

5 Preferred infrastructure report

The EIS noted that refinements could be made to the design features and construction methods for the project during the detailed design phase. This section identifies and assesses the minor design modifications to the concept design that have been made since preparation of the EIS, and describes the reasons for these modifications.

All proposed design modifications would generally minimise the environmental impact of the project. Ongoing investigations will be carried out as required to further progress detailed design, or as committed to assist the implementation of management and mitigation measures during the construction and operation of the project.

Ongoing refinements may continue during detailed design development.

5.1 Increase in the clearance of the new bridge over The Terrace

5.1.1 Description

During the development of the project, the vertical alignment of the new bridge and approach road through Thompson Square was lowered substantially to minimise impacts on heritage views and vistas. This was achieved by lowering the design speed from 60 kilometres per hour to 50 kilometres per hour. The alignment was lowered while maintaining a 3.6 metre clearance over The Terrace to allow small coaches, service vehicles and emergency vehicles to access Windsor Wharf.

In consultation with Hawkesbury City Council and in response to submissions received during the exhibition of the EIS, RMS has now increased the proposed clearance of the new bridge over The Terrace from a minimum of 3.6 metres to a maximum of 4.6 metres to allow large coaches to directly access Windsor Wharf. Large coach access along The Terrace is required to allow the patrons of the Hawkesbury Paddle Wheeler to have easy access to Windsor Wharf.

Many of the patrons of the Hawkesbury Paddle Wheeler are elderly, disabled and/or have limited mobility and would find it difficult or impossible to access the wharf if large coaches were forced to park in Thompson Square road or Baker Street. The Windsor Paddle Steamer business has been operating for 14 years, with the main source of income being the provision of leisure cruises for the elderly and disabled. The viability of the Hawkesbury Paddle Wheeler business is reliant on large coaches being able to transport patrons to Windsor Wharf.

To provide the additional clearance over The Terrace, the height of the southern end of the bridge would be increased. This would result in a one metre higher bridge and abutment at the southern end, and a marginally higher 45 metre long section of the southern approach road through Thompson Square between the driveways of Number 4 Bridge Street to the southern abutment. South of the driveway of Number 4 Bridge Street and in front of the heritage listed properties of Number 6 and Number 10 Bridge Street, the height of the southern approach road would remain the same as that presented in the EIS. The grade of the bridge would also increase slightly from 1.6 to 1.9 per cent.

Figure 5-1 and **Figure 5-2** presents the difference in heights of the modified project in comparison to the project presented in the EIS.

Given the sensitivity of the environment in which the project is located, the potential changes in environmental impacts resulting from the design change were assessed in consideration of the key environmental issues identified in the Director General's Requirements. The results of the assessment are summarised in **Table 5-1**. In the following sections, a more detailed assessment is provided for those key issues most likely to be affected.

Table 5-1 Changes in environmental impact resulting from proposed increase in clearance over The Terrace

Key issues	Change in environmental impact
Historic heritage	The proposed design change would result in a slight increase in the visual and physical presence of the bridge as seen from Thompson Square and adjacent properties. With respect to the overall impact on the existing cultural landscape and heritage views and vistas, however, the difference between the exhibited bridge design and the modified bridge design would be minimal. The visual impact of the project would remain substantial. Further details of the effect of the design change on historic heritage are provided in Section 5.1.2 .
Aboriginal heritage	The design change would not increase the area disturbed by the project or result in disturbance of any new areas. The Aboriginal heritage impacts and associated environmental management measures required would therefore remain as described in the EIS.
Traffic and transport	The design change would not result in any changes to the alignment or capacity of the bridge or the impacts of the project's construction and operation on traffic and transport. The traffic and transport impacts and associated environmental management measures required would therefore remain as described in the EIS. The design change would improve access to Windsor Wharf compared to the design presented in the EIS, with the design change allowing large coaches and service vehicles direct access to the wharf. With a higher bridge, there would be increased clearance under bridge especially towards the southern bank. This would also improve the safety of on-river navigation.
Visual, urban design and landscape	The design change would result in a minor increase in the visual and physical presence of the southern end of the bridge within the landscape and a minor increase in the magnitude of visual impacts. The change would not, however, be sufficient to increase the landscape character impact ratings or the overall visual impact ratings identified in the EIS. The impact ratings would remain "high". Further details of the effect of the design change on visual amenity, urban design and landscape are provided in Section 5.1.3 .

Key issues	Change in environmental impact
Noise and vibration	The design change would not alter the duration or extent of construction works or the types of construction equipment used. The construction noise and vibration impacts and the corresponding mitigation measures required would therefore remain as described in the EIS. Additional impact assessment has been carried out to assess the impacts of the proposed design change on operational noise. This additional assessment also addresses the additional residential properties that have been identified since completion of the EIS. The results of the additional assessment indicate that, while there would be little or no increase in operational noise and vibration impacts as the result of the revised bridge design, four additional residential properties (in addition to those identified in the EIS) require consideration for noise mitigation treatments. Further details are presented in Section 5.1.4.
Soils, sediments and water	The design change would not result in any changes to the erosion and sedimentation risks of the project. The erosion and sedimentation risks and associated environmental management measures would therefore remain as described in the EIS. The design change would not result in any change to the flood immunity of the project. The northern abutment and approach road would remain at the height described in the EIS and, as the lowest points on the bridge, would determine the flood immunity of the project. There may be a very small change in the flooding effects of project, however the effect of these changes on land use and property would be negligible and the conclusions regarding flooding impacts would remain as described in the EIS. More detailed modelling of flooding impacts would be undertaken during the detailed design phase of the project. The design change would not have any significant effect on hydrology. More detailed modelling of hydrological impacts would be undertaken during detailed design.
Land use, property and socio-economic impacts	The design change would not result in any additional land take or any additional changes to property access. The design change would prevent adverse socio-economic impacts on the Hawkesbury Paddle Wheeler business. Further details of the effect of the design change on land use, property and the socio-economic environment are provided in Section 5.1.5.
Flora and fauna	The design change would not result in any changes to the flora and fauna impacts of the project. The flora and fauna impacts and associated environmental management measures required would therefore remain as described in the EIS.
Air quality	The design change would not result in any changes to the air quality impacts of the project. The air quality impacts and associated environmental management measures required would therefore remain as described in the EIS.

