Road Safety Audits – UNSW Anzac Parade Stop and UNSW High Street Stop

Transafe / Traffix Group

Appendix G

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University of New South Wales

Proposed Light Rail Platform Stops on Anzac Parade
Feasibility Design Stage Road Safety Audit

Project Ref: TS-14-RSA-0759B
Prepared for: University of New South Wales
Date: 26th March 2014

2014

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Document control

Project Ref	Date	Revision	Author	Reviewer
TS-14-RSA-0759B	26 March 2014	B	Darren Vella	Simon Penca

1. Introduction

Transafe has been engaged by the University of New South Wales to undertake a feasibility design stage road safety audit of the proposed light rail platform stop options on Anzac Parade, at the University of New South Wales in Kensington.

This audit was conducted by:

Darren Vella [BEng Civil (Hons), Director]
RMS Accredited (Level 3) Senior Road Safety Auditor (Auditor ID: RSA-03-0530)

and;

Simon Penca [BEng Civil (Hons), Director]
RMS Accredited (Level 3) Senior Road Safety Auditor (Auditor ID: RSA-03-0531)

A feasibility design stage road safety audit of several proposed light rail and platform options for Anzac Parade (at University of New South Wales) was undertaken by Transafe for University of New South Wales (report dated: 26th November 2013, report number: TS-13-RSA-0619C).

2. Road safety audit process

A road safety audit is a formal examination of an existing or future road or traffic project in which an independent, qualified team reports on the projects crash potential and safety performance (Austroads 2009). This road safety audit has been carried out in accordance with the Austroads Guide to Road Safety Part 6: Road Safety Audit (2009) with reference to relevant standards and guides, and draws on industry practice and experience to identify potential road safety audit findings. However, no guarantee is made that every deficiency has been identified.

3. Responding to this audit

As set out in the road safety audit guidelines, responsibility for the road safety audit always rests with the project team and not the auditor. The project team is under no obligation to accept or agree with all of the audit findings. Also, it is not the role of the auditor to agree to or approve the project teams response to the audit. This audit report should be responded to in writing including reasons for rejection of an audit finding. Acceptance of all findings of this report would not guarantee that every potential road safety issue has been addressed, rather adoption of the audit findings should improve the level of safety of the subject site.

4. Site details

Anzac Parade is a primary state arterial road generally aligned north-south with three lanes in each direction and a narrow central median with pedestrian fencing. Buses operate along Anzac Parade to cater for the large patronage to the adjacent university and NIDA facilities. The kerbside lane along Anzac Parade is a bus lane in peak periods in the peak direction and reverts to a parking lane at other times. A wide pedestrian operated signalised crossing exists on Anzac Parade to facilitate east-west pedestrian movements (across Anzac Parade). Bus stops are located to the north (for northbound) and south (for southbound) of the pedestrian operated signals. Anzac Parade is subject to a posted speed limit of 60km/h.

Figure F1: Location plan

Photo P1 – Anzac Parade view north from pedestrian operated signals

Photo P2 – Anzac Parade view south to pedestrian operated signals

Photo P3 – Anzac Parade view south to pedestrian operated signals

Photo P4 – University Mall view west across pedestrian operated signals

5. Proposed works and scope of the audit

As part of the new Sydney Light Rail network, a central island platform is proposed in a widened median on Anzac Parade. The central island platform will cater for northbound and southbound light rail vehicle movements on Anzac Parade, adjacent to the University of New South Wales. To cater for expected demand, two options with variations of the central island platform stop are being considered on Anzac Parade as follows:

- Transport for NSW option: This option involves the provision of a 6.4m wide central island platform is proposed adjacent to Square House. The Anzac Parade roadway would require widening on both sides, with footpaths encroaching into the University boundaries on both sides. A new northbound (western side), indented bus bay would be located at a similar location to the current bus stop (adjacent to the NIDA car park), to minimise traffic impact during operation. In the southbound direction (eastern side), a new bus stop is also proposed, in front of the existing Tyree Building (located on the southern side of the University Mall, the Tyree Building is a major building fronting Anzac Parade). The indented bus bay is proposed to the immediate south of the existing signalised pedestrian crossing, requiring some encroachment into the university campus. A central island pedestrian walkway will be provided between the platform stop and the existing pedestrian crossing of Anzac Parade at University Mall, providing an access point for passengers to access the light rail platform from either side of Anzac Parade. At this southern end of the stop, the southern end of the platform will be located approximately 45m north of the signalised pedestrian crossing. Fencing would prevent pedestrians from accessing the stop outside of the existing pedestrian crossing at University Mall. A mid-block pedestrian crossing at the northern end of the stop may potentially be accommodated, subject to consultation with RMS during detailed design. Refer to Appendix A1 for an illustration of the proposed design.

- University of NSW option: This option is similar to the previous option, with the exception that the platform will be provided immediately north of the existing University Mall signalised pedestrian crossing with the provision of 45m, 60m or 98m stop lengths, a wider central island platform width of up to 7.7m, provision of a mid-block signalised crossing at the northern end of the platform to link with the proposed pedestrian walkway (College Walk), and banning of the southbound right-turn into Day Avenue. Refer to Appendix A2 for an illustration of the proposed design.

The scope of this road safety audit is to review the two proposed options and identify potential safety deficiencies relating to the infrastructure changes with respect to all road users including vehicles, buses, light rail, pedestrians and cyclists, with a recommendation on the preferred option from a safety perspective to be provided.

This audit does not include an assessment of the existing conditions at the subject site. Although this audit may cover lighting pole locations, this is not a formal lighting luminance assessment. Similarly, this audit may cover pedestrian accessibility, however this is not a formal DDA assessment.

6. Crash statistics

Limited details of known crashes are available at the subject site. Nonetheless, the crash history at the subject site is not expected to influence the findings of this audit at this early feasibility design stage assessment.

7. Documents used to facilitate audit

The following information / drawings were used to facilitate the audit:

- TfNSW Option: Figure 6.17, Plan of revised UNSW Anzac Parade stop platform arrangement, Chapter 6 – Preferred Infrastructure Report, Page 6-71; and,
- UNSW Anzac Parade Option Overlay, UNSW Revision, March 2014, Project: 13040, Revision A, Dated: 18/03/14.

8. Audit findings

The findings of the road safety audit are detailed on the following pages. A response from the project team should be inserted into the relevant columns. Responses to audit findings are generally not required by the auditors; rather a record should be kept for reasons of adoption or rejection of the findings for future reference by the project team.

