Submission No 32

INQUIRY INTO WINDSOR BRIDGE REPLACEMENT PROJECT

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INQUIRY INTO THE WINDSOR BRIDGE REPLACEMENT PROJECT

LEGISLATIVE COUNCIL
PORTFOLIO COMMITTEE NO.5 – INDUSTRY & TRANSPORT

SUBMISSION RELATING TO TRAFFIC AND TRANSPORT ISSUES

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1.0 INTRODUCTION

This is a submission to the *Inquiry into the Windsor Bridge replacement project,* Portfolio Committee No.5 – Industry and Transport, Legislative Council of New South Wales. This submission has been prepared by Christopher Hallam BE, MEngSc. I have practised as a professional traffic and transport engineer for 46 years, primarily in New South Wales, and with my experience including ten years working for NSW Government Departments. My professional experience is summarised in Annexure A.

This submission discusses the roads and traffic engineering issues involved in the proposed Windsor Bridge replacement project. It relies on other submissions to prove that the impact of the Option 1 Concept Design would have an unacceptable impact on the archaeological remains and the heritage values of Thompson Square in particular and Windsor in general.

This submission is set out as follows:

- Section 2 introduces what I see as the key factors to be considered by the Inquiry;
- Section 3 discusses the growth in traffic, particularly heavy vehicles and how this affects the choice of the best option;
- Section 4 discusses in general terms the alternatives to the RMS preferred Concept Design;
- Section 5 details the traffic performance of alternative options and compares this performance with that of the Concept Design, and
- Section 6 sets out my conclusions.

2.0 KEY FACTORS

2.1 Archaeology and Heritage Impacts

I understand that there are major concerns about the impact of the Concept Design bridge on the early Colonial archaeology remaining in and near Thompson Square that will be seriously impacted and/or destroyed by the new bridge. I have seen photographs of early brick structures, timber wharf and road surfaces. I am not an expert in this field so cannot submit that the impact would be unacceptable. I rely on others for such submissions.

Similarly I am aware that the height, width and size of the proposed bridge will have an adverse impact on the retention of the heritage significance of Thompson Square. A new bridge substantially higher than the existing bridge will clearly be more visible and affect views of heritage structures and places. A higher bridge deck will allow a more direct path of transmission for noise, an issue becoming even more important with the continuing increase in heavy vehicle movements. While my tertiary studies did include studies of Colonial architecture and related historical research, in the context of this Inquiry I prefer to rely on the evidence of others that the proposed bridge is totally unacceptable in archaeology and heritage terms. This is a key factor in my review of the traffic and transport issues to be considered by the Inquiry.

2.2 Heavy Vehicle Movements

As I discuss further in Section 3 of this Submission, and as is covered in more depth in Annexure B, heavy vehicle numbers are increasing across Windsor Bridge in disproportionate numbers to the growth on total traffic. From seven day classified counts on Windsor Bridge in November 2012 and November 2017, the increases in traffic for seven days by vehicle type were:

Vehicle Class	**2012**	**2017**	**Increase**
Light	122,944	131,007	+6.6%
Heavy Rigid	8,391	12,147	+44.8%
Heavy Articulated	2,547	4,044	+58.8%
Total	133,882	147,198	+9.9%

The increase in heavy vehicle movements through Thompson Square is an issue of increasing concern, given the heritage significance. The increase of almost 60% of heavy articulated vehicles over five years underlines this concern, over a period when light traffic

only increased by about 7%. Putting aside for the moment any question about the structural adequacy of the existing Windsor Bridge to handle heavy articulated trucks, in the medium term some form of town centre bypass is needed. It is recognised that Wilberforce Road-Bridge Street-Windsor Road and Macquarie Street are part of the approved route network for large B-Double trucks. A new bypass, incorporating a new bridge over the Hawkesbury River will be needed in the medium term

2.3 Retention of Existing Windsor Bridge

In my consideration of the best transport outcome for the area, I have assumed that the existing Windsor Bridge would be retained for light traffic use. I have assumed that the imposition of a load limit would be required to redirect all medium and heavy trucks to the alternative bypass. In my traffic analysis I have assumed that all Class 3-13 vehicles will not use Windsor Bridge after a bypass was completed.