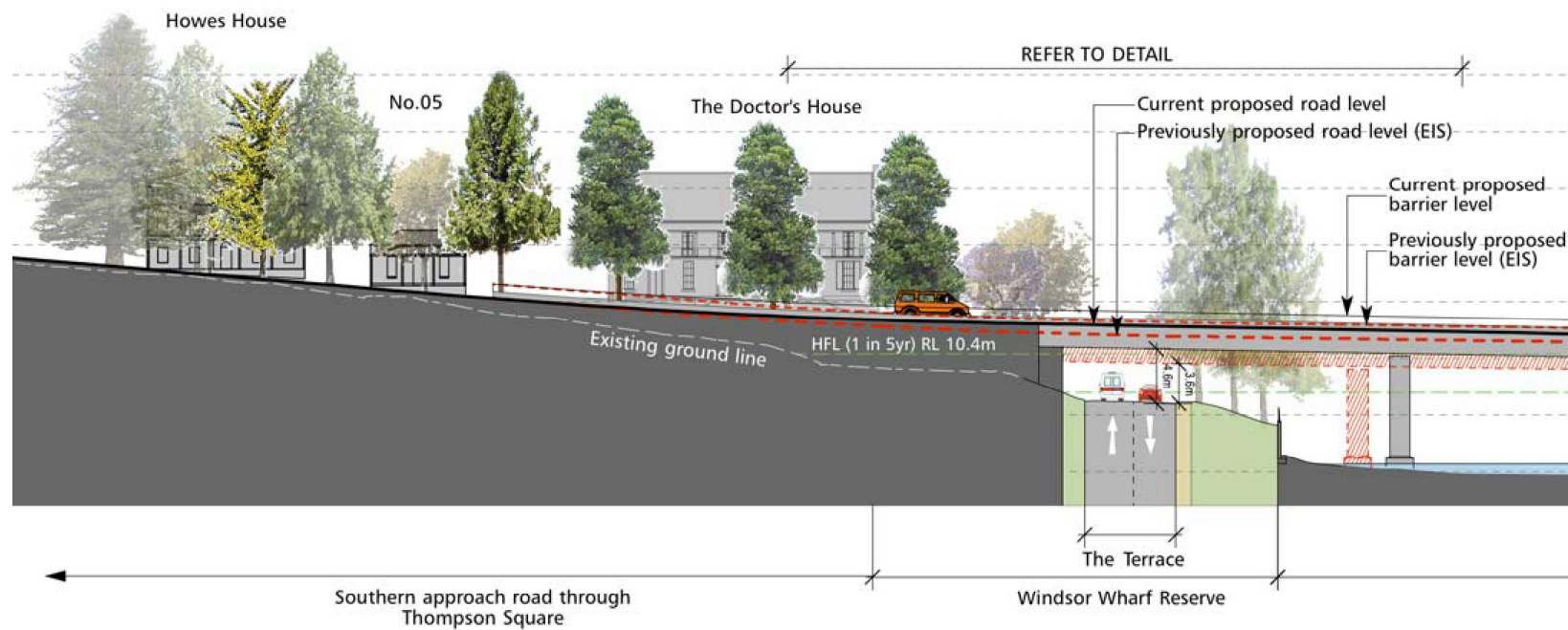


Figure 5-1 Change in height of bridge and approach road – southern bank

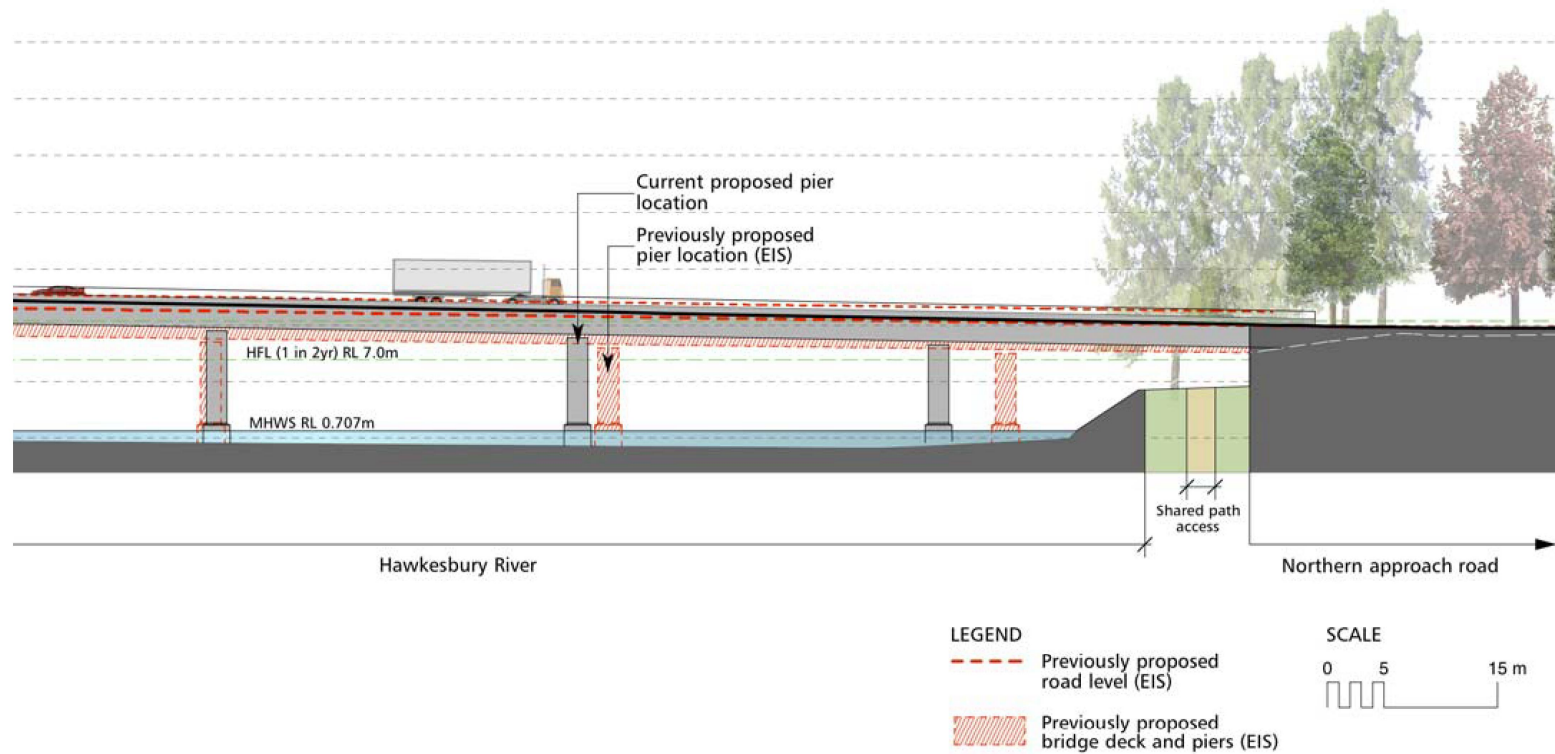


Figure 5-2 Change in height of bridge – northern bank

5.1.2 Historic heritage impacts

A detailed assessment of the impacts of design changes is included in the Heritage Addendum in **Appendix B**. A summary of the assessment is provided below.

With the proposed design change, the location and horizontal alignment of the proposed replacement bridge would remain the same as described in the EIS. The level of the bridge deck would, however, increase by a maximum of one metre at its southern end where it crosses The Terrace. The level of the approach road would rise gradually from the northern side of the driveway at 4 Bridge Street until the high point is reached along the section of the alignment between the southern bridge abutment and the crossing of The Terrace. Beyond the high point, the level of the bridge would gradually decrease until it reaches the same level described in the EIS at a location between pier 3 and pier 4.

Increasing the clearance of the new bridge over The Terrace would not increase the area disturbed by the project, result in disturbance of any new areas or introduce any other new physical impacts. As such, the design change would not increase the disturbance of archaeological resources or heritage items. The physical impacts of the project, including the impacts on the existing heritage listed bridge, Thompson Square Conservation Area and subsurface archaeological resources, would remain as described in the EIS.

