the *Protection of the Environment Operations Act 1997* (POEO Act)	Construction Contractor	Pre-construction	Project specific control
Removal of EEC	Exclusion zones will be placed around retained EECs in accordance with Guide 2: Exclusion Zones.	Construction Contractor	Pre-construction	Project specific control
Removal of aquatic habitat	Removal of aquatic habitat (seagrass) will be minimised through detailed design.	Designer	Pre-construction	Project specific control

Impact	Mitigation measures	Responsibility	Timing	Reference
Removal of threatened species habitat and habitat features	Habitat will be replaced or re-instated in accordance with *Guide 5: Re-use of woody debris and bushrock* and *Guide 8: Nest boxes* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Construction	Project specific control
Aquatic habitat impacts	Aquatic habitat will be protected in accordance with *Guide 10: Aquatic habitats and riparian zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) and Section 3.3.2 *Standard precautions and mitigation measures* of the *Policy and guidelines for fish habitat conservation and management Update 2013* (DPI (Fisheries NSW) 2013).	Construction Contractor	Construction	Project specific control
Aquatic habitat impacts	DPI (Fisheries) will be consulted with regard to the need for a permit to harm marine vegetation	Construction Contractor	Construction	Project specific control
Changes to hydrology	Changes to existing surface water flows will be minimised through detailed design.	Designer	Detailed design	Project specific control
Injury and mortality of fauna	Fauna will be managed in accordance with *Guide 9: Fauna handling* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Construction	Project specific control
Invasion and spread of weeds	Weed species will be managed in accordance with *Guide 6: Weed management* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Construction	Project specific control
Invasion and spread of pathogens and disease	Pathogens will be managed in accordance with *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Construction	Project specific control

Impact	Mitigation measures	Responsibility	Timing	Reference
Noise, light and vibration	Shading and artificial light impacts will be minimised through detailed design.	Designer	Detailed design	Project specific control

6.10 Water quality

A soil and water assessment covering construction and an operational water quality assessment have been prepared for the proposal. These are provided in Appendix K and Appendix L respectively, and are summarised in the following sections.

6.10.1 Methodology

The water quality impacts of the proposal were assessed by:

- Reviewing existing information from databases, websites, reports and other sources of information including:
  - Shoalhaven City Council water quality monitoring results (SCC, 2018)
  - Estuary health report card (OEH, 2011)
  - Sydney Catchment Authority (SCA, 2011) 'State of the Science – Catchment Impacts' report
  - NSW Government, Department of Primary Industries, Office of Water, Realtime data (NSW DPI, 2018)
  - Bureau of Meteorology (BoM)
  - Kuginis *et al*. (2012) in the Groundwater Dependent Ecosystems Atlas (BoM 2017)
- Consideration of the construction activities and ongoing operational activities associated with the proposal
- Carrying out one round of water quality monitoring within the study area in December 2017
- Carrying out a Phase 1 contamination investigation for the study area
- Assessment of impacts on receiving water quality with reference to trigger values for each indicator relevant to typical NSW water quality objectives for estuaries
- Quantitative assessment of the performance of operational water quality treatment measures.

6.10.2 Existing environment

Surface water

The Shoalhaven River catchment consists of an area of 7000 square kilometres. Land uses within the catchment include grazing (28 per cent), private conservation (34 per cent), other public usage (17 per cent), and an urban land use (six per cent) associated with Nowra, Bomaderry and Braidwood. Transport corridors for road and rail are included in the urban land use areas.

Sensitive environmental features within the study area include sea grass beds, the surface water dependent ecosystem of Bomaderry Creek and Shoalhaven River, hollow bearing trees adjacent to Bridge Road and Scenic Drive intersections, mudflats and mangroves. The Shoalhaven River is classified as a Type 1 highly sensitive key fish habitat and Class 1 major fish habitat.

Water quality monitoring carried out by Shoalhaven City Council between 2000 to 2012 in the proposal study area found that the water within the Shoalhaven River has:

- Good to excellent water quality index rating
- Dissolved oxygen levels (per cent saturation) ranging between 70 and 110 (good)
- Faecal coliform counts generally below relevant ANZECC 2000 Guidelines for swimming
- Phosphorus levels below ANZECC 2000 Guidelines
- Total nitrogen levels below ANZECC 2000 Guidelines.

The Estuary Health Report Card prepared by Shoalhaven City Council and OEH in 2011 provides a 'B' Rating for turbidity just to the east of the study area.

The Shoalhaven City Council monitoring data within Bomaderry Creek, near the confluence with the Shoalhaven River found the water quality has:

- Medium to good water quality index
- Dissolved oxygen levels (per cent saturation) of about 140 (poor)
- Faecal coliform counts above ANZECC 2000 Guidelines for swimming
- Phosphorus levels below ANZECC 2000 Guidelines
- Total nitrogen levels below ANZECC 2000 Guidelines.

A single round of surface water quality monitoring was undertaken at nine locations within the study area in December 2017 (refer Figure 6-12). This indicated that metals (arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury), total petroleum hydrocarbons, total residual hydrocarbons, benzene, toluene, ethylbenzene and xylene, total nitrogen, chemical oxygen demand, and biological oxygen demand, were all below analytical detection limits (and therefore ANZECC 2000 Guidelines).

In summary, the water quality of the Shoalhaven River is generally good. Detailed water quality results and discussion are provided in Appendix K and Appendix L.

Groundwater

There is no existing documented data relating to groundwater quality within the study area, however there are six registered groundwater bores in proximity to the study area.

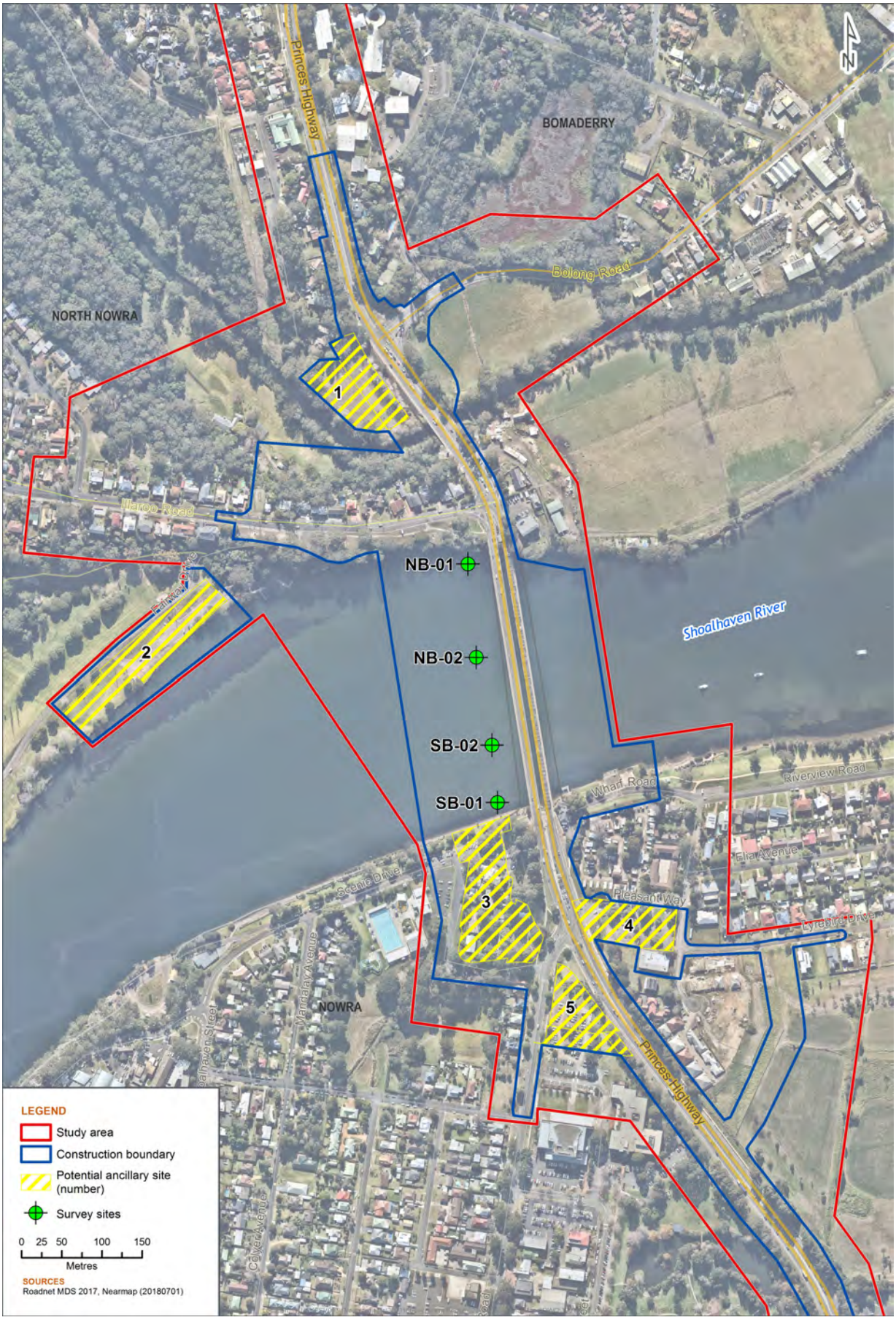

Figure 6-11: Water and sediment sample collection locations

6.10.3 Potential impacts

Construction

Surface water

The construction footprint drains to and includes the Shoalhaven River and Bomaderry Creek. As a result, ground disturbance works, vegetation clearing works and pier construction pose sedimentation risks to water quality within the study area.

Construction activities associated with the highest risk to water quality include:

- Ground disturbance work including excavation, filling and piling (on land and in water)
- Stripping vegetation and topsoil including the removal of riparian vegetation
- Stockpiling topsoil, excavated material, vegetation wastes and other construction materials
- Earthworks movements, haul roads and lay down yard boundaries including vehicle and plant movements on exposed surfaces
- Culverts and drainage outlets
- Pavement removal
- Piling and construction activities associated with the piers in the river
- Working with concrete over water on bridge deck or piles
- Oil, fuels and other chemical spills and leaks from vehicles, plant and equipment, incorrect storage or incorrect usage.

Potential impacts on water quality in receiving surface waters from sedimentation and erosion include:

- Degraded water quality due to increased sedimentation which may result in direct impacts such as reduction in light penetration (limiting the growth of macrophytes), clogging fish gills, alter stream geomorphology, smothering of benthic organisms and reduced visibility for fish
- Increased levels of turbidity, nutrients, metals and other pollutants, transported via sediment reducing overall water quality
- Potential for pH change in receiving waters from alkaline runoff from curing concrete.

In the absence of formal Water Quality Objectives (WQO) for the Shoalhaven River, the impacts of the project have been assessed against typical NSW water quality objectives for estuaries, including the protection of aquatic ecosystems, visual amenity, secondary contact recreation, primary contact recreation and aquatic foods (cooked). The impacts of the proposal have been determined with reference to trigger values for each indicator relevant to these water quality objectives. These trigger values are consistent with the equivalent environmental values in the ANZECC 2000 Guidelines.

The WQO assessment considered impacts for physical parameters such as pH, salinity, turbidity, nutrients, and chlorophyll-α. It was concluded that while construction activities would have the potential to impact on water quality, the risk of these impacts would be effectively managed through implementation of proven controls and management practices, and the residual impacts were anticipated to be minor.

Groundwater

Significant groundwater inflows are considered unlikely to be encountered during earthworks. Only minor groundwater ingress is expected during piling for bridge construction.

Operation

Surface water

Operation of the proposal is not likely to lead to a significant change in water quality within the Shoalhaven River or Bomaderry Creek.

Vehicles travelling along roads contribute to the build-up of contaminants and gross pollutants on road surfaces, gutters, median areas, and roadside corridors. During rain events, these may be transported via stormwater drainage into receiving waterways impacting water quality, with the greatest relative impacts occurring after prolonged dry periods.

Potential operational water quality impacts would be associated with:

- Discharge of stormwater runoff from the new bridge and approaches to the Shoalhaven River and to Bomaderry Creek
- Large spills of hazardous substances from traffic incidents on the bridge and approaches involving vehicles transporting hazardous substances (e.g. fuel tankers); if the spilt hazardous substance entered the Shoalhaven River or Bomaderry Creek, it could have significant environmental impacts.

The WQO assessment considered impacts for physical parameters such as pH, salinity, turbidity, nutrients, and chlorophyll-α. It was concluded that the proposal was not likely to lead to a significant change in existing water quality within the Shoalhaven River or within Bomaderry Creek.

Existing southbound bridge

Removal of vehicle traffic from the existing southbound bridge would reduce risks to water quality through removal of the principal contributor to contaminants affecting water quality.

Existing northbound bridge

There are no proposed changes to the existing stormwater drainage on the existing northbound bridge, and pavement drainage would continue to discharge directly through the scuppers in the bridge deck. Accordingly, no change in impact is anticipated.

New northbound bridge

The new northbound bridge would incorporate pavement drainage to capture runoff and direct it to land-based treatment facilities, these being a grassed stormwater basin/swale on the northern side of the Shoalhaven River and a water quality treatment basin on the southern side. Both treatment facilities would contain bioretention soil media with underlying subsoil pipes discharging to the pipe outfalls, both of which would include a catchpit overflow mechanism. Inclusion of these treatment facilities as part of the proposal would reduce the volume of pollutants reaching the Shoalhaven River, contributing to improved water quality.

The approach to water quality treatment in the concept design has considered the *Water sensitive urban design guideline* (Roads and Maritime, 2017). A preliminary quantitative assessment, using the MUSIC software modelling package, has been carried out to assess the performance of the water quality treatment devices incorporated into the current drainage design with reference to the objectives specified in Table 4 in the guideline. The results are presented in the following table.

Table 6-61: Water quality modelling results for Build vs Build with mitigation

Parameter	Existing	Build	Build with mitigation	Reduction (%)	WSUD objective (%)
Total Suspended Solids (kg/yr)	20,500	25,500	16,800	34.0	85
Total Phosphorus (kg/yr)	34.9	42.9	31.4	26.7	65
Total Nitrogen (kg/yr)	142	175	137	21.7	45
Gross pollutants (kg/yr)	1390	1650	1020	38.4	-

The modelling used four catchments as follows (moving north to south):

- North – comprising the section of the proposal to the north of the southern end of Bomaderry Creek bridge (no treatment provided)
- North 2 – comprising the section of the proposal from the southern end of Bomaderry Creek bridge to about the middle of the new northbound bridge (treatment provided)
- South – comprising the section of the proposal from about the middle of the new northbound bridge to the northern side of the Bridge Road intersection (treatment provided)
- South 2 – comprising the section of the proposal to the south of Bridge Road, and including Scenic Drive (no treatment provided).

The modelling also took a conservative approach assuming all catchment were 100 per cent impervious.

The results presented in the table show that while there would be a reduction for all parameters modelled, the current design would not meet the objectives of the guideline. This is due mainly to no treatment facilities being provided for two of the four catchments used in the model (North, South 2). On an individual catchment basis, however, the following is noted for the two catchments where treatment is provided:

- The northern section of the new bridge (North 2 catchment) is currently performing at over 95 per cent removal of total suspended solids (TSS); this meets the WSUD objective so no further mitigation is required for this catchment
- The southern section of the new bridge (South catchment) is currently performing at around 80 percent removal of TSS which is under the WSUD objective of 85 per cent.

The Princes Highway and Bolong Road intersection area (North catchment) is currently not provided with any operational controls and is contributing about one third of the pollutant load. Subject to the final acquisition area, there may be an opportunity to provide grass swales on one or both sides of the Princes Highway to improve performance.

The Bridge Road / Scenic Drive sub-catchment located within catchment South 2 is contributing the majority of the TSS load from this catchment. Rehabilitation of the ancillary site to the immediate north of this location may allow provision of a grassed swale in this area to improve performance.

The drainage design would be reviewed during detailed design to assess whether there are opportunities to further optimise water quality treatment to meet the water sensitive urban design (WSUD) objectives. Specific opportunities are identified in Section 6.10.4.

Widened Bomaderry Creek bridge

Widening of this bridge would include reconfiguration of the bridge drainage. Pavement runoff from the bridge deck would be captured as gutter flow against the kerb and conveyed to a piped network where it would be directed to a discharge point near the intersection of Princes Highway and Bolong Road, about 100 metres to the north of Bomaderry Creek.

Groundwater

Given the extent of the existing urbanised area, the change in impervious area is considered minor in comparison to the large area available for recharge in the catchment. The potential impact to groundwater via surface infiltration is considered low based on the limited information available during the preparation of the REF.

6.10.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Water quality	A Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the CEMP. The SWMP will identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction. The SWMP will contain as a minimum the following elements: • Site specific Erosion and Sedimentation Control Plans (ESCPs), including detailed consideration of staging and management at ancillary sites, in accordance with the Blue Book • Identification of site conditions or construction activities that could potentially result in erosion and associated sediment runoff • Methods to minimise potential adverse impacts of construction activities on the water quality within surrounding waterways • Details of measures to minimise any adverse impacts of sedimentation on the surrounding environment • Details of measures to minimise soil erosion caused by all construction works including clearing, grubbing and earthworks • Details of measures to make site personnel aware of the requirements of the SWMP by	Construction Contractor	Pre-construction	Section 2.1 of QA *G38 Soil and Water Manageme nt*

Impact	Environmental safeguards	Responsibility	Timing	Reference
	providing information within induction, toolbox and training sessions • Details of the roles and responsibilities of personnel responsible for implementing the SWMP • Details of measures for the inspection and maintenance of construction phase water treatment devices and structures • Details of water quality monitoring • Detailed construction methodology and environmental work method statement for the proposed bridge works and creek realignment within Shoalhaven River and Bomaderry Creek to minimise the potential for bank instability, scour, flooding, working over water and other adverse impacts of construction activities on the water quality. • The SWMP will be reviewed by a soil conservationist on the Roads and Maritime list of Registered Contractors for Erosion, Sedimentation and Soil Conservation Consultancy Services. The SWMP will be revised as required to address the outcomes of the review.			
Water quality	A site ESCP will be prepared and implemented as part of the SWMP. The ESCP will include arrangements for managing wet weather events, including monitoring of potential high risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather. Development of the ESCP will take into consideration: • Provision of sediment basins • Temporary surface drainage line controls • Bridge deck and bridge piles working with over water and alkaline waste water management	Construction Contractor	Pre-construction	Section 2.2 of QA *G38 Soil and Water Manageme nt*

Impact	Environmental safeguards	Responsibility	Timing	Reference
	• Over water sediment controls including: • Silt fences along areas of the foreshore that have been cleared • Silt curtains encompassing construction areas disturbing or releasing river bottom sediments (eg piling) • Silt booms surrounding barges to ensure leaks /spills are contained.			
Water quality	The SWMP will identify the position of an on-site environmental representative to complete self-audits and monitor implementation of the SWMP.	Construction Contractor	Pre-construction / Construction	Project specific control
Water quality	In the event of significant groundwater inflows, undertake further assessment and consultation with DPI (Water) in relation to any licencing requirements.	Construction Contractor	Construction	Project specific control
Water quality	During detailed design implement best practice WSUD measures to provide dissipation of flows and prevent gross pollutants and contaminants entering the study area's waterways. WSUD measures are designed to provide treatment of nutrients and suspended solids prior to discharge to the existing receiving environment. Detailed design will take into consideration Roads and Maritime Water Sensitive Urban Design Guidelines.	Designer	Detailed design	Project specific control
Water quality	During detailed design, review the drainage design to identify and evaluate opportunities to meet the WSUD water quality objectives, including consideration of: • Improvements to the design of the southern basin to achieve better performance • Inclusion of grass swales on both sides of the highway in the vicinity of Bolong Road (subject to the acquisition area) • Provision of a grassed swale as part of rehabilitation of the ancillary site adjacent to Bridge Road / Scenic Drive.	Designer	Detailed design	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
Water quality	Surface water quality monitoring will be undertaken prior to construction to establish baseline water quality and regularly during construction so that any impacts from the proposal construction phase can be identified and addressed. Sampling locations and monitoring methodology will be determined as part of the CEMP, but as a minimum will be undertaken upstream and downstream of creek crossings and in accordance with the Guideline for Construction Water Quality Monitoring (Roads and Maritime, 2003).	Roads and Maritime Construction Contractor	Pre-construction Construction	Project specific control
Water quality	Bulk storage of fuels or chemicals should be located greater than 100 metres from any watercourse or mapped EEC. In constrained areas where criteria cannot be achieved, additional risk assessment and additional mitigation measures may need to be considered and implemented to manage risk to sensitive receivers to an acceptable level.	Construction Contractor	Construction	Project specific control
Water quality	Vehicles and machinery will be properly maintained to minimise the risk of fuel/oil leaks.	Construction Contractor	Construction	Project specific control
Water quality	An Emergency Spill Plan will be developed and incorporated in the CEMP. This will include measures to avoid spillages of fuels, chemicals, and concrete wash or fluids into any waterways.	Construction Contractor	Construction	Project specific control
Water quality	The storage, handling and use of fuels or chemicals will be undertaken in accordance with the *Occupational Health and Safety Act 2000* and WorkCover's Storage and Handling of Dangerous Goods Code of Practice (WorkCover, 2005).	Construction Contractor	Construction	Project specific control
Water quality	If any dewatering or other activities which will impact the local groundwater system are proposed, consultation with the DPI (Water) will be undertaken to determine the requirements for water extraction licenses and approvals.	Construction Contractor	Construction	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
Water quality	Minimise direct and indirect impacts to riparian vegetation.	Designer Construction Contractor	Detailed design Construction	Project specific control

6.11 Soils

A soils and water assessment has been prepared for the proposal. The assessment is provided in Appendix K and summarised in the following sections.

