



Roads &
Maritime

Roads and Maritime Services
M1 Pacific Motorway extension to Raymond Terrace
Discussion paper – Revised concept design

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Executive summary

Introduction and need

Roads and Maritime Services has been investigating the extension of a motorway link from the M1 Pacific Motorway at Black Hill to the A1 Pacific Highway at Raymond Terrace since 2004. In 2014 the NSW Government allocated funding for Roads and Maritime to progress planning of this project.

In 2014 Roads and Maritime initiated an extensive review of the existing 2010 concept design to identify and investigate potential improvements to the project. The review found that there was an opportunity to change the alignment and existing concept design to ensure that the project adequately addressed connectivity to the adjoining local and state road networks. The review also incorporated lessons learnt from recent Pacific Highway upgrades in major floodplains and soft soil areas, such as the Pacific Highway bypass of Kempsey and Ballina. In response to the findings of this review, Roads and Maritime engaged Jacobs Australia Pty Ltd (Jacobs) in November 2014 to review and revise the existing concept design by developing additional alignment and interchange options, and to prepare an Environmental Impact Statement (EIS).

Existing 2010 concept design

The initial concept design for the project was placed on public exhibition in 2008. Roads and Maritime then issued a submissions report in December 2010 which detailed responses to the 150 submissions received from the community and stakeholders. In response to the submissions, refinements were made to the concept design, and this refined concept design was publicly released with the submissions report. Land required for the concept design was reserved in the Newcastle City Council and Port Stephens Council Local Environmental Plans (LEPs).

Review of the existing concept design

Key aspects considered during the review of the existing concept design included:

- The project's functionality and performance, including connectivity to the adjoining state road network
- Design and geometric elements of the project, and how lessons learnt from recently completed Pacific Highway projects in floodplain and soft soil areas could be incorporated into a revised design
- Environmental impacts, particularly regarding recent changes to environmental policy and legislation
- Traffic characteristics, particularly regarding changes to the regional road network since the opening of the Hunter Expressway in 2014 and completion of other road projects
- Integration with the existing transport network and the ability to accommodate any potential future upgrades.

Considering the above, the review identified a number of issues and concerns with the 2010 design:

- **Functionality:** high demand through the M1 Pacific Motorway and Weakleys Drive intersection for all traffic heading south on the motorway as a result of the Black Hill interchange and undesirable 'weaving' by traffic on the approach lanes to the intersection with John Renshaw Drive. Similar issues with traffic weaving are

present at the Tomago interchange, due to northbound traffic needing to use a loop ramp to join southbound traffic before turning into Tomago Road

- Design: bridge arrangements across the Hunter River, floodplain, and areas with poor ground conditions and flood immunity
- Constructability: site constraints at Hexham and Masonite Road, Heatherbrae and the need to extend structures across the floodplain
- Environment: impacts on wetlands listed under the State Environmental Planning Policy No. 14 – Coastal Wetlands and other sensitive environmental areas
- The LEP corridor and neighbouring developments: the Hexham rail corridor and footprint being developed by Australian Rail Track Corporation (ARTC) and Aurizon, the proposed Heatherbrae industrial development, and allowing for integration with future transport infrastructure upgrades.

Options

Further investigation and assessment was initiated following the review of the existing concept design. This process considered the project objectives, opportunities for improved performance and functionality, lessons learned from other Roads and Maritime projects, and the various constraints and opportunities associated with the project.

The focus for this investigation and assessment was the area located between Black Hill in the south-west and the Hunter Region Botanical Gardens to the north-east. The project north of the Hunter Region Botanical Gardens largely remains the same as the existing concept design presented in 2010, as the corridor is restricted by the Tomago Sandbeds (a source of drinking water for Newcastle) and the adjacent industrial development.

The investigation and assessment process identified three feasible options, which included various interchange arrangements. The options identified were:

- **Alignment 0:** Alignment 0 is the existing concept design as presented in 2010 with refinements at Black Hill and across the floodplain to improve functionality and performance. These refinements allow for a comparative assessment with the other alignments
- **Alignment 1:** Alignment 1 passes to the north of Alignment 0 between Black Hill and Tomago, bridging the Hunter River slightly to the north of the Alignment 0 crossing. This alignment improves connectivity to the regional road network and constructability in crossing the rail, road, floodplain and the Hunter River. Tomago interchange variations for Alignment 1 were called 'Tomago 1A' and 'Tomago 1B'
- **Alignment 2:** Alignment 2 passes to the north of Alignment 0 and Alignment 1 between Tarro and Tomago, bridging the Hunter River about two kilometres to the north-east of the Alignment 0 and Alignment 1 crossings. Alignment 2 avoids environmentally sensitive areas while improving connectivity and construction options. Tomago interchange variations for Alignment 2 were called 'Tomago 2A', 'Tomago 2B' and 'Tomago 2C'.

These options are shown in **Figure E-1** on page 7.

Options assessment

The process of comparing these options allowed key constraints and opportunities to be thoroughly considered within the design process. A process known as Value Management was applied. Values important to the project were identified through desktop investigations, and during collaborative workshops and meetings with key

stakeholders. These values were used to develop the assessment criteria which helped to determine the revised concept design.

Based on an initial analysis of the interchange options, Alignment 0, Alignment 1 – Tomago 1A, Alignment 2 – Tomago 2A and Tomago 2B were taken through to a Value Management Workshop in April 2015 for detailed consideration and evaluation against the assessment criteria.

It was determined through this workshop that Tomago 1A and Tomago 2A be progressed for further consideration. Both alignments performed equally from a social and economic perspective. Tomago 1A was the best performer from a functional perspective, while Tomago 2A was the best performer from an environmental perspective. It was concluded that Alignment 0 and Tomago 2B should not proceed any further.

Following the Value Management Workshop, further refinements were made to Tomago 1A to provide an intersection with Tomago Road that was comparable with Tomago 2A and to reduce the impact on sensitive wetland areas near the Hunter River. This refined alignment has been called 'Tomago 1B'.

A review of Tomago 1B and Tomago 2A found that the functionality and cost of these options were very similar. However, Tomago 2A was preferred as it avoided sensitive wetland areas near the Hunter River.

Further refinement of Tomago 2A was carried out to improve the Tomago interchange and achieve a longer-term solution for traffic demand. This included a new link road to connect between the motorway and Tomago Road and a grade separated interchange between Tomago Road and Old Punt Road. This amended alignment was called 'Tomago 2C'. Further investigation and assessment including traffic analysis, capital costs, and environmental factors confirmed Tomago 2C as the best performing alignment across the range of criteria.

Recommendation

The revised concept design for the project reflects the adoption of Alignment 2 – Tomago 2C. This allows for major improvements for connectivity to the surrounding road network and minimises environmental impacts.

The revised concept design would meet the project objectives by:

- Providing a motorway-standard dual carriageway road with a minimum of four lanes for the length of the project
- Increasing the posted speed limit to 110 km/h, which will halve travel time between Black Hill and the Raymond Terrace Bypass
- Improving access to key employment areas such as Tomago, Beresfield, Black Hill and the Port of Newcastle with interchanges that integrate with the local road network while retaining the function of existing interchanges
- Improving access for higher productivity and oversized vehicles within the study area, along the project route and to Tomago industrial area
- Improving flood access for the Lower Hunter across the Hunter River floodplain, by providing immunity for the one per cent AEP (annual exceedance probability) flood event between the M1 Pacific Motorway and Tomago
- Providing a design that will manage ongoing and incident road runoff through the Hunter Water drinking water catchment (specifically Tomago Sandbeds which supply water for Newcastle)

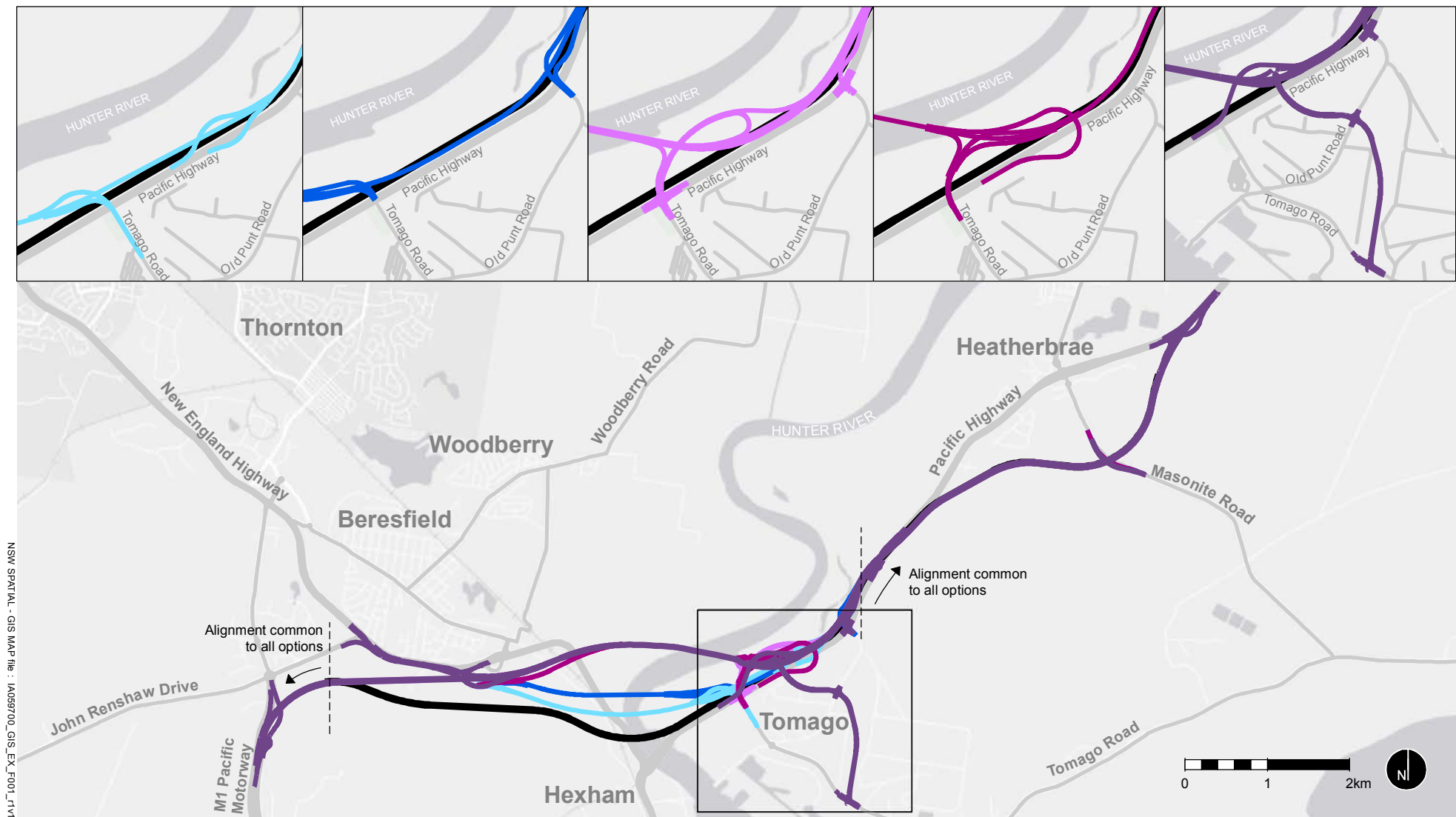
- Minimising impacts on sensitive habitats, such as waterways, wetlands, native vegetation and fauna, while promoting good urban design principles.

Next steps

The revised concept design is on display for community and stakeholder comment in October 2015. This provides an opportunity for the community and stakeholders to review the revised concept design and provide feedback.

Feedback received will be considered in completing the concept design, carrying out the environmental assessment and preparing the Environmental Impact Statement.

The timing of construction is not confirmed and is dependent on planning approval, future traffic needs and funding availability.



- Existing concept design
- Alignment 1 – Tomago 1A
- Alignment 2 – Tomago 2A
- Alignment 1 – Tomago 1B
- Alignment 2 – Tomago 2B
- Alignment 2 – Tomago 2C

Figure E-1 Options

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1 Introduction

This section introduces the project, provides an overview of the study area, outlines the strategic context and project objectives and describes the structure of the report.

1.1 Project overview

Roads and Maritime has been investigating the extension of the motorway from the M1 Pacific Motorway at Black Hill to the A1 Pacific Highway at Raymond Terrace since 2004. The project involves building about 15 kilometres of four-lane divided road that will bypass Beresfield, Tarro, Hexham, Tomago and Heatherbrae. The project will play a major role within the Lower Hunter road network, providing access to local centres such as Beresfield and Raymond Terrace, and also to major employment and commercial centres in the Hunter Region including Maitland, the Hunter Valley, Port Stephens, Newcastle Airport, the city of Newcastle and the Port of Newcastle. The extension would provide one of the last major motorway stages of the Pacific Motorway and the Pacific Highway between Sydney and Brisbane.

Planning for the M1 Pacific Motorway to the Pacific Highway at Raymond Terrace began in 2004 and has involved an extensive community and stakeholder consultation program to identify a preferred route and develop a concept design.

The initial concept design was displayed for community and stakeholder comment in 2008. Following consideration of community and stakeholder feedback, further refinements were made to the design and a submissions report was issued in December 2010.

The NSW Government allocated funding for Roads and Maritime to continue development and planning for the project in 2014. A review of the 2010 concept design was carried out to identify and investigate potential improvements to the project. The review found that further refinements of the alignment and concept design would improve connectivity with the local, regional and state road networks. The review also incorporated lessons learnt from recent Pacific Highway upgrades across major floodplains and soft soil areas, such as the Pacific Highway bypass of Kempsey and Ballina. Key aspects considered during the review of the existing concept design included:

- The project's functionality and performance, including connectivity to the adjoining state road network
- Design and geometric elements of the project, and how lessons learnt from recently completed Pacific Highway projects in floodplain and soft soil areas could be incorporated into a revised design
- Environmental impacts, particularly regarding recent changes to environmental legislation
- Traffic characteristics, particularly regarding changes to the regional road network since the opening of the Hunter Expressway in 2014 and completion of other road projects
- Integration with the existing transport network and the ability to accommodate any potential future upgrades.

In response to the findings of this review, Roads and Maritime engaged Jacobs Australia Pty Ltd (Jacobs) in November 2014 to further develop and refine the existing concept design by developing alignment and interchange options, and to prepare an Environmental Impact Statement (EIS) for the preferred concept design.

The objective was to develop and ultimately obtain approval from the Minister for Planning for a concept design that better met the project objectives and which considered lessons learned from other Roads and Maritime projects.

1.2 The study area

The study area extends from the northern end of the M1 Pacific Motorway to the Raymond Terrace Bypass. The study area is shown in **Figure 1-1**.

Key features of the study area that have influenced the location and design of the project to date include:

- The location of major roads of state importance, including the Pacific Motorway, the Pacific Highway, New England Highway, John Renshaw Drive, Hunter Expressway (via John Renshaw Drive), Tomago Road and Weakleys Drive
- The semi-rural and urban areas of Black Hill, Tarro and Heatherbrae
- The light industrial and commercial areas of Beresfield, Hexham, Tomago and Heatherbrae
- The Tomago Sandbeds, which form part of the Hunter Water drinking water catchment and the Tomago Groundwater Management Area (GMA), located to the east of Motto Farm and Heatherbrae
- Major infrastructure such as the Chichester Trunk Gravity Water Main, the New England Highway and overhead high voltage transmission lines
- The Hunter River, associated tributaries and extensive areas of floodplain
- The Hunter Region Botanic Gardens
- Extensive areas of wetland protected by State Environmental Planning Policy No.14 (SEPP 14 wetlands) in the northern parts of Hexham Swamp and along the banks of the Hunter River
- Areas of native vegetation listed as Threatened Ecological Communities (TECs) under the *Threatened Species Conservation Act 1995* at Black Hill, across the floodplain and on the Tomago Sandbeds
- Areas of potential and core koala habitat protected by State Environmental Planning Policy No.44 (SEPP 44 Koala habitat).



