University of New South Wales

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

Project Ref: TS-13-RSA-0619C
Prepared for: University of New South Wales
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Document control

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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 alternate light rail platform stops 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)

The auditors have had no involvement in the design or development of the subject site being audited.

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 new Sydney Light Rail network, light rail tram platforms are proposed for northbound and southbound movements on Anzac Parade, adjacent to the University of New South Wales. At the completion of the project and allowing for a steady growth in population and shift to public transport, on a typical semesters day the Anzac Parade light rail platforms are expected to cater for approximately 13,000 arrivals and 16,000 departures, with an arrival peak in the order of 1,100-1,200 (15mins) and departure peak in the order of 1,500-1,600 (15mins). To cater for such demand, four proposed light rail platform options are being considered as follows:

- Transport for NSW option: Involves the central light rail tracks deviating to the eastern side of Anzac Parade (commencing to the south of the pedestrian operated signals and through the High Street intersection). A central island platform is proposed adjacent to Square House, with uncontrolled pedestrian crossings at each end of the platform. Pedestrian crossing movements of Anzac Parade will be facilitated via the existing pedestrian operated signals. Refer to Appendix A1.

- Option 6 – Modified Transport for NSW proposal with wider platform, shifted west: This option is similar to the previous option, with the exception that the platforms will be provided to the left side of each arriving light rail vehicle. Pedestrian crossing movements of Anzac Parade will be facilitated via the existing pedestrian operated signals. Refer to Appendix A2.

- Option 7 – Centre Platform: This option involves maintaining the central light rail track alignment within the median of the opposing traffic lanes, with a central island platform. Pedestrian crossing movements of Anzac Parade will be facilitated via the existing pedestrian operated signals and via new pedestrian operated signals (to the north of the platforms). Refer to Appendix A3.

- Option 8 – Side Platforms: This option involves the central light rail tracks deviating to the kerbside lanes along Anzac Parade by crossing northbound and southbound traffic lanes (commencing to the south of the pedestrian operated signals and just north of the NIDA building). Platforms will simply be constructed behind the Anzac Parade kerb line. Pedestrian crossing movements of Anzac Parade would be facilitated via the existing pedestrian operated signals (to the south of the platforms) and via new pedestrian operated signals (to the north of the platforms). Refer to Appendix A4.

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, 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:

- UNSW Anzac Parade Stop Proposed by TfNSW, Drawing No: PV-01 Sheet 1 of 13 and PV-02 Sheet 2 of 13, Created: N. Bettini;
- UNSW Anzac Parade Stop Option 6, Drawing No: PV-03 Sheet 3 of 13 Version 5.1 and PV-04 Sheet 4 of 13 Version 5.1, both Modified 20/11/2013, Created: N. Bettini;
- UNSW Anzac Parade Stop Option 7a, Drawing No: PV-05 Sheet 5 of 13 Version 5.1 and PV-06 Sheet 6 of 13 Version 5.1, both Modified 20/11/2013, Created: N. Bettini;
- UNSW Anzac Parade Stop Option 8, Drawing No: PV-11 Sheet 11 of 13 Version 5.1 and PV-12 Sheet 12 of 13 Version 5.1, both Modified 20/11/2013, Created: N. Bettini;
- Site photos (taken 1/10/13) and background information including nature of the road environment, abutting development, pedestrian behaviour, and available transport links: Provided by Anthony Coyle – Senior Associate at TraffixGroup;
- UNSW Future Circulation Structure, Drawing No: -- Sheet 1 of 3, Created: N. Bettini;
- UNSW Significant Trees, Drawing No: -- Sheet 2 of 3, Created: N. Bettini;
- UNSW Potential Future Development, Drawing No: -- Sheet 3 of 3, Created: N. Bettini;
- UNSW Daily Student and Staff Movements: Departures 2013 (Monday-Thursday);
- UNSW Daily Student and Staff Movements: Arrivals 2013 (Monday-Thursday); and,
- Fig 1a, Ridership Projections 2020, Revision 2, 14 November 2013.