There has been much debate about the structural adequacy of the existing bridge, with retired senior DMR/RTA bridge engineers arguing that this bridge could be retained. An independent engineer report was commissioned by the NSW Department of Planning, to provide a peer review. The report titled *A Review of the Structural Condition of the existing Windsor Bridge – Final Review,* was prepared by Peter Stewart Consulting Pty Ltd. The *Executive Summary* states in part:

> *"...While the bridge is deteriorating from various ailments it is not about to collapse in the short term. Each ailment can be treated and this has been plainly demonstrated by RMS and others...*
>
> *The bridge can be refurbished at a cost such that it can function for the next 50 years with little ongoing maintenance. However this refurbishment would not permit the level of service required by RMS into the future hence the need for a new bridge. Refurbishment would permit alternative uses for the existing bridge such as either a pedestrian bridge or a load limited bridge (16 tonne). This report shows that it would not be an exorbitant cost (approx.$12.5m) to bring the bridge up to an "as new" condition for an alternative use..."*

The **key outcomes and conclusions** are:

> *"The condition of the existing bridge is such that it is not in dire condition and could relatively economically be refurbished and strengthened. However, it is in danger of accelerated deterioration through neglect of maintenance. It is not proposed to refurbish & strengthen the bridge to carry the future traffic volumes & loads and hence meet the RMS desired level of service, standards and specifications. It is assumed that a new bridge will provide for the future needs.*

Refurbishment/strengthening options would permit alternative uses for the existing bridge. So the remaining options for the existing bridge are:

1. *Refurbish to a condition & retain existing bridge for pedestrians and cyclists only and/or retain for Sunday morning markets as well as for pedestrians and cyclists.*
2. *Refurbish to "as new" condition and retain existing bridge for local traffic only (with 16 tonne weight restrictions applied).*
3. *Refurbish and strengthen (Carbon fibre process) for T44 loading with a compliant load factor of 2.*

It appears the optimum option is some combination between the RMS and the Pearson Wedgewood options which will be able to provide a viable option (3 above) for the next 25 to 50 years and hence not build a new bridge at this stage. Then at some time in the future a bypass can be built which avoids all the damage to property, heritage values etc. So with a relatively modest expenditure the bridge can be serviceable for the next 50 years within which time an alternative route will have been identified and agreed."

3.0 TRAFFIC GROWTH ON WINDSOR BRIDGE

3.1 Windsor Bridge Traffic Flows

I have reviewed seven day traffic counts undertaken in three periods by CFE Information Technologies on Windsor Bridge, on 14-20 November 2012, 18-24 November 2015 and 21-28 November 2017. Annexure B provides a more detailed review of these traffic flows. I present below the key points found from my review of this traffic count data.

Looking at the seven day Monday to Sunday total traffic flow data, there is a marked trend to increases in heavy vehicle movements. Totalling both directions of travel, and breaking results down into Light Vehicles (class 0-2), Heavy Rigid Vehicles (class 3-5) and Heavy Articulated Vehicles (class 6-13), the weekly figures per year are:

Vehicle Class	**2012**	**2015**	**2017**
Light	122,944	130,362 (+6.0%)	131,007 (+0.5%)
Rigid heavy	8,391	9,704 (+15.6%)	12,147 (+25.2%)
Articulated	2,547	3,233 (+26.9%)	4,044 (+25.1%)
All	133,882	143,299 (+7.0%)	147,198 (+2.7%)

While the increase in Light Vehicles has been very modest, there have been regular increases in both Rigid Heavy and Articulated Heavy vehicles. These increases have an increasingly high impact on the amenity and heritage "feel" of Thompson Square. The Concept Design will allow faster passage by heavy vehicles through Thompson Square but with the higher bridge elevation, the noise and visual impacts will also be higher.