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- Study area
- Main Northern Railway
- LGA boundary



Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

Figure 1-1 The study area

1.3 Strategic context and need

The New England Highway and the Pacific Highway between the M1 Pacific Motorway at Black Hill and Raymond Terrace form part of the National Land Transport Network. The project also forms an essential part of the overall Pacific Highway Upgrade Program, which aims to complete a four-lane divided road from Hexham to Queensland by 2020. The project is one of the remaining upgrades required to complete the motorway between Sydney and Brisbane. The other projects are NorthConnex in northern Sydney and the Coffs Harbour Bypass.

The project is consistent with NSW strategic plans:

- *NSW Government State Infrastructure Strategy* (NSW Government, 2012a): this strategy includes a commitment to proceed with the detailed assessment and planning for the project in the short-term and, if feasible, to construct the link within the medium-term
- *NSW Long Term Transport Master Plan* (NSW Government, 2012b): this plan notes the importance of the link for freight and identifies the project as a medium to long-term initiative
- *Hunter Strategic 2013 Infrastructure Plan* (NSW Government, 2014): this plan aims to provide a strategic infrastructure framework that will inform future urban growth within the Hunter Metropolitan Area. This plan identifies the project as a priority, to be delivered within the next six to 20 years.

Major intersections within the study area do not currently provide the most effective method of access to key regional destinations such as Newcastle, Newcastle Airport and Port, and the Hunter Valley. The project is required to improve safety, reliability and efficiency of travel within the Lower Hunter regional road network by connecting the New England Highway, Hunter Expressway via John Renshaw Drive, Weakleys Drive, Pacific Highway and Tomago Road. Improved safety, reliability and efficiency within the road network would benefit mining, industrial, commercial, employment, recreational and residential areas within these key destinations.

The current route between the M1 Pacific Motorway at John Renshaw Drive and the Raymond Terrace Bypass does not meet motorway standards. It is not free flowing due to:

- The roundabout at the John Renshaw Drive and Weakleys Drive intersection (this intersection is currently proposed for upgrade to traffic signals as part of a separate project).
- The roundabout at the Pacific Highway and Masonite Road intersection
- Geometric constraints, including undesirable merging arrangements from John Renshaw Drive onto the New England Highway at Beresfield and tight curves northbound on Hexham Bridge
- Traffic lights along the route at Hank Street, Old Punt Road, Tomago Road and New England Highway at Hexham (southbound)
- Varied speed limits along the route.

Significant road user delays are experienced within the network, particularly during peak periods. At-grade intersections currently produce conflict points, resulting in vehicle crashes. The project would provide a free flowing, motorway standard road. Interchanges would reduce the number of conflict points currently at intersections, providing a safer route. The project would reduce travel times along the route for all road users (including heavy vehicles).

Aspects of the road network currently do not adequately cater for heavy vehicles, providing inadequate access to the key employment areas including Tomago and the Port of Newcastle (via Tomago Road). For instance, higher productivity vehicles up to 30 metres in length travelling south from the Tomago industrial area are required to use the northbound bridge in a contra-flow arrangement. These crossings can only occur during night time periods, and also require other northbound traffic to cross the Hunter River in a contra-flow arrangement. The project would address this issue and allow higher productivity vehicles continuous access across the Hunter River without disrupting regular traffic flows. The project would also improve access to other key employment areas at Black Hill and Beresfield by improving interchanges at these locations.

Road access across the Hunter River floodplain, especially between Hexham and Raymond Terrace, is impacted during flooding events. The existing concept design only achieves one in 20 year flood immunity for one carriageway on the motorway between Hexham and Tomago. The project is targeting to provide a minimum of one in 20 year immunity along the length of the alignment (ie between Black Hill and Raymond Terrace), for both carriageways, improving access and safety during flooding events.

Benefits of the project would include:

- Improved connectivity between the M1 Pacific Motorway and the Raymond Terrace Bypass, and for the rapidly growing Lower Hunter and Mid North Coast regions
- Improved road safety for local and through travellers
- Uninterrupted traffic flow along the motorway
- Better accessibility on and off the M1 Pacific Motorway for traffic
- Improvements to the adjoining road network
- Reduced impact on environmentally sensitive areas.

1.4 Project objectives

Objectives for the project were revised to align with current requirements and expectations, as well as the overall objectives of the Pacific Highway Upgrade Program and the Long Term Transport Master Plan (NSW Government, 2012).

The primary objectives for the project are to:

- Develop a dual carriageway road targeting:
 - A crash rate of a maximum 15 crashes per 100 million vehicle kilometres travelled
 - A casualty crash rate of less than 0.3 casualty crashes per kilometre, per year, over the project length.
- Provide a free flowing route and reduce travel time between the M1 Pacific Motorway at Beresfield and Raymond Terrace
- Provide improved access to key employment areas such as Tomago, Beresfield, Black Hill and the Port of Newcastle for heavy vehicles, including higher productivity vehicles of up to 30 metres in length
- Provide a route which reduces the overall freight transport time and cost for heavy vehicles along the major north/south and east/west connections
- Provide a route that meets the geometric requirements for higher productivity vehicles up to 30 metres in length

- Provide a continuous four lane (minimum) motorway standard connection
- Provide a route that maximises connectivity benefit and supports the development of the Lower Hunter road network.

The secondary objectives for the project are to:

- Provide a minimum flood immunity of five per cent AEP (annual exceedance probability) to the edgelines and flood immunity and consistency with other Pacific Highway projects
- Minimise road user delay from incidents and road closures on the highway, particularly from vehicle crashes
- Develop a project promoting good practice urban design principles and minimising the effects on sensitive habitats, such as waterways and wetlands, native vegetation and fauna.

1.5 Structure of this report

This report outlines the process used to identify and develop a revised concept design for the project. Specifically, this report:

- Summarises community and stakeholder involvement to date, and the ongoing consultation proposed by Roads and Maritime (refer to **Section 2**)
- Describes the review of the existing concept design within the context of constraints for the study area (refer to **Section 3**)
- Summarises the approach to options development and assessment, provides an overview of each of the options and describes the selection of the preferred option that was adopted as the revised concept design (refer to **Section 4**)
- Outlines the next steps to be taken for the project (refer to **Section 5**).

2 Community and stakeholder consultation

This section provides an overview of community and stakeholder engagement that has occurred to date.

2.1 Community and stakeholder consultation to date

Roads and Maritime has maintained ongoing community and stakeholder consultation and activities since investigations started in 2004. **Figure 2-1** provides a summary of all communication and engagement activities carried out on the project to date.

A community liaison group (CLG) was established in late 2004, and a workshop was held with the group to discuss preferred options for the project in February 2005. New group members were called for in 2006 and the last CLG meeting was held in 2007.

A preferred route for the project was announced in August 2006 and displayed for community and stakeholder comment in October 2006.

The concept design was displayed in 2008 and 150 submissions were received. Concerns included access and interchange arrangements, flooding, water quality, noise, signage, and impacts on flora and fauna. A report detailing responses to these submissions was made available to the community in December 2010, which also provided information on a refined concept design. The design changes included two alternative access arrangements at the Hunter Region Botanic Gardens to be considered further, the relocation of the northbound exit ramp to Tomago Road and the relocation of the northbound exit ramp to Heatherbrae. A preferred route was selected and reserved in the Newcastle and Port Stephens Local Environmental Plans (LEPs).

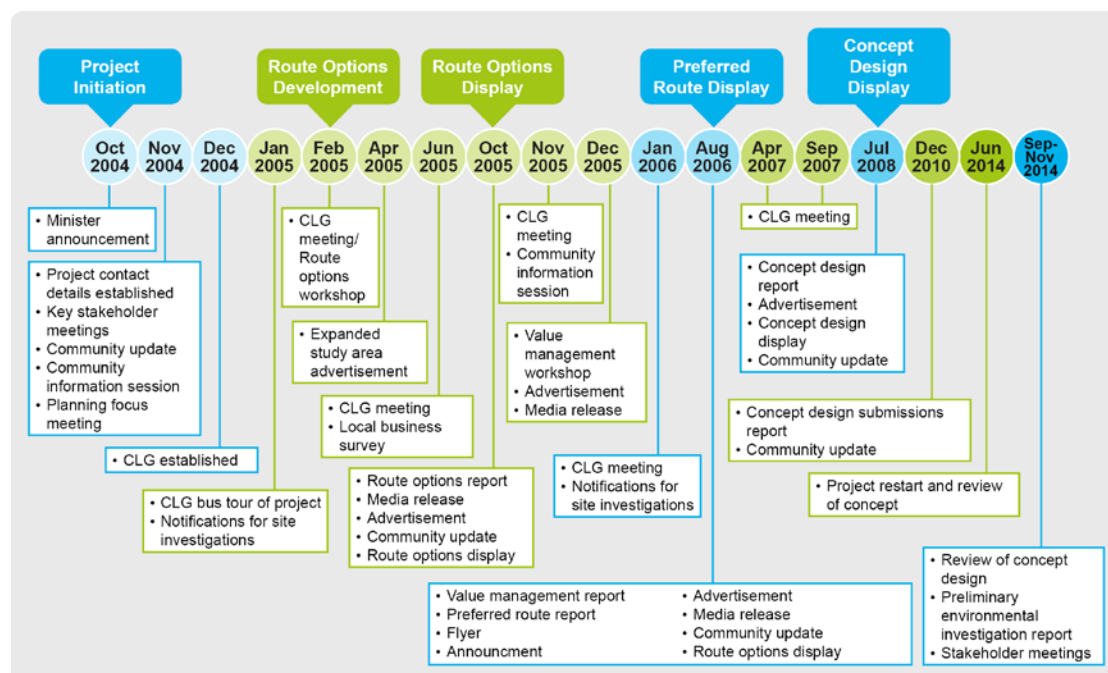


Figure 2-1 Summary of communication and engagement to date

A series of meetings with key stakeholders was held in September and October 2014 as part of the recent review of the project. Roads and Maritime project representatives met with Newcastle City Council, Port Stephens Council, Weathertex, ARTC, Hunter Water, Hunter Region Botanical Gardens, Office of Environment and Heritage (OEH), Environmental Protection Agency (EPA) and a number of directly affected property owners. The purpose of these meetings was to provide an update on the project, and to identify any changes to land use that would need to be considered in the design review.

2.2 Ongoing consultation

Consultation for this stage of the project is ongoing.

The project will be on display in October 2015. Comments are invited from all members of the public, government agencies and stakeholders and can be submitted via email, over the phone or by post. Two information sessions will be held during the display period to provide the community and stakeholders with an opportunity to learn more about the project and give feedback to the project team in person. Roads and Maritime will review and consider all comments and incorporate them into the decision-making stages of the project as appropriate. Following this, Roads and Maritime will prepare a community consultation report that will summarise the feedback received and outline the next steps for the project as it moves into the environmental assessment phase. This community and stakeholder consultation report will be published on the project website.

Consultation and community involvement will continue through the concept design development and environmental assessment phases of the project. Future consultation for the project will include:

- The display of the revised concept design in October 2015, which will give further opportunity to review the concept design and receive feedback to inform the EIS for the project
- An Aboriginal Focus Group and relevant consultation to inform the cultural heritage assessment for the project
- Written communication to all property owners within the vicinity of the proposed alignment which will advise of the environmental assessment process and the display phase of the EIS
- Public exhibition of the EIS which is expected to occur in 2017. This will be for a minimum of 30 days. Advertisements will be placed in newspapers advising of the public exhibition and where the EIS can be viewed. These will also provide advice about making a submission on the project, and will outline how these submissions will be considered and responded to during the planning process
- Community and stakeholder information sessions will be held during the display periods.

The Roads and Maritime project website will be updated with new information throughout the planning process and will highlight the status of the community and stakeholder comment periods.

3 Review of the existing concept design

This section provides a description of the existing concept design that was displayed in 2010 and summarises the characteristics of the study area that informed the review of the concept design. It also outlines the outcomes of the design review.

3.1 The existing concept design

3.1.1 Background

Planning for the project started in 2004 and the existing concept design was developed between 2008 and 2010. This design is discussed in detail in **Section 3.1.2**.

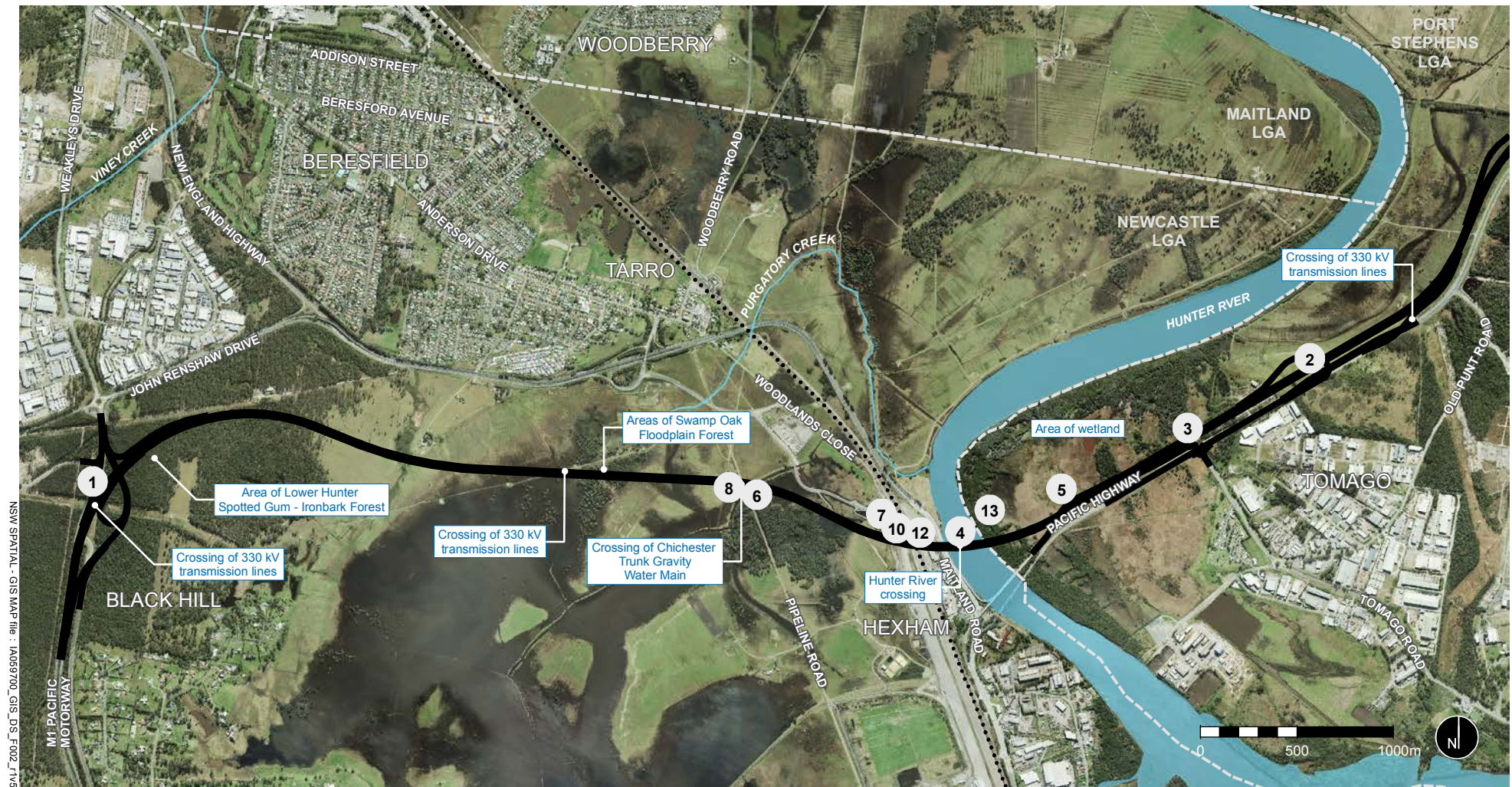
3.1.2 Description

The existing concept design is about 15 kilometres in length, shown in **Figure 3-1**.

The western section of the route begins at the M1 Pacific Motorway south of the John Renshaw Drive roundabout and crosses through an area of native vegetation at Black Hill. It crosses the Chichester Trunk Gravity Water Main and has two wetland crossings. The western section runs about 500 metres to the south of, and roughly parallel to, the New England Highway.

The route continues in a south-easterly direction, crossing under the 330 kV transmission lines south of Tarro and passing through Swamp Oak Floodplain Forest vegetation communities. It then crosses the New England Highway at Hexham, to the north of the existing Hunter River bridges. A long bridge structure will cross Woodlands Close, the Main Northern Railway line, New England Highway and the Hunter River. North-east of the Hunter River the route closely follows the alignment of the existing Pacific Highway to Heatherbrae.

