Our Ref: 210079:TIM (V2)
Contact: Tim Michel / Michael Hodges

3 April 2018

Lendlease Building
Level 14, Tower Three
International Towers Sydney
Exchange Place, 300 Barangaroo Avenue
**Barangaroo NSW 2000**

Attention: Jeremy Tompson

**Cardno (NSW/ACT) Pty Ltd**
ABN 95 001 145 035

Level 9 - The Forum
203 Pacific Highway
St Leonards 2065
Australia

**Phone +61 2 9496 7700**
Fax +61 2 9496 7748

www.cardno.com

Dear Jeremy,

**BARANGAROO SOUTH**
**C1 BUILDING - BASEMENT EXIT INTERSECTION WORKS**

This letter has been prepared in response to a Road Safety Audit (RSA) report prepared for proposed intersection modifications at the basement exit at Hickson Road, Sussex Street and Napoleon Street, Barangaroo.

The objective of this letter is to summarise proposed risk mitigation measures associated with the proposed intersection works at the basement exit. These measures are outlined in response to the following documents:

- Traffic Signal Design Plan (TCS 4625, Sheet 4), prepared by Road Delay Solutions. First issued on 14th March 2018, then updated subsequent to receipt of RSA report and reissued 19th March 2018 (contained as **Enclosure 1**).
- Detailed design Road Safety Audit report, prepared by DC Traffic Engineering and dated 15th March 2018 (contained as **Enclosure 2**).

**Table 1-1** overleaf summarises the comments and findings of the DC Traffic Engineering audit team, as well as possible measures that could be incorporated into the detailed design of the intersection works to minimise safety risks associated with the operation of the intersection.

The proposed measures outlined in this letter are intended to be used as the basis for further development during preparation of detailed design documentation and for further discussion with RMS.

**Table 1-1 Possible Risk Mitigation Measures in response to Road Safety Audit (DC Traffic Engineering, March 2018)**

| Audit Reference | Description | Possible Risk Mitigation Measures *(refer to footnotes below)* |
|---|---|---|
| C-1 | Position of hold line in the basement car park approach to the intersection | A |
| C-2 | Interface between basement car park ramp and proposed pedestrian crossing | B, C and D |
| C-3 | Impact of relocated pedestrian crossing on the operation of the intersection | A |
| C-4 | Western footpath of Hickson Rd / Sussex St | E |
| C-5 | Impact of colonnade on pedestrian "see-through" perceptions | B and C |
| C-6 | Basement car park ramp in approach to signalised intersection | No specific measures required, as the roller door remains open all day while the basement car park is in operation. |
| 1 | Impact of colonnade support pylons on driver visibility to pedestrians | B, C and D |
| 2 | Signal Posts | This has been addressed in the revised Traffic Signal Plan dated 19th March 2018. |
| 3 | TCS Plan post numbering | This has been addressed in the revised Traffic Signal Plan dated 19th March 2018. |
| 4 | C phase on TCS Plan – conflict between left turn movement for cyclists and pedestrian crossing | F |
| 5 | Signal Posts | This has been addressed in the revised Traffic Signal Plan dated 19th March 2018. |
| 6 | Egress driveway from building car park | G |
| 7 | Primary and dual primary signals in building car park egress lane | H |
| 8 | Use of signals and signs | To be considered further during detailed design |
| 9 | Pavement loop detectors | To be considered further during detailed design, in light of existing and proposed utility services that may conflict with the location of the loop detectors. |

**DESCRIPTION OF POSSIBLE RISK MITIGATION MEASURES**

A. Placement of a dynamic flashing light on the wall adjacent to one or both of the basement exit lanes, which is linked to the red signal at the intersection, refer to **Figure 1-2**.

B. Provision of signage at the eastern end of the concrete median within the basement car park, warning vehicles exiting of the impending pedestrian crossing. An example of such signage is presented in **Figure 1-3**.

C. Provision of warning signage on the proposed colonnade columns to alert pedestrians to vehicles exiting the basement car park. Examples of such signage are presented in **Figure 1-4**.

D. Provision of in-ground pedestrian lights (red, linked to the pedestrian traffic signal lights) between the C1 ground floor building / façade line and the line of colonnade columns. It is noted there are currently trials in place of these lights at two locations in the Sydney CBD (Goulburn St / Pitt St and Hay St / Dixon St).

E. Extend proposed kerb ramps to cover full width of the proposed pedestrian crossing (7.5 metres), which will cover portions of the footpath under the colonnade (within Barangaroo South) and beyond the colonnade (on the footpath within the Sussex Street / Hickson Road reserve).

F. Consider restricting the left turn movement for cyclists from Hickson Road to Napoleon Street to avoid conflict with pedestrian movements on the northern side of the intersection (C phase movements).

G. Consider line marking and signage on the approach to the two exit ramps in the basement car park to inform drivers that left lane only turns left onto Hickson Road and right lane only turns right onto Sussex Street.

H. Consider various options for the placement of primary and dual primary signal lanterns at the intersection. It is noted the current design plan shows the lanterns on signal posts adjacent to the proposed colonnade columns (not directly on the support pylons as noted on page 15 of the RSA). Alternative options that are worthy of further consideration as part of the detailed design process include:

   a. Placement of signal lanterns directly on the colonnade columns (with or without outreach arms, depending on visibility and clearance requirements for vehicles exiting the basement.

   b. Placement of signal lanterns on outreach arms directly attached to the face of the building.


**Figure 1-2** View of basement exit ramp (facing south) approaching the signalised intersection


**Figure 1-3** View of basement exit ramp (facing east) approaching the signalised intersection

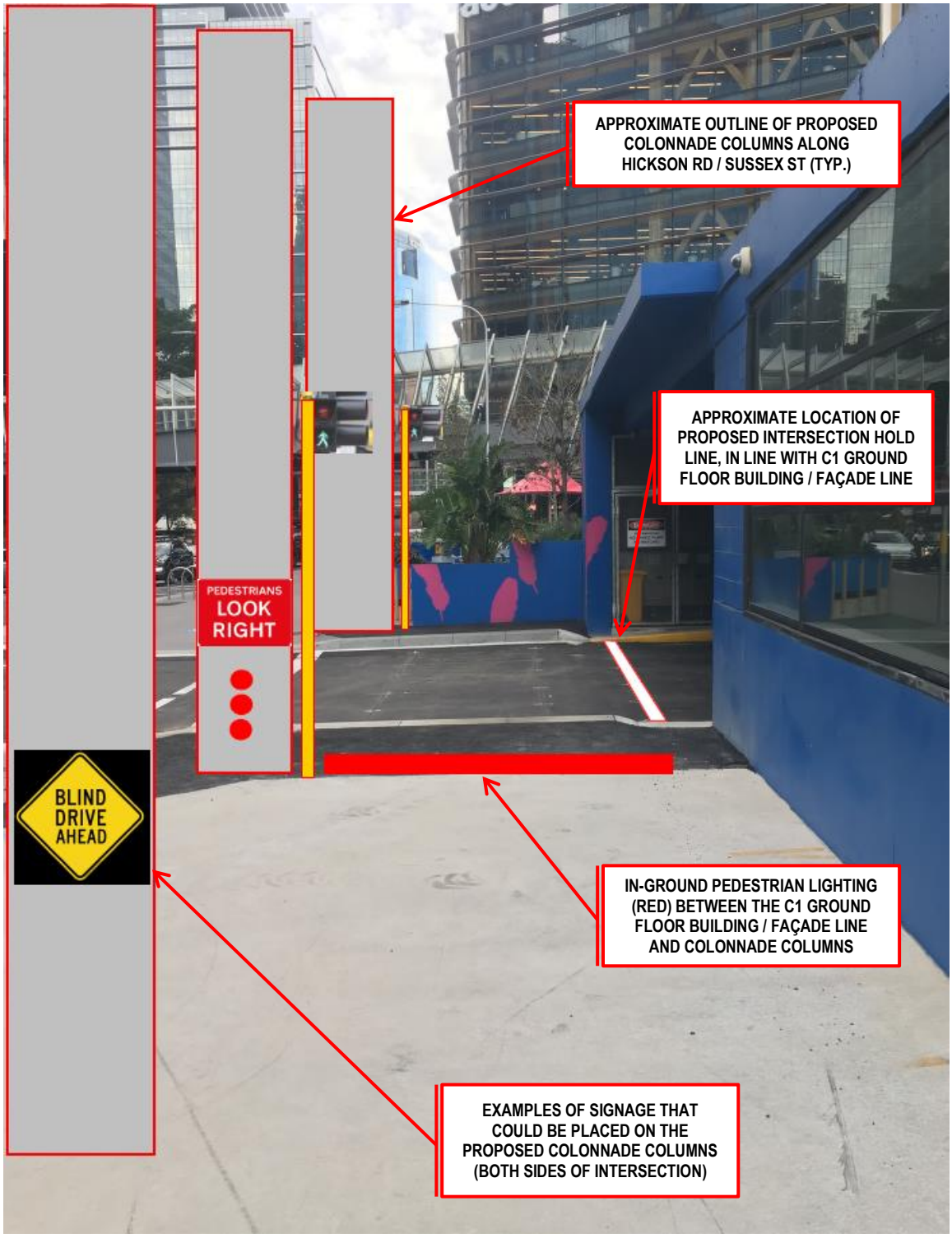



**Figure 1-4** **View of future footpath under proposed colonnade (facing south)**

Please contact the undersigned if you require any further clarification.

Yours sincerely,

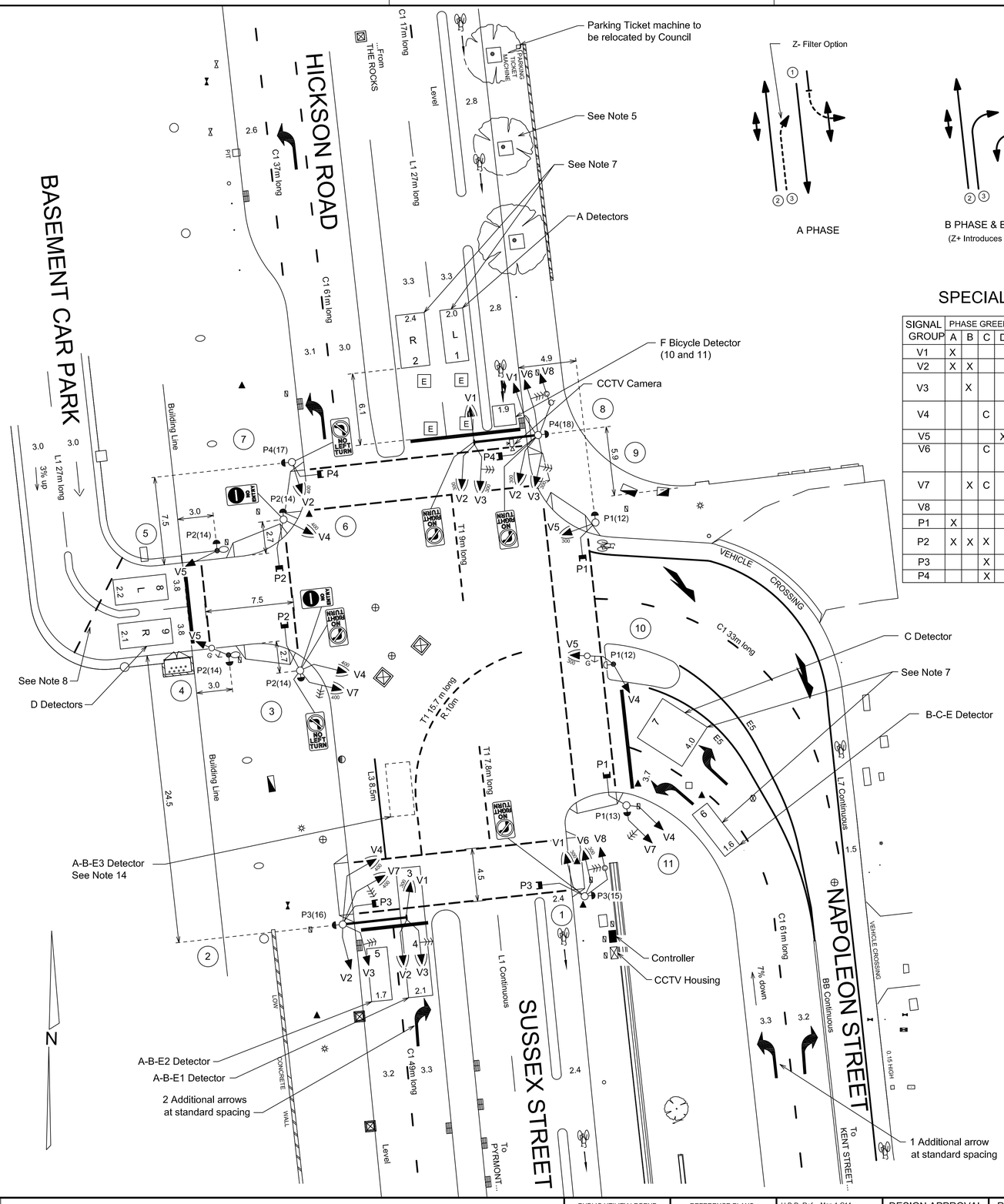
Tim Michel
Civil Engineer
for Cardno
Direct Line: +61 2 9495 8107
Email: Tim.Michel@cardno.com.au