In heavy vehicle directions, the increases are higher for southbound vehicles.

In 2012 the overall weekly percentage of heavy vehicles was 8.2%, with typical weekday heavy vehicle percentages of 9.1-9.7%. In 2017 the heavy vehicle proportion has substantially increased to 11.0% over the week and with weekday percentages of 11.9-13.6%. These are significant increases.

Looking at weekday peak hour flows, the peak hours are 8.00-9.00am and 4.00-5.00pm. The mean weekday peak hour flows for 2012, 2015 and 2017 were as shown in Table 3.1.

Table 3.1 Peak Hour Traffic Flows across Windsor Bridge

Hour	2012 Northb	2012 Southb	2012 Total	2015 Northb	2015 Southb	2015 Total	2017 Northb	2017 Southb	2017 Total
8-9am	382	1085	1467	397	1078	1475	448	1022	1470
4.5pm	1249	525	1774	1262	522	1784	1243	548	1791

The overall traffic flow increases in the daily flows are not reflected in the peak hour flows, possibly indicating that in these peak hours the bridge and its approaches are at capacity and cannot accommodate additional traffic. The capacity of this route is primarily determined by the approach intersection capacity. At other hours there has been additional traffic, reflecting a broadening out of the traffic distribution. Drivers are possibly choosing to travel at different times, in order to avoid peak times.

Finally, looking at seven day trends in heavy vehicle movements for each hour of the day, with Rigid Heavy Vehicles there has been a solid increase in almost all hours of the day. With Articulated Heavy Vehicles the substantial increases have been in the working hours of the day, between 5.00am and 6.00pm. Details are set out in Annexure B.

On **Fitzroy Bridge,** being Windsor Road over South Creek, seven day counts were undertaken 11-17 November 2017. While Windsor Bridge had a seven day average daily flow of 21,028 veh/day, with an average of 11.0% heavy vehicles, on Fitzroy Bridge the average daily flow was slightly more, at 22,410 veh/day, with 11.6% heavy vehicles.

Table 3.2 sets out the weekday peak hour traffic flows, averaged over Monday to Friday, by vehicle class.

Table 3.2 Peak Hour Traffic Flows across Fitzroy Bridge

Hour	Northbound Total	Northbound % Heavy	Southbound Total	Southbound % Heavy	Two-way Total	Two-way % Heavy
8-9am	892	8.9%	866	10.7%	1758	9.7%
4-5pm	797	12.1%	768	10.1%	1565	11.1%

Table 3.2 indicates that in the peak hours, the percentages of heavy vehicles are of a similar order, but slightly less, to the overall weekly figure of 11.6%.

As set out in Annexure B, the daily flows increase slightly from Monday to Friday, but then reduce over the weekend. The average weekly flow of 22,410 veh/day compares with the highest weekday flow of 24,246 veh/day on the Friday.

3.2 Peak Hour Intersection Flows

Up to date intersection traffic movements and capacity analysis was undertaken for the RMS by Arcadis, with their report *Windsor Bridge Replacement Project – Traffic Options Modelling Report* being published on 21 June 2017. This report presents AM and PM peak hour intersection counts for March 2017 – as counted – and projections for 2026 and 2036. Annexure C sets out the year 2017 current peak hour flows. I have also marked on these figures the year 2011 peak hour flows that were collected as part of the *Windsor Traffic Study,* a study undertaken for Hawkesbury City Council by Christopher Hallam & Associates Pty Ltd. I undertook that study in 2011.

General traffic growth is evident. The traffic flows north of George Street on Bridge Street – on Windsor Bridge – were lower in the 2011 traffic study than observed in the November 2012 seven day counts on Windsor Bridge. The 2011 southbound flow in the AM peak hour was 800 veh/hr, compared with the 1085 veh/hr counted in 2012. In the PM peak hour the 2011 northbound flow was 1040 veh/hr, compared with the 2012 figure of 1249 vrh/hr.