Audit findings table

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
General		
Item	**Findings**	**Project team response**
8.1	Specific design parameters such as lane widths, horizontal geometry, signs and line marking, etc are unknown at this early design stage and therefore have not been audited as part of this assessment. It is assumed that such design parameters will be accommodated in accordance with Austroads and RMS standards.	
8.2	Reference should be made to the previous Transafe road safety audit report TS-13-RSA-0619C for items previously raised that relate to specific features at this location that may or may not still be relevant. Such items include the possible utilisation of the light rail tracks by buses, maintaining the existing pedestrian signalised crossing at University Mall and its interaction with the proposed central island stops (including ensuring adequate widths and crossing times are provided to avoid pedestrians being stranded on the tracks or roadway, and risks associated with pedestrians crossing against the red signal), the location of proposed interconnecting bus stops, the provision for cyclists and risks associated with cyclists riding close to and across light rail tracks, the use of and location of light rail catenary poles (existing poles should be utilised where possible / new poles should be kept to a minimum – i.e. use joint use poles, etc), and other fixed hazards (i.e. required clear zone offsets), and the provision of fencing (crashworthy types, provision of unbroken lengths between designated crossing points, and possible sight obstruction).	
8.3	Given the nature of the abutting development and very high volumes of pedestrians expected to be in the vicinity of Anzac Parade traffic, consideration should be given to implementing a fulltime 40km/h speed limit along the subject length of Anzac Parade to lessen the severity of possible conflict between vehicles/light rail vehicles and pedestrians and cyclists.	
8.4	The proposed platform width varies between the two options, with the TfNSW option proposing a 6.4m wide platform, while the UNSW option proposes a 7.7m wide platform. The adopted width of the platform should best suit the expected peak patronage demand to ideally accommodate all patrons on the platform and away from the crossing points. A wider platform is preferred to comfortably cater for peak demands, special events and future growth.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
General		
Item	**Findings**	**Project team response**
8.5	The actual length of raised platform and therefore the remaining at-grade median area between the platform and adjacent crossing/s to be adopted is unclear for each option. For the TfNSW option at least, it appears that approximately 40m of the median area between the platform and the University Mall pedestrian crossing will be at-grade/level with the adjacent light rail tracks. By having this area at the same level as the tracks increases the chance of pedestrians walking along the light rail tracks or in close proximity of passing light rail vehicles. Measures to limit the likelihood of pedestrians walking on the tracks should be considered (e.g. fencing).	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Option proposed by Transport for New South Wales		
Item	**Findings**	**Project team response**
8.6	Right-turns into Day Avenue are permitted in this option with the provision of a signalised intersection, however right-turn movements out of Day Avenue will be prohibited. The following possible issues associated with this proposed arrangement should be considered further: • Given the right-turn movement out of Day Avenue is to be prohibited, ensure appropriate alternative areas for U-turns (for Day Avenue traffic to travel south) are provided. • Ensure that the right turn movement into Day Avenue is clearly delineated and the prop position is obvious to avoid vehicles encroaching upon the light rail tracks. Physical separation such as a kerb/outer separator could be considered. • Further to the previous point, physical separation could be utilised to also physically restrict the prohibited right-turn movements out of Day Avenue (but still permit right-turns into Day Avenue). • It is assumed that the expected southbound right-turn queue lengths into Barker Street (located south of Day Avenue) are not likely to extend beyond Day Avenue and encroach upon the Anzac Parade westernmost southbound traffic lane (partly due to the provision of the right-turn lane into Day Avenue which could otherwise be used to store vehicles turning right into Barker Street). • Similar to the previous point, the likely right-turn queue lengths in the right-turn lane into Day Avenue are unclear. Ensure that right-turn queues into Day Avenue will not extend beyond the length of the turn lane and encroach upon the Anzac Parade westernmost southbound traffic lane and/or across the University Mall pedestrian crossing.	
8.7	Where the mid-block signalised crossing (i.e. north of the centre island platform) is provided, this will result in the provision of 3 sets of traffic signals within a relatively short distance of approximately 240m. The provision of the right-turn into Day Avenue will increase this number to 4 sets. This could result in a see-through effect, and is likely to affect overall level of service for both light rail vehicles and other vehicles. Nonetheless, such close arrangements of signals are common at high-density activity centres such as this and the overall risk posed is considered low. Nevertheless the signals will need to be in coordinated to avoid see-through effect road safety issues.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Option proposed by Transport for New South Wales		
Item	**Findings**	**Project team response**
8.8	The signalised pedestrian operated signals at the northern end of the platform may be excluded from the TfNSW option. A crossing at this location (i.e. at both ends of the proposed platform) is considered important at this location, for this particular stop (i.e. where very high patronage is expected and user movements can reasonably be expected to and from the north of the platform – in addition to the south). The absence of a crossing at the northern end of the platform is expected to result in uncontrolled mid block pedestrian crossings and crossing movements between passing trams (pedestrians are expected to scale fencing to undertake such movements). The absence of a northern crossing will obviously increase crossing demands at the southern crossing. During high demand periods, crossing times and the width of the crossing may not be able to accommodate the pedestrian crossing demands (in the absence of an alternative crossing). This could result in pedestrians being stranded on the roadway and/or light rail tracks during the start of the north-south vehicle signal phase.	
8.9	It is understood that marshals may be employed to stop and control pedestrians on either side of Anzac Parade prior to crossing at the University Mall crossing in the event that the centre island platform is not large enough to cater for demand. While the use of marshals seems like a good idea in theory, compliance is likely to be poor. Marshalling is expected to be difficult when dealing with large numbers of pedestrians without physical barriers stopping and corralling pedestrians. Verbal messages and directions are likely to be unheeded, with most pedestrians likely to be aware of the lack of power available to the marshals, and be intent on boarding the next available light rail vehicle regardless of directions provided by a marshal. Passive control measures such as larger platforms and storage and waiting areas are obviously the best way to deal with peak demands. The provision of the centre island platform will help somewhat deal with the changing tidal flow demands (compared to other possible platform arrangement such as two side loading platforms).	
8.10	Southbound light rail vehicles will stop at the proposed platform approximately 40m north of the existing University Mall crossing. Ideally, light rail vehicles should stop as close to the crossing as possible to limit the speed of the light rail vehicles at the crossing point and reduce the likelihood of high speed conflict between a light rail vehicle and a pedestrian crossing against the red signal.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Option proposed by University of New South Wales		
Item	**Findings**	**Project team response**
8.11	Right-turns into and out of Day Avenue are to be prohibited in this option, which will prevent possible conflict points and possible delays to light rail vehicles, and is therefore supported in principle. To ensure compliance to the turn prohibition, a central physical island should ideally be provided between the two opposing light rail tracks across Day Avenue. Also, given that the right-turn movement out of Day Avenue is to be prohibited, ensure appropriate alternative routes/U-turns are provided for Day Avenue traffic to travel south, and alternative routes/detours are provided for southbound motorists wishing to access Day Avenue (provided there is a relatively high demand).	
8.12	The proposed mid-block signalised crossing (i.e. north of the centre island platform) will result in the provision of 3 sets of traffic signals within a relatively short distance of approximately 240m. This could result in a see-through effect, and is likely to affect overall level of service for both light rail vehicles and other vehicles. Nonetheless, such close arrangements of signals are common at busy transport hubs such as this and the overall risk posed is considered low. Nevertheless the signals will need to be in coordinated to avoid see-through effect road safety issues.	
8.13	A staggered signalised pedestrian crossing is proposed mid-block on Anzac Parade, north of the proposed light rail platform. It is understood that the majority of movements at this location will probably only involve one crossing movement to/from the footpath to/from the platform (i.e. crossing of only one carriageway). Therefore the subject location is considered appropriate for the provision of a staggered crossing, which will result in traffic operational advantages and efficiencies (the main reason it is proposed). The stagger is also correctly aligned so that pedestrians crossing through the stagger will do so facing approaching light rail vehicles and traffic, which is particularly important if they choose to cross against the red signal.	
8.14	As previously mentioned, it is unclear how long this platform will be in this option and therefore it is unclear where light rail vehicles will stop. It is understood that southbound light rail vehicles will stop close to the existing University Mall crossing, however if a 45m platform is initially adopted, northbound light rail vehicles will stop approximately 60m south of the northern pedestrian crossing (at College Walk). Ideally, light rail vehicles should stop as close to the crossing as possible to limit the speed of the light rail vehicle at the crossing point and reduce the likelihood of high speed conflict between a light rail vehicle and a pedestrian crossing against the red signal.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Preferred option from a safety perspective		
Item	**Findings**	**Project team response**
8.15	The key considerations in providing safe light rail platforms at the subject site includes avoiding/limiting potential conflict for all road users, and where this cannot be avoided, ensuring that consequences of potential conflict are minimised. Other important considerations include providing a road environment that: • Is simple, obvious, expected and predictable; • Is free of physical obstructions and is forgiving; • Provides logical connectivity; • Provides direct pedestrian access; and, • Caters for all expected user groups including cyclists and vulnerable/disabled pedestrians. Both options propose a centre platform, which is the preferred arrangement compared to typical side loading platforms or other arrangements (where light rail is proposed along an existing road network). The centre island platform is also suited to locations where patronage tends to peak in one direction such as the subject site. The differences between the latest two options presented for assessment are considered minor and no one particular option is strongly preferred. Apart from the provision of a fully controlled pedestrian crossing at the northern end being considered very important at this platform, the following features of the two options are favoured: • The banning of right-turns into Day Avenue is preferred to minimise overall potential conflict at this location, even if the right-turns are controlled (provided that a realistic suitable alternative will be available to facilitate southbound access to Day Avenue where the demand is relatively high). • Marshalling is not expected to be effective at controlling large numbers of pedestrians and restricting access to the platforms. Such controls are not considered suitable alternatives compared to passive control measures such as provision of a wider and longer platform that will meet expected demand with an allowance for future growth. • As mentioned, a fully controlled pedestrian crossing at the northern end of the platform is strongly supported. A staggered fully controlled arrangement is considered suitable at the subject location.	