Enc: Traffic Signal Design Plan (Road Delay Solutions, 19 March 2018)
Road Safety Audit (DC Traffic Engineering, 15 March 2018)

# TCS 4625

DATE IN SERVICE : 29/06/2015

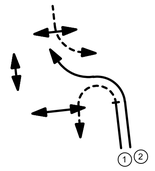
NSW GOVERNMENT | Transport Roads & Maritime Services

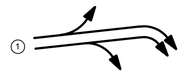


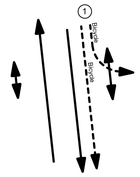







## MOVEMENTS

## SPECIAL SIGNAL GROUP DISPLAY SEQUENCE

| SIGNAL GROUP | PHASE GREEN A | B | C | D | E | F | TABLE TYPE | REMARKS |
|---|---|---|---|---|---|---|---|---|
| V1 | X | | | | | X | 4 | No overlap A⟶F |
| V2 | X | X | | | X | X | 43 | No overlap A⟶F if V3 filtering |
| V3 | | X | | | X | | 81 | Z- Filter Option. Timed Red Arrow protection for P1 pedestrians. Pushbutton on Post 11 extends RA protection subject to timer. |
| V4 | | | C | | | | 74 | Timed Red protection for P4 pedestrians. Pushbutton on Post 8 extends Red protection subject to timer. |
| V5 | | | | X | | | 1 | — |
| V6 | | | C | | | | 78 | Red in 'F' phase. Timed Red Arrow protection for P1 pedestrians. Push Button on Post 11 extends Red Arrow protection subject to timer |
| V7 | | X | C | | X | | 77 | Timed Red Arrow protection for P3 pedestrians. Pushbutton on Post 2 extends RA protection subject to timer. |
| V8 | | | | | | X | 1 | — |
| P1 | X | | | | | X | 23 | No overlap A⟶F |
| P2 | X | X | X | | X | X | 28 | Automatic introduction of P2 ped subject to presence of XSF 1. Walk for GREEN |
| P3 | | | X | | | | 2 | — |
| P4 | | | X | | | | 2 | — |

## POSTS

| POST | TYPE | LENGTH | OFFSET | REMARKS |
|---|---|---|---|---|
| 1 | 14 | 9.6 | 1.0 | EXISTING |
| 2 | 15 | 9.6 | 1.0 | NEW 5.5m OUTREACH 756kg |
| 3 | 14 | 9.6 | 1.0 | NEW TYPE B - 336kg |
| 4 | 2 | 4.1 | 0.6 | NEW |
| 5 | 2 | 4.1 | 0.6 | NEW |
| 6 | 14 | 9.6 | 1.0 | NEW TYPE B - 336kg |
| 7 | 14 | 9.6 | 1.0 | NEW TYPE B - 336kg |
| 8 | 15 | 9.6 | 1.0 | NEW 5.5m OUTREACH 756kg |
| 9 | 14 | 9.6 | 1.0 | NEW TYPE B - 336kg |
| 10 | 2 | 4.1 | 0.6 | EXISTING |
| 11 | 14 | 9.6 | 1.0 | EXISTING |

## NOTES

1. This site is SCATS linked. This site is linked to the RMS CBD fibre network by conduit to the existing housing at site TCS 310.
2. Special STOP Sign (R1-4) placed on Posts 4, 5, 10 and 11.
3. Audio tactile pushbuttons are located on Posts 1, 2, 3, 4, 5, 6, 7, 8, 9 and 11.
4. Kerb ramps to be constructed at all pedestrian crossings in accordance with RMS Standard (Road) Drawing R.0300-11.
5. Trees on all approaches are to be regularly inspected and trimmed by Council to minimise lantern obstruction.
6. For Civil Works see Drawing Nos, B10-CD0000410 and B10-CD0000411 prepared by CARDNO.
7. Stop line presence detectors 1, 2, 6 and 7 are located to avoid conflict with utility services in the roadway.
8. Denotes extent of easement for roadway dedication.
9. Supply is existing.
10. CCTV Camera is mounted on signal Post 8.
11. Presence of XSF15 in Flexilink and Masterlink automatically demands Bicycle Phase 'F'.
12. Bicycle lanterns are 200mm with square visors and no target board.
13. The Bicycle Lanterns on Posts 1 and 8 are mounted below the vehicle lanterns a minimum of 2.4m above the footpath.
14. Provision to be made in ducting and cabling for a future A-B-E3 Detector.
15. Bicycle lane to be in accordance with NSW Bicycle Guidelines and City of Sydney Guidelines.
16. Bicycle detector to be installed in accordance with Drawings VC005-36 and VC005-38.

## DETECTOR SPECIFICATION

| Detector | | Specifications | | | | |
|---|---|---|---|---|---|---|
| A | FN | A(L) | A(E1) | | | |
| | SG/PS | $\overline{A}$ | A | | | |
| | DS | — | — | | | |
| A-B-E1 Approach & Depature | FN | B(PR) | E(PR) | | | |
| | SG/PS | A | A | | | |
| | DS | Z- | Z-.Z+ | | | |
| cont. A-B-E1 Approach | FN | A(L).B(L) | B(L) | E(L) | E(L) | |
| | SG/PS | $\overline{V2}$ | $\overline{V3}$ | $\overline{V2}$ | $\overline{V3}$ | |
| | DS | Z- | $\overline{Z-}$ | Z-.Z+ | $\overline{Z-}$.Z+ | |
| cont. A-B-E1 Approach | FN | A(E3) | | | B(E3) | E(E3) |
| | SG/PS | A | | | B | E |
| | DS | Z-.A-B-E1(PR),B($\overline{NEXT}$),E($\overline{NEXT}$) | | | E($\overline{NEXT}$) | B($\overline{NEXT}$) |
| A-B-E2 | FN | A(L) | A(E2) | B(E2) | E(E2) | |
| | SG/PS | $\overline{V2}$ | A | B | E | |
| | DS | $\overline{B.E}$ | B($\overline{NEXT}$).E($\overline{NEXT}$) | A($\overline{NEXT}$).E($\overline{NEXT}$) | A($\overline{NEXT}$).B($\overline{NEXT}$) | |
| B-C-E | FN | B(L) | B(CL) | E(L) | E(CL) | |
| | SG/PS | $\overline{V7.C}$ | C | $\overline{V7.C}$ | C | |
| | DS | $\overline{C}$+P3(PB) | B-C-E(NG) | Z+.[$\overline{C}$+P3(PB)] | Z+.B-C-E(NG) | |
| cont. B-C-E | FN | B(E1) | | C(E1) | E(E1) | |
| | SG/PS | B | | C | E | |
| | DS | C($\overline{NEXT}$)+P3(PB).E($\overline{NEXT}$) | | B($\overline{NEXT}$).E($\overline{NEXT}$) | B($\overline{NEXT}$).C($\overline{NEXT}$)+P3(PB) | |
| C | FN | C(L) | C(E2) | | | |
| | SG/PS | $\overline{C}$ | C | | | |
| | DS | — | — | | | |
| D | FN | D(L) | D(E1) | | | |
| | SG/PS | $\overline{D}$ | D | | | |
| | DS | — | — | | | |
| F Bicycle | FN | F(PR) | F(E1) | | | |
| | SG/PS | $\overline{F}$ | F | | | |
| | DS | — | — | | | |
| P1 P.B. | FN | A(PB) | C(L) | | | |
| | SG/PS | V1.P1(WALK) | V1.$\overline{P1(WALK)}$ | | | |
| | DS | $\overline{F}$ | $\overline{B.C.D.E}$ | | | |
| P2 P.B. | FN | A(PB) | Reintroduce Walk | | | |
| | SG/PS | D.P2(WALK) | $\overline{V5.P2(WALK)}$ | | | |
| | DS | $\overline{B.C.E.F}$ | $\overline{D}$ | | | |
| P3 P.B. | FN | C(PB) | A(L) | | | |
| | SG/PS | $\overline{P3(WALK)}$ | C.$\overline{P3(WALK)}$ | | | |
| | DS | — | $\overline{A.B.D.E.F}$ | | | |
| P4 P.B. | FN | C(PB) | A(L) | | | |
| | SG/PS | $\overline{P4(WALK)}$ | C.$\overline{P4(WALK)}$ | | | |
| | DS | — | $\overline{A.B.D.E.F}$ | | | |

A. ORIGINAL ISSUE

| PUBLIC UTILITY LEGEND | | REFERENCE PLANS | |
|---|---|---|---|
| HYDRANT | □ | SYMBOLS/ABBS. | VD003-6 |
| STOP VALVE | ▲ | STD POSIT | VD001-5 |
| GAS VALVE | # | PRES. DETECT | VC005-17 |
| SEWER MANHOLE | ⊕ | VEH. GROUP OP | TS-TN-019 |
| TELECOM PIT | ◪ | DET. LOGIC OP | TS-TN-020 |
| ELECT LIGHT POLE | ☼ | PED. MOVEMNT OP | TS-TN-021 |
| POWER POLE | ○ | | |
| RMS PIT | ▨ | | |
| TELEPHONE BOX | T | SURVEYOR : CARDNO | |
| TELECOM PILLAR | ◕ | DATE : 2014 | |

U.B.D. Ref, Map 1-C14

LS.G. CO-ORDS E: 316 736 N: 1 246 719

DESIGNED G VARLEY, Road Delay Solutions P/L

CHECKED M HODGES, CARDNO

SITE CHECKED

M HODGES RECOMMENDED

DESIGN APPROVAL

APPROVED

Road Delay Solutions P/L

POSITION DIRECTOR

DATE 19.3.2018

ROAD DELAY SOLUTIONS

ROAD DELAY SOLUTIONS Pty Ltd
G64/79-91 Macpherson Street WARRIEWOOD NSW 2102 AUSTRALIA

RMS ACCEPTANCE

RECOMMENDED

POSITION .....

DATE .....

ACCEPTED

POSITION .....

DATE .....

