Hawkesbury City Council

attachment 1

to

item 155

Richmond Bridge Duplication and Traffic Improvements - Preferred Option Report June 2021

date of meeting:10 August 2021
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time:6:30 p.m.

Australian Government

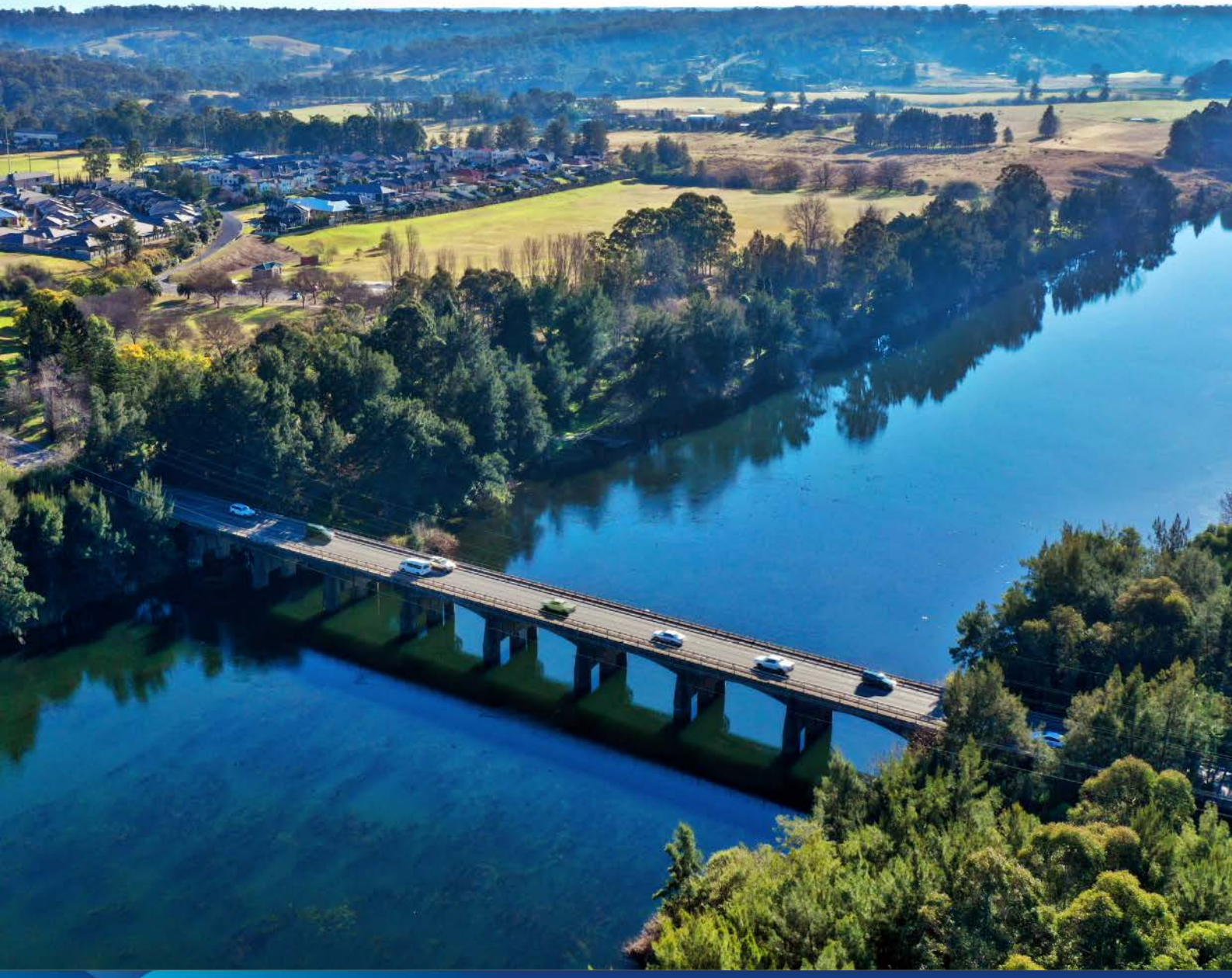
BUILDING OUR FUTURE

NSW GOVERNMENT

Transport for NSW

Richmond Bridge duplication and traffic improvements

Preferred option report



June 2021 | Version: Final

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1. Executive summary

1.1 Background

The Richmond Road corridor is an arterial road that connects the Hawkesbury Region to Blacktown, the M7 and the Central West Region of NSW via Blacktown Road, Kurrajong Road and Bells Line of Road. Within the Bells Line of Road section of this corridor is Richmond Bridge, which provides a vital link between Richmond and North Richmond - two major residential and commercial hubs of the Hawkesbury area.

The bridge and road approaches are operating at capacity during morning and afternoon peak periods resulting in congestion and increased travel times. With a number of approved developments nearby which would increase traffic on the bridge and surrounding network, there is a need to investigate traffic improvements to reduce congestion and cater for future growth.

Transport previously completed the 2013 Richmond Bridge and approaches congestion study: preferred short-term and long-term options report, which highlighted the need for intersection improvements to deliver short-term traffic improvements and additional bridge capacity to manage long-term traffic demand. The intersection improvements are nearing completion and planning has begun for an additional bridge and associated traffic improvements.

Building a new bridge to provide additional capacity over the Hawkesbury River, bypassing Richmond and North Richmond town centres and upgrading other major intersections will reduce congestion between Richmond and North Richmond; improve connectivity between Bells Line of Road and Sydney's arterial road network; reduce crash rates; improve flood resilience and enhance amenity in both town centres.

1.2 Purpose of this document

The purpose and scope of this document is to:

- Document the need for the additional bridge capacity and other traffic improvements
- Describe the options development process
- Summarise the community engagement process to date and feedback received
- Review constraints which may affect the options
- Analyse traffic benefits, economics and relative cost of the options
- Recommend a preferred option to progress to the next phase of design and environmental assessment.

1.3 Project need

Richmond Bridge is operating at capacity during morning and afternoon peak periods resulting in congestion and increased travel times. During peak periods, traffic in the road network of Richmond and North Richmond is expected to increase by 44 per cent and traffic crossing Richmond Bridge is expected to increase by 61 per cent between 2019 and 2046, largely because of residential growth in the area which will continue to increase congestion and travel times. Without improvements to the road network, travel times in the morning peak between

North Richmond and Richmond are expected to increase by 115 per cent from about 14 minutes in 2019 to about 30 minutes in 2046. In the afternoon peak, the reverse trip is expected to increase by 73 per cent from about 22 minutes in 2019 to about 38 minutes in 2046. Congestion will also effect journey time reliability for public transport.

To avoid congestion between Richmond and North Richmond, many vehicles currently travel on narrow local roads such as Yarramundi Lane and Inalls Lane which are not suitable for high volumes of traffic.

In addition to network congestion and connectivity issues, there are injury crash clusters on the approaches to Richmond Bridge, in Richmond town centre and at key intersections along The Driftway. Between 2013 and 2018, 246 crashes were recorded on key roads in the study area resulting in three fatalities and 192 injuries. The most common crash type was between through and right turning traffic at intersections. There is also a lack of active transport connections between Richmond and North Richmond.

The existing Richmond Bridge is built below the 1 in 2 chance per year flood level and is closed in relatively minor flood events. While the bridge is not part of flood evacuation routes, there is an opportunity to improve road network resilience.

Richmond is one of five original Macquarie Towns and is rich in heritage. While North Richmond has a relatively contemporary town centre, providing a route that bypasses both town centres would deliver traffic improvements and provide opportunities for revitalisation and amenity improvements in both town centres and protect the historical character.

1.4 Project objectives

The objectives of the Richmond Bridge duplication and traffic improvements project (the project) are:

- Improve travel times, journey time reliability and cater for future demand for private, public, active and freight transport between North Richmond, Richmond and the connecting arterial road network
- Improve connectivity between Bells Line of Road and Sydney's arterial road network in the medium term and to the Castlereagh Freeway in the long term
- Reduce the frequency and severity of crashes on key road corridors between Richmond and North Richmond
- Improve flood resilience
- Support economic development, liveability, and Council's strategic vision for the town centres of Richmond and North Richmond.

In doing this Transport will build a road corridor that aims to:

- Improve connections to the Central West of NSW as the alternative connection to the Great Western Highway
- Maintain the historical significance of the area
- Best fit with the built fabric and natural patterns of the area.

1.5 Funding announcements

In April 2019, The Australian Government committed $200 million to deliver the Richmond Bridge duplication and traffic improvements on an 80:20 funding basis with an expected commitment of $50 million from the NSW Government. In September 2019, the NSW Government confirmed this funding commitment bringing the total project funding to $250 million.

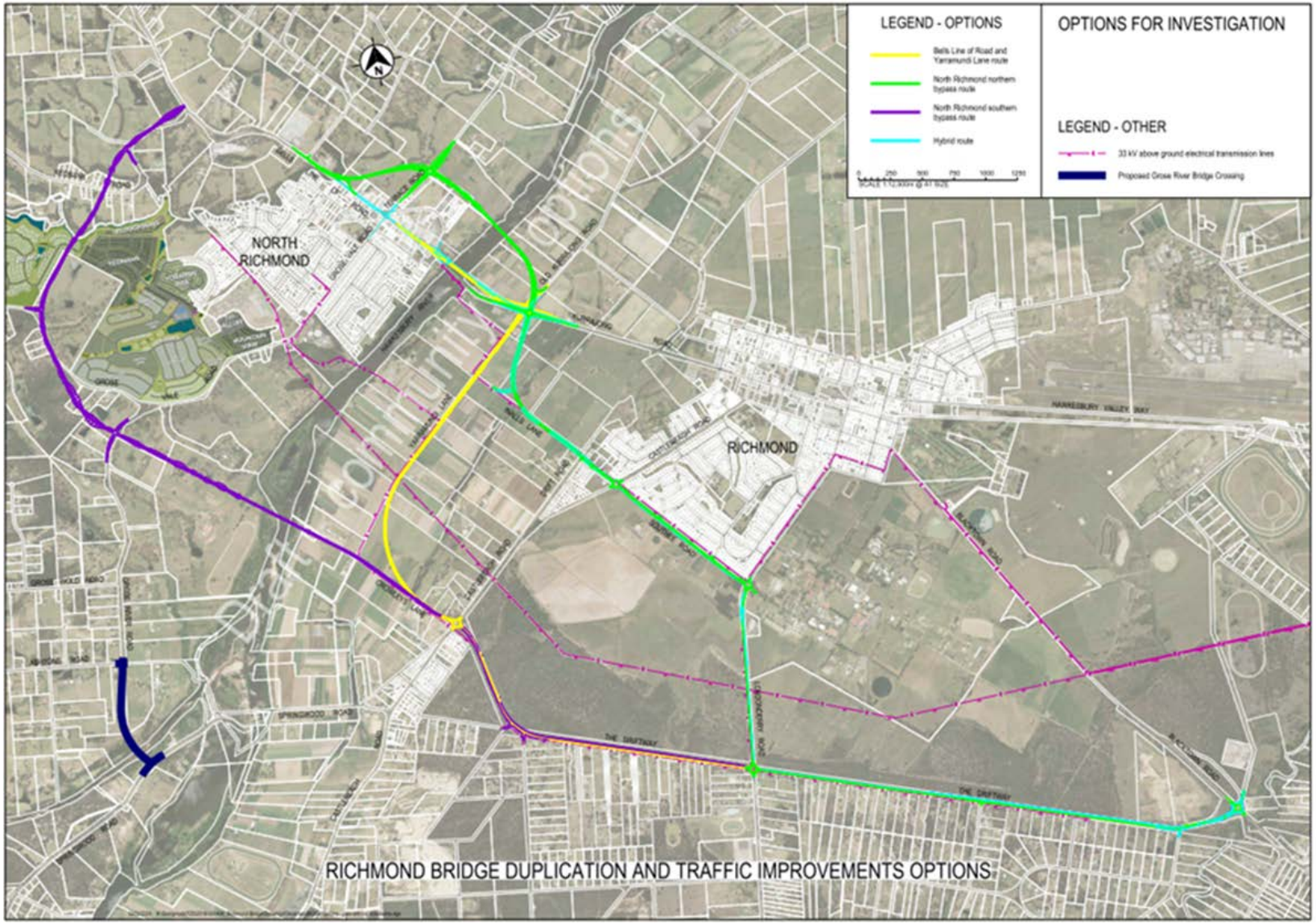
1.6 Options development

In 2019 Transport for NSW (Transport) formed a Community Working Group to play a key role in providing local knowledge to assist in developing a range of potential routes for the proposal. This group has been identified from key stakeholders within the community, and is made up of local community, business, environmental, heritage and flood advisory groups. In collaboration with this group more than eight options for the project were initially identified within five investigation routes which were put on display for community and stakeholder feedback in late 2019.

Following feedback, Transport has narrowed down the options to a shortlist of four options: Yellow, Green, Purple and a Hybrid option which is a combination of sections of the Yellow and Green options (Figure 1-1). Further details on the options development and shortlisting process can be found in Section 4. This process was based on:

- Traffic modelling, focusing on projected traffic performance
- Preliminary heritage and environmental investigations
- Collaboration with stakeholder and community workgroups made up of key community, business, emergency services and environmental groups.

Figure 1-1 - Shortlisted options



1.7 Constraints analysis

Constraints may affect the feasibility of a route. Key constraints identified are:

- Biodiversity, including Endangered Ecological Communities (ECCs) and coastal wetlands
- Heritage, both Aboriginal and non-Aboriginal
- Property ownership
- Sporting fields
- Flooding
- Visual amenity.
- Further details on constraints is included in Section 6.

1.8 Options assessment

Transport assessed the four shortlisted options at a value management workshop in March 2020. Each option was assessed on:

- performance against the project objectives
- travel savings achieved between 2026 and 2046
- the overall cost for the option and whether it delivers value for money by calculating the benefit-cost ratio (BCR). A higher number BCR indicates there is a greater project benefit relative to the cost. A project is generally considered economically viable when the benefits of the project exceeds the cost and BCR is greater than 1
- impacts on identified constraints.

The option length, travel time saving, impacts on constraints and BCR for each option is shown in Table 1-1. A project is generally considered economically viable when the value of the project exceeds the cost and BCR is greater than 1. Further details on this assessment can be found in Section 7.6.

The value management workshop identified that the Hybrid Option was the option that best achieved the project objectives within the $250 million funding available and on balance minimised impacts on constraints including heritage, property acquisition and biodiversity.

Consultation with the community and stakeholders identified a preference for a bypass of both town centres to provide a long term solution to traffic congestion and a platform for potential amenity improvements and revitalisation of the town centres. Investigations determined that additional funding would be required to achieve this outcome. From the outcomes of the value management workshop and consultation, the Green Option (North Richmond Northern Bypass) was identified as the preferred option to deliver a bypass of both town centres as it would achieve the highest travel time savings of all options, and the lowest environmental and property impacts of the options which would bypass both town centres.

1.9 Recommendation

The Green Option is recommended as the preferred route option. Subject to feedback from the community and stakeholders, the NSW and Australian Governments would confirm the funding required to deliver the Green Option. Table 1-1 below summarises this analysis.

Table 1-1 - Options assessment summary

Option	Yellow	Green	Purple	Hybrid
Route length	13.7km	12.3km	13.6km	12.0km
2026 Travel time saving (peak hours)	7 minutes	8 minutes	8 minutes	8 minutes
2046 Travel time saving (peak hours)	14 minutes	19 minutes	17 minutes	16 minutes
Bypasses town centre **North Richmond** **Richmond**	 No Yes	 Yes Yes	 Yes Yes	 No Yes
Benefit-cost ratio (BCR)	3.4	3.1	2.6	3.7
Impacts on constraints	4 minor 5 moderate 3 major	4 minor 5 moderate 2 major	4 minor 3 moderate 4 major	4 minor 7 moderate 1 major

The Green Option has the following key features:

- A bypass to the north of North Richmond including a new single lane in each direction bridge about 500 metres downstream of the existing Richmond Bridge. The bridge is proposed to be built about six metres higher than the existing bridge due to the topography of the river banks and the route would achieve a minimum 1 in 5 year flood resilience.
- Existing Richmond Bridge will be retained in its current form for local traffic
- New traffic signals at the intersection of the bypass and Terrace Road
- A new active transport connection between Richmond and North Richmond
- New traffic signals at the intersection of Kurrajong Road/Old Kurrajong Road/Yarramundi Lane
- New single lane in each direction roadway bypassing Richmond to the south connecting from Old Kurrajong Road to Inalls Lane
- Improvements to Inalls lane and a separate road parallel to Southee Road between Castlereagh Road and Londonderry Road
- New roundabout at intersection at Castlereagh Road, Inalls Lane and bypass

- New traffic signals to provide access to the University of Western Sydney connecting Londonderry Road, Vines Road, and the bypass road.

Safety improvements to The Driftway between Londonderry Road and Blacktown Road including:

- New roundabout at the intersection of Londonderry Road and The Driftway
- Realigning the eastern end of The Driftway to form a new roundabout intersection with Blacktown Road and Racecourse Road
- Pavement and drainage improvements.

Upgrades to the Driftway could be delivered as a first stage to provide early safety benefits to the community.

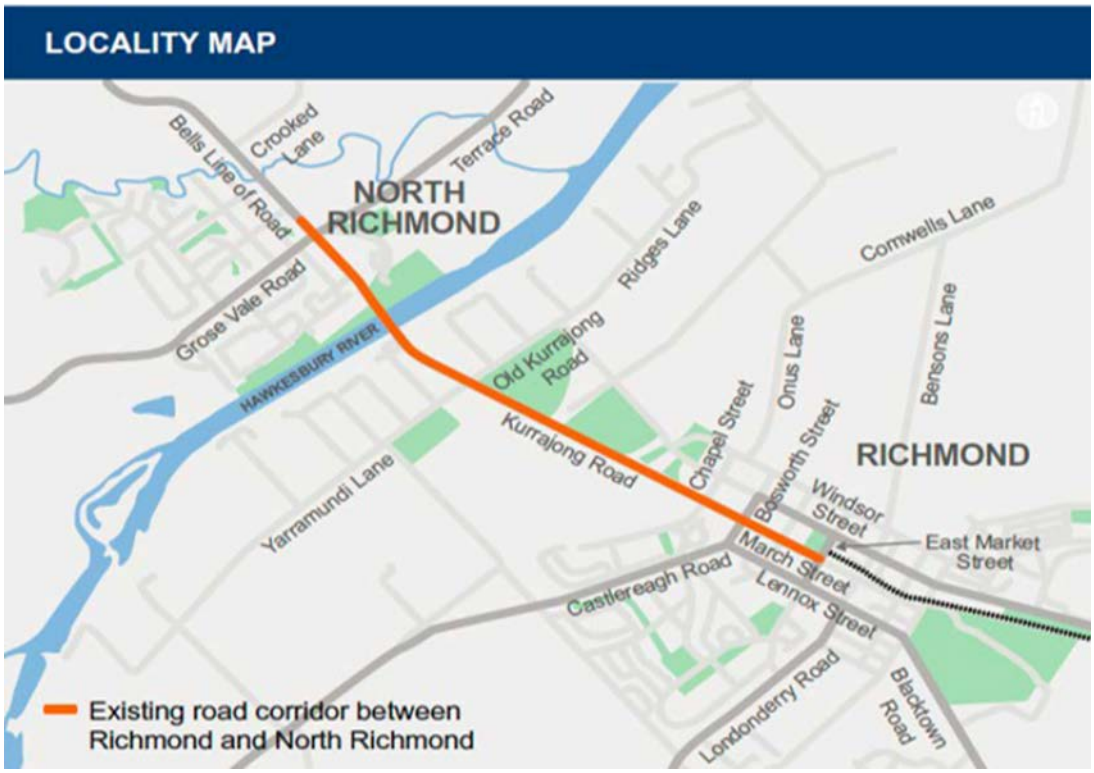
This report has been prepared for community consultation. Feedback provided will be considered in the next phase of design development and in the environmental assessment. The community will also have an opportunity to provide feedback on the concept design and environmental assessment when prepared.

2. Introduction

2.1 Project overview

The Richmond Road corridor is an arterial road that connects the Hawkesbury Region to Blacktown, the M7 and the Central West Region of NSW via Blacktown Road, Kurrajong Road and Bells Line of Road. Within the Bells Line of Road section of this corridor is Richmond Bridge, which provides a vital link between Richmond and North Richmond - two major residential and commercial hubs of the Hawkesbury area.

Figure 2-1 - Project locality



Transport previously completed the 2013 Richmond Bridge and approaches congestion study: preferred short-term and long-term options report, which highlighted that during peak periods, key approach intersections on Bells Line of Road and Kurrajong Road are negatively impacting the operation of Richmond Bridge. This highlighted the need for intersection improvements to deliver short-term traffic improvements and bridge duplication to manage long-term traffic demand.

The following intersection improvements are being delivered in stages by the NSW and Australian Governments:

- Old Kurrajong Road/Kurrajong Road (completed in 2015)
- Bells Line of Road/Grose Vale Road (completed in 2019)
- March Street/Bosworth Street (expected completion 2021).

Richmond Bridge is currently a single lane in both directions and is operating at capacity during morning and afternoon peaks, carrying an average of over 32,000 vehicles per weekday, with

44 per cent of these trips occurring during peak periods. The Richmond Road corridor is classified as a secondary freight route, is part of the Higher Mass Limit road network and is suitable for use by B-doubles up to Redbank Road. Due to the challenging topography, Bells Line of Road is not suitable for B-Doubles west of Redbank Road and is therefore unlikely to become a major freight route to the Central West of NSW. Between Richmond and North Richmond, heavy vehicles account for about eight per cent of the traffic stream with B-doubles accounting for less than one per cent.

To reduce congestion, and cater for the projected traffic growth, options for the duplication of Richmond Bridge have been investigated.

2.2 Project objectives

The objectives of the Richmond Bridge duplication and traffic improvements project (the project) are:

- Improve travel times, journey time reliability and cater for future demand for private, public, active and freight transport between North Richmond, Richmond and the connecting arterial road network
- Improve connectivity between Bells Line of Road and Sydney's arterial road network in the medium term and to the Castlereagh Freeway in the long term
- Reduce the frequency and severity of crashes on key road corridors between Richmond and North Richmond
- Improve flood resilience
- Support economic development, liveability, and Council's strategic vision for the town centres of Richmond and North Richmond.

In doing this Transport will reserve a road corridor that aims to:

- Improve connections to the Central West of NSW as the alternative connection to the Great Western Highway
- Maintain the historical significance of the area
- Best fit with the built fabric and natural patterns of the area.

2.3 Purpose of this document

The purpose of this document is to:

- Document the need for the duplication of Richmond Bridge and other traffic improvements
- Describe the options development process
- Review constraints which may affect options
- Analyse traffic benefits, economics and relative costs of options
- Recommend a preferred option to progress to the next phase of design and environmental assessment.

2.4 Strategic context

2.4.1 NSW Premier's and state priorities

The NSW Government is working to achieve 12 Premier's priorities and 18 state priorities to grow the economy, deliver infrastructure, protect the vulnerable, and improve health, education and public services across NSW.

The project supports the following Premier's priority:

- Building infrastructure – key infrastructure projects to be delivered on time and on budget across the state.

The project supports the following state priorities:

- Improving road travel reliability
- Reducing road fatalities.

2.4.2 Future Transport Strategy 2056

The NSW Future Transport Strategy 2056 (Transport for NSW, 2018) outlines a clear framework to address transport challenges in NSW over the next 40 years and is an update of the NSW Long Term Transport Master Plan released in 2012. It integrates planning for roads, freight and all other modes of transport and sets out initiatives, solutions and actions to meet NSW transport challenges.

The project would directly support the following Greater Sydney transport customer outcomes:

- Efficient, reliable and easy-to-understand journeys for customers, enabled by a simple hierarchy of services
- A safe transport system for every customer with the aim for zero deaths or serious injuries on the network by 2056
- Transport services and infrastructure are delivered, operated and maintained in a way that is affordable for customers and the community.

2.4.3 Greater Sydney Regional Plan

The Greater Sydney Regional Plan – A Metropolis of Three Cities (Greater Sydney Commission, 2018) envisages three cities where most residents live within 30 minutes of their jobs, education and health facilities, services and leisure opportunities. The plan includes a structure plan that emphasises how the principal spatial elements of the city are interconnected and integrated to best deliver in these critical areas:

- Integration of the mass transit network with the economic corridors, centres, transit-oriented development, urban renewal and health and education precincts
- Connectivity between the rail freight and strategic road networks and the trade gateways and industrial areas integration of the green grid network with residential neighbourhoods
- Retention of the integrity of the values of the Metropolitan Rural Area and the Protected Natural Area.

Richmond is identified in the plan as a strategic centre and the transport link north-west to the Blue Mountains is identified as a regional corridor.

The plan includes ten directions with related objectives, strategies and actions. The project directly aligns with the direction of 'A city supported by infrastructure' and the following related objectives:

- Objective 1 – Infrastructure supports the three cities
- Objective 2 – Infrastructure aligns with forecast growth – growth infrastructure compact
- Objective 3 – Infrastructure adapts to meet future needs.

The project also supports the following identified directions:

- A city supported by infrastructure
- A well-connected city.

2.4.4 Western City District Plan

The Western City District covers the Blue Mountains, Camden, Campbelltown, Fairfield, Hawkesbury, Liverpool, Penrith and Wollondilly local government areas. The Western City District Plan (Greater Sydney Commission, 2018) is a 20-year plan to manage growth in the context of economic, social and environmental matters to achieve the 40-year vision of Greater Sydney. It is a guide for implementing the Greater Sydney Region Plan – A Metropolis of Three Cities, at a district level and is a bridge between regional and local planning.

The project is within the Western City District. The project directly aligns with Planning Priority W1 Planning for a city supported by infrastructure and with the following associated objectives from the plan:

- Objective 1 – Infrastructure supports the three cities
- Objective 2 – Infrastructure aligns with forecast growth – growth infrastructure compact
- Objective 3 – Infrastructure adapts to meet future needs.

The project also aligns with:

- Planning Priority W7 - establishing the land use and transport structure to deliver a liveable, productive and sustainable Western Parkland City
- Planning Priority W10 - maximising freight and logistics opportunities and planning and managing industrial and urban services land.

Both priorities have the objective of ensuring the freight and logistics network is competitive and efficient.

2.4.5 Bells Line of Road – Castlereagh Connection – Corridor identification

The NSW Government is planning for the long-term transport needs of Western Sydney by identifying and protecting corridors of land for future transport infrastructure. In mid-2018 Transport for NSW sought feedback from the community on a preferred corridor of land for the Bells Line of Road – Castlereagh connection for a possible future road.

The Bells Line of Road – Castlereagh Connection corridor displayed to the community would extend about 45km between Bells Line of Road at Kurrajong Heights and the existing motorway network at the intersection of Richmond Road and the M7 Motorway at Colebee.

Following feedback from the community, Transport decided to Continue with the previously gazetted 1951 corridor for the Bells Line of Road Castlereagh Connection and relinquish the section of previously exhibited Bells Line of Road corridor from Castlereagh to Kurrajong Heights.

2.4.6 Road Safety Plan 2021

The Road Safety Plan 2021 (Transport for NSW, 2018) outlines how the NSW Government will work towards the State Priority Target of reducing fatalities by 30 per cent by 2021 (compared to average annual fatalities over 2008-2010). It also aligns the Towards Zero vision with Future Transport 2056, which aims to have an NSW transport network with zero trauma by 2056.