Project team response undertaken by:

Name.....Signed.....Date.....

9. Audit conclusion

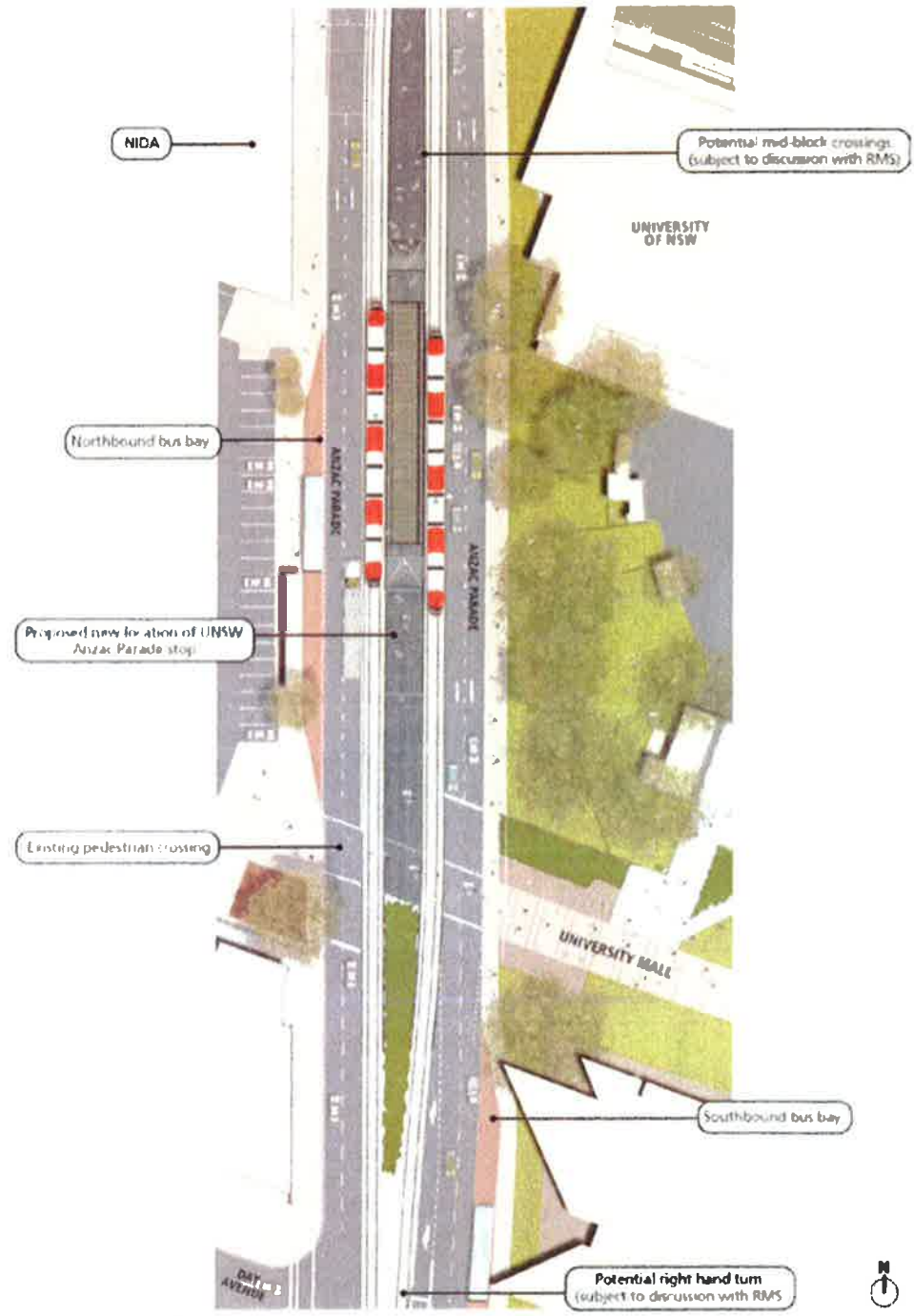
This road safety audit has attempted to balance the safety needs of all road users within the site/design constraints. It is the intention that all audit recommendations are realistic and feasible and commensurate with the actual risk posed.

