3. Part 3 - Long-term options study

3.1. Introduction

The Part 3 study was conducted by SMEC (Australia) Pty Ltd. It investigated current and projected future traffic congestion in the study area and was required to identify and recommend an option to address traffic congestion in the long-term, from 2021 to 2036.

Before the Part 3 study began, proposals resulting from the Part 2 study were presented to the public at a community workshop. Information and comments gathered at this workshop were taken into consideration by the Part 3 study.

This study also took into account the potential of the identified options to improve the level of flood immunity across the flood plain and the bridge.

3.1.1. Study area

The study area is shown at Figure 2 at page 4 of this report.

As part of the initial long-term option development process for the Part 3 study, the study area was divided into four distinct sections (or precincts):

- Section 1: March Street precinct
- Section 2: Kurrajong Road / Old Kurrajong Road / Yarramundi Lane precinct
- Section 3: Richmond Bridge precinct
- Section 4: North Richmond precinct

3.2. Option selection methodology

3.2.1. Strategic concept option development

The timeframe for the implementation of a long-term preferred option is 2021 to 2036.

Connection with other local strategic projects

A separate planning investigation into the long-term upgrade of the Bells Line of Road corridor is being conducted in parallel with this study. The implementation of the long-term preferred option and its relationship to potential future upgrades to Bells Line of Road has been considered as part of this study.

Based on the traffic modelling undertaken as part of the project, it is clear that even with a future Bells Line of Road upgrade or a developer funded Grose River Bridge crossing it will still be necessary to upgrade the corridor between Richmond and North Richmond, as identified in this study.

3.2.2. Strategic option development process

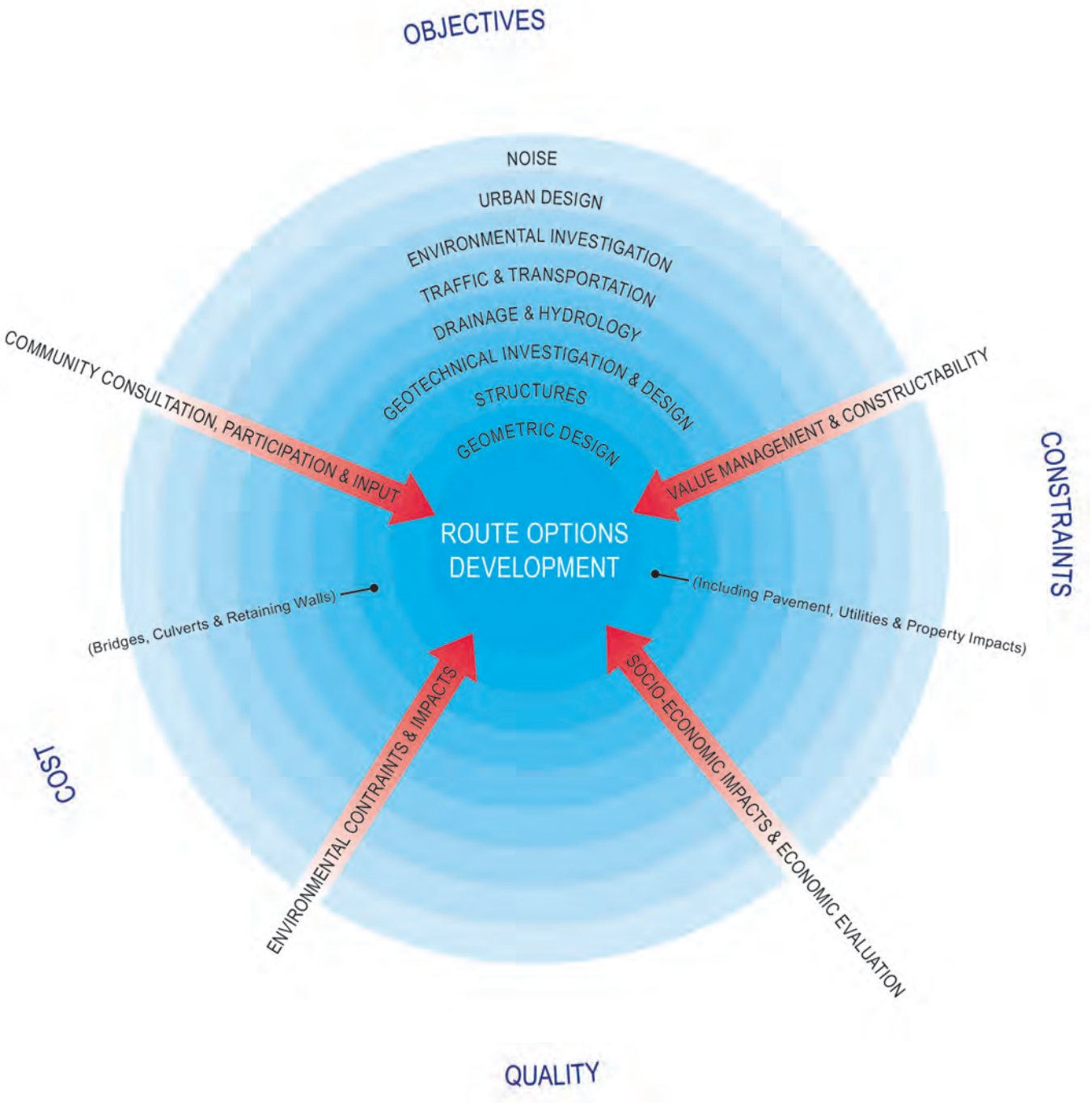


Figure 9 - Strategic concept option development process

The information collected in the process of identifying the constraints associated with the corridor allowed for the identification of a number of road and bridge alignment options, including:

- Contraflow traffic management options
- Widening the existing carriageway and bridge by two lanes
- New bridges at a higher elevation to improve flood immunity
- Additional lanes on the eastbound carriageway and / or the westbound carriageway.

Options that bypass the townships of Richmond and North Richmond were not considered as these will be examined as part of the overall transport planning for the north-west region of Sydney.

The most viable options were identified and further refined to produce the following strategic concept options:

Option 1 Contraflow traffic management together with an additional lane from Yarramundi Lane to Grose Vale Road and widening the existing bridge to accommodate it.

Option 2 Widening the existing bridge to provide two additional lanes and a shared user path to provide two additional lanes for the eastbound carriageway.

Option 3 A new bridge five metres downstream of, and at the same level as, the existing bridge, to provide two additional lanes for the eastbound carriageway.

Option 4 A new bridge 25-50 metres downstream of the existing bridge, constructed at a 1:5 year ARI flood level, to provide two additional lanes for the eastbound carriageway. This option would provide a 1:5 year ARI flood immunity for the road formation.

Option 5 A new bridge 25-50 metres downstream of the existing bridge, constructed at a 1:20 year ARI flood level, to provide two additional lanes for the eastbound carriageway. This option would provide a 1:20 year ARI flood immunity for the road formation.

Option 6 A new bridge 25-50 metres downstream of the existing bridge, constructed at a 1:100 year ARI flood level, to provide two additional lanes for the eastbound carriageway. This option would provide a 1:100 year ARI flood immunity for the road formation.

All the above options would involve minor intersection adjustments (widening) in the Richmond and North Richmond precincts.

3.2.3. Short listing of options

Options 2 and 6 were not selected for the shortlist. These two options were considered less desirable on the basis of the:

- Impacts on the heritage value of the existing bridge
- Structural limitations of the existing bridge
- Severity of the impacts on properties on the North Richmond side of the bridge
- Impacts on the high voltage power assets within the corridor
- Requirement to widen both sides of Kurrajong Road which would involve complex staging and make the existing traffic issues worse during construction.

Consultation with the State Emergency Service (SES) and HCC commented that the impacts of a 1:5 year, 1:10 year and 1:20 year ARI flood event and the flood access issues should be addressed with regard to the bridge and approaches. It was established that the routes to be considered should not be flood evacuation routes for either the SES or HCC.

Options involving the full grade separation of existing intersections such as Grose Vale Road / Bells Line of Road were not considered due to the following reasons:

- Traffic volumes can be catered for by at grade intersections and can still provide an adequate LoS; and
- The preliminary economic assessment of the capital cost of grade separation interchanges indicated that this is not economically justifiable.

The final short list of strategic options is:

- Option A (previously Option 1)
- Option B (previously Option 3)
- Option C (previously Option 4)
- Option D (previously Option 5)

3.2.4. Technical investigations

The following technical studies were undertaken to identify the project constraints and provide a technical assessment of the route options. These studies were designed to address the project objectives and enable the route options to be assessed against the assessment criteria.

- Strategic traffic modelling using BTS data and the EMME/2 modelling software was performed to assess the various scenarios for possible future development and infrastructure provision. Key intersections were modelled using SIDRA to assess their likely performance. When the preferred option is chosen a Paramics model will be prepared for it to model the operation of the corridor and assess traffic flows
- Flood modelling using a RUBICON model of the Hawkesbury-Nepean River was performed to provide an understanding of the behaviour of flows across the flood plain in times of flood. As a result of this, the drainage structure requirements, based on a need to meet an assumed acceptable afflux of 200 millimetres across the flood plain, could be determined
- A series of environmental studies were undertaken to provide an understanding of the constraints and opportunities in relation to the ecology, site contamination, noise and air quality impacts and heritage (Aboriginal and non-Aboriginal) within the project area
- Community consultation in September and October 2012 provided the opportunity for community members to view the four strategic concept options and provide comments. These comments were then taken into consideration during the process of refining and assessing the options to determine the preferred option
- Urban and landscape design parameters and constraints provided the guiding principles in the development of the route options
- Dial Before You Dig (DBYD) records were used to identify utility assets in the project area and determine utility locations to be considered for each option
- Strategic engineering designs for the short listed route options were prepared to identify construction staging, road safety and alignment issues and opportunities to be considered in the selection of the preferred option. More refined engineering drawings were prepared for the four viable route options to ensure that they are both able to be constructed and to show a realistic footprint
- Preliminary geotechnical investigations of the options corridors under consideration were undertaken
- Strategic cost estimates were prepared for the four options.

3.2.5. Technical assessment methodology

The technical assessment methodology, Outline of Infrastructure Australia's Prioritisation Methodology, was used. This methodology was developed by Infrastructure Australia to objectively assess existing and future projects for possible inclusion in their Infrastructure Priority List. The process involves the following steps:

1. Goal definition – set targets / performance criteria
2. Problem identification – identify areas of growth, congestion and opportunities for reduced travel time
3. Problem assessment – preliminary studies
4. Problem analysis – analyse constraints identified during preliminary studies
5. Option generation – develop route options
6. Solution assessment – assess route options to identify a preferred route
7. Solution prioritisation - once a preferred route is identified.

3.2.6. Technical assessment criteria

The set of technical assessment criteria established for the project are based on those presented in Table B.2 in the Australian Transport Council's National Guidelines for Transport System Management in Australia (2006). The criteria were also described to assist in the decision making during the assessment process.

The technical assessment criteria were developed to reflect the goals and objectives of the project. The criteria were then categorised corresponding to the relevant project objective.

Table 11 on the following page lists the criteria by project objective, with a brief description to clarify the scope. The MCA was used in the process of refine the options to four viable options.

Note: The criteria are not listed in order of priority.

Table 11 - Technical assessment (MCA) criteria

Category	*Evaluation criteria*	*Description*
Safety	Improves road safety for all road users along the corridor	A qualitative comparison of the overall improvement to safety for each option. Key factors to consider are: divided carriageways for 80 km/h zones, protected turn bays, signal control with pedestrian crossing facilities at intersections, safety barriers, off road shared paths. A higher performing option will be one that provides the greatest improvement to safety.
	Improves safety along and across the corridor for vulnerable road users (pedestrians and cyclists)	Provision of off road shared path facilities and safer crossing locations (mid-block and with signal control at intersections). A higher performing option will be one that provides the greatest improvement to safety.
Road capacity	Reduces congestion along the corridor, particularly in morning and afternoon peak periods	A qualitative assessment of the improvement to congestion provided by the option when compared against a Do nothing scenario. A higher performing option will be one that provides the best possible reduction in traffic congestion.
	Improves the travel time along the corridor	A qualitative assessment of the improvement to travel time provided by the option when compared against a Do nothing scenario. A higher performing option will be one that provides the best possible improvement to travel time.
	Improves access (and safety) onto and off the corridor	Minimising the restriction of turning movements onto and off the corridor and providing safer facilities (TCS or sheltered turning bays). A higher performing option would be one that provides the greatest improvement to safety. A dedicated right turn bay for eastbound traffic on Kurrajong Road to access Old Kurrajong Road / Yarramundi lane will also be provided.
Visual and landscape	Visual impact of the proposed bridge structures	Provides an indication of the visual impact of the proposed bridge options when compared to the current situation. Higher performing options would provide a design that either maintains a view downstream of the river (from the existing bridge) or provides a bridge structure that minimises any disruption of this view. A higher performing option is one that would have the least visual impact on the built and natural attributes of the corridor.