The turning movements at the intersections of Bridge Street/Macquarie Street and Bridge Street/George Street provide an indication of origins/destinations of Windsor Bridge traffic, allowing for manual traffic redistributions for different options. In the AM peak hour southbound across the bridge, in 2011 about 42% of traffic headed on Windsor Road towards McGraths Hill. In 2017 this had increased to about 49%. However northbound flows in the AM peak hour remained at about 40% from McGraths Hill for both 2011 and 2017. In the PM peak hour some 27% of bridge southbound traffic continued to McGraths Hill, compared with 39% in 2017. Again, the distribution of northbound traffic did not change, remaining at about 43% in 2011 and 2017 from McGraths Hill to the bridge. Note that in deriving these figures, account has been taken of all turning movements at the two Bridge Street intersections.

With the increase in bridge traffic heading towards Windsor Road, McGraths Hill, some of the new bridge options north-east of Windsor might be a little more favourable.

One interesting figure in the Arcadis report is Figure 2.8, showing the crash history over the period 1 July 2011 to 30 June 2016. There were no crashes on the bridge itself, three on the northern approach and one on the southern approach.

The Arcadis report gives the capacity of each lane of the current Windsor Bridge as 820 veh/hr, taking heavy vehicle speed reductions and upstream and downstream intersection capacity into account. This figure is intriguing because they counted the southbound AM peak hour flow to be 1227 veh/hr and the northbound PM peak hour flow to be 1249 veh/hr, with both figures consistent with the seven day tube counts. It could be that Arcadis are saying the corridor capacity is 820 veh/hr, but this is still inconsistent with how much traffic is getting through this corridor in the peak periods.

4.0 ALTERNATIVES TO CONCEPT DESIGN

4.1 Concept Design

Corridor capacity

My keystone assumption in my traffic review is that the Concept Design would have an unacceptable impact on archaeology and heritage in Thompson Square and Windsor generally. In traffic terms, it is by no means perfect. The June 2017 Arcadis report reviewed the operation of the Bridge Street intersections and found capacity concerns in the PM peak hour. Tables 4.6 and 4.7 of this report assesses the PM peak level of service at both Bridge Street/George Street and Bridge Street/Macquarie Street intersections as "E" in 2026 and "F" in 2036. Acceptable levels of service were found for the AM peak hour, where the two southbound lanes on the new bridge and the resulting intersection redesign for southbound traffic would make a difference. In contrast, northbound traffic has to channel down to one lane at some point.

Arcadis then developed a Modified Concept Design, with the result that in 2026 in the PM peak hour the level of service at the Bridge Street/George Street intersection would improve from "E" to an acceptable "B". At the Bridge Street/Macquarie Street intersection the 2026 PM level of service would improve from "E" to "D", which is marginally acceptable. For the year 2036 design flows, the Bridge Street/Macquarie Street intersection would remain a problem in the PM peak, with a level of service of "F", the worst, lowest level. This of course assumes that the Modified Concept Design is adopted.

An advantage of the Concept Design, or original Option 1, is that the basic corridor of the river crossing and its intersections through Windsor remains unaltered. This keeps costs to a minimum. However it does not necessarily result in the best outcome, as measured by a range of factors. Heritage/archaeology cannot be factored into the benefit-cost analysis. Intersection capacity can be factored in. The alternative of providing a new bridge as a bypass, to primarily carry heavy traffic, plus to spread the load of light traffic with the retention of the current bridge would provide a broader traffic distribution, with point loads reduced.