Injury crash clusters and safety issues have been identified around Richmond town centre and along The Driftway from conflicts between through traffic and right-turning traffic and conflicts with vulnerable road users. There is a higher-than average occurrence (compared to the Sydney Region rate) of injury crashes at dusk/dark in the Richmond area.

The project is consistent with the directions set out in Road Safety Plan 2021 to provide a better standard of road with improved road width, intersections and active transport links.

2.4.7 NSW Freight and Ports Plan

The NSW Freight and Ports Plan (NSW Government, 2018) is aligned with NSW Future Transport Strategy 2056 and has the aim of providing a network to move goods in an efficient, safe and environmentally sustainable manner, providing successful outcomes for communities and industry. One of the aims of the plan is to ensure safe, efficient and sustainable freight access to places. The project is consistent with this aim because it will assist the safe and efficient freight movements along a secondary freight route.

3. Project need

To determine the need for the project, this section outlines the issues around current and future traffic performance, safety, flood resilience and amenity.

3.1 Current traffic performance

We carried out traffic surveys to collect data in Richmond and North Richmond during December 2018 and March 2019, including 24-hour classification counts, peak hour intersection counts, travel time surveys and origin-destination data.

Richmond Bridge is at capacity during the morning (AM) and afternoon (PM) peaks as shown in Figure 3-1 and Figure 3-2. More than 32,000 vehicles use the bridge on an average weekday, with over 44 per cent of these trips occurring during both peaks. The Austroads' Guidelines suggests an indicative capacity threshold between 1,400 and 1,600 vehicles per hour per lane for a two-lane urban arterial road with no interference from parking and adequate spacing between intersections.

Figure 3-1 - Eastbound traffic on Richmond Bridge in the AM peak

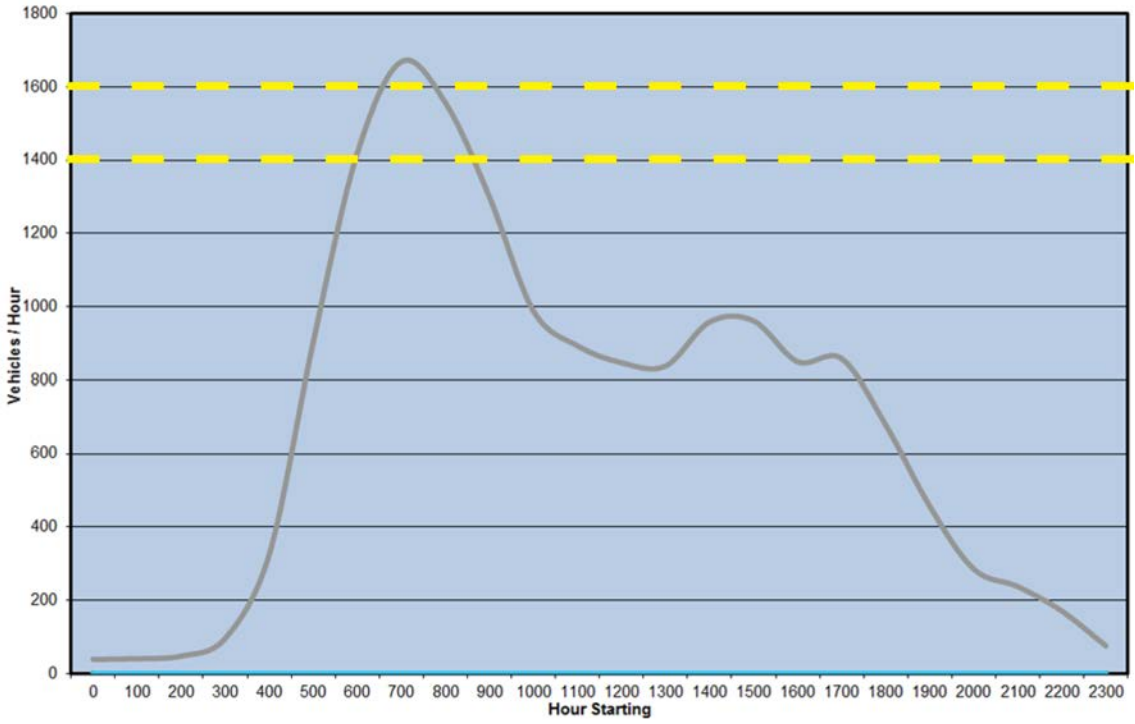
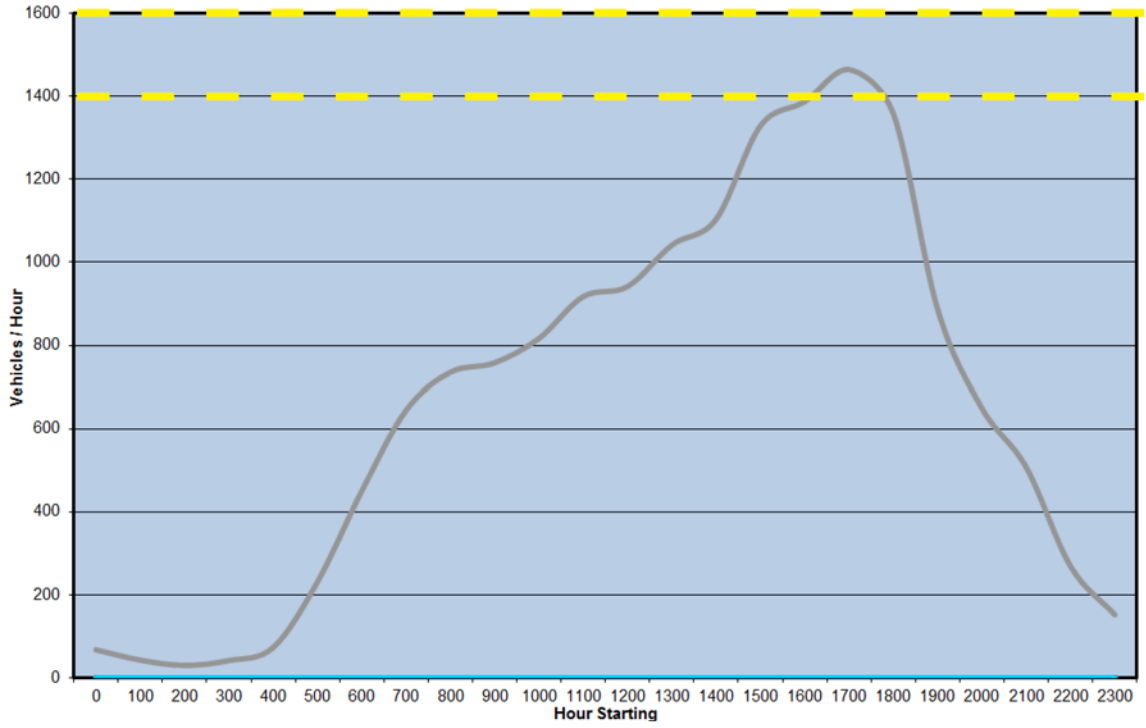


Figure 3-2 - Westbound traffic on Richmond Bridge in the PM peak



Currently, Kurrajong Road is predominantly one lane in each direction between Richmond and North Richmond. The road network is congested during the morning and afternoon peaks resulting in lower travel speed, higher travel time and a long queue between Richmond and North Richmond.

Figure 3-3 and Figure 3-4 use the origin-destination data to show the key travel patterns of traffic crossing the bridge in the AM and PM peaks. In the AM peak about 31 per cent of traffic crossing the bridge eastbound has destinations within Richmond and 25 per cent continue through Richmond towards Windsor, and about 40 per cent has destinations south of the study area via Castlereagh Road, Londonderry Road and Blacktown Road while the remainder return to the western side of the Hawkesbury River.

In the PM peak about 35 per cent of traffic crossing the bridge westbound have origins within Richmond and 19 per cent from Windsor direction travel through Richmond, about 42 per cent have origins south of the study area via Castlereagh Road, Londonderry Road and Blacktown Road while the remainder return to the eastern side of the Hawkesbury River.

This shows the existing route between North Richmond, Richmond and Windsor is a strong desire line catering for a large proportion of trips.

Figure 3-3 - Key traffic patterns near Richmond Bridge in the AM peak

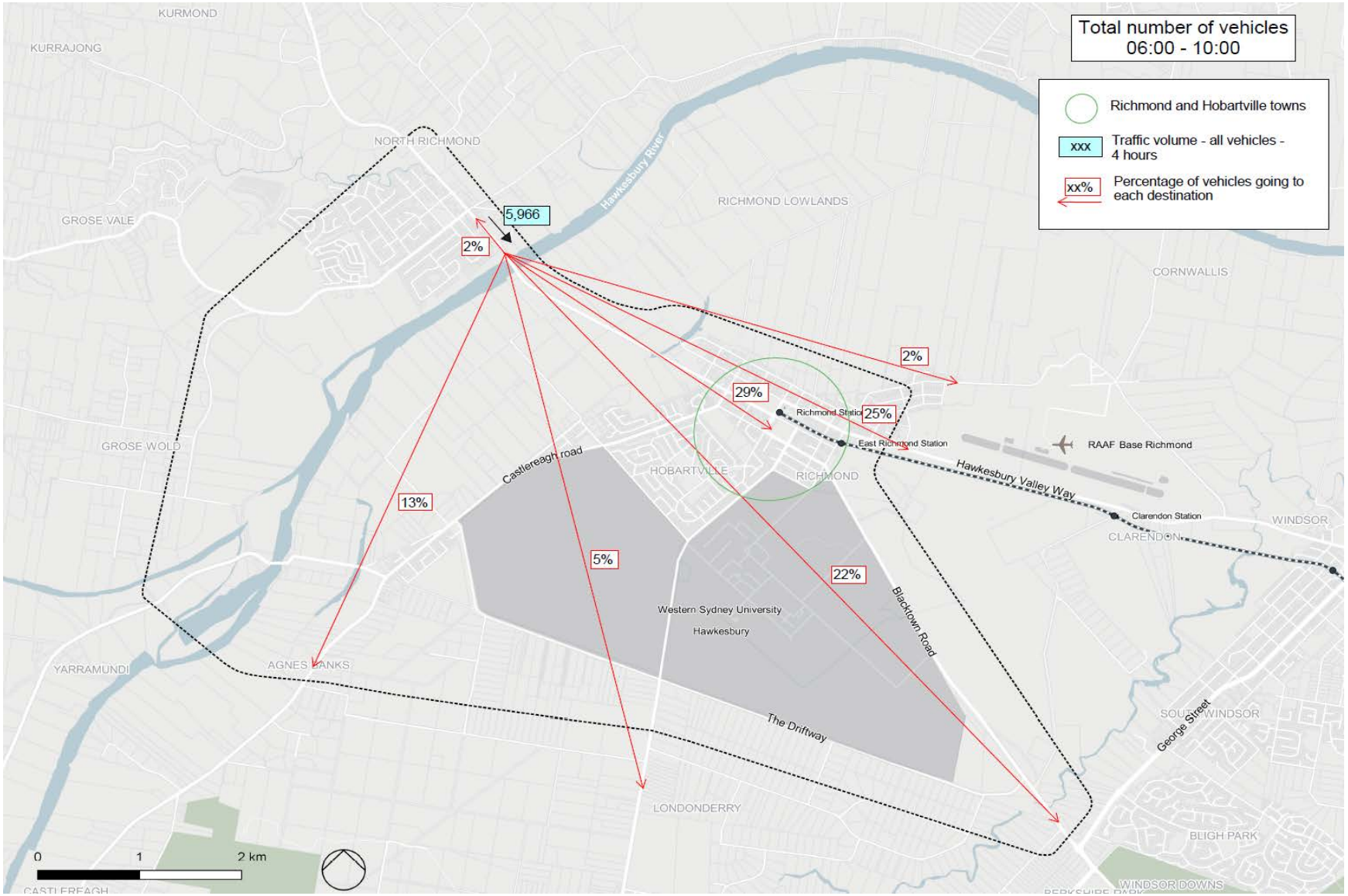
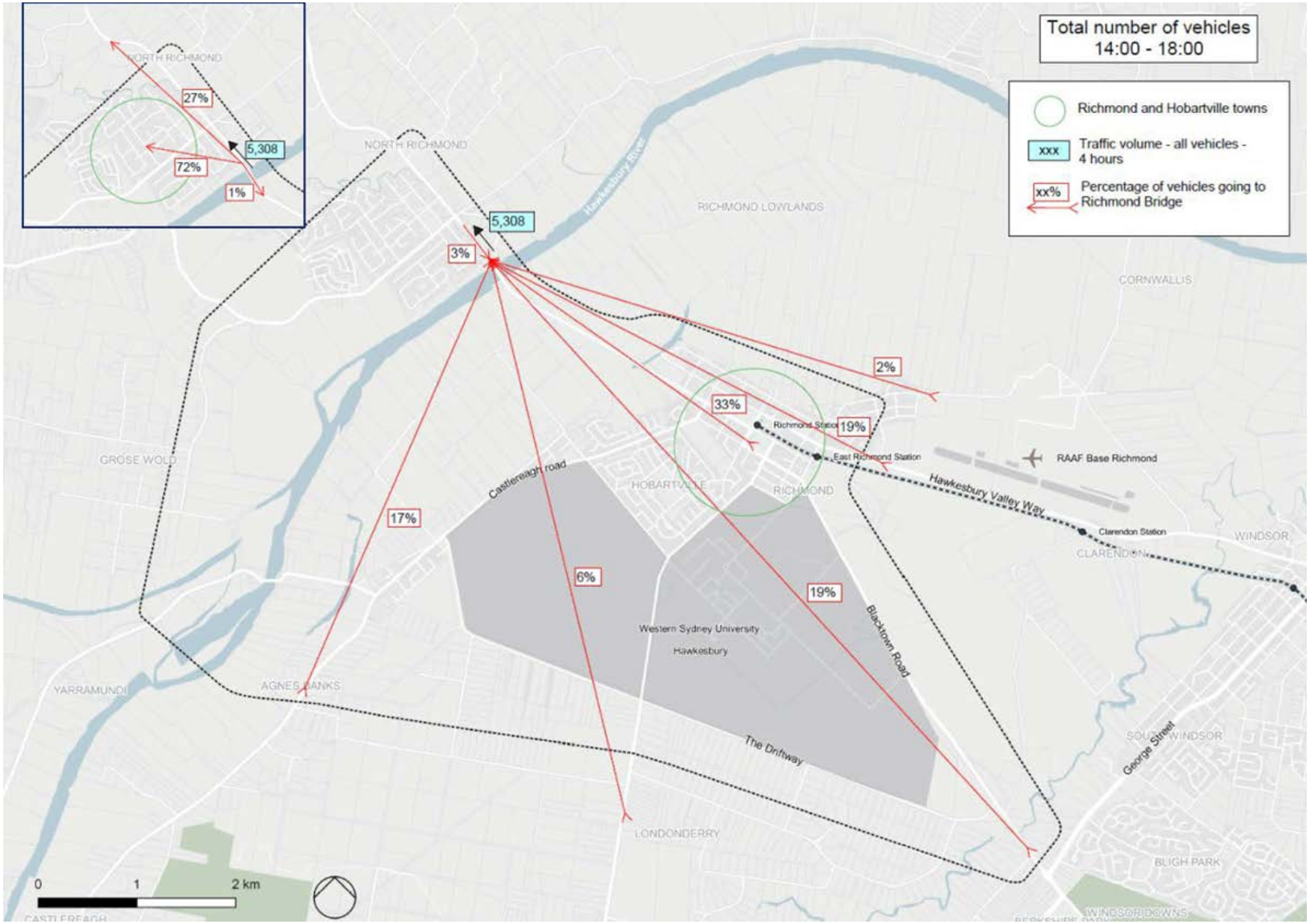


Figure 3-4 - Key traffic patterns near Richmond Bridge in the PM peak



In the morning peak most traffic congestion is experienced in North Richmond as traffic travels south east towards Richmond and destinations accessed by Castlereagh, Londonderry and Blacktown/Richmond Roads. In the afternoon peak as vehicles return, most congestion is experienced in Richmond.

Adding to the congestion, many residents avoid using public transport in the area because of unreliable journey times and limited bus stops. Around 77 per cent of residents (and 87 per cent of workers travelling to the area) choose to drive to work. This is significantly higher than the average across Sydney, where 54 per cent drive to work. There is also a lack of active transport connections between Richmond and North Richmond which further contributes to the high percentage of private vehicle use.

3.2 Future traffic performance

The traffic data collected in Richmond and North Richmond during December 2018 and March 2019 was used to develop a base model. Microsimulation traffic modelling was carried out for the four-hour AM and three-hour PM peak. Three future years were modelled: 2026, 2036 and 2046, for the base case and each of the project options (see Section 7.1). This information was supplemented with reviews of traffic growth estimations, population and employment growth, and future proposed developments. Hawkesbury City Council provided the latest future dwelling forecasts for developments including Redbank and Jacaranda Ponds which will deliver over 2000 new homes west of the Hawkesbury River.

Network traffic volumes are projected to grow by 44 per cent between 2019 and 2046 (Table 3-1). Traffic crossing Richmond Bridge is expected to increase by 61 per cent during peak periods between 2019 and 2046. This traffic growth will increase existing congestion issues and result in a reduction in average network speed in the AM peak from 35 km/h to 19 km/h and in the PM peak from 33 km/h to 10 km/h between 2019 and 2046.

The Redbank development in North Richmond partially accounts for the large growth in traffic demand between 2019 and 2026 compared to 2036. This growth would increase congestion and travel times in the area without major improvements to the road network.

Table 3-1 - Projected network growth

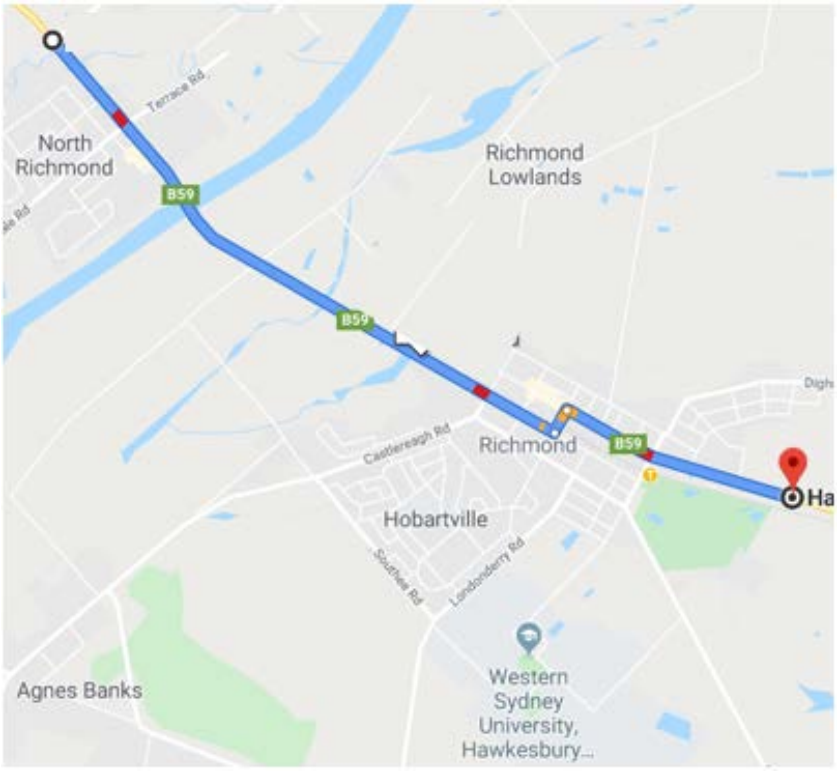
	2019	2026	2036	2046
Peak demands	44,190	50,590	54,560	63,550
Per cent growth	-	14%	23%	44%

Without improvements to the road network, travel times in the AM peak between North Richmond and Richmond (using Route 1 shown in Figure 3-5) are expected to increase from about 14 minutes in 2019 to about 30 minutes in 2046. In the PM peak, the reverse trip is expected to increase from about 22 minutes in 2019 to about 38 minutes in 2046. This is shown in Table 3-2 below.

Table 3-2 - Forecast travel times in 2046 without road network improvements

Travel time (minutes)	Direction of travel	2019	2026	2036	2046
AM peak	South bound	13:45	27:30	26:25	30:25
PM peak	North bound	22:10	37:55	34:40	38:05

Figure 3-5 - Route 1 from Bells Line of Road, North Richmond to Windsor Street Richmond



Traffic modelling shows that without road network improvements, intersection performance decreases and delays around Richmond town centre increase. Figure 3-6 and Figure 3-7 below show future intersection LoS during the AM and PM peaks.

Figure 3-6 - Intersection performance AM peak

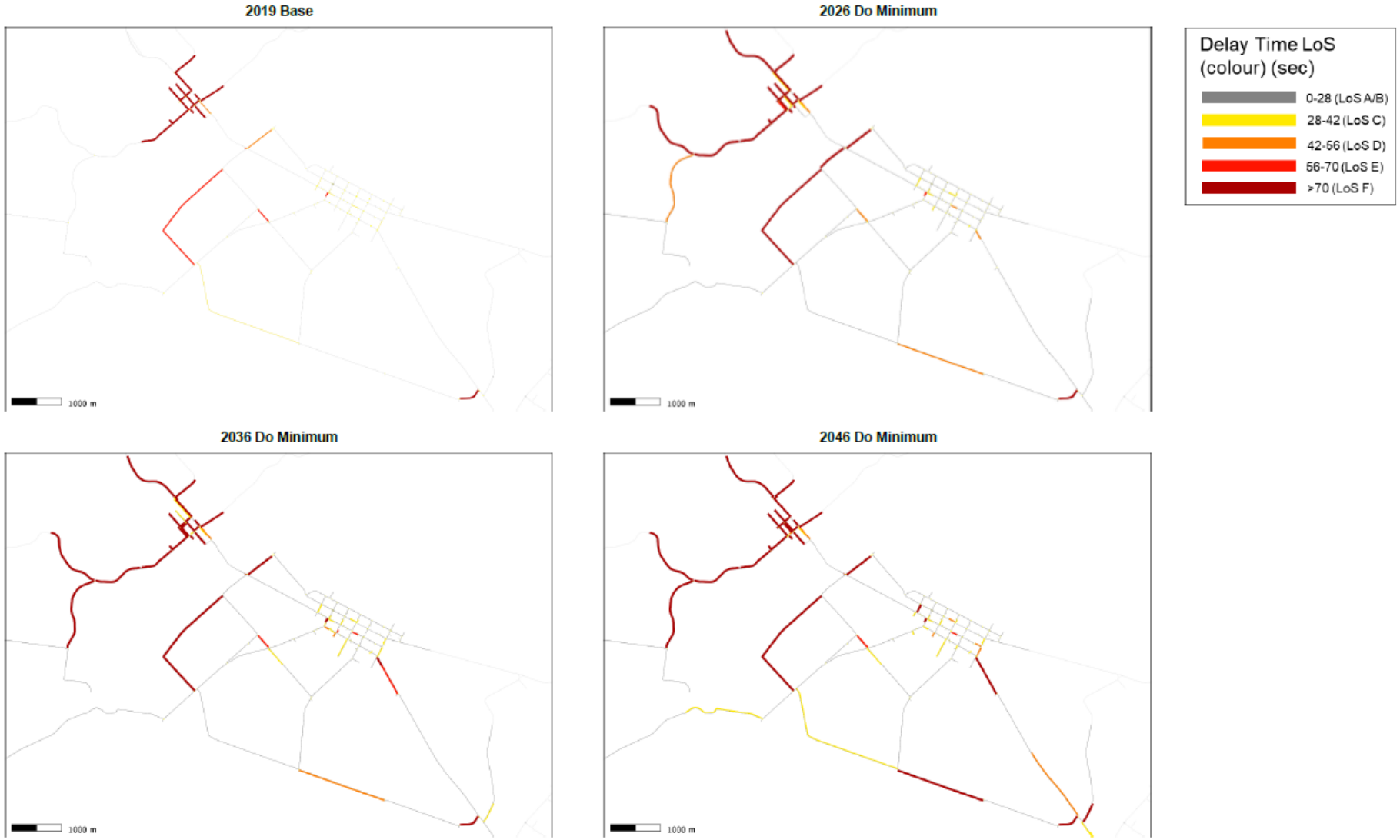


Figure 3-7 - Intersection performance PM peak

3.2.1 Future improvements

Recently completed and currently planned projects in the area will improve traffic but will not cater for future traffic demands between Richmond and North Richmond. These projects include short-term intersection improvements identified in the 2013 Richmond Bridge and approaches congestion study:

- Old Kurrajong Road/Kurrajong Road (completed in 2015)
- Bells Line of Road/Grose Vale Road (completed in 2019)
- March Street/Bosworth Street (expected completion 2021).

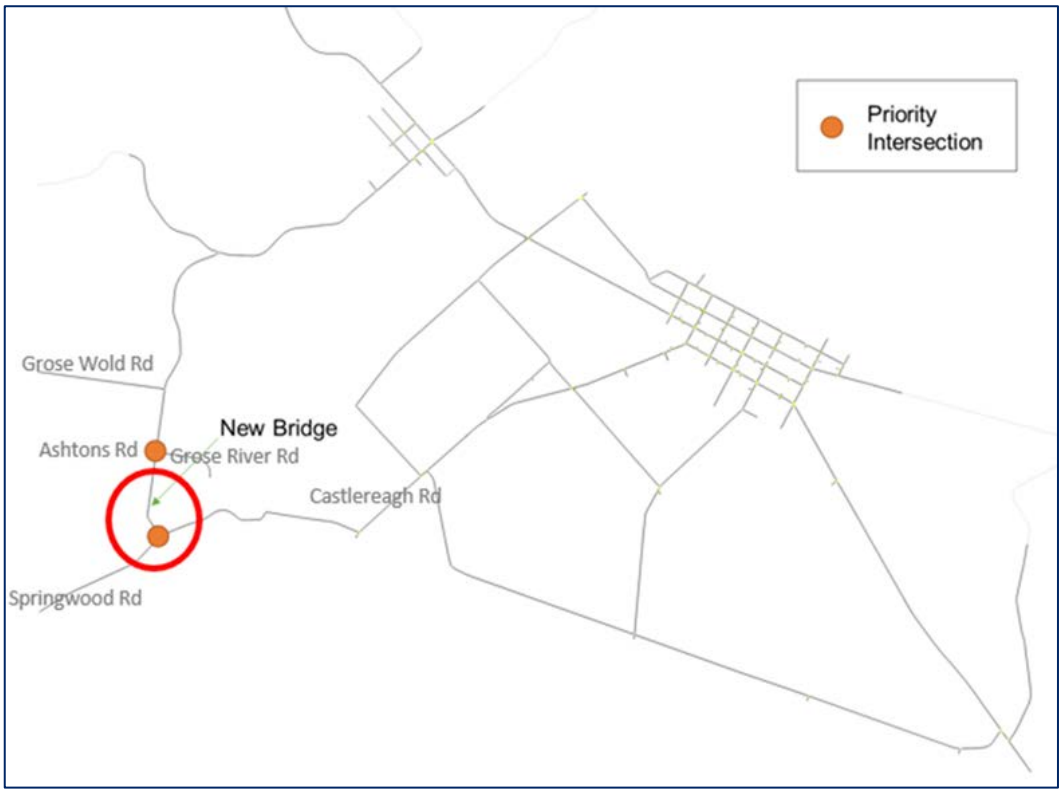
The developer of the Redbank residential development is required to fund a new bridge over the Grose River between Ashtons Road and Springwood Road, shown in Figure 3-8.