Category	*Evaluation criteria*	*Description*
Noise	Extent (percentage of grade) and length (km) of steep grades (ie n excess of 3 per cent)	There is a correlation between this criterion and the occurrence of (max) noise levels due to truck noise compression braking associated with steeper grades. A higher performing option will have a shorter overall length of steep grades.
	Noise impacts on community facilities	These include schools, places of worship etc. A higher performing option will impact les on community facilities.
Local economic	Number of existing businesses to be acquired ie those located within the proposed route corridor.	This indicates less economic disruption within the study area. A higher performing option will have a lower number of businesses affected.
	Extent (land area) of property and land acquisition	A higher performing option will have less impact and requirement for property acquisition therefore have a lower area of land acquisition. However, residential /business / commercial land will be more valuable than rural / flood plain land. As a result a higher performing option will also have less impact on residential /business / commercial land.
	Area (ha) of high and medium potential for archaeological deposits directly affected	A higher performing option will have a lower area (ha) affected.
Environ-ment and cultural heritage	Number and area (ha) of high and medium value remnant and regenerated vegetation or habitat likely to be affected	This criterion accounts for potential affects to flora and fauna including threatened species and territorial animals. Where riparian flora and fauna has been mapped, this will also be included. A higher performing option will have aa lower number and area (ha) impacted.
	Number of high and medium value sites of cultural heritage significance (Aboriginal and non-Aboriginal) directly affected	The cultural heritage evaluation includes Aboriginal and non-Aboriginal sites. A higher performing option will have a lower number and therefore indicate a lower disturbance of cultural heritage sites.

Category	Evaluation criteria	Description
Engineering and cost	Relative cost of options	Route options costs will represent the likely total project cost for each option, including allowances for design, project development costs incurred by RMS, land acquisition, mitigation measures etc. A higher performing option will have a lower cost.
	Constructability	This criteria needs to be assessed qualitatively. It includes aspects of construction techniques including traffic management, movement of construction materials through the study area, ease of bridge construction, noise, dust, environmental management strategies, geological considerations and construction program. A higher performing option will be one that is perceived to be a more constructible design.
	Level of flood immunity provided for a 1:5 year ARI	Improving the flood immunity and maintaining flood access along the corridor for a 1:5 year ARI flood event. A higher performing option will have a greater length (km) of flood immunity for a 1:5 year ARI flood event.
	Level of flood immunity provided for a 1:20 year ARI	Improving the flood immunity and maintaining flood access along the corridor for a 1:20 year ARI flood event. A higher performing option will have a greater length (km) of flood immunity for a 1:20 year ARI flood event.
	Maintenance (and ease of maintenance) of bridge structures	This is a qualitative assessment for each option against the degree and ease of maintenance of bridge structures. A higher performing option will be one that will be easier to maintain.
	Maintenance (and ease of maintenance) of road carriageway	This is a qualitative assessment for each option against the degree and ease of maintenance of the road carriageway and associated structures. A higher performing option will be one that will be easier to maintain.

3.2.7. Multi-Criteria Analysis (MCA)

Together with the value management workshop, technical studies and inputs from community consultation, the MCA is one of the tools used to assess the four options in order to recommend a preferred option. The MCA provides for the assessment of a wide range of project attributes for each route option.

The outcomes from each of the technical studies is used to perform the MCA. Although the MCA was primarily applied during Step 6 – Solution assessment, the MCA criteria were considered throughout the entire project, including the short listing of options.

3.3. Description of the short listed options

The following summary describes the four short listed options.

All four short listed options provide for:

- Two lanes in the peak direction during peak periods between Richmond and North Richmond. This would be achieved through a mix of peak hour on-street parking restrictions and the provision of a new two-lane carriageway between Chapel Street and Old Kurrajong Road / Yarramundi Lane
- Signalised intersections with right turn bays and pedestrian crossing facilities, except at West Market Street and Old Kurrajong Road / Yarramundi Lane
- A three metre wide shared use path between Richmond and North Richmond.

3.3.1. Option A

This option involves three-lane contraflow traffic management to provide two lanes in the peak direction and one lane in the off peak direction.

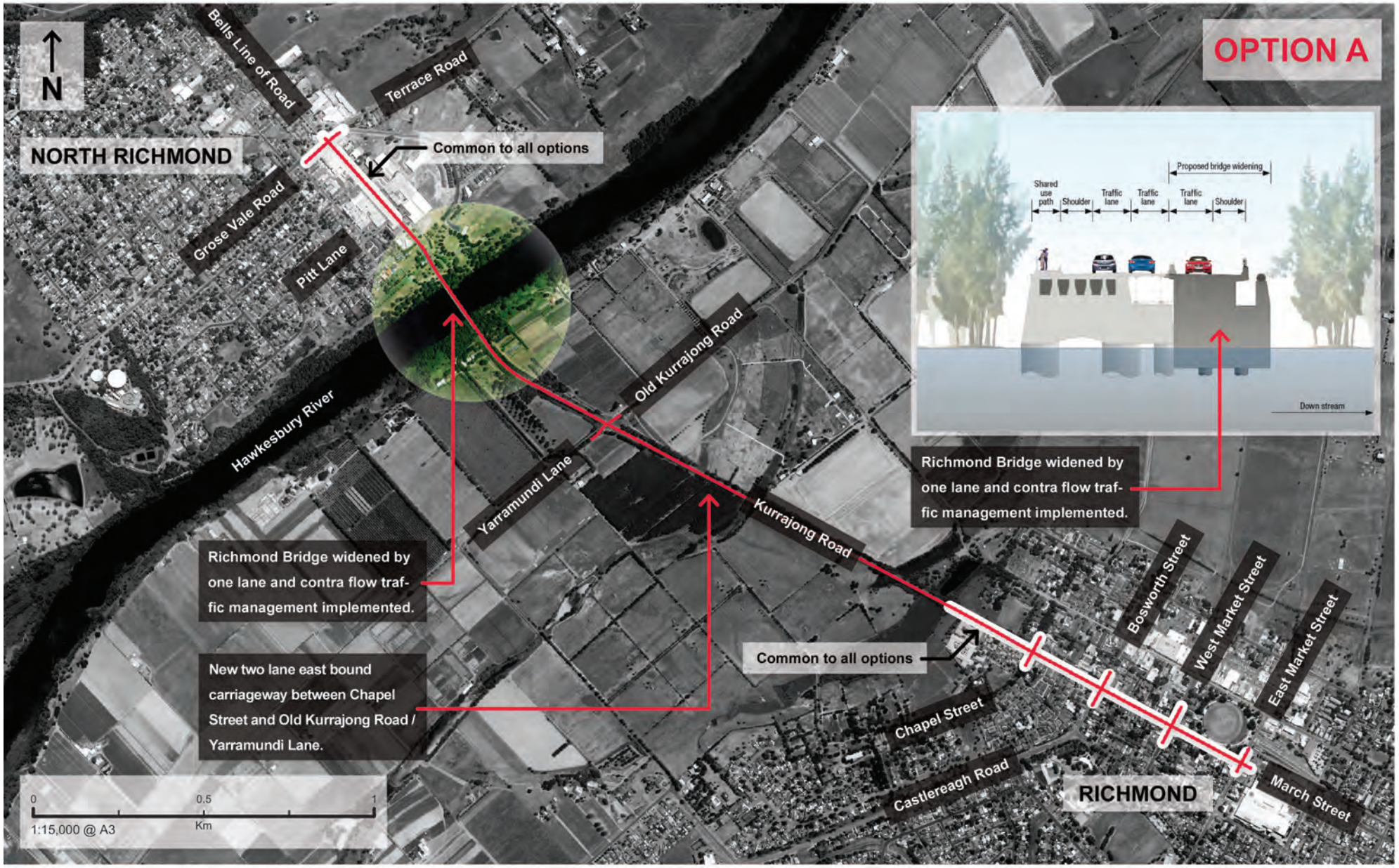
This would involve:

- Widening the existing bridge downstream to accommodate three travel lanes across the bridge
- Adding two lanes to the Kurrajong Road eastbound carriageway between Chapel Street and Old Kurrajong Road / Yarramundi Lane to provide four lanes (two lanes in each direction)
- Contraflow traffic management from approximately 50 metres west of Old Kurrajong Road / Yarramundi Lane to approximately 120 metres east of Pitt Lane, including across the bridge
- No change to the current level of flood immunity.

Figure 10 illustrates the view of the bridge in Option A from the existing bridge.

Figure 11 on the following page provides an aerial view of Option A.

Figure 10 - Option A - View of the new bridge from the existing bridge



Source - Vector Backdrop Data © MDS 2012 **Imagery -** SKM provided by RMS **Cross Section -** Tract

Figure 11 - Option A - Aerial view

3.3.2. Option B

This option would provide a total of four lanes, two in each direction, with the additional bridge constructed at the same level as the existing bridge and no change to the current level of flood immunity.

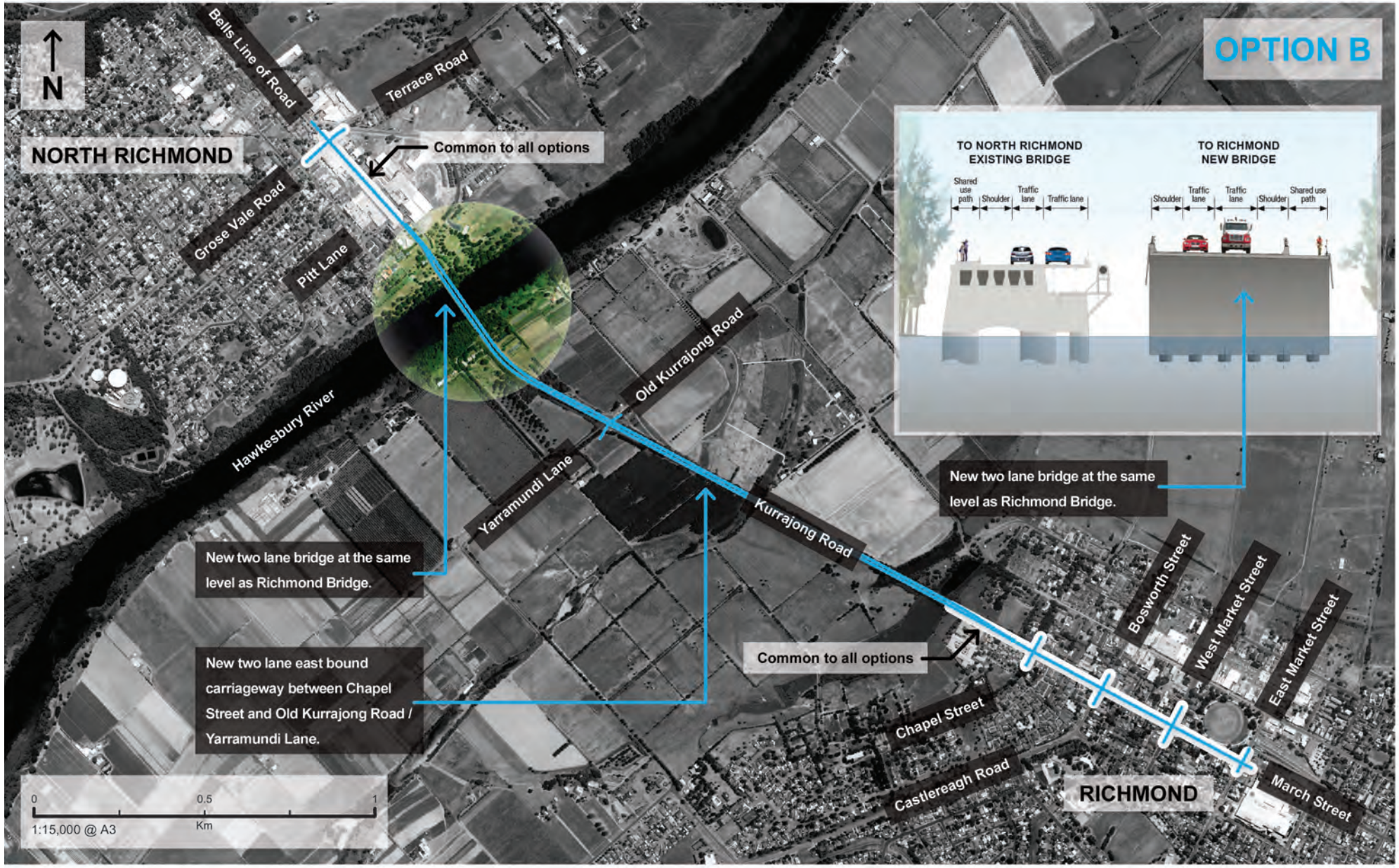
This would involve:

- Constructing a new two-lane bridge five metres downstream from the existing bridge constructed at the same level as the existing bridge
- Retaining the existing bridge
- Adding two lanes to the Kurrajong Road eastbound carriageway between Chapel Street and Old Kurrajong Road / Yarramundi Lane to provide four lanes (two lanes in each direction).

Figure 12 illustrates the view of the bridge in Option B from the existing bridge.

Figure 13 on the following page provides an aerial view of the Option B.

Figure 12 - Option B - View of the new bridge from the existing bridge



Source - Vector Backdrop Data © MDS 2012 **Imagery -** SKM provided by RMS **Cross Section -** Tract

Figure 13 - Option B - Aerial view

3.3.3. Option C

This option would provide a total of four lanes, two in each direction, with the additional eastbound bridge and carriageway constructed at a level to provide 1:5 year ARI flood immunity.