On the western side of the southern approach road, the height of the road (and therefore the retaining wall to the parkland) would increase slightly but this would not have a significant impact on the visual impact of the retaining wall. The wall would not be any more noticeable than with the original design presented in the EIS.

With respect to the overall impact of the proposed design change on the existing cultural landscape and heritage views and vistas, the difference between the exhibited bridge design and the modified bridge design would be minimal. The visual impact of the project would remain substantial and, in combination with the other elements of the project, the overall findings with respect to the significance of heritage impacts remain as described in the EIS.

5.1.3 Visual, urban design and landscape impacts

A detailed assessment of the landscape and visual impacts of increasing the clearance of the new bridge over The Terrace has been undertaken. The results of this assessment are presented in **Appendix D**. A summary of the main findings is presented below.

Landscape character impacts

Increasing the clearance of the new bridge over The Terrace would affect the following two landscape character zones (LCZs) identified in the EIS:

- LCZ 1 - Thompson Square.
- LCZ 2 - Hawkesbury River and River Banks.

The impacts on these LCZs are summarised in **Table 5-2**. Overall, the proposed design change would not change the landscape character impact ratings for the affected LCZs. The impact ratings would remain “high”.

Table 5-2 Changes in landscape character impacts resulting from proposed increase in clearance over The Terrace

LCZ	Effects of design change	Effect on landscape character impact rating
Thompson Square	The design change add to the vertical scale of the bridge, which would result in a slight increase in the physical and visual presence of the southern approach road and bridge abutments within the lower section of Thompson Square and when viewed from the buildings along Thompson Square road. The change would slightly improve the spatial experience of The Terrace, with slightly increased headroom and increased amounts of natural light. It would also further improve vehicle connectivity along The Terrace, although this may result in increased pedestrian and vehicle conflicts.	The design change would not change the landscape character impact rating for this LCZ. The impact rating would remain “high”.
Hawkesbury River and River Banks	The design change would increase the scale and height of the bridge, making it a slightly more dominant structure in the landscape. It would also, however, increase the perception of space along the foreshore and under the bridge on The Terrace.	The design change would not change the landscape character impact rating for this LCZ. The impact rating would remain “high”.

Visual impacts

A total of eighteen viewpoints formed the basis of the original visual impact assessment presented in the EIS. Increasing the clearance of the new bridge over The Terrace would affect eight of these viewpoints. The impacts of the proposed design change on the magnitude of visual impacts and the overall visual impact rating for these viewpoints are summarised in **Table 5-3**. In summary, while the proposed design change would result in a minor increase in the magnitude of visual impacts, the degree of change would not be sufficient to increase the magnitude rating or the overall impact rating. The proposed design change would not affect the visual sensitivity ratings of the viewpoints.

Table 5-3 Changes in visual impact resulting from proposed increase in clearance over The Terrace

View point	Description	Previous impact ratings		Effect of design change
		Magnitude	Overall	
5	Foreground view from Bridge Street, looking north west. Overlooks the southern approach road.	Moderate	High	The southern approach road would be slightly higher as a result of the design change. The change would not be sufficient to increase the 'magnitude' rating or the overall visual impact rating as the changes viewed from this location would be minor and the majority of the works would be obscured by existing buildings along Bridge Street.
7	Foreground view from Thompson Square, looking north. Overlooks the southern approach road and the bridge itself.	Moderate to High	High	The bridge abutments would be slightly more prominent from this viewpoint, and would further obscure views to the water. The change would not be sufficient to increase the 'magnitude' rating or the overall visual impact rating as the changes in this view would be minor due to the angle of the view.
8	Foreground and mid distance view from Bridge Street, looking north west.	High	High	The slightly raised southern approach road and raised abutments and deck would increase the visual dominance of the structure from this location and would further obscure views of the river. The magnitude impact rating and overall visual impact rating would remain High, the highest rating on the impact assessment grading matrix.
9	Foreground and mid distance view from Thompson Square, adjacent to the Doctor's House, looking north.	High	High	This viewpoint overlooks the river and the changes would clearly be visible from this location. The magnitude impact rating and overall visual impact rating would remain High, the highest rating on the impact assessment grading matrix.

View point	Description	Previous impact ratings		Effect of design change
		Magnitude	Overall	
11	Foreground view from the small carpark near The Terrace, looking north west. Viewpoint is located under the replacement bridge.	High	High	The increased height of the bridge would reduce the sense of enclosure under the bridge along this section of The Terrace and would slightly open the view over the river. The magnitude impact rating and overall visual impact rating would remain High, the highest rating on the impact assessment grading matrix.
12	Foreground view from Windsor Wharf, looking south west. Provides extensive views along the river towards existing bridge.	High	High	The increased height of the bridge and abutments would be noticeable on the already prominent structure. The magnitude impact rating and overall visual impact rating would remain High, the highest rating on the impact assessment grading matrix.
17	Foreground view from Wilberforce Road, west of Freemans Reach Road, looking south. Viewpoint looks towards Windsor and the bridge replacement works.	Moderate to High	Moderate to High	The increased height of the bridge would be visible from this location, although the view would not be substantially different to the previous proposal. The change would not be sufficient to increase the 'magnitude' rating or the overall visual impact rating due to the distance between the works and the viewpoint.
18	Foreground view from Wilberforce Road, east of Freemans Reach Road, looking south. Viewpoint looks towards Windsor and the bridge replacement works.	Moderate to High	Moderate to High	The increased height of the bridge would be visible from this location. The change would not be sufficient to increase the 'magnitude' rating or the overall visual impact rating due to the distance between the works and the viewpoint.

5.1.4 Operational noise impacts

Additional impact assessment has been carried out for the proposed design change to assess the effects of the change on operational noise and vibration. This additional assessment takes into consideration not only the proposed design change, but also new information from site visits and zoning information on residential property use that has become available since completion of the EIS. Specifically, four residential properties that were incorrectly identified as commercial properties in the EIS have now been re-assessed as residential properties to determine the need for impact mitigation in accordance with the Road Noise Policy. The revised list of residential receivers for the project is presented in **Table 5-4**.

The properties that have been re-classified as residential receivers since completion of the EIS are R16, R17, R18 and R19.