South of Heatherbrae, the route crosses the existing Pacific Highway. The existing Pacific Highway would be realigned and pass over the M1 Pacific Motorway near the Hunter Region Botanic Gardens. The route then skirts to the east of Heatherbrae, passing across the northern edge of the Tomago Sandbeds. The route is crossed by Masonite Road, skirts the proposed Heatherbrae industrial development and then joins the existing Pacific Highway north of Windeyers Creek.



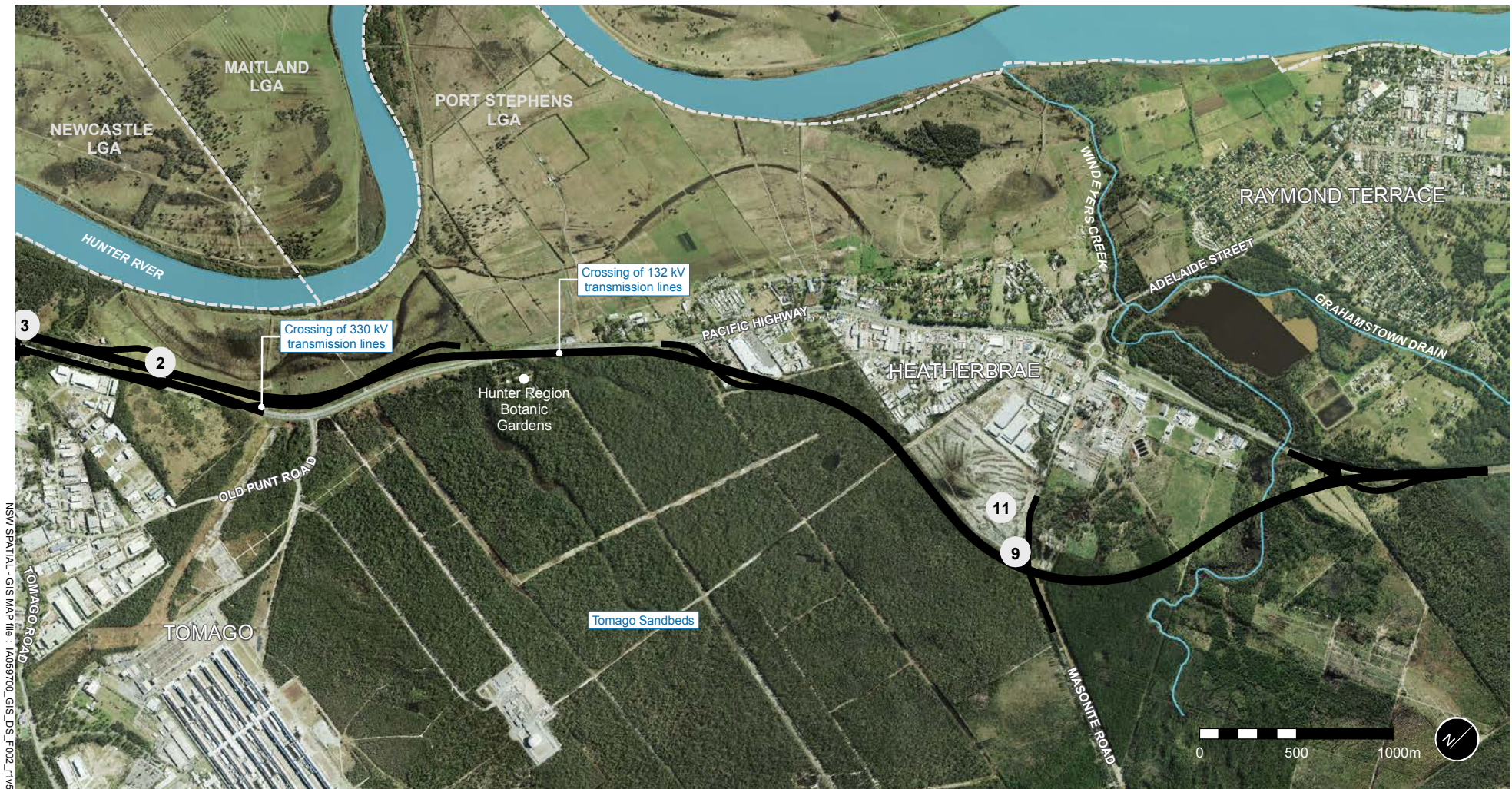
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- Main Northern Railway
- - - - - LGA boundary
- Existing concept design
- 7 Issues (refer to Section 3.2 of the Discussion Paper)



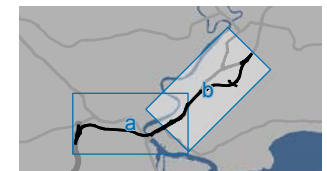
Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

Figure 3-1a Existing concept design



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- Main Northern Railway
- - - - - LGA boundary
- Existing concept design
- ⑦ Issues (refer to Section 3.2 of the Discussion Paper)



Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

Figure 3-1b Existing concept design

3.2 Review of the existing concept design

In 2014 Roads and Maritime initiated a review of the existing concept design with the following considerations:

- The project's functionality and performance, including connectivity to the adjoining state road network
- Design and geometric elements of the project, and how lessons learnt from recently completed Pacific Highway projects in floodplain and soft soil areas could be incorporated into a revised concept design
- Environmental impacts, particularly regarding recent changes to environmental policy and legislation
- Traffic characteristics, particularly regarding changes to the regional road network since the opening of the Hunter Expressway in 2014 and completion of other road projects
- Integration with the existing transport network and the ability to accommodate any potential future upgrades.

The preliminary environmental investigation for the corridor was updated while carrying out the review. New traffic data for the existing road network was collected to assist with the assessment of any new traffic arrangements being developed.

The review identified a number of issues and concerns with the project which would need further investigation and assessment. These are detailed below and shown on **Figure 3-1**.

Functionality

1. Traffic accessing the motorway at the Black Hill interchange is concentrated immediately south of the existing M1 Pacific Motorway and Weakleys Drive intersection. This causes potential congestion issues. Motorway traffic heading west via the reverse loop at Black Hill would experience a weave conflict while merging with northbound motorway traffic before the John Renshaw Drive intersection
2. The arrangement of Tomago interchange is physically limited by flooding and environmental constraints. As a result, northbound traffic must use a loop ramp onto the Pacific Highway southbound before exiting onto Tomago Road. This arrangement does not provide sufficient lane length for vehicles to weave safely after the loop ramp to exit at Tomago Road
3. The Tomago interchange does not provide an acceleration lane for traffic at the southbound entry ramp to safely merge onto the M1 Pacific Motorway.

Design

4. Twin viaduct bridges across the Hunter River and floodplain need to be widened to provide suitable stopping sight distance, which is the distance that motorists need to see ahead to safely stop or avoid hazards
5. Only the northbound carriageway across the floodplain east of the Hunter River achieves desirable flood immunity as it is on a viaduct. The southbound carriageway is a low level embankment similar to the existing highway and does not meet flood immunity objectives
6. The bridge across the floodplain does not extend far enough south to cross the paleochannel, which is a historical river channel filled with soft sediments. The

major earthworks proposed are unlikely to be cost-effective across the floodplain and associated adverse ground conditions.

Constructability

7. The site is constrained where the viaduct crosses the New England Highway, rail infrastructure and the Hunter River at Hexham
8. Viaducts are likely to be required across the full extent of the floodplain to cater for floodplain flows and avoid upstream flooding impacts
9. There are constructability issues resulting from the Masonite Road overbridge and the proposed approaches to be constructed on the existing alignment.

LEP corridor and adjacent development

10. ARTC and Aurizon have developed the Hexham rail corridor, substantially increasing the rail footprint to accommodate additional capacity for freight rail and maintenance areas. The project will have to consider this increased footprint and the access arrangements to these areas
11. The approved development near Masonite Road, Heatherbrae will need to be considered, as well as how it will fit next to the LEP corridor
12. Allowances for potential integration with future infrastructure upgrades must be considered. These transport networks include interface with other road and rail infrastructure as well as navigational requirements on the Hunter River.

Environmental impact

13. There is the potential for significant impact on SEPP 14 wetlands and environmentally sensitive areas north and south of the river crossing, which will need to be minimised.

4 Options development and assessment

This section provides an overview of the options development and assessment process, summarises the key constraints and opportunities within the study area, describes the options developed and outlines the selection of the preferred option subsequently adopted as the revised concept design.

4.1 Overview

In reviewing the existing concept design, Roads and Maritime has sought to meet the project objectives, enhance the performance and functionality of the project and address major technical, social and environmental constraints. The options development and assessment process for the project has been continuous and has involved field investigations, engineering designs, key stakeholder input and technical workshops. The process has involved the following key steps (refer to **Figure 4-1**):

- A review of the existing concept design (as discussed in **Section 3.2**)
- Consideration of constraints and opportunities within the study area
- Development of options to address key technical issues and the broader constraints
- A comparison of options
- Recommendation of a preferred option for the revised concept design.

These steps are documented in this report, which forms the basis for further review and comment by stakeholders and the local community on the revised concept design.

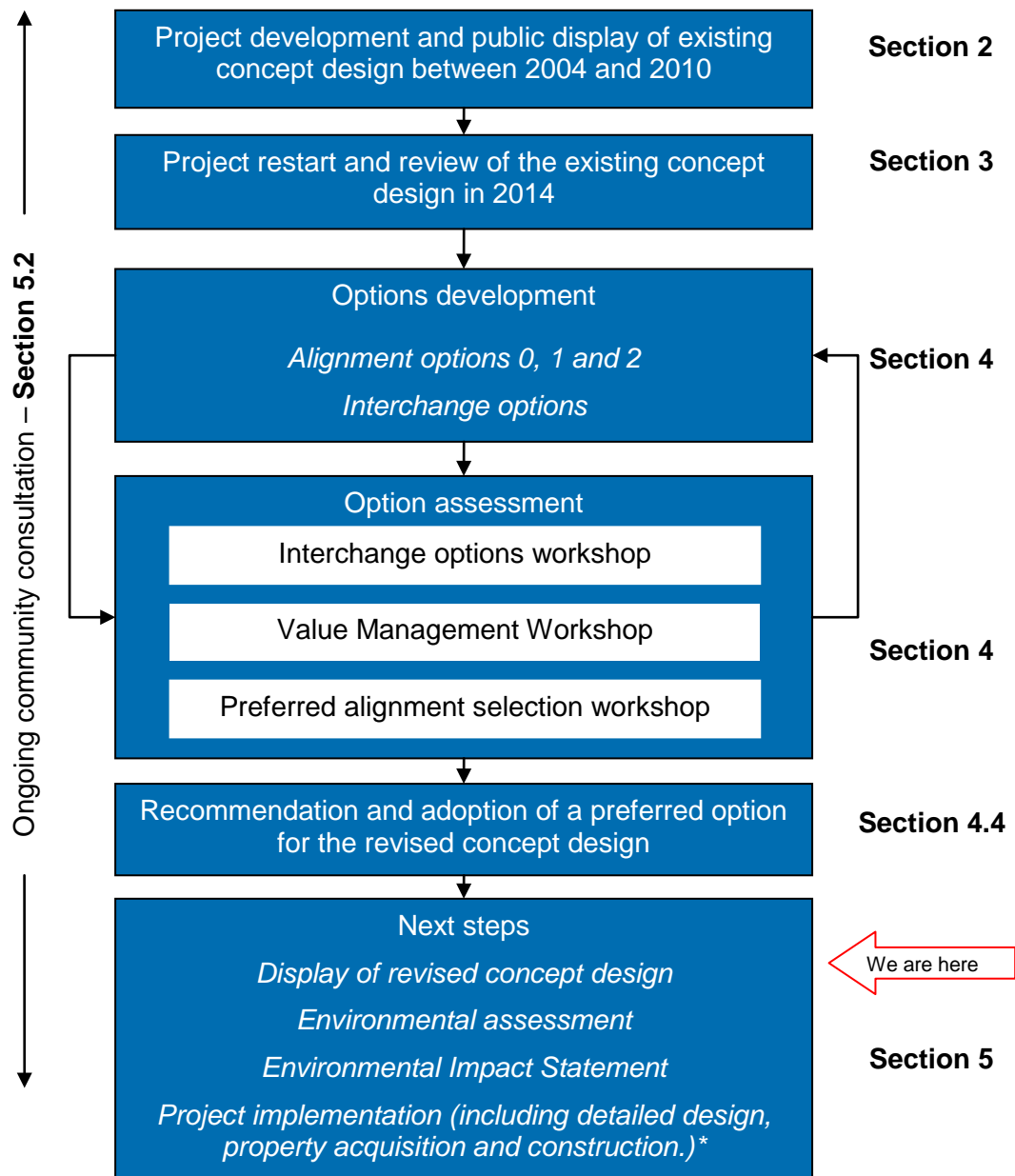
4.2 Constraints and opportunities

The study area for the project extends from the northern end of the M1 Pacific Motorway, south of the John Renshaw Drive roundabout to the existing section of dual highway carriageway at the Raymond Terrace Bypass. As discussed in **Section 1.2**, a number of features within the study area have had an influence on the location of the project.

This section discusses the constraints and opportunities within the study area that have specifically influenced or informed the concept design review and options development process. These constraints are mapped in **Figure 4-2** to **Figure 4-5**.

These constraints have been considered in detail within the State Significant Infrastructure Application Report (Roads and Maritime, 2015) and the preliminary environmental investigations report (Hills Environmental, 2014), and are only briefly described here. Environmental constraints will be considered in further detail during the environmental assessment phase of the project as discussed in **Section 5**.

Figure 4-1 Options development and assessment process



* Timing for implementation and potential project staging is not yet confirmed. This is dependent on planning approval, future traffic needs, project approval and funding availability.

4.2.1 Traffic, transport and access

Access and connectivity

Roads within the study area play a key role in facilitating transport and connectivity within the Lower Hunter. State roads in the area such as John Renshaw Drive, Weakleys Drive and Tomago Road, together with the New England Highway and the Pacific Highway connect local centres such as Beresfield, Tarro, Hexham, Tomago, Heatherbrae and Raymond Terrace. The Raymond Terrace Bypass and the M1 Pacific Motorway, as well as the Main North Rail Line, provide for important north-south movements within the Hunter region. East-west movements are facilitated by

the Hunter Valley rail network, the New England Highway and the Golden Highway (NSW Government, 2014c).

Together, the Pacific Highway, New England Highway, Hunter Expressway, John Renshaw Drive and Tomago Road provide access to significant destinations such as the City of Newcastle, Port of Newcastle, Newcastle Airport, Hunter Valley mining developments, Maitland and other major employment and commercial centres in the Hunter Region. As discussed in **Section 1.3**, the urban arterial sections of the New England Highway and the Pacific Highway also form part of the National Land Transport Network, and form part of the Sydney to Brisbane road link (DIRD, 2015).

Traffic volumes and flow

Traffic volumes on the M1 Pacific Motorway just south of John Renshaw Drive recorded average daily traffic volumes of about 34,000 vehicles in 2014. About 21 per cent of these vehicles are heavy vehicles. An investigation into the hourly traffic pattern indicated evening peak is slightly higher than the morning peak. The highest peak hour traffic volume was recorded at between eight per cent and nine per cent of daily traffic.

The New England Highway is the east-west corridor within the study area. Traffic volumes on the New England Highway increase from about 40,000 vehicles per day at Maitland to about 60,000 vehicles per day west of the Hunter River Bridge within the study area. About 13 per cent of these vehicles are heavy vehicles.

Between Maitland and Newcastle the daily profile along the New England Highway exhibits a conventional morning and evening peak pattern, with the peaks occurring at about 8am and 5pm respectively. Traffic volumes between peak periods remain comparatively high as a proportion of total flow, which shows that this section of the corridor has heavy commuter use, but also a high level of local traffic throughout the day.

John Renshaw Drive is a key east-west corridor in the study area linking the Hunter Expressway, the townships of Kurri Kurri and Cessnock with the M1 Pacific Motorway and New England Highway. Since the opening of the Hunter Expressway in 2014 this route has taken on a greater strategic importance through its interchange at Buchanan. John Renshaw Drive via its interchange with the Hunter Expressway provides a key route from the Upper Hunter to the Port of Newcastle and central business district.