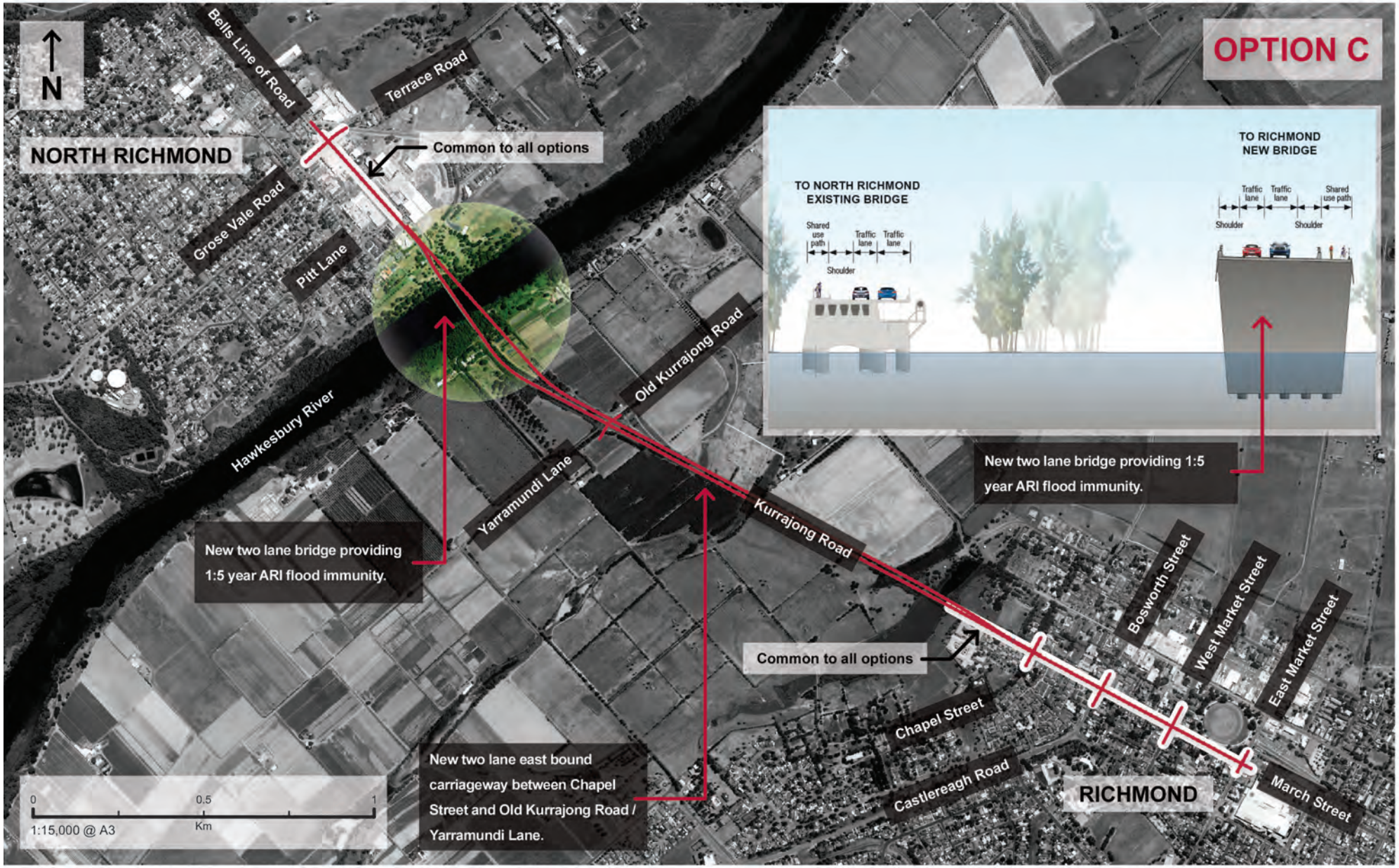
This would involve:

- Constructing a new two-lane bridge 25-50 metres downstream from the existing bridge
- Retaining the existing bridge
- Adding two lanes to the Kurrajong Road eastbound carriageway between Chapel Street and Old Kurrajong Road / Yarramundi Lane to provide four lanes (two lanes in each direction).

Figure 14 illustrates the view of the bridge in Option C from the existing bridge.

Figure 15 on the following page provides an aerial view of the Option C.

Figure 14 - Option C- View of the new bridge from the existing bridge



Source - Vector Backdrop Data © MDS 2012 **Imagery -** SKM provided by RMS **Cross Section -** Tract

Figure 15 - Option C - Aerial view

3.3.4. Option D

This option would provide a total of four lanes, two in each direction, with the additional eastbound bridge and carriageway constructed at a level to provide 1:20 year ARI flood immunity.

This would involve:

- Constructing a new two-lane bridge 25-50 metres downstream from the existing bridge
- Retaining the existing bridge
- Adding two lanes to the Kurrajong Road eastbound carriageway between Chapel Street and Old Kurrajong Road / Yarramundi Lane to provide four lanes (two lanes in each direction)
- Removing some turning movements at Old Kurrajong Road / Yarramundi Lane.

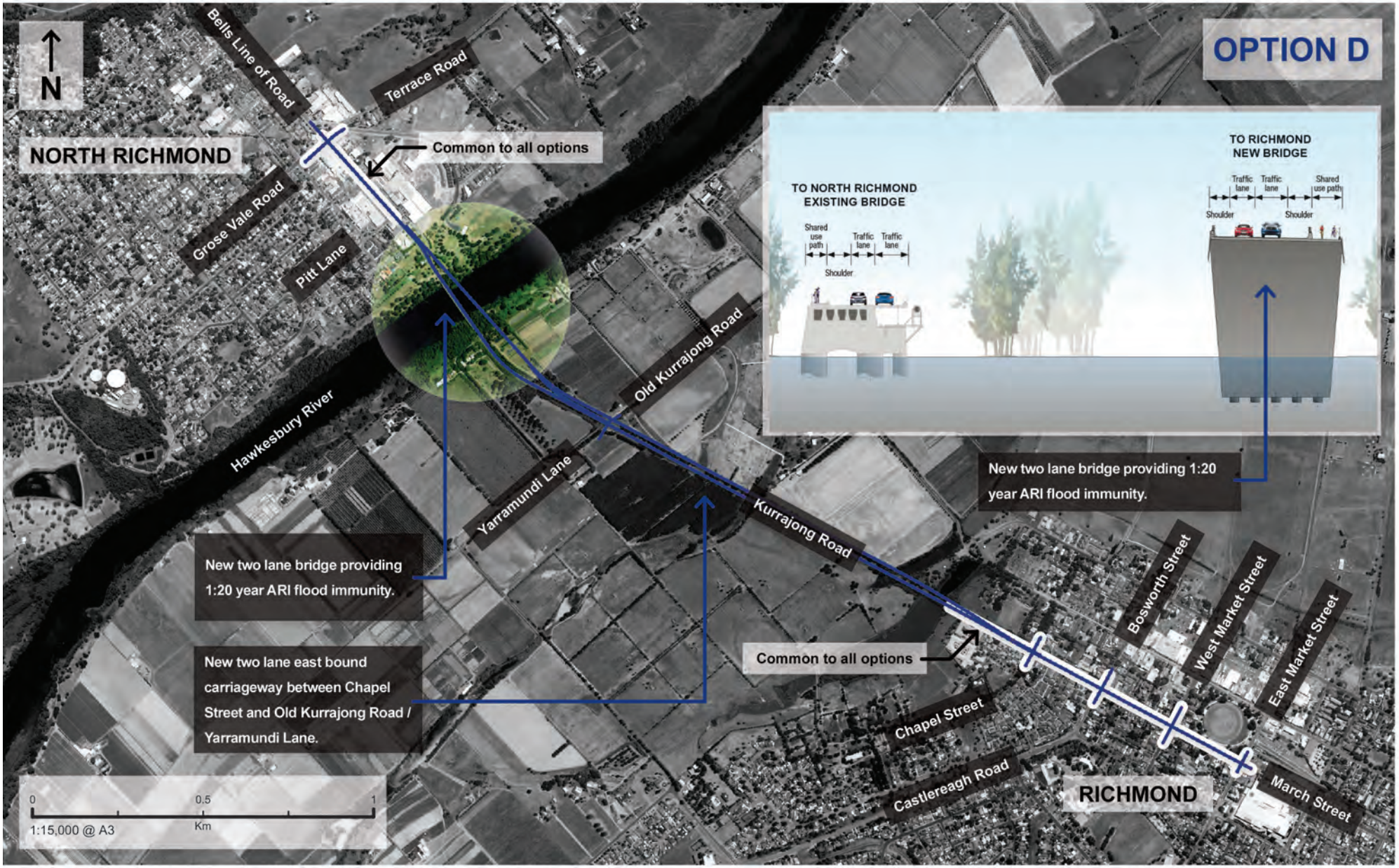
The following movements will not be possible at the intersection of Old Kurrajong Road and Yarramundi Lane with Kurrajong Road:

- Right turn from Old Kurrajong Road into Kurrajong Road to head west
- Right turn from Kurrajong Road into Old Kurrajong Road to head north
- Through movements from Old Kurrajong Road across Kurrajong Road and into Yarramundi Lane and vice versa.

Figure 16 illustrates the view of the bridge in Option D from the existing bridge

Figure 17 on the following page provides an aerial view of the Option D.

Figure 16 - Option D - View of the new bridge from the existing bridge



Source - Vector Backdrop Data © MDS 2012 **Imagery -** SKM provided by RMS **Cross Section -** Tract

Figure 17 - Option D - Aerial view

3.3.5. Sub option development

Options A, B, C and D are the four key options that form the basis of the detailed strategic concept investigations and development to improve congestion. Options C and D, in particular, also provide improvement to flood immunity.

However, as part of the project development process and following requests from key project stakeholders, several sub-options were also considered. The development and assessment of these sub-options was subject to less investigation than the four key options.

Option A1

This option involves the addition of two lanes across the flood plain between Chapel Street and Old Kurrajong Road / Yarramundi Lane for all options. This will provide four lanes (two lanes in each direction) across the flood plain to improve traffic flow and reduce congestion along this section of the corridor. This addition was investigated and incorporated into Option A. All four key options now provide four travel lanes along this section.

Option A2

This is a hybrid of Option A and provides for the construction of an additional two lanes on the existing bridge, as opposed to the additional single lane proposed for Option A. The construction of two additional lanes on the existing bridge presents some challenges and constraints when compared to the other options, particularly with regard to cost, constructability and maintenance. This sub option was not progressed beyond this level of assessment due to issues with constructability, maintenance and cost which make it undesirable.

Options C1 and D1

These sub options provide for the addition of a new bridge between the existing bridge and the bridge specified in Options C and D. This was assessed at a strategic level to determine whether there is sufficient space for a new bridge at this location (should the existing bridge be deemed unserviceable). Plan view drawings were prepared to determine the feasibility of constructing a new bridge at this location but no further detailed assessment was undertaken as part of design development.

Four-lane bridge option

This sub-option of Options C and D, consisting of a new four-lane bridge on the downstream side of the existing bridge with the same level of flood immunity as Options C and D, was also considered. It would provide two lanes in each direction across a single bridge, allowing the existing bridge to be used for recreational purposes such as a green link pedestrian and cycle route across the river.

The new four-lane bridge could be accommodated within the proposed corridor but, due to the height difference in the approach alignment, it would have impacts on turning movements at Old Kurrajong Road / Yarramundi Lane that would require adjustments to be made at Bosworth Street to cater for the additional traffic.

3.4. Environmental considerations

In conjunction with the development of the options, preliminary environmental investigations of the study area were undertaken. The results of these investigations described the existing environment in the area and identified any potential constraints associated with the options under consideration.

As part of this investigation, desktop environmental searches of the study area were performed, followed by a field investigation. This was limited to public spaces, such as the road corridor and river bank. No field investigations were undertaken on private land.

Results

The treatment of the corridor through the townships of Richmond and North Richmond is consistent for all options and, for all the options that involve the flood plain and the Hawkesbury River, the area affected is within a corridor approximately 50 metres wide.

Therefore the environmental constraints in these areas are similar for all options. The main distinctions between the constraints for the options are:

- The options involving construction closest to the existing road corridor (Options A and B) may have greater Aboriginal and non-Aboriginal heritage constraints through the flood plain and across the river
- Options C and D would require more property acquisition as they specify a wider road corridor
- Options C and D may require more flood and hydrology management due to the height of the new road embankment across the flood plain. However these options would also provide a higher level of flood immunity for the local community.

3.4.1. Biodiversity

The study area is dominated by cleared land with patches of remnant native vegetation along the southern bank of the Hawkesbury River and freshwater wetlands on alluvial floodplains. Where remnant stands of native vegetation occur in the study area, they are generally considered to be of high conservation significance due to their threatened status.

The following ecological databases were searched for locations within 10 kilometres of the study area:

- Atlas of NSW Wildlife for threatened fauna records
- NSW Government Department of Primary Industries (DPI) Fishing and Aquaculture records
- Protected Matters (EPBC Act) database.

The results of these searches and preliminary field investigations are outlined below.

