

4 Rickabys Line option

4.1 Overview and description of the option

Two ex-RMS bridge engineers have proposed an alternative option to the project. The alternative is known as the Rickabys Line option and involves refurbishing and retaining the existing bridge for light traffic and building an alternative river crossing route to the west of Windsor. The Rickabys Line option was considered in Section 4.2.2 of the EIS based on the information available at that time, although it was then referred to as one of the Hawkesbury Valley Way options (three in total). At the time of preparing the EIS, there was insufficient detail available to assess this alternative more thoroughly. A bypass option west of Windsor was not considered a viable option during the options development and assessment phase or in the EIS due to potential impacts on Macquarie Park, vegetation communities listed under the *Threatened Species Conservation Act 1995* and flooding levels upstream of Windsor.

Since the exhibition of the EIS, the ex-RMS bridge engineers have provided a more detailed submission outlining their Rickabys Line option. This alternative option received media publicity and was identified in many submissions as a preferred alternative to the project. To provide more detail on the option the following information is presented:

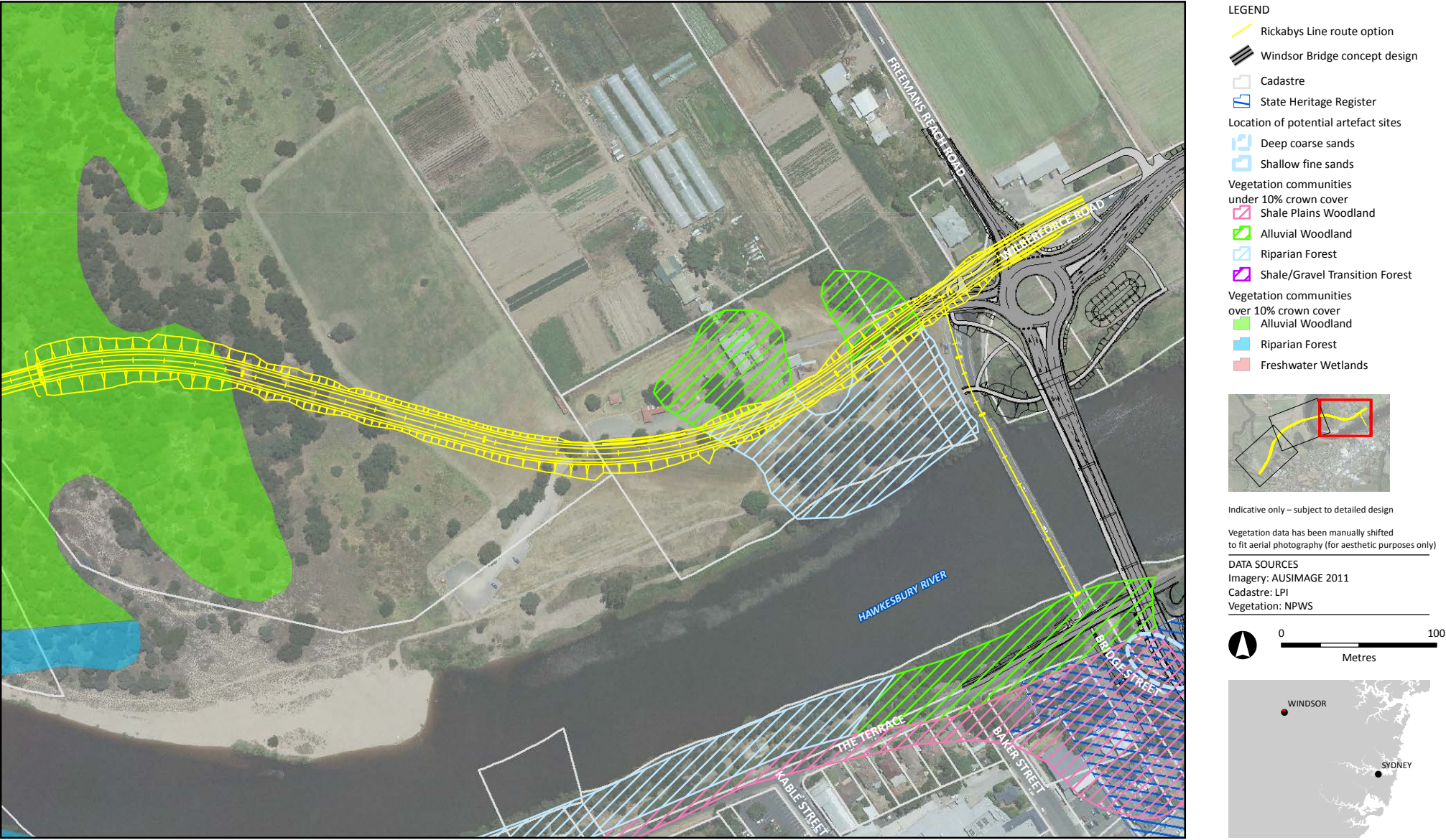
- A more detailed environmental impact assessment of the Rickabys Line option.
- A review of the alternative refurbishment methodology for the existing Windsor Bridge proposed as part of the Rickabys Line option.
- A review of the cost estimates supplied by the ex-RMS bridge engineers.
- Comparison of the Rickabys Line option against the project objectives and criteria.

The Rickabys Line option as presented in the submission includes:

- Rehabilitating and retaining the existing Windsor Bridge for light vehicles and pedestrian access. A cost estimate and overview of the proposed methodology to refurbish the existing bridge was also provided as part of the submission.
- Constructing a new two lane alternative route at AHD 11 metres to the west of Windsor, named Rickabys Line option. The Rickabys Line option would start at the intersection of Freemans Reach Road and Wilberforce Road, pass through Macquarie Park, cross the Hawkesbury River via a 200 to 240 metre long Super T bridge, head south west until Rickabys Creek where a 40 metre long bridge would be constructed and then head generally south between the Sebel Resort and Spa and the Rum Corps Barracks Golf Club before intersecting with Hawkesbury Valley Way.

To enable a more comprehensive environmental, cost and engineering assessment of the Rickabys Line option, a preliminary design of the alternative route was prepared based upon the description provided in the submission. In reviewing the description of the option as provided in the submission, a number of issues were identified as needing refinement to meet relevant design standards and mitigate significant impacts. These issues are outlined in the following sections. Based upon the refinements made to the proposed alternative a preliminary concept design was developed which is presented in **Figure 4-1** to **Figure 4-3**.