Detailed design – bridge height

As a comment on the priorities of the designers of the Concept Design, the vertical clearance of The Terrace under the new bridge has been set at 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." This quote is from the *Windsor Bridge Replacement Submissions Report.*

In the original Option 1, the proposed height clearance under the new bridge to The Terrace was 5.1m. I made a submission in January 2012 titled *WINDSOR BRIDGE OVER THE HAWKESBURY RIVER – SUBMISSION FOR OPTION 1 REVISED DESIGN,* in which I argued that the original clearance would make the bridge deck height about 2 metres higher than the roadway at the northern end of Thompson Square, or about 1.85 metres higher than the north-east corner of the Doctors House base. This would result in a serious visual and noise impact on Thompson Square. My submission argued that a reduction of the height clearance to 3.5 metres would have significant benefits. I have included a Summary of that Submission in Annexure D, including a bridge cross-section and a plan showing where a coach parking area could be located, on the current carriageway of Bridge Street just south of the current bridge. Capacity for up to three coaches could be provided. I commented: *Tourists travelling to the wharf simply are dropped at this parking area and walk a short distance. A coach parking facility in this location would also serve tourists visiting Thompson Square. A walkway could easily be incorporated between the coach parking area and Thompson Square. Tourist coach parking is never an easy issue, but this option will provide a multi-use facility to benefit many tourists.*

The proposed coach parking area is 90 metres from the wharf. It is also very close to Thompson Square, where visitors using boats from the wharf might also visit. Following my submission, and probably other similar submissions, the design of the scheme changed, with the clearance over the Terrace reducing to 3.6 metres. However, the *Submissions Report* argued that the clearance should be put back, to 4.6 metres, as set out above. There was no quantification of the number of large coaches per week seeking access to the wharf. It cannot be assumed that all patrons of the paddlewheel boat are old disabled visitors arriving in large coaches. The statement in this *Submissions Report* that "*The viability of the Hawkesbury Paddle Wheeler business is reliant on large coaches being able to transport patrons to Windsor Wharf"* is made without supporting proof. At best this is an example of the project being designed to support one small business, while significantly disadvantaging the broader public interest. At worst it is simply an example of the bridge designers not wanting to alter their design for any reason. The statements in this *Submissions Report* ignore the suggestion made in my Submission that a coach parking area be provided on the current Bridge Street carriageway.

My submission on this issue is that IF the current Concept Scheme is to be constructed, the height clearance under the bridge to The Terrace should be changed to 3.6m.

4.2 Overview of Alternatives to Concept Design

In the short term the current Windsor Bridge can be retained in its current use, but with observed and forecast increases in heavy vehicle movements, a bypass bridge for heavy vehicles would be appropriate. To avoid impacts on Thompson Square and its environs, the bypass bridge needs to be either upstream or downstream of the current location. The Rickabys Line is the logical upstream alignment. For a downstream option, the original Option 6 is clearly an alternative, subject to detailed design issues. An alternative would be a connection from Wilberforce Road onto Pitt Town Bottoms Road, joining Pitt Town Road where it meets Saunders Road. In all of these alternative bypass routes, I recommend the retention of the current Windsor Bridge for light traffic, pedestrians and cyclists.

I have estimated the affect on the traffic flows on the current Windsor Bridge based on traffic re-assignments derived from the March 2017 peak period intersection counts, and other information contained in the Arcadis June 2017 report. I have assumed that all heavy vehicles (class 3-13) would be diverted onto the bypass bridge, but that the retained original bridge would serve light vehicles where it provides the shortest route. This would maintain the accessibility of Windsor for shoppers, business visitors and tourists. For diversions onto the bypass bridge for drivers with destinations/origins on Windsor Road past McGraths Hill, a downstream bypass would clearly be used. For the Rickabys Line, drivers heading to Richmond would use the new route. For drivers heading to/from Macquarie Street west of Hawkesbury Valley Way, to go to Blacktown, Penrith and areas in this direction, I have re-assigned 50% of this traffic onto the new route, with the balance of light vehicle traffic continuing to use the Bridge Street-Macquarie Street route. Table 4.1 sets out the resulting weekday peak hour flows on the current Windsor Bridge, based on the March 2017 traffic counts. The total volumes in the table are expressed as passenger-car-units, where a heavy vehicle is given the equivalence of two passenger cars (default value in SIDRA intersection modelling program).