The funding of this bridge is part of the developer's Voluntary Planning Agreement with Hawkesbury City Council. This bridge will provide a local connection between North Richmond and Springwood and Castlereagh Roads providing a more efficient connection between North Richmond and areas to the south reducing congestion at the Bells Line of Road/Grose Vale Road intersection.

In addition to reducing traffic congestion in North Richmond, the Grose River Bridge is proposed to be built above the 1 in 100 chance per year flood level to improve flood resilience and reduce detours during flood events in association with other upgrades. Further details on flood resilience are provided in Section 3.4.

Traffic modelling shows that these upgrades would reduce congestion in the short term however average network speeds would still decrease in the morning peak from 38 km/h to 24 km/h and in the afternoon peak from 40km/h to 18 km/h between 2026 and 2046.

Figure 3-8 - Developer funded Grose River Bridge



3.3 Road safety

Injury crash clusters and safety issues have been identified between Richmond and North Richmond, in Richmond town centre, and along The Driftway. Many of these crashes relate to conflicts between through and right-turning traffic at key intersections such as The Driftway with Blacktown Road and Londonderry Road, which in the last five years of available crash data have recorded two fatalities and 27 injuries (Figure 3-9 and Figure 3-10).

Sections with casualty crash rates higher than the Sydney average are:

- The high-traffic area within the bounds of Lennox Street, Bosworth Street and March Street
- Kurrajong Road, from Bourke Street to Yarramundi Lane (Figure 3-10).

Figure 3-9 - Crash clusters along The Driftway and approaches (2013-2018)

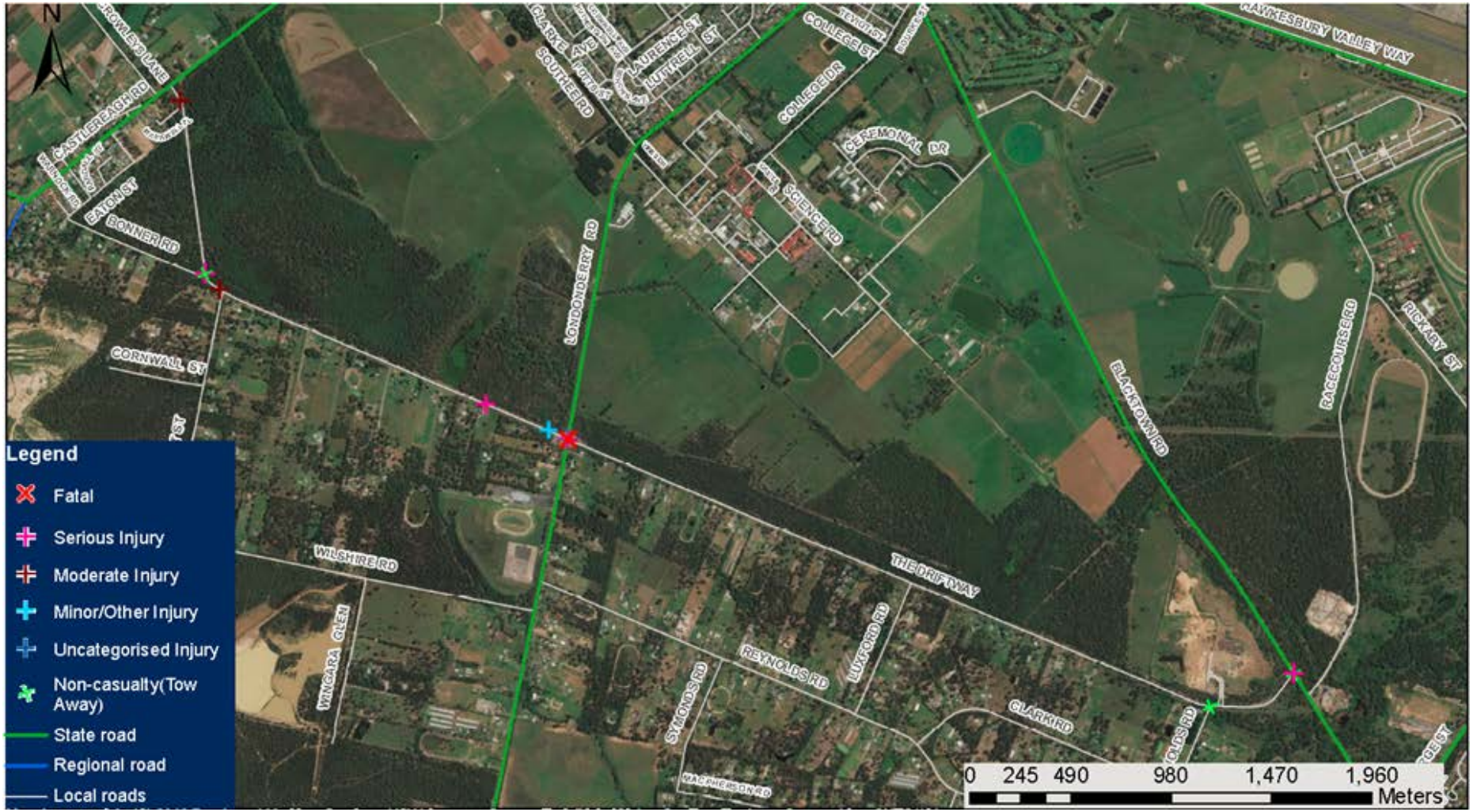
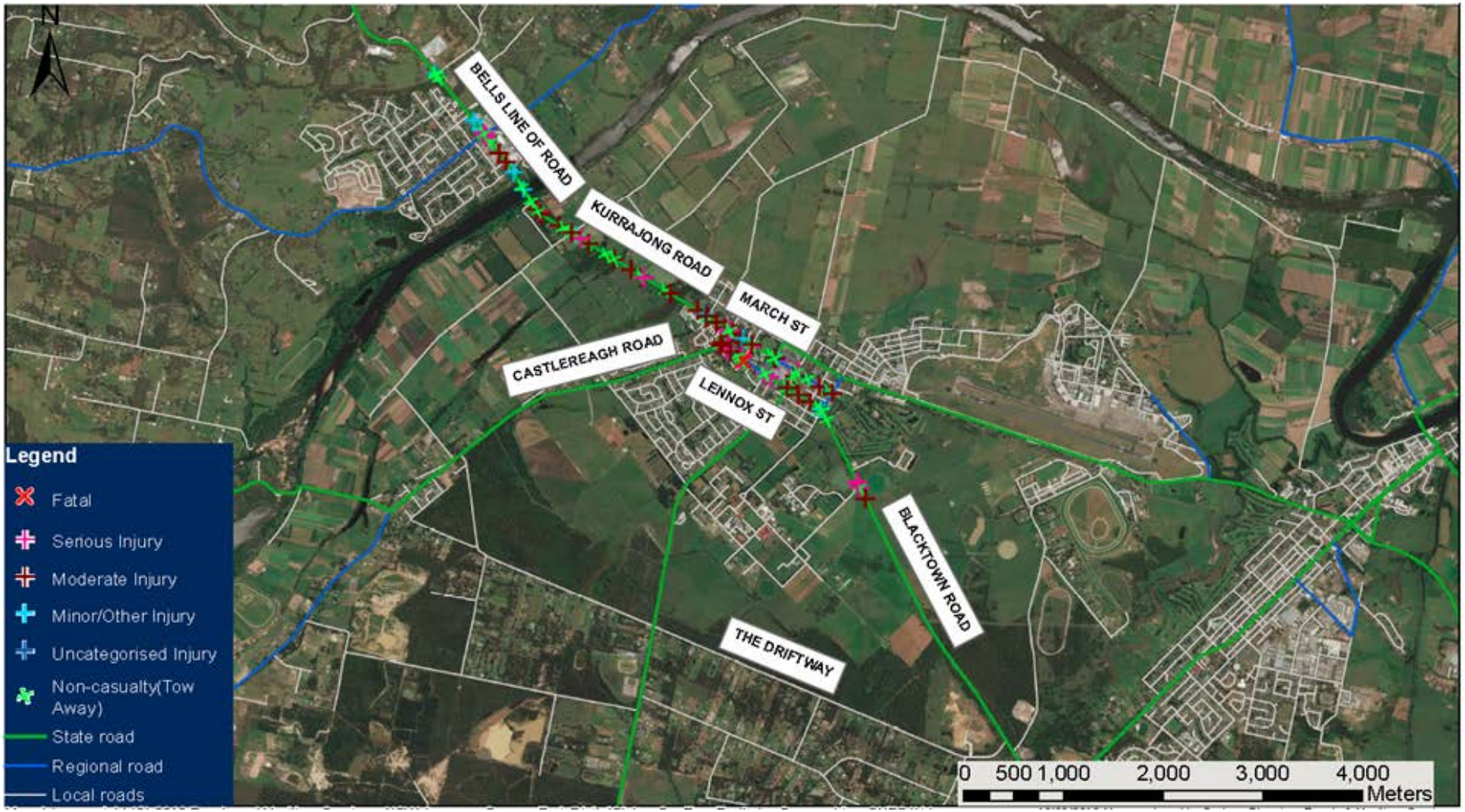


Figure 3-10 - Crash clusters in Richmond and North Richmond (2013-2018)



Crash data for the project area from October 2013 to September 2018 identified a total of 246 crashes. The assessment of the crash data identified the following:

- 25 per cent of all crashes were right through (crash involving a vehicle turning right in front of an oncoming vehicle) incidents and 17 per cent were rear-end incidents
- 61 per cent of all crashes resulted in injury
- A total of 3 fatalities occurred over the five-year period
- The highest crash rate (23 per cent of all crashes) was on Kurrajong Road.

To avoid congestion on the eastern approach to Richmond Bridge, many vehicles utilise the local road network including narrow country lanes such as Inalls Lane and Yarramundi Lane, increasing road safety risks and maintenance issues.

There are also limited pedestrian and cyclist connections between Richmond and North Richmond, with narrow shoulders and no direct off-road paths between Richmond Bridge and Richmond.

3.4 Flood resilience

The Hawkesbury Nepean Valley has a high flood hazard with a history of flood events. In response to this, Infrastructure NSW prepared the Resilient Valley, *Resilient Communities – the Hawkesbury-Nepean Valley Flood Risk Management Strategy* (INSW 2017) which is a comprehensive long-term framework for the NSW Government, local councils, businesses and the community to work together to reduce and manage the flood risk in the Hawkesbury-Nepean Valley.

The strategy includes a range of infrastructure and non-infrastructure actions to improve flood resilience. The strategy stated that major regional evacuation road options would not have positive net benefits as they have high construction costs relative to their benefits in terms of reducing risk to life. In addition, these options do not reduce potential economic damages. Therefore, no major regional evacuation road options were selected for the Flood Strategy. However, the strategy includes actions to consider flood risk on regional road planning for growth in this Valley.

Flood evacuation routes are identified in Figure 3-11. Richmond Bridge does not form part the flood evacuation routes. During major flood events, residents east of the Hawkesbury River evacuate when required on designated flood evacuation routes to the south and east. Residents west of the Hawkesbury River which have a lower flood risk due to the higher ground would remain on the western side of the Hawkesbury River until flood levels reduce to allow the road network to reopen. SES, NSW police and other agencies position resources as required to manage incidents during these events.

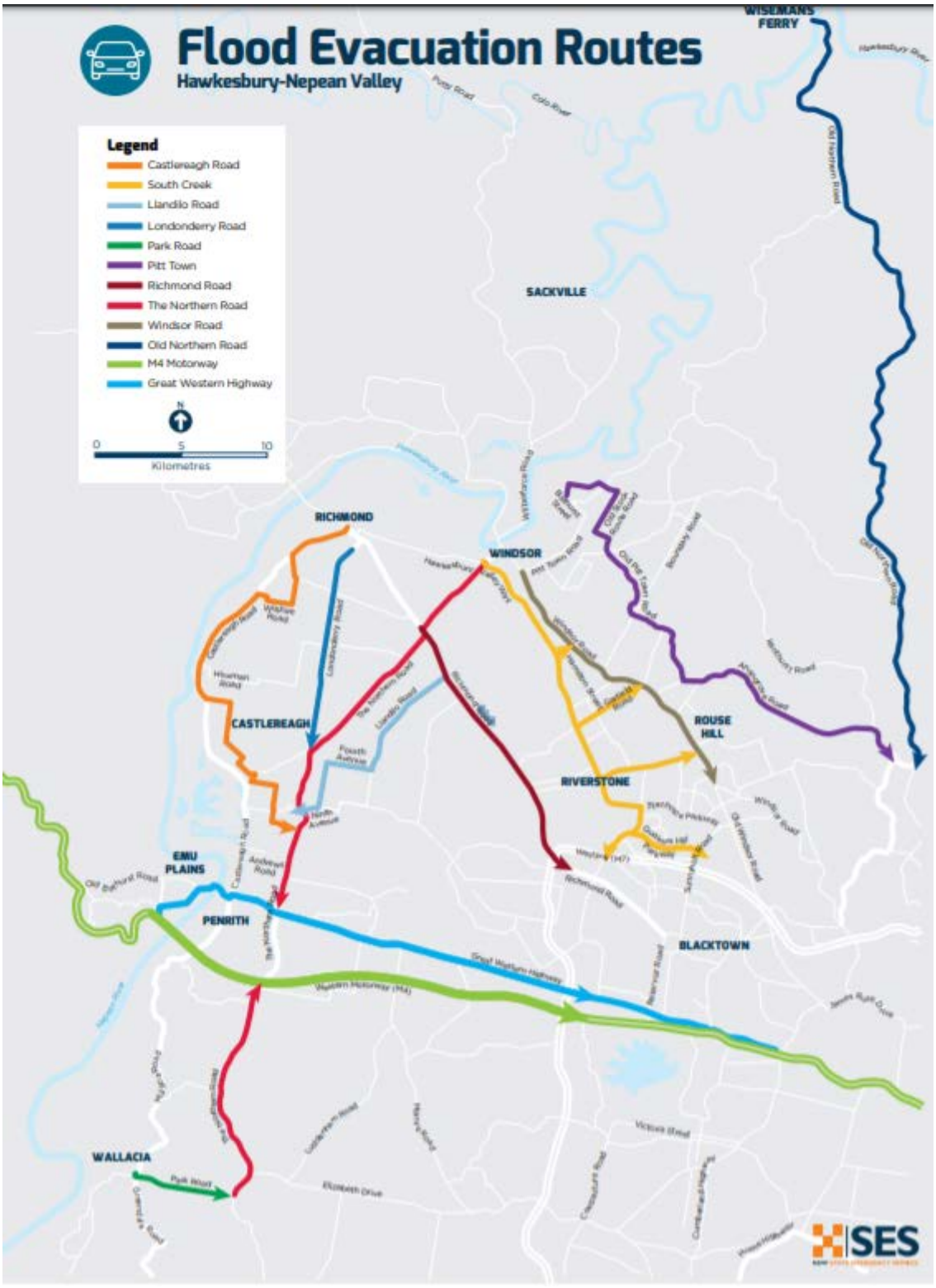
The existing Richmond Bridge is built below the 1 in 2 chance per year flood event level and is closed in relatively minor flood events. In the current situation, bridge closures during flood events result in lengthy detours of up to 161 kilometres between North Richmond and Richmond via Bells Line of Road, Darling Causeway and Great Western Highway. Heavy rainfall can also affect this route such as in the March 2021 flood event where Bells Line of Road was closed due to landslides.

Following completion of the Grose River Bridge which is proposed to be built to achieve 1 in 100 chance per year flood resilience, detours during flood events via Springwood Road and Great

Western Highway could reduce by up to 90 kilometres. In the short term this route would achieve 1 in 10 chance per year flood event resilience due to other low points along the route however as part of a long term strategy further upgrades on Springwood Road could achieve 1 in 100 chance per year flood resilience.

In combination with the Grose River Bridge, increasing the height of the proposed Richmond Bridge would improve flood resilience. While the route between Richmond and North Richmond as a whole would achieve 1 in 5 chance per year flood resilience, the bridge is proposed to be built above this level due to the topography of the banks avoiding the need to cut into the bank. This would result in reduced risk of the bridge being overtopped resulting in reduced closure times during flood events.

Figure 3-11 - Hawkesbury Nepean Flood Evacuation Routes (SES 2019)



3.5 Visual landscape and amenity

Richmond is one of five original Macquarie Towns and is rich in heritage with numerous historic commercial, civic and municipal buildings and residences, a traditional main street commercial strip, a central town oval and tree lined streets and avenues. North Richmond is a relatively

contemporary township with a lower density of heritage items and limited existing streetscape compared to Richmond.

Between the two townships is the Hawkesbury River and a scenic floodplain which provides long range views to the Blue Mountains. Providing a route that bypasses Richmond and North Richmond town centres and minimises impacts to the floodplain could provide opportunities for the revitalisation of the town centres. Residential amenity is another important consideration in terms of impacts to views from properties.

4. Options

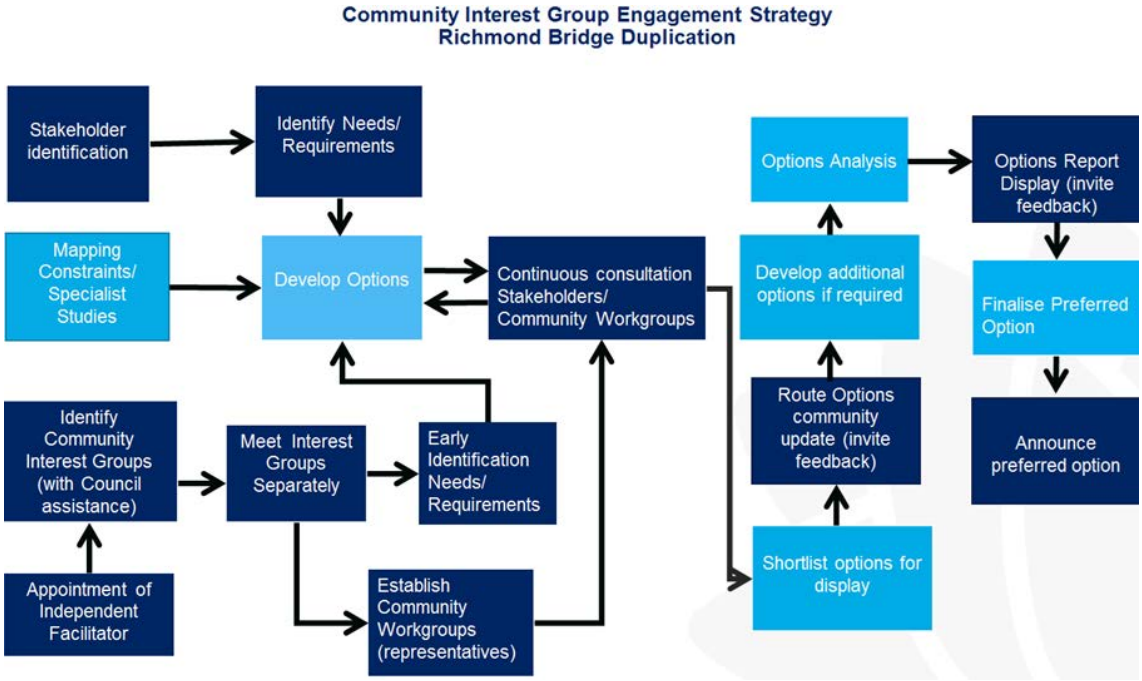
4.1 Options development

In 2013, Transport identified a preferred option to duplicate Richmond Bridge adjacent to the existing bridge and to upgrade the existing Bells Line of Road and Kurrajong Road corridor through Richmond and North Richmond, to provide two lanes in each direction including peak hour clearways in both town centres. This option was documented in the Richmond Bridge and approaches congestion study: preferred short-term and long-term options report (Transport, 2013).

During community engagement for the abovementioned report, feedback was received that bypass options should be investigated. As part of the current options development process, and in consultation with a Community Working Group, a range of options have been considered that would bypass Richmond and either upgrade Bells Line of Road through North Richmond or bypass North Richmond to the north or south.

The flow chart in Figure 4-1 shows the community and stakeholder engagement strategy for the project up to determining a preferred option. This strategy involved forming a Community Working Group and Stakeholder Consultation Committee to have input into the development of route options before wider community consultation on the potential route options.

Figure 4-1 - Community interest group engagement strategy



The groups were established based on previous consultation for projects in the broader area and in consultation with Hawkesbury City Council who assisted in identifying a range of key stakeholder groups. Transport engaged an independent facilitator to assist in managing the complexity of the engagement process. The Community Working Group played a key role in providing local knowledge to assist in developing a range of potential routes for the proposal. This group was identified from key stakeholders within the community, and is made up of local community, business, environmental, heritage and flood advisory groups.

Nine alignment options were developed as shown in Figure 4-2 and four of these options were shortlisted for further analysis as outlined in Table 4-1.

Figure 4-2 - Nine alignment options

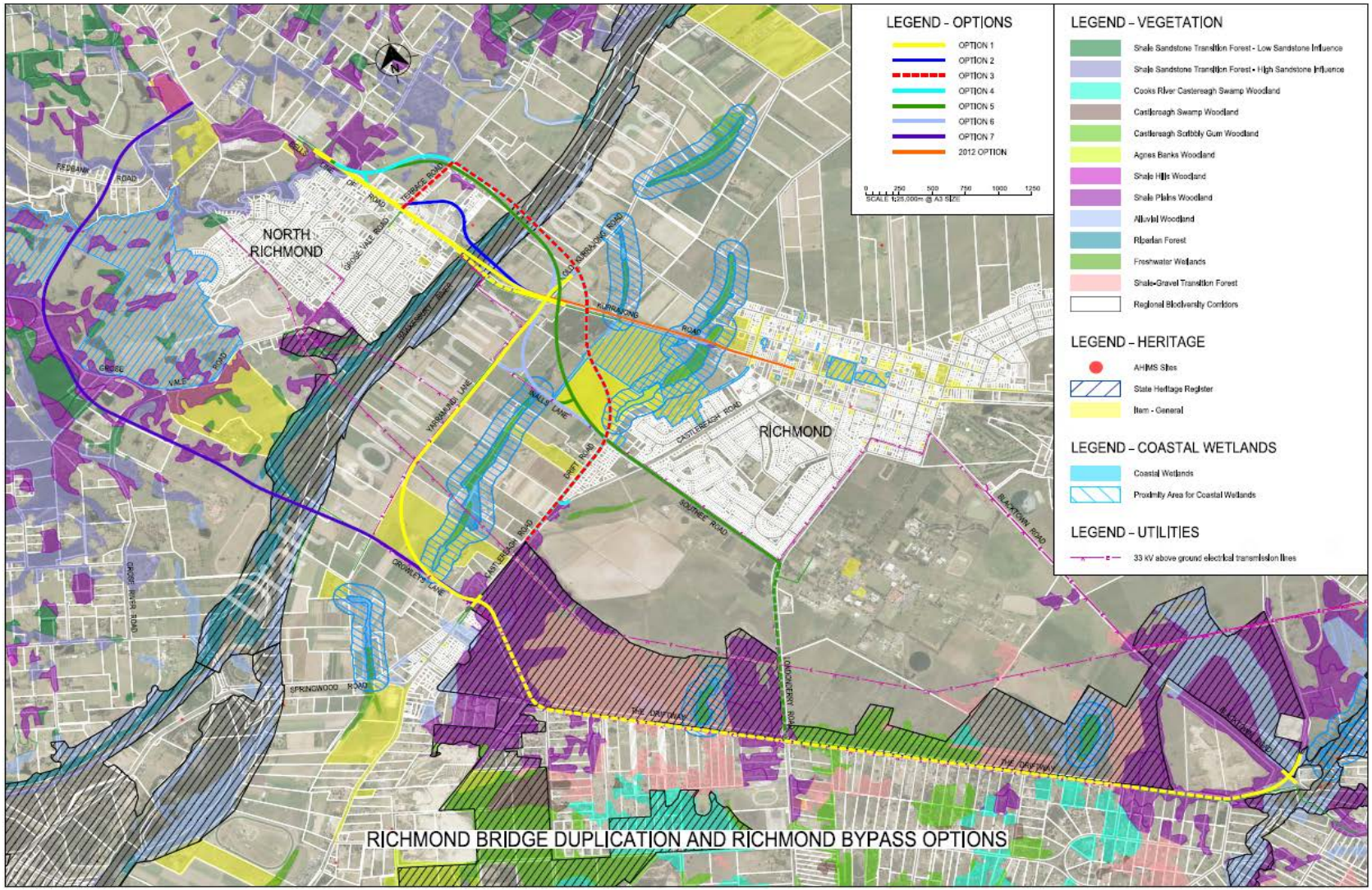


Table 4-1 - Initial options and shortlisting

Option	Description	Shortlist (Yes / No)	Reason
Do Minimum	Three intersection improvements on Bells Line of Road and Kurrajong Road and a new bridge over the Grose River between Ashtons Road and Springwood Road.	Yes	This option does not cater for future traffic demands between Richmond and North Richmond, it is required for base case assessment.
Option 1 (Yellow): Bells Line of Road and Yarramundi Lane Route	Upgrade Bells Line of Road through North Richmond, duplicate Richmond Bridge adjacent to the existing bridge and bypass Richmond by providing an upgraded route via Yarramundi Lane and Crowleys Lane to connect to Castlereagh Road and The Driftway.	Yes	Provides increased traffic capacity, bypasses Richmond town centre with relatively low property and amenity impacts and would include safety improvements.
Option 2: (Blue) Beaumont Avenue Route	Beaumont Avenue converted to two lanes eastbound and Richmond Bridge is duplicated further downstream. Could be combined with Option 1, 5, or 6 to connect with Castlereagh Road.	No	Future traffic volumes would be 2024 per hour (2026 AM Peak) increasing to 2680 per hour (2046 AM Peak) on a road which provides access to a number of residences, a nursing home, businesses and sporting fields resulting in access and amenity impacts.
Option 3: (Red hatch) North Richmond Northern Bypass Route (1 of 4 variations)	North Richmond Northern Bypass would travel north from Bells Line of Road east of Crooked Lane bypassing North Richmond town centre and provide a new two-way two-lane bridge about 500-600 metres downstream of the existing bridge. Would require upgrades to full length of The Driftway. A potential staged variation of Options 4-6 which would begin at the western end from Terrace	No	Traffic surveys have shown that a route which ends at Terrace Road is unlikely to attract a high volume of traffic (about 13%) and therefore a partial bypass would not achieve substantial travel time savings or the project objectives. Additional reasons highlighted below for Option 4.