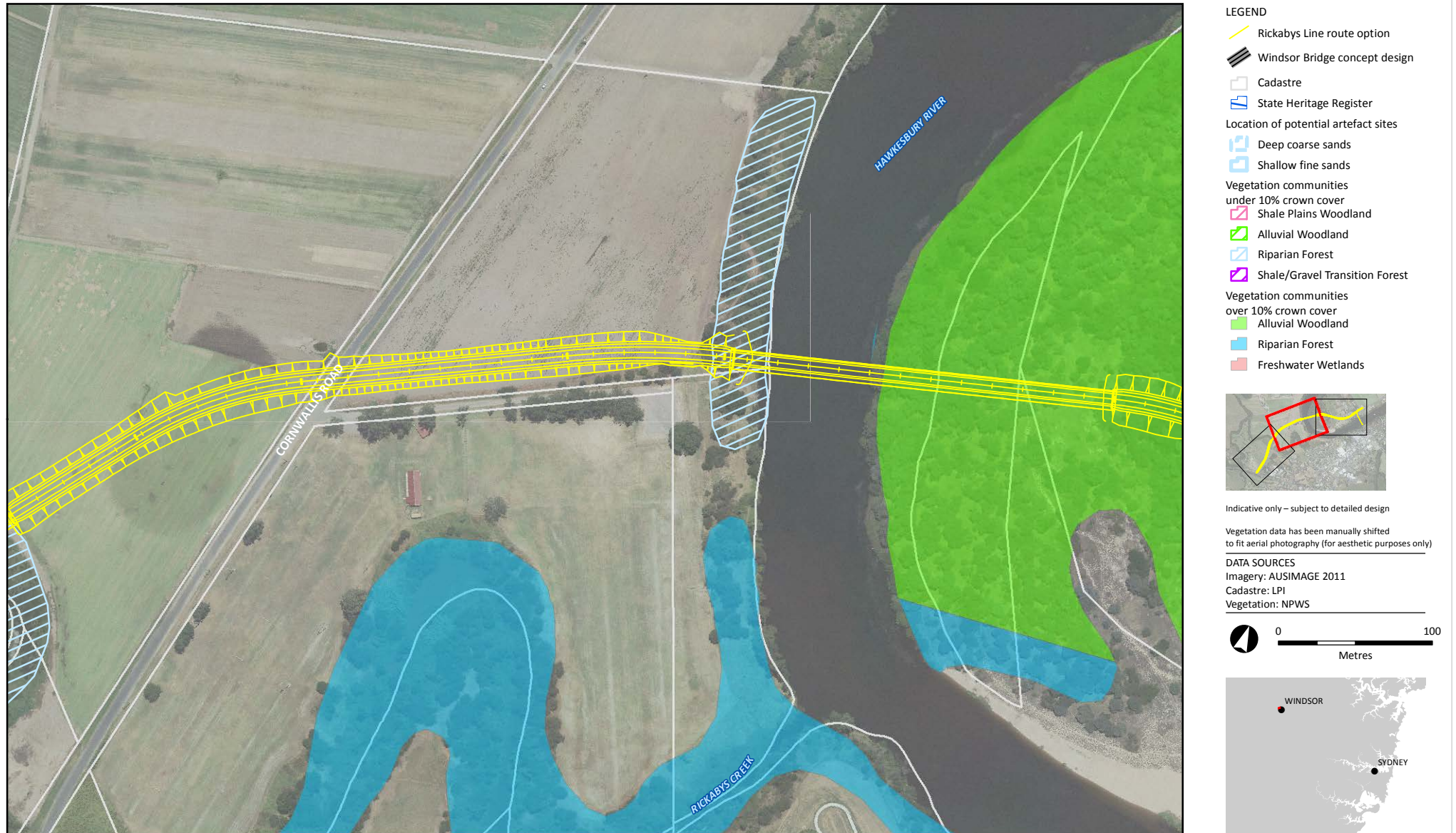
Figure 4-1 | Rickabys Line route option



Windsor Bridge replacement site layout plan



Figure 4-2 | Rickabys Line route option



Windsor Bridge replacement site layout plan



Figure 4-3 | Rickabys Line route option



Windsor Bridge replacement site layout plan



4.1.1 Bridge structure

The submission nominated Super Ts for bridge construction using the Kempsey Bypass bridges as an example and the basis for determining costs for the bridges. However, due to buoyancy impacts, the RMS does not permit the use of Super Ts where the soffit of the bridge is less than the 1 in 50 year flood level. As the bridges for the Rickabys Line option are around the 1 in 5 year flood level, the use of Super Ts would not be permitted. Instead, a conventional Queensland precast plank bridge was assumed for bridge construction. As described in Section 4.4 of the EIS, precast plank bridges are relatively easy and cheap to construct and are able to withstand regular immersion by floodwaters but they have a higher visual impact in comparison to other bridge types. A Queensland precast plank bridge has a maximum span of about 25 metres, which means that additional piers in the river and floodplain would be required to support the bridge. An incrementally launched bridge is proposed by RMS for the Windsor Bridge replacement project due to its better aesthetic qualities, fewer piers in the river and the ability to predominately construct it from the northern bank hence minimising construction impacts in Thompson Square. This bridge type was not considered for the Rickabys Line option because the need to minimise visual impacts was not a major factor in bridge type selection (given the bridge would be outside of Windsor) and the higher cost of the incrementally launched bridge type would not be justified.

4.1.2 Bridge height and levels

The submission nominated an alternative route and bridge level of 11 metres AHD. Preliminary design of roads and bridges at this level indicated that substantial fill embankments would be required along the majority of the alternative route. Specialist hydrologists have indicated that fill embankments of this level within the Hawkesbury River and Rickabys Creek floodplains would substantially increase flooding of upstream areas for flood events up to the 1 in 10 year ARI flood. To mitigate this impact, large sections of the alternative route would need to be constructed on a viaduct or large banks of culverts would be required, which would substantially increase costs. Also, with the road surface at 11 metres AHD, the intersection of the alternative route with the existing Windsor Bridge approach roads would be expensive and difficult to design and construct (due to the differences in levels between the alternative route and the existing bridge approach roads). Additionally, there would be no advantage in constructing the alternative route at 11 metres AHD as this would provide a higher level of flood immunity than the approach roads of Freemans Reach Road and Wilberforce Road, which would be closed to traffic in such an event.

To provide a reasonable comparison with the project, the alternative route road level was set at 9.8 metres AHD, which is about the same level as the lowest point on the project and the maximum flood level for which Freemans Reach Road remains open. Reducing the height of the alternative route road would also reduce the cost of this option as not as much fill material would be required. The 11 metres AHD for the bridge over the Hawkesbury River was retained as this was the level of the western bank at the proposed crossing location and, if in the future it was decided to increase the height of roads on the northern bank to provide improved access during flood events, the bridge would not require modification.

4.1.3 Pedestrian and cycle access

The submission did not contain any details of cycleways or footpaths apart from a two metre shared path on the bridges. For the purposes of the design and cost estimates, it has been assumed that apart from the shared path on the bridges, no dedicated shared paths would be provided. This reduces the overall costs of the alternative route option. The shoulders of the road would be wide enough to safely accommodate cyclists on the road pavement. Pedestrians would be unlikely to use the alternative route as it does not link with existing pedestrian routes.

4.1.4 Intersections

A preliminary concept design was prepared for the intersections of the Rickabys Line option with Hawkesbury Valley Way (see **Figure 4-4**) and the existing bridge/Freemans Reach Road/ Wilberforce Road intersection (see **Figure 4-5**). At Hawkesbury Valley Way, a traffic light controlled intersection would be required and Hawkesbury Valley Way would need to be widened to provide turning and merge lanes for traffic travelling to and from the Rickabys Line option. The intersection on the northern bank of the Hawkesbury River would be more complicated because it would not be possible to build a roundabout or four legged intersection that complied with road design and safety standards due to the low level and location of the existing bridge approach road in relation to the other roads. Instead, two traffic light controlled T-intersections would be required. A less complicated and better performing intersection could be built if the heritage listed Bridgeview property was acquired and demolished but this was not considered to be feasible. Cornwallis Road would require a minor realignment near its intersection with the Rickabys Line option to meet road safety design codes. The intersection of Cornwallis Road and the Rickabys Line option would be controlled by stop signs for traffic on Cornwallis Road.

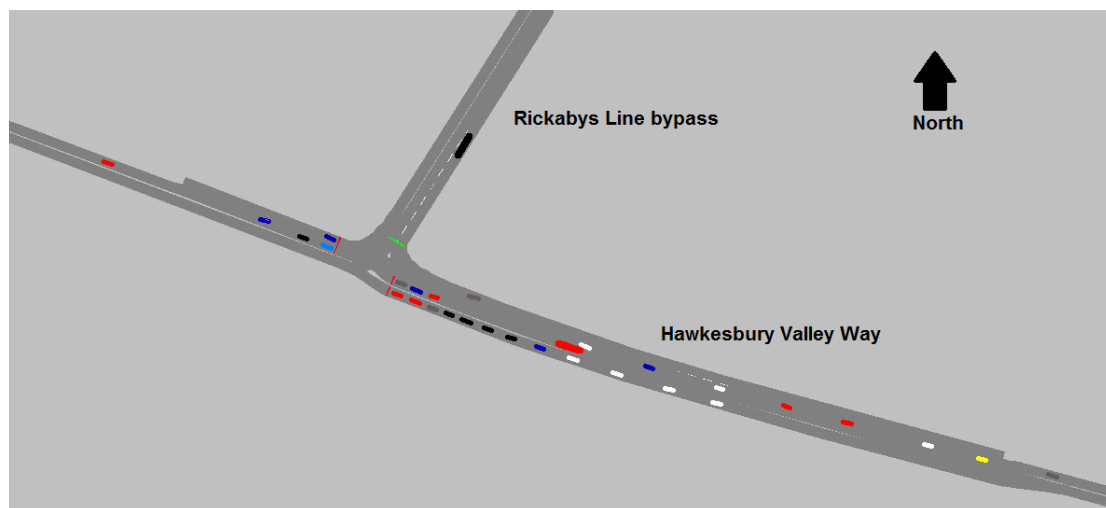


Figure 4-4 Hawkesbury Valley Way / Rickabys Line option intersection – traffic control signals

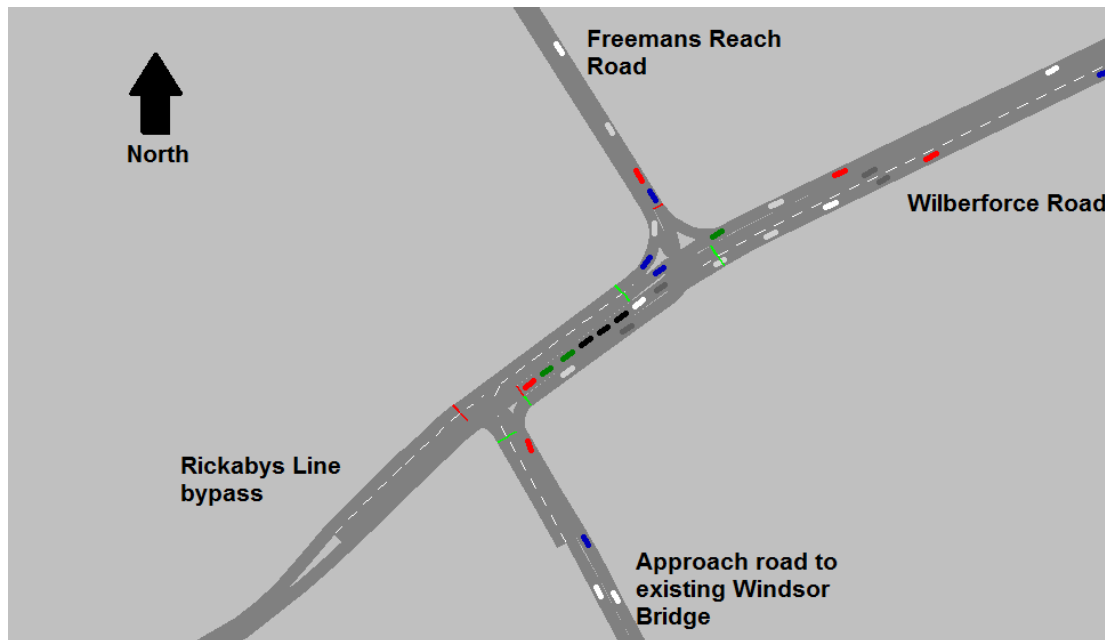


Figure 4-5 Wilberforce Road / Freemans Reach Road / Windsor Bridge / Rickabys Line option intersection – two signalised intersections

4.1.5 Route alignment

The Rickabys Line option described did not include a detailed description of the precise route proposed. For the purposes of this assessment, a more defined route has been identified. The route has been refined in some areas to minimise impacts and costs.

The route of the southern section (near Hawkesbury Valley Way) of the Rickabys Line option has been assessed based on the description in the submission, minimising the length (and therefore cost) of the alternative route, minimising property acquisition and minimising impacts on the Rum Corps Barracks Golf Course. The route of the Rickabys Line option in this section could be moved further to the west, although the cost of the option and impacts on Rum Corps Barracks Golf Course would be greater. It may, however, be preferable to move the route further west to minimise operational noise impacts on residential properties and the Sebel Resort and Spa.

Moving the route east of its current alignment is not considered feasible or desirable as land acquisition costs would be higher and operational noise impacts on about 100 residences would be potentially much greater. As these residences are currently not impacted by traffic noise, they would qualify for noise mitigation, which would substantially increase the costs of the option.