Table 5-4 Revised list of residential receivers for the project

ID	Receiver location	Details	Distance from existing road
R1	27 Wilberforce Road	Single storey residential dwelling	17 metres
R2	4 Bridge Street	Single storey residential dwelling. Lightweight brick and weatherboard construction.	27 metres
R3	10 Bridge Street	Double storey mixed residential upper floor and commercial lower floor, heritage building. Masonry construction	10 metres
R4	53 George Street	Double storey residential building. Masonry construction	40 metres
R5	12 The Terrace	Single storey residential dwelling. Masonry construction	145 metres
R6	14 The Terrace	Single storey residential dwelling. Masonry construction	160 metres
R7	16 The Terrace	Single storey residential dwelling. Masonry construction	172 metres
R8	18 The Terrace	Single storey residential dwelling. Masonry construction	190 metres
R9	20 The Terrace	Single storey residential dwelling. Masonry construction	205 metres
R10	22 The Terrace	Single storey residential dwelling. Masonry construction	223 metres
R11	45 George Street	Single storey residential dwelling. Masonry construction	120 metres
R12	43 George Street	Single storey residential dwelling. Masonry construction	133 metres
R13	41 George Street	Single storey residential dwelling. Masonry construction	150 metres
R14	39 George Street	Single storey residential dwelling. Masonry construction	178 metres
R15	29 George Street	Single storey residential dwelling. Construction unknown	250 metres
R16	3 Thompson Square	Double storey residential dwelling. Heritage building. Masonry construction	10 metres
R17	64-68 George Street	Double storey commercial, heritage building. Masonry construction	18 metres
R18	14 Bridge Street	Single storey commercial/residential dwelling. Heritage building. Masonry construction	7 metres
R19	16 Bridge Street	Single storey residential dwelling. Masonry construction	8 metres

A summary of the key findings of the additional noise assessment is presented in the following section. The full details of the assessment are attached in **Appendix E**.

Effects of the design change on operational noise and vibration

The modeling of noise impacts for the revised project design was based on the same traffic data used in the EIS. The results of the modeling indicate that there would be little or no increase in operational noise or vibration as a result of the proposed design change.

At the previously assessed residential receiver locations, the results of the noise impact assessment, including the identified impact mitigation requirements, remain as described in the EIS. For the four residential receivers that have been identified since completion of the EIS (R16, R17, R18 and R19), the modeling results indicate that these properties are currently exposed to acute traffic noise levels from the existing alignment and would continue to be impacted by acute noise levels during operation of the project. These properties would therefore be considered for noise mitigation treatments as described below.

Additional noise mitigation measures

As detailed in Section 7.5 of the EIS, installation of noise barriers and application of road surface treatments are not feasible noise mitigation options for the project. The noise mitigation options for the project would be limited to the application of architectural treatments to affected individual properties.

The four additional residential properties identified since completion of the EIS (R16, R17, R18 and R19) have been re-assessed against the project criteria in accordance with the Road Noise Policy. The results of this assessment indicate that the properties are affected by noise levels in excess of the project criteria and therefore qualify for noise mitigation.

Three of the additional residential dwellings that would require noise mitigation measures (R16, R17 and R18) are located around Thompson Square and have been identified as having heritage values. These properties would therefore be subject to appropriate architectural treatments that reduce the effects of traffic noise while minimising adverse impacts on heritage. This is discussed further in **Section 5.3**.

Properties further south of the project (eg. Corner of Macquarie Street and Bridge Street) do not qualify for noise mitigation as the road corridor in this area would not be redeveloped by the project and the project would not result in the generation of additional traffic along the road corridor.

There has been some suggestion that the building at R2 (4 Bridge Street) is a listed item on the State Heritage Register (SHR). While this is correct insofar as the property is listed as part of the Thompson Square Conservation Area (SHR listing 00126), like many other properties that form the Thompson Square Conservation Area it is not listed as an individual item on the SHR. The results of an online search of the state heritage register indicate what appears to be an individual listing, it is not listed individually. Heritage items that are located within the historical entity of Thompson Square and are listed separately from the Conservation Area (that is, these items have different listing identifiers) are the "Macquarie Arms Hotel" (00041)

and the "house and outbuilding" at number 5 Thompson Square (00005). All other properties are listed as part of the Thompson Square Conservation Area. Further the Lot and DP numbers identifying 4 Bridge Street in the register are incorrect and the Lot and DP number are attached to a vacant block of land in west Windsor.

The building at 4 Bridge Street is a weatherboard bungalow built in 1955 which has been subsequently modified and has no significant heritage value. However the land on which the bungalow is constructed has high archaeological potential and visible heritage items such as the sand stock brick retaining wall, and may retain evidence of earliest phase of the settlement. Thus while any potential architectural noise mitigation measures would be sympathetic to the building's construction and age, they do not require identification at this stage.

5.1.5 Land use and socio-economic impacts

Increasing the clearance of the new bridge over The Terrace would not result in any additional land take or any additional changes to property access. The effects of the design change on noise would be negligible, with construction and operational noise impacts remaining as described in the EIS.

Increasing the clearance of the new bridge over The Terrace would, however, minimise the adverse socio-economic effects that the project may otherwise have on the Hawkesbury Paddle Wheeler business. Without this proposed design change, the project may result in loss of income for this business.

The Hawkesbury Paddle Wheeler is a commercial river cruise boat that has been operating from Windsor Wharf for around 14 years. The Paddle Wheeler conducts about 100-150 charter cruises annually, attracting an average of about 50 passengers and a maximum of 90 passengers per trip. The main source of income for this business is providing leisure cruises for the elderly and disabled, with about 70 per cent of cruises being for this market sector. In recognition of this river usage, Windsor Wharf was upgraded in 2011-2012 to provide easier access for people with limited mobility. These patrons also need direct vehicle access to Windsor Wharf and typically arrive by large coach services. The viability of the Paddle Steamer business therefore requires all sizes of coach to have direct access to Windsor Wharf.

Demand for cruises fluctuates throughout the year, with February, July and October to December identified by the Paddle Wheeler operator to be popular times for cruises. Many of the bookings for charter cruises originate from multiple tour operators, with a number of operators incorporating the cruise into tours of the Windsor town centre and the wider Windsor region. The operator of the Hawkesbury Paddle Wheeler indicated that some charter cruises attracted two to three tour coaches.

Vehicle access to the wharf is currently via Bridge Street. Following the implementation of the project, however, the Bridge Street access would not be available and access to the wharf would need to be via The Terrace, which runs underneath the proposed replacement bridge. If the clearance under the proposed replacement bridge on The Terrace remains at 3.6 metres as described in the EIS, large coaches would not be able to access the wharf, which would lead to considerable financial impacts on the Hawkesbury Paddle Wheeler business.

Alternative sites for operation of the Hawkesbury Paddle Wheeler have been examined and are not considered to provide viable alternatives. During the upgrade of Windsor Wharf, for example, the Hawkesbury Paddle Wheeler operated from a temporary pontoon at South Creek, downstream of the bridge. Concerns were raised by the paddle wheeler operator about the use of this site on a more permanent basis, due to its distance from Windsor town centre. Service access for the paddle wheeler was also identified as a challenge for the South Creek site.

Maintaining direct access to the Windsor Wharf for bus coaches has been identified as important by the Paddle Wheeler operator. Concerns were also raised by the operator that preventing or restricting large bus and coach access to the Windsor Wharf will also have adverse impacts on the multiple tour operators who organise charter cruises, which may in turn have wider impacts on tourism in Windsor. There is also the potential that restricting vehicle access to Windsor Wharf would have a direct impact on general access for people with mobility difficulties. The proposed design change is therefore important to the Hawkesbury Paddle Wheeler, the wider tourism industry of Windsor, and a large sector of the community.