Darren Vella [BEng Civil (Hons), Director]
Accredited Senior Road Safety Auditor

and;

Simon Penca [BEng Civil (Hons), Director]
Accredited Senior Road Safety Auditor

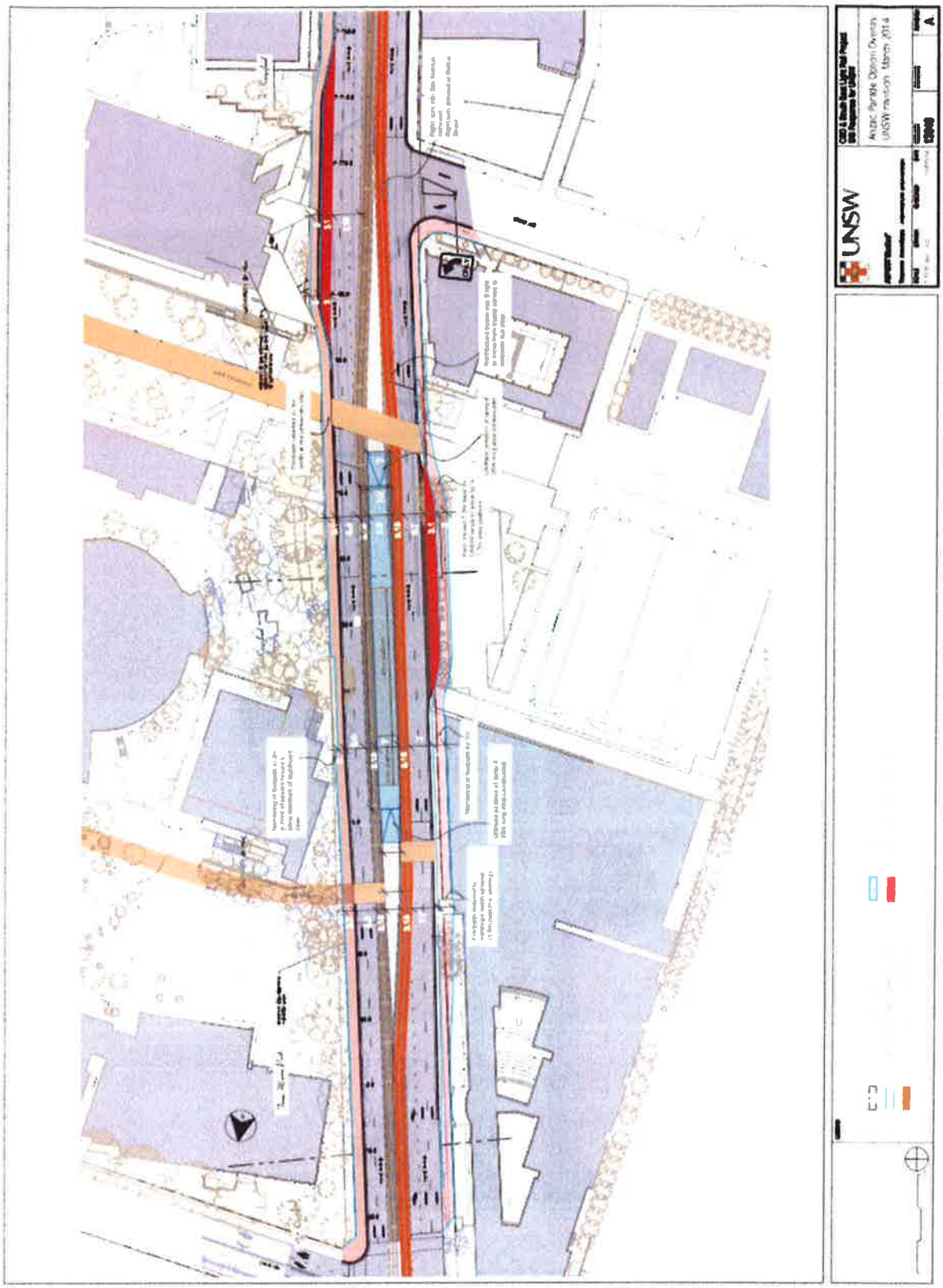
10. Appendix A1: Transport for NSW option



Note: Indicative only. Subject to detailed design

Figure 6.17 Plan of the revised UNSW Anzac Parade stop platform arrangement

11. Appendix A2: University of New South Wales option



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University of New South Wales

Proposed Light Rail Platform Stops on High Street
Feasibility Design Stage Road Safety Audit

Project Ref: TS-14-RSA-0794C
Prepared for: University of New South Wales
Date: 4th April 2014

2014

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Document control

Project Ref	Date	Revision	Author	Reviewer
TS-14-RSA-0794C	4 April 2014	C	Darren Vella	Simon Penca

1. Introduction

Transafe has been engaged by the University of New South Wales to undertake a feasibility design stage road safety audit of the proposed light rail platform stops on High Street, at the University of New South Wales in Kensington.

This audit was conducted by:

Darren Vella [BEng Civil (Hons), Director]
RMS Accredited (Level 3) Senior Road Safety Auditor (Auditor ID: RSA-03-0530)

and;

Simon Penca [BEng Civil (Hons), Director]
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2. Road safety audit process

A road safety audit is a formal examination of an existing or future road or traffic project in which an independent, qualified team reports on the projects crash potential and safety performance (Austroads 2009). This road safety audit has been carried out in accordance with the Austroads Guide to Road Safety Part 6: Road Safety Audit (2009) with reference to relevant standards and guides, and draws on industry practice and experience to identify potential road safety audit findings. However, no guarantee is made that every deficiency has been identified.

3. Responding to this audit

As set out in the road safety audit guidelines, responsibility for the road safety audit always rests with the project team and not the auditor. The project team is under no obligation to accept or agree with all of the audit findings. Also, it is not the role of the auditor to agree to or approve the project teams response to the audit. This audit report should be responded to in writing including reasons for rejection of an audit finding. Acceptance of all findings of this report would not guarantee that every potential road safety issue has been addressed, rather adoption of the audit findings should improve the level of safety of the subject site.

4. Site details

High Street is classified as a major Council road and is generally aligned east-west with two lanes in each direction, however it operates predominantly as one lane in each direction due to a mix of permitted kerbside parking, and the presence of kerbside bus zones. Located on the northern boundary of the University of New South Wales, High Street provides access to the University of New South Wales facilities, and is a major bus route to cater for the large patronage to the adjacent university and medium-density residential properties (north side of High Street).

A zebra crossing exists on High Street (to the east of Wansey Road) to facilitate north-south pedestrian movements (across High Street). Bus stops are located on the southern side of High Street, east of the zebra crossing and Wansey Road.