The route alignment of the bypass component of the Rickabys Line option is shown in **Figure 4-1** to **Figure 4-3**. As discussed above, the route could be modified within this corridor, however the route was identified to minimise potential impacts and reduce the cost of the option. While the environmental assessment included in the following sections is based on this alignment, it should be noted that the impacts identified would be broadly consistent with alternative alignments through this corridor.

4.2 Environmental Impacts

4.2.1 Historic heritage

A desktop level assessment of historic heritage has been undertaken for the alternative option. This assessment has identified there would be considerable construction and operational visual and amenity impacts on the heritage listed building in Macquarie Park and on a locally listed heritage building on the corner of Freemans Reach Road and Wilberforce Road ("Bridgeview"). The Rickabys Line option would pass very close to both buildings and these heritage listed buildings would experience a greater impact in comparison to what they would experience as a result of the project. There may also be other unknown historic sites to the west of Windsor that may be impacted by the alternative route option.

The Rickabys Line option would not result in any changes to the existing roads, parklands and heritage vistas of within Thompson Square Conservation Area. This is one of the significant impacts of the project that would be avoided by the Rickabys Line option. However, Thompson Square parkland would continue to be bisected by the 1934 approach road to the existing bridge and there would be around 10,000 vehicles a day still travelling through Thompson Square.

While heritage views and vistas within Thompson Square would not be impacted, the heritage vista from Thompson Square across the river would change with multiple traffic light controlled intersections and the start of the Rickabys Line option. This would change the heritage rural character of the landscape to one more urbanised and modern, although the northern roundabout proposed as part of the project would have similar impacts.

The archaeological remains below the ground surface in Thompson Square and on the southern bank and adjacent river bed would remain intact as there would be no need for works in Thompson Square and the archaeological investigation and salvage would not proceed.

The existing heritage listed Windsor Bridge would also remain *in situ*, rather than being demolished. This is another of the significant impacts of the project that would be eliminated by the Rickabys Line option.

Although the Rickabys Line option would have heritage impacts, it would undoubtedly have a lower impact on historic heritage than the project.

4.2.2 Aboriginal heritage

The impact of the Rickabys Line option on Aboriginal heritage cannot be assessed without undertaking additional detailed studies. Nevertheless, as much of the land impacted by the route has either been cleared and disturbed for agriculture or is below the 1 in 100 year flood level, the risk of encountering intact and significant Aboriginal archaeological sites during construction is likely to be low. There may, however, be sites containing isolated artefacts along the route and, if intact Aeolian sands are present, there may be locations with significant Aboriginal archaeological sites.

The impact of the Rickabys Line option on Aboriginal heritage is unknown.

4.2.3 Visual impact and urban design

A review of urban design and landscape impacts was undertaken for the Rickabys Line option. The review involved:

- Analysis of the existing study area conditions based on a desktop review of current background studies.
- Identification of the primary urban design and landscape issues and the likely key landscape character and visual impacts.

The major issues identified from the review are as follows:

- A large section of the bypass east of the Hawkesbury River would need to be constructed on a viaduct or large banks of culverts to mitigate potential flooding impacts. This section of the alignment would have a high physical and visual impact.
- The alignment traverses an area of Windsor that has few roads and would result in visual and landscape character impacts on areas not currently impacted by road infrastructure.
- The alignment would disrupt the existing landscape patterns by cutting across paddocks and parkland and intersecting local roads at a variety of angles.
- The alignment would have adverse physical and visual impacts on the important recreation areas of Macquarie Park and Deerubbin Park, with key issues as follows:
 - Macquarie Park would be bisected by the alignment, restricting access between the existing facilities and the river, including access from the playground, cafe and restaurant to the popular sandy beach area.
 - There would be extensive vegetation loss in the western section of Macquarie Park, which would have a potentially high impact on the park's character and amenity.
 - Adjustments would be required to a number of existing carparks and access roads within the park, which would affect the existing operations of the restaurant and cafe.
 - The alignment would run along the northern boundary of Deerubbin Park playing fields and may conflict with the existing carpark access road, in addition to having adverse effects on the recreational amenity of the park.
- The alignment would be highly visible from other important recreation areas, such as Howe Park and The Terrace.
- The alignment passes adjacent to the heritage listed residence, 'Bridgeview', and would have adverse impacts on the view of this building from the southern river foreshore.
- The road and embankment would be visible to motorists travelling along Cornwallis Road and from a number of farm buildings west of the river.
- The bridge over the Hawkesbury River and associated viaduct, would be potentially visible to motorists travelling south west along Freemans Reach Road, and from a number of farm buildings north of the river.
- The alignment would be highly visible when looking east from the carpark of the Rum Corps Barracks Golf Club.

- The alignment would potentially be visible from the grounds of the Sebel Resort and Spa, although its visibility may be reduced by the groups of existing trees along the western boundary of the resort.
- The alignment would generally not be visible from Thompson Square and George Street.

4.2.4 Traffic and access

Traffic performance

Traffic modelling of the Rickabys Line option was undertaken using the VISSIM regional road network model to assess its performance. The key findings of the traffic assessment are summarised below. The level of service for each of the intersections is presented in **Table 4-1**.

At the Macquarie Street/ Bridge Street intersection, vehicles wanting to turn into Macquarie Street from Bridge Street north in the morning peak are predicted to experience a 'poor' level of service with the alternative option and 'good' level of service with the project. This is one of the major turning movements at this intersection in the morning peak. There would be little difference in the level of service for other turning movements between the project and alternative. During the evening peak, the levels of service for major turning movements for both the alternative and the project are predicted to be good in 2016. In 2026, however, the alternative would provide a considerably better level of service in the PM peak than the project for all major turning movements at the Macquarie Street / Bridge Street intersection.

At the George Street/ Bridge Street intersection, the level of service in 2016 and 2026 would be similar for both the project and the alternative, for all major traffic movements.

For the intersection on the northern bank, the project would have high levels of service in both the morning and evening peak in 2016 and 2026. The more complex double T-intersection for the alternative would perform at a similar level to the project for all major turning movements, but would provide a lower level of service for vehicles turning from Freemans Reach Road towards Windsor Bridge and Rickabys Line option in the morning peak and vehicles travelling from Rickabys Line option into Wilberforce Road or Freemans Reach Road in the evening peak. There would be a particularly poor level of service for vehicles travelling from Rickabys Line option into Wilberforce Road or Freemans Reach Road in the evening peak in 2026.

The alternative would have an additional intersection where the Rickabys Line option connects to Hawkesbury Valley Way. The level of service at this intersection is generally good to acceptable except for south bound vehicles turning right into Hawkesbury Valley Way in the evening peak. However, the number of vehicles undertaking this movement in the evening peak is relatively small.

Overall, the alternative and the project are predicted to provide similar levels of service for major turning movements at all intersections with the following exceptions:

- The project's northern intersection would generally have a better level of service especially in the PM peak than the alternative. This is because the project's northern intersection is less complex with a roundabout, rather than a double T intersection. The roundabout also performs better for traffic flow outside peak periods.
- The Macquarie Street/Bridge Street intersection would have a better level of service in the evening peak in the future with the alternative compared to the project. This is because there would be less vehicles using the Macquarie Street/Bridge Street intersection as about 50 per cent of vehicles would be using the Rickabys Line option. In general the queues at this intersection would lower indicating reduced congestion.
- Macquarie Street / Bridge Street intersection would have a poor level of service in the AM peak compared with a good level of service for the project.

While there would be about 50 per cent fewer vehicles using Bridge Street and Windsor Bridge, there would still be about 10,000 vehicles a day with up to a 16 tonne load limit using this corridor based on traffic modelling.

It is likely that Bridge Street north of Macquarie Street to the intersection of Wilberforce Road and the Rickabys Line bypass would revert to a local road and would no longer be a major arterial route or approved B-Double route. As a local road, the responsibility for maintenance and further works in this corridor would be transferred to Hawkesbury City Council. Hawkesbury City Council have indicated that they are not in a position to be able to provide the required ongoing maintenance.

Construction traffic impacts on Thompson Square and Bridge Street for the alternative option would be similar to that predicted for the project as the main bridge across the Hawkesbury River would likely be constructed from the northern bank.

Table 4-1 Traffic performance (Level of Service) of the project and the Rickabys Line option for key turning movements

		2016 AM		2026 AM		2016 PM		2026 PM	
From	To	Project	Alternative	Project	Alternative	Project	Alternative	Project	Alternative
Macquarie Street/Bridge Street intersection									
Bridge Street N	Bridge Street S	A	B	A	B	A	A	A	A
Bridge Street N	Macquarie Street	B	D	B	D	C	D	C	D
Macquarie Street	Bridge Street N	A	A	A	A	B	B	F	D
Macquarie Street	Bridge Street S	C	C	D	C	C	C	F	E
Bridge Street S	Macquarie Street	A	A	A	A	A	A	F	A
Bridge Street S	Bridge Street N	B	B	C	C	B	B	F	C
George Street/ Bridge Street intersection									
Bridge Street N	George Street E	A	A	B	D	A	A	B	A
Bridge Street N	Bridge Street S	B	B	C	D	B	A	B	A
Bridge Street N	George Street W	B	A	C	D	D	A	F	A
Bridge Street S	George Street W	A	A	A	A	B	A	E	A
Bridge Street S	Bridge Street N	A	A	A	A	B	A	B	A
Bridge Street S	George Street E	-	A	-	A	-	A	-	A
Northern intersection									
Freemans Reach Road	Wilberforce Road W/ Bridge Street	A	C	B	C	A	D	A	E
Wilberforce Road W	Freemans Reach Road	A	A	A	A	B	A	A	A
Wilberforce Road	Rickabys Line	-	A	-	A	-	B	-	B
Wilberforce Road	Bridge Street	A	A	A	A	A	A	A	A
Bridge Street	Freemans Reach Road	A	-	A		A		B	-
Bridge Street	Wilberforce Road	A	C	A	D	A	B	B	B
Rickabys Line	Wilberforce Road	-	A	-	B	-	C	-	F

Pedestrian access

Many of the benefits to pedestrians and cyclists that would be provided by the project would not be provided by the Rickabys Line option, including:

- The sub-standard one metre wide pedestrian path on the existing bridge would remain as the only pedestrian access across the river from Thompson Square. This pathway is not suitable for cyclists and does not provide access for individuals with limited mobility.
- Pedestrians from the town centre or the upper Thompson Square parkland would still be required to cross the busy northern approach road to the existing bridge to access Macquarie Park.
- There would be no reconnection of The Terrace to provide continuous water front access for pedestrians.
- The traffic lights at the intersection of George and Bridge Street would not be installed and therefore there would be no new safety benefits for pedestrians crossing at this location. Around 10,000 vehicles a day are predicted to continue to use the Bridge Street/ George Street intersection with the alternative option, which would continue to interact with pedestrians trying to cross these roads.
- In contrast to the project, the Rickabys Line option would not contribute to meeting Hawkesbury City Council's objectives for their Mobility Access Plan and Great River Walk.