John Renshaw Drive carries average daily traffic volumes of about 12,000 vehicles per day west of the M1 Pacific Motorway and Weakleys Drive intersection and about 32,500 vehicles per day just west of the New England Highway.

Weakleys Drive is a single carriageway road with generally one lane in each direction for most of its length, which acts as a connector from the M1 Pacific Motorway to the New England Highway. Land near Weakleys Drive has recently been developed with light industrial and commercial uses. Weakleys Drive carries average daily traffic of about 20,000 vehicles per day north of John Renshaw Drive.

The Pacific Highway within the study area is about a seven kilometre long section between the Hexham Bridge across the Hunter River and the southern end of the Raymond Terrace Bypass at Masonite Road. Tomago Road is a key intersection along this section of the highway, as it connects employment areas along its length as well as the Newcastle Regional Airport and Royal Australian Air Force Base at Williamtown. The Pacific Highway carries average daily traffic of about 50,000

vehicles per day just north of the Hexham Bridge. Of this traffic, about 15 per cent are heavy vehicles.

The key traffic flow characteristics within the study area are as follows:

- Heavy eastbound and westbound traffic along the New England Highway, Maitland Road and the Pacific Highway during morning and afternoon peak periods.
- A large proportion of traffic from the M1 Pacific Motorway travels toward Newcastle and the Pacific Highway via John Renshaw Drive and the New England Highway as an alternative to using the Newcastle Link Road from the M1 Pacific Motorway at the M1 Motorway/John Renshaw Drive intersection. This traffic movement contributes to congestion during morning and afternoon peak periods on the New England Highway
- Substantial delays are experienced at the intersection of the New England Highway and the Pacific Highway at Hexham during morning and afternoon peak periods. The high traffic demands on the New England Highway, combined with the relatively high traffic demand southbound on the A1 Pacific Highway, at the signalised intersection result in queuing and delays to all movements at this location High volumes of traffic during traditional holiday periods due to travel between the M1 Pacific Motorway and the Pacific Highway via John Renshaw Drive, the New England and existing Hexham Bridge
- Heavy traffic volumes at the intersection of the Pacific Highway and Tomago Road during morning and afternoon peak periods
- Moderate traffic volumes along the Pacific Highway through Heatherbrae and the A1 Pacific Highway, Masonite Road and Adelaide Street intersections during morning and afternoon peak periods.

Travel times

Travel time information has been collected for key routes within the study area. In the morning peak period, the travel time from the M1 Pacific Motorway to the Pacific Highway at Heatherbrae is slightly shorter than the travel time from the New England Highway at Weakleys Drive to the same destination. Travel times for routes in the reverse direction are longer due to the traffic lights on the southern side of the Hexham Bridge. The additional delay is due to the heavy east-west movement on the New England Highway passing through this intersection.

Travel times in the evening peak are similar to the morning peak. The southbound movement from Heatherbrae to either the M1 Pacific Motorway or the New England Highway at Weakleys Drive is longer than the northbound movement due to the additional delays experienced at the traffic lights at the New England Highway and the Pacific Highway intersection at the southern side of the Hexham Bridge.

Transport

The existing road and rail network supports local, regional and international freight transport including transport to and from the Port of Newcastle, which is the largest bulk shipping port on the east coast of Australia, and one of the world's leading coal export ports.

Rail infrastructure within the study area also provides passenger transport to and from the Hunter Region. The Main North Rail Line within the study area is located between Tarro and Hexham with stations at Beresfield, Tarro and Hexham.

Other public transport services include local and regional bus services that connect Newcastle, the Hunter Valley, Port Stephens and other regional towns within NSW.

4.2.2 Biodiversity

Vegetation communities, threatened flora and fauna

Desktop searches of publically available databases together with targeted surveys carried out since 2004 identified twelve vegetation communities within or alongside the project area. Of these:

- Five native vegetation communities are listed as Threatened Ecological Communities under the State *Threatened Species Conservation Act 1995*
- One Threatened Ecological Community (Coastal Saltmarsh) is listed under both the *Threatened Species Conservation Act 1995* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
- One Mangrove-Estuarine Complex community (Grey Mangrove low closed forest) is listed under the *Fisheries Management Act 1994*.

Most of these vegetation communities are groundwater dependent ecosystems, as mapped in **Figure 4-2** and **Figure 4-3**. Extensive areas of SEPP 14 wetlands are located within the study area, in the northern parts of Hexham Swamp and along the banks of the Hunter River, as shown in **Figure 4-3**. The Hunter River and two tributaries, Purgatory Creek and Windeyers Creek, and the associated riparian habitats would be crossed by the road alignment. These waterways are identified as key fish habitat.

The study area contains potential habitat for a number of threatened flora and fauna species. A search of the NSW BioNet Atlas of Wildlife database on 27 July 2015 indicated that 10 threatened flora or fungi species and 60 threatened fauna species have been recorded or are predicted to occur within 10 kilometres of the project. However, not all of these species would have suitable habitat within the study area. Some species such as *Grevillea parviflora* and *Callistemon linearifolius* are known to be located within the project site.

In addition, a search of the EPBC Act protected matters search tool on 6 July 2015 indicated that 58 listed threatened species or species habitat (or habitat which provides for foraging, feeding or related behaviour) were either known to occur, may occur, or likely to occur within 10 kilometres of the project.

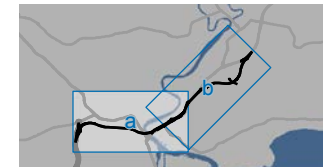


NSW SPATIAL - GIS MAP file : 1A059700_GIS_DS_F009_113

- Main Northern Railway
- - - - - LGA boundary
- Existing concept design

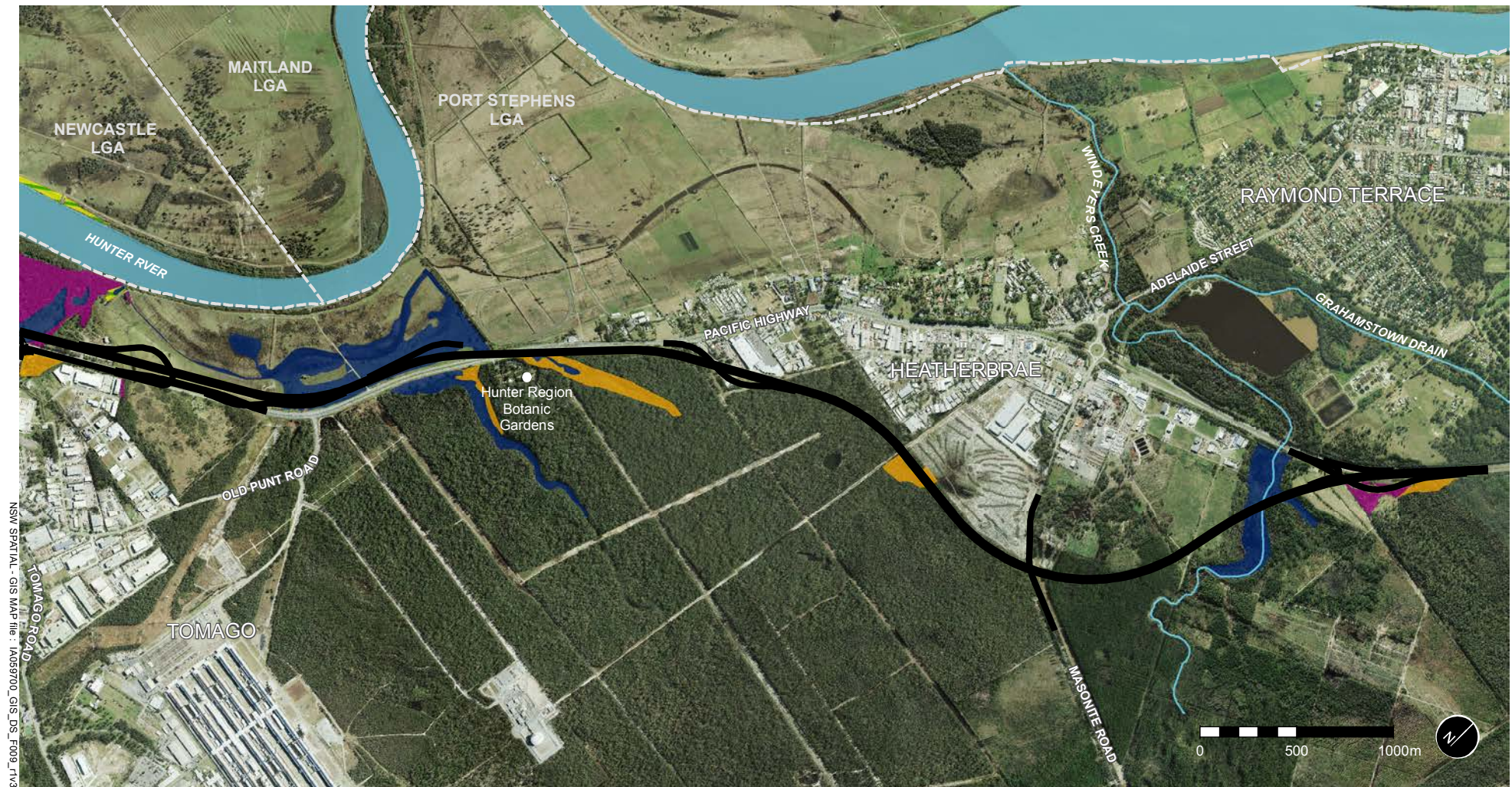
- Threatened vegetation (EPBC Act)
- //// Subtropical and Temperate Coastal Saltmarsh
- Threatened vegetation (TSC Act)
- Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

- Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion
- River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions



Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

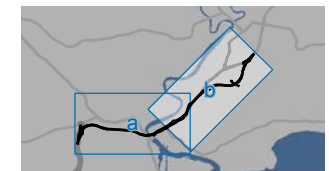
Figure 4-2a Biodiversity in the study area



- Main Northern Railway
- LGA boundary
- Existing concept design

- Threatened vegetation (EPBC Act)
- //// Subtropical and Temperate Coastal Saltmarsh
- Threatened vegetation (TSC Act)
- Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions
 - Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

- Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion
- River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions



Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

Figure 4-2b Biodiversity in the study area

Fauna habitat and wildlife corridors

The study area hosts a range of resources for threatened fauna species. All vegetation communities and wetlands noted above provide habitat for state and Commonwealth listed threatened species. The study area between Tomago and Raymond Terrace is known to include areas with suitable Koala habitat features, such as areas of high Koala habitat value, preferred feed trees and occasional feed trees. Within the forested areas of Black Hill, and east of Tomago and Heatherbrae within the Tomago Sandbeds Catchment Area, there are areas of high conservation value foraging habitat for the Grey-headed Flying-fox. Potential habitat for wetland birds and migratory waders has also been identified within the study area.

The study area bisects a state significant wildlife corridor identified by the Lower Hunter Regional Conservation Plan (DECCW, 2009), which extends from the Watagan Ranges, through Hexham Swamp to Port Stephens.

4.2.3 Surface water and groundwater

Surface water

The key water courses within the study area include the Hunter River, Purgatory Creek, Windeyers Creek, Grahamstown Drain and Viney Creek (refer to **Figure 4-4**). These watercourses are sensitive receiving environments that drain directly into the Hunter River or nearby wetland systems.

Groundwater

Three groundwater systems have been designated by the NSW Office of Water within the study area. These are divided by the Hunter River.

- On the western side of the Hunter River is the coastal alluvial floodplain within the Newcastle Water Source of the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009
- Above the floodplain to the north-west is porous rock of the Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources (currently in draft)
- On the eastern side of the Hunter River are coastal sands within the Tomago Groundwater Source of the Water Sharing Plan for the Tomago Tomaree Stockton Groundwater Sources 2003.

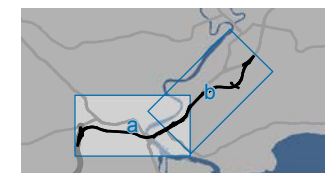
These water sources have been designated as highly productive. Level 1 minimal impact considerations under the Aquifer Interference Policy (DPI, 2012) would apply to the project.

The study area includes a number of active extraction bores, including monitoring bores, domestic bores and drinking water wells.

Most vegetation communities within the study area are groundwater dependent ecosystems (refer to **Figure 4-2** and **Figure 4-3**). High priority groundwater dependant ecosystems have also been identified in Water Sharing Plans for the study area. These include SEPP 14 wetlands as well as Wetland Vegetation, Swamp Forest and Swamp Heath Woodland native vegetation communities.



- Main Northern Railway
- LGA boundary
- Existing concept design
- SEPP 14 wetland



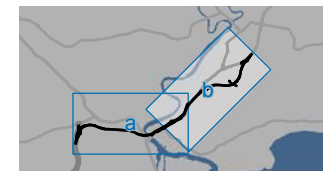
Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 Department of Planning and Environment
 AUSIMAGE May 2014 and May 2015

Figure 4-3a Wetlands in the study area



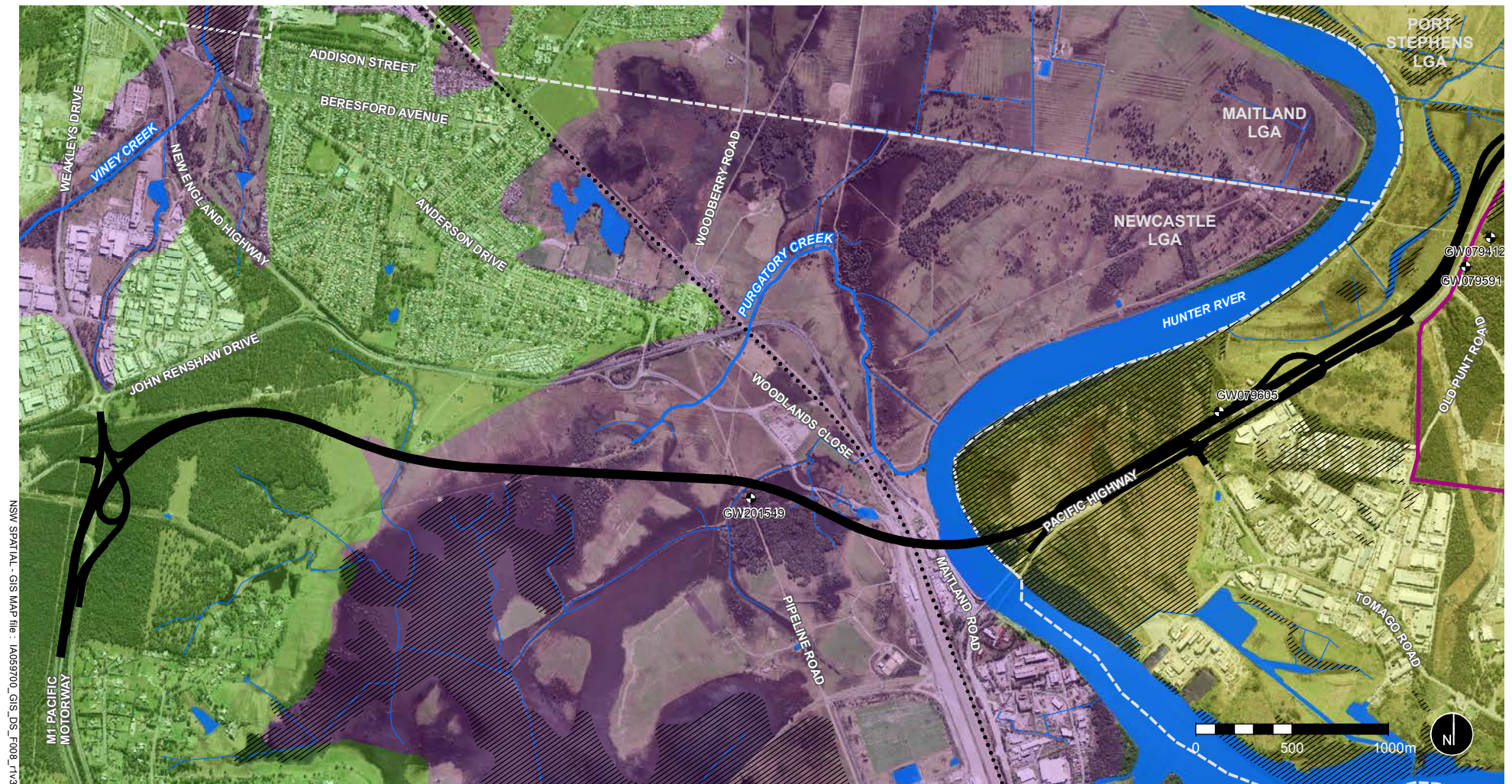
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- Main Northern Railway
- LGA boundary
- Existing concept design
- SEPP 14 wetland



Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 Department of Planning and Environment
 AUSIMAGE May 2014 and May 2015

Figure 4-3b Wetlands in the study area



NSW SPATIAL - GIS MAP file : 1A059700_GIS_DS_F008_1V3

- Main Northern Railway
- LGA boundary
- Existing concept design
- ⊕ Groundwater bore hole
- Major waterway
- Minor waterway
- Water body
- ▨ High priority groundwater dependant ecosystem
- ▭ Tomago Sandbeds Catchment Area (special area)
- Water sharing plans
- Draft North Coast Fractured and Porous Rock Groundwater Sources
- Hunter Unregulated and Alluvial Water Sources 2009
- Tomago Tomaree Stockton Groundwater Sources 2003



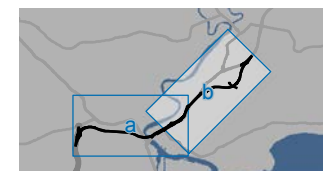
Data sources
 Office of Water 2015
 Hunter Water 2015
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

Figure 4-4a Surface and groundwater resources in the study area



NSW SPATIAL - GIS MAP file : IAO59700_GIS_DS_F008_1V3

- | | | |
|-----------------------------|-------------------------|---|
| Main Northern Railway | ⊗ Groundwater bore hole | ▨ High priority groundwater dependant ecosystem |
| --- LGA boundary | — Major waterway | ▭ Tomago Sandbeds Catchment Area (special area) |
| — Existing concept design | — Minor waterway | Water sharing plans |
| | ■ Water body | ■ Draft North Coast Fractured and Porous Rock Groundwater Sources |
| | | ■ Hunter Unregulated and Alluvial Water Sources 2009 |
| | | ■ Tomago Tomaree Stockton Groundwater Sources 2003 |



Data sources
 Office of Water 2015
 Hunter Water 2015
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

Figure 4-4b Surface and groundwater resources in the study area

The Tomago Sandbeds Catchment Area is an underground water source (aquifer) operated by the Hunter Water Corporation. The catchment is also classified as a special area under the *Hunter Water Act 1991* to protect it as a drinking water supply. The special area covers about 100 square kilometres and supplies about 20 per cent of the Lower Hunter's drinking water. All development within the special area is regulated to maintain water quality of the aquifer.

4.2.4 Hydrology and flooding

The study area traverses the Hunter River floodplain, which covers an area of 22,000 square kilometres. The study area is located within the tidal lower reaches of the Hunter River and has numerous tributaries and other minor waterways including Purgatory Creek, Windeyers Creek, Grahamstown Drain and Viney Creek. The majority of the study area is located within land which would be affected by the one per cent Annual Exceedance Probability (AEP) flood event (refer to **Figure 4-5**). This includes areas of the New England Highway to the east of John Renshaw Drive, and areas of the existing Pacific Highway, particularly between Hexham and Tomago.

Flooding on the lower reaches of the Hunter River floodplain is a result of both mainstream flooding from the Hunter River and local catchment runoff. The floodplain within the study area varies in width from about seven kilometres between Heatherbrae and Thornton to 2.5 kilometres between Tarro and Tomago. The Hunter River along this reach, from Raymond Terrace to Hexham Bridge is generally bounded by levee banks, with flooding occurring on the low lying areas around Raymond Terrace.

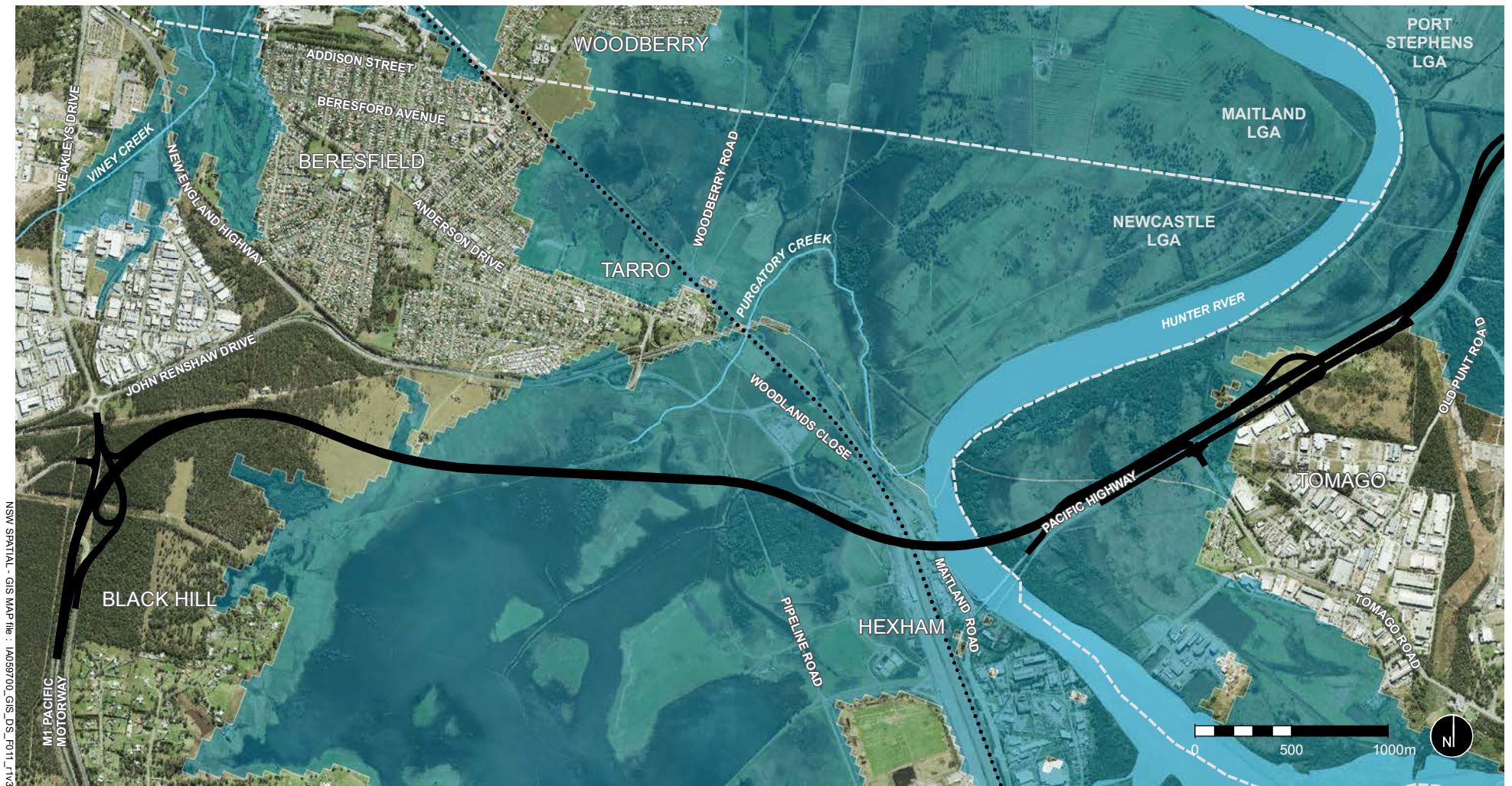
During flood events, Windeyers Creek catchment experiences flooding in low lying areas from the local catchment and/or from backwater from the Hunter River. When the western levee bank of the Hunter River is overtopped, a larger area of the Hunter River floodplain is inundated. Areas of Hexham, Tomago, Woodberry, Tarro and Raymond Terrace would be affected by this larger flooding area.

4.2.5 Land use and property

Land use within the study area includes industrial, commercial, retail, agricultural, residential and conservation. The project straddles the boundary between Newcastle and Port Stephens local government areas and is located within a number of land zones listed on the Newcastle Local Environmental Plan 2012 (Newcastle LEP) and Port Stephens Local Environmental Plan 2013 (Port Stephens LEP). These land zones include:

- Newcastle LEP:
 - SP2 Infrastructure (Classified Road)
 - E4 Environmental Living
 - E2 Environmental Conservation
 - W2 Recreational Waterways.

- Port Stephens LEP:
 - SP1 Special Activities (Tomago Sandbeds Catchment special area)
 - SP2 Infrastructure (Classified Road)
 - RU2 Rural Landscape
 - E2 Environmental Conservation
 - IN1 General Industrial.

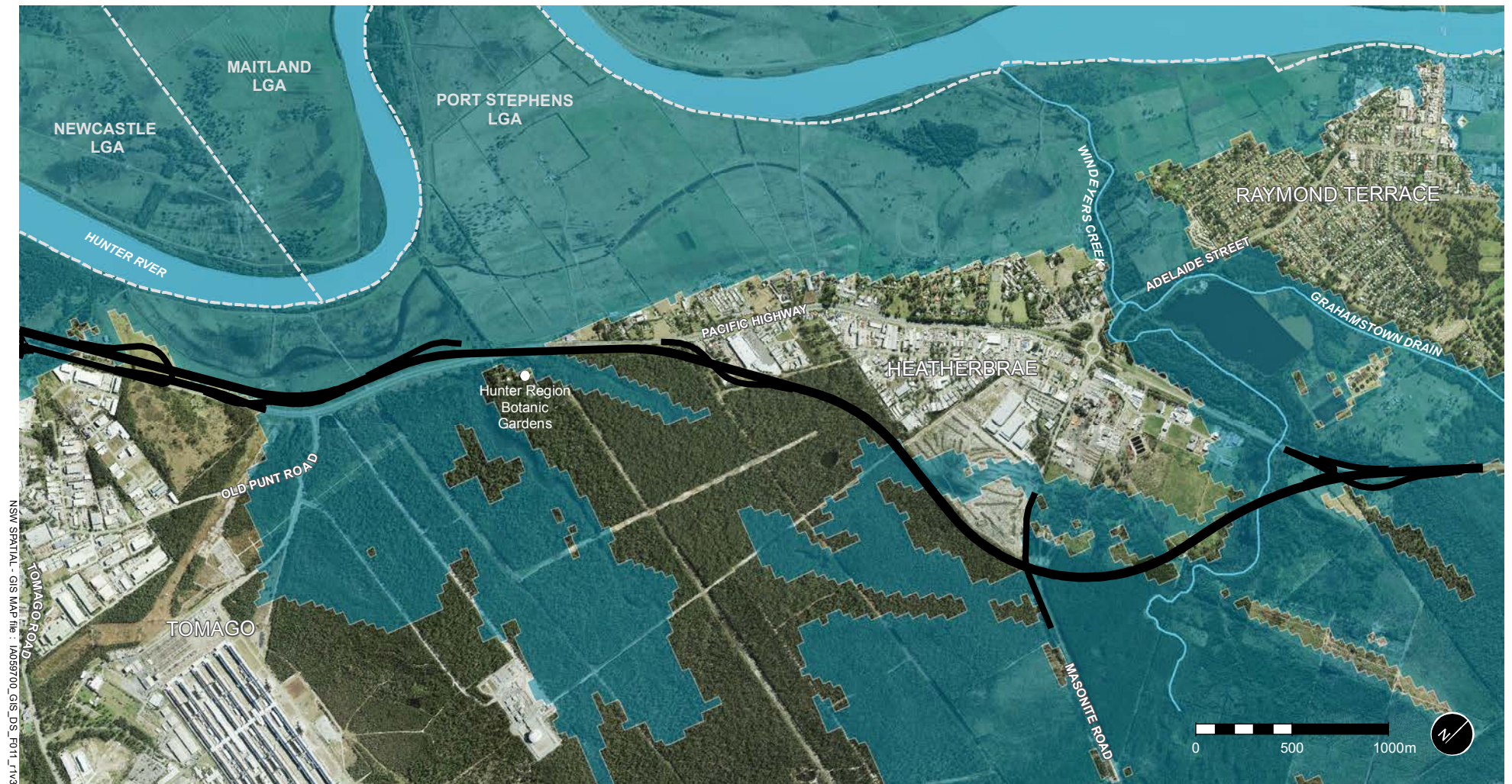


- Main Northern Railway
- LGA boundary
- Existing concept design
- Inundation 1% Annual Exceedance Probability



Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

Figure 4-5a Flood extents within the study area (1% Annual Exceedance Probability)



- Main Northern Railway
- LGA boundary
- Existing concept design
- Inundation 1% Annual Exceedance Probability



Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

Figure 4-5b Flood extents within the study area (1% Annual Exceedance Probability)

A road corridor for the project was gazetted in both LEPs as SP2 Infrastructure (Classified Road). Change in land use near the gazetted corridor is mostly associated with the further development of established commercial areas including the Heatherbrae economic corridor/bulky goods zone.

Residential areas within the study area are typically low density detached dwellings on large lots. The main residential areas are within Black Hill, Beresfield, and Heatherbrae; and Tarro where the density is at its greatest.

Industrial and commercial land uses are located at Beresfield, Hexham, Black Hill, Tomago, and Heatherbrae. These industrial and commercial areas function as major employment opportunity areas within the Newcastle and Port Stephens LGAs. The Beresfield industrial area located on the New England Highway and Weakleys Drive has developed rapidly over the past five years while the Tomago industrial area is expected to increase substantially by 2031. An area near the M1 Pacific Motorway and John Renshaw Drive intersection at Black Hill was rezoned in mid-2013 for employment purposes. This employment area is expected to deliver up to 3600 full-time jobs and support a further 9000 indirect jobs in the wider economy (Department of Planning and Infrastructure, 2013).

Agricultural land uses as defined by the Lower Hunter Regional Strategy (Department of Planning, 2006) within the study area include:

- Beef cattle (Class 4) (including other livestock grazing) located in the western portion of the study area, near Black Hill, and south of the existing Raymond Terrace Bypass, near Tomago
- Broadacre agriculture (Class 1) (including dairy cattle) located north and south of the existing Raymond Terrace Bypass, near Tarro
- Viticulture (Class 4) (including fruit and nut orchards) located in the western portion of the study area, near Black Hill.

Major utilities and services occur within the project footprint. These include:

- Electrical utilities: 132 kV overhead transmission lines and the West Wallsend to Tomago 330 kV transmission lines
- Water utilities: Hunter Water services within the study area and the Hunter Water Chichester Trunk Gravity Main
- Gas: Tomago to Hexham high pressure gas pipeline owned and operated by AGL. AGL also have easement approval for the Stratford to Tomago pipeline.

4.3 Options description

As outlined in **Section 4.1**, further investigation and assessment was carried out for the project following the review of the existing concept design. Several alternatives to the existing concept design were developed to address the issues identified in the Roads and Maritime review. These were refined to two separate alignments: Alignment 1 and Alignment 2.

A number of interchange arrangements were also investigated at Black Hill, New England Highway/Tarro, Tomago, Heatherbrae and Raymond Terrace. These were refined to a single combination of interchanges for each alignment with the exception of the Tomago interchange, where several options were retained for each alignment due to the complex vehicle movements that had to be accommodated (refer to **Figure 4-6**).