Table 4.1 Windsor Bridge Peak Hour Flows with Options (2017 passenger-car-units)

Option	8-9	AM	North	8-9	AM	South	4-5	PM	North	4-5	PM	South
	light	heavy	total	light	heavy	total	light	heavy	total	light	heavy	total
Current	326	88	502	1084	143	1370	1141	108	1357	465	60	585
Concept Scheme	326	88	502	1084	143	1370	1141	108	1357	465	60	585
Rickabys Line	234	0	234	857	0	857	873	0	873	344	0	344
Downstream options	255	0	255	803	0	803	875	0	875	344	0	344

With either of the Rickabys Line or Downstream options, the peak hour flows on the current Windsor Bridge are significantly reduced, in terms of passenger-car-units. This means that

the existing intersections of Bridge Street with George Street and with Macquarie Street will function with lower average delay levels than the current levels, and will continue to function at satisfactory levels into the future, without any intersection works required. This is further addressed in Section 5.

4.3 Rickabys Line

The location of the new Hawkesbury River bridge under the Rickabys Line is close to Rickabys Creek, and has been determined by two retired DMR/RTA senior bridge engineers, Mr Pearson and Mr Wedgewood. The route would intersect with Hawkesbury Valley Way between the RAAF Base and the Sebel Resort. All trucks would need to use this route. Trucks heading to/from Windsor Road would simply continue on Hawkesbury Valley Way, as a flood free access. Trucks with origins/destinations in the Blacktown/Penrith direction would turn at the Macquarie Street/Hawkesbury Valley Way intersection. For southbound truck movement, this option would eliminate heavy vehicles making a right turn from Bridge Street into Macquarie Street, transferring these movements to the right turn from Hawkesbury Valley Way into Macquarie Street. Hence two-way heavy vehicle movement along Macquarie Street between Bridge Street and Hawkesbury Valley Way would be reduced.

With light vehicle movements, traffic to/from Richmond would use the new route. Traffic to/from Windsor Road would continue to use Bridge Street. Traffic to/from Blacktown/Penrith would have the choice of the new route or continue to use Bridge Street-Macquarie Street. In practice it would split between the two routes. Table 4.1 assumes a 50/50 split for this traffic.

The *Windsor Bridge Replacement – Submissions Report* presents the results of traffic modelling of the Rickabys Line, compared with the Concept Scheme. Table 4.1 of this report presents *Traffic performance (Level of Service) of the project and the Rickabys Line option for key turning movements.* I do not understand the results set out in this Table for the intersections of Bridge Street with George Street and with Macquarie Street. My Table 4.1 sets out the reductions in traffic using the current Windsor Bridge with Rickabys Line, where for the AM peak southbound the passenger-car-equivalent flow would reduce from 1370 to 857 pcu/hr, and the PM peak northbound situation where the flow would reduce from 1357 pcu/hr to 873 pcu/hr. In Section 5 I set out my detailed intersection analysis.

Another problem with Table 4.1 of the *Submissions Report* is that it reviews individual movements but does not quote overall intersection performance and levels of service. A low level of service on one movement might not mean much if the actual traffic flow is low. The nature of traffic signals is that the signal timing attempts to provide lowest total

intersection delay, so delay levels on movements with low flows might be less important than delays on the major movements.

4.4 Downstream Bridge Options

The original public consultation by the RTA (RMS) showed 8 options. Of these, three were downstream of the current bridge, excluding option 1 that is just 35 metres downstream. Options 6 and 7 follow the same new bridge alignment, with the route passing just to the north-east of Palmer Street, Windsor. Route 7 returns directly to Bridge Street via Court Street-North Street, while Route 6 continues further to the South-East before curving back to rejoin Windsor Road. Route 7 has the significant disadvantage of passing through the North Street heritage precinct.

Route 8 would link King Road, Wilberforce with Punt Road, Pitt Town. This route would cause substantial increases in travel distances.