Vegetation communities

The desktop assessment identified four threatened vegetation communities listed under the NSW Threatened Species Conservation (TSC) Act and one endangered ecological community (EEC) listed under the Commonwealth Environmental Protection and Biodiversity Conservation Act, 1999 as potentially occurring within the study area. A preliminary site survey, undertaken to verify the desktop assessment, confirmed that the study area contains two EECs listed under the TSC Act. These are:

- River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (mapped as Alluvial Woodland and Riparian Forest in NPWS mapping). The river-flat forest on the northern bank of the Hawkesbury River, within the study area, is highly disturbed mown parkland and on the southern bank the overstorey canopy is intact but the ground cover is highly infested with weedy vines
- Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions Pugh's Lagoon is part of the EEC, Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. It is also a highly disturbed area, however it is in a moderately good condition.

Flora

The desktop search indicated that 25 threatened flora species listed in the TSC Act were previously recorded within 10 kilometres of the study area. Of these species, 24 were also identified in the EPBC protected matters search. Each of these species has been assessed to determine the likelihood of it occurring within the study area, based on vegetation communities present, habitats present and from observations during the site inspection.

Of the threatened flora species considered in the desktop search, none were found on site during the ecological site inspection. One species was considered to potentially occur in the study area, based on habitat assessment. This is the Pomaderris brunnea (Rufous Pomaderris), listed as vulnerable under the TSC Act and the EPBC Act. This species typically grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines. Several potentially hollow bearing trees exist within the riparian forest on the southern bank of the Hawkesbury River, in the vicinity of Richmond Bridge.

Weeds

The desktop search identified 98 noxious weed species listed within the Hawkesbury Local Government Area. During the field ecological survey 12 noxious weed species, in three different habitats, were observed within the study area. Vegetation along the road verges is dominated by the following noxious weeds:

- Small and Large Leaved Privet
- Lantana
- Giant Parramatta Grass.

The riparian forest is heavily infested with the following noxious weeds:

- Moth Vine
- Madiera Vine
- Balloon Vine
- Morning Glory
- Wandering Jew.

Waterways in the study area contained the following noxious weeds:

- Alligator Weed
- Water Hyacinth
- Salvinia
- Cabomba.

Fauna

Database searches revealed 55 threatened fauna species known or likely to occur within 10 kilometres of the study area. These include:

- Seven bat species
- Sixteen bird species (including eleven migratory species)
- Two fish species
- Six frog species
- Three insect species
- Five marsupial species
- One reptile species
- One rodent species
- One snail species.

No threatened fauna species were observed during the field investigation of the study area. No microchiropteran bats were observed in the study area nor was there any evidence of current or past roosting (ie guano marks). No bat noises were recorded on the ANABAT detector.

An assessment of the likely occurrence of these fauna species has been made on the basis of available habitat and other identifiers. Of the 55 threatened species identified in the desktop search, 29 are considered as potentially occurring in the study area.

Aquatic environments and species

Hawkesbury River

The Hawkesbury River has two main aquatic habitats within the study area. These are run (areas of moderately flowing water in the middle of the river) and pool (still areas of water along the riverbanks).

Shading is restricted to the banks of the river. The northern bank at Richmond Bridge is lined with a narrow band of Swamp Oak, with sparse groundcover, evidence of recent flood damage, fallen timber and clumps of aquatic weeds including Salvinia, Cabomba and Alligator Weed.

River-flat forest with dense Swamp Oak and a number of large eucalypt trees occurs in a band up to 50 metres wide along the southern bank of the river adjacent to Richmond Bridge. This vegetation provides protection and nutrient input for aquatic habitat.

Key fish habitat includes all marine and estuarine habitats up to the highest tide level (as reached by king tides, DPI 2011a) as occurs in the study area. DPI's key fish habitat maps indicate that the Hawkesbury River at Richmond Bridge represents an important aquatic habitat to support local fish communities.

There are no SEPP 14 listed wetlands in the study area or the surrounding area. No wetlands listed on the NSW Directory of Important Wetlands occur within the study area. There are several small freshwater lagoons within the study area.

Pugh's Lagoon

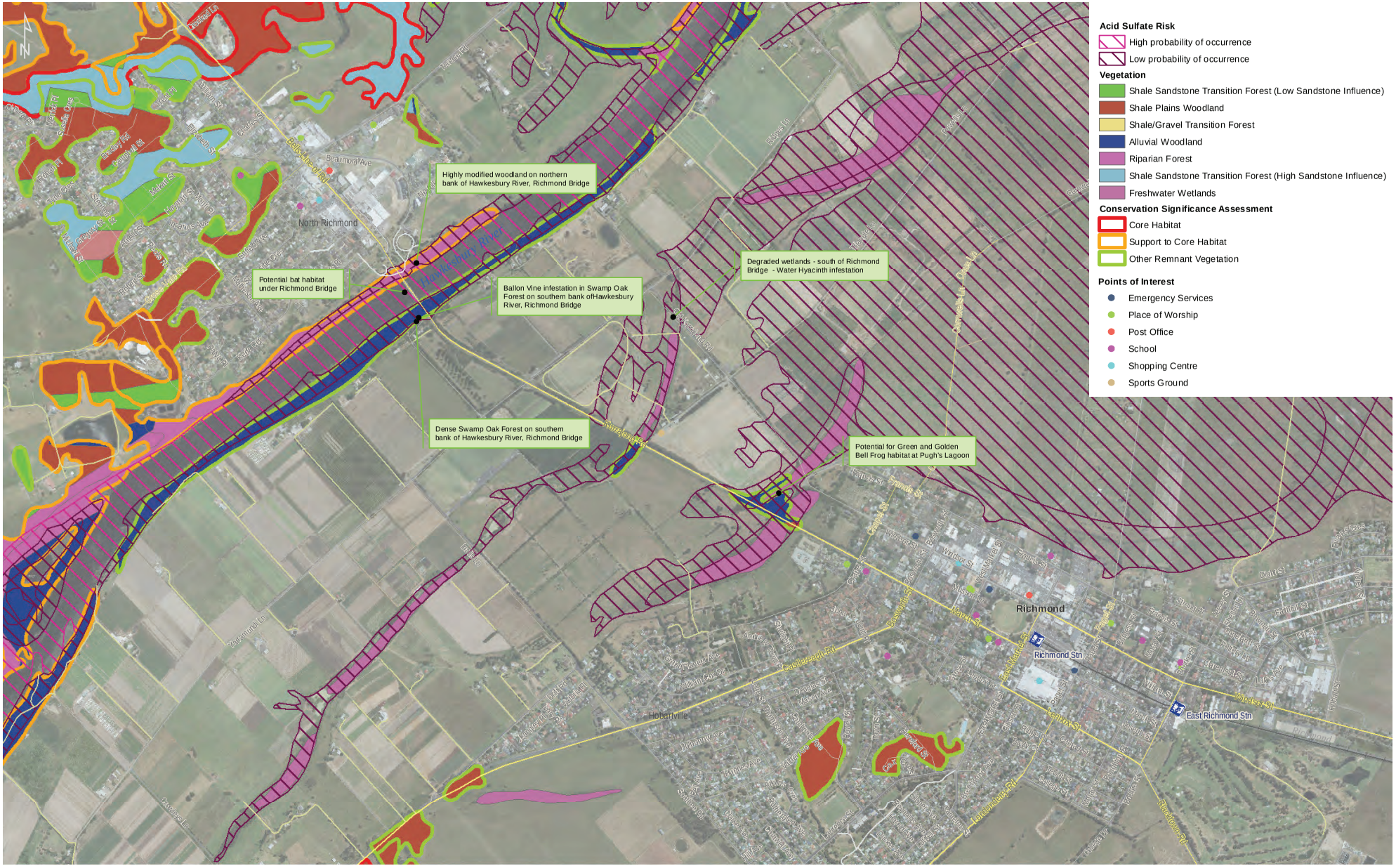
Pugh's Lagoon, situated on the floodplain between Richmond and the Hawkesbury River, is located just to the north of the Richmond township. It is a wetland in moderately good condition with very few weeds but it is straddled by Kurrajong Road. The lagoon comprises a series of small ponds with fringing vegetation of emergent macrophytes, such as species of Typha and Phragmites. The lagoon is part of the EEC, Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. It is noted that this area is incorrectly mapped as Alluvial Woodland in the NPWS vegetation mapping.

The Green and Golden Bell Frog was not recorded during the site investigation and is not recorded within the Hawkesbury River, however this species is known to occur in local tributaries. It is also often found within other highly disturbed areas within the greater Sydney region that are effectively similar to the environmental conditions existing at Pugh's Lagoon. Therefore there is some potential that this species may be present as habitat for this species is present within the study area. Table 12 provides a summary of the constraints relating to biodiversity. Table 12 summarises the constraints of biodiversity in the area.

Table 12 - Constraints relating to biodiversity

Aspect	*Constraint*
Biodiversity	• Low quality River-flat eucalypt forest on coastal floodplains (of the NSW North Coast, Sydney Basin and South East Corner bioregions) endangered ecological community exists within the study area along the banks of the Hawkesbury River. This constraint is common for all options. • Freshwater wetlands on coastal floodplains (of the NSW North Coast, Sydney Basin and South East Corner bioregions) endangered ecological community exists around the Pugh's Lagoon wetland. This constraint is common for all options. • There is potential for Green and Golden Bell Frogs to exist within Pugh's Lagoon. This constraint is common for all options. • Hollow bearing trees exist within the riparian forest on the southern bank of the Hawkesbury River along the banks of the river adjacent to the existing bridge. Options A and B have more potential to impact these, therefore this is a common for these options. • Noxious weeds in the area are common to all options.

Figure 18 on the following page shows the map of environmental constraints.



Source - Vector Backdrop Data © MDS 2012 AHIMS Data - AMBS; Vegetation - Native Vegetation of the Cumberland Plain, NPWS; Imagery - SKM provided by RMS

Figure 18 - Map showing the environmental constraints on the project

3.4.2. Aboriginal heritage

Aboriginal occupation of the Sydney basin dates back 20,000 years or more, but the majority of Aboriginal sites in the region are 3,000 to 5,000 years old. Aboriginal occupation in the study area would have been influenced by the local environment, for example suitable rock for producing stone tools would have been available within three kilometres of the study area and the Hawkesbury-Nepean River system and various lagoons located between Richmond and North Richmond would have represented an important water and food source.

The study area is located within the Deerubbin Local Aboriginal Land Council (DLALC) area. A search of the Aboriginal Heritage Information Management System (AHIMS) database identified 90 recorded Aboriginal sites within a five kilometre area around the study area. The majority of the recorded sites are listed as open campsites. This type of site usually comprises stone artefact scatters or isolated finds. Other recorded sites included rock shelters with art, axe grinding grooves and scarred trees.

Two of these sites are within the study area. One site is located in close proximity to the existing road corridor near Beaumont Avenue, North Richmond. The other site is located in the vicinity of Richmond Marketplace. This site has been destroyed by the construction of the shopping centre.

These search results only identify known Aboriginal sites that have been reported to OEH and recorded on the AHIMS data base. However, given the high number of finds and the type of adjacent environment, it is likely that more Aboriginal finds and sites may be located within the study area. These sites however, may have been previously impacted by agricultural and urban development within the area. With the close proximity of the options across the same type of environment, this would be a constraint for all options.

Preliminary consultation with the DLALC identified no known Aboriginal cultural sites within the study area, however water bodies such as the Hawkesbury River generally hold cultural value for Aboriginal communities. Table 13 provides a summary of the constraints relating to aspects of Aboriginal heritage.

Table 13 - Constraints relating to Aboriginal heritage

Aspect	*Constraint*
Aboriginal heritage	• There are known Aboriginal sites close to the existing bridge alignment. This would be a greater constraint to Options A and B. • There is a potential for further unrecorded Aboriginal heritage and cultural sites to occur within the local landscape. This constrain would be common to all options.

3.4.3. Non-Aboriginal heritage

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.

The majority of heritage listed sites within the study area are located within Richmond. However, there are two heritage sites in North Richmond listed on the local register.

Transport infrastructure

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 immunity. 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.

Non-Aboriginal heritage study area precincts

Due to the number of heritage items, places and sites within and adjacent to the study area, it was divided into four precincts (study areas) for the purpose of describing the non-Aboriginal opportunities and constraints related to the options. The precincts used to describe the non-Aboriginal heritage constraints are:

Section 1 March Street precinct (includes the part of Richmond township that lies within the study area from the eastern extent of the study area to Chapel Street)

Section 2 Kurrajong Road / Old Kurrajong Road / Yarramundi Lane (includes Kurrajong Road and its surrounds within the study area from Chapel Street to Richmond Bridge)

Section 3 Richmond Bridge (includes the Hawkesbury River and its banks within the study area)

Section 4 North Richmond (includes from the western abutment of Richmond Bridge through North Richmond to the western extent of the study area)

Section 1 - March Street precinct

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. In this precinct there are four State Heritage Register items and 39 local heritage items.

Section 2 - Kurrajong Road / Old Kurrajong Road / Yarramundi Lane precinct

West of the town of Richmond the concentration of heritage items and places reduces considerably. Within the Kurrajong Road / Old Kurrajong Road / Yarramundi Lane precinct there are three local heritage items:

- St Peter's Anglican Church
- Hobartville (Hobartville is also listed on the State Heritage Register)
- The avenue of trees on the east and west side of Chapel Street.