6.11.1 Methodology

Assessing impacts on soils within the study area generally involved the following:

- Review of existing publicly available information from databases, websites, reports and other sources of information including:
  - Soil landscape mapping
  - Geological series sheets
  - New South Wales Natural Resource Atlas
  - Shoalhaven LEP 2014
- Developing a general understanding of construction activities and ongoing operational activities associated with the proposal
- Conducting a Phase 1 environmental site assessment (ESA) to characterise contaminated land issues and risks within the study area.

6.11.2 Existing environment

Regional geology

A review of the 1:100,000 Geological Series Sheet for Kiama map indicates that the study area is on Nowra Sandstone and undifferentiated formation. The Nowra Sandstone comprises medium to coarse grain quartz sandstones, minor siltstones and conglomerate beds. The landscape is characterised by moderately to gently undulating rises to undulating low hills with relief less than 40 metres and slopes below five per cent. The majority of the area has been extensively to moderately cleared with stands of tall open-forest. The topsoil generally has a low erodibility, however the subsoils have a high erodibility.

Undifferentiated formation comprises alluvium, gravel, sand, silt and clay. This formation occurs in on both the northern and southern banks of the Shoalhaven River crossing, as well as the crossing of Bomaderry Creek.

Soil landscapes

A review of the Soil Landscapes of the Kiama 1:100 000 Sheet (Hazelton, 1992) indicates that the study area occurs on the Shoalhaven and Nowra Soil landscapes.

The Shoalhaven landscape is associated with the river bed, banks and undulating terrace surfaces, active floodplain with levees and backwater swamps on alluvium. Levees are moderate deep prairie soils, terraces red earths and Yellow and Red Podzolic Soils. The floodplains are alluvial soils and Gleyed Podzolic Soils. Key soil constraints are flood hazard, seasonal waterlogging, permanently high water table, hard setting, acid sulfate potential, strong acid and sodicity.

The Nowra soil landscape is associated with moderately to gently undulating rises to low hills on Nowra Sandstone. Key features include benched sandstone outcrops adjacent to drainage lines and extensive to moderately cleared tall open-forest. Crests and upper slopes consist of moderately deep Brown Podzolic Soils. Lower slopes and drainage lines consist of Soloths and/or Yellow Earth.

Key soil constraints include rock outcrops, shallow soil, stoniness, low permeability and low wet bearing strength.

Contaminated land

The Phase 1 ESA identified:

- Residential and agricultural land use prior to1949
- Former gasworks facility in operation in adjacent land in the early 1900s (EPA regulated site)
- Two major road alignments include the Bolong Road intersection (circa 1960) and Princes Highway widening at the northern and southern approaches and second road bridge across Shoalhaven River (circa 1980).
- Agricultural land progressively redeveloped to residential and commercial land uses.
- Eight potential areas of environment concern (AEC):
  - Bomaderry substation (AEC 1)
  - Agricultural paddocks, road verges, public open space (parks) and localised residential garden areas (AEC 2)
  - Fill materials (AEC 3)
  - Former and current structures (AEC 4)
  - Existing southbound bridge (AEC 5)
  - Acid sulfate soils (ASS) and sediments (AEC 6)
  - Former gas works, including down-gradient impacted areas within Harry Sawkins Park (AEC 7)
  - Road pavement (coal tar) and buried utility conduits and service pits (asbestos containing) material, ACM) (AEC 8).

The AECs are shown in Figure 6-13 and Figure 6-14.

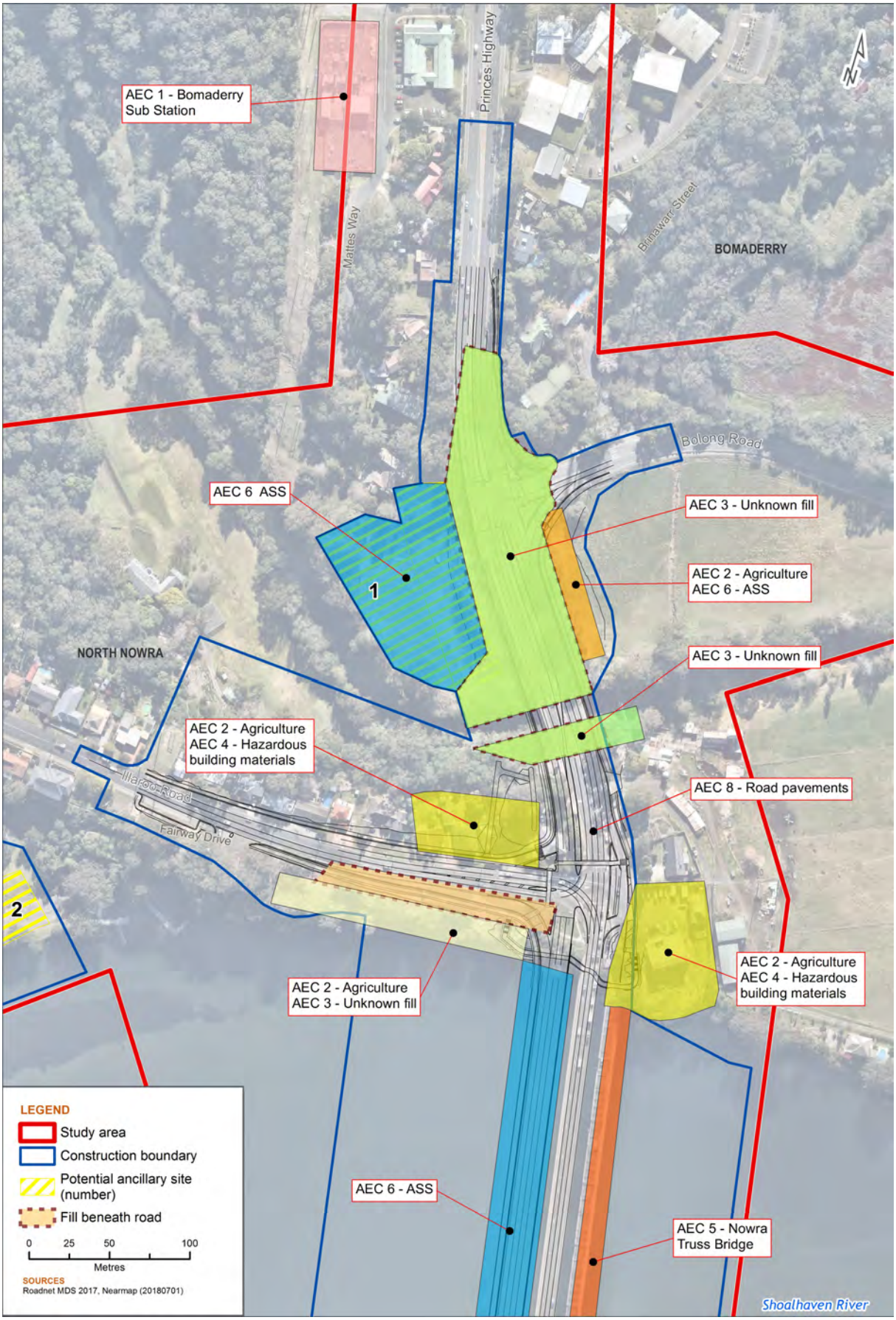

Figure 6-12: Areas of environmental concern – North

Figure 6-13: Areas of environmental concern – South

Table 6-62 provides the risk summary criteria developed to assess the AEC's. An assessment of the risk impact for each AEC from construction of the proposal was carried out based on the likely scale of contamination activities, proximity to construction/operational footprint and expected construction activities.

Table 6-62: Risk rating criteria for AECs

Risk rating	AEC risk assessment criteria
Low	Low potential of residual soil and/or groundwater contamination to exist within the extent of the proposal footprint. Low probability of engaging any potential contaminated land associated with identified AEC due to extent of proposed works.
Moderate	Moderate potential of residual soil and/or groundwater contamination to exist within the proposal footprint. Contaminated soil and / or groundwater associated with identified AEC may be engaged due to the extent of the proposed works.
High	High potential of some level of residual soil and/or groundwater contamination to exist within the extent proposal footprint. Contaminated soil and / or groundwater associated with identified AEC are likely to be engaged due to the extent of the proposed works. Further investigations recommended

A summary of the AECs identified as having a moderate to high potential for contamination is provided in the following table.

Table 6-63: AECs within the study area with moderate to high potential for contamination

AEC	Comment
3	• Fill of unknown origin and quality appears to have been placed widespread throughout the existing road alignment with a moderate potential for soil contamination • Fill embankments were observed at various depths, typically deepest near the approach to existing bridge structures and within the northern and central southern zones adjacent to low lying floodplains
4	• Former and current structures has also been identified as moderate to high potential for soil contamination given the age of existing or former residential properties (circa 1960s) within the alignment • There is a potential for residual localised contaminated soil may be encountered during demolition works • Residential properties potentially contain surface soil or uncontrolled fill impacted by asbestos, domestic waste and other hazardous materials
5	• There is a high potential for lead-based paint having been used (circa 1980s) during historic maintenance of the existing southbound bridge; this has since been removed however residual lead paint would remain in difficult to access parts of the structure • A low potential for soil contamination residues is considered within near surface soils beneath/surrounding these features.

AEC	Comment
6	• There is a high potential for ASS north of the Bomaderry Creek crossing (east and west of the Princes Highway) where Bolong Road meets the Princes Highway and for sediments within the Shoalhaven River and Bomaderry Creek • There is low potential for ASS to occur within the majority of the southern portion of the proposal.
8	• The existing road pavements within the study area have a medium to high potential to contain coal tar, noting this was common practice prior to 1987 • The main highway easement has a moderate to high potential of asbestos containing materials in road assets like service conduits and communication pits, noting that construction materials containing asbestos were still used until 1986

There are no known previous investigations that undertook groundwater sampling within the proposal area. At a primary level, a moderate potential for groundwater contamination is assessed within two areas of environmental concern; AEC 1 Bomaderry substation (localised impacts) and/or AEC 7 Former gas works including Harry Sawkins Park (more widespread). Groundwater contamination at these locations within/adjacent to the study area is considered to have a low potential to impact the proposal based on the proximity to actual construction/operational extent of the proposal and the low likelihood for engaging groundwater. A low potential for widespread groundwater contamination is assessed in remaining AECs.

The Phase 1 ESA identified the area of concern as posing a moderate to high potential for soil contamination, including potential contaminants:

- Total recoverable hydrocarbons (TRH)
- Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX)
- Polycyclic aromatic hydrocarbons (PAH)
- Phenols
- Organophosphorus (OPP) and Organochlorine Pesticides (OCP)
- Polychlorinated biphenyls (PCBs)
- Heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc)
- Asbestos containing materials (ACM)
- Ammonia and cyanide (potentially in groundwater)
- Hazardous materials (lead paint, synthetic mineral fibres).

Acid sulfate soils

While not regarded as contaminated land, ASS have been identified within relevant areas of environmental concern. ASS within the study area include:

- A high probability of ASS within sediments is mapped in the Shoalhaven River and Bomaderry Creek
- A high probability of ASS (occurring at elevations between one to two metres AHD) is mapped in the northern zone within the low lying floodplain
- A low probability of ASS (occurring at elevations between two to more than four metres AHD) is mapped within central northern, central southern and southern zones.

The areas of ASS risk are shown in Figure 6-15.

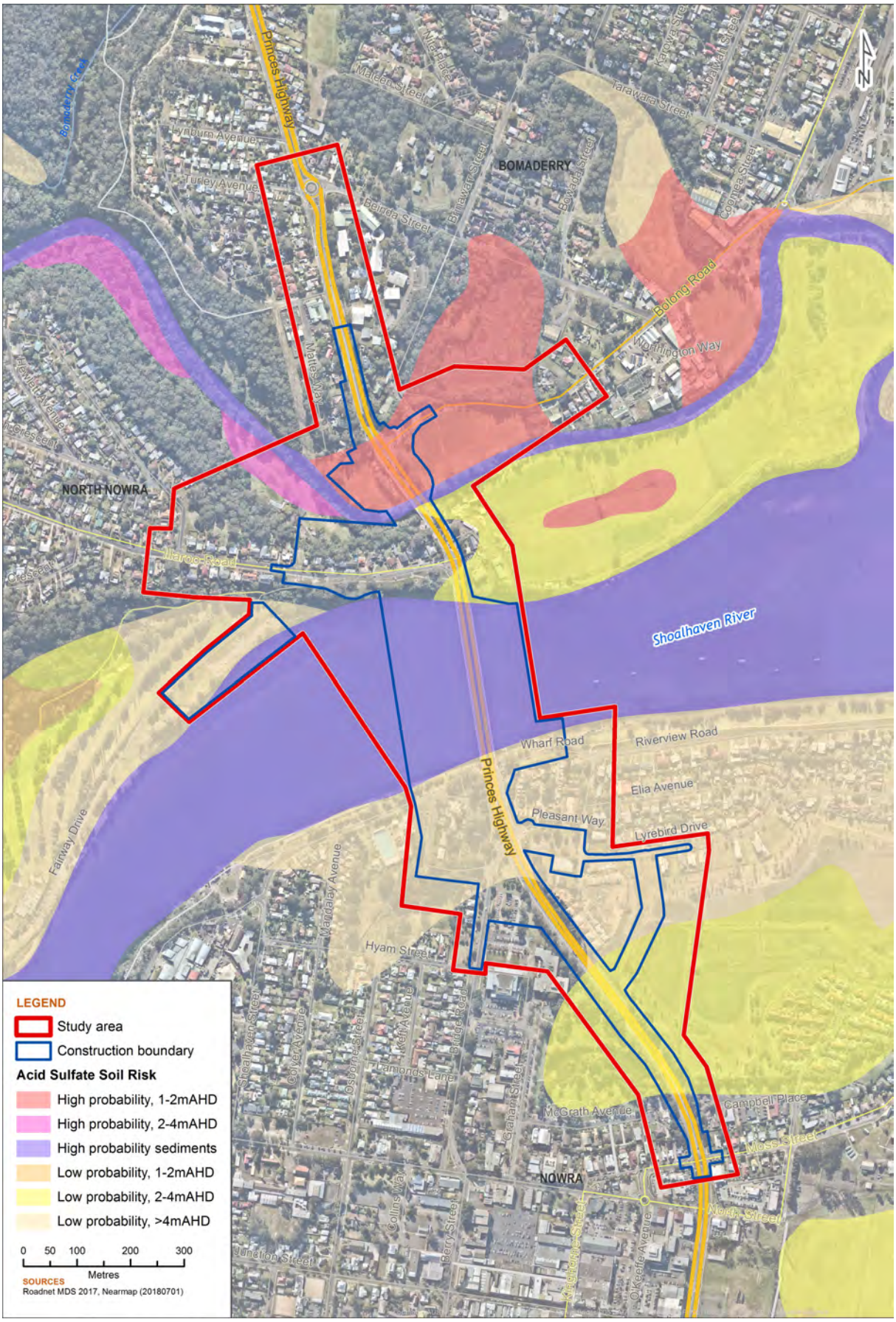

Figure 6-14: Acid sulfate soil risk

River sediments

Sediment sampling undertaken as a part of the Phase 1 ESA indicated:

- The shallow portion of the river is dominated by sand
- Deeper change on the northern bank is dominated by fine particles
- Metals and metalloids, PAH, TPH, BETW were all below ANZECC (2000) sediment quality guidelines.

The following table provides a summary of sediment physical and chemical attributes.

Table 6-64: Sediment physical and chemical attributes

Parameter / Site	SB-01	SB-02	NB-02	NB-01	Guideline
Soil Classification					
Per cent fines (< 75 µm)	2	<1	1	77	N/A
Per cent sand (>75 µm)	95	94	99	23	N/A
Per cent sand (>75 µm)	95	94	99	23	N/A
Per cent cobbles (> 6 cm)	<1	<1	<1	<1	N/A
Per cent moisture	44.9	30.0	64.8	35.7	N/A
pH	7.6	7.8	7.9	7.6	N/A
Per cent organic matter	1.8	<0.5	5.6	<0.5	N/A
Per cent total organic carbon	1.0	<0.5	3.2	<0.5	N/A
Metals / Metalloids (mg/kg)					
Arsenic	<5	<5	11	<5	20-70^
Cadmium	<1	<1	<1	<1	1.5-10^
Chromium	7	6	20	8	80-370^
Copper	<5	<5	24	<5	65-270^
Lead	6	<5	20	8	50-220^
Nickel	8	7	17	10	21-52^
Zinc	27	20	77	28	200-410^
Mercury	<0.1	<0.1	<0.1	<0.1	0.15-1^
Petroleum hydrocarbons / Derivatives					
Total PAH	<0.5	<0.5	<0.8	<0.5	4000-45000^
TPH	<10	<10	<10	<10	N/A
BTEX	<0.2	<0.2	<0.2	<0.2	N/A

* ANZECC / ARMCANZ Interim Sediment Quality Guidelines (ISQG)

^ ISQG-Low (trigger value) to ISQG-High

Available data suggests that sediment quality of the Shoalhaven River is generally good, with little influence from urbanised pollution, and some influence from weather events (e.g., floods) which may cause temporary fluctuations. Note that the sediment sample data presented in this report is indicative only. The data is representative of one sampling event and does not account for spatial and temporal variations, or replication.