ROADS AND MARITIME SERVICES

SYDNEY COUNCIL AREA
TRAFFIC SIGNALS AT
HICKSON ROAD, SUSSEX STREET
AND NAPOLEON STREET
SYDNEY

DESIGN LAYOUT TCS No 4625

EXISTING ☐ PROPOSED ☒

CADD FILE: VV4625_4A.dgn

SCALE 5 0 (1:200) 5 10

ISSUE A

FILE SF2014/038544

SUPERSEDES SHEET/ISSUE 1/A

REG No. DS2014/005640

TCS No. 4625

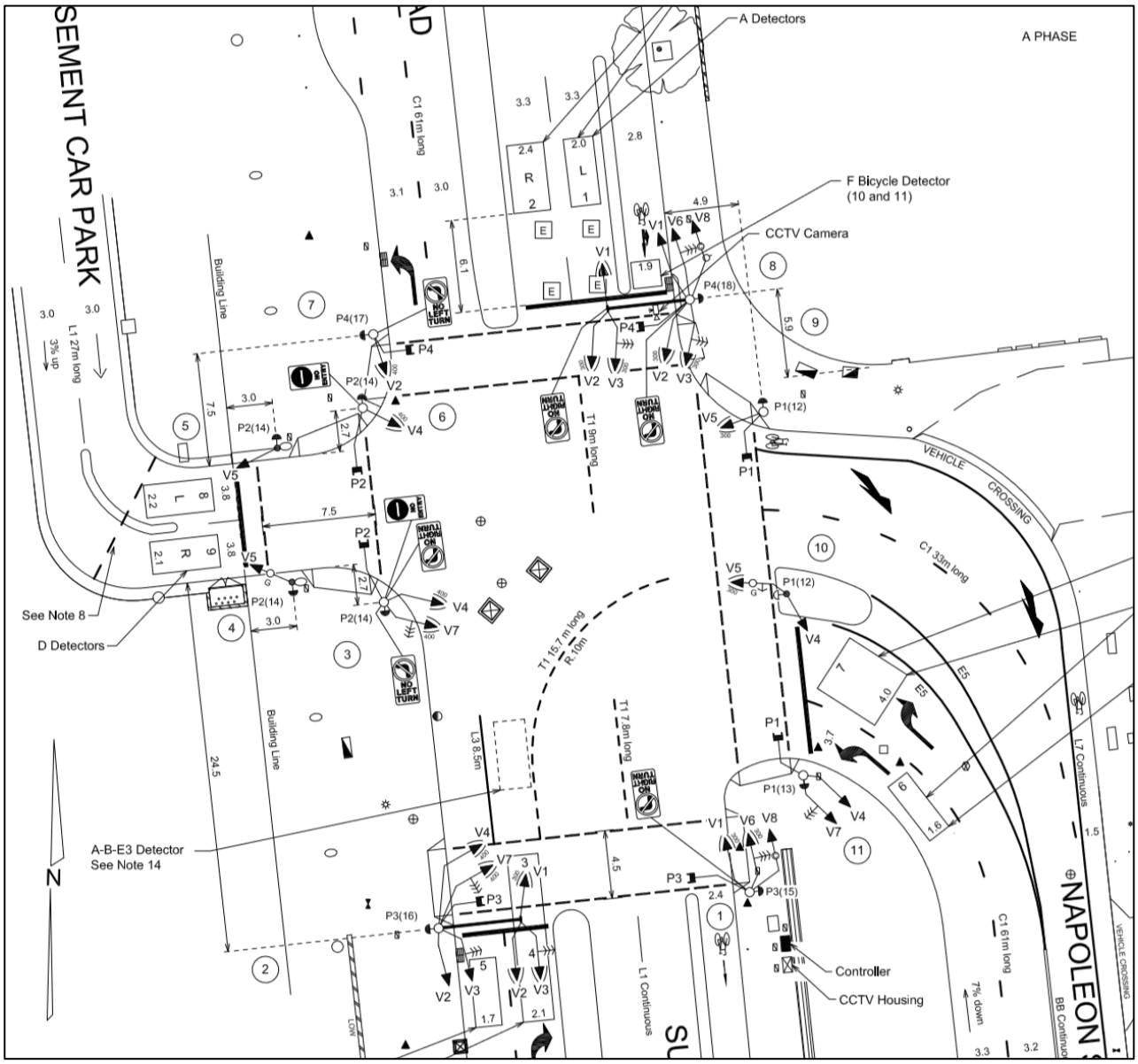
SHEET 4

TRAFFIC ENGINEERING

# Cardno

# Hickson Road, exit from C1 building car park, Barangaroo

## Detailed design road safety audit



**DC Traffic Engineering Pty Ltd**
ABN 50 148 960 632
www.dctrafficengineering.com.au

# Cardno

# Hickson Road, exit from C1 building car park, Barangaroo

## Detailed design road safety audit

**Authors** Damien Chee

-

**Report No** CARD-PROJ-0003-08 DD RSA HICKSON-NAPOLEON REV 1

**Date** 15/3/2018

This report has been prepared for Cardno.

# CONTENTS



## Appendices

# 1 Introduction

## 1.1 Project and audit details

Details of the audit have been summarised in Table 1.

**Table 1 Details of the road safety audit.**

| | |
|---|---|
| **Audited project** | Hickson Road/ Sussex Street/ Napoleon Street/ C1 building car park egress intersection and traffic signal control (TCS) plan, with a focus on the C1 building egress. |
| **Client/ contact** | Tim Michel<br>Civil Engineer<br>Cardno<br>Ph: (02) 9495 8107<br>E: Tim.Michel@cardno.com.au |
| **Audit type** | *Detailed design* road safety audit. |
| **Purpose** | A *detailed design* road safety audit is required to identify any potential safety risks prior to construction. |
| **Background** | The Hickson Road/ Sussex Street/ Napoleon Street/ C1 basement car park exit is a four-way, traffic signal controlled intersection adjacent to the Barangaroo South Development. Hickson Road and Sussex Street form the northern and southern legs respectively. Napoleon Street forms the eastern leg. The C1 building basement car park exit forms the fourth leg which includes two approach lanes only (no departure lanes from the intersection). There are signalised pedestrian crossings on all four legs.<br>As part of the ultimate layout of the C1 building and its surrounding street and open space improvement plan, a TCS plan has been prepared for the traffic signal control of this intersection, and its road and pedestrian traffic. A *detailed design* road safety audit was requested to specifically assess the safety implications of the C1 building egress and its interface with the intersection and western pedestrian crossing. |
| **Scope of project/ audit** | The following plans were issued to the audit team and regarded as the auditable materials (scope):<br>▪ TCS plan registered as DS2014/005640, CADD file VV4625_4A.dgn (revision A).<br>▪ Ground floor plan BC1AD20000S (revision 4). |
| **Audit team details** | Damien Chee, level 3 (lead) road safety auditor - Registration number: RSA-02-0094.<br>Linda Chee, level 2 road safety auditor –Registration number RSA-02-1069. |
| **Audit methodology** | The audit was undertaken using the following methodology:<br>▪ Formal review of the plans on 15/3/2018.<br>▪ Supporting site inspection carried out on 15/3/2018.<br>▪ The road safety audit findings have been documented in this report in accordance with the NSW Centre for Road Safety's *Guidelines for Road Safety Audit Practices* (2011).<br>▪ This report includes completed road safety audit checklist as sourced from the Austroads *Guide to Road Safety Part 6: Road Safety Audit*. |
| **Material supplied** | See *scope of project/ audit*. |
| **Meeting and assessment details** | Formal review of design plans on 15/3/2018.<br>Supporting site inspection carried out on 15/3/2018. |

## 1.2 Responding to the audit report

Road safety audits provide the opportunity to highlight potential road safety problems and have them formally considered by the project manager in conjunction with all other project considerations.

The responsibility for the project rests with the project manager, not with the auditor. The project manager is under no obligation to accept the audit findings. Also, it is not the role of the auditor to agree to, or approve the project manager's responses to the audit.

## 1.3 Previous audits

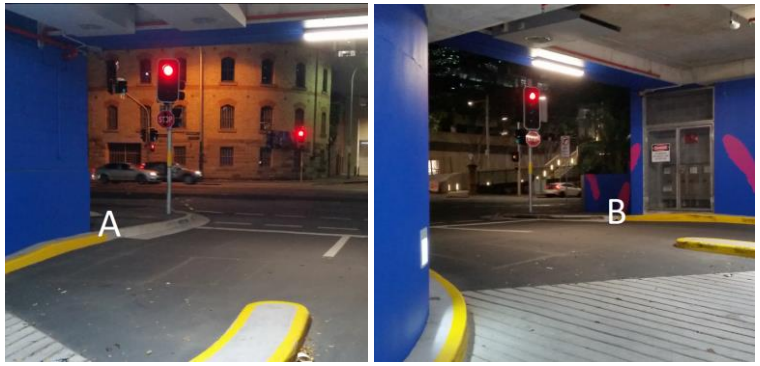
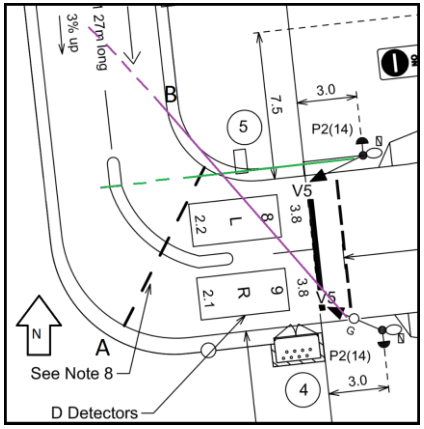
A number of previous road safety audits were carried out on the Barangaroo South Development. The *concept design* road safety audit of the temporary TCS layout, as documented in DC Traffic Engineering report CARD-PROJ-0003-06 (rev 1 dated 26/9/2017) was the most relevant.

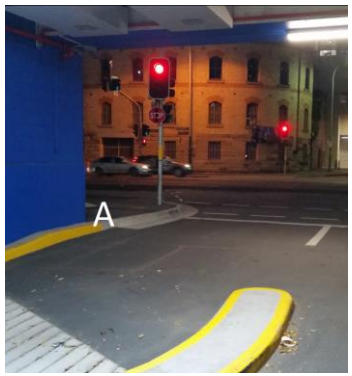
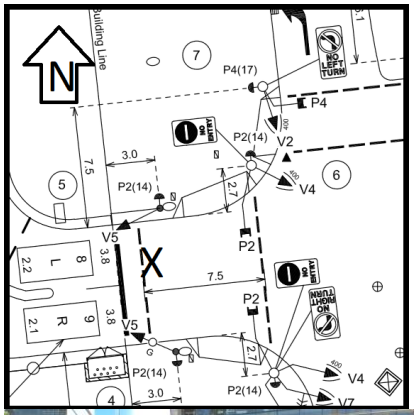
The audit team holds the position that if issues were raised in previous road safety audits, and made known to the project team, then these need not be re-raised as new findings in the current audit. This is based on the assumption that the project team has considered each issue in detail, and has established a reasonable "risk position" on each matter. This would be based on a balanced consideration of all project objectives including road safety performance.

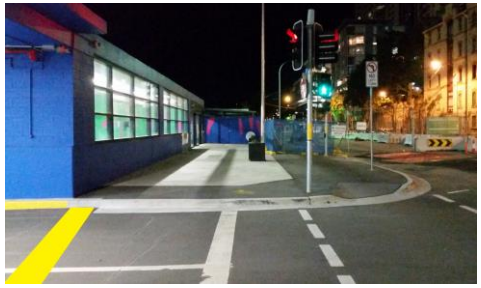
In these respects, the previous road safety audit findings (from the concept design stage) have been reproduced in Table 2. This table also includes a comment from the current audit team regarding the relevance of the issue to the detailed design, which is the subject of the current audit. It is recommended that the project team reviews the previous road safety audit findings in Table 2 to confirm their position on each matter.

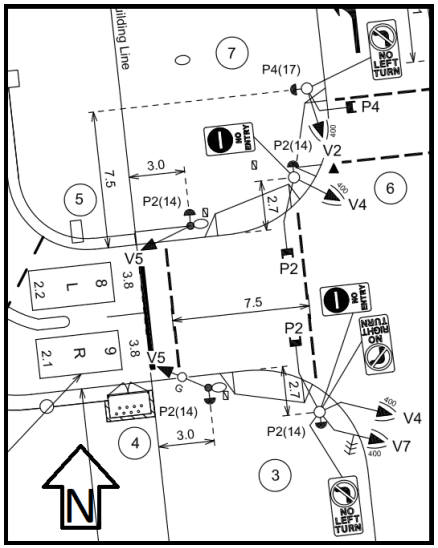
The items in Table 2 have been numbered as C-1, C-2 etc where "C" refers to *concept design* stage, and the suffix number is the same sequential number of the audit finding as documented in report CARD-PROJ-0003-06. This is to allow cross referencing between this report and the previous report.