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		
Item	**Findings**	**Project team response**
General		
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	Ideally poles and other objects should be set back from the road. Each of the proposed options require realignment of adjacent traffic lanes along Anzac Parade, resulting in traffic being deviated and ultimately located closer to existing fixed hazards such as power 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, the change in alignment and narrowing of lanes is expected to increase the likelihood of crashes overall. Ideally no pole (or any other roadside hazard) should be placed within the clear zone. In practice, this is difficult to achieve, particularly in urban areas. A clear zone of 3.0m is applicable for a posted speed limit of 60km/h at the subject site.	
8.3	Further to the previous point, the inherent nature of the raised tram platforms presents possible roadside hazards. Ideally, the approach end of raised tram platforms should be shielded using a crash cushion (depending on its location with respect to adjacent traffic, clear zone, etc). The longitudinal side of a tram platform should also be considered for shielding using safety barrier (depending on the stop use, patronage, type, location, etc).	
8.4	Catenary utility poles will be required to provide power to trams. Where possible, the location of these poles should be provided in between the opposing tram 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 tram reserve effectively provides a 'buffer'). Ideally, all new catenary poles should be positioned outside the clear zone as they are considered significant roadside hazards.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
8.5	Fencing is proposed at most of the new stops for each proposed option to encourage particular pedestrian routes, which is supported in principle. Fencing should be considered to also act as a physical obstruction should a tram driver open the incorrect side tram doors (and physically restrain tram patrons and prevent them stepping out into traffic). Any fencing located within the clear zone should be crashworthy (i.e. no horizontal members). Typical roadside fencing such as weldmesh is considered appropriate.	
8.6	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/trams and pedestrians and cyclists.	
8.7	The longitudinal step-up/down from the platforms to the tram 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. This hazard cannot be effectively addressed given the need to maintain access between the platforms and trams, however its presence can be highlighted using adequate delineation. Appropriate devices such as signage, line marking and pavement marking, raised reflective pavement markers and flexible paddles/bollards should be considered to highlight the ramps and step-down (in addition to tactile ground surface indicators for DDA compliance).	
8.8	Special attention is required when developing either option to ensure the widths of the pedestrian crossings and signalised crossing times are adequate to accommodate the peak pedestrian platoons (e.g. morning and afternoon weekdays). Narrow crossings (with fencing that creates a bottleneck) can result in 'bunching', and short crossing phases can result in pedestrians being stranded on the roadway and /or tram reserve during high pedestrian demand times. Of particular concern is the likely increased crossing distance to accommodate the light rail tracks; this needs to be carefully considered, along with crossing technology such as PUFFIN.	
8.9	Specific cyclist provisions along Anzac Parade are unclear at this early design stage. Ideally, cyclists should be catered for in the form of exclusive bicycle lanes, segregated from other road users. Where this cannot be achieved, other facilities such as shared use paths, on road bicycle lanes, wide kerbside lanes etc should be considered, along with subtle additions such as head-start storage boxes at signals.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
8.10	Further to the previous point, where bicycle lanes/traffic lanes cross tram tracks, consideration should be given to the crossing angle to limit the likelihood of bicyclists and motorcyclists wheels being caught or redirected by the tracks. The tracks are also particularly slippery for two-wheeled vehicles and therefore avoiding crossing of traffic lanes and tracks so far as possible should be achieved.	
8.11	It is unclear if and how access and egress movements to and from abutting side roads such as Day Avenue can / will be facilitated (if at all – this is unclear from the information provided). Where right-turn movements in / out of these roads will be prohibited, ensure appropriate alternative areas for U-turns are provided. Right-turn movements across the tram tracks can be facilitated where appropriate sight lines, gaps in traffic and storage space can be accommodated, however it is preferred it be avoided to prevent unnecessary conflict points and delaying light rail.	
8.12	It is understood that southbound buses (in some options) will drive along the light rail track south of the university to access the terminus further south. It is unclear how southbound buses will safely access the light rail tracks from the adjacent traffic lanes. This requires further investigation.	
8.13	Options 6, 7 and 8 include 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 trams and 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.	
8.14	Apart from option 7 (centre platform), each of the options will not be able to accommodate kerbside parking during off-peak periods (if only one trough lane of traffic is considered acceptable during such off-peak periods).	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
Option proposed by Transport for New South Wales		
8.15	The longitudinal edge and face of the island platform will be located approximately 3.5m from adjacent southbound traffic, which is just outside the 3.0m clear zone for 60km/h. The immediate preceding southbound traffic lanes are aligned straight and therefore the likelihood of errant vehicle encroachment into the platform is considered low.	
8.16	While northbound tram patrons will alight from the right side of the tram at the platform stop, the appropriate side for southbound trams is unclear. Patrons wishing to board a southbound tram may be confused whether to wait in the central island or the kerbside. Similarly, a tram driver may inadvertently open the doors on the incorrect side especially if abutting tram stops are central island type stops. Alternatively, if the intention is for both platforms to be used at once, both sides of the tram could be opened.	
8.17	Light Rail Vehicle (LRV) priority pedestrian crossings are proposed at each end of the proposed platform, which increases the likelihood of pedestrian/tram conflict and is less preferred than a signalised fully controlled crossing. Given the short length of the proposed crossings in this particular case, uncontrolled crossings would be warranted (it is acknowledged that it is difficult to control pedestrian movements even where signalised crossings are provided). It is important to ensure uncontrolled crossing movements are made as safe as possible. The main way to make uncontrolled crossings as safe as possible is to ensure appropriate sight lines are provided at crossing points, and to provide direct access to the adjacent roadside. Signs and pavement markings (for pedestrians) to ensure they 'look and give-way' to trams should also be considered.	
8.18	Northbound bus drivers propped in the bus bays (north of the pedestrian operated signals) will have difficulty seeing and picking gaps in traffic given the offset of the preceding traffic lanes closer to the kerb and behind propped buses. To a lesser extent, southbound bus drivers will have some difficulty sighting approaching vehicles due to the curved preceding road alignment.	
8.19	It is understood that northbound buses will utilise the central tram tracks south of the pedestrian operated signals before moving across to the kerbside lane and bus stops north of the crossing. While the general principle of this operation (including using the signals as a head-start) is supported in principle, the alignment of the tram tracks/bus lane south of the crossing is in direct line with the southbound fast lane. The directly opposing lane arrangement is undesirable and may 'spook' southbound drivers. This is expected to be exacerbated at night when vehicle headlights are on, adding glare.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
8.20	Further to the previous point, the delineation of the skewed southbound traffic lanes and deviation through the crossing and across the light rail tracks is reliant on line marking only, without the benefit of separation and a median. The reliance of such delineation without separation and a physical barrier such as a raised median is undesirable and likely to increase the risk of conflict such as head-on (southbound vehicles and northbound buses) and sideswipe (vehicles in same direction).	
8.21	Maintaining the existing signalised pedestrian operated signals is supported, however the following potential safety issues associated with the crossing should be considered for this proposed light rail platform option: • Pedestrians crossing from the eastern side of Anzac Parade are likely to wait within the tram reserves before crossing the traffic lanes given the seemingly wide free open tram reserve available when trams are not immediately present. This increases the risk of conflict between pedestrians and trams. • Pedestrians crossing from the western side of Anzac Parade and wishing to access the tram platform are simply likely to complete crossing the southbound traffic lanes and take a shortcut along the tram reserve to access the platforms. Such movements cannot be prevented due to the need to maintain access. This increases the risk of conflict between pedestrians and trams especially as pedestrians walking north will have their back to northbound trams. Similar issues are likely for pedestrians leaving the platform (to the south) and walking directly to the pedestrian crossing to travel west across Anzac Parade. • No central median is proposed in this option, which removes the possible opportunity for a safe refuge. Crossing against a red man can reasonably be expected (and this is consistent with advice provided to Transafe during the audit inception meeting) and the provision of two staged crossing movement and a median refuge lessens the risk. • The vehicle hold lines need to be positioned well in advance of the pedestrian crossing due to the nature of the light rail track alignment and bus jump lane. This offset may encourage pedestrians to cross against the red man as they seemingly will have more 'time' to do so, however this increases the likely speed at the conflict point and consequences of impact (especially at the end of a pedestrian walk phase). • Pedestrians crossing against the red man may use the red vehicle signal aspects as a guide to see if it is 'safe' to cross, unaware that an early start phase may be given to northbound buses from the light rail tracks. This increases the risk of conflict between buses and pedestrians.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
8.22	Further to item 8.4, catenary power poles are likely to be located close to adjacent traffic where the tram tracks cross the traffic lanes (i.e. they are likely to be located close to traffic to support the wires that span across the traffic lanes). Suitable protection of these poles is likely to be difficult, which could result in significant unshielded roadside hazards.	
8.23	The deviation of the light rail tracks from the centre of Anzac Parade to the eastern side of the road is proposed through the signalised intersection at High Street. This arrangement is expected to complicate an otherwise typical intersection, affecting the typical operation of the signal phases, position of vehicle hold lines and pedestrian crossing arrangements. Some of the following issues are likely: • The southbound vehicle hold line is required well in advance of the intersection. This will result in increased left-turn speeds into High Street due to the additional acceleration length (this only applies at the end of the red southbound vehicle phase. Also, the risk doesn't change during the green phase for this intersection for any of the options). The opportunity for eye contact between left-turning motorists and crossing pedestrians is also lost, which puts crossing pedestrians at increased risk of conflict. • Pedestrians crossing from the eastern side of Anzac Parade are likely to wait within the tram reserve before crossing the traffic lanes given the seemingly wide free open tram reserve available when trams are not immediately present. This increases the risk of conflict between pedestrians and trams. • Pedestrians crossing Anzac Parade in either the eastbound or westbound direction may do so against the red man, or when there appears to be a through traffic red light (when southbound traffic is propped at the hold line), but be in conflict with trams during the signal phase where trams are permitted through the intersection. • The southbound traffic lanes will be deviated to the west through the intersection. This required deviation would be difficult to delineate across the tram tracks, with the tram tracks and likely surrounding concrete apron providing a misleading visual cue for southbound motorists. Some vehicles may inadvertently drive along the tram reserve, while others may inadvertently follow a tram that has departed the intersection immediately before the southbound green vehicle phase is given. • The presence of tram tracks within the intersection can result in loss of skid resistance, particularly when the pavement is wet. This will be exacerbated by the increased need for braking that is increased at an intersection.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