The August 2011 report *Windsor Bridge over the Hawkesbury River – Traffic modelling and evaluation of options – preliminary report* it is stated: *"At the government stakeholder workshop held in September 2009, it was suggested that option 1 and option 6 should be refined and analysed further".* The relevant page from this report is reproduced in Annexure E. The route shown for Option 6 joins Windsor Road further to the North, in comparison with the original route option, plus there is fine tuning of the route and its access points. It curves to the West just before the Tebbutt's Barn. Also, it is shown as having no direct connections to George Street, Court Street or Pitt Street, to minimise additional traffic through this residential area. Access to Governor Phillip Park would be via the new route.

A disadvantage of Option 6 is the level of Windsor Road between McGraths Hill and the Fitzroy Bridge over South Creek. If the level of Windsor Road was raised between Fitzroy Bridge and the junction with this new route, access by heavy vehicles to Macquarie Street could be safeguarded during flood events.

A second downstream option would be to construct a new bridge to connect with Pitt Town Bottoms Road, and then through to join Pitt Town Road at its junction with Saunders Road. I understand that RMS own land allowing the expansion of this intersection. Pitt Town Bottoms Road would need to be reconstructed and widened. Pitt Town Road is a designated B-Double route. I have not undertaken any design feasibility work of this route, but present it as a possible option.

5.0 DETAILED TRAFFIC ANALYSIS OF BRIDGE OPTIONS

5.1 Methodology

I have re-assigned traffic onto a new downstream route based on current peak hour traffic patterns, as counted by RMS in March 2017. I have made similar assumptions for the Rickabys Line option. Table 4.1 set out the resulting peak hour flows. I have then analysed the intersection operations using the SIDRA6 program. Annexure F sets out the Movement Summaries for each intersection option tested. These Summaries provide individual movement delays and levels of service. I have only modelled year 2017 traffic flows. They provide a good basis to compare options. In the development of a preferred option, it would be appropriate to model future traffic levels, such as in the years 2026 and 2036, as was undertaken in the Arcadis report of June 2017. Table 5.1 reproduces a table in the RMS *Guide to Traffic Generating Developments,* that sets out the levels of service at intersections for different intersection delay levels, to allow a better understanding of the discussion in the following Sections.

Table 5.1 Level of Service Criteria for Intersections

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabouts	Give Way & Stop signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays & spare capacity	Acceptable delays & spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident Study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity; at signals incidents will cause excessive delays Roundabouts require other control mode	At capacity, requires other control mode

5.2 Intersection Capacity

At the intersection of Bridge and George Streets, the current operation is a one lane roundabout. Under either the Rickabys Line or Downstream options, it would remain unchanged, as a one lane roundabout. Under the Concept Scheme, the roundabout would be replaced by traffic signals. For the SIDRA modelling, I have modelled this intersection assuming the Modified Concept Design recommended in the Ardadis report is adopted. Table 5.2 sets out the results, expressed in terms of year 2017 peak hour intersection delays and levels of service.

Table 5.2 Bridge & George Streets Junction: 2017 Peak Hour Flows

Option	8-9am Avg Delay (secs/veh)	8-9am Level of service	4-5pm Avg Delay (secs/veh)	4-5pm Level of service
Current	6.8	A	35.3	C
Concept Scheme	23.3	B	20.6	B
Rickabys Line	6.2	A	6.8	A
Downstream (Op6)	6.2	A	6.8	A

Table 5.2 indicates that the Concept Scheme will increase delays in the AM peak hour and reduce delays in the PM peak hour. There is a trade-off in these peak periods, in terms of total daily delays. Either the Rickabys Line or Downstream options will substantially reduce traffic through this intersection and hence reduce traffic delays in both peak periods. Leaving the current roundabout in place does not cost anything.

An advantage of the Concept Scheme's traffic signal installation is that it would provide safe pedestrian crossings. However the Rickabys Line and Downstream options would substantially reduce traffic through this intersection and hence make it easier for pedestrians to cross Bridge Street.