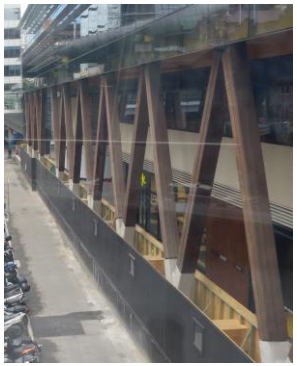
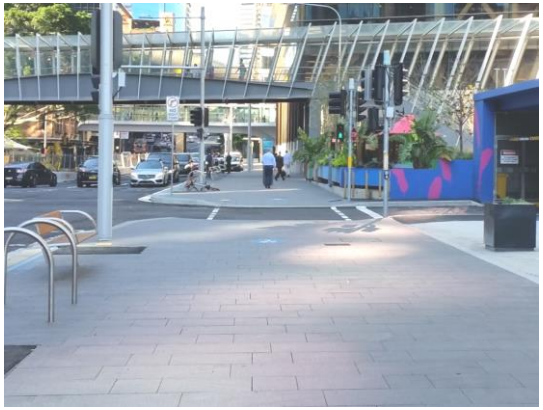
**Table 2 Previous road safety audit findings from the concept design stage (sourced from DC Traffic Engineering report CARD-PROJ-0003-06, rev 1).**

| *Ref* | *Location* | *Previous road safety audit finding (sourced from report CARD-PROJ-0003-06)* | Comment from the current audit team |
|---|---|---|---|
| *C-1* | *The new hold line in the basement car park approach to the intersection.* | *The proposed relocation of the pedestrian crossing will require the primary and dual primary signals to be shifted to the west to line up with the new hold line (which will be set deeper into the ramp)*. These points are marked "A" and "B" in the images below respectively. By convention, the primary and dual primary lanterns should be in line with the hold line as a cue on where drivers are required to stop.*<br><br>*By shifting the primary and dual primary lanterns to their new positions, this is likely to reduce the approach sight distance (ASD) from drivers on the ramp, to the signals. ASD (like stopping sight distance) is a critical sight line which allows the driver to see the controls, react and then decelerate to a stop without breaching the hold line. If there is insufficient ASD, the driver is more likely to over-run into the control area of the intersection (with consequential risks of cross traffic crashes) or enter the pedestrian crossing area (with consequential risks of vehicle-pedestrian crashes). The poor ASD would be due to the combined effect of the curvature of the ramp structure, the eastern boundary wall of the ramp structure and its lack of offset from the traffic lanes, and the height of the signal posts (and hence lanterns).*<br><br>*Furthermore, if a shorter post is used to address the excessive mounting height of the lanterns, this would also reduce the prominence of the east-facing signals (which are mounted to the same posts). These signals are critical in controlling westbound traffic from Napoleon Street.*<br><br>** The design indicates that the existing signal posts will be retained. However, this may create legal implications as non-compliant drivers may argue that these were not placed at the hold line. As such, the audit team has assessed safety conditions based on the signal posts being realigned/ shifted according to the relocated crossing. This is also the most likely position that RMS will adopt as it is consistent with their traffic signal design guidelines.*<br><br>  <br>***Above:** The proposed relocation of the pedestrian crossing would necessitate a relocation of the primary and dual primary signals to points "A" and "B" respectively. Photos taken on 25/9/2017.* | ASD remains a critical issue with the revised design. An extract from the TCS design is provided below showing the primary lanterns (post 5) and the dual primary lanterns (post 4). The green line is the ASD sight line to post 5 and the purple line is the corresponding sight line to post 4. Both sight lines are horizontally constrained by the eastern wall of the car park ramp. The solid portion of the lines are the ASD sight lines from lane 1 and the dotted portion of the lines are the ASD sight lines from lane 2. These sight lines are very short and give the egressing driver very little time-distance to interpret, react and stop in response to the signals. A prominent *vehicle-pedestrian* crash risk still remains.<br><br>Consideration should be given to compensatory measures such as a dynamic flashing light for egressing drivers which is linked to the red signal display. The flashing light units could be placed at points A, B or both.<br><br>  <br>***Above:** Extract from the TCS design showing the poor ASD to the primary and dual primary signals.* |

| Ref | Location | Previous road safety audit finding (sourced from report CARD-PROJ-0003-06) | Comment from the current audit team |
|---|---|---|---|
| *C-2* | *Interface between basement car park ramp and the proposed pedestrian crossing.* | *The proposal involves relocation of the pedestrian crossing to the west, deeper into the ramp structure. This is likely to reduce the mutual sight line between drivers ascending the ramp and pedestrians standing or moving from either side of the new crossing. This is especially the case for pedestrians on the northern side of the crossing as this side is most sight-constrained by the curvature of the ramp and its eastern boundary wall. Under current conditions, these sightlines are already non-ideal with limited driver visibility to the footpath areas either side of the crossing. The reduced approach length to the crossing as proposed will worsen these sight lines. Pedestrians are more likely to be hidden from driver's view by the side walls.*<br><br>*The point marked "A" below is the likely hold line of this approach under the proposed changes. The corresponding shift of the pedestrian crossing will result in pedestrians emerging from immediately behind the northern boundary wall. Similarly, pedestrians would also emerge from immediately behind the southern boundary wall at point "B".*<br><br>*The audit team acknowledges that the pedestrian crossing is fully controlled. However, the significant reduction in these sightlines presents unforgiving conditions for pedestrians as there is less margin for error by both drivers and pedestrians. For example:*<br>▪ *Pedestrians who decide to "j-walk" or cross when the pedestrian signals are red could be in danger of being impacted.*<br>▪ *Drivers who fail to see the red traffic signals or react in time may breach the hold line and threaten the safety of pedestrians.*<br>▪ *Pedestrians who are distracted (eg. mobile phones) may lack awareness of egressing vehicles and may not be able to react accordingly.*<br><br>  <br>  <br><br>***Left:*** *Following the relocation of the pedestrian crossing, pedestrians standing or commencing their crossing from the northern side of the ramp ("A") are likely to be hidden from the view of egressing drivers.* ***Right:*** *Similarly, pedestrians standing or commencing their crossing from the southern side of the ramp ("B") are also likely to be hidden from the view of egressing drivers. Photos taken on 25/9/2017.* | This is still an issue in the detailed design. The top image is an extract from the TCS design indicating that the hold line of the C1 building egress is collinear with the building line. The pedestrian crosswalk commences a short distance to the east of this point as marked "X" in the top image and the yellow line in the bottom image. As such, the pedestrian crossing area would be significantly closer to the building line compared with existing conditions.<br><br>  <br>  <br><br>***Above:*** *Extract from the TCS design and photo of existing conditions indicating that the pedestrian crossing area would be much closer to the building line compared with existing conditions. Photo taken on 15/3/2018.* |

| Ref | Location | Previous road safety audit finding (sourced from report CARD-PROJ-0003-06) | Comment from the current audit team |
|---|---|---|---|
| C-3 | *General – Impact of the relocated pedestrian crossing on the operation of the intersection.* | *The proposed relocation of the pedestrian crossing to the west will also have the following impacts on the operation of the intersection:*<br>▪ *The control area/ conflict zone of the intersection will increase. The control area is generally the area between all of the respective stop lines in each approach. With a larger control area, the clearance times for any vehicles emerging from the basement car park will also increase. This requires more "all red" period for these vehicles clear the intersection before the conflicting traffic streams can be given a green display. This will increase overall intersection delay, possibly leading to additional queuing (due to wasted signal cycle time) and consequential congestion-related crashes (eg. rear-end crashes).*<br>▪ *Under existing conditions, vehicles egressing from the basement car park and standing at the hold line of the intersection are in the "open air" environment and are more easily seen by other drivers, cyclists and pedestrians using the intersection. Similarly, these drivers would have clearer sight lines to those conflicting traffic streams as well. As such, physical and traffic conditions in the control area of the intersection are predictable for drivers as they progress into the intersection. Under the proposed conditions with the relocation of the pedestrian crossing and stop line, any egressing vehicle would be emerging from a visually concealed area. These drivers would have less awareness of the conditions in the road ahead. Similarly, other road users would have less awareness of any imminent threats posed by these egressing drivers. The movements from each respective traffic stream become less predictable (ie. increased "surprise factor"). Some egressing drivers may respond by "creeping" out into the intersection, or baulking/ hesitating when entering the intersection. These behaviours often lead to cross traffic and rear-end crashes.*<br>*The white unbroken stop lines in the two photos below show the existing starting positions of egressing drivers from the basement car park as they enter the intersection. The yellow lines mark the likely starting positions under the proposed scenario.*<br>   <br>***Above:*** *Looking north (left-hand image) and south (right-hand image) across the basement car park approach under existing conditions. Note the existing visibility conditions to and from any vehicles at the existing hold line (white unbroken line) compared with the proposed conditions (yellow line). Photos taken on 25/9/2017.* | This is still the case as per the detailed design. See the comment to item C-2. |

| Ref | Location | Previous road safety audit finding (sourced from report CARD-PROJ-0003-06) | Comment from the current audit team |
|---|---|---|---|
| *C-4* | *Western footpath of Hickson Road-Sussex Street.* | *Under existing conditions (see below), there is a footpath on the western side of Hickson Road-Sussex Street. The design does not indicate whether this footpath will be retained following the development or whether all pedestrian movements along this side of the road will be restricted to the colonnade.*<br>*Whilst the relocated crossing will satisfy the pedestrian crossing desire line from one side of the colonnade to the other, it may no longer satisfy the existing pedestrian desire lines from the external footpaths either side of the basement car park ramp (if these persist). Pedestrians on the external (and pre-existing) footpaths who fail to move to the new crossing and who decide to j-walk, may be at increased risk of impacts by vehicular movements at the intersection.*<br>  <br>***Above:*** *If the pre-existing external footpaths on the western side of Hickson Road-Sussex Street are retained, then the pedestrian crossing desire line (green line) may also persist. These pedestrians are less likely to shift to the colonnade and the relocated crossing marked by the yellow polygon. Photo taken on 25/9/2017.* | The detailed design appears to be more accommodating. The pedestrian crosswalk (between the two dashed lines) extends for most of the footpath width, including both the colonnade-covered section as well as the "open air" section.<br>  <br><br>***Above:*** *Extract from the TCS design showing the proposed width of the pedestrian crossing (between the dashed PCW lines) which extends for most of the external footpath width. The colonnade supports are shown by the ovals in the footpath.* |