Section 3 - Richmond Bridge precinct

Richmond Bridge forms an important part of the visual landscape of the Hawkesbury River and it represents the culmination of successive modes of river crossing at this section of the river.

There is the potential for evidence associated with the construction and operation of the early river crossings and quarrying to be located along the east bank of the Hawkesbury River. This may include the remains of a ferry crossing, timber bridges, railway lines, signalling, buildings and traces of former roadways.

Section 4 - North Richmond precinct

Two local heritage items are located within the study area in the North Richmond precinct. These are the Police Station and former residence and the Seventh Day Adventist Church.

The surviving remnants of the 1870s timber bridge over the Hawkesbury River are important reminders of the early attempts to construct a bridge that would withstand the flood events that characterise the area. The former Richmond to Kurrajong railway and the early settlement of Enfield are also located in close proximity to the current alignment of Bells Line of Road.

Review of Heritage databases and registers

The following databases and registers were reviewed:

- State Heritage Register
- Section 170 Registers
- Hawkesbury Local Environment Plan (1989)
- Draft Hawkesbury Local Environmental Plan (2011)
- Register of National Estate.

State Heritage Register

The review included a search for heritage items, places and sites within and adjacent to the study area. The Heritage Act 1977 provides protection for heritage places, buildings, works, movable objects and archaeological sites that are important to the people of NSW. Part 4 of the Act refers to items listed on the State Heritage Register. Table 14 lists the places within or adjacent to the study area that are listed on the State Heritage Register.

Table 14 - State Heritage Register items

No	Name	Address
00468	Bowman House	368-370 Windsor Street, Richmond
00610	Building	257-259 Windsor Street, Richmond
00753	Building, outbuildings, grounds, trees	49-51 Bosworth street, Richmond
00035	Hobartville, including outbuildings	Kurrajong Road, Richmond
00045	House	126 Windsor Street, Richmond
01808	Richmond Park	Bounded by East Market Street, Windsor and March Streets, Richmond
01410	Richmond Post Office	286 Windsor Street, Richmond
01236	Richmond railway station and yard group	Richmond
00681	Seymours House	24 Bosworth Street, Richmond
00014	Toxana	157 Windsor Street, Richmond

Section 170 Registers

Section 170A (2) of the Heritage Act 1977 requires public authorities to maintain a register of heritage assets, known as a Section 170 Register. Table 15 lists the items within the study area that are listed on Section 170 Registers.

Table 15 - Items listed on the S170 Registers

Ref	Register	Name	Address
4309511	RMS	Hawkesbury River Bridge	Kurrajong Road, North Richmond, NSW 2753
SRA5	RailCorp (State Register)	Richmond Railway Station Group	East Market Street, Richmond, NSW 2753
N/A	NSW Police Service	Richmond Police Station and Court House	288 Windsor Street, Richmond, NSW 2753

Hawkesbury Local Environment Plan 1989

The Hawkesbury Local Environment Plan (HLEP) 1989 provides for the protection of heritage buildings, places, works and trees, heritage conservation areas and archaeological relics. Schedule 1 of the plan provides a list of protected heritage items. A draft Hawkesbury Local Environment Plan 2011 is currently being exhibited. It lists some additions and changes to the heritage listings provided in the 1989 plan. There are 105 items within or adjacent to the study area that are listed in the HLEP (1989) and draft HLEP (2011).

Register of the National Estate

The Register of the National Estate was originally established under Section 22 of the Australian Heritage Commission Act 1975. Since February 2012 it has been phased out and it is now used as a non-statutory archive of information. Seventy-one items within or adjacent to the study area are listed on the Register.

Non-listed heritage constraints

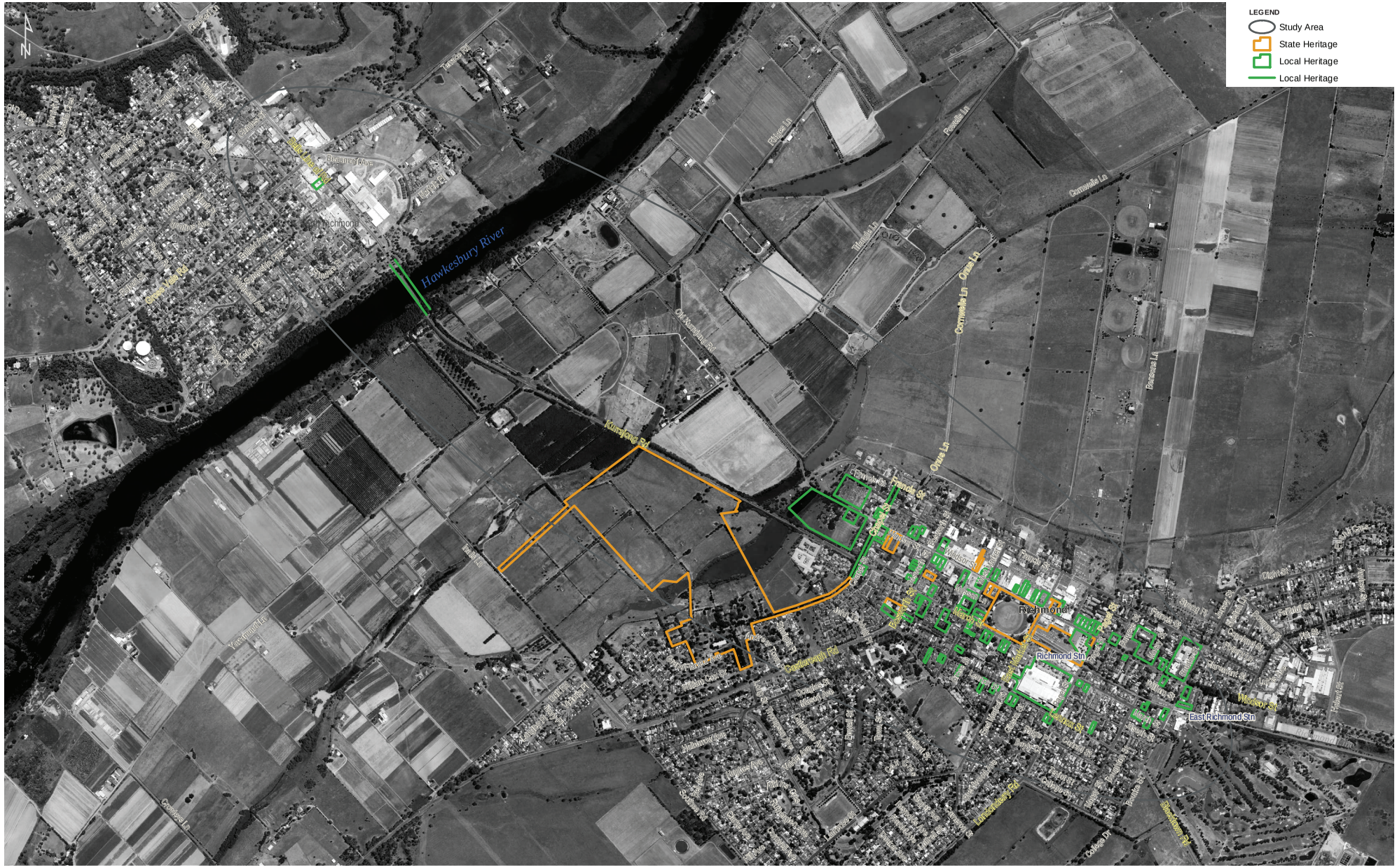
There is potential for archaeological remains to exist within the study area. These could include the remains of the old river crossing, including the punt wharf and former timber bridge to exist adjacent to the current road corridor and remains of the former railway line to North Richmond.

Table 16 on the following page provides a summary of the constraints relating to aspects of Non-Aboriginal heritage.

Table 16 - Constraints relating to aspects of non-Aboriginal heritage

Aspect	*Constraint*
Non-Aboriginal heritage	Within or adjacent to the study area there are: • Ten items listed on the State Heritage Register within the Richmond township, some immediately adjacent to the road corridor. As all options are the same through the township, this constraint is common to all options. • Three items listed on Section 170 Registers, including Richmond Bridge in the RMS Register. While the constraint within Richmond is the same for all options, the existing Richmond Bridge is only a constraint for Option A as it would require modifications to the bridge structure. • One hundred and five local heritage items listed on the current and draft HCC Local Environment Plans. These are predominantly within townships and are a common constraint for all options. • There is potential for archaeological remains of the old river crossing, including the punt wharf and former timber bridge to exist adjacent to the current road corridor. This constraint has more impact on Options A and B as they would have and closer to existing road alignment at the river. • There is potential for archaeological remains of the former railway line to North Richmond to exist within the study area. This constraint is common to all options.

Figure 19 on the following page shows the non-Aboriginal heritage items.



Source - Vector Backdrop Data © MDS 2012 AHIMS Data - AMBS; Vegetation - Native Vegetation of the Cumberland Plain, NPWS; Imagery - SKM provided by RMS

Figure 19 - Locations of non-Aboriginal heritage items

3.4.4. Landforms, geology and soils

The study area landform falls from North Richmond down to the Hawkesbury River and flood plain, rising again on the south easterly approach into Richmond.

The soils of the study area are underlain by the Wianamatta Group geological formations, generally comprising Bringelly Shale, Minchinbury Sandstone and Ashfield Shale, formed during the Triassic period. Within the region this is typically overlain by an unconformity of sand, silt, clay and gravel laid down during the Tertiary period, with alluvium along the Hawkesbury-Nepean River. Generally the soils of the study area have a low susceptibility to erosion. More specifically, the north-western portion of the study area is underlain by the Ashfield Shale formation which generally comprises dark-grey to black claystone-siltstone and fine sandstone- siltstone laminite. The south-eastern portion of the site is underlain by the Lowlands Formation which generally comprises gravel, sand, silt and clay.

A review of historic documents indicates that piling for the widening of Richmond Bridge in 1927 was founded on sandstone bedrock. The sandstone bedrock was located about 14 metres below the existing bridge deck level and was overlaid by sand and gravel layers.

Desktop searches indicate the study area is located in a high risk area for actual or potential acid sulphate soils. Mapping indicates that actual or potential acid sulphate soils are likely to be present about two metres below the soil surface at various locations across the study area, particularly in the vicinity of the Hawkesbury River.

At the surface level, no evidence of major scarring or infertility has been observed in the study area that would be linked to potential or actual acid sulphate soils, however this is only one potential indicator. Acid generating rock is not known to occur in the study area. Table 17 is a summary of the constraints relating to acid sulphate soils.

Table 17 - Constraints relating to aspects of landform, geology and soils

Aspect	*Constraint*
Landform, geology and soils	• Potential to expose acid sulphate soils at various locations across the proposed site. This constraint is fairly common for all options. • Given the close proximity of the options, the soil type constraints are similar for all options.

3.4.5. Water quality and hydrology

The study area is located in the Hawkesbury-Nepean catchment and drains to the Hawkesbury River. The Hawkesbury River originates at the confluence of the Nepean and Grose Rivers, north of Penrith and flows north through the study area.

The Hawkesbury River periodically floods, sometimes quite extensively. The study area contains floodplains between the eastern bank of the Hawkesbury River at Richmond Bridge and the township of Richmond. The approaches to Richmond Bridge and Richmond Bridge itself have a vertical alignment below the 1:5 year ARI flood level.

Freshwater wetlands occur between the eastern bank of the Hawkesbury River and the township of Richmond on both sides of the existing road corridor. The majority of these wetlands are located on private land. One wetland is named Pugh's Lagoon. Freshwater wetlands in the study area are subject to periodic flooding. The wetlands generally exhibit standing pools of shallow water which are fragmented by Kurrajong Road. In the study area groundwater is typically encountered within 10 metres of the ground surface as the groundwater level is associated strongly with the Hawkesbury River. Groundwater aquifers are located in alluvial sediments, particularly within floodplain environments and within sandstone aquifers at depth. The quality of groundwater in the study area would be affected by factors which include the frequency of flooding events and the effects of nearby agriculture and urban development.

Within the townships of Richmond and North Richmond stormwater drainage is managed with kerb and gutter along roads. These discharge into the riparian areas and floodplains surrounding the urban areas. Between Richmond and North Richmond Kurrajong Road has no kerb and gutter. Through this section of Kurrajong Road stormwater drains to roadside verge areas which comprise open grassed areas, swales and minor depressions that form into freshwater wetlands. Table 18 is a summary of the constraints relating to water quality and hydrology.

Table 18 - Constraints relating to aspects of water quality and hydrology

Aspect	*Constraint*
Water quality and hydrology	• The Hawkesbury River is a common constraint for all options. • Pugh's Lagoon on the northern side of the existing road corridor is a constraint for all options as they require the road corridor to be widened in this area.

The management of hydrology across the flood plain is a constrain for all options. However for Options C and D additional consideration for flood mitigation under the new road alignments would be required due to the potential height of the embankments. These options would provide a higher level of flood immunity for the local communities.

3.4.6. Noise

The study area is characterised by low density residential and commercial areas in the townships and semi-rural areas across the flood plain between Richmond and the river. There are more than 100 sensitive noise receivers within the study area. These predominantly comprise residential dwellings in the towns of Richmond and North Richmond as well as child care centres and places of worship.