At the Bridge Street/Macquarie Street traffic-signal controlled junction, there would be no changes to the intersection layout in all options, except for a minor alteration in line marking in Bridge Street under the Modified Concept Scheme for traffic leaving the intersection. Table 5.3 sets out the results.

Table 5.3 Bridge & Macquarie Streets Junction: 2017 Peak Hour Flows

Option	8-9am Avg Delay (secs/veh)	8-9am Level of service	4-5pm Avg Delay (secs/veh)	4-5pm Level of service
Current	18.5	B	23.5	B
Concept Scheme	18.5	B	23.5	B
Rickabys Line	13.9	A	18.4	B
Downstream(Op6)	17.8	B	21.0	B

The Rickabys Line option would have the greatest benefit at this junction because the right turn movement from Bridge Street (North) into Macquarie Street would be substantially reduced, as would the complimentary left turn out of Macquarie Street. The Downstream options would provide some traffic divergence, thus reducing delay levels. These results confirm that Table 4.1 of the *Submissions Report* does not reflect the situation at this junction under the Rickabys Line option. Note that the traffic redistribution for the Downstream options redirected heavy vehicles onto Windsor Road and hence onto Macquarie Street, increasing the left turn into Macquarie Street and the right turn out of Macquarie Street.

5.3 Option 6 Intersection Review

For the purpose of this assessment, I have taken original Option 6 as the Downstream option. For its connection to Wilberforce Road I have assumed a priority-controlled junction. The existing junction of Wilberforce Road and Freemans Reach Road has been assumed unchanged, as a priority-controlled junction. For the connection of the Option 6 road back to Windsor Road, I have assumed it to be traffic-signal controlled, to provide the necessary capacity, with flaring of the Windsor Road approaches. Table 5.4 sets out the results of the SIDRA analysis of this option.

Table 5.4 Downstream Option 6 Intersection Analysis – 2017 Peak Hour Flows

Intersection	8-9am Avg Delay (secs/veh)	8-9am Level of service	4-5pm Avg Delay (secs/veh)	4-5pm Level of service
Wilberforce Rd/Route 6	6.1	Na *	6.5	Na *
Wilberforce Rd Freemans Reach Rd	4.4	Na *	5.7	Na *
George & Bridge Sts	6.2	A	6.8	A
Bridge & Macquarie Sts	17.8	B	21.0	B
Windsor Rd & Route 6	13.9	A	19.0	B

* Levels of service at priority-junctions defined by individual movements

The purpose of this analysis was to assess if there were any significant capacity constraints on intersections with such an option. Table 5.4 indicates that the intersections could be designed to provide adequate capacity. A logical further stage would be to use projections for future traffic levels to review intersection capacity and as required, refine the design of the intersections, in a similar manner to the work by Arcadis for the Concept Design.

6.0 CONCLUSIONS

1. If it is considered that the impact of the Concept Scheme on the archaeology and heritage significance of Thompson Square and its environs would be unacceptable, this traffic analysis has indicated that there are reasonable alternatives to the Concept Scheme, alternatives that provide a bypass of the historic heart of Windsor while leaving the existing Windsor Bridge in place to maintain local accessibility for light traffic.
2. The extent of growth in heavy vehicle traffic across Windsor Bridge has been very significant in recent years. This by itself affects the heritage significance and amenity of Windsor in general and Thompson Square in particular. Thus while the existing bridge can handle current traffic loads in the short term, as set out in the Independent Engineer Report by Peter Steward Consulting Pty Ltd, in the medium term a heavy vehicle bypass is needed. Both the Rickabys Line and Downstream options could provide such a bypass, while retaining Windsor Bridge for light traffic, pedestrians and cyclist use only.
3. Traditional benefit-cost analysis cannot adequately take heritage impacts into account. While it would assist in comparing the Rickabys Line with Downstream options, it cannot be used to compare the Concept Scheme with these alternatives that would preserve the heritage integrity of Thompson Square and Windsor.

Christopher Hallam 27 December 2017