6.11.3 Potential impacts

Construction

Erosion and sedimentation

The construction activities would include excavation, earth moving and vegetation clearing. As a result, the potential impacts to soils include elevated risk of soil erosion from the exposed earth at:

- Bridge abutments and piers over land or water
- Road embankments and cut faces
- Haul road and lay down yard boundaries
- Works on the northern bank
- Culverts and drainage outlets.

Acid sulfate soils

There is potential for ASS to be encountered during construction. Disturbance of potential acid sulfate soils (PASS) is most likely to occur during construction activities associated with the bridges over Shoalhaven River and Bomaderry Creek. This includes construction of bridge piles, bridge abutments and excavation for drainage structures.

Acid leachate runoff has the potential to be generated if the handling and management of ASS material including excavation, loading, transportation and storage and stockpiling is not properly managed. Other impacts associated with disturbance of ASS may occur during excavation and dewatering activities. Disturbance or poor management of ASS has the potential to result in generation of low pH waters (surface and groundwater) which may result in the following impacts:

- Sulfuric acid generation leading to heavy metal leaching both of which have terrestrial and aquatic ecological impacts, including fish disease, kills, loss of food resource, reduced fish migration and recruitment potential, disturbance to water plant communities and secondary effects on water quality and potential human health risks
- Reduced land and soil conditions, potentially inhibiting growth of vegetation and land productivity, agricultural impacts and land quality degradation
- Soil structure degradation and loss (including infrastructure instability)
- Loss of infrastructure integrity (i.e. corrosion).

Contaminated land and hazardous materials

Construction activities would involve the use of plant and equipment, excavation works potentially uncovering areas of contaminated land and temporary stockpiling of cleared vegetation. Potential impacts on soils include:

- Contamination from vehicle wash down areas
- Contamination from the incorrect management of vehicle refuelling

- Contamination from the incorrect storage of fuel, chemical and material storage
- Tannin leachate from clearing, mulching and stockpiling (if any) impacting biological oxygen demand in receiving waters.

The risk of disturbing any existing contamination would be highest at road cuttings. Conversely, in areas of fill (embankments), the proposal would be unlikely to increase the risks associated with any site contamination and the placement of fill would also act as a barrier to future exposure and disturbance of contamination.

The risk of disturbing any existing hazardous materials would be highest near the existing southbound bridge, structures proposed for demolition, and relocation/adjustment of buried utility conduits and service pits.

Potential environmental impacts associated with construction activities include:

- Increasing waste volumes from excavated (potentially contaminated) materials
- Mobilisation of contaminated sediments via surface runoff into stormwater systems, potentially affecting water quality in receiving waters
- Adverse effects on human health (construction personnel, public pedestrians or nearby residential/commercial land use communities)
- Surface water runoff from identified AECs may potentially impact groundwater and surface water quality, and if not appropriately managed, potential pollutants in fill or near surface soils may reach perched groundwater or surface water bodies.

The risks of these impacts would be low with the implementation of the mitigation measures as outlined in Section 6.11.4.

Operation

There is a low potential for sedimentation and erosion impacts during the operational phase of the proposal. The road and footpath areas would be paved and any disturbed areas (such as embankments and road verges) would be revegetated and stabilised.

The proposal has a low potential for ASS impacts during operation. There would be no permanent change to the water table in the areas identified as areas containing ASS.

The proposal has a low potential for contaminated land impacts during operation. This would be further assessed and subject to the findings of Phase 2 contamination assessments.

Accidental spillage of hazardous materials or dangerous goods, without appropriate containment, could pass into the drainage system and impact receiving waterways and ecosystems.

The likelihood of a potential spill of hazardous substances such as fuels and oils from traffic incidents would be reduced because of the proposal and improved road design standards. The local topography would be changed through the upgrade of the local road network, intersections and bridge abutments.

6.11.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Contaminated land	A Contaminated Land Management Plan will be prepared in accordance with the	Construction Contractor	Pre-construction	Section 4.2 of QA *G36*

Impact	Environmental safeguards	Responsibility	Timing	Reference
	Guideline for the Management of Contamination (Roads and Maritime, 2013) and implemented as part of the CEMP. The plan will include, but not be limited to: • Capture and management of any surface runoff contaminated by exposure to the contaminated land • Further investigations required to determine the extent, concentration and type of contamination, as identified in the detailed site investigation (Phase 2) • Management of the remediation and subsequent validation of the contaminated land, including any certification required • Measures to ensure the safety of site personnel and local communities during construction.			*Environment Protection*
Contaminated land	If contaminated areas were encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. All other works that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed and any necessary site-specific controls or further actions identified in consultation with the Roads and Maritime Environment Manager and/or EPA.	Construction Contractor	Construction	Section 4.2 of QA *G36 Environment Protection*
Accidental spill	A site specific emergency spill plan will be developed, and include spill management measures in accordance with the Roads and Maritime *Code of Practice for Water Management* (RTA, 1999) and relevant EPA guidelines. The plan will address measures to be implemented in the event of a spill, including	Construction Contractor	Pre-construction	Section 4.3 of QA *G36 Environment Protection*

Impact	Environmental safeguards	Responsibility	Timing	Reference
	initial response and containment, notification of emergency services and relevant authorities (including Roads and Maritime and EPA officers).			
Acid sulfate soils	During geotechnical investigations, soil sampling and testing for ASS parameters will be carried out in areas of proposed ground disturbance where there is a low to high probability of encountering PASS/ASS. Assessment of the presence/absence of ASS will be made with reference to NSW *Acid Sulfate Soils Assessment Guidelines* (ASSMAC,1998).	Designer	Detailed design	Project specific control
Acid sulfate soils	During detailed design, the preferred management strategy for PASS/ASS is to avoid its disturbance wherever possible. Where disturbance of PASS/ASS is unavoidable, preferred design strategies are: • Minimisation of disturbance which may include avoiding/ minimising impact on areas with high levels of sulfides, limiting disturbances so that only shallow disturbances occur and minimising groundwater fluctuations. • Neutralisation with lime • Hydraulic separation of sulfides from the sediment either on its own or in conjunction with dredging • Strategic reburial (re-interment) where material can be permanently placed in anaerobic conditions, for example covered by water and compacted soil to keep it wet and free of oxygen. Other management measures may be considered during construction stage but must not pose unacceptably high risks.	Designer	Detailed Design	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
Acid sulfate soils	An ASS Management Plan (ASSMP) will be prepared to identify procedures for mitigation and management of known PASS/ASS areas during construction stage. The ASSMP will include details on: • Identification of specific areas where PASS/ASS are required to be managed • Determine liming rates for neutralisation of PASS/ASS within each area • Details on appropriate construction staging and methods used in relation to PASS/ASS on site • Specific mitigation measures to prevent disturbance of and/or acid generation from PASS/ASS to manage and control environmental issues • Procedures for handling, treatment (including acid neutralisation), containment and disposal of PASS/ASS associated with proposed excavation activities at the site. • Additional testing will be required during construction to determine liming rates relevant to each area of ASS that will be disturbed. The plan will be prepared in general accordance with NSW *Acid Sulfate Soils Assessment Guidelines* (ASSMAC,1998).	Construction Contractor	Pre-construction	Project specific control
Hazard and risk management	A Hazard and Risk Management Plan (HRMP) will be prepared and implemented as part of the CEMP. The HRMP will include, but not be limited to: • Details of hazards and risks associated with the activity • Measures to be implemented during construction to minimise these risks	Construction Contractor	Pre-construction	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
	• Record keeping arrangements, including information on the materials present on the site, material safety data sheets, and personnel trained and authorised to use such materials • A monitoring program to assess performance in managing the identified risks • Contingency measures to be implemented in the event of unexpected hazards or risks arising, including emergency situations. The HRMP will be prepared in accordance with relevant guidelines and standards, including relevant Safe Work Australia Codes of Practice, and EPA or Office of Environment and Heritage publications.			
Hazardous materials	A Hazardous Materials (HAZMAT) survey will be carried out to assess the potential for lead-based paints and/or asbestos containing materials including: • Structures identified for demolition • Known buried utilities and service pits • A Hazmat Register will identify the location of all known or suspected hazardous materials. Risk assessments will be carried out to quantify and control potential exposure to human and ecological receptors during construction.	Designer	Detailed Design	Project specific control
Hazardous materials	A Hazardous Materials Management Plan applying to known areas of asbestos contamination / other hazardous materials will be developed in accordance with the Roads and Maritime Procedure Asbestos	Construction Contractor	Pre-construction	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
	Related Work No. 066P25 (Roads and Maritime, 2013).			
Hazardous materials	Any works requiring asbestos removal should be carried out in accordance with an Asbestos Removal Control Plan prepared in accordance with the relevant published guidelines and codes of practice: • Code of Practice. How to safely remove asbestos in the workplace (SafeWork NSW, 2016a) • Code of Practice. How to manage and control asbestos in the workplace (SafeWork NSW, 2016b) • Roads and Maritime Procedure Asbestos Related Work No. 066P25 (Roads and Maritime, 2013). Prior to works, notifications to SafeWork NSW will be carried out by the appropriate licensed asbestos removal contractor. At the completion of the asbestos removal, clearance certificates will be issued to the contractor confirming the effectiveness of asbestos removal.	Construction Contractor	Construction	Project specific control
Hazardous materials	An unexpected finds protocol will be employed if previously unidentified asbestos contamination is discovered during construction. Work in the affected area will cease immediately, and an investigation must be undertaken and report prepared to determine the nature, extent and degree of the asbestos contamination. The level of reporting must be appropriate for the identified contamination in accordance with Guidelines for Consultants Reporting on Contaminated Sites (OEH, 2011), any relevant SafeWork NSW codes of practice and include the proposed	Construction Contractor	Construction	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
	methodology for the remediation of the asbestos contamination. Works may only recommence upon receipt of a validation report from a suitably qualified contamination specialist that the remediation activities have been undertaken in accordance with the investigation report and remediation methodology.			
Sedimentation and erosion	During detailed design, the potential impacts associated with bridge construction and operation will be further considered to minimise the likelihood of bank instability and scouring, flow alteration and potential increased risk of flooding. The design and construction methodologies should, wherever possible, minimise direct and indirect impacts to riparian vegetation, and implement best practice water sensitive urban design (WSUD) measures to provide dissipation of flows and prevent gross pollutants and contaminants entering the study area's waterways.	Designer	Detailed Design	Project specific control

6.12 Waste management

Roads and Maritime is committed to ensuring the responsible management of unavoidable waste and promotes the reuse of such waste in accordance with the resource management hierarchy principles outlined in the *Waste Avoidance and Resource Recovery Act 2001*. These resource management hierarchy principles, in order of priority are:

- Avoidance of unnecessary resource consumption in operations, maintenance, construction and management
- Resource recovery (including reuse, reprocessing, recycling and energy recovery)
- Disposal.

By adopting the above principles, Roads and Maritime aims to efficiently reduce resource use, reduce costs, and reduce environmental harm in accordance with the principles of ecologically sustainable development, as outlined in Section 8.2 of this REF.

6.12.1 Potential impacts

The proposal has the potential to generate waste from the following activities:

- Clearing of vegetation
- Earthworks for constructing the bridge approaches and intersection upgrades
- Structural works for the new northbound bridge and abutments, and for widening of Bomaderry Creek bridge
- Utility adjustments
- Demolition waste such as concrete, steel, and asphalt from the removal of the existing Bomaderry Creek bridge and sections of highway, and material from the removal of existing buildings and road furniture.

Waste streams associated with construction of the proposal would likely include:

- Excess spoil
- Contaminated spoil
- Green waste from clearing of vegetation
- Surplus construction materials that could not be reused such as form work and small quantities of concrete
- Roadside materials (fencing, guide posts, guard rails etc.)
- Packaging and general waste from staff (lunch packaging, portable toilets etc.)
- Chemicals and oils
- Wastewater from wash-down and bunded areas
- Redundant erosion and sediment controls.

The potential to reuse all materials would be further investigated during detailed design and construction planning. Unsuitable fill material and all other wastes would be classified in accordance with the NSW EPA Waste Classification Guidelines (2014) and disposed of to an appropriately licensed facility.

6.12.2 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Waste management - general	A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to: • Measures to avoid and minimise waste associated with the project • Classification of wastes and management options (re-use, recycle, stockpile, disposal) • Statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • Procedures for storage, transport and disposal • Monitoring, record keeping and reporting. The WMP will be prepared taking into account the Environmental Procedure - Management of Wastes on Roads and Maritime Services Land (Roads and Maritime, 2014) and relevant Roads and Maritime Waste Fact Sheets.	Construction contractor	Pre-construction	Project specific control
Waste management - general	All wastes will be managed and disposed of in accordance with the POEO Act.	Construction contractor	Construction	Project specific control
Waste management - general	Noxious weeds removed during construction will be managed in accordance with Department of Primary Industries requirements and relevant legislation.	Construction contractor	Construction	Project specific control
Waste management - general	Site inductions will include waste management and disposal requirements and facilities.	Construction contractor	Construction	Project specific control
Waste management - general	Appropriate portable toilets with either pump out facilities or sewer connections will be provided for site personnel and sewage will disposed of appropriately and in accordance with relevant legislation.	Construction contractor	Construction	Project specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
Fill material	Excavated material will be reused on site where feasible and suitable for the intended reuse to reduce demand on resources. Where excavated material cannot be used on site, opportunities for reuse on nearby projects will be investigated.	Construction contractor	Construction	Project specific control
Fill material	Any required additional fill material will be sourced from appropriately licensed facilities and/or other construction projects wherever possible. Additional fill material will be sourced and verified as suitable for use in accordance with relevant EPA and Roads and Maritime guidelines.	Construction contractor	Construction	Project specific control
Green waste	Where practicable and suitable for use, cleared vegetation will be mulched for use on site.	Construction contractor	Construction	Project specific control
Disposal of waste	Excavated material will be reused on-site where feasible and suitable for the intended reuse to reduce demand on resources. Where excavated material cannot be used on site, opportunities for reuse on nearby projects will be investigated.	Construction contractor	Construction	Project specific control
Disposal of waste	All waste will be disposed of to an appropriate licensed facility.	Construction contractor	Construction	Project specific control
Management of tannins	A tannin leachate management protocol will be developed in accordance with Roads and Maritime' Environmental Direction – Management of Tannins from Vegetation Mulch (Roads and Maritime, 2012) to manage the stockpiling of mulch and use of cleared vegetation and mulch filters for erosion and sediment control	Construction contractor	Construction	Project specific control

6.13 Air quality

6.13.1 Air quality criteria

Air quality criteria are used to access the potential for ambient air quality to give rise to adverse health or nuisance effects. Emissions from construction plant and vehicles have the potential to impact on local air quality. The emissions of most interest for motor vehicles are:

- Oxides of nitrogen (NO_x)
- Carbon monoxide (CO)
- Particulate matter (PM_{10}).

Construction activities would also generate dust and other particulate matter. There are various classifications of particulate matter, with the OEH providing assessment criteria for:

- Total suspended particulates
- Particulate matter (PM_{10} and $PM_{2.5}$)
- Deposited dust.

Air quality standards are contained in the 2016 National Environment Protection (Ambient Quality) Measure. The following table summarises the criteria which are relevant to the proposal.

Table 6-65: Criteria for relevant air pollutants

Pollutant	Averaging time	Criterion
Particulate matter – PM_{10}	24 hours	50 µg/m^3
	Annual	25 µg/m^3
Particulate matter – $PM_{2.5}$	24 hours	25 µg/m^3
	Annual	8 µg/m^3
Nitrogen dioxide – NO_2	24 hours	120 µg/m^3
	Annual	30 µg/m^3
Carbon monoxide	8 hours	10 µg/m^3

6.13.2 Existing environment

There are no OEH air quality monitoring stations in the proposal study area or the region, with the nearest station being at Albion Park South about 35 kilometres to the northeast and which is located in a similar coastal setting. Air quality data for 2017 for the Albion Park air quality monitoring station (OEH, 2017) showed:

- PM_{10} concentrations were below both daily and annual criteria (44.6 µg/m^{3,} 15.3 µg/m^3 respectively)
- $PM_{2.5}$ concentrations were below both daily and annual criteria (19.3 µg/m^{3,} 6.6 µg/m^3 respectively)
- No days above the national standards.

The annual NSW compliance report for 2016 for the National Environment Protection (Ambient Air Quality) Measure (State of NSW / OEH, 2018) identifies the annual average concentration of NO2 as 0.004 ppm or 4 µg/m^3 which is well below the annual average criterion.

Based on the above air monitoring results, air quality for the region is considered good.

A search of the National Pollutant Inventory (Department of Environment and Energy, 2018) for the Shoalhaven LGA identified four air pollutant sources from 1999 to 2014 including, petroleum product wholesaling, other basic chemical plant manufacturing and log saw milling. These are unlikely to have substantial air emissions.

Motor vehicles on the Princes Highway and local road network are a significant source of local emissions. Other sources include rural activities and domestic wood-fire heaters.

Climate data for the study area is available from the Bureau of Meteorology station located at the Royal Australian Navy base at Nowra (station number 068076). Climate data for the locality is summarised as follows:

- Annual average rainfall is 1133.1 millimetres, with the highest average monthly rainfall of about 124.4 millimetres occurring in March.
- Annual mean maximum temperature is 21.3 degrees, with January and February being the warmest months with a mean maximum temperature 25.8 degrees (for both months). The coolest month is July, with a mean minimum and maximum temperature of 6.2 degrees and 15.8 degrees respectively.

6.13.3 Potential impacts

Construction

Construction activities may have short-term localised impacts on air quality associated with:

- Clearing of vegetation
- Stripping, stockpiling and managing of topsoil
- Earthworks and excavation giving rise to potential emissions of airborne dust, especially in dry and windy conditions
- Road sub-grade preparation and road pavement work
- Transport and handling of soil and materials
- Use of construction vehicles and plant, and their associated exhaust emissions
- Spray painting of the road for line marking
- Demolition activities.

The principal air quality impact associated with construction activities would be the generation of dust affecting the amenity of receivers in proximity to construction works. Generally, these impacts would be minor, however, more substantial dust generation could result in health impacts to nearby receivers. Air quality impacts due to dust generation are considered to be minor as they would be limited to the construction phase only, and would be minimised through the implementation of established safeguards and management measures. Management of dust emissions would be undertaken to ensure that relevant criteria are met at sensitive receivers during construction.

Construction vehicles plant and vehicles emit exhaust fumes. The impact of these emissions would be localised and limited to the duration of the construction phase. There would be potential for

odour generation associated with the laying of asphalt and with line marking. These would be relatively short term in duration and impacts would be minor.

Overall, potential air quality impacts during construction would be short-term and minor, and effectively managed through appropriate safeguards and management measures listed in Section 6.13.4.

Operation

There is not expected to be any material change in air quality impacts from the existing situation. While the proposal would shift emission sources slightly to the east, it is anticipated this would have negligible impact on receivers and the environment.

The proposal would have the net effect of adding one additional traffic lane to the Shoalhaven River crossing, potentially increasing traffic use and emissions. However, the proposal would also contribute to reduced congestion through this section of the Princes Highway, in turn contributing to reduced levels of emissions at most times, particularly outside of peak holiday periods.