While the Rickabys Line option would include a two metre shared path across the bridges, there would be no connection to existing pedestrian paths or cycleways and therefore would be unlikely to be used. A shared path would not be provided along the road sections of the Rickabys Line option.

Overall, the alternative would result in poorer outcomes for pedestrian and cyclists in comparison to the project

Property access

There would be some changes in property access with the alternative option. The access for Bridgeview (Number 27 Wilberforce Road) and Number 33 Wilberforce Road would require some minor modifications, similar to those that would be required for the project (potentially left in and left out access only). Other properties may require minor changes to access but more consultation and design work is required to confirm the affected properties

The major impact on access would be for the Sebel Resort and Spa as the Rickabys Line option would sever the resort complex from their nine golf course. An underpass would need to be built to provide safe access for guests and workers from the resort complex to the golf course.

4.2.5 Noise and vibration

Noise modelling of the alternative option was undertaken using the preliminary strategic design (see **Figure 4-6** and **Figure 4-7**). It was not possible to undertake a full noise assessment as background noise data for west Windsor was not available.

With the Rickabys Line option, residential premises in west Windsor are predicted to experience additional traffic noise. Apart from some residences in Greenway Crescent and Claremont Crescent, however, the increase in traffic noise would be unlikely to be significant. For some residences in Greenway Crescent and Claremont Crescent, the increase in traffic noise would be greater as they would have a direct line of sight to the Rickabys Line option and would be between 150 metres and 250 metres away from the new alignment. Existing traffic noise at these locations would be relatively low due to the topography, shielding from other buildings and the distance to other traffic noise sources. The Sebel Resort and Spa would also experience considerably higher traffic noise with the alternative option.

While a proportion (about 50 per cent) of traffic would use the Rickabys Line option, there would still be a significant proportion of traffic (about 10,000 vehicles per day) using the existing bridge and travelling through Thompson Square. The properties along this route would still experience high levels of traffic noise, albeit lower than existing noise levels.

Macquarie Park would experience high traffic noise levels as the Rickabys Line option would bisect the park. As the Rickabys Line option would carry all of the heavy vehicle traffic that would otherwise pass through Windsor, and Macquarie Park does not currently experience significant traffic noise, the increase in noise levels within the park would be considerable and would reduce its amenity for recreational use.

Construction noise impacts would be lower for the Rickabys Line option than the project due to the greater distance between the road alignment and noise sensitive receivers such as residential properties. The only exception to this would be for the Sebel Resort and Spa, which is immediately adjacent to the new route alignment. The risk of vibration impacts during construction and operation would be negligible for the Rickabys Line option.

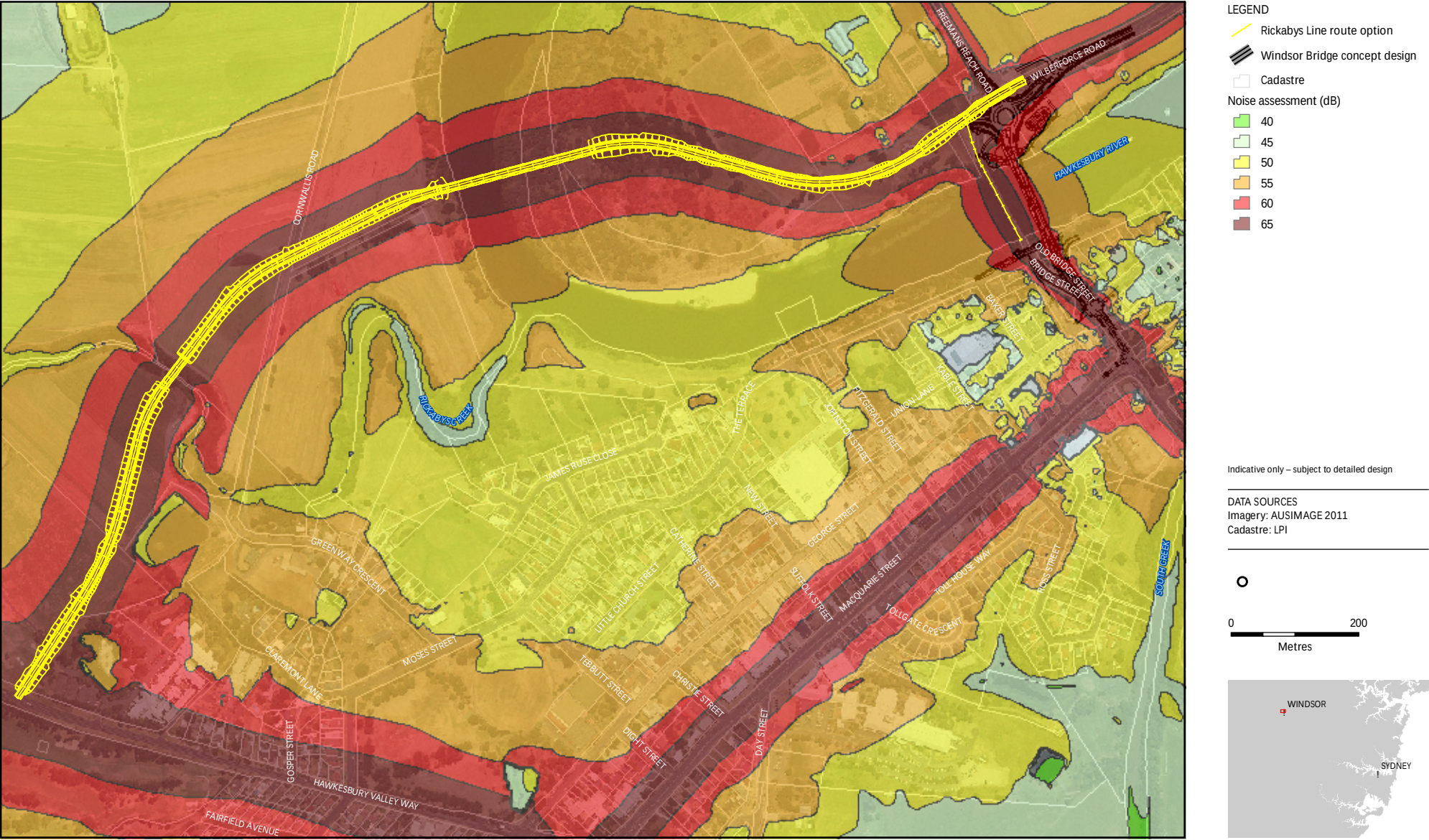
Overall, in comparison to the project, the Rickabys Line option would result in a minor reduction in noise levels in Thompson Square and at properties around Thompson Square. The alternative option would also result in new noise impacts, affecting Macquarie Park, some residential properties in west Windsor and the Sebel Resort and Spa.

4.2.6 Soil and water

For both the Rickabys Line option and the project, soil and water risks would be largely restricted to the construction phase in association with earthworks. The soil and water risks associated with the Rickabys Line option would be greater than those associated with the project as the Rickabys Line option involves two bridges and a longer length of road. For both the Rickabys Line option and the project, however, the soil and water risks can be effectively managed using standard environmental management measures and are not a major consideration for option selection.

The requirements for operational water quality control measures would be substantially greater for the alternative option (compared with the project) due to the length of the road and the presence of two bridges. While the cost of operational water quality controls has been included in the cost estimate for the project, this cost has not been included in the cost estimate for the alternative.