Figure F1: Location plan

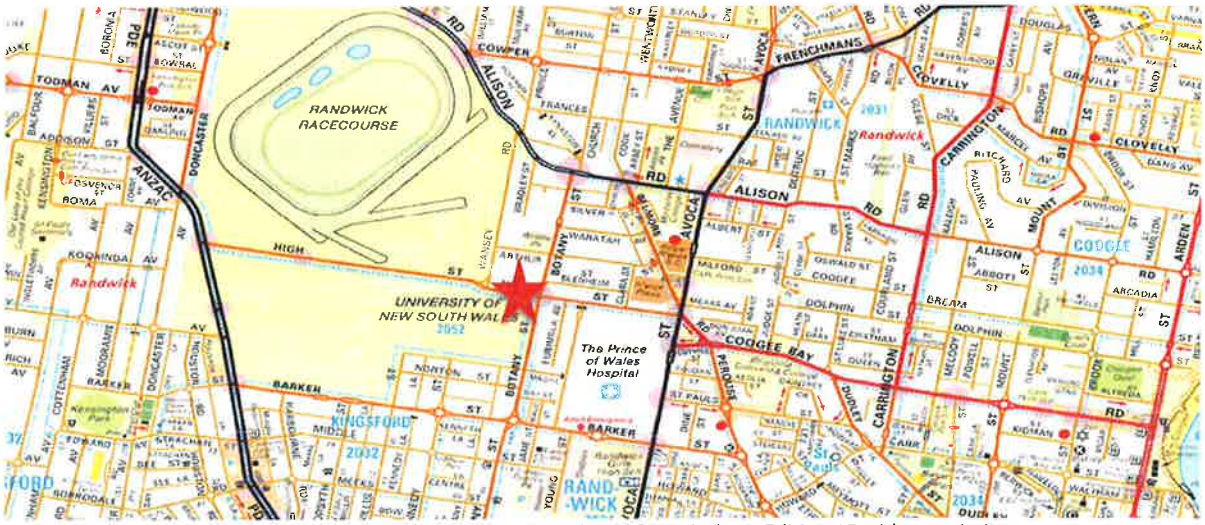

Photo P1 – High Street/Wansey Road intersection, view east from south side of intersection

5. Proposed works and scope of the audit

As part of new Sydney Light Rail network, light rail platforms are proposed on High Street, between Wansey Road (to the west) and Botany Street (to the East), adjacent to the University of New South Wales. To cater for expected demand, two proposed light rail platform options have been presented for consideration on High Street as follows:

- Transport for NSW Option: This option involves the light rail tracks along Wansey Road separating around the curve into High Street to allow for the provision of a central island platform. This centre island platform will commence approximately 40m east of Wansey Road and will be approximately 45m long and 6.4m wide to cater for patrons that wish to travel eastbound or westbound. Traffic movements (one lane in each direction) along both Wansey Road and High Street will be permitted with this option, however all right-turns into Botany Street, Eurimbla Avenue and Hospital Road will be banned. Pedestrians will be channelled to and from the central island platform through the median area to cross High Street at the pedestrian operated signals at the intersections with Wansey Road and Botany Street. Refer to Appendix A1.

- University of NSW Option: This option involves the provision of left-side loading light rail platforms within a pedestrian plaza. These side loading platforms will be located approximately 40m east of Wansey Road and each platform (one for eastbound and one for westbound movements) will be approximately 45m long and at least 3.5m wide, with the rear-side of the platforms at-grade with the plaza area to cater for high volumes of light rail patrons. Apart from light rail vehicle movements along High Street, all other traffic movements will be prohibited (vehicle access to the northern side High Street properties will be redirected via a laneway to the rear of these properties), with the section of High Street between Wansey Road and Botany Street being converted into a pedestrian plaza. Refer to Appendix A2.

The scope of this road safety audit is to review the proposed options and identify potential safety deficiencies relating to the infrastructure changes with respect to all road users including vehicles, buses, light rail, pedestrians and cyclists.

This audit does not include an assessment of the existing conditions at the subject site. It also does not include an assessment of the proposed light rail arrangement along Wansey Road, north of the intersection with High Street, nor does it include an assessment of the light rail arrangement along East of Botany Street. Although this audit may cover lighting pole locations, this is not a formal lighting luminance assessment. Similarly, this audit may cover pedestrian accessibility, however this is not a formal DDA assessment.

6. Crash statistics

Limited details of known crashes are available at the subject site. Nonetheless, the crash history at the subject site is not expected to influence the findings of this audit at this early feasibility design stage assessment.

7. Documents used to facilitate audit

The following information / drawings were used to facilitate the audit:

- TfNSW Option: Figure 6.13, Revised UNSW High Street Stop, Chapter 6 – Preferred Infrastructure Report, 6-53 (*refer to Appendix A1)*; and,
- UNSW Option: High Street Stop – UNSW Proposal, Revision 12, Project 13040, Revision A (*refer to Appendix A2*).

8. Audit findings

The findings of the road safety audit are detailed on the following pages. A response from the project team should be inserted into the relevant columns. Responses to audit findings are generally not required by the auditors; rather a record should be kept for reasons of adoption or rejection of the findings for future reference by the project team.

Audit findings table

University of New South Wales – Proposed Light Rail Platform Stops on High Street Feasibility Design Stage Road Safety Audit		
General Items		
Item	**Findings**	**Project team response**
8.1	Specific design parameters such as horizontal geometry, signs and line marking, etc are unknown at this early design stage and therefore have not been audited as part of this assessment. It is assumed that such design parameters will be accommodated in accordance with Austroads and RMS standards.	
8.2	Given the nature of the abutting development and very high volumes of pedestrians expected to be in the vicinity of Wansey Road and High Street traffic, consideration should be given to implementing a fulltime 40km/h speed limit along the subject lengths of Wansey Road and High Street to lessen the severity of possible conflict between public vehicles, light rail vehicles and pedestrians and cyclists.	
8.3	The longitudinal step-up/down from the platforms to the light rail tracks is a potential pedestrian hazard. Pedestrians can reasonably be expected to take shortcuts directly from the platforms to their desired destination and between platforms (although this is less likely with the centre platform option with fencing between traffic and the tracks). This hazard is difficult to address given the need to maintain access between the platforms and light rail vehicles, however its presence can be highlighted using adequate delineation. Appropriate devices such as signage, line marking, pavement marking, different surfaces / textures along the tracks, and fencing should be considered to highlight the ramps and step-down (in addition to tactile ground surface indicators for DDA compliance).	