8.24	This option limits the possibility of extending the length of the central island platform (for future growth demands) due to the nature of the curved light rail tracks on each approach side of the proposed platform. As patronage increases, waiting numbers of passengers may not be able to be appropriately and safely accommodated.	
8.25	Much of the opposing traffic lanes within the subject length of road will only be separated by a centre dividing line instead of a physical median (i.e. the existing situation). The narrowing of traffic lanes and removal of physical separation is expected to increase the risk of conflict such as head-on and sideswipe.	
8.26	This option involves the unusual arrangement of northbound trams travelling towards and to the left of southbound traffic without a buffer between the approaching trams and southbound traffic lanes. This arrangement is expected to be disconcerting for some motorists and is likely to lead to 'spooking' creating a shy-line effect and encroachment of the right southbound lane (from the left southbound lane).	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
Option 6 – Modified Transport for New South Wales proposal with wider platform shifted west		
8.27	The longitudinal edge and face of the island platform will be located immediately adjacent to southbound traffic, and therefore within the 3.0m clear zone for 60km/h. The immediate preceding southbound traffic lanes are skewed on approach to the platform and therefore increase the likelihood of errant vehicle encroachment into the platform. This arrangement would require a longitudinal safety barrier and approach crash cushion to adequately shield traffic from the platform hazard and also protect pedestrians from errant vehicles.	
8.28	Southbound slow lane vehicles are likely to have obstructed sight distance around the curved alignment adjacent to the platform due to the close proximity of pedestrian fencing (and possible safety barrier). Sight distance to the actual signals is expected to be met, however the concern is the likely obstructed sight distance between drivers and pedestrians (and vice versa) that chose to cross against the red man.	
8.29	A tram driver may inadvertently open the doors on the incorrect side especially if abutting tram stops are central island type stops.	
8.30	The final stopping point along these platforms is important. Ideally each stopping tram should stop as close to the relevant pedestrian crossing as possible to encourage crossing pedestrians to utilise the crossing. In reality, during busy times, trams may need to stop at the end of the platform due to the presence of trams ahead. This is expected to increase the likelihood of pedestrians crossing 'mid-block' between the available pedestrian crossings. A fence between the two opposing trams lines could discourage this.	
8.31	Northbound and southbound bus drivers propped in the bus bays (north and south of the pedestrian operated signals respectively) will have difficulty seeing and picking gaps in traffic due to the curved preceding road alignment. This could be mitigated somewhat by the use of the signals, but would only apply when the signals are called-on by pedestrians.	
8.32	It is understood that northbound buses will utilise the central tram tracks south of the pedestrian operated signals before moving across to the kerbside lane and bus stops north of the crossing. While the general principle of this operation (including using the signals as a head-start) is supported in principle, the alignment of the tram tracks/bus lane south of the crossing is in direct line with the southbound fast lane. The directly opposing lane arrangement is undesirable and may 'spook' southbound drivers. This is expected to be exacerbated at night when headlights are on, adding glare. A physical median (denoted in green hatching with planting) may help reduce the spooking and glare effect somewhat.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
8.33	Maintaining the existing signalised pedestrian operated signals is supported, however the following potential safety issues associated with the crossing should be considered for this proposed light rail platform option: • Pedestrians crossing from the eastern side of Anzac Parade are likely to ignore the red man (if a controlled crossing of the tram tracks is applicable in this case) across the tram reserve given the seemingly wide free open tram reserve available when trams are not immediately present. This increases the risk of conflict between pedestrians and trams. • A narrow central median is proposed in this option, which provides some opportunity for a safe refuge. While crossing against a red man can reasonably be expected, the provision of two staged crossing movements and a median refuge lessens the risk. Overall, this proposed arrangement is considered to be of similar risk to the existing narrow 'refuge' available. • The northbound vehicle hold line needs to be positioned well in advance of the pedestrian crossing due to the nature of the bus jump lane. This offset may encourage pedestrians to cross against the red man as they seemingly will have more 'time' to do so, however this increases the likely speed at the conflict point and consequences of impact. • Pedestrians crossing against the red man may use the red vehicle signal aspects as a guide to see if it is 'safe' to cross, unaware that an early start phase may be given to northbound buses from the light rail tracks. This increases the risk of conflict between buses and pedestrians. • The restricted sight lines likely within the southbound slow lane as a result of the adjacent fence and possible safety barrier increases the risk of conflict between vehicles and pedestrians crossing against the red man (the fence will also reduce available sight distance between pedestrians and vehicles).	
8.34	Further to item 8.4, catenary power poles are likely to be located close to adjacent traffic where the tram tracks cross the traffic lanes (i.e. they are likely to be located close to traffic to support the wires that span across the traffic lanes). Suitable protection of these poles is likely to be difficult, which will result in significant unshielded roadside hazards.	
8.35	A section of approximately 100m of the opposing traffic lanes within the subject length of road will only be separated by a centre dividing line instead of a physical median (i.e. the existing situation). The narrowing of traffic lanes and removal of physical separation is expected to increase the risk of conflict such as head-on and sideswipe, particularly near the university walk crossing where the southbound traffic lanes deviate.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
8.36	Allowance for pedestrian/tram patron 'lean-back' will need to be allowed for with this option given the close proximity of the western side of the platform to the southbound traffic lane. A buffer and physical separation (e.g. offset fencing) should be provided to ensure pedestrians/tram patrons leaning back on platform railing cannot be struck by passing vehicles, including trucks/buses with protruding side mirrors.	
8.37	The lateral shift of the southbound traffic lanes is abrupt and it is unlikely that vehicles can negotiate the proposed lateral shift at the 60km/h speed. This may be exacerbated for high vehicles and may result in some vehicles leaving their lane and sideswipe conflict.	
8.38	The low radius curves in the tram tracks will require trams to negotiate them at lower speed, increasing travel time and reducing overall level of service.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
Option 7 – Centre platform		
8.39	The longitudinal edge and face of the central island platform will be located approximately 3.5m from adjacent traffic, which is just outside 3.0m clear zone for 60km/h. The immediate preceding traffic lanes are aligned straight and therefore the likelihood of errant vehicle encroachment into the platform is considered low.	
8.40	Maintaining the existing signalised pedestrian operated signals is supported, however the following potential safety issues associated with the crossing should be considered for this proposed light rail platform option: • Pedestrians crossing from the central island of Anzac Parade are likely to wait within the tram reserve before crossing the traffic lanes given the seemingly wide free open tram reserve available when trams are not immediately present. This increases the risk of conflict between pedestrians and trams. • Pedestrians crossing against the red man may use the red vehicle aspects as a guide to see if it is 'safe' to cross, unaware that an early start phase may be given to northbound buses from the light rail tracks. This increases the risk of conflict between buses and pedestrians. • Sight lines between southbound vehicles and pedestrians crossing from the central island to the eastern side of the road are likely to be obstructed by the adjacent fence and therefore increases the risk of conflict between vehicles and pedestrians crossing against the red man. • Southbound tram patrons crossing from the centre platform wishing to access the university will need to cross the southbound traffic lane compared to the other options. Although the crossing is signalised, the additional crossing movement will marginally increase the risk of conflict between vehicles and pedestrians.	
8.41	It understood that the area north of the centre platform between the two light rail tracks may be used as a storage area for pedestrians during high demand. This measure is supported, based on the assumption that this area will be cordoned off using fencing to channel pedestrians between the northern crossing and the proposed tram platform (and the tracks fenced-off), and appropriate ramps provided to the platform. This option has the benefit of extending the platform as demand grows.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
Option 8 – Side platforms		
8.42	The longitudinal edge and face of the kerbside platforms will be located approximately 3.5m from adjacent traffic, which is just outside the 3.0m clear zone for 60km/h. The immediate preceding traffic lanes are aligned straight and therefore the likelihood of errant vehicle encroachment into the platform is considered low.	
8.43	A tram driver may inadvertently open the doors on the incorrect side especially if abutting tram stops are central island type stops.	
8.44	Sight lines to the south of the driveway/road access located on the western side of Anzac Parade (immediately south of the NIDA building) will be obstructed by trams and/or the adjacent tram platform. While it is appreciated that this driveway/road may only be used infrequently for deliveries, it may need to be closed and a suitable alternative provided.	
8.45	The northbound bus stop cannot be accommodated close to the main university mall access due to the proposed tram platform arrangement. Connectivity and level of service will be reduced as a result.	
8.46	Northbound and southbound bus drivers propped in the bus bays (north and south of the pedestrian operated signals respectively) will have difficulty picking gaps in traffic due to the curved preceding road alignment.	
8.47	It is understood that northbound buses will utilise the central tram tracks south of the pedestrian operated signals before moving across to the kerbside lane and bus stops north of the crossing. While the general principle of this operation (including using the signals as a head-start) is supported in principle, the alignment of the tram tracks/bus lane south of the crossing is in direct line with the southbound fast lane. The directly opposing lane arrangement is undesirable and may 'spook' southbound drivers. This is expected to be exacerbated at night when headlights are on, adding glare. A physical median (denoted in green hatching with planting) may help reduce the spooking and glare effect somewhat.	