5.2 Minor changes in bridge pier location and bridge type

5.2.1 Description

Since the EIS was exhibited, there has been further development of the design of the replacement bridge. This has resulted in two minor changes to the design of the bridge namely:

- Instead of a double box girder bridge as shown in Figure 5-4 of the EIS, a double T bridge would be constructed. A double T bridge would have a slightly shallower superstructure than a double box girder bridge but would otherwise have similar features to those described in the EIS. It would be incrementally launched as described in the EIS. **Figure 5-3** shows a cross section of the double T bridge.
- To accommodate the double T bridge, the location of the bridge piers in the Hawkesbury River would change slightly from those presented in the EIS. The changes in pier locations are presented in **Figure 5-4**. The southern and northern piers closest to the respective river banks would be located further from the banks and there would be a minor change in location for one of the central piers.

5.2.2 Environmental impacts

As a double T bridge would have a slightly shallower superstructure than a box girder bridge, it would have less visual impact and less impacts on upstream flood levels in comparison to the bridge described in the EIS. The reduction in impacts would, however, be minor. All other impacts would remain as described in the EIS.

The change in the location of the bridge pier closest to the southern river bank would result in a minor reduction in direct impacts on maritime archaeological remains and may reduce the scour of the southern bank during flood events. Additionally, the proposed location and spacing of the piers away from the river bank, combined with the proposed increase in the clearance of the bridge over The Terrace, would enhance the perception of space along the foreshore and under the bridge and open up the views from The Terrace. This is explained further in the Landscape Character and Visual Impact Assessment Addendum in **Appendix D**.