University of New South Wales – Proposed Light Rail Platform Stops on High Street Feasibility Design Stage Road Safety Audit		
General Items		
Item	**Findings**	**Project team response**
8.4	In the TfNSW option, a north-south shared path is proposed along Wansey Road between the light rail tracks and Wansey Road traffic, compared to the UNSW option, which proposes a shared path on the western side of the light rail tracks. Both options involve a mix of pedestrians and cyclists along a shared path. The provision of a shared path increases the potential for conflict between pedestrians and cyclists. The risk of conflict between shared path users and adjacent traffic is somewhat greater for the TfNSW option than the option proposed by UNSW simply because of its location adjacent to traffic, however this risk is common to all footpaths next to roads and is considered low due to the straight alignment of Wansey Road, expected high level of alertness of drivers at this location and expected low operating speeds (i.e. especially at the intersection of Wansey Road and High Street where vehicles will be turning at the intersection and hence the low speeds, and also due to the nature of the road environment, likely congestion, presence of students/pedestrians/light rail patrons – drivers are expected to be extra cautious with a heightened level of alertness due to the adjacent activity). With the TfNSW option, users of the shared path will be required to cross Wansey Road at the signals, and again at the High Street signals to access UNSW, however with the UNSW option shared path users will only need to cross at one location (across High Street), thus reducing the possible risk of conflict at the intersection/crossing/s (i.e. they need to cross Wansey Road in the UNSW option). Furthermore, pedestrians using the shared use path (for the TfNSW option) are likely to cross diagonally directly from the end of the shared path to the southeast to get to the south side of High Street (instead of crossing east across Wansey Road first) due to the need to wait for two crossing phases. This may create a defacto diagonal (Barnes) crossing, which doesn't appear to be allowed for, which could increase the risk of conflict between pedestrians and vehicles. Although the storage area at the southern end of the UNSW proposed shared path doesn't appear to be significant, it is expected to accommodate a larger volume of waiting bicyclists and pedestrians waiting to cross to the south over High Street compared to the TfNSW option, which is limited by the adjacent light rail tracks and roadway (i.e. located in the middle of the tracks and roadway).	

University of New South Wales – Proposed Light Rail Platform Stops on High Street
Feasibility Design Stage Road Safety Audit

General Items

Item	Findings	Project team response
8.5	The TfNSW option proposes to ban several right-turns from High Street in the westbound direction. This is expected to result in an increased demand for right-turns from High Street into Wansey Road and across the pedestrian crossing, increasing the risk of conflict with pedestrians crossing Wansey Road from the shared path between the light rail tracks and the roadway. Also, the right turn bans may create confusion for drivers who wish to make a right turn but are unsure where the turn can be legally made. Conversely, the right-turn bans are however an advantage for east-west pedestrian movements across the intersections along High Street due to the avoidance of potential conflict between right-turning vehicles and crossing pedestrians (a risk that also exists in the UNSW option). Regardless of the chosen option for the light rail platform arrangement on High Street, consideration should be given to fully controlling right turn movements (where permitted) into Wansey Road (and other roads in close proximity) due to the increased offset of a turning vehicle and the east-west crossings, and therefore potential for higher speed conflict between crossing pedestrians and motorists turning right that are able to pick a gap in through traffic, but fail to yield to a pedestrian that may have right-of-way at the crossing (in an uncontrolled right-turn situation).	

University of New South Wales – Proposed Light Rail Platform Stops on High Street Feasibility Design Stage Road Safety Audit		
Option proposed by Transport for New South Wales		
Item	**Findings**	**Project team response**
8.6	Ideally, poles and other objects should be set back from the road. This option will require realignment of adjacent traffic lanes along High Street (i.e. removal of parking and bus lanes/zones), which will result in traffic being ultimately located closer to existing fixed hazards such as utility poles and trees. It is acknowledged that there is an existing risk associated with collisions into parked vehicles in the kerbside lane, and the severity of a crash into the new hazards rather than the existing parked cars is difficult to quantify, however, while the change in alignment and narrowing of lanes would typically be expected to increase the likelihood of crashes overall, the proposed change in the immediate road environment (overall) is expected to result in lower operating speeds and a lower likelihood of crashes (e.g. especially near the intersection of Wansey Road and High Street where vehicles will be turning at the intersection and hence the low speeds, and also due to the nature of the road environment, likely congestion, presence of students/pedestrians/light rail patrons – drivers are expected to be extra cautious with a heightened level of alertness). Ideally no pole (or any other roadside hazard) should be placed within the clear zone (i.e. the offset from the edge of any proposed traffic lane that should be clear of fixed hazards). In practice, this is difficult to achieve, particularly in urban areas. RMS guidelines stipulate that a clear zone of 3.0m is applicable for a posted speed limit of 60km/h, and a 2m clear zone is applicable at 40km/h.	
8.7	Catenary poles will be required to provide power to light rail vehicles. Where possible, the location of these poles should be provided in between the opposing light rail tracks to reduce the number of poles required (i.e. try and avoid the use of a line of poles on each side of the road, effectively doubling the required number of poles), and maximise the offset of these poles to adjacent traffic (i.e. the light rail reserve effectively provides a 'buffer'). Ideally, all new catenary poles should be positioned outside the clear zone as they are considered significant roadside hazards (existing poles should be utilised where possible / new poles should be kept to a minimum – i.e. use joint use poles, etc). *NB. Frangible type poles such as slip base or impact absorbing are not suitable for the support of overhead wires.*	

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8.8	Further to the previous item, catenary poles are likely to be located close to adjacent traffic at the intersection of Wansey Road and High Street in order to support overhead wires that span the relatively large area of the intersection. Areas of particular concern at this intersection include the northeast and southwest corners of the intersection where eastbound and westbound vehicles will be required to deviate through the intersection. Poles at these corners would be undesirable as they will be located within the expected errant vehicle departure paths should a motorist fail to negotiate the deviation. Suitable protection of these poles is likely to be difficult, which could result in significant unshielded roadside hazards.	
8.9	The use of fencing at the proposed new centre island platform to encourage particular pedestrian routes is supported in principle. Fencing should also be considered to act as a physical obstruction should a light rail vehicle driver open the incorrect side light rail vehicle doors (and physically restrain light rail patrons and prevent them stepping out into traffic). Any fencing located within the clear zone should be crashworthy (i.e. no horizontal members). Furthermore, it is assumed that fencing will be provided between the traffic lanes and light rail tracks and extend between the pedestrian crossings at Wansey Road and Botany Street to control pedestrians, corral them to the designated controlled crossings, and to prevent mid-block crossings.	