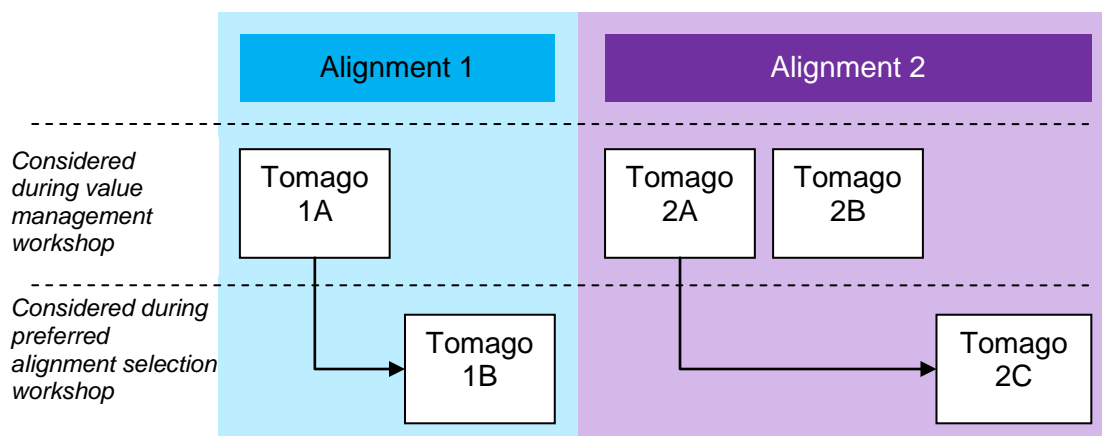


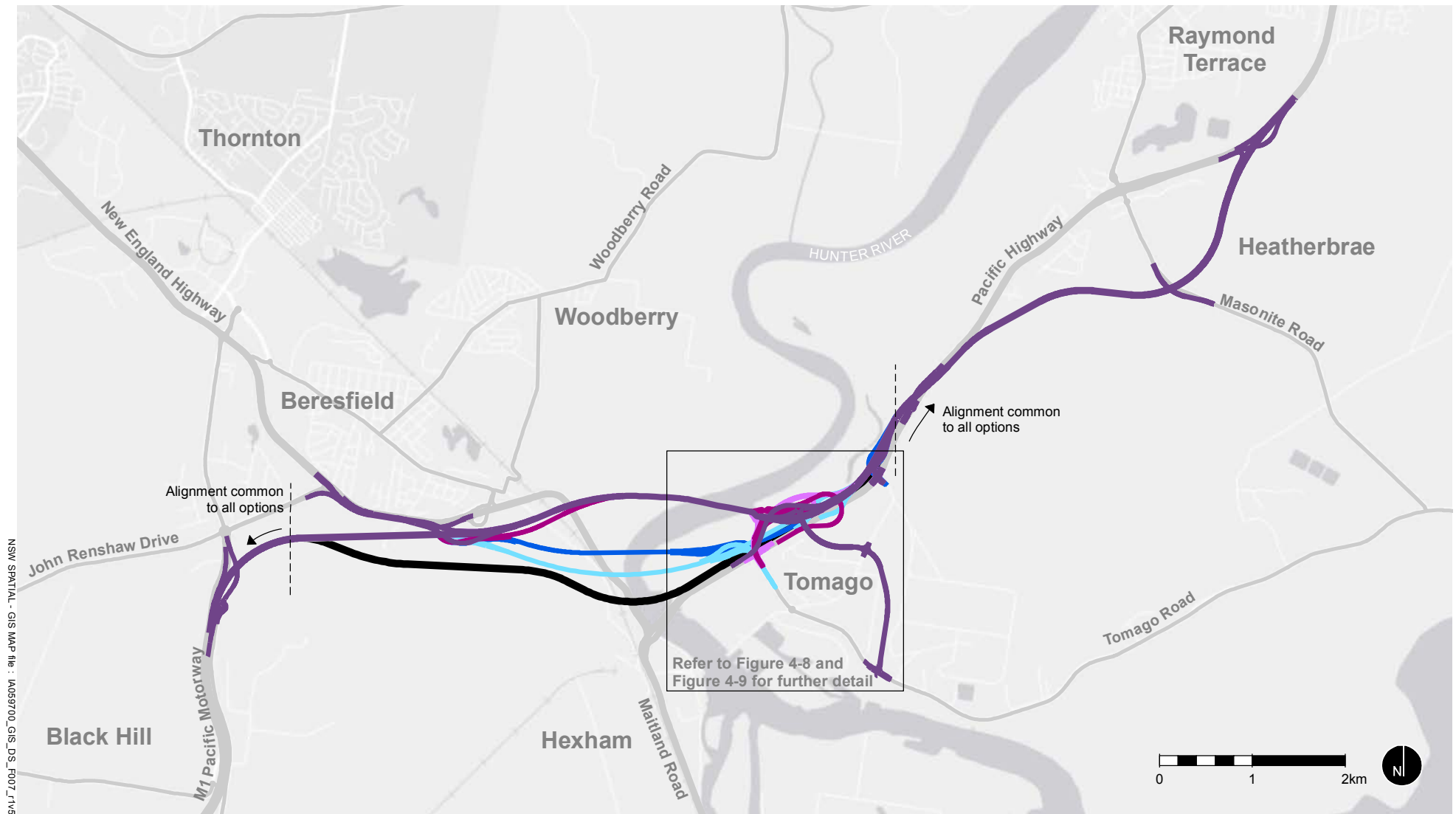
Figure 4-6 Interchange arrangements considered at Tomago for Alignment 1 and 2

The section describes the options (including the existing concept design referred to as Alignment 0), while **Section 4.4** outlines comparison of the shortlisted options to select a preferred option for adoption as the revised concept design. **Figure 4-7** illustrates the options considered.

4.3.1 Aspects common to all alignment options

All options (0, 1 and 2) share a common alignment for the first 1.8 kilometres of the project (referred to as the Black Hill section). The southern limit of the project is located about 650 metres south of Lenaghans Drive. The alignments head north before veering to the east directly after Lenaghans Drive, bypassing the John Renshaw Drive and Weakleys Drive roundabout. The interchange at Black Hill provides a northbound exit ramp to the John Renshaw Drive and Weakleys Drive roundabout, and a southbound entry ramp from John Renshaw Drive and the roundabout via an overpass to the M1 Pacific Motorway, which maintains left in and left out access at Lenaghans Drive.

All options (Alignments 0, 1 and 2) share a common alignment for the northern 7.2 kilometres of the project, which is referred to as the Heatherbrae/Raymond Terrace Section. This section begins at a common point about 300 metres west of the Pacific Highway and Old Punt Road intersection and continues along the northern side of the Pacific Highway for about 900 metres before crossing to the southern side of the Pacific Highway. All options then continue parallel to the south of the Pacific Highway before veering north-east towards Masonite Road. Masonite Road will be re-directed over the M1 Pacific Motorway with an overpass at this location. The alignments then head in a more northerly direction for about 1.9 kilometres before re-joining the Pacific Highway just north of Windeyers Creek. The Raymond Terrace interchange provides northbound entry and exit ramps at the Pacific Highway, and a southbound exit ramp onto the Pacific Highway via an overpass.



- Existing concept design
- Alignment 1 – Tomago 1A
- Alignment 2 – Tomago 2A
- Alignment 1 – Tomago 1B
- Alignment 2 – Tomago 2B
- Alignment 2 – Tomago 2C

Figure 4-7 Options

4.3.2 Alignment 0: existing concept design

Alignment 0 generally refers to the existing concept design as described in **Section 3.1** and illustrated in **Figure 3-1** on page 18 (total length about 15 kilometres). However, changes were made to Alignment 0 during the options development process to ensure that it could be cost-effectively delivered and to allow for meaningful comparison with other alignment options. These changes included:

- Changes to the Black Hill interchange: the southbound exit ramp was redesigned to allow traffic exiting the motorway to merge with increased safety by eliminating unacceptable weaving
- Changes to the intersection with the Pacific Highway east of Masonite Road intersection: the exit lane onto Adelaide Street was adjusted to remove the traffic weave and improve safety
- Adding a viaduct to replace a major fill embankment across the floodplain and soft soils: this begins south of the existing Tarro interchange and continues for about 2.5 kilometres, ending at the Tomago Road intersection. The viaduct includes a bridge section of about 220 metres in length across the Hunter River.

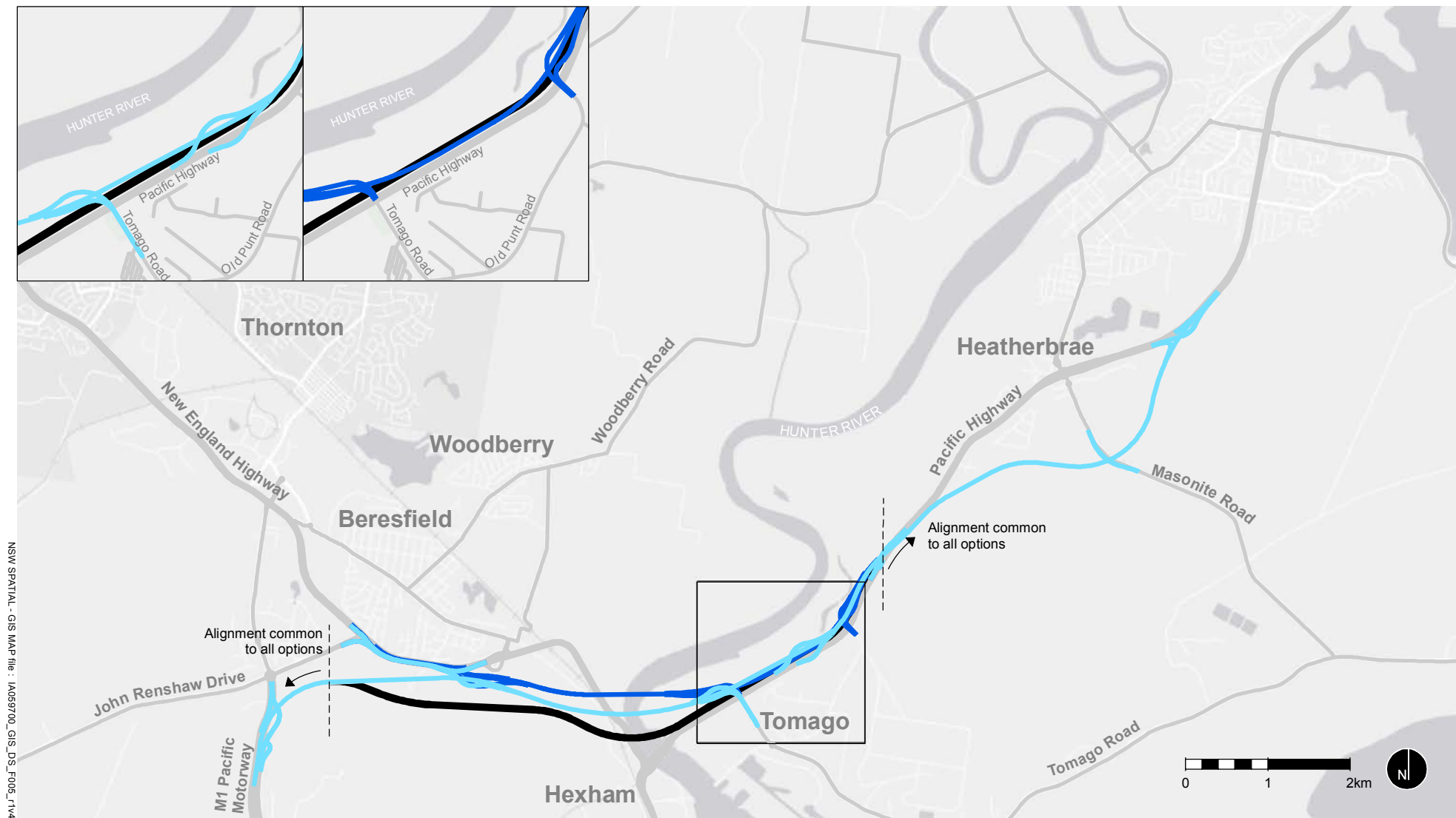
4.3.3 Alignment 1

The total length of Alignment 1 is about 14.9 kilometres (refer to **Figure 4-8**).

After the Black Hill section, Alignment 1 continues east for about 1.4 kilometres. This allows for an interchange at the New England Highway, south of Tarro. This interchange provides a northbound entry ramp onto the M1 Pacific Motorway from the New England Highway and John Renshaw Drive at Tarro. The northbound ramp enters via an underpass under the realigned westbound carriageway of the New England Highway. A southbound exit ramp from the M1 Pacific Motorway to the New England Highway and John Renshaw Drive is via an overpass over the M1 Motorway.

From the interchange, the alignment then heads southeast towards the Hunter River. This section of the alignment has two wetland crossings.

In the Hunter River/Tomago section the alignment continues in a south-easterly direction towards the Hunter River. Similar to Alignment 0, the main viaduct structure begins to the south east of the existing Tarro interchange. It continues for about 2.7 kilometres, ending about 200 metres east of the Tomago Road intersection. As it approaches the Hunter River, it rises to provide appropriate navigational clearances for maritime traffic. The Alignment 1 viaduct includes a bridge section of about 150 metres in length across the Hunter River.



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Existing concept design
 Alignment 1 – Tomago 1A
 Alignment 1 – Tomago 1B

Figure 4-8 Alignment 1

Two variations of Tomago interchange on Alignment 1 were considered:

- Tomago 1A: provides a northbound exit ramp directly into Tomago Road, northbound and southbound entry ramps at the Pacific Highway north of Tomago Road via overpasses, a southbound entry ramp from Tomago Road and a northbound entry from the Pacific Highway south of the Tomago Road intersection
- Tomago 1B: the alignment across the Hunter River was adjusted to avoid salt marsh and coastal wetlands. This arrangement provides northbound exit and southbound entry ramps at the Pacific Highway and Tomago Road intersection via an underpasses, and northbound entry and southbound exit ramps at an upgraded Pacific Highway and Old Punt Road intersection. This alignment is a variation of Tomago 1A in response to recommendations made at the Value Management Workshop (refer to **Section 4.4.2**).

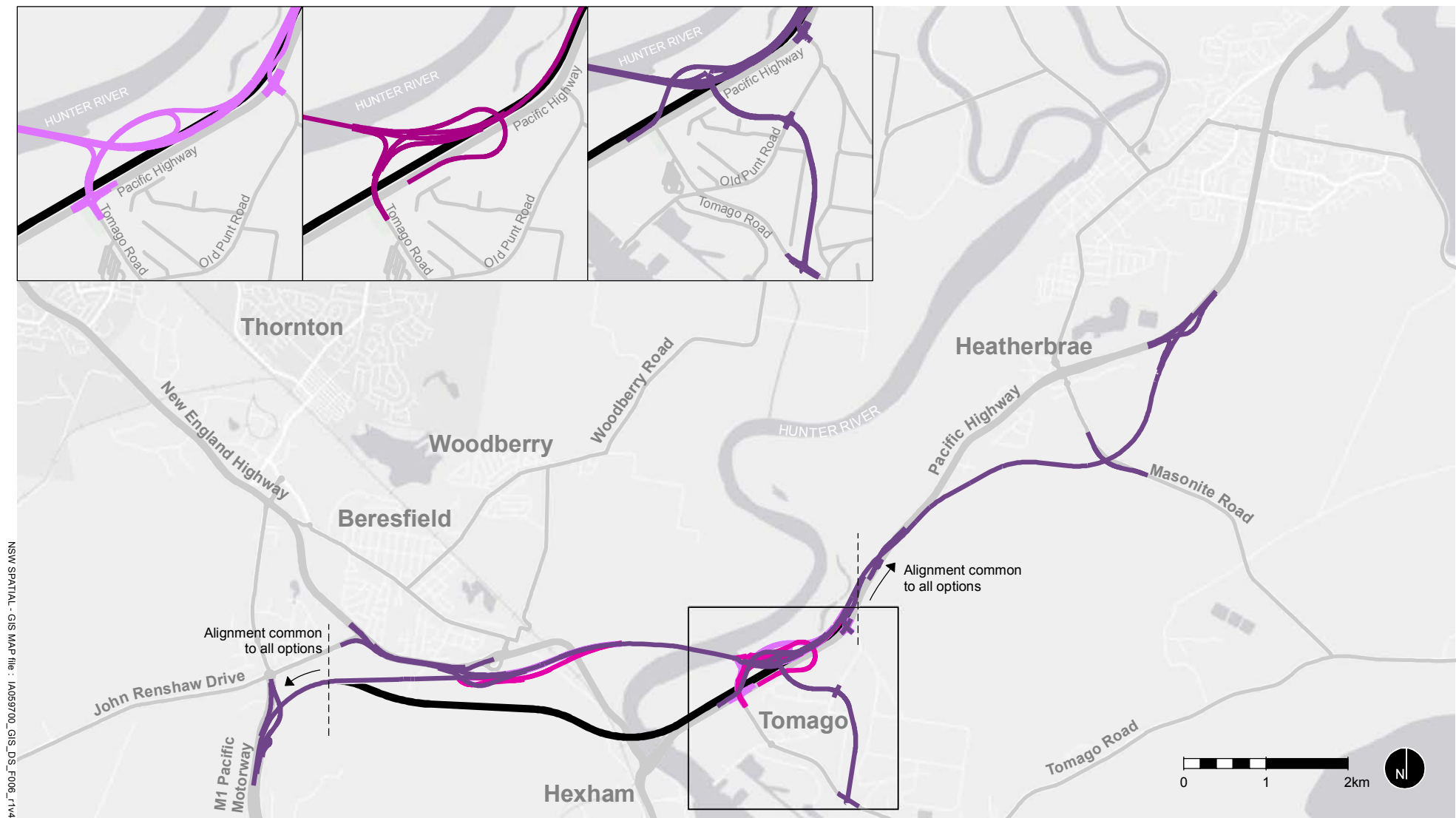
After the Hunter River crossing, Alignment 1 runs to the north of the Pacific Highway, before meeting a common point with the other alignments 300 metres west of Old Punt Road.