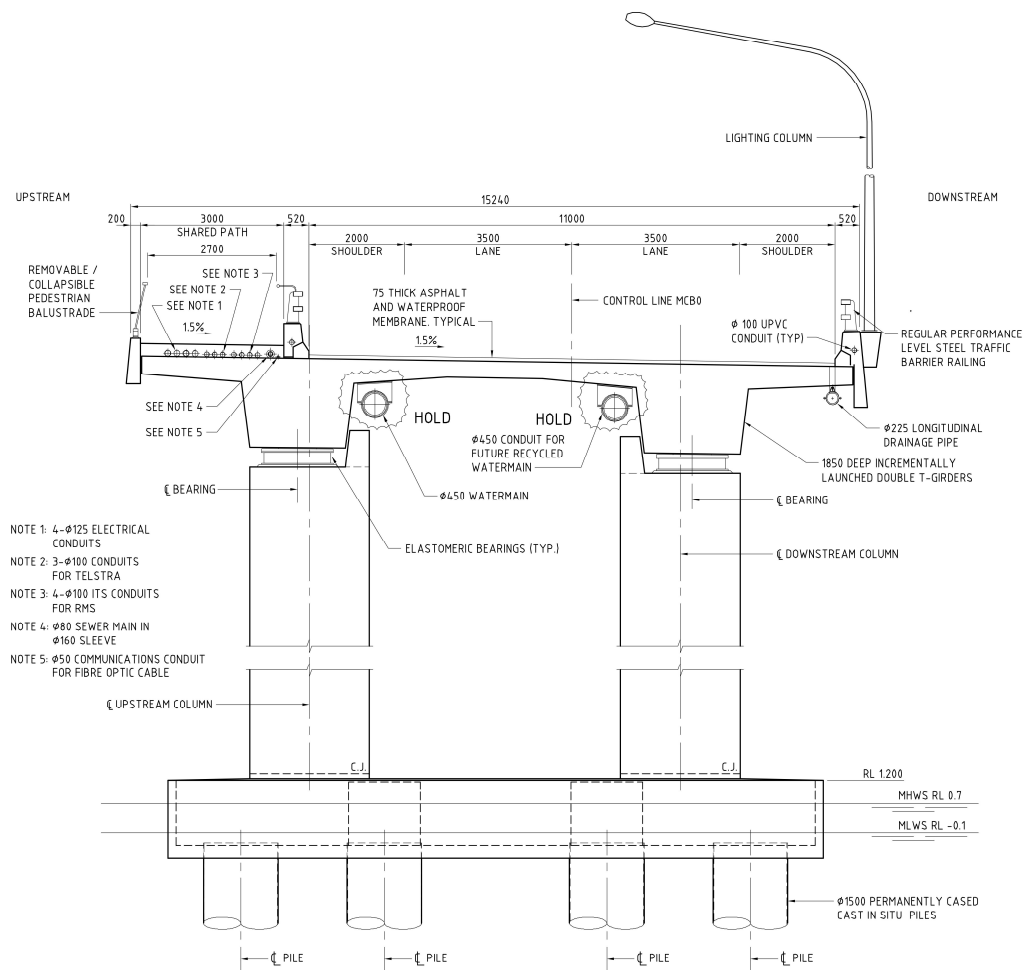


Figure 5-3 Cross-section of double T bridge

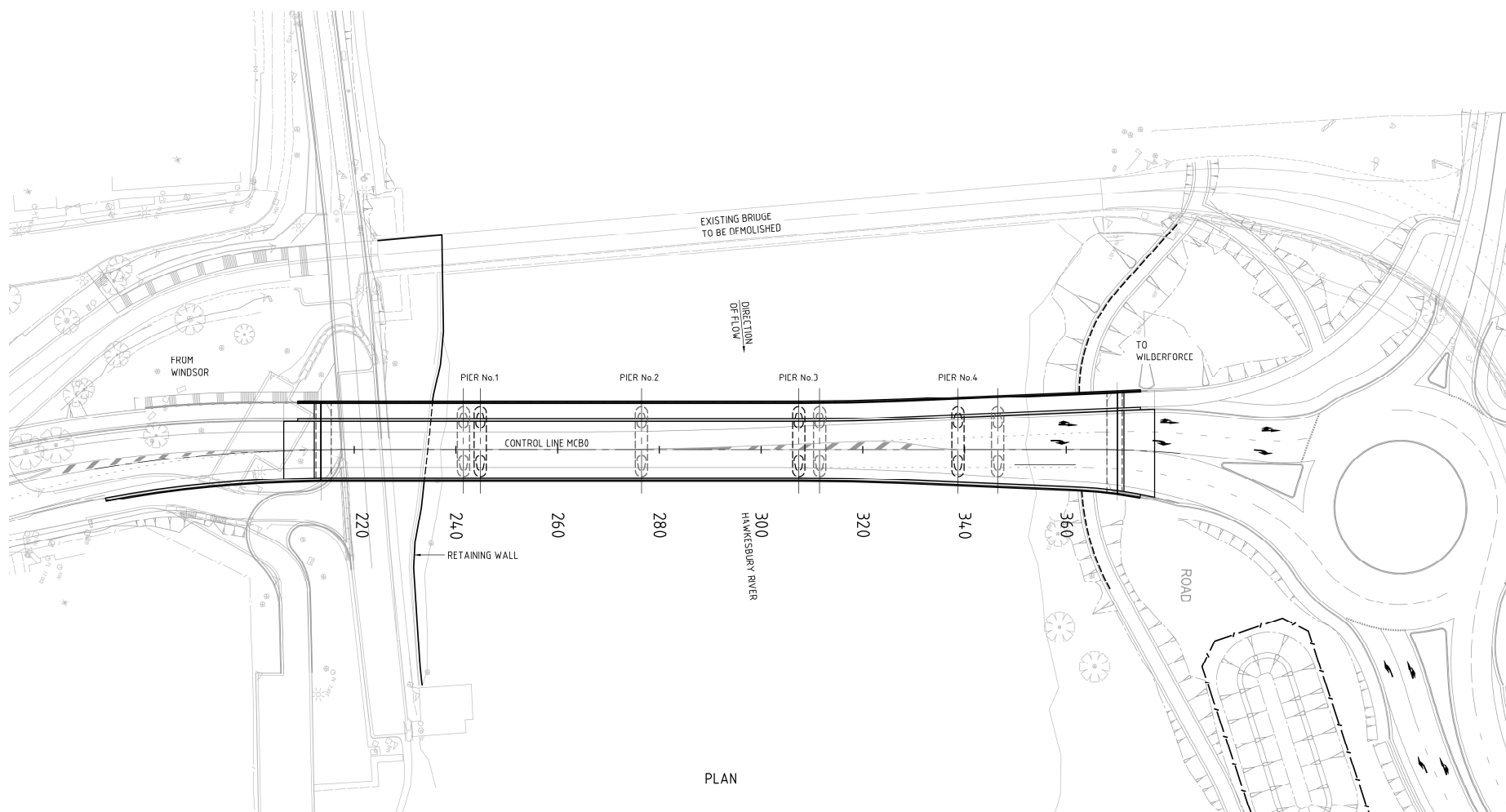


Figure 5-4 Changed pier locations – Note grey indicates original pier location and black indicates new pier location

There would be no significant changes to other environmental impacts as a result of the proposed change in pier location, with all other impacts and associated management measures remaining as described in the EIS. The new pier locations have been assessed for potential maritime heritage impacts and would not result in any impacts on maritime heritage.

Given that the potential changes in environmental impacts associated with the change in pier locations would be negligible or minor, detailed environmental assessment of the modification is not required.

5.3 Additional heritage properties requiring noise mitigation

5.3.1 Background

A total of eight residential properties have been identified as needing to be considered for architectural noise mitigation treatments as a result of the project. This includes four residential properties identified in the EIS, and four additional residential properties identified since completion of the EIS (refer to **Section 5.1.4** above). Of the eight residential properties identified as needing to be considered for architectural noise mitigation treatments, four have been identified as having heritage value of State significance. These properties comprise 10 Bridge Street, which was identified as a residential property in the EIS, and the following three additional residential properties that have been identified since completion of the EIS:

- The Doctors House, 3 Thompson Square (two residences).
- 64-68 George Street (three first floor residences).
- 14 Bridge Street (one residence).

Note that the above-listed three properties were not identified as residential properties, but rather commercial businesses, during preparation of the EIS and were therefore not considered for noise mitigation treatments at that time. The Doctors House has been reclassified as a residential premise since the completion of the EIS, while the properties at 14 Bridge Street and 64-68 George Street were incorrectly identified as commercial properties in the EIS and have since been confirmed as residential. As residential premises, these properties would qualify for noise mitigation treatments if the project proceeds given that traffic noise levels exceed the relevant Road Noise Policy criteria under existing and future conditions, both with and without the project. The additional noise assessment that has been carried out since completion of the EIS, which accounts for all design changes and considers the above-listed properties as 'residential' premises, is discussed in **Section 5.1.4** and presented in **Appendix E**. The need to consider architectural noise mitigation treatments for the property at 10 Bridge Street was identified in Section 7.5.4 and Section 7.5.5 of the EIS, while the need consider architectural noise mitigation treatments for the remaining three residential heritage properties was identified through the additional noise assessment (refer to **Section 5.1.4** and **Appendix E**).

All residential heritage properties that have been identified as requiring consideration for architectural noise mitigation treatments as a result of the project have been subject to additional assessment to assist in identifying appropriate treatments that minimise adverse impacts on heritage. Specifically, a qualified heritage architect, CityPlan Heritage, has been engaged to provide advice on the types of noise mitigation treatments that may be appropriate for these buildings. This is discussed further in the following section.

5.3.2 Advice on architectural treatments for noise mitigation

A letter of heritage advice for noise mitigation treatments for the heritage building at 10 Bridge Street was provided on 9 August 2012 (City Plan Heritage, 2012). This advice was considered and documented in the EIS (refer to Section 7.5.5 of the EIS). A second letter of advice, which builds on the previous advice, was provided on 18 March 2013 (City Plan Heritage, 2013) and presents specific recommendations for the three additional residential heritage buildings identified since completion of the EIS, namely:

- The Doctor's House at 1-3 Thompson Square.
- The former School of Arts building at 14 Bridge Street.
- The former Hawkesbury Stores building at 64-68 George Street.

This submissions report presents the findings of the heritage advice for the above-listed three properties.

Note that the letter of heritage advice for 10 Bridge Street (City Plan Heritage, 2012) was prepared following inspection of the exterior and interior of the building. The letter of heritage advice for the three additional residential heritage properties listed above was prepared based on external inspection of the properties from the street, with no internal inspections being carried out. Nevertheless, the information obtained from the internal inspection of 10 Bridge Street provided a good understanding of potential intactness and detailing of the windows and doors of the three additional heritage buildings identified as requiring noise treatments.

5.3.3 Appropriate noise mitigation treatments

General considerations

In selecting appropriate architectural treatment options, the type, condition and fabric of the building needs to be considered to provide the optimum internal noise benefit. The subject heritage buildings feature timber joinery characteristic of their construction periods and architectural styles. The joinery of these buildings is considered significant and any architectural noise treatments should therefore be applied to the interior of the buildings to prevent altering the appearance of the building exteriors.

The upper residential parts of the two-storey buildings (the Doctors House and the Hawkesbury Stores) feature French doors opening onto the front balcony from each room facing their respective street frontage. The internal configurations of the residences are unknown and it is assumed that each room relies only on the French doors for ventilation and daylight. Noise mitigation treatments therefore need to provide for easy operation of the doors. The windows of all three buildings are assumed to be operational and the majority of the existing glazing on both doors and windows is anticipated to be original.

General approach to noise mitigation

Given the need to preserve the original fabric of the existing joinery and the operational requirements of the windows and doors, the alternatives for noise mitigation treatments are limited.

A range of potential treatment options has therefore been identified to provide a basis for the future selection of the most appropriate treatments for the various types of doors and windows within the buildings.

The final selection and design of noise mitigation treatments should be determined on a case-by-case basis in consultation with a Heritage Architect following an internal inspection of the buildings, including a closer inspection of the existing joinery detailing. Consideration also needs to be given to maintenance of ventilation. Further discussion of potential treatment options and ventilation considerations is provided in the following sections.

Potential noise mitigation treatment options

The following have been identified as potential treatment options:

- Installing acoustic seals to existing windows.
- Increasing the thickness of glazing.
- Installing double glazed windows.
- Providing a new secondary window.