The primary noise source within the study area is the existing road corridor. Other noise comes from general urban activities in residential properties and recreation areas, commercial properties and rural activities. At the south eastern end of the study area there is the Richmond train station and the Blacktown to Richmond railway line. The whole study area is also regularly and intermittently subject to varying amounts of overhead aircraft noise due to the location of the nearby Richmond RAAF base and the aircraft flying over during the day and night.

Any option that moves the road corridor closer to sensitive receivers may increase road noise levels at those receivers. Table 19 is a summary of the constraints relating to noise.

Table 19 - Constraints relating to aspects of noise

Aspect	*Constraint*
Noise	• Sensitive receivers within the Richmond and North Richmond areas is a noise constraint for all options. • Heritage buildings that may be affected by increased vibration from the operation of the road is a common constraint for all options.

Social and economic issues

All options being considered have the potential to have long-term, positive effects on the local community by improving traffic flow and road and pedestrian safety in the area. The preliminary socio-economic issues are primarily confined to the Richmond and North Richmond townships. Therefore the following socio-economic constraints are common to all options:

Resident and commercial on-street parking along March Street, Richmond. For all options some on-street parking would be likely to be removed and / or limited to non-peak periods

Access to and from residential and commercial properties along the March Street, Richmond and Kurrajong Road, North Richmond road corridor

- Access to and from the adjacent recreation areas, such as Richmond Park and Hanna Park
- Impacts to amenities and heritage values within the townships
- Recreational use of and access to the Hawkesbury River
- Connections for pedestrians and cyclists. All options provide for a shared path across the bridge and between the townships.

The provision of access to the Windsor Polo Club, residents and agricultural properties along the Old Kurrajong Road on the north eastern side of Kurrajong Road is a constraint for all options.

The partial acquisition of property may be required for all options, although the amount of acquisition required varies between options. More property would need to be acquired for Options C and D than Options A and B as these options increase the size of the road corridor. The more acquisition required the more constraint on the option.

Improved local access and connectivity for flood events greater than the current level of the existing Richmond Bridge would be provided by Options C and D.

3.4.7. Surface water and flooding

Richmond Bridge and the Kurrajong Road approach from Richmond are currently subject to regular flooding. The Kurrajong Road approach from Richmond crosses a floodplain known as the Lowlands which carries flow that breaks out of the main Hawkesbury River channel during flood events.

Flood modelling for Options B, C and D was carried out to assess the impact of flooding on these options. This was required for Options C and D as the eastbound carriageway across the flood plain would be higher than the existing carriageway due to the provision of an increased flood immunity.

The purpose of the flood modelling was to:

- Assess the flooding impacts of Options C and D to ensure that they are within acceptable limits
- Determine the minimum road levels and drainage structures required to achieve the desired flood immunity. Table 20 shows the flood modelling criteria and design parameters.

Table 20 - Flood modelling criteria

Flood modelling criteria	*Description*
Maximum allowable afflux for occupied properties	200 millimetres in the flood plain
Flood immunity of proposed upgrade alignment	Option A, B: Less than 1:5 year ARI (existing) Option C: 1:5 year ARI Option D: 1:20 year ARI
Flood level in relation to strategic design level of new bridge structures	Flood level below bridge soffit (Option C and D only)

RMS nominated an increase of 200 millimetres in the flood level for events up to the 100 year ARI as acceptable for the purposes of determining waterway opening sizes at a strategic concept design detail. A RUBICON model of the Hawkesbury-Nepean River indicated that the largest flood impacts would occur upstream of the Lowlands flow path as a result of the raised carriageway embankments associated with Options C and D which involve raising the road to achieve 1:5 and 1:20 year ARI flood immunity respectively.

These impacts would be highest for events more frequent than the 1:20 year ARI. In the 1:100 year ARI event, flow would pass over the roadway.

The flood modelling results indicated that there are several flow paths (two to three) in the lowlands areas that will carry flows in a flood event. They will need suitable drainage structures (culverts or bridges) to allow flood waters to pass and to achieve the assumed acceptable afflux.

3.4.8. Land use

The study area covers a mix of land uses from residential, commercial and light industrial to open space and recreational and rural and riparian environments between the towns of Richmond and North Richmond. Most of the study area is contained between Richmond and North Richmond on the Hawkesbury-Nepean floodplain. The dominant land uses are agistment (including grazing associated with the equine industry), agriculture and rural residential properties. Agricultural land uses include fruit tree plantations, experimental forestry plantations and turf farms.

Other land uses of the floodplain include public recreation spaces such as sporting fields, parkland and private recreation (eg horse polo fields). Isolated pockets of scattered vegetation and a system of freshwater wetlands, ponds, lagoons, back swamps and drainage lines associated with the floodplain are also present.

The Hawkesbury River runs south to north through the study area and defines the interface between the rural floodplain and North Richmond. The Hawkesbury River and associated freshwater wetlands and lagoons, such as Pugh's Lagoon, are subject to provisions under SREP No.20 Hawkesbury – Nepean River (No.2– 1997) which control any development which has the potential to impact on the river environment (ie water quality, environmentally sensitive areas and Riverina scenic quality). Wetland areas are to be protected as environmentally sensitive areas (Clause 6, Part 2, SREP No.20) (HCC, 2008: 25).

The historic township of Richmond forms the eastern extent of the study area with the majority of the land uses along the study area being detached residential dwellings, interspersed with semi-detached and small scale multi-unit residential dwellings. There are also commercial land uses including fast food takeaway outlets, petrol stations, small businesses, civic land uses including a library and buildings associated with council operations and the open space and recreation area of Richmond Park. Several groups of buildings and individual buildings are listed as heritage items on the HLEP (1989) and draft HLEP (2012).

At the western extent of the study area, North Richmond is a small urban settlement containing residential dwellings with a small commercial strip along the Bells Line of Road. Commercial and light industrial are the main land uses along this strip including supermarkets and general stores, takeaway food outlets and petrol stations, the North Richmond Hotel and light industrial land uses such as Hanna Group and service type industries such as automotive mechanics.

Zoning under the LEP includes Rural, Residential, Business, Industrial, Open Space, Environmental Protection and Special Uses, such as schools and churches. The land in the vicinity of the study area is subject to zoning under the HCC Local Environmental Plan 1989. Figure 20 is a map showing zoning for North Richmond and Figure 21 for a map showing zoning for Richmond.

A concept plan and re-zoning application has been submitted to the Department of Planning for the residential development of a 180 hectare property into 1400-2000 dwellings. HCC has previously approved the construction of a nursing home and independent living units on the same site. As part of this proposal, infrastructure improvements including an alternative east-west vehicle access to North Richmond has been proposed.

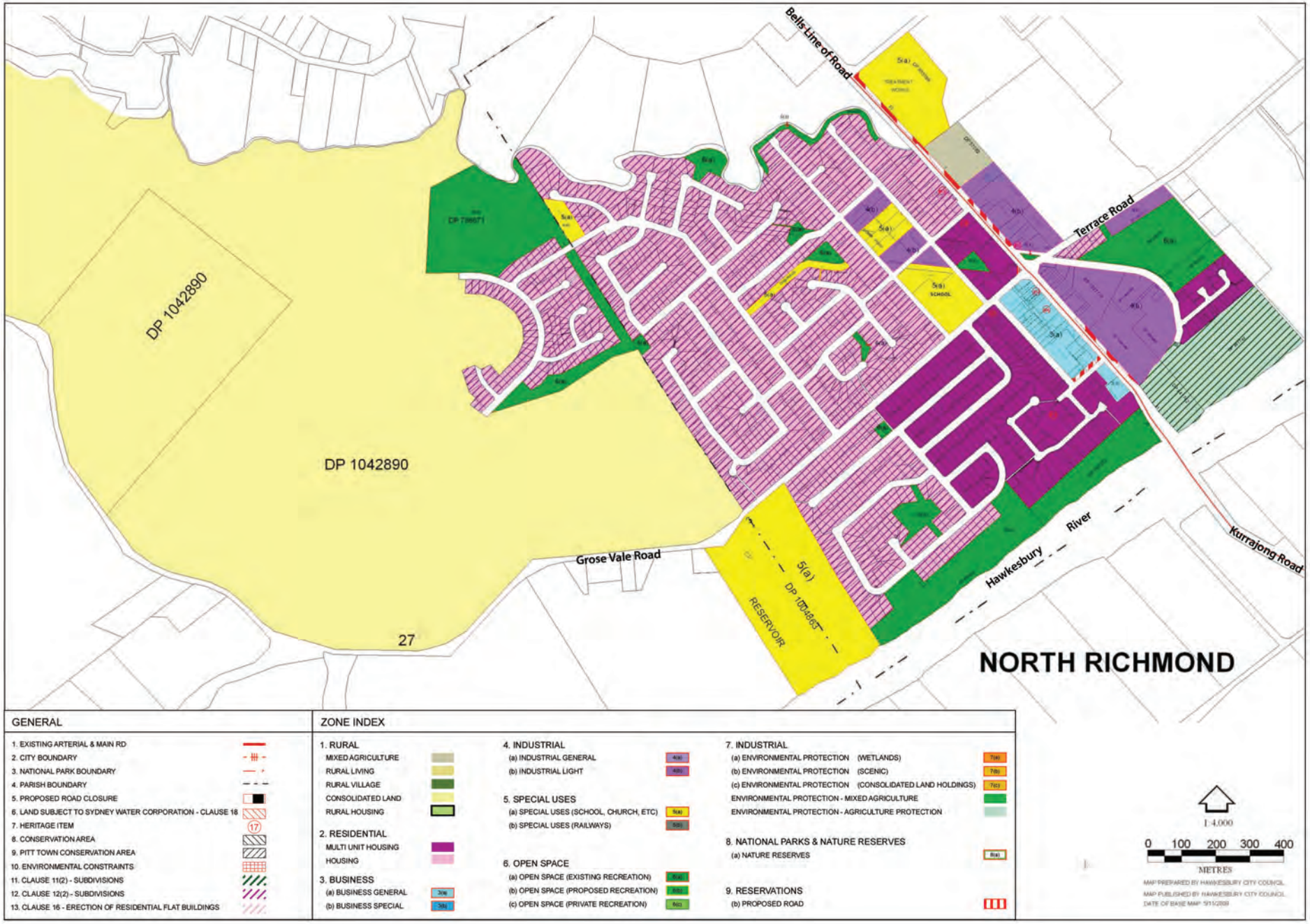


Figure 20 - Map showing land use zoning for North Richmond

Figure 21 - Map showing land use zoning for Richmond

3.5. Community consultation

3.5.1. Consultation objectives

The objectives of community consultation are to enable proactive community engagement, manage expectations through clear and responsive communications, ensure accurate documentation of feedback and capture and resolve issues where practicable.

A Community Involvement Plan (CIP) was developed to ensure proactive community engagement to aid in the achievement of these objectives. The CIP built on and utilised prior knowledge of the area and community concerns identified during Part 2 of the corridor investigations, and ensured alignment with the principles and practices of the project and RMS's community relations policies and procedures.

In order to achieve these objectives, the CIP and the subsequent program of activities were targeted to community relations and issues identified by the project team, stakeholders and government agencies. This was achieved by focussing on both advance notification and targeted consultation with potentially impacted communities and stakeholders within and close to the project area and on a broader level by undertaking engagement with stakeholder groups and the wider community as required.

3.5.2. Consultation activities

During July 2012 a community update was issued by RMS identifying the Australian Government's allocation of $2 million to investigate short-term (Part 2) and long-term (Part 3) traffic congestion mitigation measures for Richmond Bridge and its approaches between East Market Street, Richmond and Grose Vale Road, North Richmond.

The community was provided with the opportunity to comment on the contents of the Richmond Bridge and Approaches Congestion Study - Summary Report which was made available. Community members could also provide long-term congestion mitigation proposals for the Part 2 development. The closing date for comments to RMS was 31 July 2012.

The input from a community workshop held on 24 July 2012 for the Part 2 proposals with input was also collected for the Part 3 proposals. In September and October 2012 the consultation phase for the long-term (Part 3) options commenced. The Richmond Bridge and approaches congestion study: Long-term options report was released on 19 September 2012 and community information sessions were held in North Richmond on 10 and 13 October 2012. The public submission process closed on 17 October 2012. The key issues raised by the community during the long-term options consultation phase fall into the following broad categories:

- Flood immunity
- Key intersection congestion and safety
- Property and open space impacts
- Land use and development
- Project scope
- Timeframes and funding.

3.5.3. Community comments on the options

Comments on the options received from the community were captured in a Community Issues Report. The key outcomes of these submissions are summarised below. Further details can be found in the Community Issues Report (Part 3 long-term study) at Appendix 3.

Option A

Of the 18 submissions that specifically commented on Option A, 14 did not support Option A, noting:

- Traffic congestion would increase
- Contraflow traffic management systems are ineffective and a safety concern and would require continual operational maintenance
- A water pipe would need to be moved
- Increased noise and decreased property value
- Flood immunity would not be improved
- Key intersection issues, such as congestion at Grose Vale Road / Bells Line of Road, are not addressed
- It would only be a short-term solution which would not address congestion for the long-term.

Three submissions supported Option A, noting that it would:

- Maintain the rural aspect west of the river
- Have minimal visual impact and the least effect on the surrounding area
- Have the least impact on community infrastructure.