University of New South Wales – Proposed Light Rail Platform Stops on Anzac Parade Feasibility Design Stage Road Safety Audit		
Item	**Findings**	**Project team response**
8.48	Maintaining the existing signalised pedestrian operated signals is supported, however the following potential safety issues associated with the crossing should be considered for this proposed light rail platform option: • Pedestrians crossing from the either side of Anzac Parade are likely to wait within the tram reserve before crossing the traffic lanes given the seemingly wide free open tram reserve available when trams are not immediately present. This increases the risk of conflict between pedestrians and trams. • The northbound vehicle hold line needs to be positioned well in advance of the pedestrian crossing due to the nature of the light rail track alignment and bus jump lane. This offset may encourage pedestrians to cross against the red man as they seemingly will have more 'time' to do so, however this increases the likely speed at the conflict point and consequences of impact. • The northbound tram tracks cross the northbound traffic lanes in advance of and through the signalised pedestrian crossing. This is expected to result in reduced pavement skid resistance and possible overshooting of the pedestrian crossing (by northbound vehicles), increasing the likelihood of conflict between northbound vehicles and crossing pedestrians. • A narrow central median is proposed in this option, which provides some opportunity for a safe refuge. While crossing against a red man can reasonably be expected, the provision of two staged crossing movements and a median refuge lessens the risk. Overall, this proposed arrangement is considered to be of similar risk to the existing narrow 'refuge' available. • Pedestrians crossing against the red man may use the red vehicle aspects as a guide to see if it is 'safe' to cross, unaware that an early start phase may be given to northbound buses from the light rail tracks. This increases the risk of conflict between buses and pedestrians.	
8.49	Further to item 8.4, catenary power poles are likely to be located close to adjacent traffic where the tram tracks cross the traffic lanes (i.e. they are likely to be located close to traffic to support the wires that span across the traffic lanes). Also, additional kerbside poles (a row for each direction) will be required where the tracks are located adjacent to the platforms. These poles are likely to be just within the clear zone. Suitable protection of these poles is likely to be difficult, which will result in significant unshielded roadside hazards.	
8.50	The low radius curves in the tram tracks will require trams to negotiate them at lower speed, increasing travel time and reducing overall level of service.	