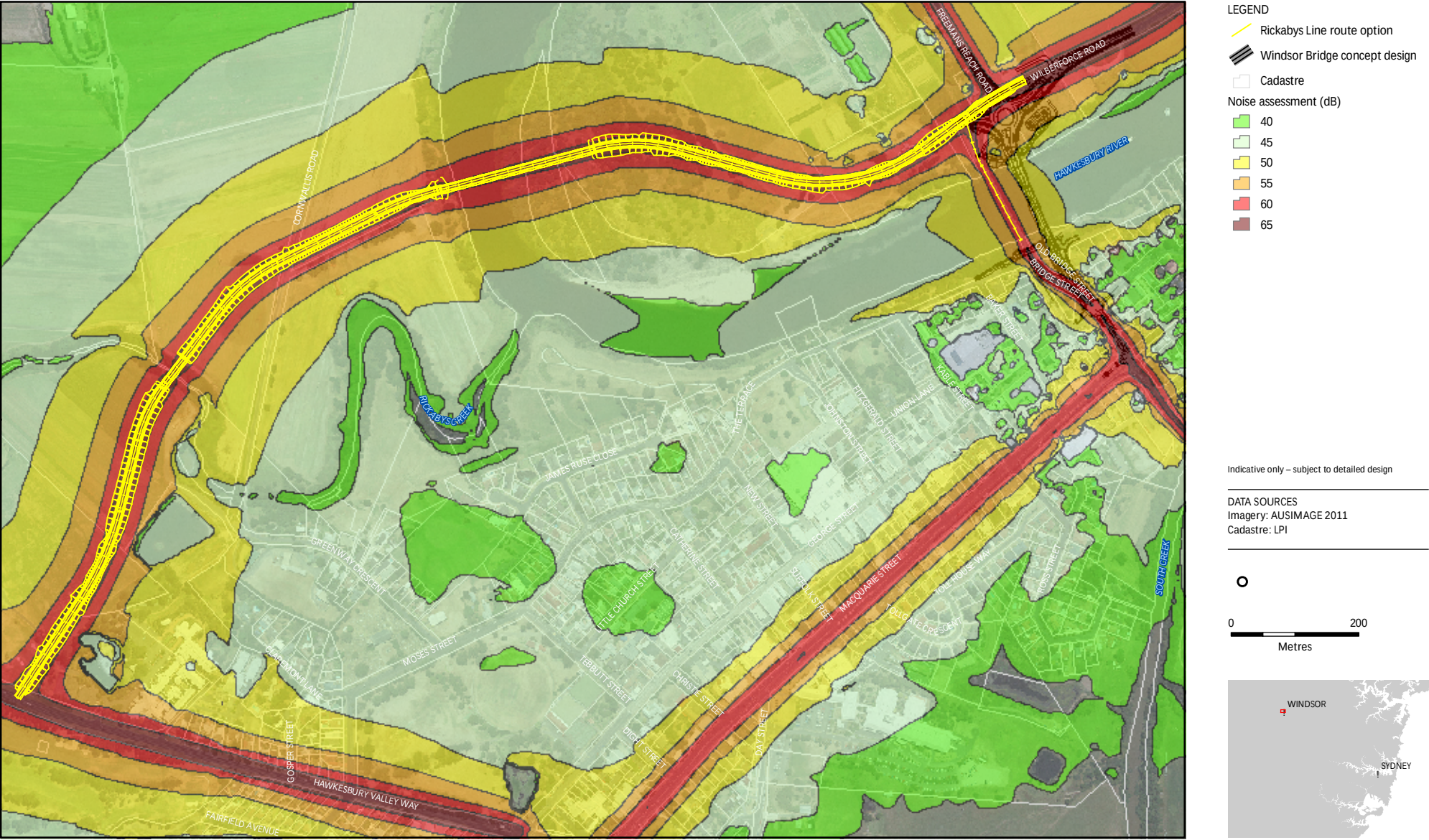
Figure 4-6 | Rickabys Line preliminary noise assessment - day



Windsor Bridge replacement site layout plan



Figure 4-7 | Rickabys Line preliminary noise assessment - night



Windsor Bridge replacement site layout plan



4.2.7 Flora and fauna

The Rickabys Line option would require clearing of around 1.6 hectares of woodland in Macquarie Park, the majority of which comprises *Forest Red Gum-Roughbarked Apple grassy woodland on alluvial flats*. This vegetation community corresponds to *River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions*, which is listed as an threatened ecological community under the NSW *Threatened Species Conservation Act 1995* (TSC Act), with a listing status of *endangered*. The clearing required for the Rickabys Line option would result in substantial fragmentation of this community and RMS may be required to purchase biodiversity offsets to compensate for this clearing. Small areas of riparian woodland would also need to be cleared on the western side of the Hawkesbury River and on either side of Rickabys Creek.

As the project involves removal of very few trees and no threatened ecological communities, the alternative option would have a substantially greater impact on flora and fauna than the project.

4.2.8 Socio-economic impacts

Land use

The Rickabys Line option would have a greater impact on land use than the project.

Around 3.5 hectares of parkland in Macquarie Park, 3.4 hectares of land used for turf farming, 0.3 hectares of horticultural land, and 0.4 hectares of a golf course would need to be acquired for the Rickabys Line option. The area of Macquarie Park located to the north of the Rickabys Line option route would become unusable due to severance from main park area. As well the loss of parkland, the traffic noise levels in the park would increase substantially, reducing its amenity.

Overall, the Rickabys Line option would result in a reduction of public open space, while the project would result in an increase in public open space. The Rickabys Line option would also result in a greater loss of productive agricultural and horticultural land and require acquisition of more private property.

Business impacts

The Rickabys Line option may result in both positive and negative business impacts for Windsor. Most of the studies on the impacts of town bypasses have concerned highway bypasses of rural towns. Many of these towns were the most convenient or only location for the local and regional community to access shops and services and, consequently, the towns did not experience a significant loss of patronage or long-term economic impacts after the opening of the bypass.

Windsor is different from a typical rural town in that it has a number of other nearby townships that can provide shopping and other services. The Rickabys Line option would allow regional traffic to bypass the Windsor town centre and instead more easily access Richmond or Rouse Hill shopping areas. Studies have shown that economies of adjacent communities may grow at the expense of the bypassed community through two effects: 1) travellers may choose to stop at a centre on the highway instead of the bypassed town and 2) local residents have easier access to metropolitan centres and may tend to use these centres in preference to shopping

locally (Sivaramakrishnan and Kockelman, 2002; Handy *et al.*, 2000). While it is impossible to predict whether this would occur with a bypass of the Windsor town centre, it is a risk that needs to be considered.

While there would be a reduction in traffic in Thompson Square, this alone is unlikely to result in greater numbers of tourists or visitors to the local area. There would still be thousands of vehicles a day using the existing bridge and approach roads and the split of the Thompson Square parkland and poor pedestrian access around the local area would remain.

4.2.9 Hydrology

The ex-RMS bridge engineer's submission contained an assessment of the potential flooding impacts of the Rickabys Line option bridge over the Hawkesbury River based on data from the EIS. They concluded that the Rickabys Line option bridge over the Hawkesbury River was unlikely to result in substantial increases in flood levels upstream. Project hydrologists generally agreed with this assessment as the Rickabys Line bridge over the Hawkesbury River is at 11 metres AHD and this is the level where the breakout of floodwaters across Freemans Reach occurs.

The ex-RMS bridge engineers did not, however, assess the impact on upstream flood levels of the road component of the alternative option. The road component would need to be built on a fill embankment, which would present a barrier to flood waters across the flood plains of both Rickabys Creek and the Hawkesbury River.

Modelling of the hydrological impacts of the alternative option was undertaken using the same model used in the EIS for the assessment of the project. The modelling was based on the preliminary concept design of the alternative option, with a road height of 9.8 metres AHD and a Hawkesbury River bridge height of 11 metres AHD. As noted previously, the road height of 11 metres AHD nominated in the ex-RMS bridge engineer's submission was not used on the advice of project hydrologists, as it was considered that it would have an unacceptable flooding impact on properties upstream. The alternative option also includes retaining the existing Windsor Bridge, which would mean that there would be three bridges which may have an impact upstream on flood levels.

The changes in flood levels at upstream locations in the river and on the floodplain as a result of the alternative option are presented in **Table 4-2**. The locations are slightly different to those presented in the EIS, as the alternative option would also impact the Rickabys Creek floodplain.

Based on the modified Rickabys Line design (to minimise flooding impacts), impacts for modelled floods larger than the five year flood event would be relatively minor and could be managed without incurring substantial flood mitigation costs. For the 5 year flood event, levels would increase by about 0.10 metres at locations just upstream of the Hawkesbury bridge and about 0.05 metres at Yarramundi. These increases in flood levels are almost identical to those identified for the project in the EIS. For relevant locations, the increase in flood levels due to the project for the 5 year flood are presented in brackets in **Table 4-2**. As the increase in flood levels are so similar, the impacts presented in the EIS for the project would be similar for the alternative option. These impacts are as follows:

- Twenty two buildings would experience increased flooding levels greater than 0.01 metres. Of these 22 buildings, two have an existing over floor flooding level of greater than one metre. The average increase in flood levels for the other 20 buildings would be about 0.09 metres. There would be 15 buildings with an increase in flood levels of greater than 25 per cent, two of which are generally subject to low levels of flooding (less than 0.1 metre) under existing conditions. These two buildings would be at most risk of increased flood damage from increases in flood levels.
- There would be increased inundation of about 400 property lots upstream of the bridges. The vast majority of the property lots are agricultural, horticultural or Crown land without any buildings or residential dwellings. Land that is within the existing five year flood event extent has an average depth of floodwaters under existing conditions ranging from 1.8 metres to over six metres, with the average increase as a result of the project ranging from 0.03 metres to 0.09 metres.

Table 4-2 Change in peak flood level as a result of the alternative option

	Hydraulic impacts of the alternative option (m)			
	5 year flood	20 year flood	100 year flood	Probable maximum flood
River locations				
Downstream of Penrith Weir	0.00 (0.00)	0.00	0.00	0.00
Yarramundi	0.05 (0.04)	0.02	0.00	0.00
North Richmond	0.06 (0.06)	0.02	0.00	0.00
Hibberts Lane	0.08 (0.09)	0.02	0.00	0.00
Argyle Reach Road	0.09 (NA)	-0.01	0.00	0.00
Hawkesbury River upstream of proposed crossing	0.09 (NA)	-0.01	0.00	0.00
Cornwallis Road bridge over Rickabys Creek	0.08 (NA)	0.03	0.01	0.00
Hawkesbury Valley Way over Rickabys Creek	0.08 (NA)	0.03	0.01	0.00
Floodplain locations				
Cupitts Lane	0.08 (NA)	0.03	0.00	0.00
Cornwallis Road upstream of Hawkesbury crossing	0.08 (NA)	0.00	0.01	0.00
Freemans Reach Road overflow path	-0.02 (NA)	0.00	0.00	0.00
Richmond	0.00 (NA)	0.00	0.01	0.00
Agnes Banks	0.04 (0.04)	0.01	0.00	0.00

As discussed in **Section 2.11**, the increases in flooding levels predicted in the EIS were identified as a matter of concern by the OEH in its submission on the EIS. As such, more detailed flooding investigations have been undertaken.

To respond to OEH concerns and to further assess requirements for scour protection, the flood modelling for the project has been revised using a more accurate model and the most up to date bridge design (refer to **Section 3.2**). The latest bridge design has a shallower profile, a lower number of piers in the river and less bulky piers compared to the bridge design used in the flood modelling for the EIS. The preliminary results from revised modelling indicate that the project would have considerably less impacts than those presented in the EIS, with no or negligible increases in flood levels immediately upstream of the replacement bridge. There would be no additional costs to mitigate flood impacts.