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8.10	It is understood that the right-turn vehicle movements from High Street into Botany Street, Eurimbla Avenue and Hospital Road will be prohibited for this option. While the turn prohibitions will help simplify the intersections, reduce the number of likely light rail vehicle/vehicle/pedestrian conflicts and reduce likely delays at the intersections, an increase in demand for right-turns at Wansey Road, and across the pedestrian crossing linking to the shared path (refer to item 8.4) will result. Also, it is unclear how the banning of right turns along High Street in the TfNSW option will affect the overall performance of the abutting road network and how alternative movements will be publicised to motorists in advance of the prohibited turns. The required 'G-Turn' due to the right-turn bans increases the overall risk of conflict between all road users because of the additional length of roadway to be travelled but also because of the additional turns required at the intersections, which are the main cause of conflict at intersections. For example, a westbound vehicle on High Street wishing to travel north at Botany Street would be required to continue west and turn right into Wansey Road, right into Arthur Street, then left into Botany Street, as opposed to a relatively simple right-turn at the High/Botany Street intersections. The turn bans could also lead to adverse safety implications at the subject intersections or in close proximity (e.g. illegal turns, illegal U-turns, frustrated motorists, hesitation and confusion along High Street, etc).	
8.11	It appears likely that larger southbound Wansey Road vehicles that turn left into High Street will encroach upon the light rail tracks and possibly within the median pedestrian refuge area (on High Street), which may result in conflict between turning vehicles and waiting pedestrians. It is unclear if the pedestrian median waiting area and crossing can be appropriately located in this option to accommodated all expected classes of large turning vehicles (without encroaching the refuge). Signal phasing at this intersection will likely require a separate left turn phase for vehicles and light rail vehicles to avoid conflict between the two. It is also important that the left rear of left-turning vehicles cannot mount the pedestrian crossing located on the north-western corner of the intersection, where pedestrians may be waiting to cross.	

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8.12	While it is appreciated that proposed signalised crossing phasing and sequencing design has not been undertaken at this early design stage, the proposed High Street crossings should be designed to allow a continuous crossing phase between the northern and southern sides of High Street. The provision of broken crossing phases (i.e. of only one direction of traffic at a time) is not supported from a safety perspective, as pedestrians are likely to assume they have complete right-of-way across the entire roadway once shown a green walking man symbol.	
8.13	Pedestrians will be required to cross High Street at one of the two crossings between Wansey Road or Botany Street due to the proposed fencing that will corral pedestrians to these locations. While the use of the controlled crossing is supported in principle, there is a risk that some pedestrians will cross against the red man, particularly when in a hurry and/or a light vehicle they wish to board is approaching or waiting at the platform. This increases the risk of conflict between car/light rail vehicles and crossing pedestrians. The risk of conflict between vehicles and crossing pedestrians does not exist with a plaza situation (i.e. where cars are prohibited).	
8.14	Several vehicle movements through the intersection of Wansey Road and High Street will require vehicles to cross the light rail tracks. Also, east-west movements require a deviation through the intersection (an existing condition). This required deviation would be difficult to delineate across the light rail tracks, with the light rail tracks and likely surrounding concrete apron providing a misleading visual cue for eastbound motorists. Some motorists may inadvertently drive along the light rail track reserve. Similarly, the right-turn from High Street into Wansey Road will be difficult to delineate across the light rail tracks and some motorists may inadvertently drive along the light rail reserve as the adjacent tracks will seemingly lead motorists into the light rail reserve. Signing this turn will be unusual as a non-preferred 'Keep Right' sign would be required on the Wansey Road median island. Also, the presence of light rail tracks within the intersection can result in loss of skid resistance, particularly during wet conditions. This will be exacerbated by the need for braking, which is increased at an intersection. Appropriate delineation devices such as signage, line marking and pavement marking, raised reflective pavement markers and flexible paddles/bollards may highlight the necessary traffic paths, but is unlikely to completely remove the risk of vehicles entering the light rail reserve.	
8.15	Further to the previous item, bicyclists and motorcyclists are particularly vulnerable when crossing/riding close to light rail tracks as their wheels can be caught or redirected by the tracks. This should be avoided as much as possible and crossing points should desirably be closer to perpendicular. However it will be difficult to avoid given the permitted right-turn from High Street to Wansey Road will align bicyclists and motorcyclists parallel to the tracks around part of the curve.	

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8.16	It appears that the area between the two opposing light rail tracks (away from the raised platforms) along the High Street median will be at the same level as the light rail tracks. By having this area at the same level as the tracks increases the chance of pedestrians walking along the light rail tracks or in close proximity of passing light rail vehicles. Measures to limit the likelihood of pedestrians walking on the tracks should be considered (e.g. fencing).	

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8.17	It is understood that the rear-side of the platforms within the pedestrian plaza will be at-grade with the plaza area, allowing for greater storage of light rail patrons and an overflow to the plaza area, which is supported. It is assumed that the platforms step down to the tracks, and ramps leading to the sides and rear of the platforms will be clearly marked to ensure they are obvious to all users and do not represent trip hazards.	
8.18	Bicyclists are particularly vulnerable when crossing/riding close to light rail tracks as their wheels can be caught or redirected by the tracks. Bicyclists may see the wide-open light rail track area as a suitable place to ride when light rail vehicles are seemingly not present, which is undesirable. It will be difficult to restrict/prevent cyclist access along the light rail tracks. The likelihood of such movements can be reduced with the use of prohibition signs and pavement markings. Overall, compared to the TfNSW option where cyclists would either ride on the light rail tracks (which is possible with both options as mentioned) or use the narrow traffic lane or narrow footpath, the availability of the plaza in the UNSW option as a place for cyclists to ride is the preferred arrangement of the options presented.	
8.19	There is the risk of conflict between light rail vehicles and wandering pedestrians within the pedestrian plaza. This is expected to be exacerbated at a location such as this (i.e. a university) given the likelihood of pedestrians utilising the plaza doing so whilst their hearing is incapacitated by devices such as phones and music players (a light rail vehicle horn/bell is likely to be ineffective). The risk of conflict between pedestrians and light rail vehicles within the pedestrian plaza can somewhat be reduced by imposing a maximum 10km/h speed limit for light rail vehicles through the plaza. The effectiveness of such a limit is however only as effective as driver compliance. The provision of strategic planting, provision of seating and urban design features within the plaza to prevent pedestrians wandering onto the tracks is supported and expected to help minimise the risk of conflict between light rail vehicles and pedestrians.	
8.20	Further to the previous item, there is a risk of conflict between pedestrians crossing between platforms behind propped light rail vehicles. Propped light rail vehicles may obscure sight lines between pedestrians crossing and oncoming light rail vehicles. This issue is more likely at the platform when patrons alight from a light rail vehicle and cross behind that vehicle to be in conflict with an opposing light rail vehicle, but is also possible along other parts of the plaza when pedestrians cross after a light rail vehicle passes (less likely when planting etc is provided as detailed in previous item). Fencing between the light rail tracks adjacent to the platforms is expected to help minimise this issue and should be considered.	