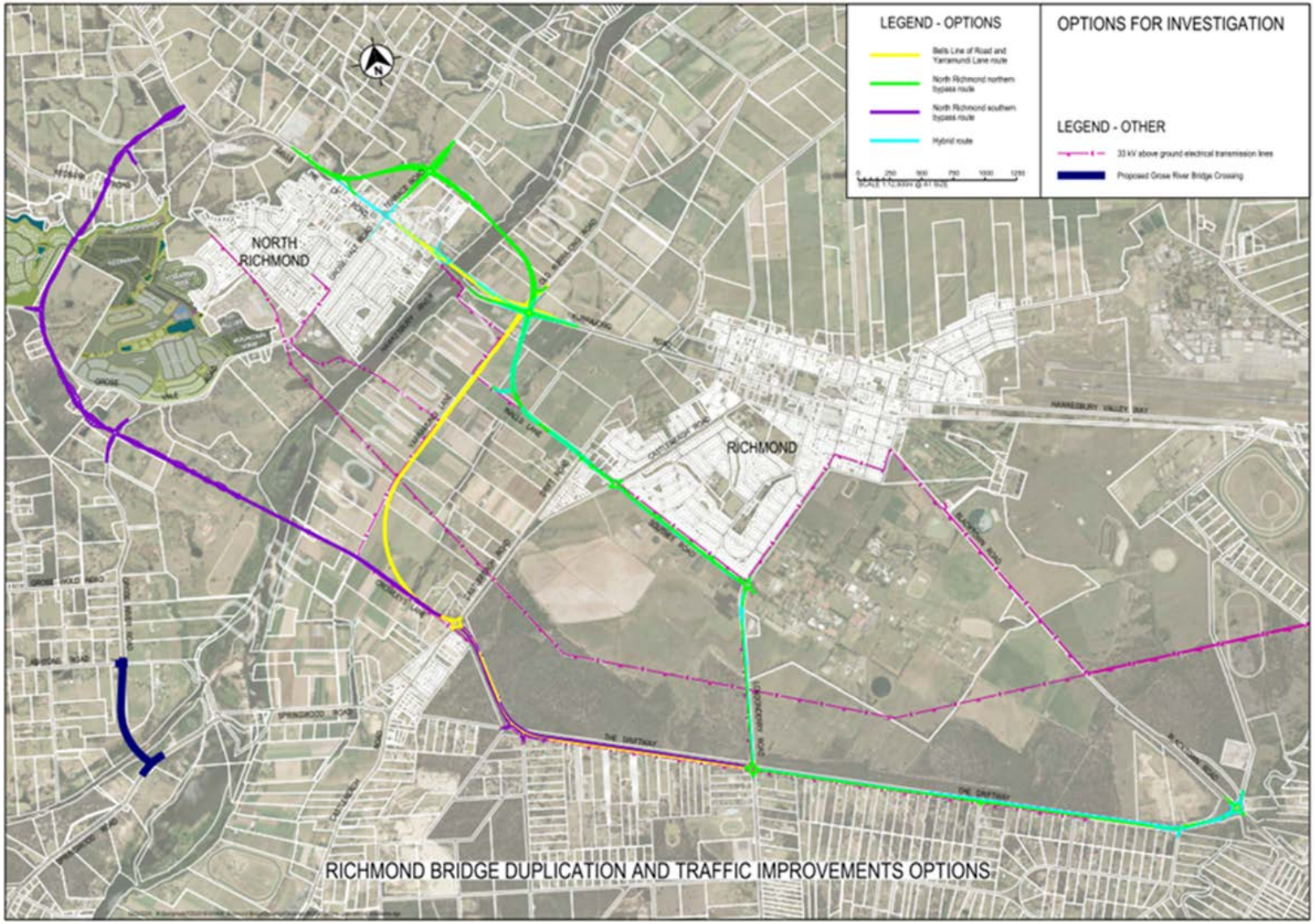
Option	Description	Shortlist (Yes / No)	Reason
	Road providing a partial bypass of North Richmond and avoiding the cost of the section west of Terrace Road		
Option 4: (Cyan) North Richmond Northern Bypass Route (1 of 4 variations)	North Richmond Northern Bypass would travel north from Bells Line of Road east of Crooked Lane bypassing North Richmond town centre and provide a new two-way two-lane bridge about 500-600 metres downstream of the existing bridge. Would require upgrades to full length of The Driftway.	No	Substantial impacts to the State Heritage listed Hobartville property. Substantial impacts to Killarney Polo Club. Connection to Castlereagh Road via the Drift Road provides less efficient connection to Londonderry Road and Blacktown Road than Options 5 and 6 (1.7 kilometres longer).
Option 5: (Green) North Richmond Northern Bypass Route (1 of 4 variations)	North Richmond Northern Bypass would travel north from Bells Line of Road east of Crooked Lane bypassing North Richmond town centre and provide a new two-way two-lane bridge about 500-600 metres downstream of the existing bridge. Would require upgrade of The Driftway between Londonderry Road and Blacktown Road.	No	Substantial (although lower than Option 4) impacts to the State Heritage listed Hobartville property without providing any significant benefits relative to Option 6.
Option 6 (Light Purple): North Richmond Northern Bypass Route (1 of 4 variations)	North Richmond Northern Bypass would travel north from Bells Line of Road east of Crooked Lane bypassing North Richmond town centre and provide a new two-way two-lane bridge about 500-600 metres downstream of the existing bridge. Would require upgrade of The Driftway between Londonderry Road and Blacktown Road.	Yes	Considered the best of the North Richmond northern bypass options. Similar to Option 5, Option 6 provides a more efficient connection to Londonderry Road and Blacktown Road. Avoids impacts to State Heritage listed Hobartville property. Avoids impacts to Killarney polo club field (still may have minor impacts to the property).

Option	Description	Shortlist (Yes / No)	Reason
Option 7 (Purple): North Richmond Southern Bypass	North Richmond Southern Bypass would travel south from Bells Line of Road near Redbank Road bypassing North Richmond town centre and cross the Hawkesbury River on a new two-way two-lane bridge about 2.3 kilometres upstream of the existing bridge. Would require upgrades to the full length of The Driftway.	Yes	Provides increased traffic capacity, bypasses Richmond and North Richmond town centres and safety improvements would be made.
Hybrid Option	Incorporates the Bells Line of Road section of Option 1 to the intersection of Kurrajong Road and Old Kurrajong Road and the bypass section of Option 6. Would require upgrade of The Driftway between Londonderry Road and Blacktown Road.	Yes	Provides increased traffic capacity, bypasses Richmond town centre and safety improvements would be made.
2013 Option	Duplicated Richmond Bridge adjacent to the existing bridge and provides two lanes in each direction between Richmond and North Richmond.	No	Impacts on or adjacent to 16 items of local and state heritage significance including the streetscape which adds to the heritage of Richmond town centre. Requires clearways removing substantial parking which supports businesses during peak hours. Does not provide a bypass of Richmond town centre which has numerous major intersections and high pedestrian activity. Richmond town centre has been identified as one of three town centres in the Hawkesbury area for revitalisation under the Western City Liveability Program.

The four shortlisted options (Figure 4-3) include – the Yellow Option (previously Option 1), Green Option (previously Option 6), Purple Option (previously Option 7) and the Hybrid Option. The elimination process involved:

- Traffic modelling, focusing on projected traffic performance
- Preliminary heritage and environmental investigations (several of the options outlined above were eliminated because of impacts to state heritage listed properties)
- Assessment of costs and an economic appraisal, focusing on BCRs
- Consideration of feedback from the community and collaboration with stakeholder and community workgroups made up from key community, business, emergency services, and environmental and groups.
- A value management workshop on 12 March 2020 which incorporated a systematic evaluation of each option against agreed project objectives and constraints to inform the selection of a preferred option. More detail on the evaluation and findings is presented in Section 7.6.

Figure 4-3 - Shortlisted options



4.2 Description of options

The following section provides high-level descriptions of the shortlisted options.

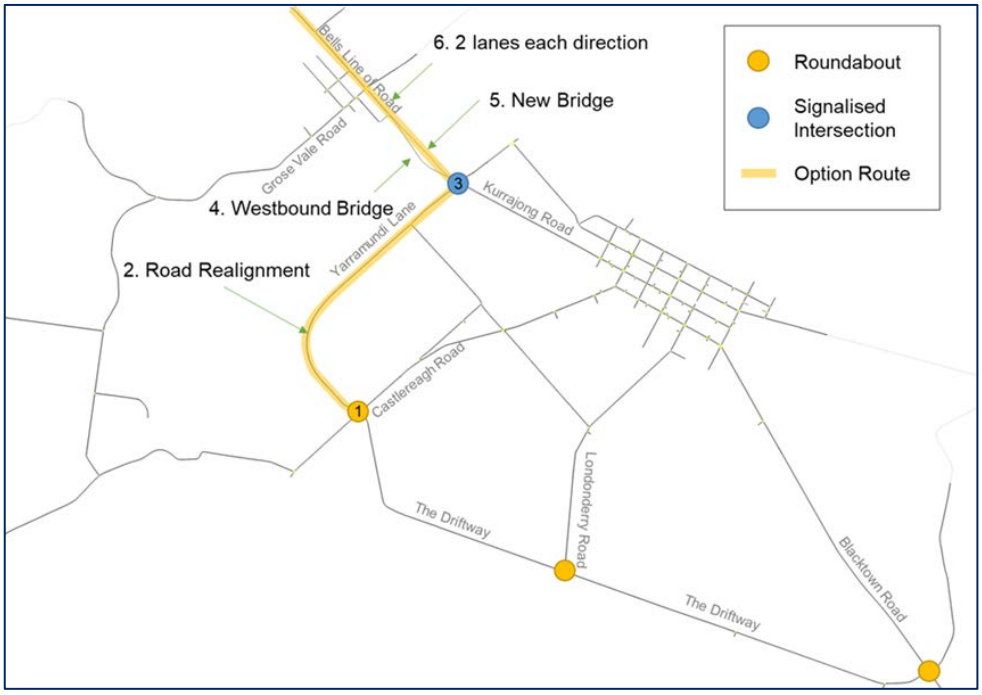
Each option would also include safety improvements to The Driftway including road widening, drainage, pavement and intersection improvements which will be developed in consultation with Hawkesbury and Penrith City Councils during the next design phase. Yellow and Purple options would include improvements to the full length of The Driftway. Green and Hybrid options would include improvements between Londonderry and Blacktown Roads.

4.3 Yellow Option

The Yellow Option would involve the construction of a second bridge adjacent to the existing bridge and would include the following improvements (Figure 4-4).

1. Realignment of the intersections of Castlereagh Road / Crowleys Lane and Castlereagh Road /The Driftway and provide a roundabout
2. Realignment of Crowleys Lane curving into Yarramundi Lane and increased posted speed to 80km/h. The realignment would have a single lane in each direction with widened lanes and shoulders to improve safety
3. New signalised intersection at the intersection of Kurrajong Road / Old Kurrajong Road / Yarramundi Lane
4. Existing Richmond Bridge would be converted into two lanes in westbound direction only.
5. New Bridge would have two lanes in the eastbound direction only and a shared path. During flood events where the existing Richmond Bridge was closed, the new bridge could be converted to two-way traffic.
6. Two lanes on Bells Line of Road, in each direction, would be extended from the Richmond Bridge to North Richmond to the intersection of Bells Line of Road / Grose Vale Road / Terrace Road.

Figure 4-4 - Yellow Option

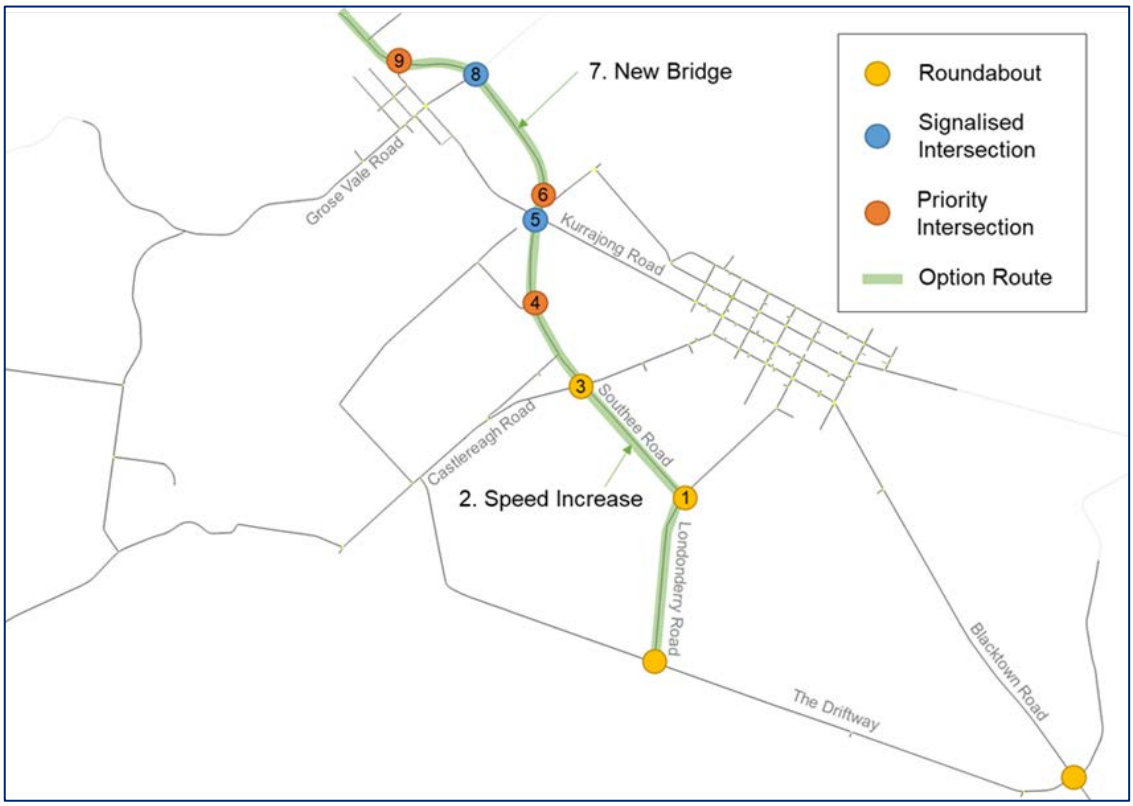


4.4 Green Option

The Green Option would involve the provision of a new bridge north of the existing bridge and would include the following improvements (Figure 4-5):

1. Traffic signals to replace the priority intersection of Londonderry Road / Southee Road/ Vines Drive.
2. New road parallel to Southee Road posted at 80km/h and speed increase on Inalls Lane to 80km/h including road and shoulder widening
3. A roundabout to replace the priority intersection of Castlereagh Road / Southee Road / Inalls Lane
4. Priority intersection along bypass at Inalls Lane
5. New signalised intersection at the intersection of Kurrajong Road / Old Kurrajong Road / Bypass
6. Priority intersection along the bypass at Old Kurrajong Road
7. Single lane, each direction, bypass across new bridge between Bells Line of Road and Londonderry Road posted at 80km/h. The existing bridge would remain in its current form.
8. New signalised intersection at the intersection of Terrace Road / the bypass
9. Realignment of Bells Line of Road, west of North Richmond, with priority intersection to access North Richmond via Bells Line of Road.

Figure 4-5 - Green Option

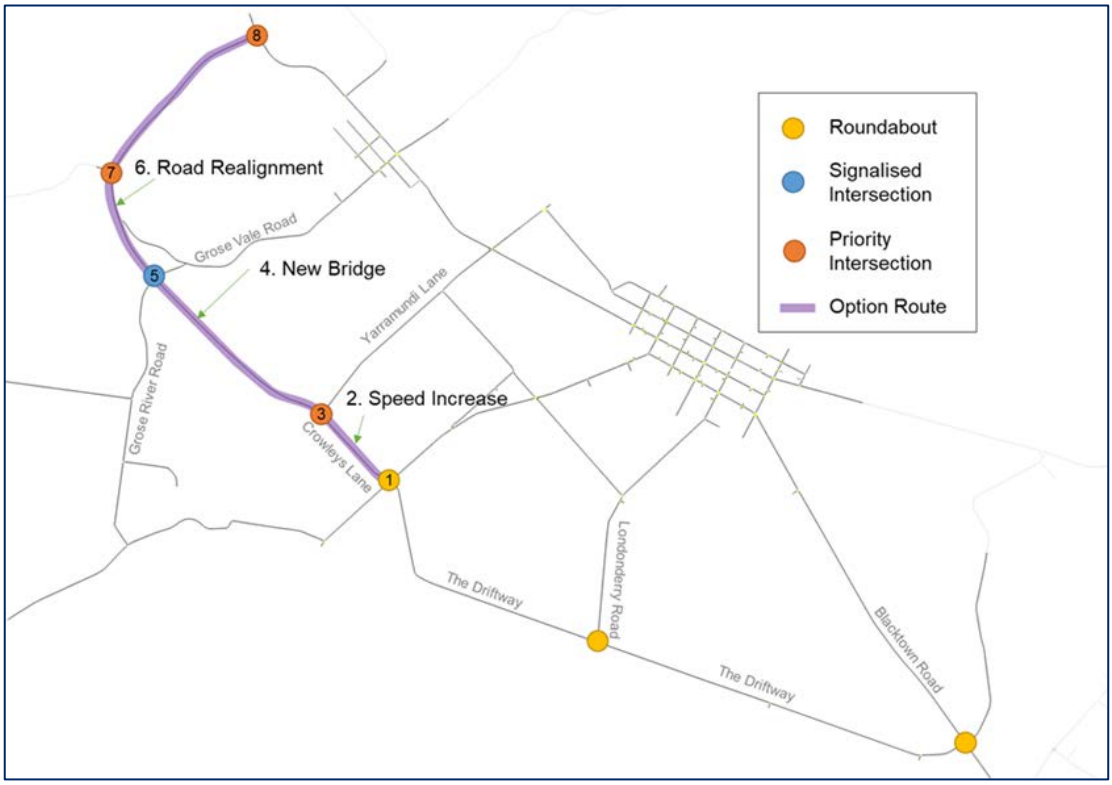


4.5 Purple Option

The Purple Option would involve the provision of a new bridge south of the existing bridge and would include the following improvements (Figure 4-6):

1. Realignment of the intersections of Castlereagh Road / Crowleys Lane and Castlereagh Road / The Driftway and provide a roundabout
2. Speed increase along Crowleys Lane to 80km/h with widened lanes and shoulders to improve safety. New road sections would be single lane in each direction
3. New priority intersection of Crowleys Lane / Yarramundi Lane / the bypass
4. New single lane in each direction road and bridge connecting Crowleys Lane to Grose River Road. The existing Richmond Bridge would remain in its current form
5. New signalised intersection at the intersection of Grose River Road / the bypass.
6. Grose Vale Road to be replaced with bypass along the overlapping section
7. Priority intersection with the existing western edge of Grose Vale Road
8. Priority intersection with the existing connection of Redbank Road to Bells Line of Road.

Figure 4-6 - Purple Option

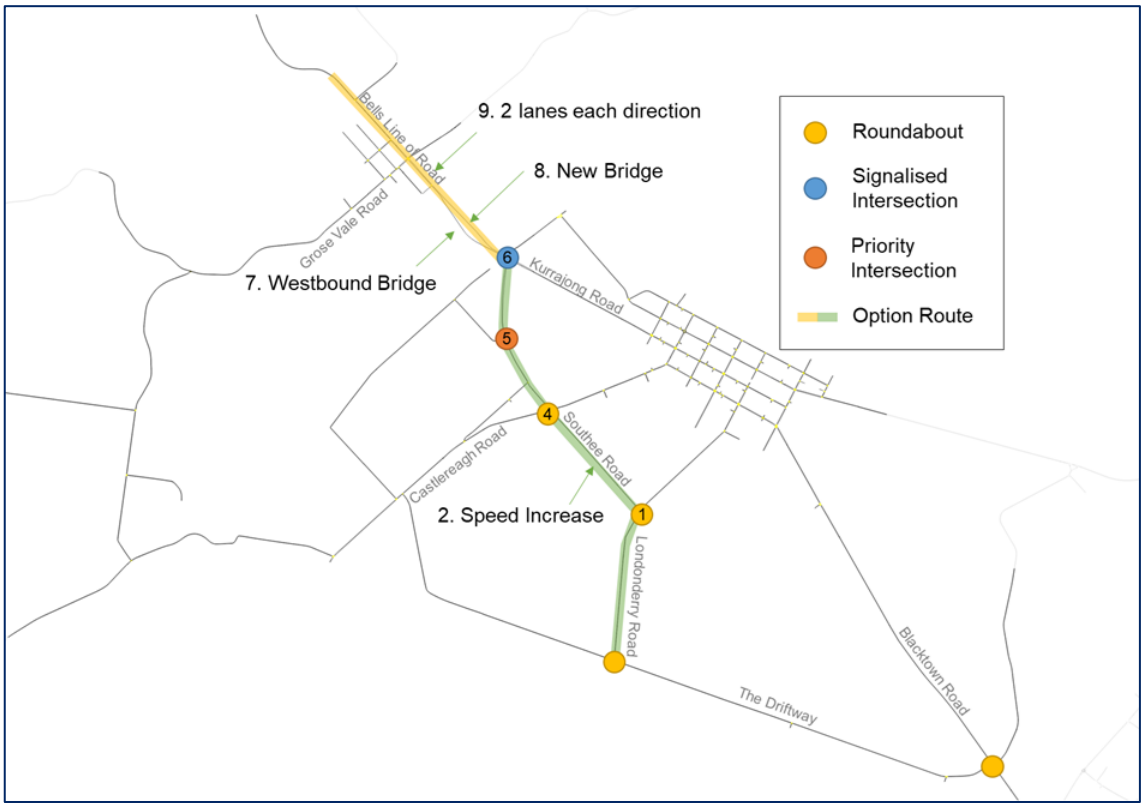


4.6 Hybrid Option

The Hybrid Option would involve the combination of parts of the Yellow Option and the Green Option. It would include the west section of the Yellow Option combined with the east bypass section of the Green Option. This forms the Hybrid Option which would include the following improvements (Figure 4-7):

1. Traffic signals to replace the priority intersection of Londonderry Road / Southee Road / Vines Drive
2. New road parallel to Southee Road posted at 80km/h and speed increase on Inalls Lane to 80km/h including road and shoulder widening
3. A roundabout to replace the priority intersection of Castlereagh Road / Southee Road / Inalls Lane
4. Priority intersection along bypass at Inalls Lane
5. New signalised intersection at the intersection of Kurrajong Road / Old Kurrajong Road / Yarramundi Lane
6. Existing Richmond Bridge would be converted into two lanes in the westbound direction only.
7. New Bridge would have two lanes in the eastbound direction only and a shared path. During flood events where the existing Richmond Bridge was closed, the new bridge could be converted to two-way traffic
8. Two lanes on Bells Line of Road, in each direction, would be extended from the Richmond Bridge to North Richmond to the intersection of Bells Line of Road / Grose Vale Road / Terrace Road.

Figure 4-7 - Hybrid Option



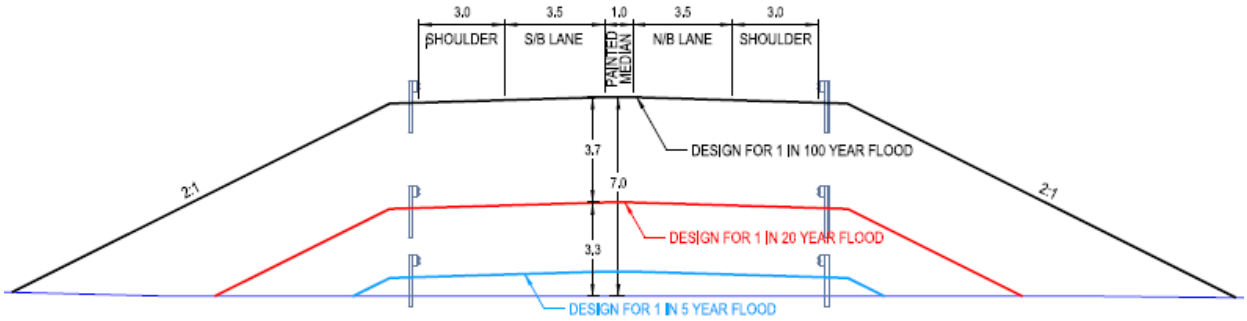
4.7 Flood resilience options

Transport has considered a range of heights to improve access during flood events. Designs for all route options are being investigated to achieve 1 in 5, 1 in 20, and 1 in 100 chance per year

flood event resilience. This will enable an assessment of the relative costs, benefits and impacts of improving access during flood events for the route options.

An example of the scale of improving flood resilience on the Richmond lowlands floodplain is shown in Figure 4-8. As embankments increase in height, floodplain bridge structures increase and so do impacts to properties in terms of property acquisition and flood levels. With increasing embankment sizes in the floodplain, compensatory excavations would be required to balance earthworks in the floodplain and reduce impacts on flood levels. As a result, the cost of increasing flood resilience increases substantially. Due to the significant height of embankments and volume of earthworks required to achieve 1 in 100 chance per year flood resilience with embankments averaging seven metres in height, embankments are not considered feasible and a bridge structure extending up to 2.5 kilometres would be required, further increasing costs.

Figure 4-8 - Embankments of varying flood resilience on the Richmond lowlands



4.8 Additional options considered

Community members suggested two additional options during consultation on the route options between November 2019 and January 2020. Further details on these options is provided in Section 5.2.1.

5. Community engagement

Transport has engaged with the community in the larger Richmond area since 2011 on projects including the Windsor Bridge replacement, the Bells Line of Road long term strategic plan and the Richmond Bridge and approaches congestion study.

To ensure community input during options development, Transport began targeted community consultation with key community groups early in the process beginning in late 2018. This early community engagement, together with information learned from previous engagement, provides initial insight into what is important to the community. Issues identified include:

- Concern about continued growth and the resulting increase in traffic volumes without the infrastructure to support it.
- Desire to bypass town centres and provide and a long-term solution to traffic congestion
- Desire to protect the visual landscape and heritage of the area
- Desire to minimise property acquisition
- Desire to improved flood resilience.

Community feedback during consultation for Bells Line of Road – Castlereagh Connection highlighted the desire for duplication of Richmond Bridge rather than a new corridor between Castlereagh and Kurrajong Heights. The community is keen to see further planning to address traffic congestion, cater for growth, and improve flood resilience.

5.1 Community and stakeholder engagement strategy

A guiding principle for the engagement of the Richmond Bridge duplication and traffic improvements is developing the project through consultation with the local communities and stakeholders to ensure a positive result for the local area and the project. The communication and engagement objectives for the project are to:

- Establish a community working group early in the project to help ensure we better understand local issues and views and to assist in identifying potential routes for further investigation based on the community's needs
- Provide regular and targeted information to the community and stakeholders on the progress of the project and construction activities, including the likely impacts and benefits
- Provide clear direction to the community and stakeholder whether we are providing information or seeking feedback so that expectations are clear
- Ensure community and stakeholder feedback and issues are considered in the decision-making process
- Ensure issues relating to project delivery are identified early and managed effectively
- Manage stakeholder feedback and complaints in a timely, respectful way
- Collaborate with government agencies and local council to ensure a whole-of-government approach to managing issues and providing consistent messages
- Monitor and evaluate stakeholder feedback and communication activities to measure success and review planning and delivery as required
- Build stakeholder and community confidence in Transport and its decisions.

5.2 Community and stakeholder feedback

In November 2019, we distributed a community update showing the five route options being investigated to 14,000 homes in the community surrounding the project. The community were invited to provide feedback via:

- Two community information sessions
- Pinning comments on an interactive map on the project webpage
- Contacting Transport via dedicated project email address and phone number.