While there may be a reduction in predicted flood levels for the alternative option with the use of the revised model, these reductions would be relatively small as:

- For the alternative option, the road embankments are causing the increase in upstream flood levels rather than the bridges. Unless the road level is lowered, which would reduce its flood immunity to below the project's, or flood waters are allowed to pass through the road alignment either via large banks of culverts or constructing sections of the road on viaducts, the change in upstream flood levels would be minimal. The cost of either providing large banks of culverts or constructing sections of the road on a viaduct are considerable and would be additional to the cost estimate for the alternative option provided in this report.
- One of the issues with the original hydrological model was that it did not accurately model the complex meander of the Hawkesbury River immediately upstream of the project. This resulted in an overestimation of upstream flood levels. As the alternative option is upstream of the meander of the Hawkesbury River, the tendency of the model used in the EIS to overestimate upstream flood levels would be reduced or eliminated.

Overall, the alternative option would have a greater impact on upstream flood levels for the five year flood compared to the project. The costs for flood mitigation of affected upstream properties or engineering solutions to allow water to pass through the road alignment are likely to be high and would be in addition to cost estimate for the alternative option presented in **Section 4.4**.

4.2.10 Air quality

The alternative option would reduce the number of vehicles travelling through Thompson Square by about 50 per cent and remove all vehicles greater than 16 tonnes. This would result in an improvement in air quality in and around Thompson Square. Nevertheless, there still would be about 10,000 vehicles a day travelling through Thompson Square and contributing to local air pollution.

The Rickabys Line option would be unlikely to result in exceedances of air quality criteria for residences and businesses given that, with the exception of the Sebel Resort and Spa, the closest residences and businesses are more than 100 metres from the road alignment.

Overall, in comparison to the project, the alternative option would reduce air pollution in Thompson Square but it would also create new localised air quality impacts along the alignment of the new bypass route. As presented in Section 7.10 of the EIS, however, the project would result in very few exceedances of air quality criteria based on conservative assumptions.

4.3 Alternative bridge refurbishment methodology

As part of their submission on the EIS, the ex-RMS bridge engineers detailed an alternative to the RMS methodology to refurbish the existing Windsor Bridge. Costs for the alternative bridge refurbishment methodology were also provided, which were considerably below the costs for the RMS methodology. The ex-RMS bridge engineers and many other submissions claimed that the RMS refurbishment methodology and associated costs were inflated and that these inflated costs were used as the basis for discarding the bridge refurbishment option.

The alternative bridge refurbishment methodology proposed by the ex-RMS bridge engineers is outlined in **Section 4.3.1**. The ex-RMS bridge engineers claimed that all works could be undertaken with only minimal closures of the existing bridge.

A comparison of the alternative refurbishment methodology and the RMS refurbishment methodology is presented in **Section 4.3.2**. An independent technical review of the alternative bridge refurbishment methodology is presented in **Section 4.3.3**. A review of the cost of the alternative bridge refurbishment methodology is presented in **Section 4.4**.

4.3.1 Outline of alternative bridge refurbishment methodology

The submission from the ex-RMS bridge engineers provided the following description of the alternative refurbishment methodology for the piers and superstructure.

Piers

"It is envisaged that the external plates would be in half section semi-circles with flanges for making a bolted connection between the half sections. Neoprene packing would give a uniform tight fit to the cylinders. The strengthening would only need to go for the depth of the cylinder that is severely affected by graphitization. The depth required for strengthening the cylinders would need to be determined (assumed 3.35m). It is envisaged that 16mm thick plates would be satisfactory for the strengthening covers"

Superstructure

"It is envisaged that the underside of the reinforced concrete deck could be restored by:

- a) Using high pressure water blasting of the underside surfaces from barges under the deck to ensure traffic using the deck is not disrupted;*
- b) Inspecting the reinforcement for possible loss of cross sectional area and determining if supplementation of the reinforcement is required;*
- c) If supplementation of the reinforcement is required it can be readily achieved by using carbon fibre epoxy bonded to the final concrete surface;*
- d) Replace the blasted concrete using "gunniting" or "shotcreting" process;*
- e) Provide a protective coating to the repaired and/or strengthened concrete"*

4.3.2 Comparison of alternative and RMS bridge refurbishment methodology

Many of the differences in methodology and costs between the RMS and alternative bridge refurbishment methodology are due to the differing load limits achieved by each method. The alternative bridge refurbishment methodology aimed to provide:

- A low up front cost to refurbish the bridge. While the initial cost of alternative refurbishment method is low, the long term maintenance costs would be high and the refurbishment method would not address some of the design features of the existing bridge that are causing its deterioration. This is further discussed in **Section 4.4**.
- A refurbished bridge with load limits and that is suitable for light vehicles use only. The refurbished bridge would not meet the required load factor for the current maximum legal load limits. An alternative methodology to strengthen the bridge to the current maximum legal load limits was proposed. However the costs of this were not estimated but would necessarily exceed the costs presented below.
- A refurbished bridge that is part of a regional road upgrade which includes an alternative route.

The RMS bridge refurbishment methodology aimed to provide:

- A low long term maintenance cost – as generally maintenance and access costs for repairs to heritage bridges are considerably higher than more modern bridges. This requires additional initial refurbishment works and costs compared with the alternative methodology.
- A refurbished bridge that would meet the required load factor for the current maximum legal load limit.
- A refurbished bridge that would not include any other regional road upgrades and would be the primary crossing of the Hawkesbury River at Windsor.

The different objectives of the two refurbishment methods explain most of the differences in work elements and costs. Additionally, unlike the RMS cost estimate, the cost estimate provided for the alternative methodology did not include incidentals, such as RMS costs and contingencies. This is discussed further in **Section 4.4**.

The work elements for each of the bridge refurbishment methodologies are described in **Table 4-3**.

Table 4-3 Comparison of work elements

2009 RMS refurbishment methodology	Alternative refurbishment methodology
Concrete encasement of piers	Steel jacket around piers
Re-Alkalisisation and patch and repair of damaged concrete	Conventional patch and repair of damaged concrete
Other minor works to replace bracing and repair headstocks	None
Strengthening of bridge deck using steel girders	None as strengthening not required for light vehicles. If strengthening was proposed to meet current maximum legal load limits, carbon fibre strips would be used.

4.3.3 Technical review of alternative bridge refurbishment methodology

An independent technical review of the alternative bridge refurbishment method was undertaken by an industry-recognised specialist in bridge rehabilitation. This included reviewing the alternative bridge refurbishment method to provide comments on the:

- Technical merits of the solutions.
- Constructability of the alternative bridge refurbishment method in terms of impacts on traffic.
- Completeness of the alternative bridge refurbishment method with respect to the items and quantities identified in the bill of quantities.
- Durability of the alternative bridge refurbishment method.

A summary of the review is presented below. The full report is presented in **Appendix C**.

Substructure

The review concurred with the approach of steel jacketing of the existing piers but recommended a number of modifications to improve the long term durability and performance of the method including:

- Increasing the length of the pier covered by the new steel jackets to protect the integrity of existing iron and to ensure that there is adequate coverage of sections of the piers that are cracked, damaged or experiencing graphitisation which continued to the river bed level.
- Increasing the thickness of the steel jackets from 16 millimetres to 20 millimetres to allow for corrosion over time.
- Rather than relying on neoprene packing alone, grouting the space between the iron piers and the steel jackets to ensure that there is effective load transfer into the steel jackets. The grout would also prevent water ingress between the cast iron piers and the steel jackets and reduce further corrosion of the iron piers.
- Repair and treat pier diaphragms.
- Replacing all corroded sections of the horizontal bracing between the piers.
- Removal of the lead-based paint and repainting of the above water metal components of the substructure would be required to preserve the cast iron and steel work. Repainting would be required approximately every 15 - 20 years.

The design life of the refurbished piers would be 100+ years. The steel jacketing of the piers can be undertaken without any impact on the traffic using the bridge.

Superstructure

The review concluded that the alternative methodology for the refurbishment of the bridge deck would successfully repair the current damage to the concrete deck to return the bridge deck to an “as is” condition. The alternative methodology does not, however, address some of the causes of deterioration in the concrete deck and would have high long term maintenance costs and access requirements. Access to areas below the existing bridge deck is difficult as, unlike modern bridges, the design of heritage bridges does not consider maintenance access requirements.

To minimise long term maintenance costs and remedy the causes of the deterioration in the concrete deck, the review proposed a number of additional activities to complement the alternative bridge deck refurbishment methodology including:

- Re-alkalisation of the concrete – which would protect the existing concrete and reduce the amount of patch repair of the concrete in the longer term.
- Repair the deck joints – mainly to limit the ingress of water into the joints to limit the corrosion the steel reinforcing in the concrete beams.
- Minor repairs to the headstocks – to remove and replace spalled concrete.
- Minor modifications to bridge deck drainage – to remedy the current problem where water collected from the bridge deck drains directly on the concrete beams of the bridge and cause corrosion of the steel reinforcing.
- Placing a waterproof layer and asphalt on the road surface of the bridge deck – to again limit water ingress into the concrete elements beneath.

If the works described above were implemented, the long term maintenance would generally consist of minor concrete patch repairs and application of an anti-carbonation coating every ten to twelve years. The design life of the superstructure would be 50+ years.

If only the works described by the ex-RMS bridge engineers were undertaken, regular major patch repairs of the deck would be required and it is likely that the other works identified by the reviewers would have to be undertaken in the short to medium term. This would be unacceptable to RMS and would have longer term whole of life costs than the approach suggested by the reviewers. It is also noted that if a bypass is constructed and the existing bridge is retained for light traffic, the existing bridge would no longer be part of an arterial route. Instead, it would become a local road and responsibility for maintenance would be transferred to Hawkesbury City Council. Under this scenario, low cost maintenance would be a key criterion in determining the most appropriate method for refurbishment.