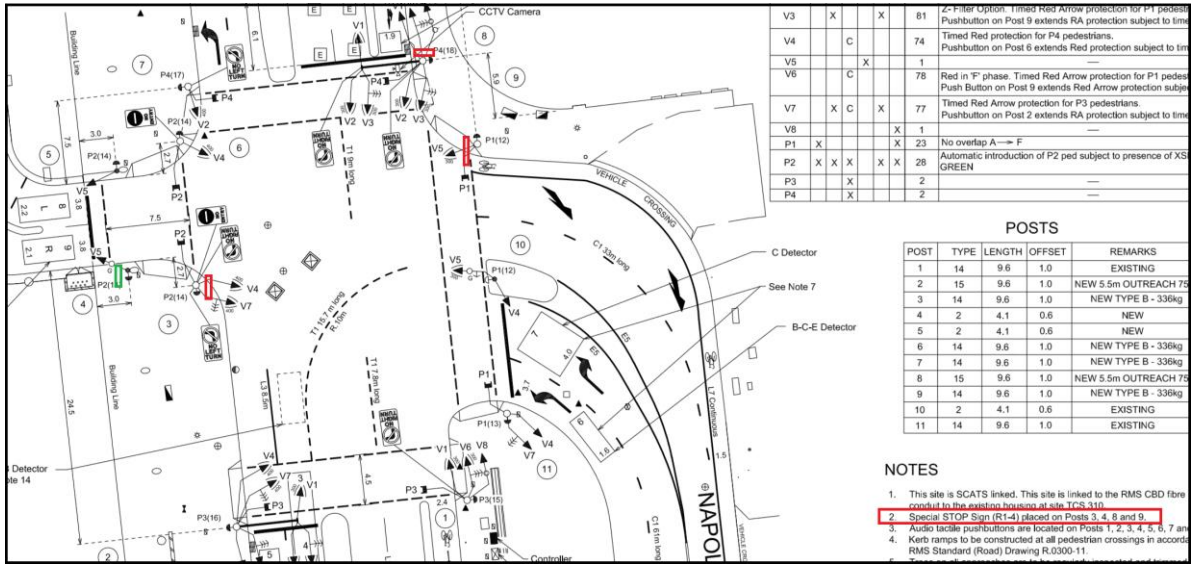
| Ref | Location | Previous road safety audit finding (sourced from report CARD-PROJ-0003-06) | Comment from the current audit team |
|---|---|---|---|
| *C-5* | *Impact of colonnade on pedestrian "see-through" perceptions.* | *The relocated crossing will line up with the colonnade walkways on the northern and southern sides of the basement car park ramp. The colonnade and the continuity of structures, décor etc may give a misleading "see through" perception to pedestrians approaching from either side of the crossing. This effect is where the pedestrian from one side of the crossing can see the continuation of the colonnade environment on the other side of the crossing and falsely believes that either (i) there is no crossing in place and the exclusive pedestrian space simply continues north-south, or (ii) that there is a crossing in place but that pedestrians have right-of-way over road vehicles. These false perceptions may increase the risk of vehicle-pedestrian crashes. Some examples of misleading "see-through" effects are provided below.*<br>    <br>***Left:** An example of a misleading "see-through" effect in Haymarket. The pedestrian mall on this side of the photo appears to continue un-impeded to the shared zone space on the other side of the road. Some pedestrians may lack awareness of the road and its conflicting traffic streams.* ***Middle:** Colonnade structures have the potential to create misleading "see-through"/ continuation perceptions due to the continuation of columns, ceilings and walkways.* ***Right:** The pre-existing colonnade to the south of the subject site.* | This would still be the case as proposed under the detailed design. Even without the colonnade in place, there is a strong "see-through" continuation effect as shown below. The footpaths either side of the car park exit are very uniform and pedestrians may fail to acknowledge the presence of a trafficable road midway along this path. With the addition of the colonnade columns and ceiling, the visual continuation effect would be even more prominent.<br>  <br>***Above:** Looking southbound along the western footpath of Hickson Road across the C1 building car park exit. Photo taken on 15/3/2018.* |

| *Ref* | *Location* | *Previous road safety audit finding (sourced from report CARD-PROJ-0003-06)* | Comment from the current audit team |
|---|---|---|---|
| *C-6* | *Basement car park ramp in approach to the signalised intersection.* | *The proposed relocation of the pedestrian crossing would effectively reduce the approach length between the roller door of the car park and the hold line. There would be a lack of storage length available between the hold line and the roller door. As such, any queues from the new hold line would be at greater risk of spilling back to the roller door. The audit team is uncertain whether the roller doors are programmed to detect obstructions to delay the closing of the door under the obstruction has cleared. As such, there is a risk of the roller door closing on top of a queued vehicle, or even queued vehicles rolling back into the roller door before starting up from rest.*<br>  <br>***Above:*** *Under existing conditions, there is limited length between the roller door and the hold line in this approach. However, under the proposed conditions, there would be even less approach length and more risk of queues spilling back to the roller door. Photo taken on 25/9/2017.* | This would still be the case as per the detailed design. |

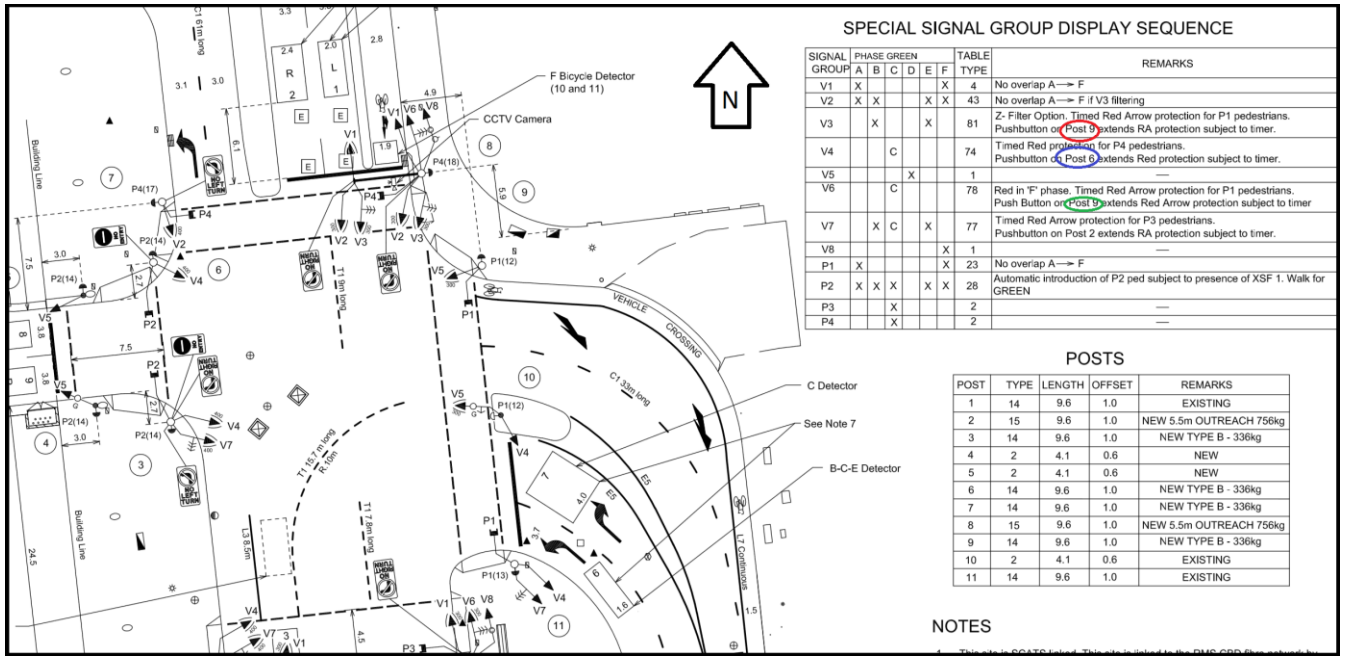
# 2 Safety audit findings

The road safety audit findings are documented in Table 3.

**Table 3 Road safety audit findings.**

| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 1 | Impact of colonnade support pylons on driver visibility to pedestrians. | The colonnade support pylons will be immediately adjacent to the kerb ramps at the crossing. These are likely to block driver visibility from the driveway to pedestrians standing or commencing the crossing from behind the pylons. This could increase the risk of *vehicle-pedestrian* crashes, particularly if either road user breaches the traffic signals. Item 7 (of this table) includes a photo of the pre-existing colonnade support pylons. As shown, these pylons have thick bases which are prone to visually obscuring pedestrians. | High |
| 2 | Posts 3, 4, 8 and 9. | Note 2 of the TCS plan states that R1-4 SPECIAL STOP signs are required on posts 3, 4, 8 and 9. These are marked by the red (incorrect) and green (correct) rectangles below. This layout does not appear to be correct.<br>Typically, the R1-4 signs would be placed on the approach sides of the intersection for the minor road approaches to the intersection. The audit team regards Hickson Road-Sussex Street as the north-south major road approaches/ departures from the intersection. The C1 building car park egress and the Napoleon Street leg would therefore be the minor road approaches. In these respects, the R1-4 signs should be placed on posts 4, 5, 10 and 11 and would face the traffic approaching the intersection.<br>  <br>***Above:*** *Note 2 on the TCS plan indicates that R1-4 SPECIAL STOP signs are required on posts 3, 4, 8 and 9 which does not appear to be correct.* | High (legal implication). |

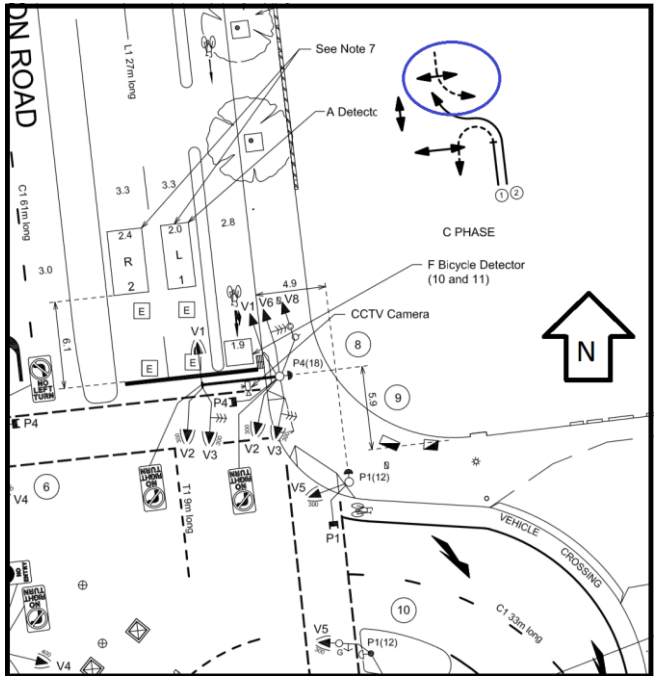
| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 3 | Drafting errors in the TCS plan with regards to posts | The following drafting errors were noted with regards to signal posts:<br>▪ Post 4 (V5 signal group) indicates a green “G” signal aspect. However, there is a south-facing arrow missing to indicate that this is a green arrow aspect. Post 10 correctly shows the “G” aspect with the south-facing arrow.<br>▪ In the special signal group display sequence, the remark for signal group V3 states that the “push button on post 9 extends the red arrow protection”. This should be post 11, not post 9.<br>▪ In the special signal group display sequence, the remark for signal group V4 states that the “push button on post 6 extends the red arrow protection”. This should be post 8, not post 6. Post 6 does not even contain a P4 push button.<br>▪ In the special signal group display sequence, the remark for signal group V6 states that the “push button on post 9 extends the red arrow protection”. This should be post 11, not post 9. | Medium |