Over 210 people attended the two community information sessions. Community and stakeholders provided a total of over 750 individual comments across the feedback platforms during the seven-week consultation period from November 2019 and January 2020. Table 5-1 identifies key themes from the feedback.

Table 5-1 - Key themes identified in community feedback

Theme	Detail
Property impacts	The high number of properties impacted for each option. (The broad corridors indicated on the map may have amplified concerns over the number of impacted properties).
Impacting quiet areas	Roads and residential areas that are currently quiet becoming busy. Keep the traffic on existing main roads.
Traffic congestion	Concern that routes which don't bypass town centres would not address traffic congestion or just move the problem.
Heritage and Environment	Impacts to local heritage properties, the natural environment and existing community spaces.
Sporting fields	Impact to community facilities such as the polo and soccer fields.
Impact to local business	Some considered bypass options would cause loss of business for the town centres while others considered it would provide amenity benefits for businesses making them more attractive to visit.
Flood resilience	Building the bridge above major flood levels.

Community feedback also highlighted some dissatisfaction at the limited detail available and broad route corridors used for this stage of community consultation. As this was early consultation in the planning phase of the project, this level of detail was not available.

Addressing traffic congestion was highlighted as the biggest issue of concern amongst the community on the interactive map followed by environmental concerns, property impacts including impacts to private property, heritage properties and sporting fields, and improving flood resilience. Table 5-2 provides a summary of the themes people commented on from the interactive map.

Table 5-2 - Interactive map themes

Interactive map themes	Number of comments
Traffic and Road safety	194
Environment	66
Property and Access	69
Land use	51
Pedestrian and Cycle ways	38
Flooding	33
Freight	17
Public Transport	15
Boating	7
Other	52

Overall the community feedback did not identify a clear preference for a particular route or rule out any route options however there was a preference for bypasses of both town centres. The feedback identified positive and negative aspects for each option which have been taken into consideration in the options assessment. How the issues raised by the community can be eliminated, minimised or mitigated for each option during further design phases has been considered. For example, the broad corridor indicated in the November 2019 community update for the Green route has been refined following further investigations and narrowed down to a route which avoids impacts to state heritage listed properties and minimises impacts to sporting facilities.

In considering the community feedback, the preferred option offers:

- the highest travel time improvements for private and public transport of all the options considered
- improved active transport connections between Richmond and North Richmond
- bypasses both Richmond and North Richmond town centres providing opportunities for amenity improvements and supports Council's town centres vision
- avoids direct impacts to heritage listed properties and of the two options that bypass both town centres it has lower environmental and private property impacts.

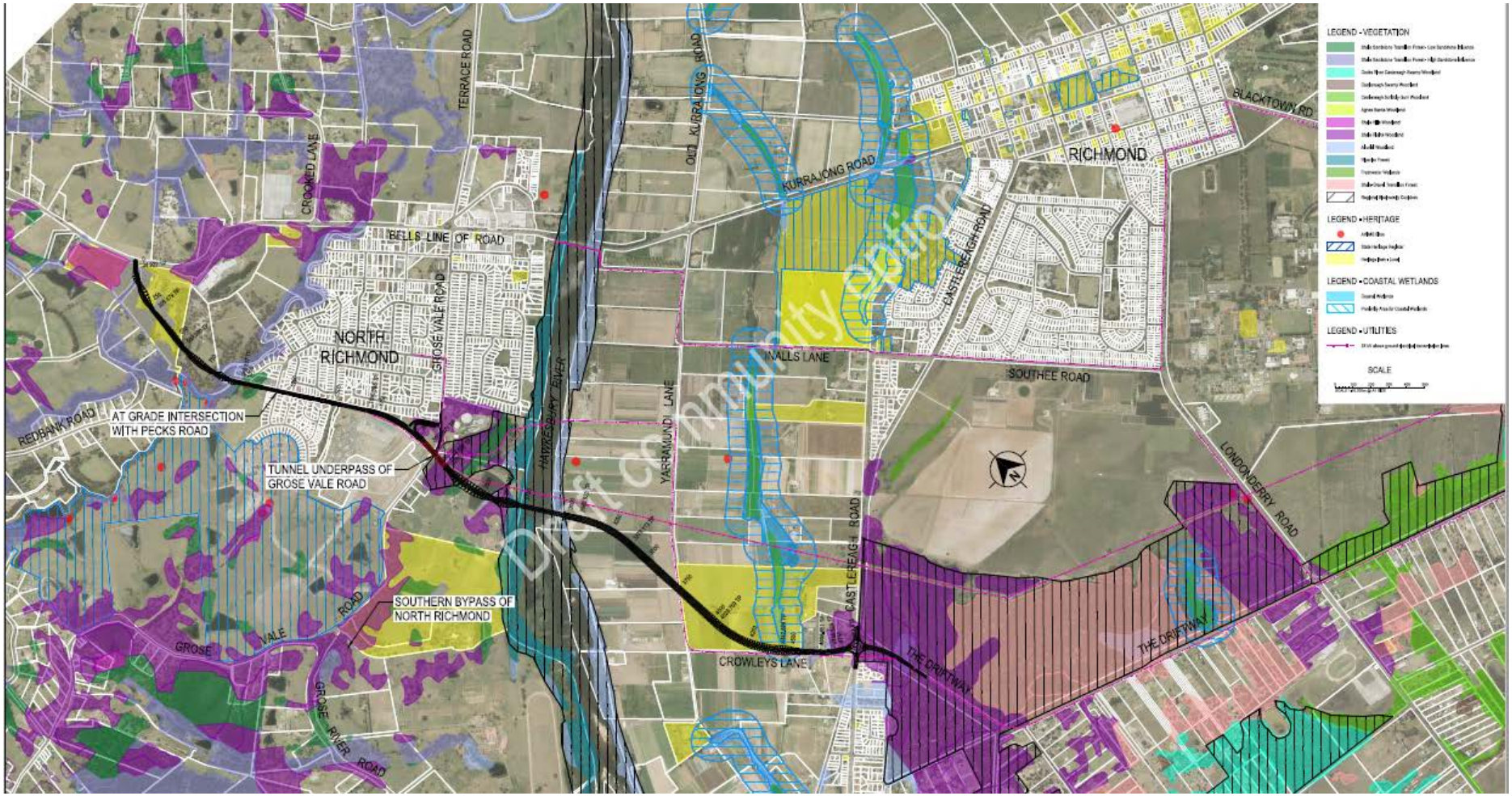
5.2.1 Additional options considered

During community engagement for the route options in late 2019 and early 2020, two additional options were suggested by community members. The first is an option that would leave Bells Line of Road near Redbank Road, similar to Option 7 (Purple, North Richmond Southern Bypass) but utilise the power easement corridor through North Richmond, provide a new bridge about 1.3 kilometres upstream from the existing bridge and cut diagonally across the floodplain to connect to a new intersection of Crowleys Lane, Castlereagh Road, and The Driftway (Figure 5-1). This option has been labelled the North Richmond power easement route.

This option would likely attract more traffic than the Purple Route as it is 1.5 kilometres shorter and would therefore deliver greater travel time savings than the Purple Route. Given its shorter length and reduced property impacts it could also potentially be a lower cost option than the Purple option however the substantial length of impacts to the power easement would require relocation underground at a significant cost. Adding to this cost would be the requirement for a tunnel under Grose River Road. This option would have greater noise and visual impacts that would require mitigation than other options by dividing North Richmond as opposed to travelling around the perimeter and severs two locally listed heritage properties. For these reasons the North Richmond Power Easement route has not been considered further.

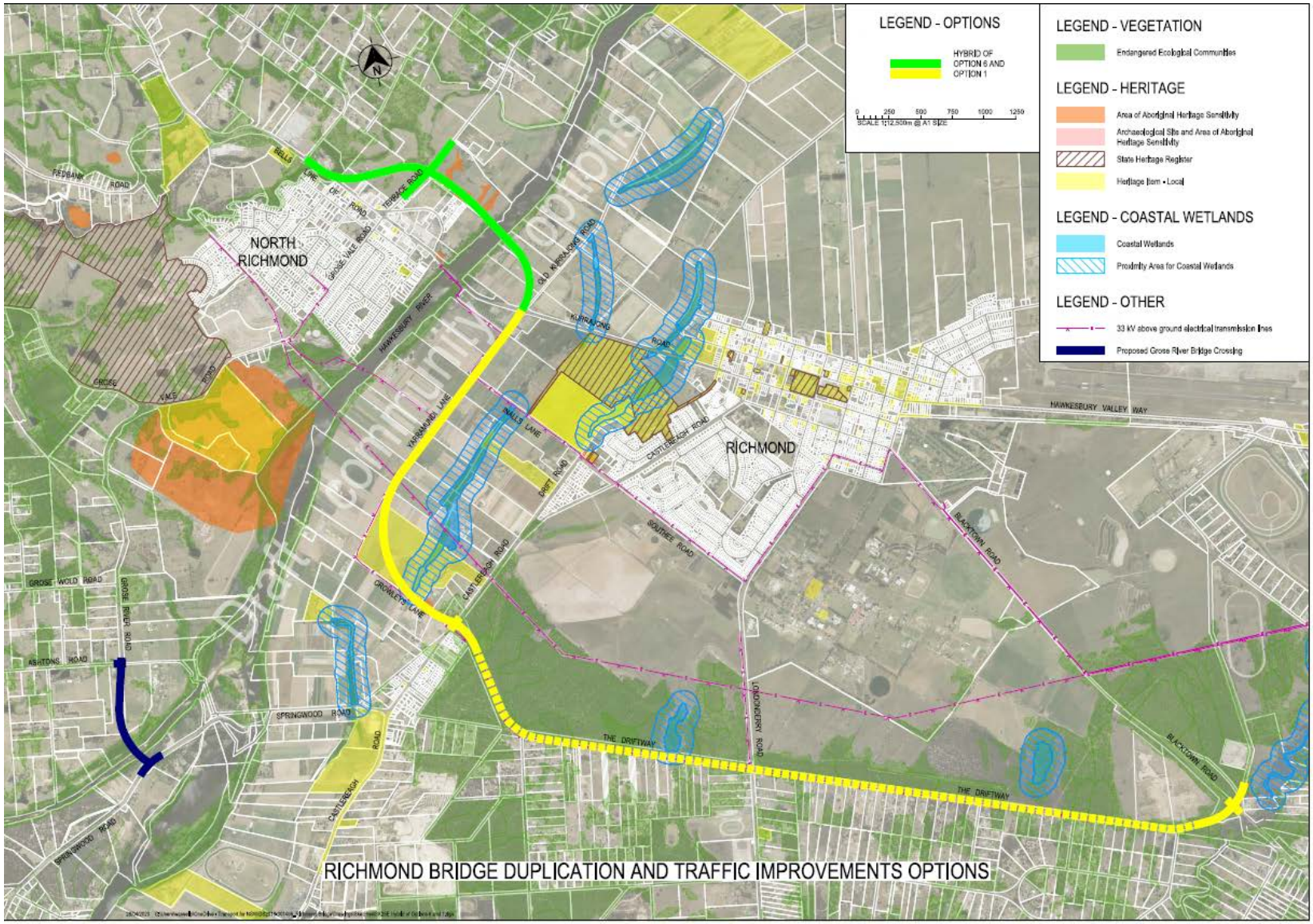
Another variation of this option was also suggested which continued along the power easement through University of Western Sydney land. This option however would have even greater impacts on the power easement which would result in substantial increases in costs, would have greater impacts on Endangered Ecological Communities including coastal wetlands and sever a substantial portion of University of Western Sydney land.

Figure 5-1 - North Richmond power easement route



The second of the two options suggested by a community member was an alternative Hybrid Option which followed Option 6 (Green, North Richmond Northern Bypass) to the intersection of Kurrajong Road and Old Kurrajong Road, then followed the Option 1 (Yellow, Yarramundi Lane Route) to connect to The Driftway (Figure 5-2).

Figure 5-2 - Alternative hybrid route



The traffic and cost assessment has shown that the combination of the Yellow and Green routes in the alternative Hybrid Option would cost more due to its longer length and deliver less travel time savings and less benefits to the Richmond town centre than the Green Option. Accordingly it has not been considered further.

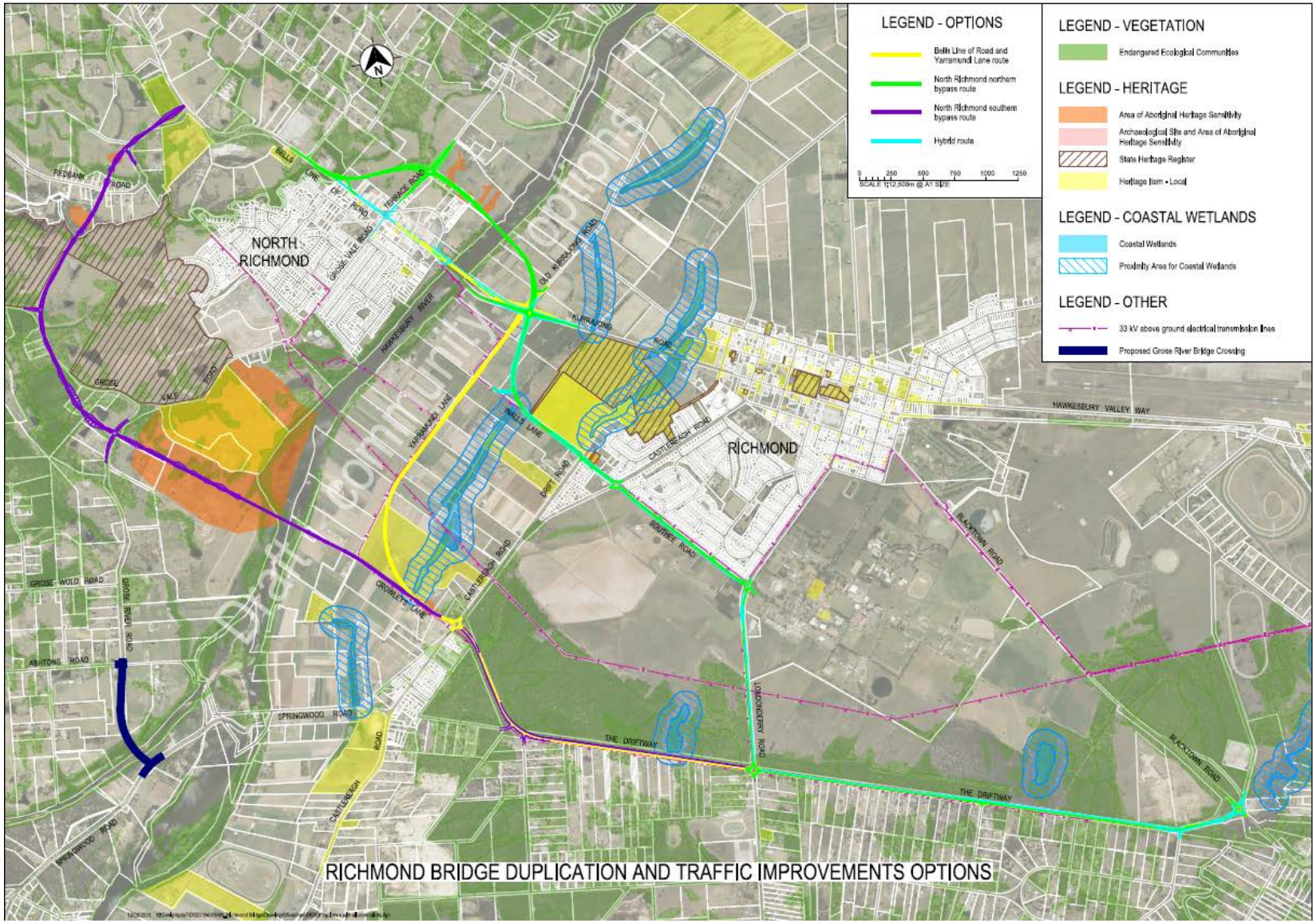
5.3 Ongoing consultation

This preferred option report includes a summary of the investigations and findings of the technical studies and the outcome of a value management workshop. The community has an opportunity to provide feedback on the preferred option which will be considered in the next phase of design and environmental assessment. When the environmental assessment is complete, the community will have a further opportunity to provide feedback.

6. Constraints analysis

We identified environmental constraints for the project through preliminary environmental investigations. Further detailed environmental investigations would be carried out in the next stage of planning. Figure 6-1 shows the four options and the key constraints in the project area including endangered ecological communities, coastal wetlands, major utilities, and Aboriginal and Non-Aboriginal heritage constraints.

Figure 6-1 - Options and constraints



6.1 Biodiversity

While most of the project area is cleared land used for agistment and other farming land uses, the presence of threatened species and Endangered Ecological Communities (EECs) is a potential constraint to all options. This is particularly the case along The Driftway which is recognised as a Regional Biodiversity Corridor and in vegetated areas south of North Richmond.

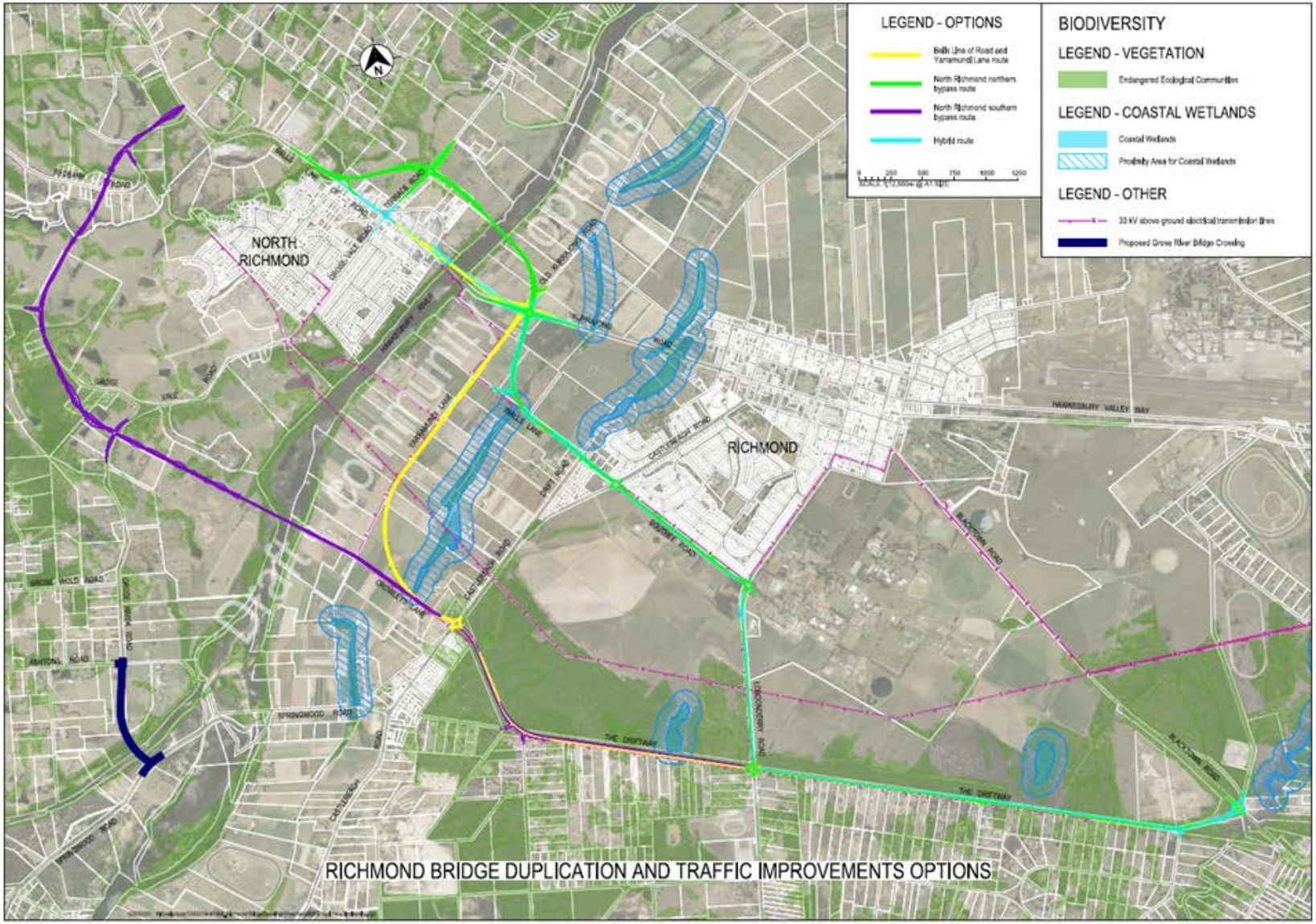
An *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) protected matters search returned 16 records for listed migratory species. Of these, six species are found in terrestrial environments, while the remaining eight species are found in wetland or marine environments.

The main biodiversity issues identified in the project are:

- Direct impacts on threatened ecological communities. There would be potential direct impacts to:
    - Cumberland Plain Woodland in the Sydney Basin Bioregion
    - River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
    - Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion
    - Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion
    - Sydney Freshwater Wetlands in the Sydney Basin Bioregion
    - Shale Sandstone Transition Forest in the Sydney Basin Bioregion
- Likely occurrence of threatened flora and fauna species and migratory species (or their habitats)
- Fauna movements and connectivity along the Hawkesbury River corridor and near The Driftway
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Clearing of native vegetation
- Presence of groundwater dependant ecosystems
- Presence of key fish habitat (Hawkesbury River).

Figure 6-2 shows the four options and how they intersect various areas of biodiversity.

Figure 6-2 - Areas of EECs and Coastal Wetlands



Threatened species and EECs are protected under state legislation and federal in some instances. Table 6-1 shows impacts to EECs for each option in hectares.

Table 6-1 - Impacts to EECs

Option	Impacts to EEC (ha)
Yellow	9.9
Green	5.9
Purple	18.9
Hybrid	4.2

The Purple Option has the highest impact to biodiversity and the Hybrid Option has the lowest impact to biodiversity. When managing biodiversity, Transport aims to:

- Avoid and minimise impacts first
- Mitigate impacts where avoidance is not possible
- Offset where residual impacts cannot be avoided.

A detailed biodiversity assessment will be carried out during the next phase of the project to determine accurate locations of threatened species and communities in the study area.

6.2 Heritage

6.2.1 Aboriginal

Transport abides by the procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI). The PACHCI has four stages of investigation and consultation:

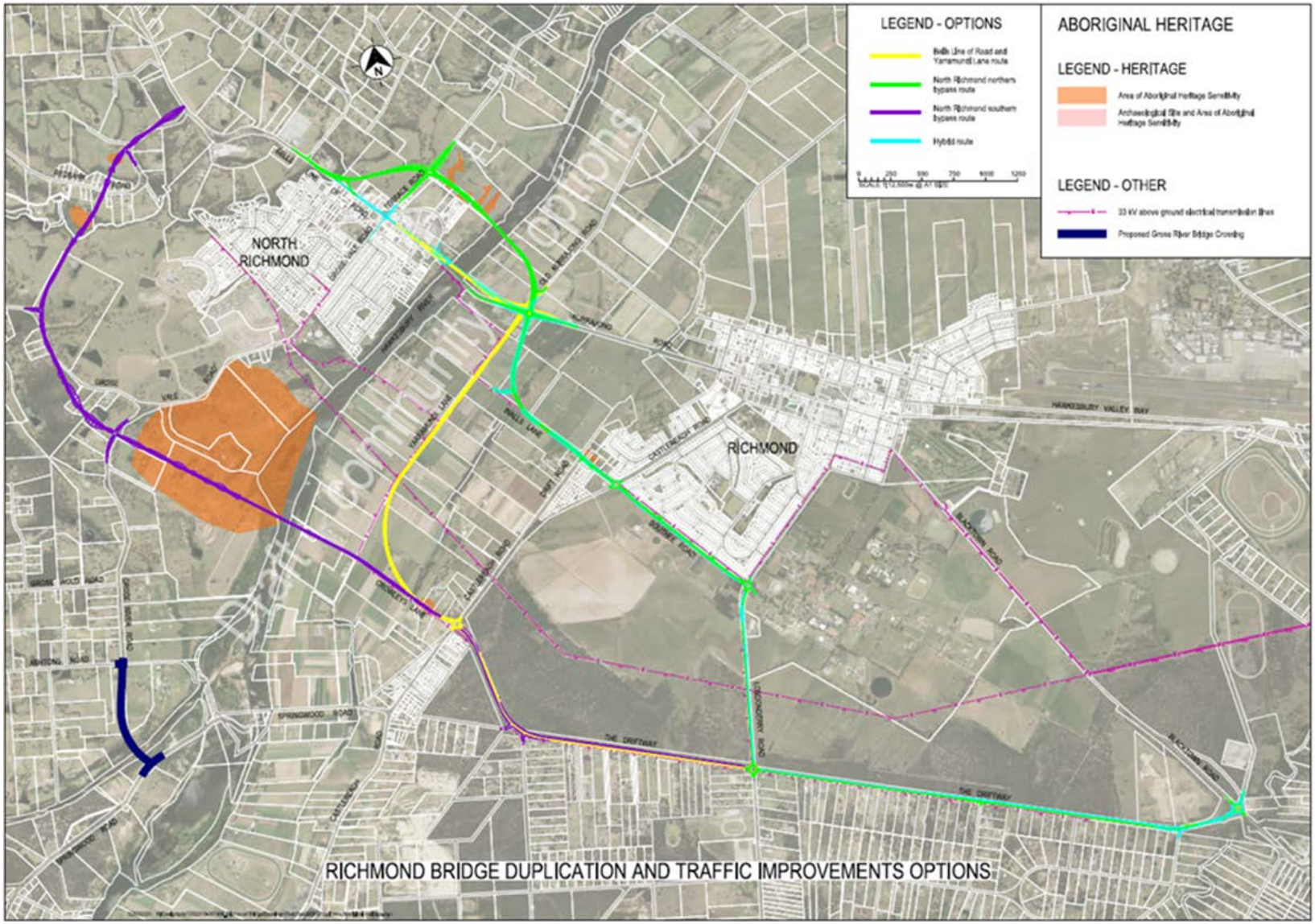
- Stage 1: an initial assessment
- Stage 2: a site survey
- Stage 3: a formal consultation and preparation of a cultural heritage assessment report
- Stage 4: implementation of environmental impact assessment recommendations.

Stage 1 and 2 have been completed. Kelleher Nightingale was engaged to carry out the Stage 2 site survey and prepare an Aboriginal Archaeological Report. Aboriginal occupation of the Sydney region is likely to have spanned at least 20,000 years, although dates of potentially more than 40,000 years have been indicated from artefacts found in gravels of the Cranebrook Terrace on the Nepean River.

The site survey was carried out with a representative from Deerubbin Local Aboriginal Land Council on 30 April 2019. The Stage 2 PACHCI report identified several areas with potential for subsurface artefacts. These are typically located on relatively elevated landforms along the margins of creeks and rivers as these would have been favourable for occupation by Aboriginal people.

All options would have potential impacts on identified areas of Aboriginal archaeological sensitivity (Figure 6-3).

Figure 6-3 - Identified areas of Aboriginal archaeological sensitivity



The Purple Option would impact on Richmond Hill, a site of a reported battle between local Darug people and the NSW Corps in May and June of 1795 and is considered to be the first recorded battle between Aboriginal people and the white settlers. As a result, a detachment of the military remained in the district for more than 50 years.