The proposal would remove the constraints for overheight and HML vehicles associated with the existing southbound bridge. This would contribute to reducing emissions at a regional level associated with these types of vehicles using alternative routes.

6.13.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Construction impacts on air quality	An Air Quality Management Plan (AQMP) will be prepared and implemented as part of the CEMP. The AQMP will include, but not be limited to: • Potential sources of air pollution • Air quality management objectives consistent with any relevant published EPA and/or OEH guidelines • Mitigation and suppression measures to be implemented • Methods to manage work during strong winds or other adverse weather conditions • A progressive rehabilitation strategy for exposed surfaces.	Construction Contractor	Pre-construction	Section 4.4 of QA *G36 Environment Protection*
Dust emissions	Work will cease when levels of visible airborne dust become excessive.	Construction Contractor	Construction	Project-specific control
Dust emissions	Works that disturb vegetation, soil or stockpiles will not be carried out during winds over 40 km/h when this may affect receivers.	Construction Contractor	Construction	Project-specific control

Impact	Environmental safeguards	Responsibility	Timing	Reference
Dust emissions	Stockpiled materials will be covered stabilised or stored in areas not exposed to high winds.	Construction Contractor	Construction	Project-specific control
Dust emissions	All trucks will be covered when transporting materials to and from the site.	Construction Contractor	Construction	Project-specific control

6.14 Climate change and sustainability

6.14.1 Existing environment

Climate change

Climate change is the general term used to refer to the higher temperatures and altered climatic conditions associated with the accumulation of greenhouse gases in the atmosphere. These have the potential to impact on both existing and new road infrastructure. In 2014, OEH published climate change projections as part of the NSW and ACT Regional Climate Modelling (NARCliM) project. The study included projections for two future 20 year time periods: 2020-2039 as the near future and 2060-2079 as the far future. The study included the analysis of over 100 climate variables, including temperature, rainfall and wind.

A brief overview of projected changes in key climate variables is provided as follows.

Temperature

The Illawarra region is projected to continue to warm in the near future and far future. The projected increase is about 0.6 °C in the near future, increasing to about 1.9 °C in the far future. The number of hot days is expected to increase with fewer frost potential days. This is line with other areas of NSW.

Projected temperatures for the region are as follows:

- Maximum temperatures to increase in the near-future by 0.4 to 0.9 °C
- Maximum temperatures to increase in the far-future by 1.6 to 2.3 °C
- Minimum temperatures to increase in the near-future by 0.4 to 0.7 °C
- Minimum temperatures to increase in the far-future by 1.5 to 2.4 °C.

Related to these projections, the number of hot days will increase while the number of cold nights will decrease (OEH, 2014).

Hot days and extreme heat

Heatwaves are a significant hazard in Australia. They are defined by consecutive stretches of hot days compared to ‘normal’ conditions. With both mean temperatures and the frequency of hot days projected to increase, the occurrence of heatwaves is also projected to occur more often and last longer. Heatwave projections are provided for intensity, frequency and duration.

Heatwave intensity is projected to increase across NSW in both near and far-future scenarios. Heatwave frequency is projected to increase by an extra 1 to 1.5 heatwave events per year in the near-future, and by 2.4 to 4.5 events per year in the far-future. Heatwave duration is projected to increase by 1.5 to 3.5 more days in the near-future, and by 2 to 11 days in the far-future (OEH, 2014).

Rainfall and storms

Extreme rainfall events are often associated with damaging storms, and can cause riverine and flash flooding. Rainfall extremes (intensity and duration) are projected to increase in both the near- and far-future.

Projected rainfall changes for the region are for rainfall to decrease in winter and to increase in summer and autumn. Projected changes in seasonal rainfall are shown in the following table.

Table 6-66: Projected changes in seasonal rainfall

Season	Near future	Far future
Summer	-20% to +21%	-12% to +40%
Autumn	24% to +33%	-13% to +50%
Winter	-21% to +14%	-39% to +35%
Spring	-25% to +13%	-18% to +19%

Roads and Maritime Climate Change Plan

Roads and Maritime has developed a Climate Change Plan to manage the impacts of climate change. The plan includes actions to:

- Reduce Roads and Maritime's carbon footprint
- Contribute to reducing the carbon footprint of NSW road transport
- Adapt the Road and Maritime road transport system to the impacts of climate change
- Manage Road and Maritime's transition to a low carbon economy.

Roads and Maritime also reports its greenhouse gas emissions and direct energy consumption annually to OEH in accordance with the NSW Government *Sustainability Policy*. The annual report includes information on greenhouse gas emissions from energy usage associated with the operation of Roads and Maritime properties, street lighting, traffic signals, and vehicles.

6.14.2 Potential impacts

Construction

Construction activities would generate greenhouse gas emissions associated with:

- Release of stored carbon dioxide from clearing of vegetation (decomposition of cleared vegetation)
- Carbon dioxide and nitrous oxide from liquid fuel use in plant, barges and vehicles (diesel, petrol) during construction, disposal and transport of materials
- Use of materials such as concrete that have high embodied energy content
- Methane from landfilling any carbon based waste, and possible fugitive emissions from the use of natural gas
- On-site electricity usage.

Construction materials and the operation of construction equipment would be the main emissions sources during construction. Vegetation removal can result in an increase in carbon dioxide in the atmosphere through removal of the mechanism for sequestration in plants and the soil.

Operation

During operation the proposal may reduce overall vehicle emissions through an increased efficiency of the road network resulting in reduced congestion and travel times. Predicted traffic growth may result in an increase in vehicle emissions, however this increase would occur regardless of whether the proposal proceeds and is not a direct result of the proposal. Improved efficiency in vehicles

movements would contribute to offsetting any such increase in emissions. Minimal emissions are expected during maintenance activities associated with the proposal.

Potential impacts of climate change on the proposal

Changes in rainfall patterns and the frequency of severe weather events may increase the risk of erosion and sediment loss from areas of exposed soil during construction. These may also disrupt construction activities lengthening the duration of construction. Over the longer term, increased maximum temperatures and an increase in the number of days of extreme temperatures may detrimentally affect the integrity of built elements of the proposal such as the resistance of the pavement to wear.

The proposal could be impacted by projected sea level rise and flooding which are related to climate change. Hydrology and flooding are discussed in Section 6.6, and include consideration of climate change on changes to the flood regime.

6.14.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Greenhouse gas emissions	The use of alternative fuels and power sources for construction plant equipment will be investigated and implemented, where appropriate	Contractor	Pre-construction	Project-specific control
Greenhouse gas emissions	The energy efficiency and related carbon emissions will be considered in the selection of vehicle and plant equipment	Contractor	Pre-construction	Project-specific control
Greenhouse gas emissions	Construction equipment, plant, and vehicles will be appropriately sized for the task	Contractor	Construction	Project-specific control
Greenhouse gas emissions	Equipment will be serviced frequently to ensure they are operating efficiently	Contractor	Construction	Project-specific control
Greenhouse gas emissions	Where possible, materials will be delivered as full loads and local suppliers would be used	Contractor	Construction	Project-specific control

6.15 Cumulative impacts

6.15.1 Study area

The cumulative impact assessment has considered other known or approved developments and proposed works within the Nowra Bomaderry area and programs of works on the Princes Highway on the NSW South Coast.

The Nowra Key Road Projects report prepared by Shoalhaven City Council in 2017 identified 13 key road projects required in the Nowra-Bomaderry area over the next 20 years.

The report identified that there are two programs of upgrades required prior to the construction of the Nowra Bridge Project including:

- Implementing a range of smaller projects that enable the Princes Highway between Moss Vale Road intersection and the bridge to continue operating effectively once the Berry to Bomaderry Upgrade is completed
- A number of short and medium term projects with the potential to address operational efficiency issues with the highway south of the bridge including impacts around Bridge Road, the increased number of traffic lights through central Nowra and the existing pinch point at Kalandar Street.

6.15.2 Broader program of work

The proposal is part of a broader program of work to widen and upgrade the Princes Highway on the NSW South Coast. The proposal would represent another section of highway work within the Shoalhaven LGA over the last 10 years. The projects outlined below have been announced and would potentially overlap with the construction of the proposal.

Albion Park Rail Bypass

The Albion Park Rail Bypass is a 9.8 kilometre extension of the Princes Highway between Yallah and Oak Flats that would bypass the suburb of Albion Park Rail. The project would form part of the Princes Highway upgrade program that seeks to improve road safety and efficiency. The project forms one of the last remaining sections of the Princes Highway to be upgraded and will complete the missing link of a high standard road between Sydney and Bomaderry.

Construction of the project is expected to start in the first half of 2019 with the first stage taking about 15 months to complete, and with construction of the whole project taking about five years. Subject to construction of the Nowra Bridge proposal commencing in early 2021, this would overlap with construction of the Albion Park Rail Bypass project. However, given the latter is about 58 kilometres to the north of Nowra, the cumulative construction and operational impacts on traffic would likely be low.

Berry to Bomaderry upgrade

The upgrade would provide about 10.5 kilometres of four-lane highway with median separation between Mullers Lane, Berry and Cambewarra Road, Bomaderry. Major construction would begin in late 2018.

Should construction of the Berry to Bomaderry upgrade not be completed prior to the anticipated start of the Nowra Bridge proposal in early 2021, there would likely be impacts on traffic from Berry to south of Nowra, extending journey times. With regard to operation, the cumulative effect of both proposals would be expected to be beneficial to traffic, contributing to shorter journey times along

this section of the Princes Highway. The upgrades would also be expected to contribute to improved road safety.

The Berry to Bomaderry upgrade and the Nowra Bridge proposal are developments removing fragmented roadside habitats amongst urban or cleared rural landscapes and so loss of current connectivity is minimal; however, both projects are removing associated native vegetation. The following table presents the cumulative impacts on native vegetation as a result of both proposals.

Table 6-67: Cumulative biodiversity impact of Berry to Bomaderry upgrade and the Nowra Bridge proposal

Biodiversity aspect	Status	Approved and proposed clearing requirements for local projects in the IBRA Subregion common to this proposal (ha)		Sum of Impact (ha)
		Princes Highway Upgrade - Berry to Bomaderry	Nowra Bridge	
Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion / Currambene-Batemans Lowlands Forest	Not an EEC	1.44	2.09	3.53
Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion	EEC	0	0.09	0.09

Batemans Bay Bridge replacement

The Batemans Bay Bridge replacement includes a new four lane bridge to the west of the existing bridge and removal of the existing bridge. The proposal would improve access to Batemans Bay and surrounding areas, allow access for larger trucks, reduce traffic delays and improve the intersection of the Kings and Princes Highways. The new Batemans Bay Bridge would take around two years to build. Construction is expected to start in early 2019 and work completed by mid-2021. The existing bridge would then be demolished.

There may be an overlap in construction periods of about 12 months, however, given Batemans Bay is about 120 kilometres further south on the Princes Highway, the likelihood of cumulative impacts is considered low. Similarly the likelihood of cumulative operational impacts is considered low to negligible.

Far North Collector Road

The Australian Government announced an allocation of $13.8 million dollars for the construction of the Far North Collector Road in the 2017 Budget. This link is critical to the future development of Nowra in the urban release areas west of Bomaderry. It would provide access to North Nowra and alleviate some of the traffic issues on Illaroo Road by potentially providing an alternative route during construction of the Nowra Bridge project .The Far North Collector Road was included in the adopted Nowra Bomaderry Structure Plan to mitigate impacts of the Moss Vale Road urban release areas on Moss Vale Road and the Princes Highway. It defers but does not replace the need for a

North Nowra link road in future. The approved funding profile outlines a delivery timeframe of about four years, with survey and land acquisition planned to start in 2018-19 (subject to Australian Government funding being released)

The construction periods for this proposal and the Nowra Bridge proposal overlap by about two years. However, the Far North Collector Road would largely be a 'greenfields' project and not affect traffic. The tie-in of the Far North Collector Road proposal to Illaroo Road is about 2.85 kilometres from the extent of works for the Nowra Bridge proposal. The likelihood of cumulative impacts with regard to construction is considered low. From an operational point of view, the Far North Collector Road would provide an alternative route for traffic wishing to travel north, reducing demand on the Illaroo Road intersection.

North Nowra Link Road

This proposal would link Illaroo Road to Moss Vale Road. Shoalhaven City Council's originally preferred North Nowra Link Road project (linking Pitt Street in North Nowra to Narang Road in Bomaderry) was not supported by the NSW Department of Planning due to the impacts on rare and threatened species in the Bomaderry Creek Regional Park. Instead, the Department of Planning recommended that options on the northern and southern fringe of the Regional Park be further investigated. The Joint Regional Planning Panel (JRPP) considered the recommendations of Department of Planning and subsequently approved the northern link road option to continue to detailed design.

For several reasons Council did not proceed to further progress the Northern Link Road option, and instead decided to bring forward the construction of the Far North Collector Road. In view of this, it is considered unlikely that there would be any cumulative impacts of this proposal and the Nowra Bridge proposal.

East Nowra Sub Arterial

The East Nowra Sub Arterial (ENSA) would commence in the Nowra CBD at North Street and Junction Street, and continue south to meet Greenwell Point Road at the intersection of Old Southern Road. This proposal is intended to reduce congestion on the Princes Highway by providing access between the Nowra CBD and the growing East Nowra / Worrigee residential area by way of accessing a direct signalised highway crossing. At the time of preparation of this REF, no specific date had been announced for construction (expected to take about 18 months).

The proposed ENSA is located on the southern side of the Shoalhaven River and, similar to the Far North Collector Road, would largely be a 'greenfields' project. Should construction of two proposals overlap, there could be minor cumulative construction impacts on traffic associated with tie-in works to the Princes Highway. From an operational perspective, the highway tie-in is to the south of the proposal area; as such, the efficiency of traffic movement through the proposal area is unlikely to be affected, assuming the operation of the new set of traffic lights would be coordinated with others along this section of the Princes Highway.

6.15.3 Other projects and developments

Searches of the NSW Major Projects Register and Shoalhaven City Council's current capital works and works under investigation were undertaken on 16 May 2018 to identify any major developments within the Nowra-Bomaderry area. The results of the searches are presented in Table 6-68.

Table 6-68: Past, present and future projects

Project	Construction impacts	Operational impacts
Regeneration of Ulladulla Harbour Foreshore. Proposed completion September 2018. The works include large rocks being placed along a section of the bank to protect it from future storm damage.	Nil. Works associated with this project are outside the study area and are anticipated to be completed prior to commencement of works associated with the proposal.	Nil
Shoalhaven River Levee Rehabilitation Project – Terara and Comerong Island Timing: April to September 2018	Nil. Works associated with this project are outside the study area and are anticipated to be completed prior to commencement of works associated with the proposal.	Nil
24-28 Hawthorn Avenue subdivision	Proposal for medium density development of 32 dwellings Approved 6 March 2015, with a modified application approved 21 December 2016. The proposal has frontage onto Lyrebird Drive. The proposal is located within 400 m of the buffer zone.	Nil

6.15.4 Potential impacts

Environmental factor	Construction	Operation
Access and connectivity	Increased travel times and disruptions to motorists due to changed road conditions over multiple locations.	Improved road safety, travel time savings and improved travel reliability across the Princes Highway corridor.
Business and industry	Traffic delays and disruptions may discourage some people from using the Princes Highway or from making some trips, potentially impacting on tourism related businesses and destinations. Increased transportation costs to business and industry due to delays and disruptions to freight movements. Movement of oversize vehicles.	Improved access and connectivity to key freight hubs Reduced transportation costs for business and industry due to travel time savings and improved travel reliability. Improved access to for self-drive tourists and visitors to tourism attractions and destinations, impacting positively on tourism related businesses.
Community values	Changes to community perceptions about road safety due to presence of construction works and changes in road conditions.	Beneficial impacts for community cohesion associated with improved access and safer and more efficient travel to regional facilities and networks.

Environmental factor	Construction	Operation
Social structure	Changes to road conditions potentially discouraging some people from accessing some social infrastructure (for example, health and medical services). Impacts on emergency services access.	Improved access to social infrastructure for residents in the study area. Improved access for emergency services to communities and locations along the Princes Highway.
Biodiversity impacts	Construction of the proposal and the Berry to Bomaderry Upgrade would collectively remove 3.53 ha of the vegetation community (non-EEC) Spotted Gum-Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South-East Corner Bioregion / Currambene-Batemans Lowlands Forest.	Landscaping works and plantings for both proposal incorporate native species that would contribute to improved biodiversity values along these sections of the Princes Highway.

6.15.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Cumulative construction impacts	Ongoing coordination and consultation will be undertaken between the project teams on Albion Park Rail Bypass, Berry to Bomaderry upgrade, and Batemans Bay Bridge replacement to ensure cumulative traffic impacts are appropriately assessed and managed, particularly during peak holiday periods	Roads and Maritime / Construction Contractor	Pre-construction and construction	Project-specific control
Cumulative construction impacts	Consultation with Shoalhaven City Council will be undertaken regarding the Far North Collector Road to ensure cumulative traffic impacts are appropriately assessed and managed, particularly during peak holiday periods	Roads and Maritime / Construction Contractor	Pre-construction and construction	Project-specific control
Cumulative impacts	The CEMP will be reviewed regularly and revised as required to consider potential cumulative impacts of surrounding development activities as they become known.	Construction Contractor	Construction	Project-specific control

7. Environmental management

7.1 Environmental management plans (or system)

A number of safeguards and management measures have been identified in the REF in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the proposal. Should the proposal proceed, these safeguards and management measures would be incorporated into the detailed design and applied during the construction and operation of the proposal.

A Construction Environmental Management Plan (CEMP) will be prepared to describe the safeguards and management measures identified. The CEMP will provide a framework for establishing how these measures would be implemented and who will be responsible for their implementation.

The CEMP will be prepared prior to construction of the proposal and must be reviewed and certified by the Roads and Maritime Environment Manager prior to the commencement of any on-site works. The CEMP will be a working document, subject to ongoing change and updated as necessary to respond to specific requirements. The CEMP will be developed in accordance with the specifications set out in QA Specification *G36 – Environmental Protection (Management System)*, QA Specification *G38 – Soil and Water Management (Soil and Water Plan)*, QA Specification *G40 – Clearing and Grubbing*, and QA Specification *G10 – Traffic Management*.

7.2 Summary of safeguards and management measures

Environmental safeguards and management measures outlined in this REF will be incorporated into the detailed design phase of the proposal and during construction and operation of the proposal, should it proceed. These safeguards and management measures will minimise any potential adverse impacts arising from the proposed works on the surrounding environment. The safeguards and management measures are summarised in Table 7-1.

.