Item	Findings	Project team response
Preferred option from a road safety perspective		
8.51	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. Option 7 - Centre Platform is the preferred platform arrangement out of the four options considered, mainly due to the lowest likely conflict points. The proposed arrangement of option 7 is by the far the safest option from a road safety perspective and each of the other three options are considered very much the same in terms of likely conflict. The design of option 7 is simple and consistent with the likely arrangement of much of the abutting tram network (running within the median). It also: • Is logical and simple. It does not require multiple deviations of the tram tracks and therefore limits potential interaction and therefore conflict between trams and other road users. • It is separate from the roadway and provides the most offset between opposing directions of traffic. • Avoids the need for low radius horizontal curves along the traffic lanes and tram reserve (i.e. is a mostly straight alignment and the need to deviate around curves does not complicate the driving task). • Avoids the need for road users, in particular two-wheeled vehicles to cross the tram tracks. • Due to no crossing of the tram and traffic lanes, there will be fewer delays to both trams and road users. • It enables complete segregation between the tram reserve and likely pedestrian areas. The use of fencing along the tram reserve will physically corral pedestrians to designated crossing points, which are fully controlled (and avoid ambiguous right-of-way confusion between trams and pedestrians often associated with uncontrolled crossings). • It enables staged crossing movements to be performed by pedestrians that choose to	