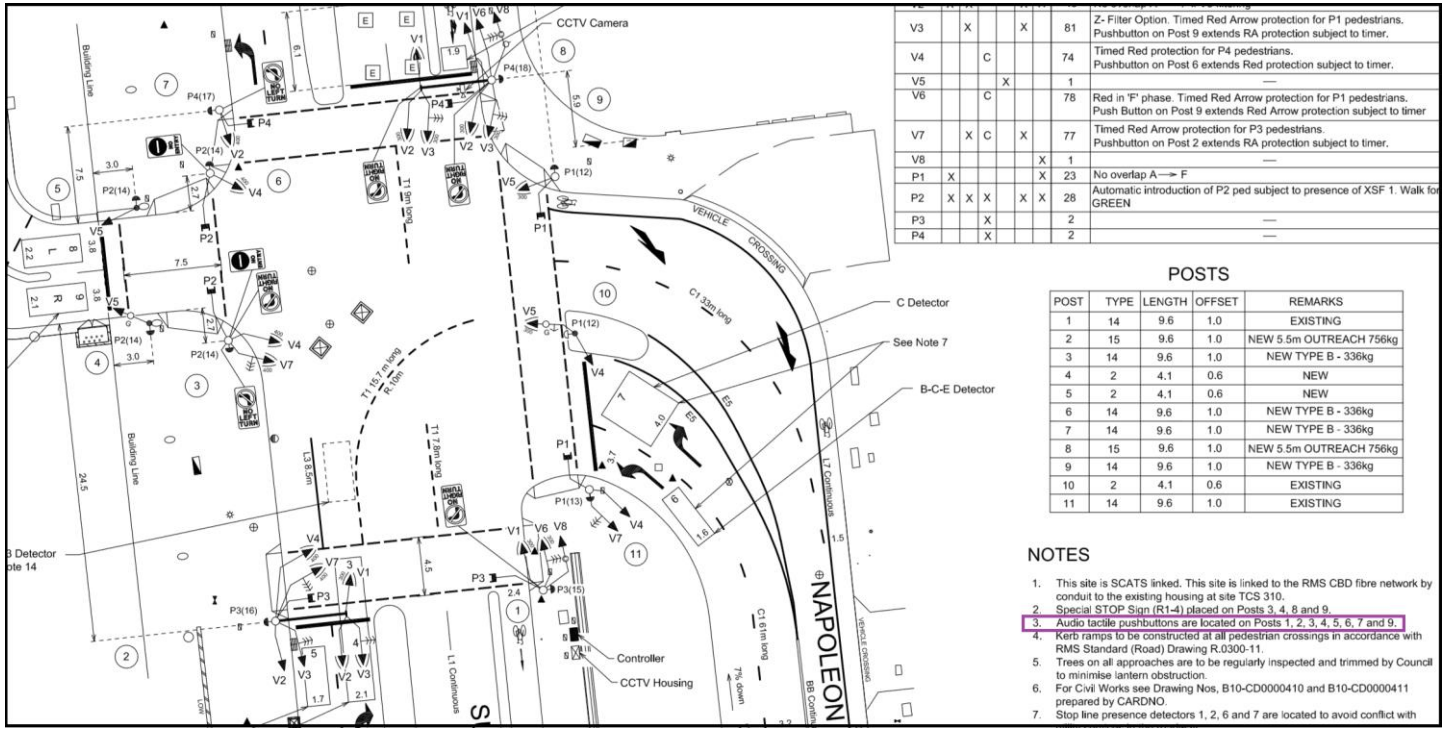


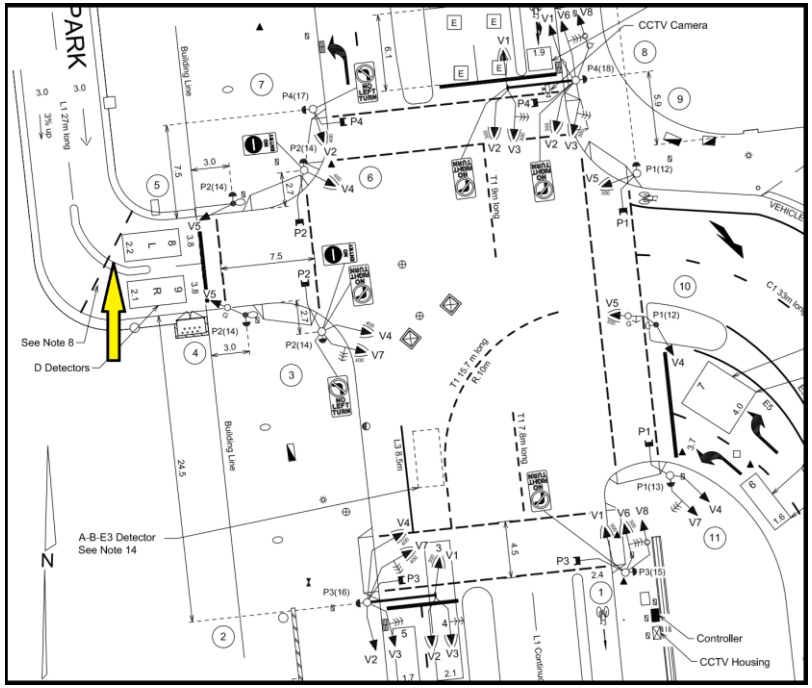

| SIGNAL GROUP | PHASE GREEN A | B | C | D | E | F | TABLE TYPE | REMARKS |
|---|---|---|---|---|---|---|---|---|
| V1 | X | | | | | X | 4 | No overlap A⟶F |
| V2 | X | X | | | X | X | 43 | No overlap A⟶F if V3 filtering |
| V3 | | X | | | X | | 81 | Z- Filter Option. Timed Red Arrow protection for P1 pedestrians. Pushbutton on Post 9 extends RA protection subject to timer. |
| V4 | | | C | | | | 74 | Timed Red protection for P4 pedestrians. Pushbutton on Post 6 extends Red protection subject to timer. |
| V5 | | | | X | | | 1 | — |
| V6 | | | C | | | | 78 | Red in 'F' phase. Timed Red Arrow protection for P1 pedestrians. Push Button on Post 9 extends Red Arrow protection subject to timer |
| V7 | | X | C | | X | | 77 | Timed Red Arrow protection for P3 pedestrians. Pushbutton on Post 2 extends RA protection subject to timer. |
| V8 | | | | | | X | 1 | — |
| P1 | X | | | | | X | 23 | No overlap A⟶F |
| P2 | X | X | X | | X | X | 28 | Automatic introduction of P2 ped subject to presence of XSF 1. Walk for GREEN |
| P3 | | | X | | | | 2 | — |
| P4 | | | X | | | | 2 | — |

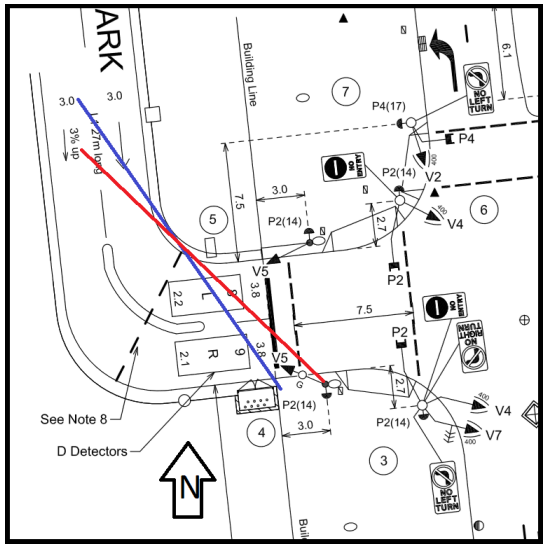
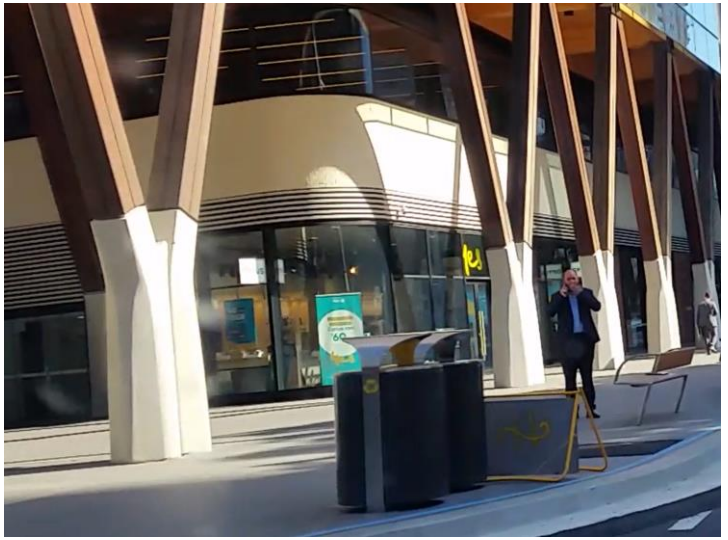
| POST | TYPE | LENGTH | OFFSET | REMARKS |
|---|---|---|---|---|
| 1 | 14 | 9.6 | 1.0 | EXISTING |
| 2 | 15 | 9.6 | 1.0 | NEW 5.5m OUTREACH 756kg |
| 3 | 14 | 9.6 | 1.0 | NEW TYPE B - 336kg |
| 4 | 2 | 4.1 | 0.6 | NEW |
| 5 | 2 | 4.1 | 0.6 | NEW |
| 6 | 14 | 9.6 | 1.0 | NEW TYPE B - 336kg |
| 7 | 14 | 9.6 | 1.0 | NEW TYPE B - 336kg |
| 8 | 15 | 9.6 | 1.0 | NEW 5.5m OUTREACH 756kg |
| 9 | 14 | 9.6 | 1.0 | NEW TYPE B - 336kg |
| 10 | 2 | 4.1 | 0.6 | EXISTING |
| 11 | 14 | 9.6 | 1.0 | EXISTING |

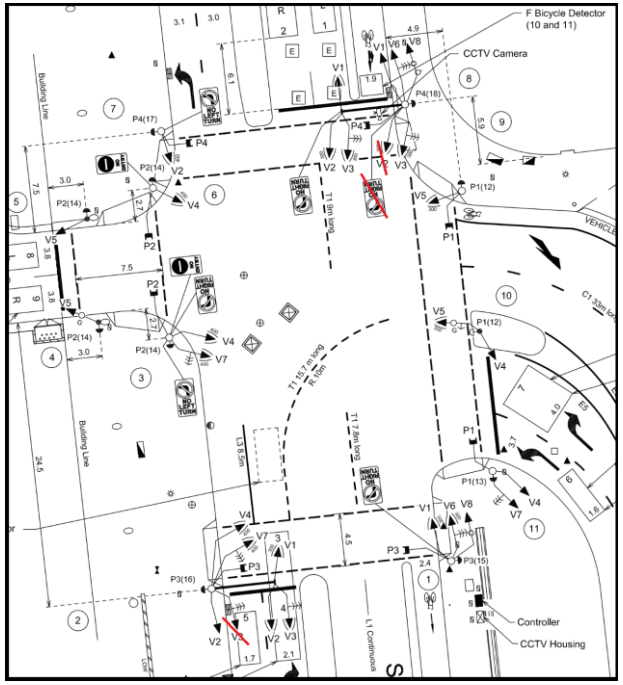
***Above:*** *The push buttons identified for the activation of the red arrow protection in the special signal group display sequence as circled in the remarks are incorrect.*

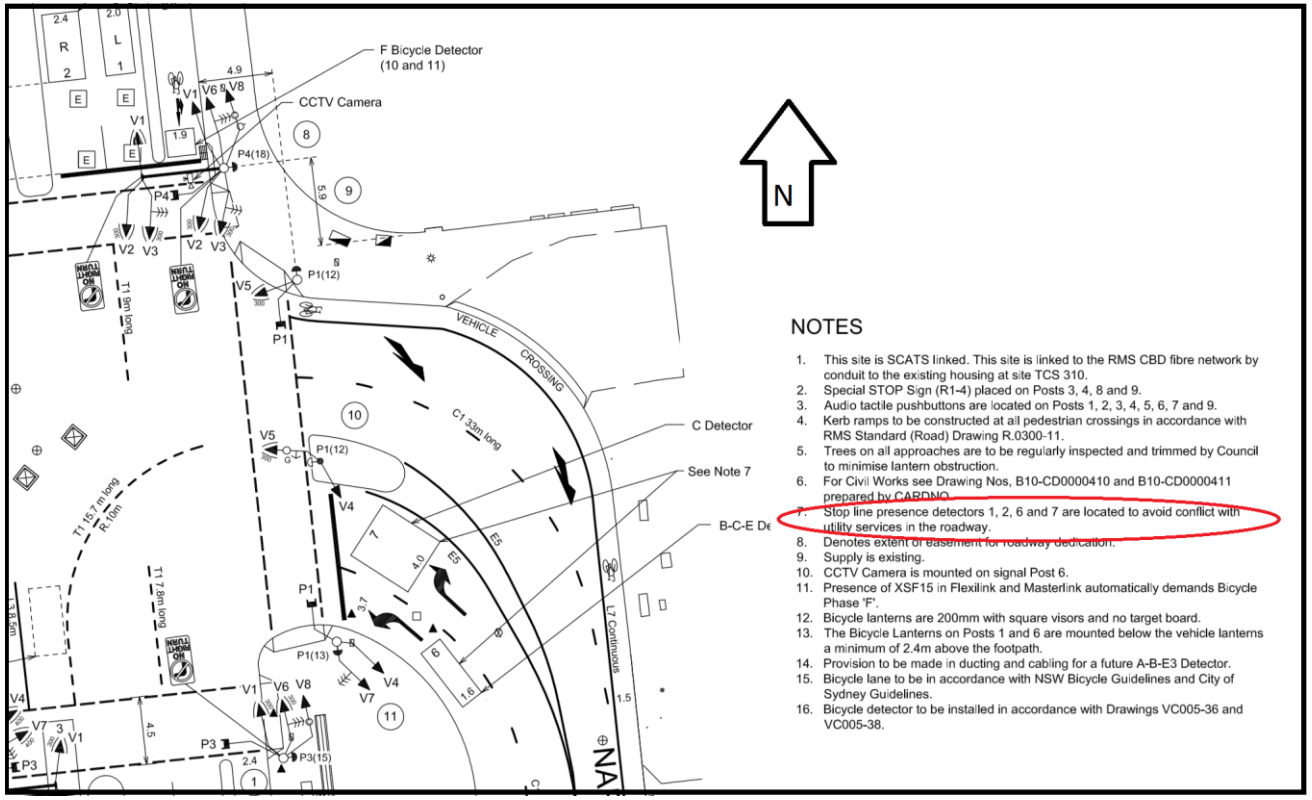
| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 4 | C phase on the TCS plan. | The C phase (see image below) includes a southbound left-turn movement from Hickson Road to Napoleon Street for cyclists. This movement (circled in blue) is marked as a filtered movement. However, it is filtering through the P4 pedestrian movement on the northern leg of the intersection. This is a direct conflict between the cyclist and pedestrian and could increase the risk of *bicycle-pedestrian* crashes. Typically, turning movements should not filter through conflicting movements on the approach side of the intersection. Rather, they would filter through parallel traffic/ pedestrian streams on the departure end of the manoeuvre. That is, if this was a filtered left-turn movement, then the movement being filtered through would be the P1 north-south pedestrian movement across the Napoleon Street leg.<br>  <br><br>***Above:*** *The C phase in the TCS plan indicates that southbound left-turning cyclists will filter through the east-west pedestrian movement (P4). This is a direct conflict which should not allow filtered movements.* | Medium |

| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 5 | Posts 1, 2, 3, 4, 5, 6, 7 and 8. | Note 3 of the TCS plan states that audio-tactile push buttons should be provided on posts 1, 2, 3, 4, 5, 6, 7 and 8. However, it fails to include posts 9 and 11 which will support push buttons P1(12) and P1(13).     ***Above:*** *Note 3 on the TCS plan fails to include posts 9 and 11 in the schedule of posts that require audio-tactile push buttons.* | Low |

| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 6 | Egress driveway from the C1 building car park. | Under existing and proposed conditions, there is a lane splitter traffic island in this egress driveway in the immediate approach to the signalised intersection with Hickson Road/ Sussex Street/Napoleon Street. This traffic island would restrict movement from one lane to the other which forces drivers to make early decisions regarding lane choice. It should be noted that although both approach lanes can be used to access Napoleon Street, the left-lane must be used for left turns into Hickson Road and the right-lane must be used to access Sussex Street. As such, if drivers intending to turn right into Sussex Street do not change to the right-hand lane by the time they reach the lane splitter island, they would be forced to turn left into Hickson Road or proceed straight into Napoleon Street. Alternatively, they may attempt an illegal right-turn movement from the left-hand lane. The same would apply if a driver intended to turn left into Hickson Road but became stuck in the right-hand lane.<br>  <br>***Above:*** *The existing lane splitter island in the C1 building car park egress driveway (marked by the yellow arrow) which forces early decision making with regards to lane choice.* | Low |

| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 7 | Primary and dual primary signals in the C1 building car park egress lane. | The TCS design indicates that the primary (post 5) and dual primary (post 4) signals will be the colonnade support pylons themselves. This has a number of concerns as follows:<br>▪ The signals will not be in line with the hold line. Typically, primary signals should be placed in line with the hold line or as close to the hold line as practicable. As primary signals, these indicate *where* the driver is to stop, as well as *when* to stop.<br>▪ Since the colonnade support columns are further offset from the hold line. This means that there is reduced *approach sight distance* (ASD) from drivers to the signals. The red line in the left-hand image shows the ASD sight line to the proposed dual primary signal post. By contrast, the blue line shows the improved ASD sight line if the dual primary post was in line with the hold line. The sight constraining feature is the wall on the eastern side of the car park ramp.<br>▪ The colonnade support pylons are "Y" shaped (see right-hand image). It is uncertain whether the actual signals will be mounted to, ie. the central stem of the "Y" or the branched arms. This could affect the position of the signals relative to the approaching traffic.<br>  <br><br>  <br>***Left:*** *The primary and dual primary signals are not aligned with the hold line of the C1 building car park egress. This is unconventional as the primary signals indicate where the driver is to stop as well as when to stop. If aligned with the hold line, there would be improved ASD to the dual primary signals (right-hand side of the approach) as indicated by the blue sight line compared with the red sight line.*<br>***Right:*** *The colonnade support pylons are "Y" shaped and it is not clear whether the signals will be mounted to the central stem or the branched arms of the "Y".* | Low |

| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 8 | General – excessive use of signs and signals. | The audit team notes the following signals and signs which are considered excessive and unnecessary:<br>▪ The V3 aspects on the vertical portion of mast-arm post 2 are unnecessary. These are right-turn arrow aspects controlling the northbound right-turn from Sussex Street to Napoleon Street. Yet these signals would be on the far left-hand side of the approach. These signals are unnecessary since the V3 signals on the mast arm outreach of the same post would be positioned directly above the northbound right-turn lane.<br>▪ The V2 aspects on the vertical portion of mast-arm post 8 are also unnecessary. These are full circle aspects controlling the northbound *through* movement, yet these are on the far right-hand side of the departure. The V2 signals on the mast-arm outreach of the same post would be sufficient as secondary signals.<br>▪ The R2-6 NO RIGHT TURN sign on the vertical portion of the mast arm post 8 is unnecessary since it is on the far left-hand side of this approach when the affected traffic stream is on the right-hand side (right-hand lane). There is also an R2-6 NO RIGHT TURN sign on the mast-arm outreach of the same post which is closer to the right-turn lane.<br>  <br><br>***Left:*** *The signs and signals marked in red are excessive and unnecessary.* | Low |

| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 9 | Pavement loop (presence) detectors 1, 2, 6 and 7. | Note 7 of the TCS plan indicates that these presence detectors have been positioned to avoid conflicts with utility services in the roadway. As shown, loops 1 and 2 are set back from the hold line in the northern approach. Loop 6 is set back in the eastern approach. The audit team is uncertain whether these loops will perform as intended in detecting the presence of the lead vehicle in the queue. This may fail to alert the system of awaiting vehicles and may lead to sub-optimal performance of the signals. This is especially the case when there is only one vehicle in each approach lane and it fails to actuate the loop (because it simply passes over it without stopping).<br>  <br>***Above:*** *Note 7 of the TCS plan indicates altered placement of detector loops 1, 2, 6 and 7 in the northern and eastern approaches of the intersection.* | Low |

# 3 Other issues

Table 4 includes other concerns expressed by the project team. The audit team's responses are also provided.

**Table 4 Other concerns raised by the project team**

| Issue | Audit team's comments |
|---|---|
| Proposed placement of signal lanterns on either an RMS signal post or directly to the proposed colonnade columns. | By convention, traffic signals should be mounted to dedicated signal posts as these are formally tested and approved devices suitable for road traffic environments. However, from a strict road safety perspective, any method of mounting the signals is considered reasonable as long as the relative position of the signals is in accordance with the RMS *Traffic Signal Design Guide*. This includes (but not limited to):<br>▪ The lateral placement of the signal aspects to address risks of nuisance impacts by vehicles that over-hang the kerbline or where the turning vehicle has swept path encroachment risks.<br>▪ The vertical placement of the signal aspects so that these are visible to the approaching traffic.<br>▪ The appropriate placement of primary, secondary and (if necessary) tertiary signals at designated locations in the approaches and departures to perform their function for their intended audience. In this regard, the audit team made comment about the primary and dual primary signals not being collinear with the hold line in the C1 building egress driveway.<br>Although not preferred from an asset management perspective, the use of third party assets such as utility poles to mount traffic signals has been used extensively across the NSW road network. This is reasonable provided that there is no major risk of *run off road* crashes where the utility pole would pose as a crash hazard. |
| Suitability (or otherwise) of in-ground pedestrian lights between the building line and the colonnade columns. | The audit team assumes that this is similar to the concept used at the Goulburn Street/ Pitt Street intersection in Sydney CBD which includes timed activation of red in-pavement lights near the kerb ramp inverts to alert pedestrians not to cross the road. There are no major concerns with the use of this technology. Many pedestrians and drivers are unfamiliar with these devices. However, there are no obvious negative impacts from such technology. If the current trials are successful, it is expected that this technology would be used on a more widespread basis, particularly in high-volume pedestrian environments.<br>Consideration could be given to using accompanying signs to advise pedestrians not to cross the road when the in-pavement red lights are activated. |
| Suitability (or otherwise) of speed humps for vehicles egressing from the basement, in particular to prevent vehicles from speeding up on the yellow light. | This is not considered essential. The car park egress driveway contains a low radius 90-degree bend, a roller door and an uphill grade. These are significant speed-reduction measures.<br>Consideration could be given to using warning signs along the ramp of the upcoming pedestrian crossing interface. For example "CAUTION – PEDESTRIANS AHEAD". |
| Width of the kerb ramp not covering the full 7.5m of the pedestrian crossing. | There are no major concerns with this. Whilst this would restrict access to the crossing for mobility-impaired road users, the impact would be limited. |

# 4 Concluding statement

*DC Traffic Engineering* has undertaken a *detailed design* road safety audit of this project in accordance with the methodology outlined in Section 1 of this report.

Issues identified have been noted in this report for the Project Manager to review, assess, and where appropriate, make the necessary recommendations to improve safety.

Damien Chee
Audit Team Leader
DC Traffic Engineering Pty Ltd

# Appendix A

# Road Safety Audit Checklist

| Checklist questions | Comments |
|---|---|
| **3.1 General topics** | |
| **3.1.1 Changes since previous audit**<br>▪ Do the conditions for which the scheme was originally designed still apply? (i.e. no significant changes to the surrounding network or area to be served, or traffic mix).<br>▪ Has the design of the project remained unchanged since previous audit (if any)? | The previous road safety audit findings reviewed in Section 1.3. |
| **3.1.2 Drainage**<br>▪ Will the new road drain adequately?<br>▪ Are the road grades and crossfalls adequate for satisfactory drainage?<br>▪ Are flat spots avoided or adequately dealt with at start/end of superelevation?<br>▪ Has the possibility of surface flooding been adequately addressed, including overflow from surrounding or intersecting drains and water courses?<br>▪ Is gully pit spacing adequate to limit flooding?<br>▪ Is pit grate design safe for pedal cycles? (i.e. gaps not parallel with wheel tracks)<br>▪ Will footpaths drain adequately? | Yes. |
| **3.1.3 Climatic conditions**<br>▪ Has the design taken into account weather records or local experience which may indicate a particular problem? (for example, snow, ice, wind, fog) | Yes. |
| **3.1.4 Landscaping**<br>▪ Will drivers be able to see pedestrians (and vice versa) past or over the landscaping?<br>▪ Will intersection sight lines be maintained past or over the landscaping?<br>▪ Will safety be adequate with seasonal growth? (for example, no obscuring of signs, shading or light effects, slippery surface, etc.)<br>▪ Will roadside safety be adequate when trees or plantings mature (no roadside hazard)?<br>▪ Has 'frangible' vegetation been used in possible run-off road areas? | NA. |
| **3.1.5 Services**<br>▪ Does the design adequately deal with buried and overhead services? (especially in regard to overhead clearances, etc.)<br>▪ Has the location of fixed objects/furniture associated with services been checked? (including any loss of visibility, position of poles, and clearance to overhead wires) | Utility plans not provided. |