Table 7-1: Summary of safeguards and management measures

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
GEN1	General - minimise environmental impacts during construction	A CEMP will be prepared and submitted for review and endorsement of the Roads and Maritime Environment Manager prior to commencement of the activity. As a minimum, the CEMP will address the following: • Any requirements associated with statutory approvals • Details of how the project will implement the identified safeguards outlined in the REF • Issue-specific environmental management plans • Roles and responsibilities • Communication requirements • Induction and training requirements • Procedures for monitoring and evaluating environmental performance, and for corrective action • Reporting requirements and record-keeping • Procedures for emergency and incident management • Procedures for audit and review. The endorsed CEMP will be implemented during the undertaking of the activity.	Construction Contractor / Roads and Maritime project manager	Pre-construction / detailed design	Section 3 of QA *G36 Environment Protection*
GEN2	General - notification	All businesses, residential properties and other key stakeholders (e.g. schools, local councils) affected by the activity will be notified at least five days prior to commencement of the activity.	Construction Contractor / Roads and Maritime project manager	Pre-construction	Project specific control
GEN3	General – environmental awareness	All personnel working on site will receive training to ensure awareness of environment protection requirements to be implemented during the project.	Roads and Maritime project manager	Detailed design /	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		This will include up-front site induction and regular "toolbox" style briefings. Site-specific training will be provided to personnel engaged in activities or areas of higher risk. These include: • Areas of Aboriginal heritage sensitivity • Threatened species habitat • Adjoining residential areas requiring particular noise management measures.	Construction Contractor	Pre-construction	
Traffic and transport					
T1	Traffic and transport	A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Roads and Maritime *Traffic Control at Work Sites Manual* (RTA, 2010) and *QA Specification G10 Control of Traffic* (Roads and Maritime, 2008). The TMP will include: • Confirmation of haulage routes • Measures to maintain access to local roads and properties • Site specific traffic control measures (including signage) to manage and regulate traffic movement • Measures to maintain pedestrian and cyclist access • Requirements and methods to consult and inform the local community of impacts on the local road network • Access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads • A response plan for any construction traffic incident	Construction Contactor	Pre-construction	Section 4.8 of QA *G36 Environment Protection*

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Consideration of other developments that may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • Monitoring, review and amendment mechanisms.			
T2	Traffic and transport	Undertake consultation with local and regional bus companies prior to and during construction.	Construction Contactor	Pre-construction / Construction	Project specific control
T3	Traffic and transport	Undertake consultation with Shoalhaven City Council regarding potential impacts to parking during construction and operation.	Roads and Maritime	Pre-construction	Project specific control
T5	Traffic and transport	Undertake consultation with emergency services and Shoalhaven District Memorial Hospital before and during construction to confirm any diversions during construction.	Construction Contactor	Pre-construction / Construction	Project specific control
T6	Traffic and transport	Undertake consultation with property owners regarding changes to access arrangements. Targeted notification to affected residents and businesses will be conducted prior to the completion of altered local road connections, where road closures and detours are proposed.	Construction Contactor	Pre-construction / Construction	Project specific control
T7	Traffic and transport	Notifications will be issued to the local community regarding changes to pedestrian and cycle path access, diversions or alternative routes and any proposed changes to parking.	Construction Contactor	Pre-construction / Construction	Project specific control
T8	Traffic and transport	Schedule partial road closures to avoid peak holiday periods.	Construction Contactor	Construction	Project specific control
T9	Traffic and transport	Provide advance notification to the community where impacts to on-street and off-street parking is unavoidable.	Construction Contactor	Construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
T10	Traffic and transport	Obtain a Road Occupancy Licence where required.	Construction Contactor	Pre-construction / Construction	Project specific control
Noise and vibration					
NV1	Construction noise and vibration	A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the Interim Construction Noise Guideline (ICNG) (DECC, 2009) and identify: • All potential significant noise and vibration generating activities associated with the activity • Feasible and reasonable mitigation measures to be implemented, taking into account Beyond the Pavement: urban design policy, process and principles (Roads and Maritime, 2014) • A monitoring program to assess performance against relevant noise and vibration criteria • Arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures Contingency measures to be implemented in the event of non-compliance with noise and vibration criteria.	Construction Contractor	Detailed design / pre-construction	Section 4.6 of QA G36 Environment Protection
NV2	Construction noise	Where feasible, use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; and consideration of site topography when situating plant.	Construction Contractor	Construction	Project specific control
NV3	Construction noise and vibration	All sensitive receivers likely to be affected will be notified of construction impacts at least seven calendar days prior to the commencement of any works that may generate noise levels above the Noise	Construction Contractor	Pre-construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		Management Level or high vibration impacts. The notification will provide details of: • The project • The construction period and construction hours • Contact information for project management staff • Complaint and incident reporting • How to obtain further information.			
NV4	Out of hours work	Out of hours works will be carried out in accordance with the *Construction Noise and Vibration Guideline* (Roads and Maritime 2016).	Construction Contractor	Construction	Project specific control
NV5	Works with high noise levels	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise levels should be scheduled during less sensitive time periods, such as after 8.00 am and before 6.00 pm.	Construction Contractor	Construction	Project specific control
NV6	Construction respite periods	High noise generating activities near receivers should be carried out in blocks that do not exceed three hours each, with a minimum respite period of one hour between each block. The duration of each block of work and respite should be flexible to accommodate the usage and amenity at nearby receivers. Unless negotiated with the community with consultation documented and approved by Roads and Maritime project manager or permitted under the licence there should be no more than: • Two consecutive evenings or nights per week • Three evenings or nights per week; and • Six evenings or nights per month. For night work these periods of work should be separated by not less than one week.	Construction Contractor	Construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
NV7	Construction noise and vibration	Shield stationary noise sources such as pumps, compressors, fans, etc. Stationary noise sources should be enclosed or shielded where feasible and reasonable while ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.	Construction Contractor	Construction	Project specific control
NV8	Damage to structures	Attended vibration monitoring should be undertaken at sensitive receivers during works with potential for vibration to cause structural damage and human response in order to confirm appropriate site-specific minimum working distances. Site-specific minimum working distances should be determined whenever significant vibration generating plant will be working close to or within the recommended minimum working distances listed in Appendix D.	Construction Contractor	Construction	Project specific control
NV9	Damage to structures	Dilapidation surveys will be conducted at all residential and other vibration sensitive receivers within 50 metres of the construction site.	Construction Contractor	Pre-construction	Project specific control
NV10	Construction vibration	Notification of residences potentially affected by vibration by letterbox drop will be carried out for all occupied buildings within 100 metres of the construction site.	Construction Contractor	Pre-construction / Construction	Project specific control
NV11	Potential damage to heritage listed structures	Attended vibration monitoring will be carried out during periods where construction plant and equipment are operating within the minimum working distance for the heritage listed structures identified in Table 6-24 of this REF	Construction Contractor	Pre-construction / Construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
NV12	Potential damage to rock shelters	Vibration monitoring will be carried out during periods where high vibration plant and equipment are operating in close proximity to the rock shelters to determine appropriate site-specific vibration levels.	Construction Contractor	Construction	Project specific control
NV13	Operational noise mitigation	Operational noise mitigation requirements will be reviewed during detailed design. At-property treatments will be agreed upon and implemented in consultation with property owners.	Roads and Maritime / Designer	Detailed design	Project specific control
NV14	Operational noise mitigation	Where practical, operational noise treatments will be implemented at the start of the construction period.	Construction Contractor	Pre-construction	Project specific control
NV15	Operational noise	Post-construction noise monitoring will be undertaken in accordance with Noise Criteria Guideline (Roads and Maritime 2016) and Noise Mitigation Guideline (Roads and Maritime 2016) within 2-12 months of proposal completion, at selected representative locations along the proposal route.	Roads and Maritime	Post-construction	Project specific control
Aboriginal heritage					
AH1	Aboriginal heritage	An Aboriginal Heritage Management Plan (AHMP) will be prepared in accordance with the Procedure for Aboriginal cultural heritage consultation and investigation (Roads and Maritime, 2012) and Standard Management Procedure - Unexpected Heritage Items (Roads and Maritime, 2015) and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented for managing impacts on Aboriginal heritage. The AHMP will be prepared in consultation with all relevant Aboriginal groups.	Construction Contractor	Pre-construction	Section 4.9 of QA *G36 Environment Protection*

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
AH2	Unexpected finds	*The Standard Management Procedure - Unexpected Heritage Items* (Roads and Maritime, 2015) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Roads and Maritime does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of that Procedure have been satisfied.	Construction Contractor	Construction	Section 4.9 of QA *G36 Environment Protection*
AH3	AHIP	An Aboriginal heritage impact permit (AHIP) will be sought for the overall proposal area, including Nowra Bridge 1 (AHIMS ID 52-5-0852), Nowra Bridge 2 (AHIMS ID 52-5-0853), Nowra Bridge 6 (AHIMS ID 52-5-0872), Nowra Bridge 7 (AHIMS ID 52-5-0875), Nowra Bridge 8 (AHIMS ID 52-5-0876), Nowra Bridge 9 (AHIMS ID 52-5-0874), and Nowra Bridge 10 (AHIMS ID 52-5-0873). Collection of surface artefacts and salvage excavations will be completed prior to any activities (including pre-construction activities) which may harm Aboriginal objects at these locations.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)
AH4	Aboriginal heritage	Where possible, all subsurface impact to Graham Lodge Aboriginal Artefact Scatter (AHIMS ID 52-5-0879) will be avoided. Where impacts are unavoidable, salvage excavations will be undertaken in accordance with an AHIP and a Section 60 permit.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction / Construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
AH5	Aboriginal heritage	Collection of surface artefacts across Nowra Bridge 1 (AHIMS ID 52-5-0852) and Nowra Bridge 2 (AHIMS ID 52-5-0853) will be conducted prior to construction, in accordance with an AHIP.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction / Construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)
AH6	Aboriginal heritage	Targeted salvage excavation will be conducted within Nowra Bridge 2 (AHIMS ID 52-5-0853), Nowra Bridge 7 (AHIMS ID 52-5-0875), Nowra Bridge 8 (AHIMS ID 52-5-0876), and Nowra Bridge 9 (AHIMS ID 52-5-0874) prior to construction in accordance with an AHIP.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction / Construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)
AH7	Aboriginal heritage	Long term arrangements for the management of excavated artefacts, such as reburial or a keeping place, will be determined in accordance with the recommendations of registered Aboriginal stakeholders and OEH.	Roads and Maritime / Construction Contractor	Pre-construction / Construction / Post construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)
AH8	Aboriginal heritage	Prepare and implement a Heritage Interpretation Strategy that addresses the cultural significance of the proposal location within the Dharawal landscape and archaeological finds from the study area. Develop the strategy in consultation with the Registered Aboriginal Parties.	Roads and Maritime / Construction Contractor	Pre-construction / Construction / Post construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
AH9	Aboriginal heritage	Maintain ongoing consultation with the Registered Aboriginal Parties during detailed design and construction.	Roads and Maritime / Construction Contractor	Pre-construction / Construction	Cultural Heritage Assessment Report (CHAR), Artefact Heritage Services, 2018)
Non-Aboriginal heritage					
NAH1	Non-Aboriginal heritage	A Non-Aboriginal Heritage Management Plan (NAHMP) will be prepared and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented to avoid and mitigate impacts to Non-Aboriginal heritage. The NAHMP will include • Provisions to appropriately protect and manage significant fabric during the proposed. • Provision of a heritage induction for all workers being carried out prior to commencement of works. • The induction will include values of the sites, avoidance procedure, and contacts (site manager, Road and Maritime environment officer) for reporting unexpected archaeological finds, or inadvertent impact to heritage items.	Construction Contractor	Detailed design / Pre-construction	Section 4.10 of QA G36 Environment Protection
NAH2	Non-Aboriginal heritage	*The Standard Management Procedure - Unexpected Heritage Items* (Roads and Maritime, 2015) will be followed in the event that any unexpected heritage items, archaeological remains or potential relics of Non-Aboriginal origin are encountered. Work will only re-commence once the requirements of that Procedure have been satisfied.	Construction Contractor	Detailed design / Pre-construction	Section 4.10 of QA G36 Environment Protection

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
NAH3	Non-Aboriginal heritage	Where practicable, impacts to Graham Lodge and curtilage should be avoided. Should subsurface works which may impact significant archaeological remains with Graham Lodge are unavoidable and justifiable, an Archaeological Research Design will be prepared to support a section 60 application.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
NAH4	Non-Aboriginal heritage	Determine a suitable location for relocation of the pavilion structure associated with the Captain Cook Bicentennial Memorial, in consultation with Shoalhaven City Council.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
NAH5	Non-Aboriginal heritage	Where practicable, investigate opportunities to minimise impacts to the curtilage of 'Lynburn' (LEP No.130). The screening vegetation will be retained where possible or replanted after construction to minimise visual impact.	Roads and Maritime / Construction Contractor	Detailed design / Pre-construction / Post construction	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
NAH6	Non-Aboriginal heritage	A heritage interpretation strategy will be prepared including an interpretation of archaeological remains should any be uncovered. The interpretation strategy will include the history, associations and significance of the existing southbound bridge, interpretive signage, panels or displays at the entry points to the bridge or at locations along its span.	Roads and Maritime	Detailed design	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
NAH7	Non-Aboriginal heritage	An archival recording will be prepared for the Captain Cook Bicentennial Memorial, the Nowra Bridge over the Shoalhaven River, 'Illowra', 'Lynburn' and the potential unlisted heritage item 'M&M Guesthouse' prior to impacts occurring. The archival recording will be prepared in accordance with Photographic	Roads and Maritime	Detailed design / Pre-construction	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		Recording of Heritage Items Using Film or Digital Capture (Heritage Council 2006).			
NAH8	Non-Aboriginal heritage	Wherever possible, natural screening adjacent to heritage items along the Princes Highway will be retained. This particularly relates to vegetation within the LEP listed 'Lynburn' heritage item (LEP No. 130) and Captain Cook Bicentennial Memorial heritage item (LEP No. 338). Where impact to vegetation cannot be avoided new plantings will be considered.	Construction Contractor	Detailed design / Pre-construction / Post construction	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
NAH9	Non-Aboriginal heritage	Consider options for relocation of the unlisted potential heritage item 'M&M Guesthouse' in consultation with Shoalhaven Council	Roads and Maritime	Prior to detailed design	Statement of Heritage Impact (SOHI), Artefact Heritage Services, 2018
Landscape character and visual impact					
LV1	Landscape character and visual impact	An Urban Design and Landscape Plan (UDLP) will be prepared to inform detailed design and will form part of the CEMP. Development of the UDLP will draw on the Urban Design Report and Landscape and Visual Assessment prepared for the REF. The UDLP will present an integrated urban design for the project, providing practical detail on the application of design principles and objectives identified in the environmental assessment. The UDLP will include design treatments for: • location and identification of existing vegetation and proposed landscaped areas, including: species to be used • built elements including retaining walls, bridges and noise walls	Designer	Detailed design	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings • fixtures such as seating, lighting, fencing and signs • details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • procedures for monitoring and maintaining landscaped or rehabilitated areas. The UDLP will be prepared in accordance with relevant guidelines, including: • Beyond the Pavement urban design policy, process and principles (Roads and Maritime, 2014) • Landscape Guideline (RTA, 2008) • Bridge Aesthetics (Roads and Maritime 2012) • Noise Wall Design Guidelines (RTA, 2006) • Shotcrete Design Guideline (RTA, 2005).Landscape Guideline (RTA, 2008) • Bridge Aesthetics (Roads and Maritime 2012) • Noise Wall Design Guidelines (RTA, 2006) • Shotcrete Design Guideline (RTA, 2005).			
LV2	Retention of existing vegetation	The proposal will be designed to avoid impact to prominent trees and vegetation communities as far as practicable possible. Water quality structures and drainage lines will be designed to avoid existing vegetation where practicable.	Designer	Detailed design	Project specific control
LV3	Bridge form	The proposed bridge design will aim to achieve a slender and less visually intrusive form and be visually harmonious with the existing bridges.	Designer	Detailed design	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
LV4	Impacts on existing vegetation	Investigate introducing retaining walls in the following locations to provide the opportunity to retain existing tree plantings, improve the visual and pedestrian amenity, and reduce the scale of the highway: • Either side of the Princes Highway between Bolong Road and Bomaderry Creek bridge. • The new northbound bridge approach road • Either side of the Princes Highway south of the Bridge Road intersection	Designer	Detailed design	Landscape Character and Visual Impact Assessment
LV5	Impacts on vegetation	Consider the proposed drainage swale design and location to minimise cutting as well as provide additional space for planting near the corner of the Princes Highway and Illaroo Road	Designer	Detailed design	Landscape Character and Visual Impact Assessment
LV6	Impact on Rotary Park	Consider the proposed footpath alignment and stair design of the path beneath the bridge structures and in Rotary Park to better reflect its parkland setting	Designer	Detailed design	Landscape Character and Visual Impact Assessment
LV7	Impacts on existing vegetation	Consider the alignment of the footpath on the north eastern corner of the existing southbound bridge, in consultation with adjacent land owners, to avoid impact to existing trees.	Designer	Detailed design	Landscape Character and Visual Impact Assessment
LV8	Active transport	Investigate the design of the entrance to properties on the north eastern corner of the existing southbound bridge to prioritise pedestrians and cyclists over vehicles and facilitate ease of travel.	Designer	Detailed design	Landscape Character and Visual Impact Assessment
LV9	Visual impact of piers	Consider the proposed pier designs to strengthen the complementary relationship between the proposed bridge piers and the piers of the existing northbound and southbound bridges. In particular, it will consider tapering the piers at their long elevation	Designer	Detailed design	Landscape Character and Visual Impact Assessment