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8.21	It is understood that consideration may be given to maintaining some eastbound and westbound public bus movements along High Street and along the light rail tracks. Similar risks mentioned in the previous two items are expected for buses, including pedestrians wandering into the path of a bus (again exacerbated where hearing is incapacitated) and propped light rail vehicles obstruct sight lines to oncoming buses. Also, while the likely presence of light rail vehicles to pedestrians within the plaza should be obvious (e.g. presence of the raised platforms, provision of light rail furniture, presence of tracks), the presence of a bus within the plaza will be far less obvious and even unexpected. The risk of conflict between pedestrians and buses within the pedestrian plaza can somewhat be reduced by imposing a maximum 10km/h speed limit for buses through the plaza. The effectiveness of this limit is however only as effective as driver compliance. The provision of strategic planting, provision of seating and urban design features within the plaza to prevent pedestrians wandering onto the tracks is supported and expected to help minimise the risk of conflict between buses and pedestrians. However the risk of conflict posed to pedestrians following the introduction of buses into the pedestrian plaza is still possible (i.e. with planting etc) and therefore it is preferred that the provision of buses within the plaza is avoided.	
8.22	The provision of the pedestrian plaza would require all eastbound and westbound High Street vehicles (and possibly public route buses) to divert to the north around the plaza, most probably via Arthur Street. The required 'detour' around the plaza increases the overall risk of conflict between all road users because of the additional length of roadway to be travelled but also because of the additional turns required at the intersections, which are the main cause of conflict at intersections. For example, a westbound vehicle on High Street would be required to perform an additional right-turn at Botany Street, a left-turn at Arthur Street, a left-turn at Wansey Road and a right-turn back onto High Street, as opposed to two relatively simple through movements at the High/Botany Street and High/Wansey Road intersections.	
8.23	As mentioned, the provision of strategic planting etc is expected to offer segregation type benefits with the UNSW option, which is supported in principle, however it is important that such planting and other street furniture does not obstruct sight lines within the plaza for light rail vehicle drivers and pedestrians in the plaza, especially at the crossing points. Planting and infrastructure should be low level only to enable light rail vehicle drivers to see pedestrians on or about to cross and if necessary take evasive action to avoid conflict.	

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8.24	Uncontrolled at-grade crossings of the light rail tracks within the plaza are proposed at each end of the platforms. The possible implications associated with the provision of uncontrolled crossing as proposed should be considered further as follows: • Sight lines to approaching light rail vehicles from the crossings and vice versa are likely to be restricted when crossing behind a light rail vehicle that is propped at one of the platforms (refer to previous item 8.20 for further details). • Pedestrians can be expected to cross at the subject crossings when a light rail vehicle has just stopped to pick up passengers. It is unclear how a light rail vehicle (i.e. once full of patrons) will be able to proceed forward and pick a gap in the crossing pedestrians during peak flows across the tracks. Light rail drivers may need to sound their bell and proceed forward slowly, or the use of dynamic warning signs and/or audible warnings at the crossing could be used. • It is important that right-of-way at these crossing is made clear, and that ambiguous paving (especially different coloured paving across the tracks which may imply right-of-way to pedestrians, when the opposite is the case) should be avoided. Pavement markings and signs advising pedestrians to watch for light rail vehicles should be clearly displayed. Dynamic warning signs and/or audible warnings activated by approaching light rail vehicles or those departing one of the platforms should be considered.	

Project team response undertaken by:

Name.....Signed.....Date.....

9. Audit conclusion

This road safety audit has attempted to balance the safety needs of all road users within the site/design constraints. It is the intention that all audit recommendations are realistic and feasible and commensurate with the actual risk posed.

Darren Vella [BEng Civil (Hons), Director]
Accredited Senior Road Safety Auditor

and;

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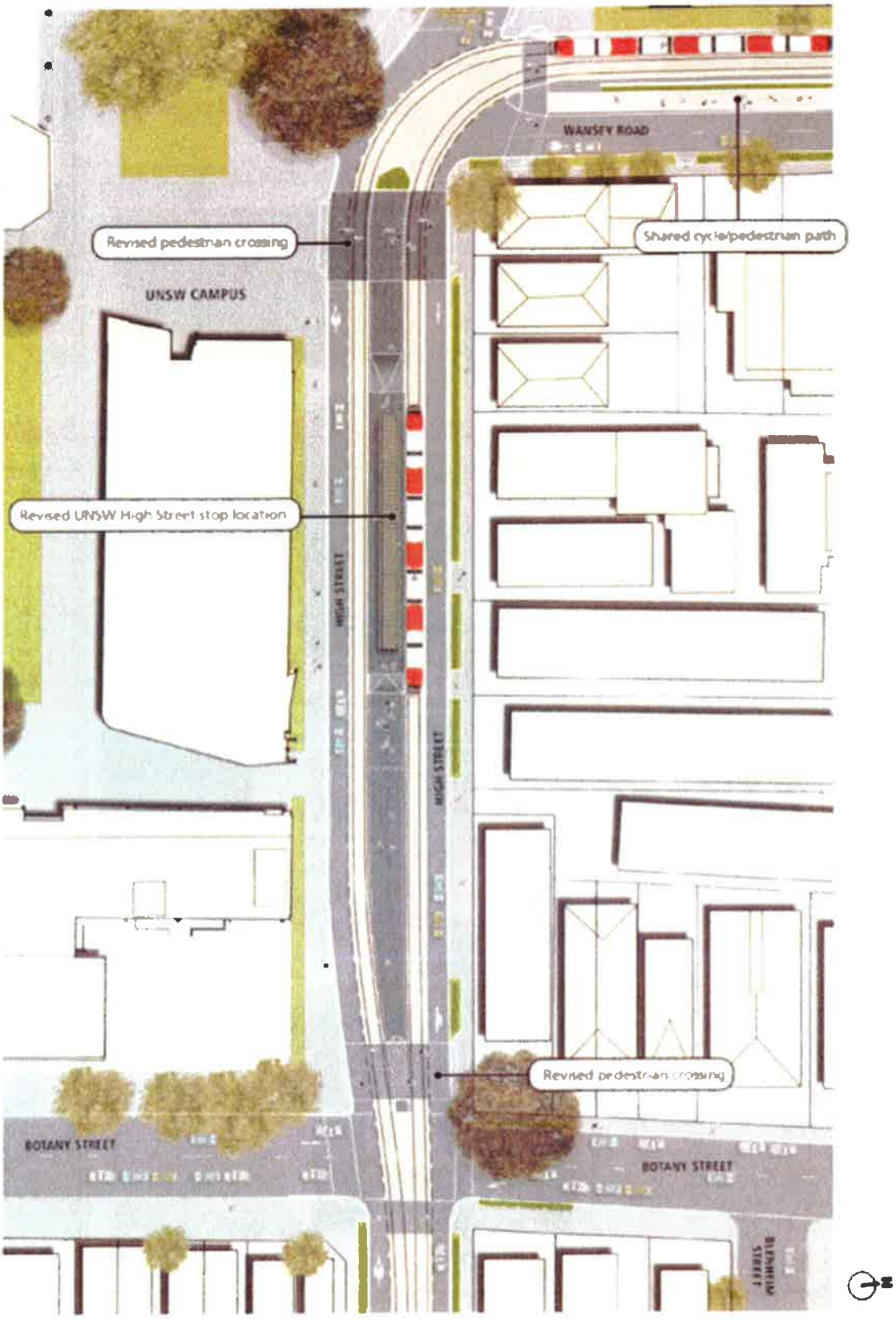
10. Appendix A1: Transport for NSW option



Note. Indicative only. Subject to detailed design

11. Appendix A2: University of NSW option