One local business did not indicate support or otherwise, but noted that Option A would not impact on truck access.

Option B

Of the 16 submissions that specifically commented on Option B, 11 cited reasons for a lack of support, such as:

- Traffic congestion would increase
- Flood immunity would not be improved
- It would only be a short-term solution
- Increased noise and decreased property value
- There may be potential impacts to community infrastructure.

Five submissions supported Option B, noting:

- The provision of four lanes treats east and west bound traffic equally and would accommodate peak hour traffic
- It is less invasive of the surrounding landscape and allows for a view of the old railway bridge
- It provides for a shared cycleway and pedestrian path
- Does not require RMS to change lanes between peaks or move the water pipe
- Provides greater traffic flow.

One submission supported Option B with the proviso that the bridge design is sympathetic to the original bridge and the new road / bridge footprint is not too large.

The submission from one local business did not indicate support or otherwise, but noted that Option B would not impact on truck access.

Option C

Of the 19 submissions that specifically commented on Option C, 12 were not supportive, citing reasons such as:

- Flood immunity is not adequate
- It would increase traffic congestion
- It would only be a mid-term solution (five to seven years)
- It would cost too much
- Increased noise and decreased property value
- The benefits of flood immunity do not outweigh the requirement to acquire land and the impact on the local environment, such as Hanna Park
- There would be impacts on visual amenity
- There may be potential impacts to community infrastructure.

Seven submissions were supportive of Option C, noting that it:

- Provides greater flood immunity
- Is a more realistic approach (but more detail is needed)
- Provides four lanes
- Provides a shared cycleway and pedestrian path
- Is preferred, provided it does not impact on a local business' exit driveway for trucks.

At its meeting on 9 October 2012, HCC resolved to support, in principle, Option C subject to further analysis. Council stressed that support for Option C may be reviewed in the light of further information or studies that may become available.

Submissions also made the following recommendations to improve Option C:

- A new four-lane bridge
- Use the old bridge as a cycleway
- Include a shared cycle path between Richmond and North Richmond
- Reconsider whether the bridge needs to be as high
- Limit the amount of prime agricultural land removed from production
- Assess any impacts for existing infrastructure, including irrigation infrastructure
- Remove the lights and implement a roundabout at the Bells Line of Road and Terrace Road intersection
- Widen the corridor on the southern side, not on the Windsor Polo Club side
- Provide two lanes in both directions at the North Richmond traffic lights on Bells Line of Road and a longer turn-right lane accommodating seven to eight vehicles
- A turn left at any time with care heading up Grose Vale Road
- Add a new roundabout at the Terrace Road and Beaumont Avenue junction and extend Beaumont Avenue to continue through Hanna Park and over a new bridge and follow the road to a new roundabout at Old Kurrajong Road / Yarramundi Lane.

Option D

Of the 25 submissions that specifically commented on Option D, 16 indicated support, noting that it:

- Provides good flood immunity
- Caters for increased traffic
- Provides a shared cycleway and pedestrian path
- Is the best plan in a very difficult area
- Is preferred provided it does not impact on the local business' exit driveway for trucks.

The nine submissions that did not support Option D, provided reasons including:

- It would create congestion at the intersections by moving the traffic faster
- It would be expensive and unnecessary
- It is too invasive on the landscape and will dominate Hanna Park
- It is too restrictive with reduced turning options at Old Kurrajong Road and Yarramundi Lane, such as right-hand turn bans
- Increased noise and decreased property value
- There may be potential impacts to community infrastructure.

Submissions also made the following recommendations to improve Option D:

- A new four-lane bridge
- Limit the amount of prime agricultural land removed from production
- Assess any impacts on existing infrastructure, including irrigation infrastructure
- Use the old bridge as a cycleway and link it to existing on-road or off-road cycleways and ensure that bicycle line markings are in accordance with the Australian standard
- Widen the corridor on the southern side, not the Windsor Polo Club side
- Provide parking, such as a multi-storey structure, for train users to mitigate parking bans in March Street.

3.5.4. Summary of community comments

Richmond and North Richmond community members provided broad ranging feedback with valuable local knowledge that will be used to further inform the development of a long-term preferred option to reduce traffic congestion on Richmond Bridge and its approach roads.

Based on the submissions received, Option D - a new two-lane bridge provided 25 to 50 metres downstream, with improved flood immunity at a 1:20 year flood event level, received more support than the other options. However, most submissions sought to modify Option D, with suggestions such as consideration of a four-lane bridge and the minimisation of property impacts.

Evidenced by the community consultation to date, there is strong support for the implementation of traffic improvements to the three key intersections (and surrounding streets) of Bells Line of Road and Grose Vale Road, Kurrajong Road, Yarramundi Lane and Old Kurrajong Road, and Kurrajong Road and Bosworth Street. While there is strong support for bypass options, the scope of this project is limited to long-term strategy to reduce traffic congestion in the Richmond and North Richmond area within the existing bridge and road corridor.

3.6. Value management process

3.7.1. The value management process is one of the three streams providing input to the preferred route selection process. It was established to review the four short listed options and identify the values that are collectively important within the study area. Details of the assessments and evaluations of the value management workshop is at Appendix 4.

3.6.1. Value management workshop

The objective of the value management workshop was to bring together key stakeholders to:

- Seek clarification in order to develop a shared appreciation of each option
- Review the draft set of assessment criteria and make any relevant minor adjustments to be adopted for the assessment process
- Assess the principal long-term options for future improvement to the capacity of the Richmond Bridge and approaches and, if appropriate, recommend a preferred option for detailed planning.

The workshop methodology involved a brief presentation of the project context and the principal long-term options by the consultant team.

Stakeholders participating in the value management workshop included representatives from:

- Federal Department of Infrastructure and Transport (DoIT)
- RMS
- TfNSW
- Sydney Water
- Community
- HCC
- Project team from SMEC, Id Planning and Tract.

3.6.2. Assessment of the options

The participants were organised into four groups to undertake the assessment, ensuring a balance of community representatives, key stakeholders, RMS representatives and SMEC project team members. (SMEC project team members only provided information to enable the other representatives to make their assessments). Each group took responsibility for assessing the four options, focusing on a particular set of the criteria as follows:

- Group 1: Safety and road capacity
- Group 2: Environment and cultural heritage
- Group 3: Engineering
- Group 4: Visual and landscape, noise and property.

The groups allocated a number from 1 (best) to 4 (worst) to reflect the relative ratings of the options. Each group performed its assessment and then presented it to the whole workshop for clarification and comment. In this way all the workshop participants had the opportunity to raise queries, suggest changes and affirm the relative assessment.

Once the assessment was complete the participants were asked to reflect on the criteria for which the options received a number 1 ranking and decide if this suggested an overall preferred option. The criteria were not weighted as the assessment was intended to examine the relative merits of each option and draw an overall conclusion about them.

Table 21 details the ranking of the short listed route options.

Table 21 - Ranking of short listed options

Criteria	*Option A*	*Option B*	*Option C*	*Option D*
Safety	4	2	2	1
Road capacity	4	3	1	1
Environment and heritage*	1	2	3	4
Engineering	4	3	1	2
Project capital cost	1	1	3	3

Note: * Includes the assessment for visual and landscape, noise and property.

3.6.3. Recommendation

The workshop participants recommended Option D because it provides superior outcomes for the principal objectives – improved travel conditions and safety as well as accessibility during flood events and network integration.

However, the recommendation was subject to addressing some of Option D's environmental and possible heritage / cultural impacts and potentially improving the Old Kurrajong Road / Yarramundi Lane access and functionality.

It was noted that although there would be a one-off impact for some people, Option D would provide broader benefits to many more people over a longer period.

3.6.4. Actions arising from the value management process

The project team noted the following key issues that would require to be addressed (not in order of priority):

- For Option D a flood access / major accident contra-flow arrangement is required for the new carriageway
- Hanna Park access to and from the new roadway needs to be defined and signage directing people to the park is required
- Intermittent traffic movements associated with sporting and other community events need to be included in the modelling for any short-term solutions to the congestion
- The modelling needs to ensure that the end points of this corridor can cope with the anticipated flows and the current problems are not just being pushed to either end of the corridor
- Accessibility for pedestrians from the retirement village to be clarified
- Council to review the local traffic network for the impacts of the options, especially in relation to Yarramundi Lane
- The report on community feedback as well as the long-term options to be posted online.

3.7. Technical assessment of the short listed options

The Richmond Bridge and approaches congestion study: Long-term options report (September 2012) documented the process used to refine the initial list of options and determine the short listed options. It included a summary of the impacts of the short listed options to enable the local communities, agencies and other stakeholders to review the short list and provide submissions and feedback to the project team.

The technical analysis of the short listed options was then performed as part of this iterative planning process.

3.7.1. Technical assessment

The technical assessment was undertaken on 26 November 2012 by the project team. Table 22 on the following page is a summary of the outcome of the technical assessment.

Table 22 - Technical assessment summary

Criteria	Weighting (%)	Option A		Option B		Option C		Option D	
		Rank	Score	Rank	Score	Rank	Score	Rank	
Safety	15	1	15	4	60	4	60	5	75
Road capacity	17.5	3	57.5	4	70	4	70	5	
Visual and landscape	12.5	5	62.5	3	37.5	4	50	2	25
Noise / social amenity	5	3	15	3	15	2	10	2	10
Local economic	5	3	15	3	15	2	10	2	10
Environment	5	3	15	3	15	2	10	2	10
Engineering / functionality / access	12.5	1	12.5	4	50	5	62.5	4	50
Community view	10	1	10	2	20	4	40	5	50
Cultural heritage	17.5	4	70	3	52.5	2	35	2	35
Total score		267.5		335		347.5		352.5	
Total score		95		100		152		168	

- The ranking is based on a scale from 1 (worst performing) to 5 (best performing)
- The score is the ranking multiplied by the weighting.

3.7.2. Comparison of options as part of the technical assessment

Safety

Option A scored the lowest compared to the other options. As a contraflow traffic management option it introduces operational risks in terms of the set-up and pull-down of the contraflow system.

Options B and C scored equally as they both comprise separated carriageways for an equal length of the corridor, provide safer facilities at intersections and right turn bays at Old Kurrajong Road / Yarramundi Lane.

Option D scored the highest. Although similar to Options B and C, it specifies the removal of through-movements and some right turns at Old Kurrajong Road / Yarramundi Lane which will improve safety by reducing the number of potential conflicts at this intersection.

All four options improve safety for pedestrians and cyclists through the provision of an off-street shared path and crossing facilities at the signalised intersections.

Road capacity

Option A scored the lowest as it only provides for two lanes in the peak direction and one-lane in the off-peak direction, through the use of a contraflow traffic management system across the bridge. This would reduce the road capacity for a short period each day to allow for the placement of the barrier system required for the contraflow arrangement.

All the other options provide a second lane in the off-peak direction across the bridge and do not require a contraflow management system.

Options B and C scored equally as these are very similar and the arrangements at the Old Kurrajong Road / Yarramundi Lane intersection are the same.

Option D scored the highest. The removal of through movements and some right-turns from the local roads would reduce the number of traffic movement at Old Kurrajong Road / Yarramundi Lane. This is likely to reduce delays for traffic turning from and into Old Kurrajong Road / Yarramundi Lane and improve capacity.

Visual and landscape

As heritage considerations were removed from consideration of this criteria, the focus was on form and the relationship of elements within the setting only.

Option A scored the highest as it would have the least visual impact when viewed from the existing bridge and downstream of the bridge.

Option C was also considered to have a lower visual impact as the new bridge would be offset 25-50 metres downstream of the existing bridge and higher than the existing bridge. It would have less impact when viewed from the existing bridge and downstream.

Option B scored less than option C, as the new bridge would only be five metres downstream and slightly higher than the existing bridge. This would block the downstream view from the existing bridge and affect views from downstream.

Option D scored the lowest. When viewed from the existing bridge and downstream, it would have the greatest visual impact.

Noise / social amenity

The scores for all options were close to each other but Options A and B were considered to perform better than options C and D. For Options A and B the alignment of the new bridges would be next to or very close to the existing bridge and therefore have minimal impact compared to the current situation.

Options C and D provide for a higher bridge 25-50 metres downstream of the existing bridge and therefore would have greater noise potential for residents on the downstream side of the bridge in North Richmond.

Local economic

All options would have the same impact in terms of the removal of on-street parking during peak hours in Richmond and North Richmond. However the impact of the options across the flood plain does vary. Options A and B were considered to perform better than options C and D. This difference is due to the reduced impact of Options A and B on the affected land due to their smaller footprint across the flood plain and on local clubs, such as the polo club, which produce economic benefits to the local community.

Environment

All options would have the same impact in Richmond and North Richmond and across the flood plain. However Options C and D would have more impact on the river banks at the bridge crossing than options A and B.

For Options A and B the alignment of the new bridge would be the same or very close to the existing bridge alignment while for Options C and D the new bridge would be 25-50 metres downstream of the existing bridge which would have a greater impact on the riverbank and associated riparian vegetation due to the new bridge abutments.

Engineering / functionality / access

Option A scored the lowest as it was considered to introduce greater complexity due to the operation of a contraflow management system. The construction of an additional lane adjacent to the existing bridge would create constructability challenges.