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
LV10	Site restoration	Construction work sites and ancillary sites will be returned to at least their pre-construction state, unless otherwise detailed in the project design, once construction activities are complete or will be progressively remediated throughout the construction program where possible	Designer	Detailed design	Landscape Character and Visual Impact Assessment
LV11	Retention of existing vegetation	Existing trees to be retained within construction facilities areas will be identified, protected and maintained for the duration of the construction works	Designer	Detailed design	Landscape Character and Visual Impact Assessment
LV12	Light spill	Temporary lighting will be screened, diverted or minimised to avoid unnecessary light spill	Designer	Detailed design	Landscape Character and Visual Impact Assessment
LV13	Site restoration	Material used for temporary land reclamation will be removed once construction activities are complete.	Designer	Detailed design	Landscape Character and Visual Impact Assessment
Flooding and hydrology					
HY1	Hydrology	Temporary drainage structures will be designed and constructed in accordance with the Technical Guideline – Temporary Stormwater Drainage for Road Construction (Roads and Maritime 2011c).	Construction Contractor	Construction	Project specific control
HY2	Flooding	The CEMP will include appropriate management measures to manage the risk and impacts of flooding including, but not limited to: • Removal or securing of loose material • Storage or removal of plant and equipment • Storage of fuels and chemicals.	Construction Contractor	Pre-construction/ construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
Property and land use					
PA1	Property acquisition and relocation issues	Roads and Maritime will continue to consult with directly affected property owners throughout the detail design phase.	Roads and Maritime	Detailed design	Project specific control
PA2	Property acquisition	All property acquisition will be carried out in accordance with the *Land Acquisition Information Guide* (Roads and Maritime, 2014b), the *Land Acquisition (Just Terms Compensation) Act 1991* and the NSW Government Land Acquisition Reform 2016.	Roads and Maritime	Detailed design, Pre-construction	Core standard safeguard PL1
PA3	Property acquisition	Acquisition of Crown land will be carried out in accordance with the *Crown Lands Management Act 2016*.	Roads and Maritime	Detailed design, Pre-construction	Project specific control
Socio-economic					
SE1	Project communications	A Community and Stakeholder Engagement Plan will be prepared and will include: • Procedures and mechanisms that will be implemented in response to the key social impacts identified for the proposal. • Procedures and mechanisms that will be used to engage with affected landowners, business owners, and the wider community to identify potential access, parking, business visibility, and other impacts and develop appropriate management measures. • Procedures to keep the community informed about construction and any associated changes to conditions (eg detours or lane closures) such as through advertisements in local media and advisory notices or variable message signs	Roads and Maritime	Detailed design / pre-construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Procedure for the management of complaints and enquiries, including a contact name and number for complaints. The plan will be prepared in accordance with the Community Involvement and Communications Resource Manual (RTA, 2008).			
SE2	Impacts on council infrastructure	Roads and Maritime will continue to consult with Council regarding impacts to council infrastructure.	Roads and Maritime	Detailed design	Project specific control
SE3	Impacts on social infrastructure – maritime activities	At least one of the two boat ramps within the proposal area will be available to the public at all times. The public would be notified in advance of any access restrictions during construction.	Roads and Maritime, Construction Contractor	Detailed design, Construction	Project specific control
SE4	Impact on Greys Beach Reserve	Use of the Greys Beach Reserve site for temporary construction activities should be planned to consider peak usage periods of the river for recreational users.	Roads and Maritime, Construction Contractor	Detailed design, Construction	Project specific control
SE5	Impacts on social infrastructure – time capsule	Roads and Maritime will endeavour to identify the location of the time capsule in Moorhouse Park and establish an appropriate salvage and/or relocation of this object, in consultation with Council and relevant community members.	Roads and Maritime	Detailed design	
SE6	Impact on parking	Consultation will be carried out with Council to identify alternative parking arrangements to replace car parking lost during construction.	Roads and Maritime	Detailed design, Pre-construction	Project specific control
SE7	Impact on access to Shoalhaven River foreshore	The CEMP will include measures to ensure public access to the Shoalhaven River foreshore and pathways is maintained during construction, where possible given safety considerations.	Roads and Maritime, Construction Contractor	Detailed design, Construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
SE8	Construction staff parking	The construction contractor will provide suitable off-street parking to accommodate workers during construction. Construction vehicles would not occupy private parking including Nowra Aquatic Centre and Shoalhaven Entertainment Centre and Visitor Centre. The Construction TMP will include appropriate measures to prevent construction staff from utilising these public parking areas.	Construction Contractor	Pre-construction, Construction	Project specific control
SE9	Business and tourism impacts – operation	Existing businesses with authorised Tourist Attraction Signposting Assessment Committee (TASAC) approved signage will be consulted to develop revised signage if impacted by the proposal.	Roads and Maritime	Detailed design	Project specific control
Biodiversity					
B1	General biodiversity	A Flora and Fauna Management Plan (FFMP) will be prepared as part of the Construction Environmental Management Plan (CEMP). The FFMP will be prepared in accordance with the Roads and Maritime Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011) (Biodiversity Guidelines) and Section 4.8 of Roads and Maritime QA Specification G36 Environment Protection and G40 Clearing and Grubbing. The FFMP will include, but not be limited to: • Pre-clearing process • Management of unexpected species finds • Delineation of exclusion zones • Process for weed management • Process for pathogen management • Requirements set out in the Landscape Guideline (RTA 2008).	Construction Contractor	Prior to construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
B2	Removal of native vegetation	Native vegetation removal would be minimised through detailed design.	Designer	Detailed design	Project specific control
B3	Impacts on fauna	Pre-clearing surveys will be undertaken in accordance with *Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011).*	Construction Contractor	Pre-construction	Project specific control
B4	Removal of vegetation	Vegetation removal will be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011)*.	Construction Contractor	Construction	Project specific control
B5	Removal of vegetation	Native vegetation will be re-established in accordance with *Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Constriction / Post construction	Project specific control
B6	Threatened flora and fauna	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) if threatened ecological communities, not assessed in the biodiversity assessment, are identified in the proposal site	Construction Contractor	Construction	Project specific control
B7	Removal of vegetation	A mulch management plan will be prepared in accordance with the mulch order 2016 under the *Protection of the Environment Operations Act 1997* (POEO Act)	Construction Contractor	Pre-construction	Project specific control
B8	Removal of EEC	Exclusion zones will be placed around retained EECs in accordance with Guide 2: Exclusion Zones	Construction Contractor	Pre-construction	Project specific control
B9	Removal of aquatic habitat	Removal of aquatic habitat (seagrass) will be minimised through detailed design.	Construction Contractor	Pre-construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
B10	Removal of threatened species habitat and habitat features	Habitat will be replaced or re-instated in accordance with *Guide 5: Re-use of woody debris and bushrock* and *Guide 8: Nest boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Construction	Project specific control
B11	Aquatic habitat impacts	Aquatic habitat will be protected in accordance with *Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) and Section 3.3.2 *Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013* (DPI (Fisheries NSW) 2013).	Construction Contractor	Construction	Project specific control
B12	Aquatic habitat impacts	DPI (Fisheries) will be consulted with regard to the need for a permit to harm marine vegetation	Construction Contractor	Construction	Project specific control
B13	Changes to hydrology	Changes to existing surface water flows will be minimised through detailed design.	Designer	Detailed design	Project specific control
B14	Injury and mortality of fauna	Fauna will be managed in accordance with *Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Construction	Project specific control
B15	Invasion and spread of weeds	Weed species will be managed in accordance with *Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Construction	Project specific control
B16	Invasion and spread of pathogens and disease	Pathogens will be managed in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Construction Contractor	Construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
B17	Noise, light and vibration	Shading and artificial light impacts will be minimised through detailed design.	Designer	Detailed design	Project specific control
Water quality					
WQ1	Water quality	A Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the CEMP. The SWMP will identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction. The SWMP will contain as a minimum the following elements: • Site specific Erosion and Sedimentation Control Plans (ESCPs), including detailed consideration of staging and management at ancillary sites, in accordance with the Blue Book • Identification of site conditions or construction activities that could potentially result in erosion and associated sediment runoff • Methods to minimise potential adverse impacts of construction activities on the water quality within surrounding waterways • Details of measures to minimise any adverse impacts of sedimentation on the surrounding environment • Details of measures to minimise soil erosion caused by all construction works including clearing, grubbing and earthworks • Details of measures to make site personnel aware of the requirements of the SWMP by providing information within induction, toolbox and training sessions	Construction Contractor	Pre-construction	Section 2.1 of *QA G38 Soil and Water Management*

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Details of the roles and responsibilities of personnel responsible for implementing the SWMP • Details of measures for the inspection and maintenance of construction phase water treatment devices and structures • Details of water quality monitoring • Detailed construction methodology and environmental work method statement for the proposed bridge works and creek realignment within Shoalhaven River and Bomaderry Creek to minimise the potential for bank instability, scour, flooding, working over water and other adverse impacts of construction activities on the water quality. • The SWMP will be reviewed by a soil conservationist on the Roads and Maritime list of Registered Contractors for Erosion, Sedimentation and Soil Conservation Consultancy Services. The SWMP will be revised as required to address the outcomes of the review.			
WQ2	Water quality	A site ESCP will be prepared and implemented as part of the SWMP. The ESCP will include arrangements for managing wet weather events, including monitoring of potential high risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather. Development of the ESCP will take into consideration: • Provision of sediment basins • Temporary surface drainage line controls • Bridge deck and bridge piles working with over water and alkaline waste water management	Construction Contractor	Pre-construction	Section 2.2 of *QA G38 Soil and Water Management*

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Over water sediment controls including: • Silt fences along areas of the foreshore that have been cleared • Silt curtains encompassing construction areas disturbing or releasing river bottom sediments (eg piling) • Silt booms surrounding barges to ensure leaks /spills are contained.			
WQ3	Water quality	The SWMP will identify the position of an on-site environmental representative to complete self-audits and monitor implementation of the SWMP.	Construction Contractor	Pre-construction / Construction	Project specific control
WQ4	Water quality	In the event of significant groundwater inflows, undertake further assessment and consultation with DPQ (Water) in relation to any licencing requirements.	Construction Contractor	Construction	Project specific control
WQ5	Water quality	During detailed design implement best practice water sensitive urban design (WSUD) measures to provide dissipation of flows and prevent gross pollutants and contaminants entering the study area's waterways. WSUD measures are designed to provide treatment of nutrients and suspended solids prior to discharge to the existing receiving environment.	Designer	Detailed design	Project specific control
WQ6	Water quality	During detailed design, review the drainage design to identify and evaluate opportunities to meet the WSUD water quality objectives, including consideration of: • Improvements to the design of the southern basin to achieve better performance • Inclusion of grass swales on both sides of the highway in the vicinity of Bolong Road (subject to the acquisition area)	Designer	Detailed design	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Provision of a grassed swale as part of rehabilitation of the ancillary site adjacent to Bridge Road / Scenic Drive.			
WQ7	Water quality	Surface water quality monitoring will be undertaken prior to construction to establish baseline water quality and regularly during construction so that any impacts from the proposal construction phase can be identified and addressed. Sampling locations and monitoring methodology will be determined as part of the CEMP, but as a minimum will be undertaken upstream and downstream of creek crossings and in accordance with the Guideline for Construction Water Quality Monitoring (Roads and Maritime, 2003).	Roads and Maritime Construction Contractor	Pre-construction Construction	Project specific control
WQ8	Water quality	Bulk storage of fuels or chemicals should be located greater than 100 metres from any watercourse or mapped EEC. In constrained areas where criteria cannot be achieved, additional risk assessment and additional mitigation measures may need to be considered and implemented to manage risk to sensitive receivers to an acceptable level.	Construction Contractor	Construction	Project specific control
WQ9	Water quality	Vehicles and machinery will be properly maintained to minimise the risk of fuel/oil leaks.	Construction Contractor	Construction	Project specific control
WQ10	Water quality	An Emergency Spill Plan will be developed and incorporated in the CEMP. This will include measures to avoid spillages of fuels, chemicals, and concrete wash or fluids into any waterways.	Construction Contractor	Construction	Project specific control
WQ11	Water quality	The storage, handling and use of fuels or chemicals will be undertaken in accordance with the *Occupational Health and Safety Act 2000* and WorkCover's Storage and Handling of Dangerous Goods Code of Practice (WorkCover, 2005).	Construction Contractor	Construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
WQ12	Water quality	If any dewatering or other activities which will impact the local groundwater system are proposed, consultation with the DPI (Water) will be undertaken to determine the requirements for water extraction licenses and approvals.	Construction Contractor	Construction	Project specific control
WQ12	Water Quality	Minimise direct and indirect impact to riparian vegetation	Designer Construction Contractor	Detailed design Construction	Project specific control
Soils					
SO1	Contaminated land	A Contaminated Land Management Plan will be prepared in accordance with the *Guideline for the Management of Contamination* (Roads and Maritime, 2013) and implemented as part of the CEMP. The plan will include, but not be limited to: • Capture and management of any surface runoff contaminated by exposure to the contaminated land • Further investigations required to determine the extent, concentration and type of contamination, as identified in the detailed site investigation (Phase 2) • Management of the remediation and subsequent validation of the contaminated land, including any certification required • Measures to ensure the safety of site personnel and local communities during construction.	Construction Contractor	Pre construction	Section 4.2 of QA *G36 Environment Protection*
SO2	Contaminated land	If contaminated areas were encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. All other works that may impact on the contaminated area will cease until the nature and	Construction Contractor	Construction	Section 4.2 of *QA G36 Environment Protection*

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		extent of the contamination has been confirmed and any necessary site-specific controls or further actions identified in consultation with the Roads and Maritime Environment Manager and/or EPA.			
SO3	Accidental spills	A site specific emergency spill plan will be developed, and include spill management measures in accordance with the Roads and Maritime *Code of Practice for Water Management* (RTA, 1999) and relevant EPA guidelines. The plan will address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including Roads and Maritime and EPA officers).	Construction Contractor	Detailed design / Pre construction	Section 4.3 of *QA G36 Environment Protection*
SO4	Acid sulfate soils	During geotechnical investigations, soil sampling and testing for ASS parameters will be carried out in areas of proposed ground disturbance where there is a low to high probability of encountering PASS/ASS. Assessment of the presence/absence of ASS will be made with reference to NSW *Acid Sulfate Soils Assessment Guidelines* (ASSMAC,1998).	Designer	Detailed design	Project specific control
SO5	Acid sulfate soils	During detailed design, the preferred management strategy for PASS/ASS is to avoid its disturbance wherever possible. Where disturbance of PASS/ASS is unavoidable, preferred design strategies are: • Minimisation of disturbance which may include avoiding/ minimising impact on areas with high levels of sulfides, limiting disturbances so that only shallow disturbances occur and minimising groundwater fluctuations. • Neutralisation with lime	Designer	Detailed design	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Hydraulic separation of sulfides from the sediment either on its own or in conjunction with dredging • Strategic reburial (re-interment) where material can be permanently placed in anaerobic conditions, for example covered by water and compacted soil to keep it wet and free of oxygen. Other management measures may be considered during construction stage but must not pose unacceptably high risks.			
SO6	Acid sulfate soils	An ASS Management Plan (ASSMP) will be prepared to identify procedures for mitigation and management of known PASS/ASS areas during construction stage. The ASSMP will include details on: • Identification of specific areas where PASS/ASS are required to be managed • Determine liming rates for neutralisation of PASS/ASS within each area • Details on appropriate construction staging and methods used in relation to PASS/ASS on site • Specific mitigation measures to prevent disturbance of and/or acid generation from PASS/ASS to manage and control environmental issues • Procedures for handling, treatment (including acid neutralisation), containment and disposal of PASS/ASS associated with proposed excavation activities at the site. • Additional testing will be required during construction to determine liming rates relevant to each area of ASS that will be disturbed. The plan will be prepared in general accordance with NSW	Construction contractor	Pre construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		Acid Sulfate Soils Assessment Guidelines (ASSMAC,1998).			
SO7	Hazard and risk management	A Hazard and Risk Management Plan (HRMP) will be prepared and implemented as part of the CEMP. The HRMP will include, but not be limited to: • Details of hazards and risks associated with the activity • Measures to be implemented during construction to minimise these risks • Record keeping arrangements, including information on the materials present on the site, material safety data sheets, and personnel trained and authorised to use such materials • A monitoring program to assess performance in managing the identified risks • Contingency measures to be implemented in the event of unexpected hazards or risks arising, including emergency situations. The HRMP will be prepared in accordance with relevant guidelines and standards, including relevant Safe Work Australia Codes of Practice, and EPA or Office of Environment and Heritage publications.	Construction Contractor	Pre-construction	Project specific control
SO8	Hazardous materials	A Hazardous Materials (HAZMAT) survey will be carried out to assess the potential for lead-based paints and/or asbestos containing materials including: • Structures identified for demolition • Known buried utilities and service pits • A Hazmat Register will identify the location of all known or suspected hazardous materials. Risk assessments will be carried out to quantify and	Designer	Detailed design	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		control potential exposure to human and ecological receptors during construction.			
SO9	Hazardous materials	A Hazardous Materials Management Plan applying to known areas of asbestos contamination / other hazardous materials will be developed in accordance with the Roads and Maritime Procedure Asbestos Related Work No. 066P25 (Roads and Maritime, 2013).	Construction Contractor	Pre construction	Project specific control
SO10	Hazardous materials	Any works requiring asbestos removal should be carried out in accordance with an Asbestos Removal Control Plan prepared in accordance with the relevant published guidelines and codes of practice: • Code of Practice. How to safely remove asbestos in the workplace (SafeWork NSW, 2016a) • Code of Practice. How to manage and control asbestos in the workplace (SafeWork NSW, 2016b) • Roads and Maritime Procedure Asbestos Related Work No. 066P25 (Roads and Maritime, 2013). Prior to works, notifications to SafeWork NSW will be carried out by the appropriate licensed asbestos removal contractor. At the completion of the asbestos removal, clearance certificates will be issued to the contractor confirming the effectiveness of asbestos removal.	Construction Contractor	Construction	Project specific control
SO11	Hazardous materials	An unexpected finds protocol will be employed if previously unidentified asbestos contamination is discovered during construction. Work in the affected area will cease immediately, and an investigation must be undertaken and report prepared to determine the nature, extent and degree of the asbestos contamination. The level of reporting must be	Construction Contractor	Construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		appropriate for the identified contamination in accordance with Guidelines for Consultants Reporting on Contaminated Sites (OEH, 2011), any relevant SafeWork NSW codes of practice and include the proposed methodology for the remediation of the asbestos contamination. Works may only recommence upon receipt of a validation report from a suitably qualified contamination specialist that the remediation activities have been undertaken in accordance with the investigation report and remediation methodology.			
SO12	Sedimentation and erosion	During detailed design, the potential impacts associated with bridge construction and operation will be further considered to minimise the likelihood of bank instability and scouring, flow alteration and potential increased risk of flooding. The design and construction methodologies should, wherever possible, minimise direct and indirect impacts to riparian vegetation, and implement best practice water sensitive urban design (WSUD) measures to provide dissipation of flows and prevent gross pollutants and contaminants entering the study area's waterways. WSUD measures are designed to provide treatment of nutrients and suspended solids prior to discharge to the existing receiving environment.	Designer	Detailed design	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
Waste management					
WA1	Waste management - general	A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to: • Measures to avoid and minimise waste associated with the project • Classification of wastes and management options (re-use, recycle, stockpile, disposal) • Statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • Procedures for storage, transport and disposal • Monitoring, record keeping and reporting. The WMP will be prepared taking into account the Environmental Procedure - Management of Wastes on Roads and Maritime Services Land (Roads and Maritime, 2014) and relevant Roads and Maritime Waste Fact Sheets.	Construction contractor	Pre-construction	Project specific control
WA2	Waste management - general	All wastes will be managed and disposed of in accordance with the POEO Act.	Construction contractor	Construction	Project specific control
WA3	Waste management - general	Noxious weeds removed during construction will be managed in accordance with Department of Primary Industries requirements and relevant legislation.	Construction contractor	Construction	Project specific control
WA4	Waste management - general	Site inductions will include waste management and disposal requirements and facilities.	Construction contractor	Construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
WA5	Waste management - general	Appropriate portable toilets with either pump out facilities or sewer connections will be provided for site personnel and sewage will disposed of appropriately and in accordance with relevant legislation.	Construction contractor	Construction	Project specific control
WA6	Fill material	Excavated material will be reused on site where feasible and suitable for the intended reuse to reduce demand on resources. Where excavated material cannot be used on site, opportunities for reuse on nearby projects will be investigated.	Construction contractor	Construction	Project specific control
WA7	Fill material	Any required additional fill material will be sourced from appropriately licensed facilities and/or other construction projects wherever possible. Additional fill material will be sourced and verified as suitable for use in accordance with relevant EPA and Roads and Maritime guidelines.	Construction contractor	Construction	Project specific control
WA8	Green waste	Where practicable and suitable for use, cleared vegetation will be mulched for use on site.	Construction contractor	Construction	Project specific control
WA9	Disposal of waste	Excavated material will be reused on-site where feasible and suitable for the intended reuse to reduce demand on resources. Where excavated material cannot be used on site, opportunities for reuse on nearby projects will be investigated.	Construction contractor	Construction	Project specific control
WA10	Disposal of waste	All waste will be disposed of to an appropriate licensed facility.	Construction contractor	Construction	Project specific control
WA11	Management of tannins	A tannin leachate management protocol will be developed in accordance with Roads and Maritime' Environmental Direction – Management of Tannins from Vegetation Mulch (Roads and Maritime, 2012) to manage the stockpiling of mulch and use of cleared	Construction contractor	Construction	Project specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		vegetation and mulch filters for erosion and sediment control			
Air quality					
AQ1	Air quality	An Air Quality Management Plan (AQMP) will be prepared and implemented as part of the CEMP. The AQMP will include, but not be limited to: • Potential sources of air pollution • Air quality management objectives consistent with any relevant published EPA and/or OEH guidelines • Mitigation and suppression measures to be implemented • Methods to manage work during strong winds or other adverse weather conditions • A progressive rehabilitation strategy for exposed surfaces.	Construction Contractor	Detailed design / pre-construction	Section 4.4 of QA G36 *Environment Protection*
AQ2	Dust emissions	Work will cease when levels of visible airborne dust become excessive.	Construction Contractor	Construction	Project-specific control
AQ3	Dust emissions	Works that disturb vegetation, soil or stockpiles will not be carried out during winds over 40 km/h when this may affect receivers.	Construction Contractor	Construction	Project-specific control
AQ4	Dust emissions	Stockpiled materials will be covered stabilised or stored in areas not exposed to high winds.	Construction Contractor	Construction	Project-specific control
AQ5	Dust emissions	All trucks will be covered when transporting materials to and from the site.	Construction Contractor	Construction	Project-specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
Climate change and greenhouse gas emissions					
CC1	Greenhouse gas emissions	The use of alternative fuels and power sources for construction plant equipment will be investigated and implemented, where appropriate	Contractor	Pre-construction	Project-specific control
CC2	Greenhouse gas emissions	The energy efficiency and related carbon emissions will be considered in the selection of vehicle and plant equipment	Contractor	Pre-construction	Project-specific control
CC3	Greenhouse gas emissions	Construction equipment, plant, and vehicles will be appropriately sized for the task	Contractor	Construction	Project-specific control
CC4	Greenhouse gas emissions	Equipment will be serviced frequently to ensure they are operating efficiently	Contractor	Construction	Project-specific control
CC5	Greenhouse gas emissions	Where possible, materials will be delivered as full loads and local suppliers would be used	Contractor	Construction	Project-specific control
Cumulative impacts					
CU1	Cumulative construction impacts	Ongoing coordination and consultation will be undertaken between the project teams on Albion Park Rail Bypass, Berry to Bomaderry upgrade, and The Consultation Plan will include consultation with Project Managers of the Batemans Bay Bridge replacement , Berry to Bomaderry upgrade and the Far North Collector Road projects to ensure cumulative traffic impacts are appropriately assessed and managed, particularly during peak holiday periods:	Roads and Maritime / Construction Contractor	Pre-construction	Project specific control
CU2	Cumulative construction impacts	Consultation with Shoalhaven City Council will be undertaken regarding the Far North Collector Road to ensure cumulative traffic impacts are appropriately assessed and managed, particularly during peak holiday periods	Roads and Maritime / Construction Contractor	Pre-construction and construction	Project-specific control