Acoustic window seals

Acoustic seals around the perimeter of a window will help to reduce noise by providing a tight seal when the window is shut. Rubber seals are best, although it is also possible to fit brush seals with a vinyl fin down the middle (which provides better noise protection than traditional brush seals). It is important to install and adjust the seals so that the window and frame both contact the seals when closed. The tighter a seal is, the better the noise reduction, provided it is not too thick to prevent the window from being able to be closed properly.

For existing windows that cannot be fitted with acoustic seals (for example singlehung and double-hung windows), secondary glazing may be installed. Secondary glazing products (either permanently fixed or removable) provide an airtight seal without the need to modify the existing window. Any secondary glazing must match the existing windows mullions and pane configuration or be a single-pane glazing to ensure no changes occur to the external presentation.

Thicker glazing

Most standard windows would have three millimetre thick glazing. Thicker glazing (ideally six or 10 millimetre) reduces lower frequency road traffic noise. Using thicker glass, however, typically requires new window frames, as standard/ traditional residential frames may not be able to bear the additional glazing weight.

Where the window frames are clearly identified as not being original, their replacement with a matching frame but thicker glazing can be considered. The authenticity of the existing frames must be based on documentary and physical evidence and must be confirmed by a Heritage Architect and a suitably qualified carpenter with knowledge of traditional joinery. Where replaced, the new frames must be well sealed to the building structure. The frame material does not play a substantial role in reducing noise penetration but it must be strong enough to hold the weight of the glass.

Note this treatment may not be suitable for many existing windows of the heritage items.

Double glazing

Double glazed windows comprise two panes of glass separated by a gap. The noise reduction through the window is controlled by the thickness of the glass, the width of the air gap, and the gasses, if any, within that gap. The use of thicker glazing and a wider gap, particularly if forming a vacuum, will increase the noise reduction. The thickness of each glass pane should be selected in accordance with manufacturer's recommendations. More noise reduction can be obtained with two panes of different thickness (eg a six millimetre thick pane and a 10 millimetre thick pane). For better noise reduction, it is noted that the space between the panes of glass should be at least 75 millimetres. The type of double-glazing optimised for thermal insulation is not as effective at reducing noise. As with single glazed windows, it is critical that window seals are provided around the perimeter.

Note this treatment may not be suitable for many existing windows of the heritage items.

Providing new secondary windows

An alternative to double-glazing is to retrofit a new secondary window with an air gap between the existing window, which will allow for the provision of a double glazed window without modifying the existing window. The secondary window should always be provided with acoustic seals. It is preferable, though not essential, that the existing window is also fitted with acoustic seals along the perimeters. Secondary windows may be glass or acrylic. Some are sealed magnetically, allowing for easy removal of panels for cleaning. Others can be designed to be sliding, which allows the window to be opened.

Note this treatment will generally be suitable for many existing windows of the heritage items depending on the depth of the internal window reveals.

Recommended solutions for internal ventilation

For any of the recommended noise mitigation treatments to be effective, the treated doors and windows will need to be kept closed. Some form of alternative ventilation system will therefore be necessary to allow fresh air into the subject rooms

The following alternative solutions, which were explored and noted for the heritage item at 10 Bridge Street, can also be considered for the subject residential heritage properties. As the internal configuration and ceiling detailing is unknown at this stage, it has been assumed that the ceilings of the subject buildings are similar to those of 10 Bridge Street and the following solutions would therefore be suitable and easily adopted.

The existing ceilings are assumed to be original and intact. Any future air-conditioning (ventilation) system should therefore be carefully installed in a manner that minimises the number of the air outlets (vents) on the ceilings. One option is to place the ceiling vents at the corners of the ceiling, rather than randomly in the centre of or in other panels of the ceilings. The ventilation system ducts and cabling can be placed within the roof cavity with only minimal openings required for the ducting registers. Consultation should be undertaken with an appropriately qualified Heritage Architect to establish the locations for ducting registers.

5.3.4 Recommendations for noise mitigation treatments

Considering the streetscape, internal presentation and importance of the existing joinery, the following option is anticipated to be the most appropriate form of treatment for windows and French doors:

- Windows - Installation of custom made individual glazed timber framed panels to each glass pane of the double-hung sashes.
- French doors - Installation of casement window frames with single glass panel (internal).

The custom made frames will create double glazing with a sealed air cavity and can be fitted without any damage to the existing original glazing panels. The appearance of the joinery, and thus the aesthetic significance of the heritage item, will not be affected. The windows, regardless their single-hung or double-hung system, will be operable. Furthermore, it will be possible to remove the new frames without damage to the existing fabric if required in the future.

A Magnetite Retrofit double glazing system should also be checked for suitability in consultation with an appropriately qualified carpenter with traditional joinery expertise.

As noted earlier, further close-up inspection of the subject windows and doors should be undertaken before starting any works so that the most suitable type of treatment is implemented without detrimental effects on the existing joinery. Replacement of timber frames and any extant joinery is not acceptable and should be the last option.

Regardless of the option implemented all work should be designed in consultation with and carried out under the supervision of a suitably qualified heritage consultant.

6 Revised environmental management measures

The EIS for the Windsor Bridge replacement project identified a range of environmental management measures that would be required to avoid or reduce the environmental impacts. After consideration of the issues raised in the public submissions, three of the 125 environmental management measures identified in the EIS (refer to Chapter 10 of the EIS) have been revised or deleted.

The three revised management measures are presented in **Table 6-1**. In the table, the revisions to environmental management measures are presented as follows:

- Revised text is shown in italics.
- Measures or parts of measures that have been deleted are struck out.

Should the project be approved, the environmental management measures in Chapter 10 of the EIS, including the revisions identified in **Table 6-1**, would guide the subsequent phases of project development.

Various NSW government agencies also proposed specific conditions of approval that the Department of Planning and Infrastructure and the Minister for Planning would consider if the project is approved. These proposed conditions of approval have not been included in the table below. Most of the proposed conditions of approval are similar or identical to the environmental management measures presented in the EIS.

Table 6-1 Summary of revised environmental management measures

Environmental issue	Revised environmental management measures	Reason for change modification
Traffic and transport		
T11	<i>Consultation with maritime operators will be undertaken so that impacts are minimised.</i>	Original environmental management measure was not complete
Hydrology		
H5	Flood impact mitigation requirements and options for buildings potentially impacted by increased flooding will be investigated during detailed design in consultation with the landholder. Appropriate measures would be identified, developed and implemented, as required, to minimise impacts on the building structure, building access and business opportunities.	Duplication of subsequent environmental management measure and revised flood modelling indicates that flooding no longer an issue
H6	During the detailed design of the new bridge, detailed flood modelling will be undertaken on the final design of the project to identify any additional impacts. This will include collecting survey data at potentially impacted properties with buildings upstream of the bridge. Where impacts are identified, appropriate measures will be identified, developed and implemented, as required, to minimise impacts on the building structures, building accesses and business opportunities.	Revised flood modelling indicates that flooding no longer an issue

7 Conclusion

This Submissions Report and PIR has been prepared to assist the Department of Planning and Infrastructure with preparation of the Director-General's environmental assessment report. The Submissions Report and PIR identifies the issues raised during exhibition of the EIS and provides responses to those issues. It also includes information on additional studies carried out since exhibition of the EIS, further details of an alternative option (the Rickabys Line option) proposed by ex-RMS bridge engineers, and a description of changes to the project since the EIS exhibition.