The potential for the presence of artefacts means that Stage 3 will be required for all options and an additional detailed cultural assessment would be required for the Purple Option. The potential significance of impact is higher for the Purple Option.

Aboriginal archaeological sites, Aboriginal cultural areas and areas of identified Aboriginal archaeological sensitivity should be avoided if possible.

6.2.2 Non-Aboriginal

European settlement of the study area started in 1794 with the first land allocations, mainly to ex-convict settlers. Agriculture and farming on the Hawkesbury River floodplains was the basis of the settlement. In 1811 Governor Macquarie formally laid out the town of Richmond, naming the streets and planning for public places including a church, school, cemetery, public buildings and parks. Richmond was one of five such towns established by Macquarie along the Hawkesbury-Nepean River, the others being Windsor, Pitt Town, Wilberforce and Castlereagh.

By 1817 Richmond was divided into 29 allotments and by the 1820s these allotments were further subdivided to form 79 blocks. Plans of Richmond from the 1830s and 1840s show the gradual consolidation of the townscape with Windsor and March Streets developing as the commercial centre.

Between the 1860s and 1880s, Richmond underwent a phase of civic growth and during this period witnessed the construction of new commercial and public buildings. Among these are several prominent buildings that form an integral part of the town's current built heritage along the frontages of Windsor Street, March Street and West Market Street.

Richmond retains the original footprint of the Macquarie town and the earlier less formal rural land allocations pre-dating the town. March Street, Windsor Street, Francis Street, Lennox Street, East Market Street, Bosworth Street and Chapel Street were all part of Macquarie's original town layout.

Prior to 1812, transport to and from the study area was predominantly provided by vessels along the Hawkesbury River. Prior to the construction of the first bridge, access to the north side of the Hawkesbury River near Richmond was dependent on river transport (such as a punt and/or ferry). The first bridge was a timber structure completed in 1860. This structure was frequently affected by flooding and river bank erosion.

Construction of the first section of the Main Western rail line, now the Blue Mountains Line, crossing the Blue Mountains from Penrith to Mount Victoria was opened in May 1868. The Blacktown to Richmond Line, a single track line of the Main Western Line was opened on 1 December 1864. Plans to build a railway to the west, following the Bells Line of Road, were proposed in the 1890s to reduce the traffic on the Main Western Line, but would not become viable until the concrete arch bridge was built in 1905 immediately upstream of the timber bridge.

The new concrete bridge was constructed at a higher level than the timber bridge to provide improved flood resilience. It utilised design and construction techniques that were innovative for the period. This concrete bridge remains as the current Richmond Bridge, although it has undergone several modifications since its original construction. Major modifications to the bridge

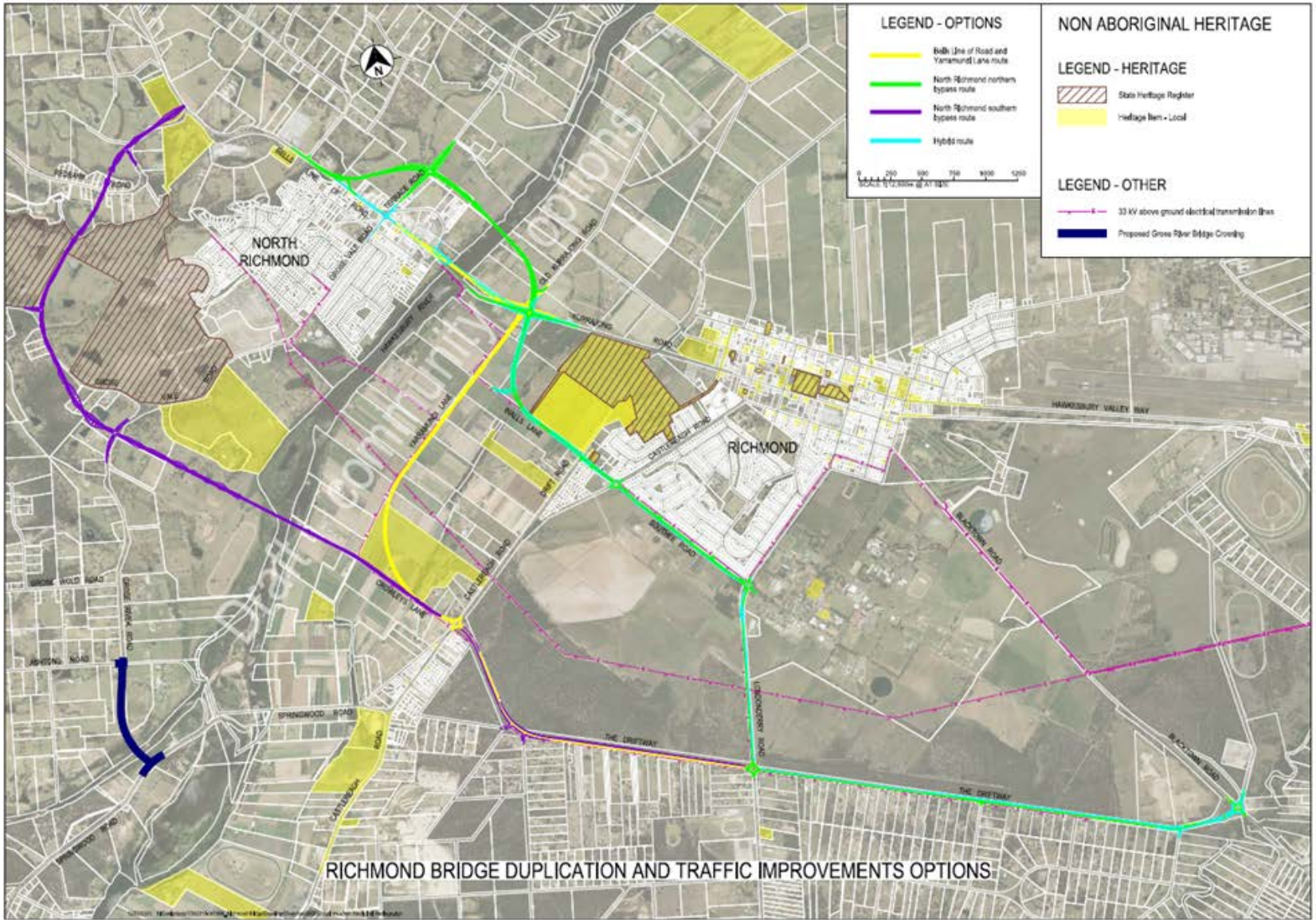
were made to accommodate the railway line and steel extensions on the downstream side of the bridge were made. When the bridge was completed the railway line left Richmond Station, and followed March Street before continuing west in a straight alignment beyond the limits of Richmond town following the route that would later become Kurrajong Road. The railway cut directly through existing property boundaries with a section of curved track on the North Richmond side of the river. The railway crossed Bells Line of Road diagonally at the intersection with Grose Vale Road and a large passenger platform and livestock siding were located in the southwest corner of the intersection. In 1928, a short platform was built on the east bank of the river (the Richmond side) to allow passengers to alight near the river. In 1966 the railway line across the bridge was converted to a vehicular traffic lane.

Philips Marler in collaboration with Biosis were engaged to complete a strategic Non-Aboriginal heritage study. The study identified there are 78 items of local and state heritage significance within the study area (with the majority located within Richmond town centre).

Richmond Bridge is listed on the NSW heritage register and therefore must form a component of the final design, as per the Heritage Act 1977 (Heritage Act) guidelines. The area has some archaeological potential associated with the former railway alignment, the river crossing and known heritage items.

The shortlisted options have been designed to avoid items of state heritage significance, however the Purple and Yellow options would have the highest impact on items of local heritage significance (Hill Crest and Bronte). Identified areas of non-Aboriginal heritage are shown in Figure 6-4.

Figure 6-4 - Identified areas of non-Aboriginal heritage



The Green and Hybrid Options have the least heritage impacts as they avoid all direct impacts to heritage items. Table 6-2 summarises the non-Aboriginal heritage impacts for each option.

Table 6-2 - Non-Aboriginal heritage impacts

Option	Impacts
Yellow	• Passes through one item of local heritage significance (Bronte) • Need to consider height and scale of a new bridge adjacent to existing state heritage bridge
Green	• Close to two items of State (Hobartville and Mountain View) and one item of local heritage significance (House on Inalls Lane)
Purple	• Passes through one item of State heritage significance (Yobarnie Keyline farm – noted that impact is likely negligent as land impacted is identified for subdivision) • Intersects one item of local heritage significance (Hill Crest) • Close to one item of local heritage significance (Bronte)
Hybrid	• Close to two items of State (Hobartville and Mountain View) and one item of local heritage significance (House on Inalls Lane) • Need to consider height and scale of a new bridge adjacent to existing state heritage bridge

Views across agricultural lands on the floodplain from nearby elevated historic homestead sites have also been highlighted as an important contributor to heritage values. Options which minimise length of work and scale of embankments on the flood plain would reduce impacts. Section 6.4 discusses how the height and scale of proposed bridges located near the existing bridge in the Yellow and Hybrid Options have been considered. An active transport bridge could be considered in a similar location for Green and Purple options so these considerations may also be relevant to those options.

During the environmental assessment, an historic heritage and archaeological assessment will be carried out in addition to a noise and vibration assessment which will consider the potential impacts on heritage properties during construction and how to manage impacts if identified.

6.3 Noise and vibration

Noise and vibration increase during construction from earth moving and road construction equipment. When the road is operational the noise levels next to the road would increase with traffic and heavy vehicles.

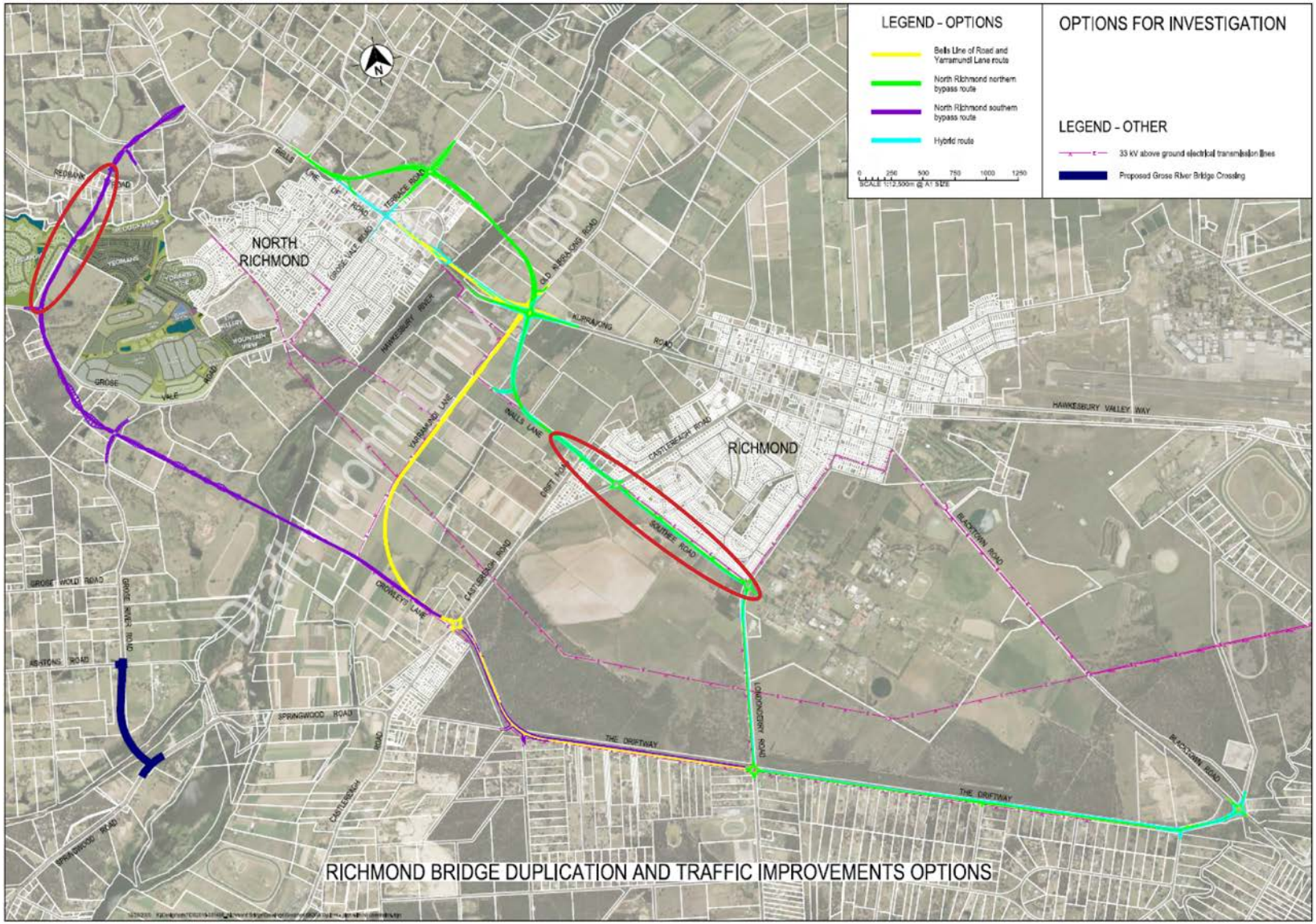
Dominant existing noise sources in the project area are road, railway and aircraft noise (RAAF Base Richmond). The main existing sensitive receivers are the residential areas in Richmond and North Richmond. There are several schools and places of worship in these areas. Non-residential sensitive receivers include public recreation areas, the Colo Soccer Football Club and a number of polo clubs.

Based on a strategic assessment, the Yellow Option appears to have the least amount of noise and vibration impacts as it largely avoids residential areas. The other options would have greater impacts (shown in red circles in Figure 6-5), in particular:

- Green and Hybrid options may impact residential areas on Southee Road and Inalls Lane
- Purple Option may impact residential areas in the Redbank land release and on Redbank Road.

During the environmental assessment phase, Transport will prepare an assessment detailing the construction and operational noise and vibration impacts and where required, mitigation strategies including low noise pavements, noise walls/mounds and/or at property treatments.

Figure 6-5 - Potential areas for noise impact



6.4 Visual amenity

Richmond has numerous historic commercial, civic and municipal buildings and residences, a traditional main street commercial strip, a central town oval and tree lined streets and avenues. All options bypass Richmond, resulting in reduced traffic demand in the town centre and removing the need for additional lane capacity improvements in the town centre. This would improve the amenity, reduce visual impacts on the historic town centre, and support Hawkesbury City Council in achieving their vision for the Richmond town centre when developed.

North Richmond is a relatively contemporary township with a much lower density of heritage items and limited existing streetscape compared to Richmond. Yellow and Hybrid Options would upgrade the existing alignment in North Richmond while the Green and Purple Options would bypass the town centre.

All options require construction of a new bridge which would have visual impacts. The Yellow and Hybrid options would require a bridge built adjacent to the existing heritage bridge. The Green and Purple options may also require an active transport bridge in a similar location depending on the active transport route identified in the next phase of design. A new bridge whether for vehicles, active transport users or both, would need to consider height, scale and materiality and its relationship to the existing bridge.

Increasing separation from the existing bridge and simplifying the bridge/pier structure would reduce impacts on the existing bridge and improve the visual experience from the existing bridge. An elevated bridge provides the opportunity to maintain long range views from the existing bridge underneath the new bridge. The images below (Figure 6-6 to Figure 6-8) show this effect.

Figure 6-6 - Parallel bridge (~20m separation) Pants pier (left) and simplified T shaped pier (right)

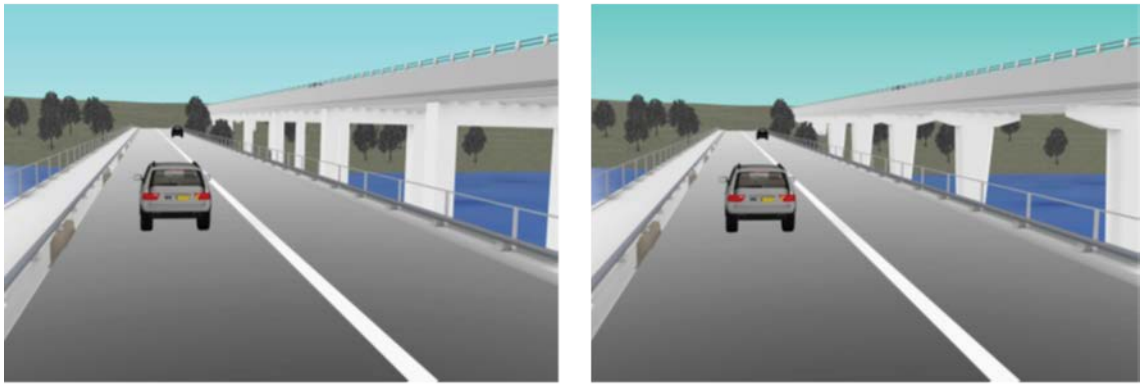


Figure 6-7 - Increased bridge separation (30-60m separation) Pants pier (left) and simplified T shaped pier (right)

Figure 6-8 - Increased bridge height allows long range views under bridge

Other potential visual impact comes from work on the floodplain which requires embankments and bridge structures and where the options interact with or are adjacent to residential areas.

Options which minimise length on the floodplain would reduce visual impacts. Increasing flood resilience increases the height of embankments and the scale of bridge structures which would increase visual impacts.

The Yellow option largely avoids residential areas however the other options would interact with residential areas. The Purple Option would cut through the Redbank residential development and other homes on Redbank Road. The Green and Hybrid Options would run parallel to Southee Road between Londonderry Road and Castlereagh Road.

Where options are located near residential areas, noise treatments are likely to be required such as noise walls and/or mounds or at property treatments. The visual impacts of noise treatments would need to be assessed in greater detail during the next phase of design and environmental assessment. A preliminary assessment of this along Southee Road is provided in Section 7.7.

Table 6-3 summarises the visual amenity impacts for each option.

Table 6-3 - Visual amenity assessment

Option	Benefits	Impacts
Yellow	• Bypasses Richmond	• New bridge close to existing Richmond Bridge • Longest length (3km) crossing the floodplain with the embankment running along Yarramundi Lane, fragmenting floodplain views • This impact would increase with height of embankments • Would be overlooked by properties on the western side of Richmond overlooking floodplain
Green	• Bypasses Richmond and North Richmond • Increases separation from existing Richmond Bridge (600m)	• Medium floodplain work • Moderate disruption to views on the floodplain due to bridge/embankment combination • Would be overlooked by properties on the western side of Richmond overlooking floodplain • Runs parallel to Southee Road • Noise treatment would be required along Southee Road
Purple	• Bypasses Richmond and North Richmond • Increases separation from existing Richmond Bridge (2.3km) • Shortest floodplain work	• Cuts through steeper terrain requiring large cut/fill in elevated western side of Hawkesbury River with impacts to vegetation and residential views • Moderate disruption to views due to elevated position and limited screening within the landscape • Largest footprint • Noise treatment would be required along to Redbank residential areas
Hybrid	• Bypasses Richmond	• New bridge close to existing Richmond Bridge • Medium floodplain work • Moderate disruption to views on the floodplain due to bridge/embankment combination • Would be overlooked by properties on the western side of Richmond overlooking floodplain • Runs parallel to Southee Road • Noise treatment would be required along Southee Road

6.5 Socio-economics

Richmond and North Richmond are communities of highly car-dependent residents, employees and businesses. There is currently only a single two-lane bridge route between North Richmond and Richmond. These two factors combined mean the local road network is highly constrained and not performing well. This has broad impacts to residents, businesses, and attractiveness of the local area for investment. This road network performance is expected to worsen and could negatively impact the prosperity and wellbeing of the Richmond and North Richmond communities. Existing congestions issues have contributed to some community resistance to further development occurring without improvements to the road network.

6.5.1 Richmond

Richmond is one of the original settlements in the Greater Sydney Area and is an established regional service centre. Richmond's population is 6,369 and the Western City District Plan, the long-term plan for the development of greater Sydney and its economy, identifies Richmond as a strategic centre.

The regional role of Richmond influences the mix of businesses and services within the town centre. It includes government services (such as a Service NSW hub, post office, courthouse and library), medical services, finance and insurance providers (including multiple banks), major supermarkets, and a variety of cafes and restaurants. The broader town also has three primary schools, a high school, a university campus and a TAFE.

This mix suggests the local economy of Richmond is closely tied to the accessibility of its surrounding localities. The types of businesses and services are also unlikely to be reliant on pass-through trade. The physical layout of the centre also suggests it benefits from 'walkability' with many street-fronting retailers along Windsor Street potentially sensitive to the negative amenity and safety impacts of traffic congestion and any influence this may have on people's decision to visit Richmond less or spend less time there when they do visit. There are several pedestrian crossings in the town centre which impact on traffic flow.

6.5.2 North Richmond

North Richmond has a population of 5181 and it is continuing to grow with three major property development areas proposed including the Redbank and Jacaranda Ponds developments and the Kurrajong Investigation Area. There is a primary school (Richmond North Public School) and a high school (Colo High School).

The mix of businesses and services within North Richmond suggests its economy is more locally focussed. It is dominated by supermarkets and grocery stores, agricultural and automotive services and trades rather than government service providers. As the last major settlement on the Bells Line of Road before the Blue Mountains there is also a greater focus on pass-through trade. As an example, in 700 metres along Bells Line of Road there are four petrol stations, a drive through coffee shop and several take-away food outlets. However, most businesses would still be servicing a largely local customer base.

Unlike Richmond, North Richmond's town centre is less likely to significantly benefit from walkability or amenity. Most businesses are clustered around dedicated off-street car parks. This suggests businesses are more likely reliant on car-based trips and that there would only be limited 'trip sharing' between the business clusters (where a customer who has driven to one part of the centre is likely to walk to or use another part of the centre). Notwithstanding, greater benefits may be realised if further investment is made to improve active transport connectivity along and across Bells Line of Road.

6.5.3 Socio-economic impact of the project

The Richmond Bridge duplication and traffic improvements project could have broad and sustained benefits. It could increase the disposable income of residents, profitability of local business, and create capacity for further residential and commercial development. These benefits could increase investment and expenditure which would drive more indirect benefits such as more local jobs.

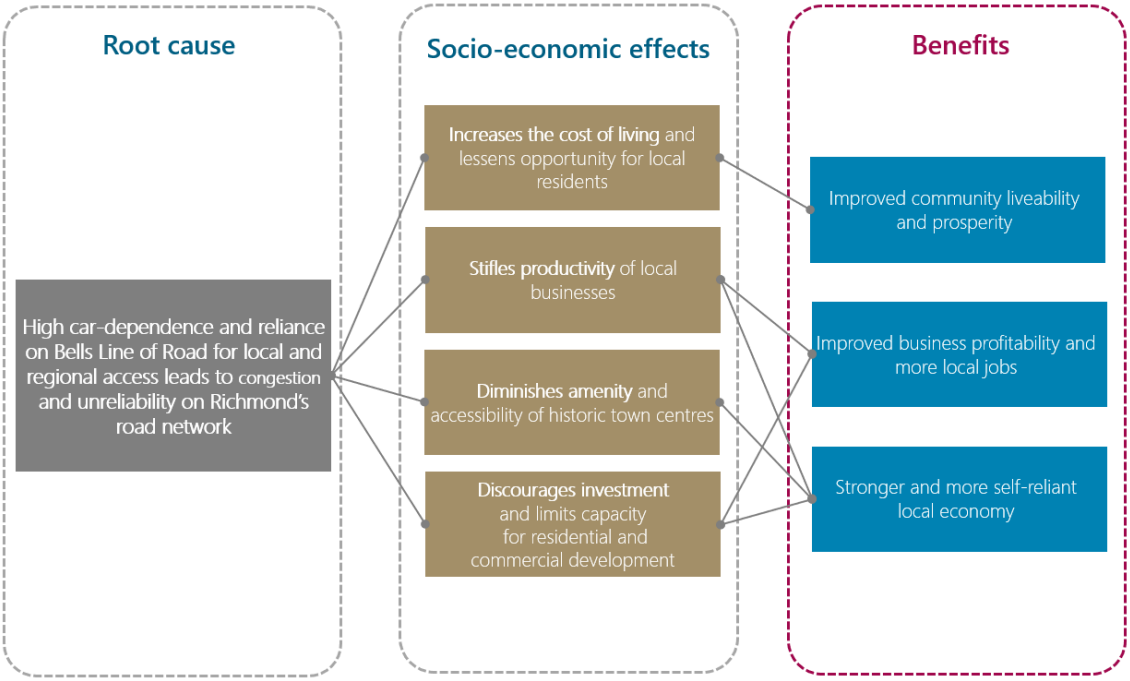
All options will achieve these benefits by improving travel times and increasing travel time reliability. These then create related reductions in vehicle operating or transport costs. This process is shown in Figure 6-9.

All four options considered are likely to support the growth and economic prosperity of the region. They would:

- Provide for amenity improvements in historic Richmond town centre and growth of the visitor economy
- Deliver travel time savings
- Improve road network performance to accommodate growth.

However, the project will redistribute traffic which can result in other socio-economic outcomes like potential losses in pass-through trade. Although a bypass of North Richmond would provide greater travel time savings, it would reduce the amount of traffic passing through the North Richmond commercial centre where a number of businesses benefit from pass-through trade. Upgrading the existing corridor through North Richmond would maintain support for businesses that are more reliant on this pass-through trade. A bypass of North Richmond could however provide a platform for amenity improvements and revitalisation of the town centre to support businesses and with appropriate access and signage, impacts are likely to be short term with long term benefits.

Figure 6-9 - Socio-economics benefits realisation



Transport will assess the socio-economic impact of the preferred option in the next stage of design. This assessment will need to document any impacts to the social infrastructure and community facilities in the area including:

- Various schools in Richmond and North Richmond
- Various places of worship in Richmond and North Richmond
- St John of God Richmond Hospital
- University of Western Sydney (Hawkesbury Campus)
- Richmond Community Services Inc and Neighbourhood Centre
- Richmond Park
- Richmond Branch Library
- Various sporting facilities.

6.6 Hydrology

The project area is in the Hawkesbury-Nepean catchment and drains to the Hawkesbury River. The Hawkesbury River originates where the Nepean and Grose Rivers meet, north of Penrith. The Hawkesbury River periodically floods and contains floodplains between the eastern bank of the Hawkesbury River at Richmond Bridge and the township of Richmond. The floodplain between Richmond and North Richmond, known as the Lowlands, is inundated in relatively frequent flood events, overtopping Kurrajong Road and Richmond Bridge.

The approach from Richmond covers a section of floodplain adjacent to the Lowlands about two kilometres wide. The approach from the south-east that crosses the floodplain between Richmond and North Richmond is slightly higher than the bridge and is also affected by regular flooding. The current bridge is closed due to flooding in events just over a 1 in 2 chance per year flood. All options have sections of alignment near the river that are affected by flooding.

All options involve a new bridge crossing the Hawkesbury River. This crossing (as well as embankments in flood affected areas) would have the potential to alter existing surface flow patterns, affect drainage capacity and modify the existing flood regime.

The three vertical alignments were investigated to achieve 1 in 5, 1 in 20, and 1 in 100 chance per year flood resilience. The height of the above flood events at Richmond Bridge as documented in the Hawkesbury Nepean Valley Regional Flood Study (WMA 2019) are 1 in 5 (11.4m), 1 in 20 (15.4m), and 1 in 100 (17.6m).