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
CU3	Cumulative impacts	The CEMP will be reviewed regularly and revised as required to reflect surrounding development works as it becomes known.	Construction Contractor	Construction	Project specific control
HR01	Hazard and risk management	A Hazard and Risk Management Plan (HRMP) will be prepared and implemented as part of the CEMP. The HRMP will include, but not be limited to: • Details of hazards and risks associated with the activity • Measures to be implemented during construction to minimise these risks • Record keeping arrangements, including information on the materials present on the site, material safety data sheets, and personnel trained and authorised to use such materials • A monitoring program to assess performance in managing the identified risks • Contingency measures to be implemented in the event of unexpected hazards or risks arising, including emergency situations. The HRMP will be prepared in accordance with relevant guidelines and standards, including relevant Safe Work Australia Codes of Practice, and EPA or Office of Environment and Heritage publications.	Construction Contractor	Detailed design / pre-construction	Project specific control

7.3 Licensing and approvals

Table 7-2: Summary of licensing and approvals required

Instrument	Requirement	Timing
Protection of the Environment Operations Act 1997 (s120)	Environment protection licence (EPL) for scheduled activities - extractive activity.	Prior to start of construction
Fisheries Management Act 1994 (s199)	Notification to the Minister for Primary Industries prior to any dredging or reclamation works.	Minimum of 28 days prior to the start of any dredging or reclamation works.
Fisheries Management Act 1994 (s205)	Permit to harm marine vegetation from the Minister for Primary Industries.	Prior to any works that could harm marine vegetation
Heritage Act 1977 (s60)	Should subsurface works which may impact significant archaeological remains with Graham Lodge are unavoidable and justifiable, an Archaeological Research Design will be prepared to support a section 60 application.	Prior to start of any construction activities affecting Graham Lodge
National Parks and Wildlife Act 1974 (s90)	Aboriginal heritage impact permit from the Chief Executive of OEH.	Prior to start of construction
Crown Land Management Act 2016 (s1.15)	Authorisation to occupy areas of Crown land.	Prior to start of construction

8. Conclusion

8.1 Justification

8.1.1 Social factors

The social benefits of undertaking the proposal compared to the do minimum include:

- Where possible, the existing road corridor has been utilised, however some property impacts would be required in order to accommodate the proposal
- Increased pedestrian and cyclist safety as current zebra crossings become signalised
- Improved traffic flow and improved road safety from signalised pedestrian crossings
- Improved congestion and reduced travel times along parts of the bus routes
- Improved reliability and travel times of bus services
- Improved active transport by providing a physically separated path for pedestrian and cyclists
- The provision of additional pedestrian crossing.

Overall the proposal would improve liveability and amenity for residents and businesses within the study area and region, by improving travel times, and reducing delays and frustrations and by improving pedestrian and cyclist facilities. Access to employment and community facilities and community connectivity, aspects which are highly valued by the local community, would be improved through the upgraded road and improved infrastructure.

8.1.2 Biophysical factors

The biophysical benefits of undertaking the proposal compared to the do minimum include:

- Reduced impact on receiving water quality for the Shoalhaven River through removal of vehicles from existing southbound bridge, and incorporation of pavement drainage into the new northbound bridge and treatment of runoff via a bioretention basin
- Reduced impact on receiving water quality for Bomaderry Creek through removal of scuppers in upgraded bridge and conveyance of pavement drainage to bioretention swale/basin prior to discharge to Bomaderry Creek
- Potential improvements in local air quality associated with improved efficiency of vehicle movements.

8.1.3 Economic factors

The proposal is consistent with a number of strategies and plans including:

- NSW State Priorities
- State Infrastructure Strategy
- NSW Future Transport Strategy 2056
- NSW Freight and Ports Strategy
- Draft NSW Freight and Ports Plan
- Illawarra Regional Transport Plan
- Nowra Bomaderry Structure Plan

- Princes Highway Corridor Strategy.

An outline of the strategies and plans and how they apply to the proposal is presented in Section 2.1. Nowra Bridge provides an important link for the A1 Princes Highway, the primary coastal route between Sydney and Melbourne.

The economic benefits of undertaking the proposal compared to the do minimum include:

- Improved travel times including the forecast projections for 2046
- Increased freight productivity due to the removal of overheight and HML vehicle restrictions
- Decreased travel times on would result in positive economic effects to freight, commuter and tourist traffic travelling both within the proposal area and longer distance regional trips (originating from, ending within or passing through the proposal area)
- Decreases in travel times would increase the attractiveness of the local area to commercial business and industry; new business may choose to locate inside the local area to gain adequate freight access, while decreasing commuting times in the proposal area would promote employment growth in the region
- Supporting regional tourism through improved access to tourist attractions and destinations along the Princes Highway and in the wider Shoalhaven region
- Improved safety and travel time savings and reliability would facilitate safer and quicker access along the highway for visitors and tourists, resulting in beneficial impacts for tourism related businesses and destinations.

8.1.4 Public interest

The proposal would improve vehicle travel times, improve safety, reduce congestion and improve freight movement along the Princes Highway in the Nowra Region. Retention of the existing southbound bridge would maintain the heritage significance for the local area and State Government heritage asset.

8.2 Objects of the EP&A Act

Object		Comment
1.3(a)	To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources.	The proposal would improve the efficiency of traffic movements along a key section of the Princes Highway. The existing southbound bridge would be retained, retaining its heritage values and providing for future use as a shared path, benefiting the local community. A range of safeguards and management measures have been identified to minimise environmental impacts associated with the proposal.
1.3(b)	To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment.	Ecologically sustainable development is considered in Sections 8.2.1 to 8.2.4.

Object		Comment
1.3(c)	To promote the orderly and economic use and development of land.	Not relevant to the proposal.
1.3(d)	To promote the delivery and maintenance of affordable housing.	Not relevant to the proposal.
1.3(e)	To protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats.	Potential impacts on biodiversity are discussed in Section 6.9. Removal of vegetation would be required in some areas, however the impacts would be minimised through the safeguards and mitigation measures for the proposal.
1.3(f)	To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage).	Potential impacts on Aboriginal and non-Aboriginal heritage are discussed in Sections 6.3 and 6.4 respectively. The proposal would directly impact up to seven Aboriginal sites and partially impact one State Heritage Registered site, Graham Lodge, which has identified Aboriginal cultural values. The proposal would impact on non-Aboriginal heritage including the locally listed Captain Cook Bicentennial Memorial (LEP No. 338), 'Lynburn' (LEP No. 130), 'Illowra' (LEP No. 136), and the potential unlisted heritage item 'M&M Guesthouse'. There would be neutral to minor physical and visual impacts to remaining listed non-Aboriginal heritage items within the study area. Impacts would be minimised through the safeguards and mitigation measures for the proposal.
1.3(g)	To promote good design and amenity of the built environment.	Urban design, landscape character and visual impacts are discussed in Section 6.5. Assessment and mitigation of impacts has been carried out in accordance with the key urban design objectives and principles developed for the proposal.
1.3(h)	To promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants.	Not relevant to the proposal.
1.3(i)	To promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State.	Not relevant to the proposal.

Object		Comment
1.3(j)	To provide increased opportunity for community participation in environmental planning and assessment.	Community and relevant government agency engagement has been ongoing from the beginning of the proposal in 2013, and during the preparation of this REF.

8.2.1 The precautionary principle

This principle requires evaluation of the threats of serious or irreversible environmental damage. This principle states 'if there are threats of serious or irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation'.

This REF has been prepared utilising the precautionary principle, with options being considered and assessed with the purpose of reducing risk of serious and permanent impacts on the environment.

The detailed assessment is provided in Chapter 6 of the REF and recommendations for environmental management are provided in Chapter 7.

Safeguards have been proposed to minimise potential impacts. These would be implemented during construction and operation of the proposal. No safeguards have been postponed as a result of lack of scientific certainty.

A CEMP would be prepared prior to construction. This would ensure the proposal achieves a high-level of environmental performance. No management measures or mechanisms would be postponed as a result of a lack of information.

8.2.2 Intergenerational equity

The proposal would not result in any impacts that are likely to adversely impact on the health, diversity or productivity of the environment for future generations. The proposal would benefit future generations by reducing congestion which would have a positive benefit for all road users.

Should the proposal not proceed, future generations would continue to experience a lower level of service associated with the existing crossings and associated local road network.

8.2.3 Conservation of biological diversity and ecological integrity

The study area is predominantly cleared of native vegetation with current land uses including residential, commercial, and public recreation. A robust assessment was carried to identify and manage any potential impacts of the proposal on local biodiversity. Biodiversity constraints have been and would continue to be considered throughout the design process. The construction footprint has been delineated with careful consideration of the design's direct footprint, where possible to minimise impacts on all environmental aspects.

The assessment concluded the proposal would not have a significant impact on biological diversity and ecological integrity.

8.2.4 Improved valuation, pricing and incentive mechanisms

The proposal has been designed with the objective of minimising potential impacts on the surrounding environment, thereby minimising costs to the environment.

The environmental consequences of the proposal have been assessed in this REF and mitigation measures identified for factors with potential adverse impact. The requirement to implement these management measures would result in an economic cost to Roads and Maritime. The implementation of management measures would increase both the capital and operating costs of the proposal. Similarly, the concept design has been developed with an objective of minimising potential impacts on the surrounding environment.

8.3 Conclusion

The proposed new Shoalhaven River crossing and associated intersection and road upgrade works at Nowra is subject to assessment under Division 5.1 of the EP&A Act. The REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity.

This has included consideration (where relevant) of conservation agreements and plans of management under the NPW Act, biodiversity stewardship sites under the BC Act, wilderness areas, areas of outstanding value, impacts on threatened species and ecological communities and their habitats and other protected fauna and native plants. It has also considered potential impacts to matters of national environmental significance listed under the Federal EPBC Act.

A number of potential environmental impacts from the proposal have been avoided or reduced during the concept design development and options assessment. The proposal as described in the REF best meets the project objectives but would still result in some impacts on traffic (during construction) native vegetation, seagrass, amenity (associated with construction noise and vibration emissions), water quality, Aboriginal and non- Aboriginal heritage, flooding, property acquisition and visual impacts. Safeguards and management measures as detailed in this REF would ameliorate or minimise these expected impacts. However, the proposal would also improve safety, improve driving conditions and reduce travel times on the Princes Highway.

On balance, the proposal is considered justified and the following conclusions are made.

Significance of impact under NSW legislation

The proposal would be unlikely to cause a significant impact on the environment. Therefore it is not necessary for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning under Division 5.2 of the EP&A Act. A Biodiversity Development Assessment Report or Species Impact Statement is not required. The proposal is subject to assessment under Division 5.1 of the EP&A Act. Consent from Shoalhaven City Council is not required.

Significance of impact under Australian legislation

The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*. A referral to the Australian Government Department of the Environment and Energy is not required.

9. Certification

This review of environmental factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.

Chris Masters

Technical Principal, Environment

SMEC Australia Pty Ltd

Date: 22 August 2018

I have examined this review of environmental factors and accept it on behalf of Roads and Maritime Services.

Daniel McClure

Project Development Manager

Regional Project Office | Technical and Project Services

Date:

10. References

AECOM. (2014) Nowra Bridge Project, Site Options Development report

Artefact Heritage Services (2015) Nowra Bridge Conservation Management Plan

Artefact Heritage Services. (2018a) Non-Aboriginal Statement of Heritage Impact

Artefact Heritage Services. (2018b) Nowra Bridge Project Draft Aboriginal Cultural Heritage Assessment Report PACHCI Stage 3

Artefact Heritage Services. (2018c) Nowra Bridge PACHCI Stage 3 Aboriginal Technical Report

Arup Pty Ltd. (2018a) Nowra Bridge 80% Concept Design Report

Arup Pty Ltd. (2018b) Nowra Bridge Project Traffic and Transport Assessment

Arup Pty Ltd. (2018c) Nowra Bridge Project Technical Paper – Flooding and Hydrology Assessment

Australian and New Zealand Environment and Conservation Council *and Agricultural and Resource Management Council of Australian and New Zealand. (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

Bureau of Meteorology (2017) Daily Weather Observations from Nowra RAN Air Station AWS (station 068072), Bureau of Meteorology, Melbourne.

Department of Environment and Climate Change. (2009) Interim Construction Noise Guideline

Department of Environment, Climate Change and Water (2010) Aboriginal Cultural Heritage Consultation Requirements for proponents.

Department of Environment, Climate Change and Water (2011) Road Noise Policy

Department of Environment. (2013) Matters of National Environmental Significance, Significant Impact Criteria Guidelines 1.1 Environmental Protection and Biodiversity Conservation Act 1999.

Department of Environment and Energy. (2018). National Pollutant Inventory. http://www.npi.gov.au/

Department of Industry. (2018) Shoalhaven Catchment. Accessed on 8 June 2018 from http://www.water.nsw.gov.au/water-management/basins-and-catchments/shoalhaven-catchment

Department of Primary Industries (2013) *Policy and guidelines for fish habitat conservation and management*, NSW Department of Primary Industries.

Department of Urban Affairs and Planning. (1995/1996) *Is an EIS Required?* Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979

Department of Urban Affairs and Planning.(1996) Roads and Related Facilities EIS Guideline

Environment Protection Authority (2000) Industrial Noise Policy

Environment Protection Authority (2014) NSW Waste Classification Guidelines

Hazelton, P.A. (1992) *Soil Landscapes of Kiama 1:100 000 Sheet*. Soil Conservation Service of NSW

Infrastructure NSW. (2012) State Infrastructure Strategy 2012-2032

Infrastructure NSW. (2018) State Infrastructure Strategy 2018-2038: Building Momentum

Kuginis L, Byrne G, Serov P and Williams J.P. (2012) Risk assessment guidelines for groundwater dependent ecosystems, Volume 3 – Identification of high probability groundwater dependent ecosystems on the coastal plains of NSW and their ecological value, NSW Department of Primary Industries, Office of Water, Sydney

Lampert, R. (1971) Interim Report on Archaeological Fieldwork in December 1970, NSW South Coast. Unpublished Report to NSW National Parks and Wildlife.

Landcom. (2004) Managing urban stormwater: soils and construction Volume 1, (the 'Blue Book')

Moenting A. and Morris D. (2006) Disturbance and Habitat Use: Is Edge More Important than Area? *Oikos* Vol. 115, No 1, pp. 23-32. Published by Wiley on behalf of Nordic Society Oikos.

NSW Maritime. (2009). Shoalhaven River Safe Boating Plan 2009 – 2013

Office of Environment and Heritage. (2016) NSW Guide to Surveying Threatened Plants

Office of Environment and Heritage. (2014) Illawarra Climate change snapshot, OEH, Sydney.

Office of Environment and Heritage. (2011) Guidelines for Consultants Reporting on Contaminated Sites, OEH, Sydney.

Peter Freeman Pty Ltd. (2000) Graham Lodge Precinct, Nowra. Conservation Management Plan. Report prepared for the Shoalhaven City Counci.

Peter Freeman Pty Ltd. (2003) Heritage Study 1995-1998. Report prepared for the Shoalhaven City Council.

Renzo Tonin and Associates. (2018) Nowra Bridge Project Princes Highway Upgrade Noise and Vibration Assessment

Roads and Maritime Services. (2011) *Procedure for Aboriginal Cultural Heritage Consultation and Investigation*. November 2011.

Roads and Maritime Services. (2012a) Bridge Aesthetics

Roads and Maritime Services. (2012b) Environmental Assessment Practice Note: Biodiversity Assessment EIA-N06.

Roads and Maritime Services. (2013) Environmental Impact Assessment Guidance Note – Guidelines for Landscape Character and Visual Impact Assessment

Roads and Maritime Services. (2013) EIA Practice Note on Socio-economic Assessment (EIA-05)

Roads and Maritime Services. (2014a) Noise Criteria Guideline

Roads and Maritime Services. (2014b) Noise Mitigation Guideline

Roads and Maritime Services. (2014) Nowra Bridge Project Consultation Report

Roads and Maritime Services. (2014c) Beyond the Pavement urban design policy, process and principles

Roads and Maritime Services. (2015) The Standard Management Procedure - Unexpected Heritage Items

Roads and Maritime Services. (2015) Nowra Bridge Project Consultation Summary

Roads and Maritime Services. (2016) Construction Noise and Vibration Guideline

Roads and Maritime Services. (2017) Water sensitive urban design guideline

Roads and Maritime Services. (2018) Nowra Bridge Project Community Consultation Report

Roads and Traffic Authority. (2001) Environmental Noise Management Manual

Roads and Traffic Authority. 2005. Princes Highway Shoalhaven River Crossing Interchange Study, report prepared by SMEC Australia for Roads and Traffic Authority, Sydney.

Roads and Traffic Authority. (2004) Additional Shoalhaven River Crossing, Nambaa Island to Bangalee, report prepared by SMEC Australia for Roads and Traffic Authority, Sydney.