Most of the works could be undertaken with no impact on traffic. Some works (eg repair of the bridge deck joints) would require partial closure of the bridge. These works would be undertaken at night or during other low traffic conditions. As the bridge would need to be reopened every day to cater for peak traffic movements, the progress of these works would be relatively slow and could take up to three months to complete. Full closure of the bridge and diversion of traffic to an alternative river crossing would only occur for short periods (less than half a day at a time).

Strengthening of the existing bridge deck

The alternative methodology proposed by the ex-RMS bridge engineers would result in a load factor of about 1.5 for current legal maximum loads (42.5 tonne semi-trailer and 62.5 tonne B-double vehicles). The additional works proposed by the technical reviewers would increase the load factor to about 1.87, which is still below the required safe load factor of 2. If load limits were placed on the existing the bridge, a load factor of 2 would be achieved.

If, however, the bridge was required to have a load factor of 2 for the current legal maximum loads or the T44 standard, additional strengthening of the bridge would be required. The alternative methodology proposes the use of carbon fibre strips which are bonded to the existing concrete deck beams to provide them with additional strength. Apart from potential long term maintenance issues if the carbon fibre strips are incorrectly applied, their use to strengthen the bridge would be suitable and is

likely to result in the bridge having a load factor of 2 or greater for the current legal maximum loads or the marginally higher T44 standard. The carbon fibre strips alone are unlikely to be able to achieve a load factor of 2 or greater for the M1600 standard. This is the current standard that all new bridges are required to achieve. Further, because of the possible future recurrence of carbonation of the repaired concrete, the long-term performance of carbon fibre strips cannot be guaranteed.

Summary

The alternative bridge refurbishment methodology is a viable approach to restoring the existing bridge, although additional works (in addition to those proposed by the ex-RMS bridge engineers) would be required to remedy some of the causes of bridge deterioration and reduce long term maintenance costs. These additional works would increase the cost estimates provided by the ex-RMS bridge engineers. This is further discussed in **Section 4.4**.

The refurbished bridge would be capable of achieving a load factor of 2 if load limits on the bridge were introduced. The bridge could be further strengthened to have a load factor of 2 for the current legal maximum loads or the marginally higher T44 standard through the use of carbon fibre strips.

The works associated with refurbishment could be undertaken with only minor closures of the bridge. Full closure of the bridge over an extended period would not be required.

4.4 Review of cost estimates for Rickabys Line option

In their submission, the ex-RMS bridge engineers presented cost estimates for both the bypass and the refurbishment of the existing Windsor Bridge, the two components of the Rickabys Line option. Based on their cost estimates, the ex-RMS bridge engineers claim that the Rickabys Line option could be delivered for a similar cost to the project. The cost estimates for each component have been reviewed and are discussed in further detail in the following sections.

4.4.1 Costs estimates for the alternative route

The cost of the alternative route component of the Rickabys Line option estimated by the ex-RMS bridge engineers was approximately \$61 million. The cost estimate for the alternative route was based upon press releases and media articles detailing the costs, length and type of bridges used for the 3.4 kilometres Kempsey Bridge and costs for the road component of Kempsey Bypass. This information was then prorated to provide an indication of the approximate costs per square metre of bridge and metre of road for the Rickabys Line option. There are, however, a number of reasons why the Kempsey Bridge and Kempsey Bypass projects do not provide a realistic basis for cost comparison. These reasons are as follows:

- The Kempsey Bridge project was constructed using Super Ts. As discussed above, Super Ts would not be permitted for the Rickabys Line option bridge due to their poor flood performance.
- The majority of the Kempsey Bridge was across the floodplain and the construction contractor was able to use land-based construction methods, which are generally 30 per cent cheaper than marine based construction. While some of the spans of Rickabys Line option bridge could be constructed via land-based construction, a greater proportion of construction would be marine based.

- The construction contractor undertook the piling themselves rather than subcontracting this activity, which reduced the costs of the Kempsey bridge. This is relatively uncommon and is only cost-effective for large bridge projects. For the Rickabys Line option, there would be insufficient piles to justify self-performing pile installation and therefore this activity would be subcontracted and would cost more than for the Kempsey bridge.
- The Super T girders were supplied at or near cost to maintain the operational viability of a pre-cast facility.
- There are considerable efficiencies of scale in constructing over three kilometres of bridges compared with about 0.3 kilometres of bridges for the Rickabys Line option.

Consequently the cost of the Kempsey Bridge project was low in comparison to typical costs for bridges. Typical recent rates for similar bridges have ranged between \$3,500 and \$6,000 per square metre. While the alternative costs addressed some of these issues and used a cost of \$3,500 per square metre of bridge, this is still in the lower range for bridges and does not reflect the construction complexity of the bridge across the Hawkesbury River.

Additionally, the alternative costing did not contain incidentals (such as environmental approvals), RMS costs and other option specific costs such as additional turning lanes on Hawkesbury Valley Way and traffic lights at intersections. While there was a considerable contingency included in the alternative costings, this was not sufficient to cover all additional costs and was compounded by the under-estimation of base rates for bridge and road construction (as discussed earlier).

RMS also used a different methodology for pricing the project. This methodology includes all components of the project and is based upon the RMS Project Estimation Manual. A direct comparison of the project cost in the EIS with the alternative cost is therefore misleading as the project cost in the EIS includes more aspects of project delivery. If the alternative costing methodology was used to cost RMS's preferred, the cost estimate would be substantially lower than the cost presented in the EIS.

To provide a more realistic comparison of the cost of the alternative option and the cost of the project, the preliminary design of the alternative option was priced using the same methodology applied in the EIS for the costing of the project (the methodology in the RMS Project Estimation Manual) with current market rates. The revised cost of the alternative option was also reviewed by an independent cost estimator.

The revised cost estimate for the Rickabys Line option using the RMS Project Estimation Manual methodology is about \$117 million (see **Table 4-4** for a breakdown of costs). This excludes a number of items that were too difficult to cost at the preliminary concept design stage including:

- Excavating, managing and disposing of soils unsuitable for construction.
- Cross-drainage.
- Adjustments to services and utilities.
- Biodiversity offsets from the clearing of the Endangered Ecological Community in Macquarie Park.
- Upgrade to Hawkesbury Valley Way to provide additional turning and merge lanes.

- Flood mitigation works.
- Noise mitigation works.
- Any other environmental management measures that may be required such as archaeological salvage.

Table 4-4 Cost estimate for the Rickabys Line option – bypass only

Item	Cost estimate (including contingency)
1. Project development	
1 (a) Route/Concept/EIS or REF	\$2,596,832
1 (b) Project Management Services	\$155,810
1 (c) Client Representation	\$15,581
Sub total	\$2,768,223
2. Investigation and design	
2 (a) Investigation and Design	\$7,163,674
2 (b) Project Management Services	\$429,820
2 (c) Client Representation	\$42,982
Sub total	\$7,636,476
3. Property acquisitions	
3 (a) Acquire Property	\$6,211,376
3 (b) Professional Services for Property	\$0
3 (c) Project Management Services	\$124,228
3 (d) Client Representation	\$6,211
Sub total	\$6,341,815
4. Public utility adjustments	
4 (a) Adjust Utilities	\$0
4 (b) Project Management Services	\$0
4 (c) Client Representation	\$0
Sub total	\$0
5. Construction	
5 (a) Infrastructure	\$92,530,784
5 (b) PAI	\$508,919
5 (c) Primary Testing	\$0
5 (d) Project Management Services	\$5,551,847
5 (e) Client Representation	\$555,185
Sub total	\$99,146,735
6. Handover	
6 (a) Refurbish old route	\$0
6 (b) Project data and performance	\$925,308
6 (c) Project Management Services	\$55,518
6 (d) Client Representation	\$5,552
Sub total	\$986,378
TOTAL COST	\$116,879,627

In contrast, the estimated RMS preferred project cost is about \$65 million, including all relevant items listed above. The project cost has increased since the EIS was prepared and following further community consultation. This has resulted in a more developed design that now includes additional scope such as signalised intersection at George and Bridge streets, scour protection, an incrementally launched bridge and renewal of Thompson Square. However, the revised cost of the alternative route component of the Rickabys Line option is still about double the project cost.

This revised cost of the alternative route is lower than strategic RMS cost estimates for a bypass provided previously by RMS (which were between \$150-200 million) but over double the project budget. The long term operational costs of the Rickabys Line option would also be substantially higher as there would be three bridges to maintain, one of which is already over 130 years old, around 1.6 kilometres of additional roads within the floodplain, and two additional sets of traffic lights, both in the floodplain.

RMS has also incurred considerable costs to date in the development of the project, including costs associated with the options assessment and development phase, the preparation of the concept design and environmental impact assessment, the selection of a construction contractor, and the development of the detailed design of the project. While some of the work already undertaken could be used for the Rickabys Line option, most of the work and associated costs are not possible to recover. While these incurred costs have not been presented in the above table, they would be in addition to the costs for the Rickabys Line option presented in the table.

4.4.2 Cost estimate for the alternative bridge refurbishment methodology

The ex-RMS bridge engineer's submission provided a cost estimate of \$3 million for their alternative bridge refurbishment methodology. This compared to RMS's cost estimate of \$18 million for bridge refurbishment. As discussed in **Section 4.4**, however, the objectives and outcomes of the two bridge refurbishment methodologies were different, so the two cost estimates are not appropriate to compare directly to each other.

There were a number of issues with the cost estimate provided by the ex-RMS bridge engineers in the submission that detailed the alternative bridge refurbishment methodology as part of the Rickabys Line option. These issues are as follows:

- The proposed construction methodology is unlikely to be acceptable for safety and environmental reasons. Rather than all superstructure works being undertaken from a barge, a purpose built platform would need to be constructed and installed to provide a safe working location and to capture all debris from the concrete removal process. The platform would be moved from span to span as the works progressed across the bridge. This platform was not included in the cost estimate for the alternative bridge refurbishment.
- The cost estimate was not based on the latest standard RMS and market rates.
- The costing methodology did not follow the methodology in RMS's Project Estimation Manual and substantially underestimated the contingency requirements and incidental costs. All cost estimates prepared and presented by RMS comply with their Project Estimation Manual.