	cross against a red man (which can reasonably be expected to occur at any signalised crossing), a safer alternative to the other options that either have no central median, or a narrow median. • It enables the installation of a single row of catenary power poles between the two tram tracks, outside the clear zone of adjacent traffic, and therefore limits the risk associated with this necessary tram infrastructure. • Has the option of expanding the platform waiting area within the central median as demand grows. • Enables close connectivity of adjacent bus stops. • Allows a straight alignment and therefore good visibility for egressing bus drivers is expected. • Provides the possibility of facilitating kerbside parking (with a single through lane of adjacent traffic) during off-peak periods. • Centre island platforms are particularly suited to locations where patronage tends to peak in one direction (such as at the university). • Can be implemented in conjunction with a reduced speed limit of 40km/h to further reduce risk and consequences of conflict. A centre platform arrangement has been in operation for several years at one of Melbourne's busiest transport hubs, Flinders Street at Swanston Street. At this location, a centre platform caters for very high volumes of tram patrons; linking to the busy Flinders Street train station and central tram route along Swanston Street (which provides the main tram access to the northern and southern suburbs of Melbourne). This central island platform arrangement has been a success largely due to the separation provided between trams and adjacent traffic and the provision of fencing between the tram reserve and adjacent traffic lanes which forces pedestrians to access the tram platform from the fully controlled signalised crossing at each end of the platform.	