4.3.4 Alignment 2

The total length of Alignment 2 is about 14.9 kilometres (refer to **Figure 4-9**).

After the Black Hill section, Alignment 2 continues east for about 2.2 kilometres. This allows for an interchange at the New England Highway, south of Tarro. Similar to Alignment 1, this interchange provides a northbound entry ramp onto the M1 Pacific Motorway from the New England Highway and John Renshaw Drive at Tarro. The northbound ramp enters via an underpass under the realigned westbound carriageway of the New England Highway. The southbound exit ramp from the M1 Pacific Motorway to the New England Highway and John Renshaw Drive is via an overpass over the M1 Motorway. This section of the alignment has one wetland crossing.

In the Hunter River/Tomago section the alignment heads in a north-easterly direction, just before Woodlands Close and heads towards the railway line. After crossing the railway line and the New England Highway, Alignment 2 continues in an easterly direction to the Hunter River. It crosses the Hunter River about 2.2 kilometres north of the existing Hexham Bridge, in a south-easterly direction. The main viaduct structure begins just before Woodlands Close and ends about 550 metres east of the Tomago Road intersection, with a total length of about 2.6 kilometres. Similar to the other alignment options, the main viaduct rises as it approaches the Hunter River to provide appropriate navigational clearances for maritime traffic. The Alignment 2 viaduct includes a bridge section of about 400 metres in length across the Hunter River.



Existing concept design
 Alignment 2 – Tomago 2A
 Alignment 2 – Tomago 2B
 Alignment 2 – Tomago 2C

Figure 4-9 Alignment 2

Three variations of Tomago interchange on Alignment 2 were considered:

- Tomago 2A: provides a northbound exit ramp to the Tomago Road intersection via a reverse-loop ramp and northbound and southbound entry ramps from the Tomago Road intersection. A southbound exit ramp is provided at an upgraded Old Punt Road intersection
- Tomago 2B: provides a northbound entry ramp from Tomago Road intersection, a northbound exit ramp flying over the alignment to join the Pacific Highway southbound, and southbound entry and exit ramps at Tomago Road intersection
- Tomago 2C: provides a northbound entry ramp from the Pacific Highway west of Tomago Road via a flyover. A northbound entry and exit ramp and a southbound entry ramp are also provided east of Tomago Road via a roundabout and overpass over the alignment. This overpass would connect to new intersections at Old Punt Road and Tomago Road. A southbound exit ramp connects to an upgraded Pacific Highway and Old Punt Road intersection. This variation of Alignment 2 was developed following recommendations from the Value Management Workshop and further investigations. This variation is an evolution of Tomago 2A.

After the Hunter River crossing, Alignment 2 continues towards the Pacific Highway before taking a left bend to run parallel to the north of the Pacific Highway and eventually meeting the common point for the other alignments 300 metres west of Old Punt Road.

4.4 Assessment of options

The process of comparing and assessing these options enabled key constraints and opportunities to be considered and addressed throughout the design process.

A process known as Value Management was used to carry out the options assessment process for the project. Values important to the project were identified through desktop investigations and during collaborative workshops and meetings with key stakeholders. These values informed the assessment criteria which were used to identify a preferred option.

4.4.1 Interchanges

A multi-criteria analysis workshop was held in March 2015 involving project team members. The purpose of the multi-criteria analysis workshop was to determine which combination of interchanges was to be developed for each of the alignments (as described in **Section 4.3.2 to 4.3.4**). The workshop also captured feedback for further consideration at the Value Management Workshop.

To assess the interchanges, criteria were developed with project objectives. These criteria were related to alignment/engineering, connectivity, direct community impact, environment and constructability. The criteria were developed to be assessable and measurable at the interchange level.

Following the assessment process, the preferred interchanges for Black Hill, New England Highway/Tarro, Tomago Road and Raymond Terrace were put forward at the Value Management Workshop. Additional interchanges for Tomago were considered during the assessment process and a number of options were put forward to the Value Management Workshop, as discussed below.

4.4.2 Alignments

Value management workshop

The Value Management Workshop was held in April 2015 with the project team, Roads and Maritime stakeholders, representatives from Newcastle and Port Stephens councils and from LALCs. The intention of the workshop was to discuss the alignment options and gain a shared understanding of which option would provide the best balance across social, environmental, economic and engineering issues while also taking estimated costs into account. The primary purpose of the Value Management Workshop was to recommend a preferred alignment to progress to concept design.

The alignments assessed during the Value Management Workshop were Alignment 0, Alignment 1 – Tomago 1A, Alignment 2 – Tomago 2A and Tomago 2B.

The comparison and assessment of the alignment options was based on:

- Review of the assumptions, criteria and weightings used at the Value Management Workshop
- Analysis of the preliminary environmental investigation findings of the route option
- Review of constructability benefits or requirements
- High level cost estimates.

The Value Management process captures the detailed specialist knowledge, experiences and perspectives of the participant stakeholders to generate value and improve ideas.

Assessment criteria were developed under three key categories – functional, social and economic, and natural environment and culture.

Following the endorsement of the assessment criteria, the workshop used a paired comparison process to agree on the weightings that would be attached to each of the criteria.

Table 4-1 outlines the assessment criteria and their weightings for the Value Management Workshop.

Table 4-1 Assessment criteria for the Value Management Workshop

Perspectives	Assessment criteria	Weighting*
Functional	• Improve road safety for end users	24%
	• Maximise benefits to the road network and improve accessibility	26%
	• Improve travel times and freight efficiency	24%
	• Ease of construction	10%
	• Provide the best ongoing operational and maintenance solution	16%
Social and economic	• Minimise adverse changes in land use (including severance, business impacts and property acquisitions)	37%
	• Optimise local amenity (eg noise impacts, lighting)	37%

Perspectives	Assessment criteria	Weighting*
	<ul style="list-style-type: none"> Minimise the impact on the existing visual and landscape character 	27%
Natural environment and culture	<ul style="list-style-type: none"> Impacts on Commonwealth listed vegetation/species 	22%
	<ul style="list-style-type: none"> Impacts on state listed vegetation/species 	18%
	<ul style="list-style-type: none"> Impacts on SEPP14 Coastal Wetlands 	22%
	<ul style="list-style-type: none"> Impacts on known Aboriginal heritage 	30%
	<ul style="list-style-type: none"> Impacts on non-Aboriginal heritage 	8%

* Note that weighting totals may exceed 100% due to rounding

The alignment options were reviewed in detail to ensure there was a common understanding of each option and the opportunities and risks likely to be associated with each.

Following this review, the performance of each option was evaluated against each of the assessment criteria. Once the qualitative evaluation was complete, the assessment was scored using the agreed weightings. This established a relative overall ranking for each option for each of the three key categories.

Based on this comparison the Value Management Workshop recommended that Tomago 1A and Tomago 2A be progressed for further consideration. In summary, Tomago 1A was the best performer from a functional perspective, while Tomago 2A was the best performer from a natural environment and culture perspective. Both alignments performed equally from a social and economic perspective. The Value Management Workshop recommended additional design and assessment work be carried out for Tomago 1A and Tomago 2A by:

- Reducing the environmental impact of Tomago 1A
- Reviewing the functionality of the Tomago interchange for Tomago 2A.

The Value Management Workshop concluded that Alignment 0 and Tomago 2B would not proceed further.

Further design and assessment

After the additional design and assessment work was carried out, a preferred alignment selection workshop was held in May 2015 with project team members. The purpose of the workshop was to review Tomago 1A and Tomago 2A and recommend which alignment should be adopted for the revised concept design.

In preparation for the meeting, Tomago 1A and Tomago 2A were further refined and were renamed to reflect this change.

Tomago 1A was refined to include an at-grade intersection at Tomago Road that was comparable to the intersection at Tomago 2A. Its alignment was also adjusted to reduce impacts on ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* and the *Threatened Species Conservation Act 1995*. This resulted in Tomago 1B.

A review of Tomago 1B and Tomago 2A found that the functionality and cost of these options was very similar. However, Tomago 2A was found to be preferred as it avoided sensitive wetland areas near the Hunter River.

Further refinement of Tomago 2A was carried out to improve the Tomago interchange and achieve a longer term solution to meet traffic demand, resulting in Tomago 2C. These refinements include the link road connection from the interchange into Tomago Road, which would provide efficient access for freight to the industrial and commercial centre, as discussed in **Section 4.3.4**. Further investigation and assessment including traffic analysis, capital costs and environmental factors showed that Tomago 2C performs the best as a further improvement to Tomago 2A.

Figure 4-6 illustrates the development of interchange options at Tomago for Alignments 1 and 2.

A comparison of Tomago 1B, Tomago 2A and Tomago 2C found that the construction cost estimates were similar for the options. Accordingly, Tomago 2C was selected as the preferred option for the revised concept design as it was the more environmentally sensitive alignment as it would avoid the high value biodiversity areas located either side of the Hunter River compared to Alignment 0 and 1. Tomago 2C was found to best balance the functional, social and economic and natural environment and culture considerations.

A summary of the main advantages and disadvantages of the alignment options is provided in **Table 4-2**.

Table 4-2 Main advantages and disadvantages of alignment options

Option	Advantages	Disadvantages
Alignment 0	Existing corridor that requires the least number of new property acquisitions.	Impacts on high value biodiversity areas including SEPP 14 wetlands north and south of the Hunter River. Has poor functionality and connectivity to the local road network, particularly at Black Hill and Tomago. Alignment requires the bridge crossing of the Hunter River to be widened and constructed as twin bridges.
Alignment 1 – Tomago 1A	Improved functional performance at Black Hill and Tarro with new interchanges proposed providing improved connectivity to the adjoining road network. Improved alignment providing simpler construction than Alignment 0. Grade separated interchange at Tomago provides improved functionality over Alignment 0.	Worst performer on the basis of environmental impact. In particular, this option would have a major impact on the wetlands located on the northern side of the Hunter River. Tomago interchange could have constructability issues due to proximity to flood plain and environmental constraints Does not have the improved connectivity of other options at Tomago.

Option	Advantages	Disadvantages
Alignment 1 – Tomago 1B	<p>Improved functional performance at Black Hill and Tarro with new interchanges proposed providing improved connectivity to the adjoining road network.</p> <p>Improved alignment providing simpler construction than Alignment 0.</p> <p>Improved alignment over Alignment 1A due to decreased impact on environmentally sensitive areas including of the SEPP 14 wetland south of the river and the Federally listed coastal salt marsh north of the river.</p> <p>Tomago interchange provides improved connectivity by connecting to existing traffic signals at Tomago Road and Old Punt Road.</p>	<p>This option would still have a major impact on the wetlands located on the northern side of the Hunter River.</p> <p>Tomago interchange performs with less functionality and road safety due to connection into the signalised intersection.</p> <p>Tomago interchange could have constructability issues due to proximity to flood plain and environmental constraints.</p>
Alignment 2 – Tomago 2A	<p>Improved functional performance at Black Hill and Tarro with new interchanges proposed providing improved connectivity to the adjoining road network.</p> <p>Minimises environmental impact (ie avoids severance of high quality vegetation and avoids the majority of the SEPP 14 wetlands north and south of the river).</p> <p>Improved alignment providing simpler construction than Alignment 0.</p> <p>Tomago interchange provides improved connectivity by connecting to existing traffic signals at Tomago Road and Old Punt Road.</p>	<p>Requires new acquisitions of property in comparison to the Alignment 0 option.</p> <p>Requires a more complex Hunter River bridge crossing due to angle of river crossing.</p> <p>Road safety issues at proposed northbound exit ramp to Tomago (reverse loop).</p> <p>Tomago interchange could have constructability issues due to proximity to flood plain and environmental constraints.</p>
Alignment 2 – Tomago 2B	<p>Improved functional performance at Black Hill and Tarro with new interchanges proposed providing improved connectivity to the adjoining road network.</p> <p>Minimises environmental impact (ie avoids severance of high quality vegetation and avoids the majority of the SEPP 14 wetlands north and south of the river).</p> <p>Improved alignment providing simpler construction than Alignment 0.</p>	<p>Requires new acquisitions of property in comparison to the Alignment 0 option.</p> <p>Requires a more complex Hunter River bridge crossing due to angle of river crossing.</p> <p>Tomago interchange provides less functionality for changed northbound exit. Additional infrastructure requirements to provide the interchange.</p> <p>Tomago interchange could have constructability issues due to proximity to flood plain and environmental constraints.</p>

Option	Advantages	Disadvantages
Alignment 2 – Tomago 2C	<p>Improved functional performance at Black Hill and Tarro with new interchanges proposed providing improved connectivity to the adjoining road network.</p> <p>Minimises environmental impact (ie avoids severance of high quality vegetation and avoids the majority of the SEPP 14 wetlands north and south of the river).</p> <p>Improved alignment providing simpler construction than Alignment 0.</p> <p>Tomago interchange provides improved connectivity and functionality due to provision of grade separated interchange.</p> <p>Allows for improved constructability of Tomago interchange, predominantly out of the flood plain and located for simplified construction.</p>	Requires new acquisitions of property in comparison to other options, due to additional new link road at Tomago.

4.5 Recommendation

The preferred option for the revised concept design was identified through an extensive assessment and review process as outlined in the preceding sections.