Roads and Traffic Authority. (2008) Landscape guideline.

Shoalhaven City Council. (2006a) Nowra Bomaderry Structure Plan

Shoalhaven City Council. (2006b) Nowra Bomaderry Structure Plan Background Report.

Shoalhaven City Council. (2008) Shoalhaven River Estuary Management Plan

Shoalhaven City Council. (2017) Nowra Key Roads Projects Strategic Overview Report.

Shoalhaven City Council, (2018) Surface water quality, accessed on 8 June from https://www.shoalhaven.nsw.gov.au/soe/Region/Indicator%20homes/Surfacewaterquality.htm

Shoalhaven Historical Society. (2014) The Old Nowra Bridge: Protecting our Heritage, ensuring our future. Report prepared for Roads and Maritime Services NSW.

SMEC Australia Pty Ltd. (2018a) Nowra Bridge Biodiversity Assessment Report

SMEC Australia Pty Ltd. (2018b) Nowra Bridge Operational Water Quality Assessment

SMEC Australia Pty Ltd. (2018c) Nowra Bridge Soil and Water Assessment

SMEC Australia Pty Ltd. (2018d) Nowra Bridge Project Socio-economic Impact Assessment

Spackman Mossop Michaels. (2018) Nowra Bridge and Interchanges Urban Design Report and Landscape Character and Visual Impact Assessment

State of NSW and Office of Environment and Heritage. (2018) *New South Wales Annual Compliance Report 2016 National Environment Protection (Ambient Air Quality) Measure*

Sydney Catchment Authority. (2011) State of the Science – Catchment Impacts Summary report, August 2011

Transport for NSW. (2012) Construction Noise Strategy 7TP-ST-157/2.0

Transport for NSW. (2013) NSW Freight and Ports Strategy.

Transport for NSW. (2014) Nowra Bridge Project Site Development Report.

Transport for NSW. (20150 Regional Boating Plan Shoalhaven – Illawarra Region.

Transport for NSW. (2016) Princes Highway Corridor Strategy

WMAwater. (2013) Lower Shoalhaven River Flood Study

Terms and acronyms used in this REF

Term / Acronym	Description
AEC	Areas of environmental concern
AEP	Annual exceedance probability
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management Systems
AHIP	Aboriginal Heritage Impact Permit
AoS	Assessment of Significance
AQMP	Air Quality Management Plan
ARI	Average recurrence interval
ASS	Acid sulfate soils
ASSMP	Acid Sulfate Soil Management Plan
BAR	Biodiversity Assessment Report
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BoM	Bureau of Meteorology
CEMP	Construction environmental management plan
CSEP	Community and Stakeholder Engagement Plan
CLM Act	*Crown Land Management Act 2016* (NSW)
DOS	Degree of saturation
DPI	Department of Primary Industries
EEC	Endangered ecological community
EIA	Environmental impact assessment
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW); provides the legislative framework for land use planning and development assessment in NSW
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth); provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
EPL	Environment Protection Licence
ESA	Environmental site assessment
ESCP	Erosion and Sedimentation Control Plan
ESD	Ecologically sustainable development; development which uses, conserves and enhances the resources of the community so that ecological processes

Term / Acronym	Description
	on which life depends, are maintained and the total quality of life, now and in the future, can be increased
FFMP	Flora and Fauna Management Plan
FM Act	*Fisheries Management Act 1994* (NSW)
GDE	Groundwater dependent ecosystem
Heritage Act	*Heritage Act 1977* (NSW)
HML	Higher mass limit
HRMP	Hazard and Risk Management Plan
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
KTP	Key threatening process
LEP	Local Environmental Plan; a type of planning instrument made under Part 3 of the EP&A Act
LGA	Local government area
LoS	Level of Service. A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers.
MNES	Matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*
NAHMP	Non-Aboriginal Heritage Management Plan
NCA	Noise Catchment Area
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
NVMP	Noise and Vibration Management Plan
OEH	Office of Environment and Heritage
PACHCI	Procedure for Aboriginal Cultural Heritage Consultation and Investigation
PAD	Potential archaeological deposits
PASS	Potential acid sulfate soil
PBS	Performance Based Standards
PCT	Plant community type
PEI	Preliminary environmental investigation
POEO Act	*Protection of the Environment Operations Act 1997* (NSW)
REF	Review of environmental factors
Roads and Maritime	NSW Roads and Maritime Services
SEIA	Socio-economic impact statement

Term / Acronym	Description
SEPP	State Environmental Planning Policy; a type of planning instrument made under Part 3 of the EP&A Act
SHR	State Heritage Register
SOHI	Statement of Heritage Impact
SWMP	Soil and Water Management Plan
TMP	Traffic Management Plan
TSS	Total Suspended Solids
VHT	Vehicle hours travelled
VM	Value Management
WMP	Waste Management Plan
WQO	Water Quality Objective(s)
WSUD	Water sensitive urban design

Appendix A

Consideration of clause 228(2) factors and matters of national environmental significance

Clause 228(2) Checklist

In addition to the requirements of the *Is an EIS required?* guideline (DUAP 1995/1996) and the *Roads and Related Facilities EIS Guideline* (DUAP 1996) as detailed in the REF, the following factors, listed in clause 228(2) of the Environmental Planning and Assessment Regulation 2000, have also been considered to assess the likely impacts of the proposal on the natural and built environment.

Factor	Impact
a) Any environmental impact on a community? Construction activities would have impacts on the local community associated with property acquisition, changed visual amenity, and potential noise, traffic impacts, and air quality impacts. These would be managed through implementation of the management measures and safeguards listed in Chapter 7. Once operational the proposal would improve the efficiency of traffic movement along this section of the Princes Highway through providing additional capacity that would accommodate predicted traffic growth up to 2046. The proposal would remove restrictions for southbound HML and overheight vehicles, and would improve road safety.	Short term negative Long term positive
b) Any transformation of a locality? The proposal includes local road upgrades and construction of a new bridge across the Shoalhaven River to the west of the existing northbound bridges. Construction works would introduce short term changes to the locality associated with construction activities and temporary use of areas for works. The new bridge has been designed to generally match the form of the northbound bridge to limit changes in views from key view points. The existing southbound bridge would be retained, allowing the ongoing historical significance and vistas to remain within the area. The proposal footprint is within or directly adjacent to the existing road corridor and as such is not considered to substantially transform the locality. Urban design would form part of the detailed design and potential visual impacts would be managed through adopting the management measures and safeguards as listed in chapter 7.	Short term negative Nil
c) Any environmental impact on the ecosystems of the locality? The proposal would result in: • Clearing of up to 2.18 hectares of native vegetation, including 0.09 hectares of the EEC Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions • Removal of 19 *Syzygium paniculatum* individuals (threatened flora); this species is listed as endangered under the *Biodiversity Conservation Act 2016* • Potential impacts on up to 0.09 hectares of seagrass (*Zostera muelleri*), which constitute a Type 1 key fish habitat under the *Fisheries Management Act 1994*.	Short term negative impact

Factor	Impact
The assessment concluded that these impacts would not be significant. . Impacts would be managed through the adopting the management measures and safeguards as listed in Chapter 7 including biodiversity offsets and detailed design recommendations.	
d) Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? The proposal would result in the removal of road side vegetation which would alter the visual amenity of this section of the highway, particularly to the north of the Shoalhaven River. This would be mitigated through the through landscaping and plantings but would take 10-15 years to reach maturity. Short term impacts associated with the construction period would be managed through the adopting the management measures and safeguards listed in Chapter 7.	Medium-term negative
e) Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations? The proposal would result in a minor physical impact to Graham Lodge (SHR, LEP 389), a major physical and visual impact to the locally listed Captain Cook Bicentennial Memorial (LEP No. 338), a moderate physical and visual impact to the locally listed 'Lynburn' (LEP No. 130), minor physical and visual impact to the existing southbound bridge (s170). There would be neutral to minor physical and visual impacts to the remaining listed non-Aboriginal heritage items within the study area. The proposal would impact up to eight known Aboriginal sites. Impacts to these sites will be managed through application for an AHIP. The proposal has assessed the impacts on these sites in consultation with Aboriginal stakeholders, and it was concluded that none had significant cultural value. Impacts to heritage items would be managed through adopting the management measures and safeguards as listed in Chapter 7.	Short–term negative impact
f) Any impact on the habitat of protected fauna (within the meaning of the *National Parks and Wildlife Act 1974)?* The proposal would result in the removal of up to 2.18 hectares of native vegetation (including 0.09 hectares of the EEC Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions) and potentially impact on up to 0.09 hectares of seagrass *Zostera muelleri* (which constitutes Type 1/Type 2 key fish habitat). Impacts have been assessed as unlikely to be significant. Hollow-bearing trees were recorded at very low density throughout the study area with two hollow-bearing trees being found in the south of the study area, accounting for one small (0 to 5 centimetre diameter) and three medium sized (5 to 10 centimetre diameter) hollows Biodiversity impacts would be managed through the adopting the management measures and safeguards as listed in chapter 7 including biodiversity offsets and detailed design recommendations to reduce impact to biodiversity within the locality.	Short–term negative impact

Factor	Impact
g) Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? The proposal would require the removal of native vegetation and seagrass. Significant impacts to flora and fauna are unlikely as a result of the proposal. The proposal would not result in the endangering of any species. The management measures and safeguards listed in Chapter 7 include biodiversity offsets and detailed design recommendations to reduce impact to biodiversity.	Nil
h) Any long-term effects on the environment? The proposal would result in the removal of up to 2.18 hectares of native vegetation (including 0.09 hectares of the EEC Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions) and potentially impact on up to 0.09 hectares of seagrass *Zostera muelleri* (which constitutes Type 1/Type 2 key fish habitat). Impacts have been assessed as unlikely to be significant. Long term effects are considered unlikely. The proposal would result in a minor physical impact to Graham Lodge (SHR, LEP 389), a major physical and visual impact to the locally listed Captain Cook Bicentennial Memorial (LEP No. 338), a moderate physical and visual impact to the locally listed 'Lynburn' (LEP No. 130), minor physical and visual impact to the existing southbound bridge (s170). There would be neutral to minor physical and visual impacts to the remaining listed non-Aboriginal heritage items within the study area. These effects are considered to be short to medium term in duration. The proposal would impact up to eight known Aboriginal sites. Impacts to these sites will be managed through application for an AHIP. The proposal has assessed the impacts on these sites in consultation with Aboriginal stakeholders, and it was concluded that none had significant cultural value. These effects are considered to be short to medium term in duration. Impacts to the environment would be managed through adopting the management measures and safeguards as listed in Chapter 7.	Nil
i) Any degradation of the quality of the environment? Construction of the proposal has the potential to degrade the quality of the environment through accidental spills, inadequate erosion and sedimentation controls during construction and vegetation removal. Impacts to the environment would be managed through adopting the management measures and safeguards as listed in Chapter 7.	Short-term negative
j) Any risk to the safety of the environment? Once operational, the proposal would improve traffic safety within the area. Impacts to the environment would be managed through adopting the management measures and safeguards as listed in chapter 7.	Long-term positive
k) Any reduction in the range of beneficial uses of the environment? There may be a temporary reduction in the range of beneficial uses during construction associated with restricting public access to specific areas for safety reasons.	Short term negative

Factor	Impact
The proposal would improve safety for vehicles, pedestrians and cyclists using the Princes Highway through Nowra Bomaderry.	Long-term positive
l) Any pollution of the environment? Construction activities have the potential to degrade the quality of the environment through accidental spills, and through inadequate erosion and sedimentation controls. Local air quality may be reduced during construction activities, associated with dust and plant emissions. Impacts to the environment would be managed through adopting the management measures and safeguards as listed in Chapter 7. The new bridge would capture and treat pavement drainage prior to discharge, reducing suspended solids and nutrients, which would be beneficial to receiving water quality. The removal of vehicles from the existing southbound bridge, which drains directly to the Shoalhaven River, would also contribute to improved water quality through removing a source of pollutants.	Short-term negative Long-term positive
m) Any environmental problems associated with the disposal of waste? No material issues are anticipated with regard to disposal of wastes. Impacts to the environment would be managed through adopting the management measures and safeguards as listed in Chapter 7.	Nil
n) Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply? No issues with resource demand have been identified. Impacts to the environment would be managed through adopting the management measures and safeguards as listed in Chapter 7.	Nil
o) Any cumulative environmental effect with other existing or likely future activities? There is potential for cumulative impacts on travel times should construction overlap with other nearby projects, particularly the Berry to Bomaderry upgrade, resulting in longer travel times. This project would also contribute to the reduction in fragmented road side habitat, however, the affected vegetation community is not an EEC. Potential cumulative impacts on travel times during the construction period. Impacts to the environment would be managed through adopting the management measures and safeguards as listed in Chapter 7. The proposal, together with other upgrade projects along the Princes Highway would be expected to collectively contribute to improved travel times once construction is completed.	Short term negative Long term positive
p) Any impact on coastal processes and coastal hazards, including those under projected climate change conditions? The new northbound bridge would have minimal impact on coastal processes in view of it being of a similar size and form to the existing northbound bridge, and its distance from the coast. Projected climate change conditions have been considered in the concept design as outlined in Chapter 6.	Nil

Factor	Impact
Impacts to the environment would be managed through adopting the management measures and safeguards as listed in Chapter 7.	

Matters of National Environmental Significance

Under the environmental assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposal should be referred to the Australian Government Department of the Environment and Energy.

A referral is not required for proposed actions that may affect nationally listed threatened species, endangered ecological communities and migratory species. Impacts on these matters are still assessed as part of the REF in accordance with Australian Government significant impact criteria and taking into account relevant guidelines and policies.

Factor	Impact
a) Any impact on a World Heritage property? There are no World Heritage properties within or near the proposal study area.	Nil
b) Any impact on a National Heritage place? There are no National heritage places within or near the proposal study area.	Nil
c) Any impact on a wetland of international importance? There are no wetlands of international importance within the proposal study area.	Nil
d) Any impact on a listed threatened species or communities? 19 Magenta Lilly Pilly (*Syzygium paniculatum*) will be removed as a part of the proposal. These individual plants were planted as part of the screening vegetation and it is highly unlikely that these individuals form part of a local, naturally occurring population. Grey-headed Flying-fox (*Pteropus poliocephalus*) are located within the study area, however these will not be directly or indirectly impacted as a result of the proposal.	Short-term negative
e) Any impacts on listed migratory species? Rufous Fantail (*Rhipidura rufifrons*) has been recorded within 100 metres of the proposal study area during the fauna surveys. There would be minimal impact to listed migratory species during the construction phase of the proposal.	Short-term negative
f) Any impact on a Commonwealth marine area? There are no Commonwealth marine areas within or near the proposal study area.	Nil
g) Does the proposal involve a nuclear action (including uranium mining)? The proposal not involve a nuclear action.	Nil
h) Additionally, any impact (direct or indirect) on Commonwealth land? There is no Commonwealth land within or near the proposal study area.	Nil

Appendix B

Statutory consultation checklists

Infrastructure SEPP

Council related infrastructure or services

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Stormwater	Are the works likely to have a *substantial* impact on the stormwater management services which are provided by council?	Yes	Shoalhaven City Council	ISEPP cl.13(1)(a)
Traffic	Are the works likely to generate traffic to an extent that will *strain* the capacity of the existing road system in a local government area?	Yes	Shoalhaven City Council	ISEPP cl.13(1)(b)
Sewerage system	Will the works involve connection to a council owned sewerage system? If so, will this connection have a *substantial* impact on the capacity of any part of the system?	No	Shoalhaven City Council	ISEPP cl.13(1)(c)
Water usage	Will the works involve connection to a council owned water supply system? If so, will this require the use of a *substantial* volume of water?	No	Shoalhaven City Council	ISEPP cl.13(1)(d)
Temporary structures	Will the works involve the installation of a temporary structure on, or the enclosing of, a public place which is under local council management or control? If so, will this cause more than a *minor* or *inconsequential* disruption to pedestrian or vehicular flow?	Yes	Shoalhaven City Council	ISEPP cl.13(1)(e)
Road & footpath excavation	Will the works involve more than *minor* or *inconsequential* excavation of a road or adjacent footpath for which council is the roads authority and responsible for maintenance?	Yes	Shoalhaven City Council	ISEPP cl.13(1)(f)

Local heritage items

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Local heritage	Is there is a local heritage item (that is not also a State heritage item) or a heritage conservation area in the study area for the works? If yes, does a heritage assessment indicate that the potential impacts to the heritage	Yes	Shoalhaven City Council	ISEPP cl.14

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
	significance of the item/area are more than *minor* or *inconsequential?*			

Flood liable land

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Flood liable land	Are the works located on flood liable land? If so, will the works change flood patterns to more than a *minor* extent?	Yes	Shoalhaven City Council	ISEPP cl.15

Public authorities other than councils

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
National parks and reserves	Are the works adjacent to a national park or nature reserve, or other area reserved under the *National Parks and Wildlife Act 1974*, or on land acquired under that Act?	No	Office of Environment and Heritage	ISEPP cl.16(2)(a)
National parks and reserves	Are the works on land in Zone E1 National Parks and Nature Reserves or in a land use zone equivalent to that zone?	No	Office of Environment and Heritage	ISEPP cl. 16(2)(b)
Aquatic reserves	Are the works adjacent to an aquatic reserve or a marine park declared under the *Marine Estate Management Act 2014*?	No	Department of Industry	ISEPP cl.16(2)(c)
Sydney Harbour foreshore	Are the works in the Sydney Harbour Foreshore Area as defined by the *Sydney Harbour Foreshore Authority Act 1998?*	No	Sydney Harbour Foreshore Authority	ISEPP cl.16(2)(d)
Bush fire prone land	Are the works for the purpose of residential development, an educational establishment, a health services facility, a correctional centre or group home in bush fire prone land?	No	Rural Fire Service	ISEPP cl.16(2)(f)
Artificial light	Would the works increase the amount of artificial light in the night sky and that is on land within the dark sky region as identified on the dark sky region map? (Note: the dark sky	No	Director of the Siding Spring Observatory	ISEPP cl.16(2)(g)

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
	region is within 200 kilometres of the Siding Spring Observatory)			
Defence communications buffer land	Are the works on buffer land around the defence communications facility near Morundah? (Note: refer to Defence Communications Facility Buffer Map referred to in clause 5.15 of Lockhardt LEP 2012, Narrandera LEP 2013 and Urana LEP 2011.	No	Secretary of the Commonwealth Department of Defence	ISEPP cl. 16(2)(h)
Mine subsidence land	Are the works on land in a mine subsidence district within the meaning of the *Mine Subsidence Compensation Act 1961*?	No	Mine Subsidence Board	ISEPP cl. 16(2)(i)

Appendix C

Traffic and Transport Assessment

Appendix D

Noise and vibration assessment

Appendix E

Cultural heritage assessment report

Appendix F

Statement of heritage impact

Appendix G

Landscape character and visual impact assessment

Appendix H

Flooding and hydrology assessment

Appendix I

Socio-economic impact assessment

Appendix J

Biodiversity assessment report

Appendix K

Soil and water assessment

Appendix L

Operational water quality assessment

rms.nsw.gov.au/

13 22 13

Customer feedback
Roads and Maritime
Locked Bag 928,
North Sydney NSW 2059

August 2018
RMS 18.942
ISBN: 978-1-925797-58-9