View east along Flinders Street – Eastbound carriageway (double traffic lane)

View west along Flinders Street – Westbound carriageway (single traffic lane)

The Flinders Street arrangement is much preferred over other arrangements that involve complex deviations of the tram tracks (e.g. from the centre of the road to the kerbside and vice versa) and multiple potential conflict points. A perfect example is that along Harbour Esplanade at the Docklands precinct (Melbourne). The tram reserve was previously located on the western side of

	Harbour Esplanade adjacent to a shared use path and pedestrian footpath. Delineation and segregation of the tram reserve at this location was difficult and resulted in a mixture of pedestrians and bicyclists utilising the tram reserve. It also resulted in a reduced level of service for both tram patrons and other road users along this roadway because of the required tram reserve crossovers (with the traffic lanes). The potential for conflict and reduced level of service was duly recognised and the kerbside arrangement was recently changed to a central tram reserve arrangement, albeit with side platforms (within the central median).	

Project team response undertaken by:

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

9. Audit conclusion

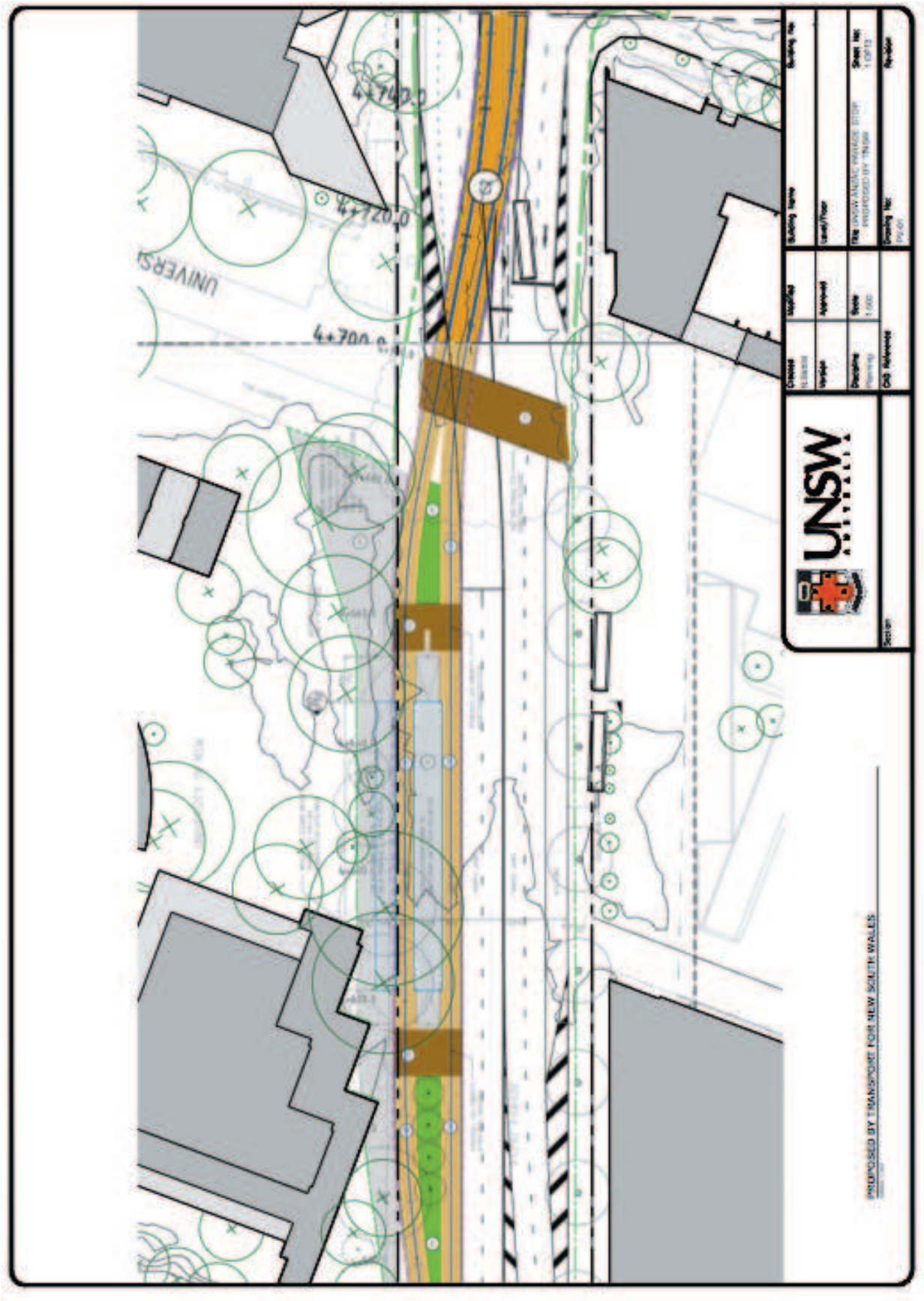
This road safety audit has attempted to balance the safety needs of all road users within the site/design constraints. It is the intention that all audit recommendations are realistic and feasible and commensurate with the actual risk posed.

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

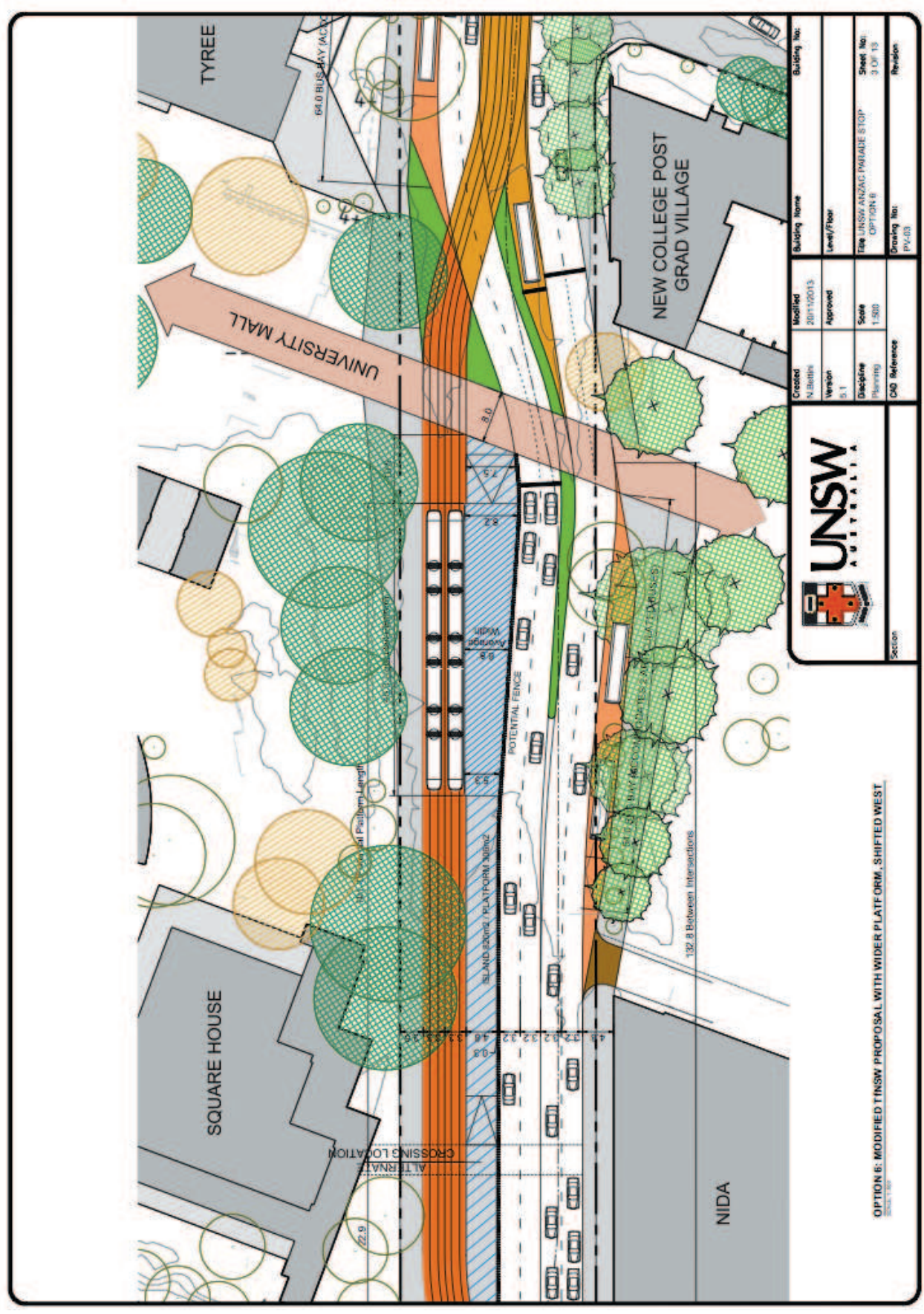
and;