Options B scored higher than option A as it met all of the key project objectives and would maintain the access arrangements at Old Kurrajong Road / Yarramundi Lane. It would also be more easily constructible as much of the construction could be undertaken off main carriageway.

Option D also scored higher than option A as it would provide the greatest level of flood immunity which is a key issue for the community. However its score was lower than Option C due to the earthworks required for features such as on / off ramps and the restricted access to Old Kurrajong Road / Yarramundi Lane.

Option C scored the highest as it would not restrict access at Old Kurrajong Road / Yarramundi Lane, the footprint is smaller than option D requiring less earthworks and it would require less engineering features (no on / off ramps required). It would also provide a 1:5 year ARI level of flood immunity which is an improvement when compared to Option A and Option B which would provide less that 1:5 year ARI.

Community view

From the community issues report (Part 3 long-term study) and feedback from the community, it was clear that Option A was the lowest scoring option. It would not improve the level of flood immunity, it would introduce a contraflow management system and it would only provide a total of three lanes across the bridge.

The score for Option B was close to option A. It is only marginally better than Option A as it would not improve the level of flood immunity but it does not introduce a contraflow management system.

Option C scored better than options A and B as it would provide an improved 1:5 year ARI flood immunity when compared to options A and B.

Option D scored the highest as the level of flood immunity is a key issue for the community. Although this option would restrict some movements at Old Kurrajong Road / Yarramundi Lane this is perceived to be less of an issue by the community compared to the greater flood immunity it would provide.

Cultural heritage

All options have the same impact through the townships of Richmond and North Richmond. Across the river and the on the riverbanks. Option A was considered to have the least impact on known cultural heritage items such as the old railway line, bridge abutments and other potential archaeological deposits, as it would follow the same alignment as the existing bridge.

Option B was considered to have a slightly higher impact on heritage items as the new bridge would be five metres downstream of the existing bridge alignment.

Options C and D received the lowest score as they would both locate the new bridge 25-50 metres downstream of the existing bridge and therefore have a greater potential to impact on the riverbank and potential archaeological deposits. Refer to the PEI for more detail about this assessment.

3.7.3. Further design considerations

Following the value management process and the actions arising from it, the following design considerations were identified:

1. For Option D a flood access / major accident contra-flow arrangement will be needed for the new carriageway.
2. The access to and from Hanna Park and the new roadway needs to be defined as well as the signage required to direct people to the park.
3. The accessibility issues for pedestrians from the retirement village need to be clarified.
4. Design development in future design stages to minimise impacts on recreational facilities such as the polo fields needs to occur.

3.8. Estimated cost and Benefit to Cost Ratio (BCR)

The strategic cost estimate for Option D is $154 million (in 2012 dollars at P90) with an estimated Benefit to Cost Ratio (BCR) of 2.8.

3.9. Making recommendation

3.9.1. Methodology

The recommendation of the preferred option is based on the results of three independent streams of work conducted as part of the Richmond Bridge and approaches congestion study project. These are:

1. Community and agency submissions received as a result of the community consultation process in September and October 2012.
2. The Value Management Workshop held in October 2012. This was conducted to analyse the short listed route options.
3. The technical assessment of the short listed route options.

The project team conducted an overall assessment of the short listed route options by comparing the outcomes of the three streams and considering costs and value for money.

Figure 22 shows how the recommendation is made.

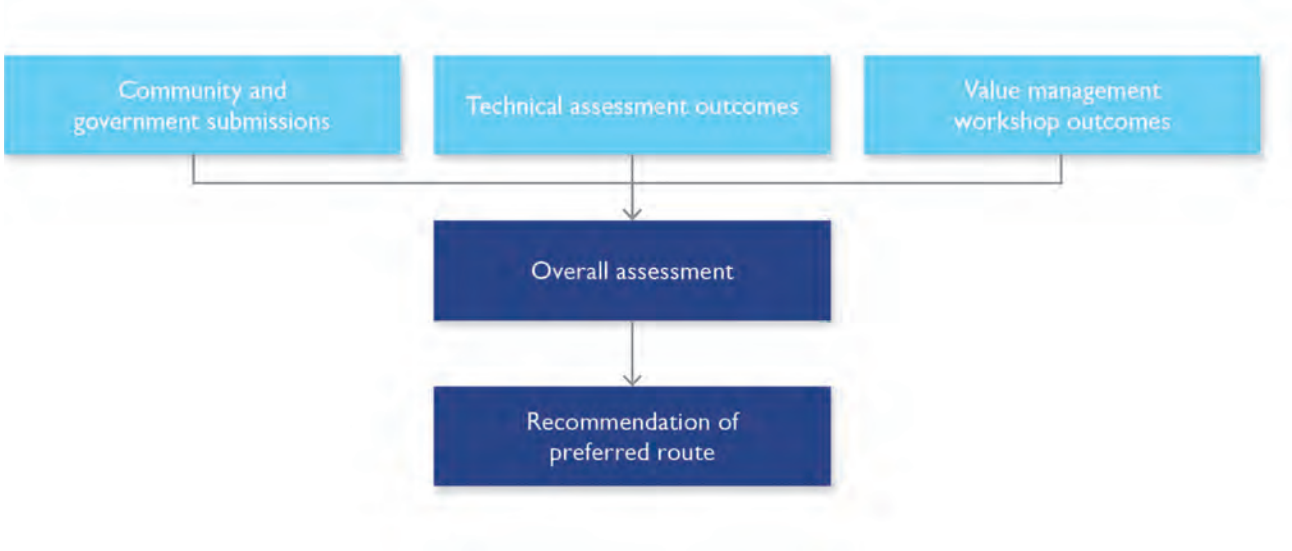


Figure 22 - Recommendation making process

Following the recommendation of the preferred option and approval by the applicable government agencies, the revised corridor can be reserved for the future and the option can be developed to a more detailed design stage.

3.9.2. Key outcomes of the three streams

The key outcomes of the three streams are:

Community and government (agency) submissions

A total of 31 submissions on the long-term options report were received. Based on the submissions Option D appears to have the strongest support, followed by Option C, B and A which received very little support.

Value Management Workshop

Option D was recommended as the preferred option by the Value Management Workshop attendees. The group considered that this option would present the best outcome for the local and wider community as it not only addresses the congestion issue but it also provides the highest level of flood immunity.

Technical assessment

The technical assessment undertaken by the project team scored Option D the highest on the non-price performance criteria, closely followed by Option C, then Option B. Option A scored the worst against the non-price performance criteria.

3.9.3. Recommended preferred option

Based on the comparison of the outcomes of the three streams and value for money considerations, Option D is the preferred option. It was selected for the following key reasons:

- It is the highest performing option on the non-price performance criteria
- It provides the greatest improvement to safety and road capacity
- It does not perform any worse than Option C and is only marginally worse than Options A and B in terms of noise, social amenity, local economic and environmental criteria
- It has the highest score on the community view criteria. This is strongly influenced by the higher level of flood immunity it provides (1:20 year ARI) when compared to the other options.

3.9.4. Preferred option summary

Option D will provide a total of four lanes (two lanes in each direction) along March Street, Kurrajong Road and Bells Line of Road between East Market Street, Richmond and Grose Vale Road / Terrace Road, North Richmond. The bridge and additional eastbound carriageway will be constructed at a level to provide 1:20 year ARI flood immunity. This would involve:

- Constructing a new two-lane bridge 25-50 metres downstream from the existing bridge
- Retaining the existing bridge
- Adding two lanes to Kurrajong Road eastbound carriageway between Chapel Street and Old Kurrajong Road / Yarramundi Lane to provide four lanes (two lanes in each direction)
- Removing some turning movements at Old Kurrajong Road / Yarramundi Lane
- Restricting street parking along the corridor to off peak hours in Richmond and North Richmond to provide for four lanes during the morning and afternoon peaks.

It is noted that in October 2012, HCC resolved to support, in principle, Option C subject to further analysis and the determination of the short-term options report currently being finalised in conjunction with the long-term options report. Council stressed that the in principle support for Option C may be reviewed in the light of further information or studies that may become available.

3.10. Next steps

Following the announcement of the preferred option and approval by the relevant government agencies, the next step is the reservation of the revised road corridor for future design and development. The plans showing the proposed new road corridor are attached in Appendix 5.

To reserve the corridor RMS would write to the local council providing a plan defining the extent of the boundary and requesting that the road corridor be included in the Local Environmental Plan. Council would then need to amend the existing Local Environmental Plan or include the corridor in a new Local Environmental Plan. These would then undergo statutory consultation before being approved by the NSW Minister for Planning and Infrastructure and formally gazetted.

Once fully incorporated into Local Environmental Plans, the corridor would be regarded as being reserved as a future main road.

Figure 23 shows the steps that are needed to reserve the road corridor.

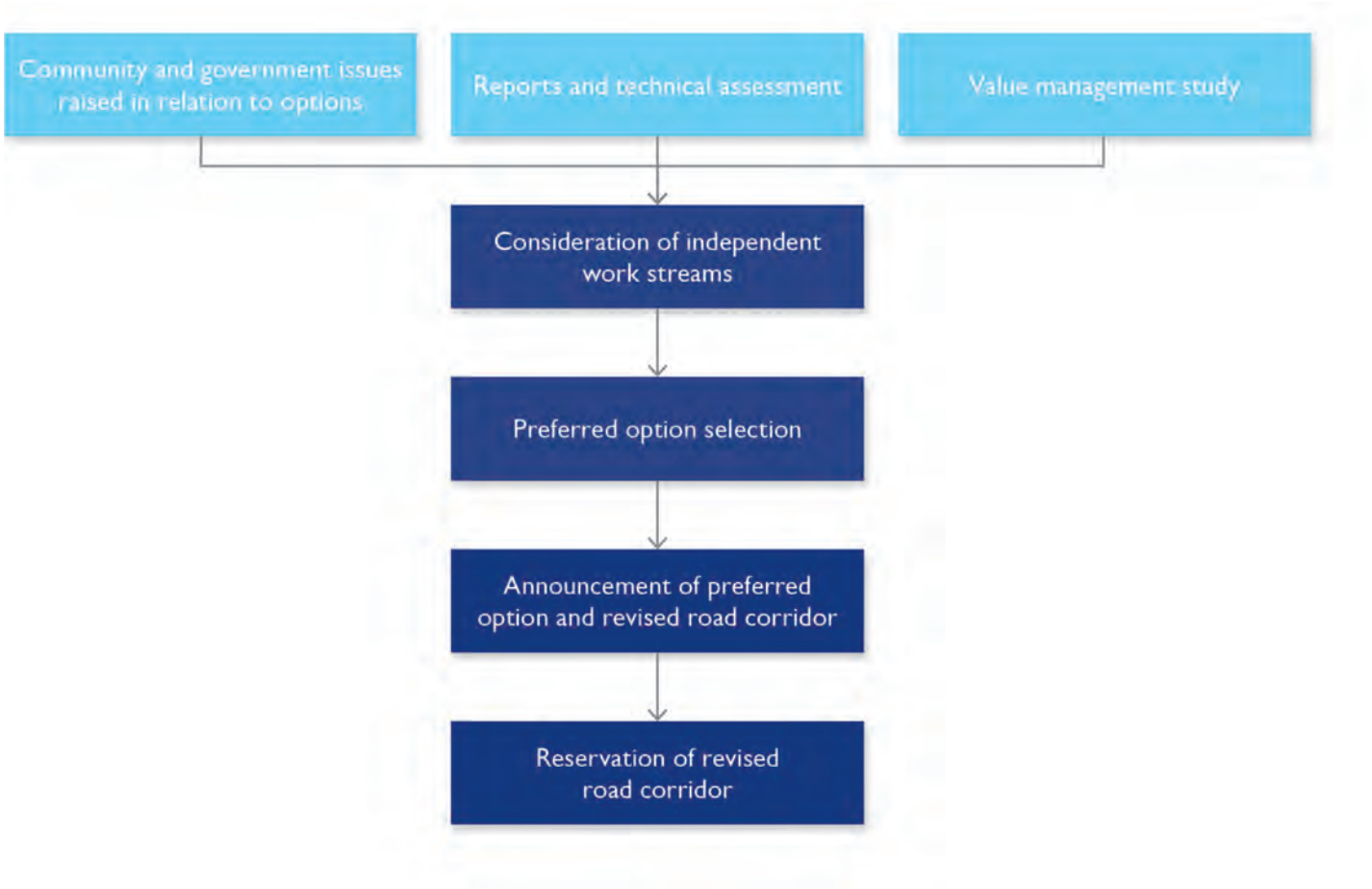


Figure 23 - Next steps to reserve a revised road corridor

References

- Austroads Guide to Road Safety Part 6
- Guidelines for Road Safety Audit Practices (2011), TfNSW's Centre for Road Safety
- National Guidelines for Transport System Management in Australia (2006), Australian Transport Council

The following reports are also available on the RMS project website:

http://www.rta.nsw.gov.au/roadprojects/projects/sydney_region/outer_west_blue_mtns/richmond_bridge/project_documents

- Richmond Bridge and approaches congestion study – Stage 1 short-term solutions
- Richmond Bridge and approaches congestion study – Stage 1 Appendix 2 (Bridge inspection and structural assessment)
- Community issues report (Part 2 short-term study)
- Richmond Bridge and approaches congestion study – long-term options report
- Community issues report (Part 3 long-term study)