Raising the height of the road through the floodplain would substantially increase costs through increased imported fill which would require compensatory excavations and increased river and floodplain bridge structures. For example to achieve 1 in 100 year flood resilience would require embankments up to seven metres high within the floodplain. Flood levels and potential impacts to property would also increase with increasing embankment height which could further increase costs to compensate for impacts. Embankments of that height are not considered feasible in the floodplain. To achieve 1 in 100 chance per year flood resilience, a bridge of up to 2.5 kilometres in length would be required which would further increase costs.

As the bridge does not form part of evacuation routes, there is no requirement to achieve a particular level of flood resilience however there is opportunity to improve it. The decision on the

level of flood resilience to be achieved will be based on the costs, benefits and impacts of improving flood resilience.

Transport will further assess impacts on surface and groundwater flow regimes and quality in the next phase of design.

6.7 Contamination

Current and historical land uses like agricultural, industrial and commercial land use could result in contamination. Contamination on a route can increase investigation, sampling, remediation, mitigation and management costs.

A contamination assessment of the study area found:

- 35 areas of environmental concern across the four options
- Four formerly licensed sites or areas within one kilometre of the study area based on a search of the NSW EPA public register on 20 November 2019
- The study area is located 900 metres north west and 400 metres south west of the RAAF Base PFAS Off-site Management Area. The Department of Defence has prepared a PFAS Management Area Plan (PMAP) for the RAAF Base and some areas of surrounding land and waterways. The PMAP defines management areas where monitoring of PFAS in surface water and groundwater would occur
- Several current potential contamination sources and historical activities exist or have occurred within and adjacent to the study area, including areas of stockpiling or waste dumping, a former stone crushing site and a former railway.

The Green and Purple Options would have the highest risks related to management of potentially contaminated soil, with the Hybrid Option having a lower risk and the Yellow Option having the lowest. All options could be impacted by potential contamination from agricultural activities (pesticides) and illegally discarded waste (asbestos).

Future project planning would incorporate further contamination risk investigation including soil sampling and contamination testing.

6.8 Property and land use

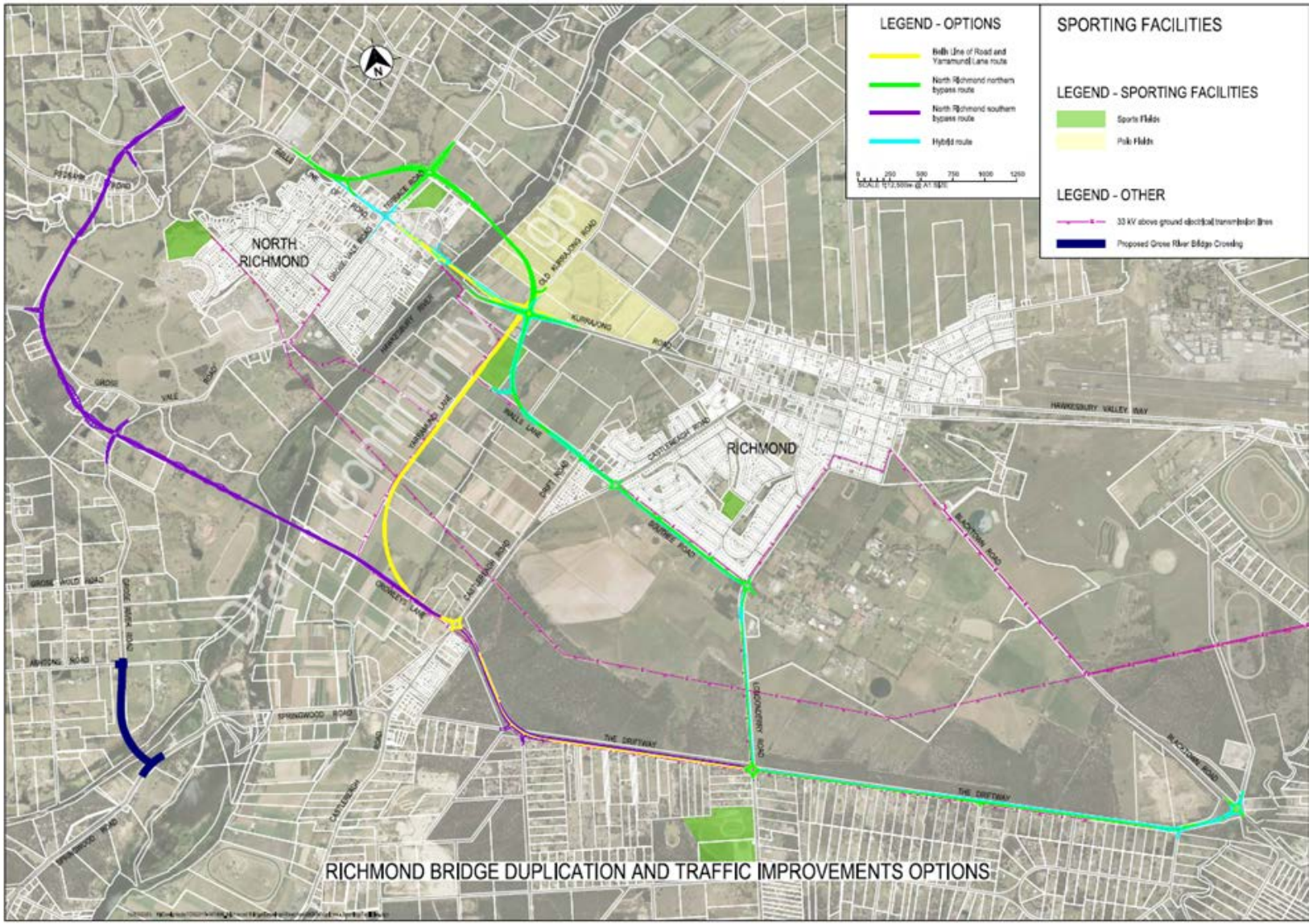
The extent of land acquisition for a road upgrade can increase cost and have social impacts. The road upgrade location can impact nearby current and future land uses. We have reviewed property ownership and land uses in the area. Some of the current land ownership constraints include:

- Privately owned property that would need to be partially or wholly acquired
- Sporting fields
- High Capability Land
- Aboriginal Land Claims.

Land use in the area is a mix of residential, commercial and light industrial, rural (agricultural) to open space and recreation located between and adjacent to the towns of Richmond and North Richmond and across the floodplain of the Hawkesbury Nepean System. The land in the area is subject to zoning under the Hawkesbury City Council Local Environmental Plan 2012.

Immediately to the east of the river (from the riverbank to the outskirts of the township of Richmond), land uses are generally a mix of semi-rural, agricultural developments, including turf farms, a soccer club and a polo club. These areas are shown in Figure 6-10.

Figure 6-10 - Sporting facilities in the study area



On the western side of the Hawkesbury River within North Richmond, land uses are generally a mix of residential, commercial and some light industrial uses, together with some developed open space devoted to parkland. The North Richmond Shopping Centre is on the south western side of Bells Line of Road, surrounded by parking.

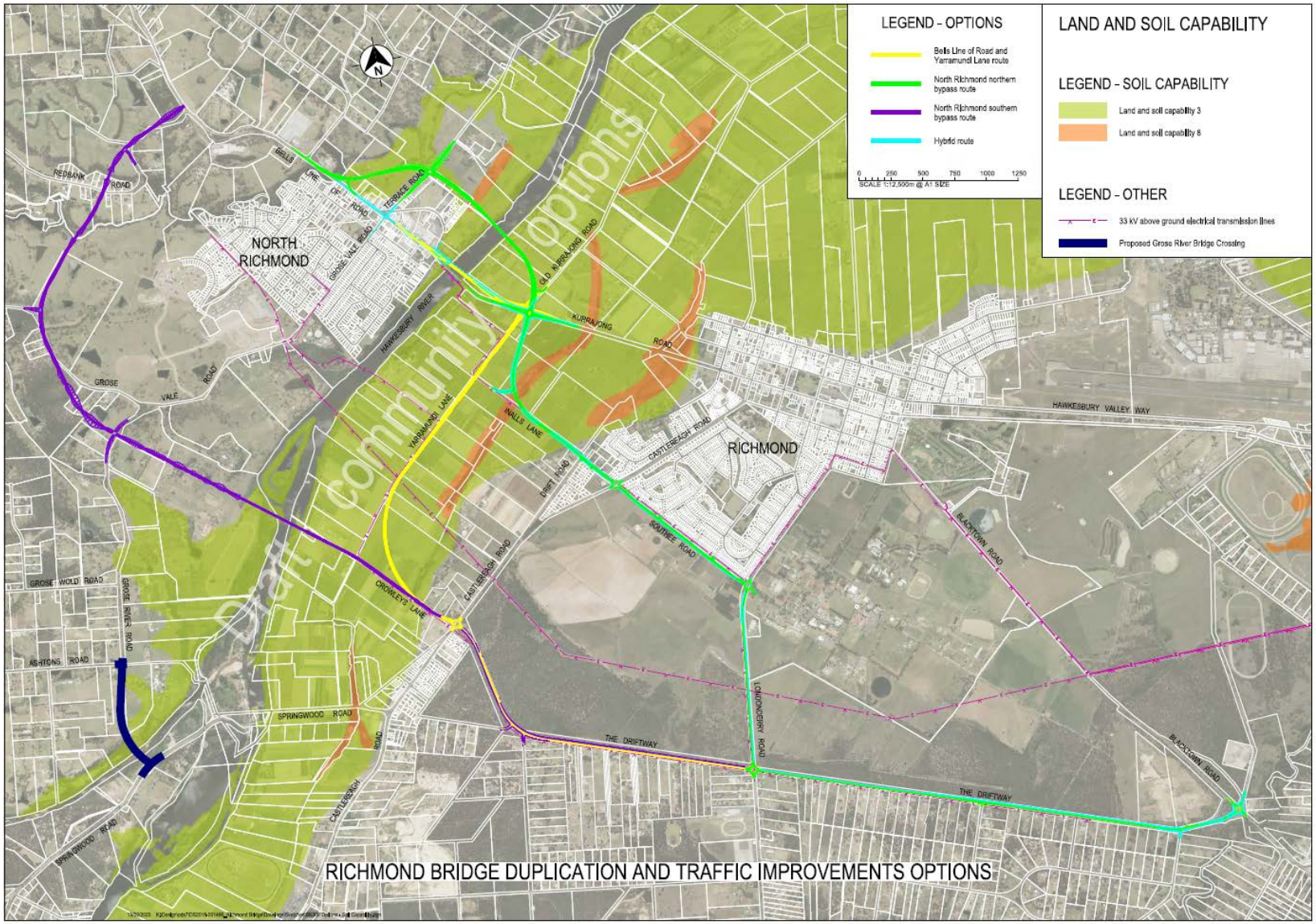
Land and soil capability (LSC) is the inherent physical capacity of the land to sustain a range of land uses and management practices in the long term without degradation to soil, land, air and water resources. Engagement with the community has identified a desire to reduce impacts to high productivity land that is or can be used for agricultural purposes.

The LSC assessment scheme uses the features of the land and soil including landform position, slope gradient, drainage, climate, and soil characteristics to derive detailed rating tables for a range of land and soil hazards. These hazards include water erosion, wind erosion, soil structure decline, soil acidification, salinity, waterlogging, shallow soils and mass movement. The rating system is between 1 (best, highest capability land) and 8 (worst, lowest capability land). Land within the investigation area is primarily class 3 (high capability) and class 8 (extremely low capability) (Figure 6-11).

These classes are defined as:

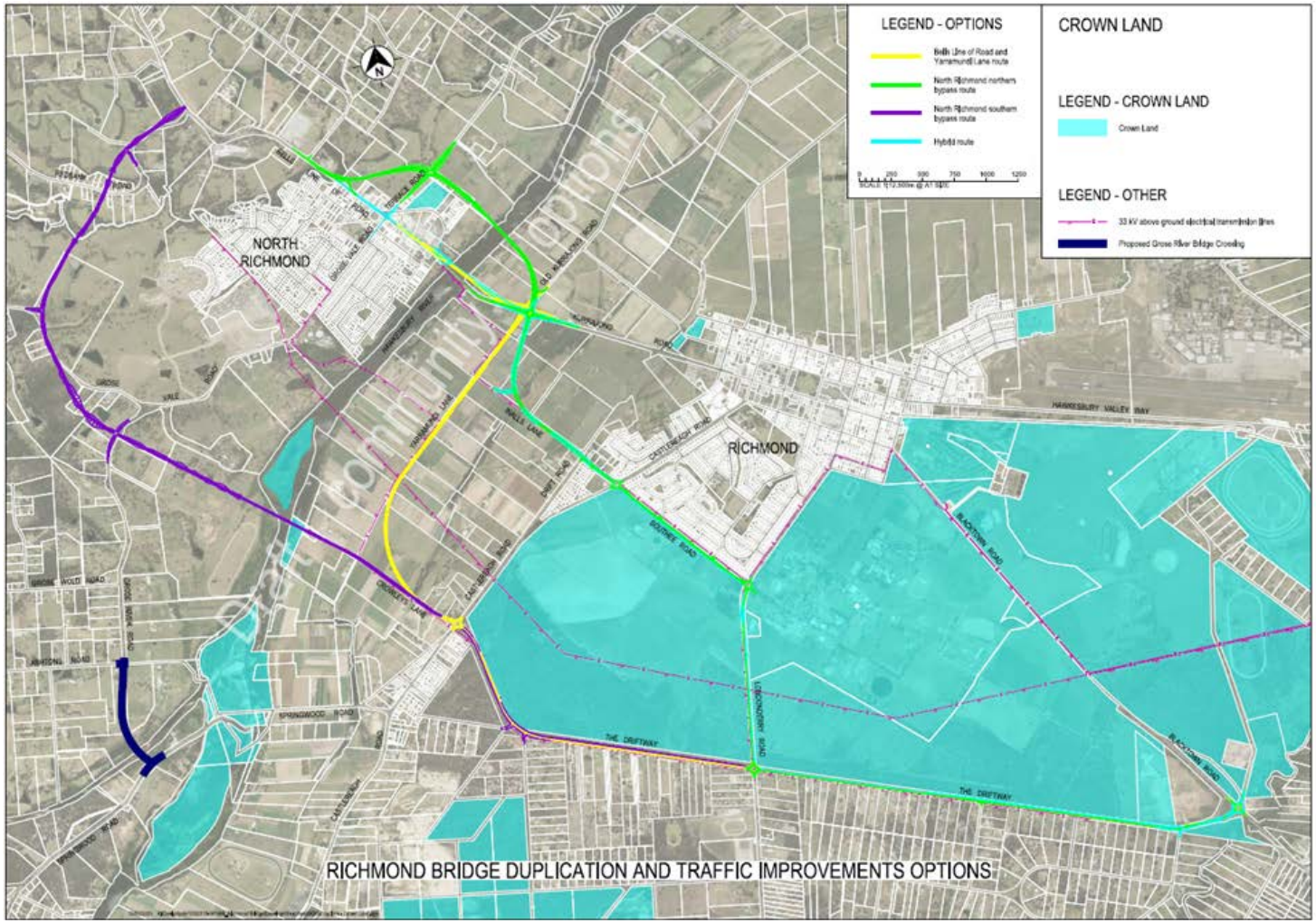
- Class 3 – High capability land: Land has moderate limitations and is capable of sustaining high impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation
- Class 8 – Extremely low capability land: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation.

Figure 6-11 - Soil and land capability



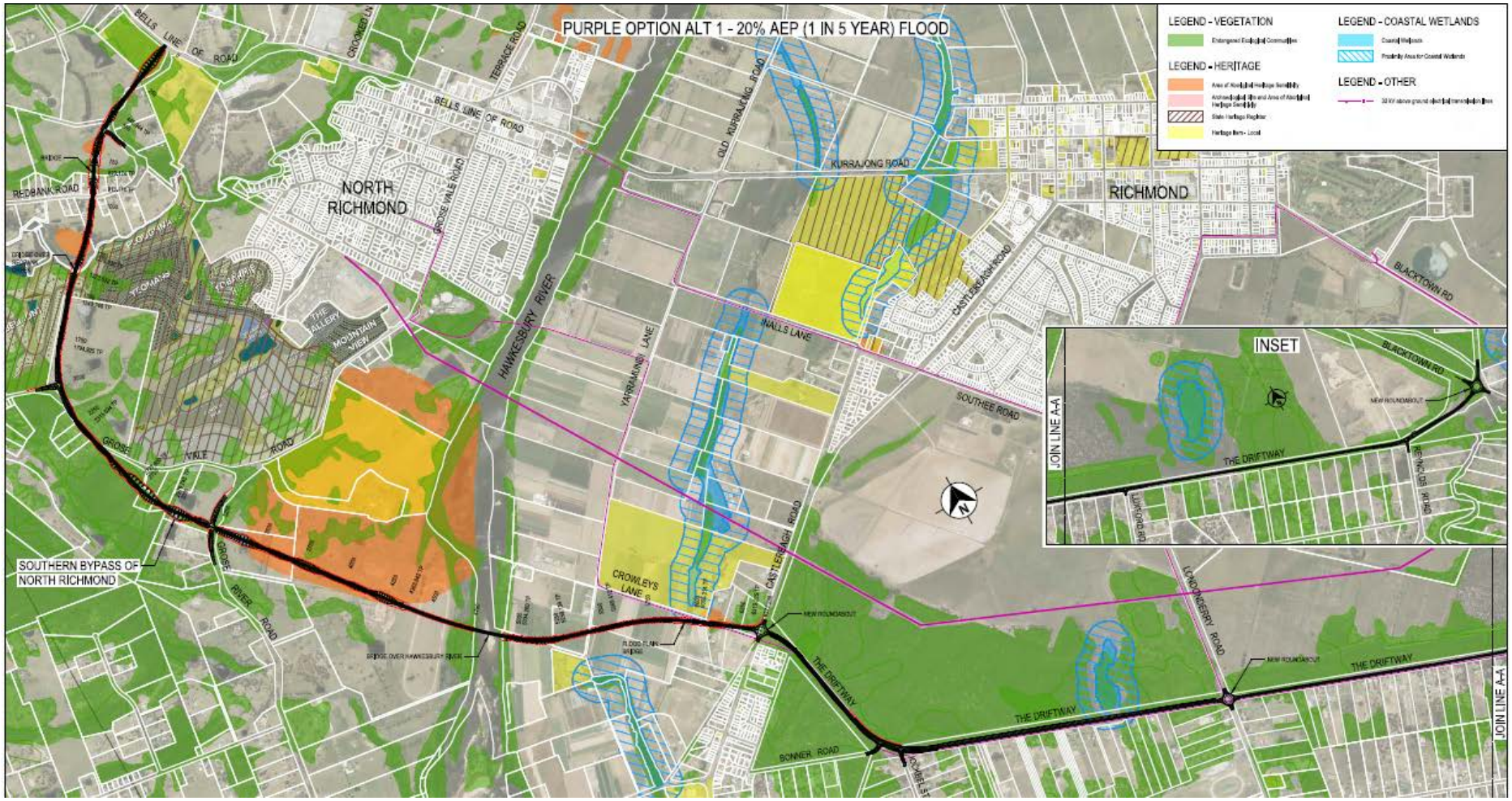
Crown Land can be a major constraint if it is subject to an Aboriginal Land Claim (ALC). Crown Land is shown in Figure 6-12. Crown Land at the University of Western Sydney was subject to an ALC which was refused in 2016. The Crown Land at the Hawkesbury River is subject to a current undetermined ALC. Land that is subject to an undetermined ALC cannot be compulsorily acquired and would have impact on timeframes and cost.

Figure 6-12 - Crown Land in the study area



A variation to the Purple Option to avoid this impact was considered and shown in Figure 6-13. This option while avoiding the Aboriginal Land Claim and reducing impacts to Richmond Hill is a marginally longer route with greater private property impacts and increased costs compared to the original Purple Option.

Figure 6-13 - Variation to Purple Option



Property and land use impacts for each option are summarised in Table 6-4 below.

Table 6-4 - Property and land use impacts

Option	Number of impacted properties	High Capability Land (ha)	Sporting land use	Aboriginal Land Claims
Yellow	25 (1 wholly, 24 partially)	14.6	• Partial polo club • Soccer club	No
Green	25 (5 wholly, 20 partially)	16.4	• Partial polo club • Partial Soccer club	No
Purple	39 (7 wholly, 32 partially)	4.4	None	Yes
Purple (Avoid ALC)	39 (10 wholly, 29 partially)	4.8	None	No
Hybrid	18 (2 wholly, 16 partially)	10.8	• Partial polo club • Soccer club	No

**These figures are based on current strategic level designs for the purpose of assessing and comparing options. Options may be refined which could change impacts.

6.9 Infrastructure and utilities

6.9.1 Infrastructure

Richmond Railway Station is located within the Richmond town centre and is not located on any of the options.

The following bus routes use the Richmond Bridge crossing of the Hawkesbury River:

- Route 668 Windsor to Richmond via Wilberforce, Glossodia and North Richmond (Busways)
- Route 680 Richmond to Bowen Mountain via North Richmond, Grose Wold and Grose Vale (Busways)
- Route 682 Richmond to Kurrajong (Busways).

6.9.2 Utilities

Telecommunication cables, water and sewer mains and traffic signal cables are all underground assets in the project area. All options would impact utilities and require relocation or protection. A water main is attached to the Richmond Bridge (downstream side). Overhead electricity transmission lines run throughout the project area and cross or run alongside all options at multiple points.

The Yellow and Hybrid options that pass through North Richmond town centre would have higher impacts on utilities which has been considered in developing the cost estimates. Green and Purple options which bypass the North Richmond town centre would have lower impacts on utilities. Transport will consult with utility owners in the next stage of investigations.

7. Options assessment

7.1 Travel time savings

Traffic data was collected in December 2018 and March 2019 to understand the existing operation of the road network. Traffic growth within the study area was validated against Hawkesbury Council's forecast development growth including almost 2000 new homes west of the Hawkesbury River by 2035. Traffic growth in the broader Sydney area has been validated against land use projections in Transport's Sydney Travel model. Traffic is expected to grow in the study area by 44 per cent during peak periods.

The shortlisted options have been modelled in 2026, 2036 and 2046 to determine their traffic performance compared to the do minimum scenario which includes the three short term intersection improvements identified in the Richmond Bridge and approaches congestion study: (2013) and the Grose River Bridge. The outcomes of the traffic modelling are summarised below in terms of travel time savings on key routes, overall reduction in vehicle hours travelled in the study area road network, and effectiveness of routes in redistributing traffic. The modelling shows that the Green Option delivers the greatest traffic benefits.

7.1.1 2026

An assessment of travel time savings has been undertaken for two key routes (Figure 7-1 and Figure 7-2) in the study area reported in the peak direction of travel in both the AM and PM peak. For example in the AM peak, travel times are reported in a south east direction and in the PM peak, travel times are reported in the north west direction.

Figure 7-1 - Route 1 from Bells Line of Road, North Richmond to Windsor Street Richmond

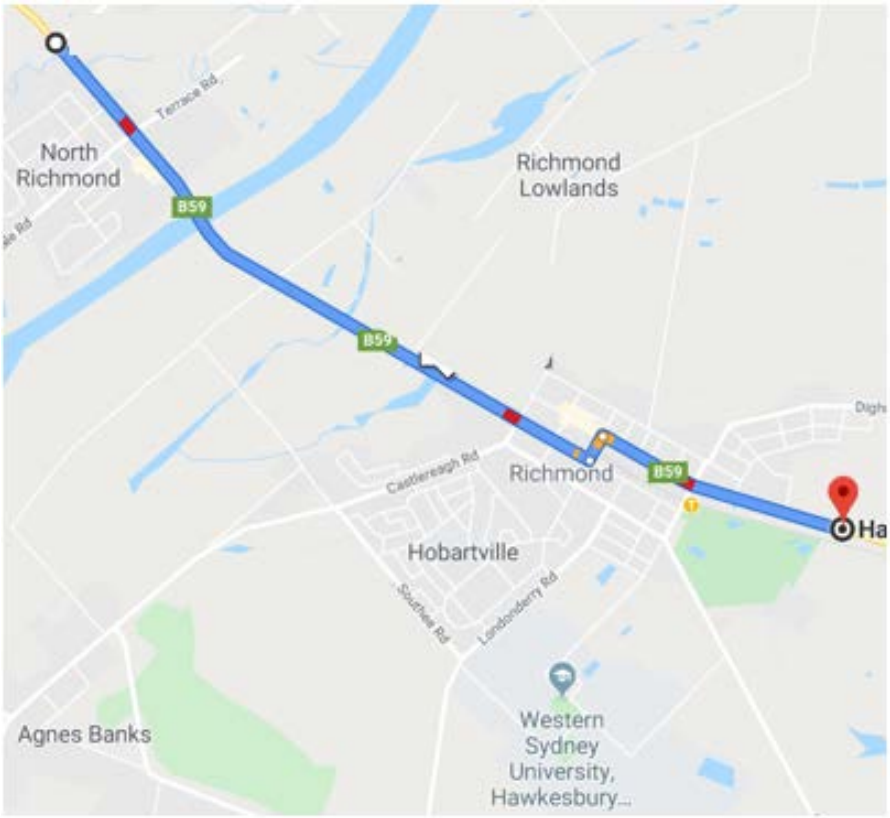
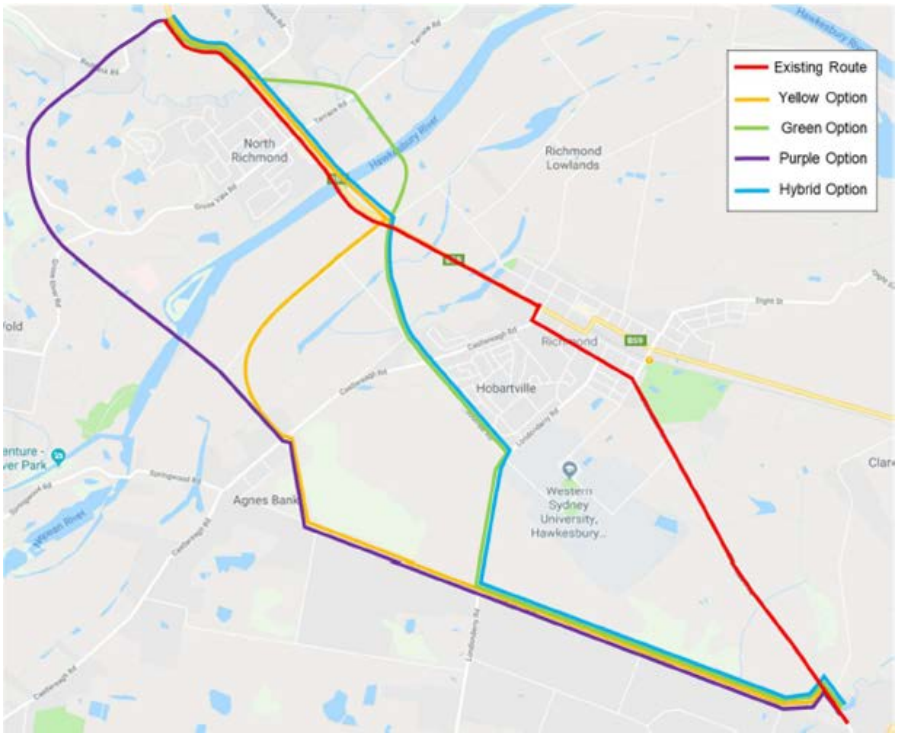


Figure 7-2 - Options Route from intersection of Redbank Road and Bells Line of Road to intersection of Blacktown Road and The Driftway



The lengths of the options routes and the existing route are:

- Existing Route: 10.7km
- Yellow: 13.7km
- Green: 12.3km
- Purple: 13.6km
- Hybrid: 12.0km

Table 7-1 and Table 7-2 show the travel times for each route for each option in the AM and PM peaks respectively. All options show substantial travel time savings, particularly in the AM peak with travel time savings of 11-12 minutes and three to four minutes in the PM peak. These travel time savings would be realised by private vehicles, buses, and freight.