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

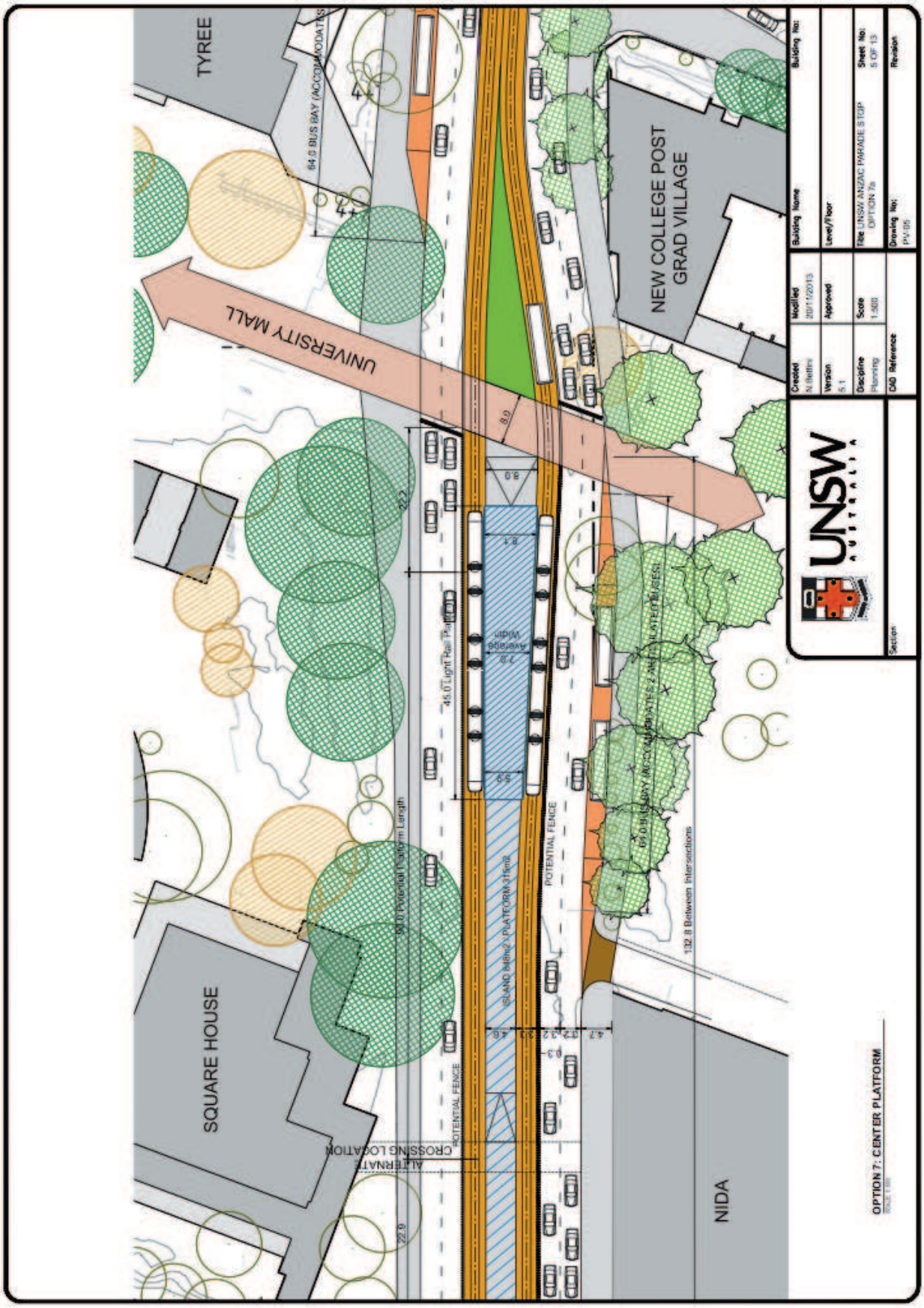
10. Appendix A1: Transport for NSW option



11. Appendix A2: Option 6 – Modified Transport for NSW proposal



12. Appendix A3: Option 7 – Centre platform



13. Appendix A4: Option 8 – Side platforms