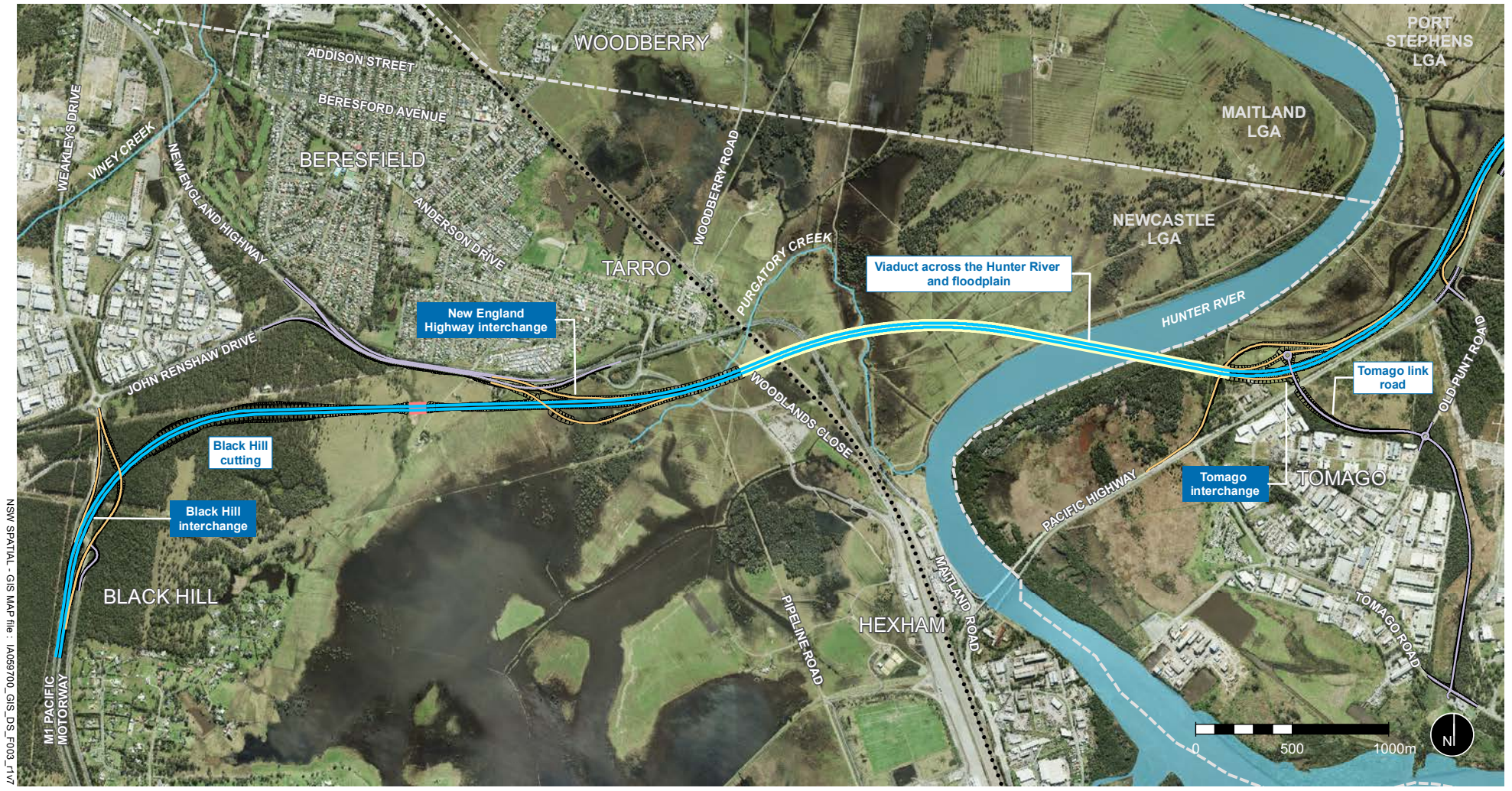
The preferred option adopted for the revised concept design is Alignment 2 – Tomago 2C, as described in **Section 4.3.4** and shown on **Figure 4-10**. This option has less environmental impacts, provides better opportunities to connect to the regional road network, improves interface and constructability across the New England Highway and the Hunter rail infrastructure and best allows for future development of these transport networks.

The revised concept design will meet the project objectives by:

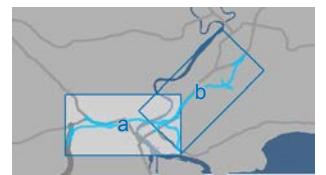
- Providing a motorway standard dual carriageway road with a minimum of four lanes for the length of the project
- Increasing the speed limit to 110 km/h, halving travel time between Black Hill and the Raymond Terrace Bypass
- Improving access to key employment areas such as Tomago, Beresfield, Black Hill and the Port of Newcastle with interchanges that integrate with the local road network, while retaining the existing function of existing interchanges
- Improved access for higher productivity and oversized vehicles within the study area, along the project route and to Tomago industrial area
- Improving flood access for the Lower Hunter across the Hunter River floodplain, by providing immunity for the one per cent AEP flood event between the M1 Pacific Motorway and Tomago
- Providing a design that will manage ongoing and incident road runoff through the Hunter Water drinking water catchment (specifically the Tomago Sandbeds which supply water for Newcastle)

- Minimising impacts on sensitive habitats, such as waterways and wetlands, native vegetation and fauna, while promoting good urban design principles.

In addition, the revised concept design improves the opportunity for a staged delivery of the project.

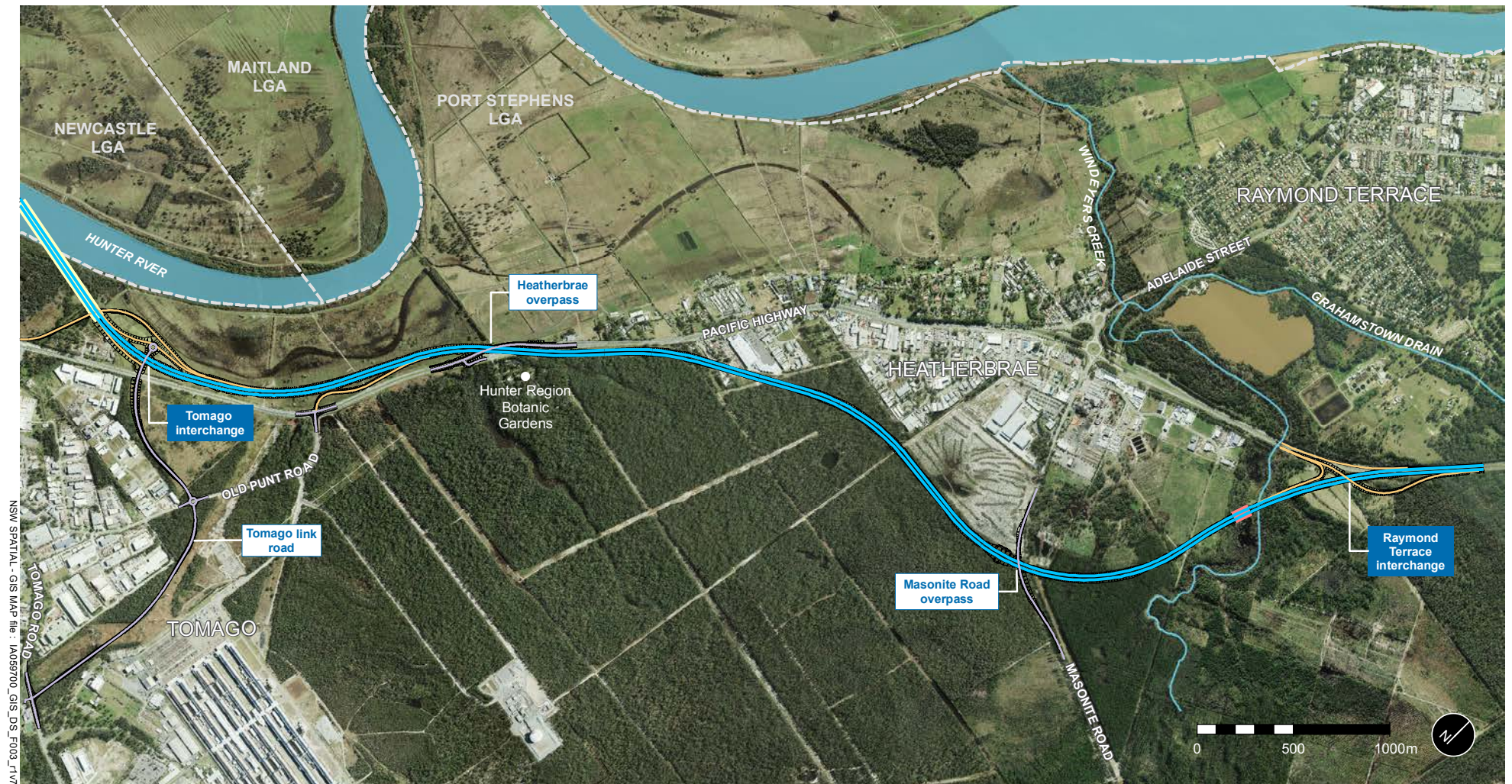


- The revised concept design
- New dual carriageway
- New ramp
- New local road
- Viaduct - dual carriageway
- Bridge - dual carriageway
- Main Northern Railway
- - - - LGA boundary

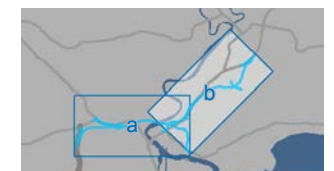


Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

Figure 4-10a The revised concept design



- The revised concept design
- New dual carriageway
- New ramp
- New local road
- Viaduct - dual carriageway
- Bridge - dual carriageway
- Main Northern Railway
- LGA boundary



Data sources
 Roads and Maritime Services 2015
 Land and Property Information 2014
 Jacobs 2015
 AUSIMAGE May 2014 and May 2015

Figure 4-10b The revised concept design

5 Next steps

This section discusses the next steps for the project.

5.1 Project process

5.1.1 Display of revised concept design

The revised concept design will go on display for community and stakeholder comment in October 2015. This will provide an opportunity for the community to review the revised concept design and give feedback. Roads and Maritime will use this information to further finalise the concept design.

5.1.2 Environmental assessment

Roads and Maritime will conduct an environmental assessment for the project, following the requirements of the *Environmental Planning and Assessment Act 1979* and the *Environment Protection and Biodiversity Conservation Act 1999*. The environmental assessment will involve further refinement of the revised concept design, based on more detailed input from technical investigations and community and stakeholder consultation.

5.1.3 Environmental Impact Statement

An EIS will be prepared and will include detailed information about the design features of the project, and will outline the likely environmental impacts of the project and the commitments and mitigation measures in managing those impacts. The EIS is expected to be exhibited in 2017 at which point further community and stakeholder feedback will be invited.

5.1.4 Project implementation

If the project is approved and funding is made available, the following step is project implementation. Implementation includes the following:

- Detailed design: the creation of detailed specification and working drawings of the approved concept which can be used for detailed costing and construction
- Property acquisition: property that would be affected by the project, and is not owned by Roads and Maritime, would need to be acquired before construction. Acquisition would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and following the process outlined in Roads and Maritime Services Land Acquisition Information Guide (Roads and Maritime, 2014)
- Construction: timing for implementation, including construction or potential staging of the project is not confirmed and is dependent on planning approval, future traffic needs, project approval and funding availability.

5.2 Ongoing consultation

Consultation and community involvement will continue through the concept design development and environmental assessment phases of the project. Future consultation for the project would include:

- The display of the revised concept design in October 2015, which will give further opportunity to review the concept design and receive feedback to inform the EIS for the project

- An Aboriginal Focus Group and relevant consultation to inform the cultural heritage assessment for the project
- Written communication to all property owners within the vicinity of the proposed alignment which will advise of the environmental assessment process and the display phase of the EIS
- Public exhibition of the EIS. This will be for a minimum of 30 days. Advertisements will be placed in newspapers advising of the public exhibition and where the EIS can be viewed. These will also provide advice about making a submission on the project, and will outline how these submissions will be considered and responded to during the planning process
- Community and stakeholder information sessions will be held during the display periods.

The Roads and Maritime project website will be updated with new information throughout the planning process and will promote community and stakeholder comment periods.

6 Glossary and terms

Acronym	Definition
A1 Pacific Highway	A major transport route connecting Sydney and Brisbane. The section of the Pacific Highway of relevance to the project is the section between Hexham and Raymond Terrace.
AADT	Annual average daily traffic, the total volume of traffic passing a roadside observation point over a period of a year, divided by the number of days per year.
AEP	Annual exceedance probability
Alignment	The geometric layout (eg of a road) in plan (horizontal) and elevation (vertical).
ARTC	Australian Rail Track Corporation
Arterial roads	The main or trunk roads of the state road network.
Aquifer	An underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be usefully extracted.
Aquifer Interference Policy	The policy that sets out the requirements for assessing the impacts that aquifer interference activities have on water resources.
Bore	A drilled hole constructed by a drilling rig to access groundwater.
Catchment	Land area collecting rainfall and contributing to surface water or groundwater.
CEMP	Construction Environment Management Plan
CLG	Community liaison group
Concept design	Initial functional layout of a road/road system or other infrastructure.
Constraint	Something that limits or restricts the project design, development or construction.
Constructability	Refers to the ease in which a project can be built.

Acronym	Definition
DECCW	Department of Environment, Climate Change and Water
DIRD	Department of Infrastructure and Regional Development
Environmental assessment (process)	A specialised part of the decision-making process, where the environmental impact of a development or proposal or activity is considered in detail, together with other aspects of the development.
EIS	Environmental Impact Statement
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
Existing concept design	Refers to the concept design developed between 2004 and 2010, and displayed to the community in 2010.
Floodplain	An area of low-lying ground next to a river, often prone to flooding.
Functionality	A term that describes the effectiveness of an element of the project.
GMA	Groundwater management area. GMAs are areas which have defined management boundaries and have been intensively developed.
Groundwater dependent ecosystems	Communities of plants, animals and other organisms within an area that depend on underground water for their water needs.
Habitat	The place where a species, population or ecological community lives (whether permanently, periodically or occasionally). Habitats are measurable and can be described by their flora and physical components.
HRBG	Hunter Region Botanic Gardens
Hunter Water drinking water	The area within the Lower Hunter that collects drinking water.

Acronym	Definition
catchment	
Interchange	A grade separate junction between roads where the local road passes above or beneath the highway via bridge or underpass structure with one or more interconnecting roadways.
Key fish habitat	Aquatic habitats that are important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. Further definition is provided in the <i>Fisheries Management Act 1994</i> .
km/h	Kilometres per hour
kV	Kilovolts
LEP	Local Environment Plan
LEP corridor	An area gazetted in the Newcastle City and Port Stephens Councils LEPs for the project.
LGA	Local Government Area
M1 Pacific Motorway	A major road linking Sydney to the Central Coast, Newcastle and the Hunter Regions.
MCA	Multi-criteria analysis
Migratory species	Species listed as migratory under the EPBC Act relating to international agreements to which Australia is a signatory. These include Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals.
NSW	New South Wales
OEH	Office of Environment and Heritage (formerly Department of Environment, Climate Change and Water)
Pacific Highway upgrade program	Program to upgrade the Pacific Highway within NSW to provide a four lane divided road from Hexham to Queensland.
Paleochannel	A historical river channel filled with soft sediments.

Acronym	Definition
Property acquisition	In the context of the project, property acquisition refers to purchasing property from owners to provide land for the project.
Raymond Terrace Bypass	The A1 Pacific Highway located to the east of Raymond Terrace. This section of road is a dual carriageway, four lane road of motorway standard.
Revised concept design	The design currently being developed following the review and options process described in Section 3 of the report.
Riparian habitat	Riparian refers to the area between land and a waterway. This area often provides habitat for animal and plant species.
Roads and Maritime	Roads and Maritime Services (formerly Roads and Traffic Authority)
Runoff	Water which does not infiltrate into the soil, and flows downslope over the ground surface.
SEPP	State environmental planning policy
SEPP 14	State Environmental Planning Policy 14 – Coastal Wetlands
SEPP 44	State Environmental Planning Policy No 44 – Koala Habitat Protection
Sight distance	The distance that motorists need to see ahead to drive safely.
Special area	An area protected by legislation because of its recognised importance to protecting fresh water for drinking.
Stakeholder	Organisations, parties and/or special interest groups likely to have an interest in the proposal.
State Significant Infrastructure	Refers to major infrastructure, in particular linear infrastructure such as roads, railway lines or pipes which often cross a number of council boundaries, or where development may have a significant environmental impact (in the meaning of the EP&A Act).
State Significant Infrastructure Application	An application to the NSW Department of Planning and Environment to demonstrate that a project meets the criteria for State Significant Infrastructure (as outlined in the State Environmental Planning Policy (State and Regional Development (2011)), and to request Secretary's environmental assessment requirements (SEAR). The application is also

Acronym	Definition
	accompanied by a report that details the proposal and its likely environmental impacts.
Study area	The study area encompasses the proposal area and the area that may be indirectly impacted by the proposal.
TEC	Threatened Ecological Communities. For the purposes of this report this includes ecological communities listed or nominated under the EPBC Act and ecological communities listed or nominated under the TSC Act.
Threatened	As defined under the NSW <i>Threatened Species Conservation Act 1995</i> . A species, population or ecological community that is likely to become extinct or is in immediate danger of extinction.
Tributary	A river or stream that flows into a larger river or lake.
TSC Act	<i>Threatened Species Conservation Act 1995</i>
Water Sharing Plan	Outlines the rules for how water is allocated within certain areas. The purpose of a water sharing plan is to protect the fundamental environmental health of the water source, ensure the water source is sustainable in the long term and provide water users with a clear indication of when and how water will be available for extraction.
Weaving	The undesirable situation where traffic merging and diverging must cross paths within a limited distance, usually before an intersection.
Wetland	A swamp or marsh in which the soil is frequently or permanently saturated with water, or under water.
Wildlife corridors	Wildlife corridors are links of native vegetation that join two or more areas of similar habitat, and are critical for sustaining ecological processes, such as provision for animal movement and the maintenance of genetically viable populations.

7 References

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