Table 7-1 - AM Peak options travel time

Route	Do Min	Yellow	Green	Purple	Hybrid
Route 1	23:15	12:15	11:30	11:15	11:15
Options Route	25:45	15:45	14:45	14:30	14:00

Table 7-2 - PM Peak options travel time

Route	Do Min	Yellow	Green	Purple	Hybrid
Route 1	12:30	11:00	11:30	10:30	11:00
Options Route	17:45	14:30	13:30	13:45	13:45

Table 7-3 and Table 7-4 show the reduction in vehicle hours travelled (VHT) in the AM and PM peaks respectively across the study area road network. All options show a reduction in VHT in the AM peak ranging from 17-20 per cent and from 8-15 per cent in the PM peak.

Table 7-3 - AM Peak Options VHT

Route	Do Min	Yellow	Green	Purple	Hybrid
VHT	3857	3214 (-17%)	3099 (-20%)	3127 (-19%)	3170 (-18%)

Table 7-4 - PM Peak Options VHT

Route	Do Min	Yellow	Green	Purple	Hybrid
VHT	3212	2827 (-12%)	2959 (-8%)	2746 (-15%)	2840 (-12%)

Another measure of the effectiveness of each route option is how much traffic uses the new route compared to existing routes. Table 7-5 shows the percentage of traffic using each bridge crossing. The results show that the existing route between Richmond and North Richmond remains a strong desire line. The Green option which remains closer to the existing route and is shorter than the Purple option attracts a greater percentage of traffic.

Table 7-5 - Percentage of traffic on each bridge crossing

Bridge	Yellow (AM)	Yellow (PM)	Green (AM)	Green (PM)	Purple (AM0	Purple (PM)	Hybrid (AM)	Hybrid (PM)
Richmond Bridge	88%	86%	48%	40%	61%	62%	91%	89%
Bypass Bridge	-	-	43%	49%	32%	28%	-	-
Grose River Bridge	12%	14%	9%	11%	7%	10%	9%	11%

In 2026, the Yellow Option is the least effective at redistributing traffic away from the Richmond CBD, followed by the Purple Option, then Hybrid Option while the Green Option is the most effective (Table 7-6).

Table 7-6 - Redistribution of traffic away from Richmond CBD

Bridge	Yellow (AM)	Yellow (PM)	Green (AM)	Green (PM)	Purple (AM0	Purple (PM)	Hybrid (AM)	Hybrid (PM)
Kurrajong Road towards Richmond CBD	74%	71%	55%	61%	63%	63%	62%	58%
Bypass Route	26%	29%	45%	39%	37%	37%	38%	42%

7.1.2 2036

Table 7-7 and Table 7-8 show the travel times for each route for each option in the AM and PM peaks respectively. All options show substantial travel time with travel time savings of 12-14 minutes in the AM and PM peak. These travel time savings would be realised by private vehicles, buses, and freight.

Table 7-7 - AM Peak options travel time

Route	Do Min	Yellow	Green	Purple	Hybrid
Route 1	25:30	13:15	11:45	12:15	11:45
Options Route	28:15	16:30	15:00	14:30	14:15

Table 7-8 - PM Peak options travel time

Route	Do Min	Yellow	Green	Purple	Hybrid
Route 1	18:00	11:30	11:45	11:00	11:15
Options Route	26:00	14:45	14:15	14:00	14:15

Table 7-9 and Table 7-10 show the reduction in vehicle hours travelled (VHT) in the AM and PM peaks respectively across the study area road network. All options show a reduction in VHT in the AM peak ranging from 21-25 per cent and from 22-23 per cent in the PM peak.

Table 7-9 - AM Peak Options VHT

Route	Do Min	Yellow	Green	Purple	Hybrid
VHT	4671	3703 (-21%)	3486 (-25%)	3643 (-22%)	3589 (-23%)

Table 7-10 - PM Peak Options VHT

Route	Do Min	Yellow	Green	Purple	Hybrid
VHT	4097	3173 (-23%)	3179 (-22%)	3139 (-23%)	3154 (-23%)

Table 7-11 shows the percentage of traffic using each bridge crossing. The results show that the Green option which remains closer to the existing route and is shorter than the Purple option continues to attract a greater percentage of traffic.

Table 7-11 - Percentage of traffic on each bridge crossing

Bridge	Yellow (AM)	Yellow (PM)	Green (AM)	Green (PM)	Purple (AM0	Purple (PM)	Hybrid (AM)	Hybrid (PM)
Richmond Bridge	89%	87%	45%	41%	64%	65%	90%	90%
Bypass Bridge	-	-	46%	47%	29%	26%	-	-
Grose River Bridge	11%	13%	9%	12%	7%	9%	10%	10%

In 2036, the Yellow Option is the least effective at redistributing traffic away from the Richmond CBD, followed by the Purple Option, then Hybrid Option while the Green Option is the most effective (Table 7-12).

Table 7-12 - Redistribution of traffic away from Richmond CBD

Bridge	Yellow (AM)	Yellow (PM)	Green (AM)	Green (PM)	Purple (AM0	Purple (PM)	Hybrid (AM)	Hybrid (PM)
Kurrajong Road towards Richmond CBD	74%	71%	55%	61%	63%	63%	62%	58%
Bypass Route	26%	29%	45%	39%	37%	37%	38%	42%

7.1.3 2046

Table 7-13 and Table 7-14 show the travel times for each route for each option in the AM and PM peaks respectively. All options show substantial travel time with travel time savings of 11-18 minutes in the AM peak and 18-20 minutes in the PM peak. These travel time savings would be realised by private vehicles, buses, and freight.

Table 7-13 - AM Peak options travel time

Route	Do Min	Yellow	Green	Purple	Hybrid
Route 1	29:15	18:15	13:00	17:30	17:15
Options Route	32:15	21:30	14:45	16:00	18:45

Table 7-14 - PM Peak options travel time

Route	Do Min	Yellow	Green	Purple	Hybrid
Route 1	28:30	12:00	13:30	14:00	12:00
Options Route	34:15	16:45	14:15	16:30	15:00

Table 7-15 and Table 7-16 show the reduction in vehicle hours travelled (VHT) in the AM and PM peaks respectively across the study area road network. All options show a reduction in VHT in the AM peak ranging from 26-42 per cent and from 45-53 per cent in the PM peak. The Green option achieves the greatest travel time savings by providing an effective bypass of North Richmond town centre and particularly the traffic signals at the intersection of Bells Line of Road and Grose Vale Road.

Table 7-15 - AM Peak Options VHT

Route	Do Min	Yellow	Green	Purple	Hybrid
VHT	7422	5500 (-26%)	4331 (-42%)	5155 (-31%)	5228 (-30%)

Table 7-16 - PM Peak Options VHT

Route	Do Min	Yellow	Green	Purple	Hybrid
VHT	8377	4647 (-45%)	3952 (-53%)	4301 (-49%)	4032 (-52%)

Table 7-17 shows the percentage of traffic using each bridge crossing. The results show that the Green option which remains closer to the existing route and is shorter than the Purple option

attracts a greater percentage of traffic. By 2046, with forecast traffic growth in the network, the existing Richmond Bridge would be operating at capacity with the Purple option and additional upgrades would be required.

Table 7-17 - Percentage of traffic on each bridge crossing

Bridge	Yellow (AM)	Yellow (PM)	Green (AM)	Green (PM)	Purple (AM0	Purple (PM)	Hybrid (AM)	Hybrid (PM)
Richmond Bridge	87%	84%	39%	37%	59%	57%	89%	89%
Bypass Bridge	-	-	52%	51%	32%	29%	-	-
Grose River Bridge	13%	16%	10%	12%	9%	14%	11%	11%

In 2046, as travel times increase through Richmond CBD, all bypass options become more attractive than in previous years. The Yellow Option continues to be the least effective at redistributing traffic away from the Richmond CBD, followed by the Purple Option while the Hybrid Option and Green Options are the most effective (Table 7-18).

Table 7-18 - Redistribution of traffic away from Richmond CBD

Bridge	Yellow (AM)	Yellow (PM)	Green (AM)	Green (PM)	Purple (AM0	Purple (PM)	Hybrid (AM)	Hybrid (PM)
Kurrajong Road towards Richmond CBD	65%	63%	49%	43%	59%	60%	50%	43%
Bypass Route	35%	37%	51%	57%	41%	40%	50%	57%

7.1.4 The Driftway

All options would result in increased traffic volumes on The Driftway. While the traffic volumes would not be sufficient to require additional lanes on The Driftway, safety improvements are proposed to manage the increase in traffic volumes such as pavement and intersection improvements. These improvements will be determined in consultation with Hawkesbury and Penrith City Councils in the next design phase and could be delivered as a first stage to provide early safety benefits.

7.2 Crash analysis

There were 246 crashes recorded in the study area between October 2013 and September 2018. The assessment of the crash data identified the following:

- 25 per cent of all crashes were right through (crash involving a vehicle turning right in front of an oncoming vehicle) incidents and 17 per cent were rear-end incidents
- A total of 3 fatalities and 192 injuries occurred over the five-year period

To determine the safety benefits associated with each project option, an analysis was conducted using crash data which includes the type of crash and the crash treatment reduction rates matrix. Crash treatment reduction rates were applied to the road user movement (RUM) codes from each crash location to estimate the expected reduction in crashes at that location.

The crash treatment reduction rates were dependent on the type of crashes occurring at the existing intersection and the proposed treatment, for example, installing a roundabout or installing traffic signals. This reduction factor was applied across each option depending on the type of treatments in each option.

For example, the priority intersection at The Driftway and Londonderry Road would be upgraded to a roundabout in all options. According to the crash treatment reduction rates matrix this is estimated to reduce adjacent-cross traffic crashes by 85 per cent. Based on analysis of the crash statistics, there have been 16 adjacent-cross traffic crashes at that intersection in the last five years. This means that the amount of adjacent-cross traffic cashes is estimated to be reduced by over 13 crashes over a five year period as a result of installing the roundabout. This methodology has been applied to all crash types across the network.

Table 7-19 shows the predicted reduction in crashes as a result of proposed intersection improvements along the route.

Table 7-19 - Decrease in crashes

Predicted reduction	Yellow	Green	Purple	Hybrid
Number of crashes reduced	26	29	23	29
Percentage decrease in crashes	13%	15%	12%	15%

7.3 Cost estimates

Transport prepared strategic cost estimates for each option. All cost estimates are preliminary estimates for comparative purposes and for use in the economic analysis and may be revised as part of further planning.

Options which bypassed North Richmond (Green and Purple) would be more costly to deliver. In addition, to improve flood resilience above the 1 in 5 chance per year flood level would substantially increase cost to raise embankments and increase bridge lengths. The cost of improving flood resilience for each option would increase with length of work required on the flood plain.

The options are ranked from lowest cost to highest cost below.

1. Hybrid
2. Yellow
3. Green
4. Purple

7.4 Economic analysis

We assessed the economic viability of the options by calculating a Benefit-Cost Ratio (BCR) for each option. A BCR is the ratio of the option's benefits compared to the option's costs. Cost and benefits are calculated over a 30-year period. The options are compared against the costs and operational performance of the 'do minimum' scenario. A BCR of one or greater indicates that the benefits of an option exceed total project construction costs.

The total project construction cost includes the capital as well as the operation and maintenance costs. The project benefits include:

- Vehicle travel time savings
- Vehicle operating cost savings
- Environmental externalities
- Crash cost reduction
- Asset residual benefits, which reflects the value of the asset at the end of the assessed period.

The results of the cost benefit analysis of bypass options are presented in Table 7-20.

Table 7-20 - BCRs

BCR	Yellow	Green	Purple	Hybrid
BCR	3.4	3.1	2.6	3.7

All options have a BCR above one meaning all options are economically viable. The Hybrid Option has the highest BCR of 3.7 and the Purple Option has the lowest BCR of 2.6. While the Green Option is more costly than the Hybrid Option, it delivers increased traffic benefits and has a strong BCR of 3.1.

7.5 Summary of value management workshop

The value management workshop was held on 12 March 2020, with the purpose to update the community representatives and other key project stakeholders on the status of the project and the options that have been developed to address project objectives. The workshop incorporated a systematic evaluation of each option against agreed project objectives and constraints to inform the selection of a preferred option.

During the workshop the participants were asked to consider the options in more detail to consider how well each alignment option performs against the agreed project objectives and constraints. The performance of options against the objectives/assessment criteria was scored on a scale of 1 to 5, with the best performing option scoring 5. The scale of scores below 5 was based on the relative performance compared to the best performing option. The results of the objectives assessment are shown in Table 7-24.

Table 7-21 - Value management workshop objectives assessment

Objective	Description	Yellow	Green	Purple	Hybrid	Comments
Maximise travel time savings and travel time reliability	The option should minimise travel time for all road users (private, public, freight)	4.0	5.0	4.5	4.5	Peak Hour VHT 2026-2046 **Base:** 31,593 **Yellow:** 23,064 **Green:** 21,006 **Purple:** 22,111 **Hybrid:** 22,013
Cater for future traffic demand	The option can cater for future traffic demand without the need for additional bridge capacity in 2046	5.0	5.0	0.0	5.0	**Yellow:** Does not require more bridge capacity **Green:** Does not require more bridge capacity **Purple:** requires more bridge capacity at existing bridge location by 2046 **Hybrid:** Does not require more bridge capacity
Improve connectivity between Bells Line of Road and Sydney's arterial road network	The options should formalise connections between Bells Line of Road and arterial roads. Reduce rat running on substandard local roads	-	-	-	-	All options improve connectivity. Does not differentiate the options.
Maximise Active Transport	The option should maximise active transport connections by providing direct desire line links between Richmond and North Richmond	4.0	1.0	1.0	5.0	Options which bypass do not provide direct connection across river between Richmond and North Richmond. Hybrid option provides efficient connection to University also, Yellow does not.
Minimise negative impacts on local businesses and	The option should minimise impacts from loss of passing trade in North Richmond. In Richmond options bypassing Richmond should remove	4.0	4.0	4.0	5.0	North Richmond businesses more reliant on passing trade. Yellow and Hybrid Options support continued passing trade in North Richmond (5/5).

Objective	Description	Yellow	Green	Purple	Hybrid	Comments
supports Council's town centres vision.	more traffic from Richmond to provide platform for revitalisation					Green and Purple divert traffic away from North Richmond. Green (3/5) more so than Purple (4/5) Richmond would benefit more from a bypass. All options bypass Richmond. Yellow provides less efficient bypass taking less traffic away (3/5). Purple takes more traffic out of Richmond (4/5), Green and Hybrid take most traffic out of Richmond (5/5)
Maximise safety improvements	The option should maximise crash cost savings	4.5	5	4.5	5	Hybrid and Green Option: 15% reduction Yellow and Purple Options: 12-13% reduction.
Maximise BCR	Provides greatest economic outcome	4.0	4.0	3.0	5.0	**Hybrid:** 5.1 **Green:** 4.5 **Yellow:** 4.5 **Purple:** 3.6 *BCRs have altered with changes to project costs
Maximise flood resilience	Maximise flood resilience within the available funding	-	-	-	-	Any option can be designed to the determined flood resilience. Does not differentiate the options.

Total score of Yellow is 25.5, Green is 24.0, Purple is 17.0 and Hybrid is 29.5.

The assessment found that the Hybrid Option scored the highest against the project objectives, followed by the Yellow and then Green Option. The purple option scored the lowest and was not considered to adequately achieve the project objectives.

Following the Value Management workshop, it was deemed that an active transport connection between Richmond and North Richmond was a critical part of the scope and could be provided if additional funding was available. Therefore both the Green and Purple Options could satisfy the active transport objectives and scores would increase to 28 and 20 respectively.

After the review of how well each alignment option performs against the agreed project objectives, participants assessed the options in terms of how they impacted on project constraints.

Constraints were considered in terms of whether or not they were critical constraints. For example, funding was considered a critical constraint as the project has a funding allocation of $250 million. Options that could not be delivered within the available funding were therefore not considered viable.

Other constraints were considered not critical as impacts to them could be compensated, mitigated, or offset. The first rule is to avoid, then minimise, then mitigate, then offset as a last resort.

The following colour coding was used:

Colour	Level of impacts on constraint
Black	Option does not achieve critical constraint.
Red	Option has major impacts on constraint, but constraint is not critical.
Yellow	Option has moderate impacts on constraint.
Green	Option has minor or no impacts on constraint.

The results of the constraints assessment are shown in Table 7-25.

Table 7-22 - Value management workshop constraints assessment

Constraint	Description	Critical	Yellow	Green	Purple	Hybrid	Comments
Utilities	Minimise impacts to existing utilities	No	Yellow	Green	Green	Yellow	Bypasses reduce utility risks
Biodiversity	Minimise impacts to Endangered ecological communities, coastal wetlands	No	Yellow	Green	Red	Green	EEC impacts: **Yellow:** 9.9ha **Green:** 5.9 ha **Purple:** 18.9ha **Hybrid:** 4.2ha
Noise	Minimise noise impacts to residential areas. Impacts on liveability were considered to be addressed in noise and urban design outcomes	No	Green	Yellow	Yellow	Yellow	Yellow avoids residential areas Green and Hybrid: Southee Road impacts Purple: Redbank and surrounds impacts
Property Impacts							
*Private	Minimise impact to properties. Full or Partial acquisition	No	Green	Yellow	Red	Green	**Yellow:** 25 properties (1 full, 24 partial) **Green:** 28 properties (6 full, 22 partial) **Purple:** 39 properties (7 full, 32 partial) (10 full, 29 partial to avoid ALC) **Hybrid:** 18 properties (2 full, 16 partial)
*Sporting facilities	Polo club, soccer club	No	Yellow	Yellow	Green	Yellow	**Yellow:** Partial impact to Colo Soccer Club fields, Killarney Polo Club (property not fields)

Constraint	Description	Critical	Yellow	Green	Purple	Hybrid	Comments
							Green: Impact to private polo fields, partial impact to Colo Soccer Club fields, partial impact to Killarney Polo Club (property not fields) **Purple:** no impact to sporting facilities **Hybrid:** Partial impact to Colo Soccer Club fields, Killarney Polo Club (property not fields)
*High capability land	Minimise impacts to high capability land that could be used for agriculture	No	Red	Red	Green	Yellow	High capability land impact **Yellow:** 14.6 ha **Green:** 16.4 ha **Purple:** 4.4 or 4.8 ha if ALC is avoided **Hybrid:** 10.8 ha
*Aboriginal Land Claims	Where land not in current use, ALC cannot be simply revoked	Yes	Green	Green	Green	Green	Only purple impacts on ALC. ALC could be avoided with additional cost and private property impacts
Aboriginal Heritage	Minimise impacts to Aboriginal sites	No	Yellow	Yellow	Red	Yellow	All options likely to have some impact on Aboriginal heritage/artefacts. Purple option impacts on Richmond Hill with potentially higher significance of impacts
Non-Aboriginal Heritage	Minimise heritage impacts (particularly State Heritage items, existing bridge, Hobartville)	No	Red	Green	Yellow	Yellow	**Yellow:** Bridge adjacent to existing SHR bridge (impact reduced by maximising separation), impacts to local item Bronte **Green:** No direct impacts, adjacent to state items Mountain View and Hobartville. Increases separation from existing bridge

Constraint	Description	Critical	Yellow	Green	Purple	Hybrid	Comments
							Purple: Adjacent to Bronte and impacts on local item Hill Crest. Maximises separation from existing bridge **Hybrid:** No direct impacts, Adjacent to existing SHR bridge (impacts reduced by increasing separation), Mountain View and Hobartville.
Urban design	Improves amenity in town centres, fits within built fabric and natural patterns. Impacts on liveability were considered to be addressed in noise and urban design outcomes.	No	Yellow	Red	Red	Red	**Yellow:** Widens through North Richmond (neg), new bridge adjacent to existing bridge (impact reduced by maximising separation) (neg), 3.3km work on floodplain (not major issue at 1:5 but worsens with increased height) (neg) **Green:** Avoids widening through North Richmond (pos) however impacts on green fields areas north of North Richmond including 3.1km floodplain (neg). Southee Road impacts reduced by maintaining vegetation (neg) **Purple:** Avoids widening through North Richmond (pos) however changes landscape through Grose Vale and impacts Redbank (neg), shortest floodplain work (pos) **Hybrid:** Widens through North Richmond (neg). New bridge adjacent to existing bridge (impact reduced by maximising separation) (neg), short floodplain work (pos). Southee Road impacts reduced by maintaining vegetation (neg)
Construct-ability	Minimise construct-ability risks - length of work in	No	Red	Yellow	Yellow	Yellow	**Yellow:** longest floodplain work risk (3.2km), widens through North Richmond and 6 intersection upgrades

Constraint	Description	Critical	Yellow	Green	Purple	Hybrid	Comments
	floodplain, interaction with live traffic						**Green:** long floodplain work (2.5km) Avoids widening through North Richmond, 8 intersections 3 new, 5 upgrades **Purple:** Shortest floodplain work. Avoids widening through North Richmond, 9 intersections, 3 new 6 upgrades **Hybrid:** Medium floodplain work, Widens through North Richmond, 6 intersections, 1 new, 5 upgrades
Available funding	Delivered within $250M budget	Yes	Green	Black	Black	Green	Yellow and Hybrid only options which can be delivered within budget

* indicates property impacts

Total numbers	Yellow Alignment	Green Alignment	Purple Alignment	Hybrid Alignment
Number of Greens	4	4	4	4
Number of Yellows	5	5	3	7
Number of Reds	3	2	4	1
Number of Blacks	0	1	1	0

The assessment at the time found that the Green and Purple options were not considered viable as they could not be delivered within the available funding. The Hybrid Option was identified as the optimum solution which could be delivered within the available funding as it delivered greater benefits than the Yellow Option.

The workshop recommended that further work is required to assess the proposed road parallel to Southee Road from a noise and visual amenity perspective prior to the Hybrid Option being adopted as the preferred option.

Community and stakeholder engagement has identified a preference for a bypass of both town centres. From the outcomes of the value management workshop and consultation, the Green Option (North Richmond Northern Bypass) was identified as the preferred option to deliver this outcome as it would achieve the highest travel time savings of all options, and the lowest environmental and property impacts of the options which would bypass both town centres.

7.6 Investigations following the value management workshop

Following the value management workshop, a preliminary assessment was made to determine if noise treatments would be required along the bypass parallel to Southee Road. The preliminary assessment determined that a 3.5 metre noise treatment would likely be required to mitigate the impacts of traffic noise on Southee Road residents.

Sections of Southee Road have dense vegetation opposite (Figure 7-3) while others have views over open paddocks with the Blue Mountains visible in the distance (Figure 7-7).

Figure 7-3 - Existing Southee Road looking west with views of dense vegetation

Figure 7-4 - Existing Southee Road looking west with views over open paddocks

Visuals of a potential noise treatment for the densely vegetated section of Southee Road is shown in Figure 7-5. The image shows the noise wall set behind existing mature vegetation on Southee Road so the avenue of trees can remain where possible.

Figure 7-5 - Potential noise mitigation treatments

A visual for a potential noise treatment for the section of Southee Road which is less vegetated with more open views is shown in Figure 7-6. A partially transparent noise wall would allow for

longer range views toward the Blue Mountains to be retained with lower lying vegetation screening the view towards the bottom concrete section of the noise wall.

Figure 7-6 - Potential noise mitigation treatments

Further design, environmental assessment and engagement with Southee Road residents, University of Western Sydney and Hawkesbury City Council will occur during the next phase of design to determine a preferred noise mitigation and visual treatment.

8. Conclusion

Green

The Green Option is considered the preferred option as it delivers the community and stakeholder preference for a bypass of Richmond and North Richmond town centres providing a platform for amenity improvements and revitalisation of the town centres. The Green Option has the highest travel time savings of all options and caters for future traffic demands providing a long term solution to traffic congestion in the area. Of the options that bypass both town centres, it has lower property and environmental impacts and avoids direct impacts to heritage listed properties.

Hybrid

While the Hybrid Option is more efficient than the Yellow and Purple Options it does not deliver as high travel time savings as the Green Option. Similar to the Yellow Option, it would require upgrades through North Richmond town centre and therefore does not deliver on the community and stakeholder preference for bypasses of both town centres.

Yellow

While the Yellow option delivers substantial travel time savings, it has the lowest savings out of all the options as it has a less efficient (1.7 kilometre longer) connection across the floodplain towards existing arterial roads such as Castlereagh Road and therefore is less effective at reducing traffic in Richmond town centre. It also impacts on the locally listed heritage property Bronte.

Purple

The Purple Option has the highest cost and the lowest economic performance. While it bypasses both town centres, the Purple option takes a longer route to bypass North Richmond and therefore does not attract adequate traffic to the bypass meaning that by 2046, more capacity would be required at the existing bridge location. Therefore this option does not achieve the traffic objectives of the project.

The Purple Option also has the greatest impacts on biodiversity and private property.

8.1 Recommendation

The Green Option is recommended as the preferred option to progress to the next phase of design and environmental assessment.

Glossary

Term	Definition
Aboriginal Land Claims	Land transfers to Aboriginal people, recognising the need of Aboriginal people for land and acknowledging that land for Aboriginal people in the past was progressively reduced without compensation.
Accessibility	The potential ability of an individual or group to reach a destination. It is distinguished from mobility which is the propensity of that individual or group to make a journey.
Average Daily Traffic (ADT)	The average number of vehicles which pass a given point on the road, in both directions, on a day. Daily variations during the week are averaged to obtain the ADT.
Benefit-Cost Ratio (BCR)	A ratio of benefits compared to costs. A BCR of one or greater indicates that the benefits of a project exceed total project construction costs.
Casualty Crash Rates	The above which involve a treated injury.
Crash rates	The number of reported crashes on a road as a proportion of the traffic usually expressed as per 100 million vehicle kilometres.
Governance	The process put in place to achieve, in this context, the construction of a road project.
Heavy vehicles	Classes 3-12 under the Austroads' vehicle classification system. Does not include short vehicles (e.g. cars, motorbikes or short vehicles towing another)
Levels of Service (LoS)	A qualitative descriptor of the road environment describing the ability of vehicles to manoeuvre. 'A' represents complete freedom to accelerate or manoeuvre. "F' represents high levels of congestion.
Project scope	The geographic and physical description of a road project during the planning process. Scope may vary with further project development.
Stakeholder	An individual or organisation potentially affected by, or who have an interest in, a proposed project.
Sustainability	The concept that, in undertaking current actions (e.g. building a road) there should be positive net benefits for future generations.
Traffic Modelling	A process that predicts future traffic volumes based on trip generation, destination attractiveness and geographic options to make those trips.

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