An additional factor considered in the revised cost estimate is that RMS requires carbon fibre strengthening of the superstructure to achieve the safe load factor for illegal overweight heavy vehicles that may use the bridge.

Additional costs over the actual construction costs include:

- Contingency for additional works - Budgets for works on heritage bridges generally have a high contingency because additional works are generally identified during construction due to age of the structure and the difficulty in inspecting all components and areas of the bridge before construction commences. For example the amount of concrete that requires treatment on Windsor Bridge is likely to increase as the works progress.
- Heritage and environmental planning approval and compliance costs.
- Design costs – though not likely to be substantial, some design work needs to be completed to verify that the methodology would have the required outcomes.
- RMS costs – which would include project development and management, quality inspections of the works, preparation and implementation of environmental management plans, and testing once work has been completed.
- Some environmental management works – for example the management of the lead based paint on some components on the bridge has not been costed.
- Community liaison and information during construction.

The technical review of the alternative bridge refurbishment methodology concluded that, while the alternative methodology was generally suitable, a number of additional works would be required to provide a better structural solution and minimise long term maintenance costs. While the alternative bridge refurbishment methodology proposed by the ex-RMS bridge engineers may result in a functional bridge in the short term, it would still require substantial regular maintenance and many of the issues that would contribute to ongoing deterioration would not be addressed. It has been estimated that, with the incorporation of the additional works identified in the technical review, long term maintenance costs would be almost halved relative to the long term maintenance costs of the methodology proposed by the ex-RMS bridge engineers.

The revised cost estimate of the alternative bridge refurbishment methodology presented in this report was therefore based on a modified version of the alternative bridge refurbishment methodology. This modified alternative bridge refurbishment methodology included:

- The scope of works and activities recommended detailed in the technical review of the alternative bridge refurbishment methodology, including the additional works required to minimise long-term maintenance costs.
- Current market rates for the works and materials.
- The methodology for cost estimation contained in the RMS Project Estimation Manual.

The revised costs for the modified alternative bridge refurbishment methodology is presented in **Table 4-5**. The overall cost estimate for the modified alternative bridge refurbishment methodology is about \$16 million, including contingency.

Table 4-5 Cost estimate for the modified alternative bridge refurbishment methodology

Item	Estimate (including contingency)
1(a) Route/Concept/EIS or REF	\$564,725
1(b) Project management	\$45,178
1(c) Client representation	\$4,518
1(d) Community liaison	\$108,000
Sub-total	\$722,421
2(a) Investigation and design	\$752,967
2(b) Project management	\$60,237
2(c) Client representation	\$6,024
Sub-total	\$819,228
5(a) Infrastructure	
Establish/ demolish	\$152,380
Environmental (including monitoring)	\$319,760
Supply steel collars to existing piers	\$1,152,811
Install steel collars to existing piers	\$1,253,507
Repainting, cross bracing and diaphragm beams	\$218,895
Replace dowelling and defective concrete	\$1,114,325
Remediation of existing bridge soffit	\$8,285,954
Deck repair work	\$434,229
Sub-total	\$12,931,861
5(b) PAI insurance	\$71,125
5(c) Primary testing	\$129,319
5(d) Project management	\$1,034,549
5(e) Client representation	\$103,455
Sub-total	\$14,270,308
6 (a) Refurbish old route maintenance	\$0
6 (b) Project data and performance	\$117,128
6 (c) Project management services	\$9,370
6 (d) Client representation	\$937
Sub total	\$127,436
TOTAL	\$15,939,393

4.5 Assessment of the Rickabys Line option

To provide an overall assessment of the Rickabys Line option, the results of an economic analysis are presented and the option has been assessed against the project objectives and criteria in the context of the key findings of the environmental assessment from **Section 4.2**.

4.5.1 Economic analysis

An economic analysis was undertaken for the project as part of the EIS (Section 3.3). The analysis returned a BCR of 14.6 and concluded that the project would create benefits that would be realised by the general community and would outweigh the initial upfront construction and ongoing operational costs. The options analysis also included a BCR comparison for different options.

Since the economic analysis was undertaken for the EIS the capital cost of the project has been updated. Accordingly, the economic analysis has been updated.

The benefit cost analysis for the Rickabys Line option was based on two different methodologies as follows:

- Rickabys Line option, with refurbishment of the existing bridge using the re-alkalisation method with carbon fibre bridge strengthening (option R1).
- Rickabys Line option with refurbishment of the existing bridge using the conventional 'concrete patch repair' method but excluding carbon fibre bridge strengthening (option R2).

The economic analysis uses the same methodology as used for the EIS, including adoption of a seven per cent discount rate to the present value.

The analysis compares the project, Option R1 and Option R2 to the base case option (ie the 'do nothing' option). The assessment assumes that in the base case, the existing Windsor Bridge would remain open to traffic and there would be no modifications to intersections. Traffic modelling for the base case indicates that by 2026 there would be considerable congestion and the average travel times and speeds would decrease substantially, especially in the evening peak period.

Costs already incurred by RMS have been excluded from the analysis.

A summary of the economic analysis for the project is provided in **Table 4-6** below.

Table 4-6 Benefit cost ratio for project and Rickabys Line options

	Project	Option R1	Option R2
Costs			
Capital costs [#]	\$ 52.0 million	\$ 116.9 million	\$ 116.6 million
Maintenance costs	-\$ 0.3 million	\$ 1.4 million	\$ 2.5 million
Total costs	\$ 51.7 million	\$ 118.3 million	\$ 119.1 million
Benefits			
Travel time savings	\$ 548.8 million	\$ 494.4 million	\$ 494.4 million
Vehicle operating cost savings	\$ 119.0 million	\$ 87.8 million	\$ 87.8 million
External savings	\$ 0.6 million	-\$ 5.2 million	-\$ 5.2 million
Safety savings	\$ 3.7 million	-	-
Total benefits	\$ 672.1 million	\$ 577.0 million	\$ 577.0 million
Benefit cost ratio	13.0	4.9	4.8
Net present value	\$ 620.3 million	\$ 458.7 million	\$ 457.9 million

The results of the economic analysis indicate that while the revised BCR has decreased to 13.0 from 14.6, it still provides a considerably better economic return than the Rickabys Line options of around five. While the Rickabys Line options both produce a BCR of greater than two (which indicates that these options offer value for

money) they require considerably more upfront capital and ongoing maintenance and achieve less economic benefits than the project. Key findings are as follows:

- The Rickabys Line options would reduce the total vehicle travel time compared to the base case. The reduction in travel time achieved by the Rickabys Line options would, however, be slightly less than achieved with the project.
- The total vehicle operating costs for the Rickabys Line options would be lower than the base case but higher than they would be for the project.
- As the Rickabys Line options would result in an increase in vehicle kilometres travelled, the projected externality costs for the Rickabys Line options would be higher than in the base case.
- The Rickabys Line options would have much greater on-going maintenance and operating costs compared to the base case (for three bridges) while the project would not have high on-going maintenance costs and would decrease operating costs as compared to the base case (as indicated by the negative maintenance cost for the project in **Table 4-6** above).

4.5.2 Assessment of Rickabys Line option against project objectives and criteria

As discussed above, the Rickabys Line option is assessed as one of the “Hawkesbury Valley Way” community options in Section 4.2.2 of the EIS. The objectives against which the options are assessed are identified in Section 3.4 of the EIS.

The assessment of the Rickabys Line option in the EIS identified benefits to traffic efficiency and pedestrian safety within Windsor due to a reduction in the number of vehicles travelling through the area. This more detailed assessment has further identified that the Rickabys Line option would perform better than the project on the objective to improve traffic and transport efficiency by minimising traffic queue lengths, improving the performance of the road network and providing efficient connections for regional and local traffic. However, unlike the assessment in the EIS, the current assessment identified the Rickabys Line option would not perform as well as the project on pedestrian and cyclist safety and accessibility.

Rickabys Line option was also shown to perform better on the objective to minimise impacts on heritage and the character of the local area by reducing impacts on Thompson Square and the existing Windsor Bridge. However, consistent with the assessment of the option in the EIS, potential impacts were identified on the local character of the area along the proposed route, including a number of recreational areas and businesses. The assessment concluded that the option would perform poorly against the cost objective, with high costs associated with two bridge structures, unknown additional costs associated with flood mitigation, considerable property acquisition and costly maintenance.

The Rickabys Line option would also have additional impacts that are not specifically addressed by the objectives. These include:

- The loss of about 1.6 hectares of a threatened ecological community listed under the *Threatened Species Conservation Act 1995*.
- Increases in upstream flood levels that would necessitate expensive flood mitigation measures, which would further increase the cost of the Rickabys Line option.

While the Rickabys Line option has some clear advantages compared to the project in terms of minimising heritage impacts and improving traffic performance, it would have greater impacts on significant vegetation, the amenity of Macquarie Park, increasing flood levels upstream and would impact other properties and businesses. Further, around 10000 vehicles a day would continue travelling through Thompson Square. This continued traffic would limit any amenity improvements to the area, while also introducing new traffic related impacts to the amenity of an area that is not currently impacted by traffic. Some of the benefits of the project would also not be realised with the Rickabys Line option, such as improvements in pedestrian and cyclist access and safety, and consolidation of the Thompson Square parkland.

Finally, the preliminary cost estimate of the Rickabys Line option is over double the cost of the project and is likely to increase as the cost of items unable to be estimated at this preliminary stage are included.

4.6 Conclusion

This assessment has reconfirmed the replacement of Windsor Bridge 35 metres downstream of the existing bridge as the preferred option for the Windsor Bridge replacement project. The Rickabys Line option is not favoured as an alternative to the project due to:

- The impacts on Macquarie Park and its associated threatened ecological community.
- The predicted increase in upstream flood levels and the unknown associated costs with mitigation of this impact.
- It's less than optimal traffic performance. Other bypass options would be likely to have better traffic performance in comparison to the Rickabys Line options.
- The high capital and operational costs of the option.