Most community submissions objected to the project on the grounds of significant impacts on the heritage of Thompson Square and the demolition of the existing Windsor Bridge, both items of heritage significance. Other community submissions raised issues around the justification for the project and the integrity and transparency of the project development and community consultation processes. Some submissions expressed a preference for an alternative option to avoid heritage and traffic-related impacts on Thompson Square, while others supported the project as a cost-effective and reasonable solution for a replacement bridge identifying benefits to local traffic, flood immunity and pedestrian safety.

Agency and council submissions identified a range of construction and operational phase issues that would need to be addressed by the project, including potential flooding impacts, urban design, and impacts on riparian vegetation and agricultural land. Notably, the Heritage Council of NSW objected to the project, raising significant concerns on the grounds of long-term irrevocable and serious negative impacts on the Thompson Square heritage conservation area and the heritage of Windsor.

RMS has considered each of the issues raised and the implications for the project. This has resulted in a number of further investigations, including a more detailed assessment of the alternative option (the Rickabys Line option) proposed by ex-RMS bridge engineers and mentioned by many respondents. This alternative comprised an alternative methodology for rehabilitation of the existing bridge for light traffic and an alternative route carrying traffic around the Windsor township. The assessment in this report identified the need to amend the alternative route option, as presented, to meet relevant design standards and mitigate significant impacts. Third party cost estimates were also undertaken.

The assessment concluded that the alternative bridge refurbishment methodology is a viable approach to restoring the existing Windsor Bridge, however, some works in addition to those proposed by the ex-RMS bridge engineers would be required to remedy some of the causes of the deterioration of the bridge and to reduce long term maintenance costs. These additional works would increase the costs estimated for the refurbishment of the bridge.

In comparing the costs and benefits of the Rickabys Line option to the Windsor Bridge replacement project, the assessment concluded that while the alternative would minimise heritage impacts and provide a more efficient connection for regional traffic, it would not provide the same pedestrian and cyclist benefits, would require substantially more private property acquisition and would introduce visual, noise and amenity impacts to areas that are currently not impacted by road infrastructure. The Windsor Bridge replacement project also provides greater value for money than the alternative option, with the alternative option requiring substantially greater capital, operational and maintenance expenditure.

This Submissions Report and PIR also proposes a number of changes to the project in response to issues raised in submissions and to minimise environmental impacts including:

- An increase in the clearance of the new bridge over The Terrace from 3.6 metres to 4.6 metres to allow large coaches to directly access Windsor Wharf.
- Changes in bridge pier location.
- Noise mitigation treatments for additional properties, including heritage properties.

The assessment of the proposed design changes demonstrates that they would reduce specific adverse impacts in comparison to the project presented in the EIS. While the design changes would also result in adverse impacts these have been assessed as minimal, with only a minor or negligible change compared with the impacts of the project identified in the EIS.

Finally, this report describes additional flooding and historic heritage investigations that have been undertaken since exhibition of the EIS. These further clarify potential impacts of the project.

RMS has now considered the issues raised in submissions and the conclusions of the additional investigations undertaken as part of this report in the context of the benefits that the project would provide. These project benefits include the provision of a cost-effective, efficient and safe route for local and regional traffic with a higher flood immunity than the existing bridge and appropriate for the surrounding road network. The project would also consolidate and create a larger green space area in Thompson Square parkland and improved pedestrian and cyclist paths and crossings linking Thompson Square with Macquarie Park, The Terrace and east Windsor.

8 References

CityPlan Heritage, 2012. Heritage advice on noise reduction mitigation measures associated with Windsor Bridge replacement project. CityPlan Heritage: Sydney.

CityPlan Heritage, 2013. Heritage advice on noise reduction mitigation measures associated with Windsor Bridge replacement project. CityPlan Heritage: Sydney.

DECC, 2009. *Interim Construction Noise Guideline*. Department of Environment and Climate Change (DECC): Sydney, NSW.

Handy, S.L., Kubly, S., Jarrett, J. and Srinivasan, S. 2000. Economic effects of highway relief routes on small and medium-sized communities: Literature review and identification of issues. Centre for Transportation Research. The University of Texas at Austin. Report No. 1843-1.

Sivaramakrishnan, S. and Kockelman, K.M. (2002) The impacts of bypasses on small and medium sized communities: an econometric analysis. *Journal of Transportation and Statistics*, Vol 5. No. 1, 57-69.

Appendix A - List of submissions

Submission number	Description of submitter
1	Individual
2	Individual
3	Individual
4	Unknown – Name withheld
5	Unknown – Name withheld
6	Individual
7	Individual
8	Individual
9	Individual
10	Unknown – Name withheld
11	Individual
12	Individual
13	Individual
14	Individual
15	Individual
16	Individual
17	Individual
18	Individual
19	Individual
20	Unknown – Name withheld
21	Unknown – Name withheld
22	Unknown – Name withheld
23	Unknown – Name withheld
24	Individual
25	Individual
26	Individual
27	Company/ Business - Christopher Hallam and Associates
28	Individual
29	Individual
30	Individual
31	Individual
32	Individual
33	Individual
34	Individual
35	Individual
36	Individual

Submission number	Description of submitter
37	Individual
38	Individual
39	Unknown – Name withheld
40	Individual
41	Unknown – Name withheld
42	Individual
43	Individual
44	Unknown – Name withheld
45	Individual
46	Unknown – Name withheld
47	Unknown – Name withheld
48	Individual
49	Unknown – Name withheld
50	Company/ business - Lee Bralee of Hawkesbury Paddlewheelers
51	Unknown – Name withheld
52	Unknown – Name withheld
53	Unknown – Name withheld
54	Individual
55	Company/ Business - Glen Kanawati of Blooms the Chemist Windsor Market Place
56	Individual
57	Individual
58	Individual
59	Individual
60	Individual
61	Unknown – Name withheld
62	Individual
63	Individual
64	Unknown – Name withheld
65	Individual
66	Unknown – Name withheld
67	Company/ Business - Christian Steinbach of Freemans Reach Greenhouses PTY LTD
68	Individual
69	Unknown – Name withheld
70	Individual
71	Individual

Submission number	Description of submitter
72	Individual
73	Individual
74	Individual
75	Individual
76	Group/ Organisation - Annette Hogan of Cronulla Dunes & Wetlands Protection Alliance
77	Unknown – Name withheld
78	Individual
79	Individual
80	Individual
81	Unknown – Name withheld
82	Individual
83	Individual
84	Group/ Organisation - Carol Edds of Hawkesbury Branch of the National Trust of Australia (NSW)
85	Individual
86	Group/ Organisation - Ian Bowie of the Engineering Heritage Committee of Sydney Division, Engineers Australia
87	Individual
88	Group/ Organisation - Dr Anne Maree Whitaker of the Royal Australian Historical Society
89	Individual
90	Individual
91	Individual
92	Individual
93	Group/ Organisation – Community Action Against Windsor Bridge (CAWB)
94	Individual
95	Unknown – Name withheld