| Checklist questions | Comments |
|---|---|
| **3.1.6 Access to property and developments**<br>▪ Can all accesses be used safely?<br>▪ Is the design free of any downstream or upstream effects from accesses, particularly near intersections?<br>▪ Do rest areas and truck parking area have adequate sight distance at access points? | Most of the issues were with respects to the car park egress driveway. |
| **3.1.7 Emergencies, breakdowns, emergency and service vehicle access**<br>▪ Has provision been made for safe access and movements by emergency vehicles?<br>▪ Does the design and positioning of medians and vehicle barriers allow emergency vehicles to stop and turn without unnecessarily disrupting traffic?<br>▪ Have broken-down vehicles or stopped emergency vehicles been adequately considered?<br>▪ Is provision for emergency telephones satisfactory?<br>▪ Are median breaks on divided carriageways safely located? (i.e. frequency, visibility) | Yes. |
| **3.1.8 Future widening and/or realignments**<br>▪ If the scheme is only a stage towards a wider or dual carriageway is the design adequate to impart this message to drivers? (is the reliance on signs minimal/appropriate, rather than excessive?)<br>▪ Is the transition between single and dual carriageway (either way) handled safely? | Yes. |
| **3.1.9 Staging of the scheme**<br>▪ If the scheme is to be staged or constructed at different times:<br>  ▪ are the construction plans and program arranged to ensure maximum safety?<br>  ▪ do the construction plans and program include specific safety measures, signing; adequate transitional geometry; etc. for any temporary arrangements? | Unknown. |
| **3.1.10 Staging of the work**<br>▪ If the construction is to be split into several subprojects, is the order safe? (i.e. the stages are not constructed in an order that creates unsafe conditions) | Unknown. |
| **3.1.11 Adjacent developments**<br>▪ Does the design handle accesses to major adjacent generators of traffic and developments safely?<br>▪ Is drivers' perception of the road ahead free of misleading effects of any lighting or traffic signals on an adjacent road?<br>▪ Has the need for screening against glare from lighting of adjacent property been adequately considered? | Yes. |

| Checklist questions | Comments |
|---|---|
| **3.1.12 Stability of cut and fill**<br>▪ Is the stability of batters satisfactory? (for example, no potential for loose material to affect road users) | Yes. |
| **3.1.13 Skid resistance**<br>▪ Has the need for anti-skid surfacing been considered where braking or good road adhesion is most essential? (for example, on gradients, curves, approaches to intersections and signals) | Yes. |
| **3.2 Design issues (general*)*** | |
| **3.2.1 Geometry of horizontal and vertical alignment**<br>▪ Does the horizontal and vertical design fit together correctly?<br>▪ Is the vertical alignment consistent and appropriate throughout?<br>▪ Is the horizontal alignment consistent throughout?<br>▪ Is the alignment consistent with the function of the road?<br>▪ Is the design free of misleading visual cues? (for example, visual illusions, subliminal delineation like lines of poles) | The approach geometry of the C1 building car park egress is poor with a 90-degree curve and a sight-obstructing wall on the inside of this curve. |
| **3.2.2 Typical cross-sections**<br>▪ Are lane widths, shoulders, medians and other cross section features adequate for the function of the road?<br>▪ Are the shoulder widths adequate for stationary vehicles and errant vehicles?<br>▪ Are median widths adequate for road furniture?<br>▪ Is superelevation consistent with the road environment?<br>▪ Is the width of traffic lanes and carriageways suitable in relation to:<br>  ▪ alignment?<br>  ▪ traffic volume?<br>  ▪ vehicle dimensions?<br>  ▪ the speed environment?<br>  ▪ combinations of speed and traffic volume?<br>▪ Are the shoulder crossfalls safe for vehicles to traverse?<br>▪ Are batter slopes drivable for cars, trucks?<br>▪ Are side slopes under structures appropriate?<br>▪ Have adequate facilities been provided for pedestrians and cyclists? | The lane splitter island in the C1 building car park egress driveway forces early decision making regarding lane choice. |
| **3.2.3 Effect of cross-sectional variation**<br>▪ Is the design free of undesirable variations in cross section design?<br>▪ Are crossfalls safe? (particularly where sections of existing highway have been used, there have been compromises to accommodate accesses, at narrowings at bridges, etc.)<br>▪ Are any curves with adverse crossfall within appropriate limits?<br>▪ Is superelevation provided and sufficient at all locations where required? | See above. |

| Checklist questions | Comments |
|---|---|
| **3.2.4 Roadway layout**<br>▪ Are all traffic management features designed so as to avoid creating unsafe conditions?<br>▪ Is the layout of road markings and reflective materials able to deal satisfactorily with changes in alignment? (particularly where the alignment may be substandard)<br>▪ Is there adequate provision for overtaking?<br>▪ Are overtaking lanes provided where required and safely commenced and ended?<br>▪ Are overtaking requirements satisfactory?<br>▪ Is the design free of sunrise/sunset problems?<br>▪ Have public transport requirements been adequately catered for? | Yes. |
| **3.2.5 Shoulders and edge treatment**<br>▪ Are the shoulders likely to be safe if used by slow moving vehicles or cyclists?<br>▪ Are the following safety aspects of shoulder provision satisfactory?<br>  ▪ provision of sealed or unsealed shoulders<br>  ▪ width and treatment on embankments<br>  ▪ crossfall of shoulders | Yes. |
| **3.2.6 Effect of departures from standards or guidelines**<br>▪ Any approved departures from standards or guidelines:is safety maintained?<br>▪ Any hitherto undetected departures from standards: is safety maintained? | Primary and dual primary signals are not in line with the hold line. |
| **3.2.7 Visibility and sight distance**<br>▪ Are horizontal and vertical alignments consistent with visibility requirements?<br>▪ Has an appropriate design speed been selected for visibility requirements? | There is expected to be poor ASD to the signals from the C1 building car park egress lane. |
| **3.2.8 Environmental treatments**<br>▪ Has safety been considered in the location of environmental features? (for example, noise fences) | Yes. |
| **3.3 Alignment details** | |

| Checklist questions | Comments |
|---|---|
| **3.3.1 Visibility; sight distance**<br>▪ Are horizontal and vertical alignments consistent with the visibility requirements?<br>▪ Is the design free of sight line obstructions due to safety fences or barriers?<br>  ▪ boundary fences?<br>  ▪ street furniture?<br>  ▪ parking facilities?<br>  ▪ signs?<br>  ▪ landscaping?<br>  ▪ bridge abutments?<br>  ▪ parked vehicles in laybys or at the kerb?<br>  ▪ queued traffic?<br>▪ Are railway crossings, bridges and other hazards all conspicuous?<br>▪ Is the design free of any other local features which may affect visibility?<br>▪ Is the design free of overhead obstructions (for example, road or rail overpasses, sign gantries, overhanging trees) which may limit sight distance at sag curves?<br>▪ Has a clear headroom or a high vehicle detour been provided where necessary?<br>▪ Is visibility adequate at:<br>  ▪ any pedestrian, bicycle or cattle crossings?<br>  ▪ access roads, driveways, on and off ramps, etc.?<br>▪ Has the minimum sight triangle been provided at:<br>  ▪ entry and exit ramps?<br>  ▪ gore areas?<br>  ▪ intersections?<br>  ▪ roundabouts?<br>  ▪ other conflict points? | See item 3.2.7.<br>Poor sight lines to pedestrians noted. |

| Checklist questions | Comments |
|---|---|
| **3.3.2 New/existing road interface**<br>▪ Have implications for safety at the interface been considered?<br>▪ Is the transition from old road to the new scheme satisfactory?<br>▪ If the existing road is of a lower standard than the new scheme, is there clear and unambiguous warning of the reduction in standard?<br>▪ Have the appropriate provisions for safety been made where sudden changes in speed are required?<br>▪ Is access or side friction handled safely?<br>▪ Does the interface occur well away from any hazard? (for example, a crest, a bend, a roadside hazard or where poor visibility/distractions may occur)<br>▪ If carriageway standards differ, is the change effected safely?<br>▪ Is the transition where the road environment changes (for example, urban to rural; restricted to unrestricted; lit to unlit) done safely?<br>▪ Has the need for advance warning been considered? | Yes. |
| **3.3.3 Readability of the alignment by drivers**<br>▪ Will the general layout, function and broad features be recognised by drivers in sufficient time?<br>▪ Will approach speeds be suitable and will drivers correctly track through the scheme? | Yes. |
| **3.3.4 Detail of geometric design**<br>▪ Are the design standards appropriate for all the requirements of the scheme?<br>▪ Is consistency of general standards and guidelines, such as lane widths and crossfalls, maintained? | Yes. |
| **3.3.5 Treatment at bridges and culverts**<br>▪ Is the geometric transition from the standard cross-section to that on the bridge handled safely? | NA. |
| **3.4 Intersections** | |

| Checklist questions | Comments |
|---|---|
| **3.4.1 Visibility to and at intersections**<br>▪ Are horizontal and vertical alignments at the intersection or on the approaches to the intersection consistent with the visibility requirements?<br>▪ Is the standard adopted for provision of visibility appropriate for the speed of traffic and for any unusual traffic mix?<br>▪ Will the design be free of sight line obstructions due to safety fences or barriers<br>  ▪ boundary fences?<br>  ▪ street furniture?<br>  ▪ parking facilities?<br>  ▪ signs?<br>  ▪ landscaping?<br>  ▪ bridge abutments?<br>  ▪ parked vehicles in laybys and at the kerb?<br>  ▪ queued traffic?<br>▪ Are railway crossings, bridges and other hazards all conspicuous?<br>▪ Is the design free of any other local features which may affect visibility? | Poor ASD from C1 building car park approach to signals.<br>Poor SSD to pedestrians due to colonnade support pylons. |
| **3.4.2 Layout**<br>▪ Are intersections and accesses adequate for all vehicular movements?<br>▪ Have the appropriate design vehicle and check vehicle been used for turning dimensions?<br>▪ Are swept paths accommodated for all likely vehicle types? (has the appropriate design vehicle been used?)<br>▪ Are intersections free of any unusual features which could affect road safety?<br>▪ Are pedestrian fences provided where needed? (for example, to guide pedestrians or discourage parking)<br>▪ Has pavement anti-skid treatment been provided where needed?<br>▪ Have islands and signs been provided where required?<br>▪ Vehicles which may park at or close to the intersection: can they do this safely or does this activity need to be relocated?<br>▪ Are safety hazards due to parked vehicles avoided? | Yes. |

| Checklist questions | Comments |
|---|---|
| **3.4.3 Readability by drivers**<br>▪ Will the existence of the intersection and its general layout, function and broad features be perceived correctly and in adequate time?<br>▪ Are the approach speeds and likely positions of vehicles tracking through the intersection safe?<br>▪ Is the design free of misleading elements?<br>▪ Is the design free of sunrise or sunset problems which may create a hazard for motorists? | Yes. |
| **3.4.4 Detailed geometric design**<br>▪ Can the layout safely handle unusual traffic mixes or circumstances?<br>▪ Does any median or any island safely account for:<br>  ▪ vehicle alignments and paths?<br>  ▪ future traffic signals?<br>  ▪ pedestrian storage space and surface?<br>  ▪ turning path clearance?<br>  ▪ stopping sight distance to the nose?<br>  ▪ mountability by errant vehicles?<br>▪ Is adequate vertical clearance to structures provided? (for example, powerlines, shop awnings) | Yes. |
| **3.4.5 Traffic signals**<br>▪ Is the signal phasing/sequence safe?<br>▪ Is adequate time provided for traffic movements and pedestrian movements?<br>▪ Will the signal lanterns be visible? (for example, not obstructed by trees, poles, signs or large vehicles)<br>▪ Are lanterns for other approach directions adequately shielded from view?<br>▪ Are high-intensity signals and/or target boards provided if likely to be affected by sunrise/sunset?<br>▪ Does the alignment (vertical and horizontal) provide satisfactory stopping sight distance to the intersection or back of queue?<br>▪ Are pedestrian facilities provided where they are required?<br>▪ Will approaching drivers be able to see pedestrians?<br>▪ Are partially or fully controlled turning phases provided where required?<br>▪ Are signal posts located where they are not an undue hazard?<br>▪ Are road markings for turning traffic satisfactory?<br>▪ Have adequate pedestrian phases been provided? | Issue noted with C phase allowing filtered left-turn bicycle movements through a conflicting pedestrian crossing stream on the approach (not departure) side of the intersection.<br>Several issues identified with regards to traffic signal layout, phasing, post locations and other drafting errors associated with the TCS plan. |

| Checklist questions | Comments |
|---|---|
| **3.4.6 Roundabouts**<br>▪ Is adequate deflection provided to reduce approach speeds?<br>▪ If splitter islands are needed, are they adequate for sight distance, length, pedestrian storage, etc.?<br>▪ Is the central island prominent?<br>▪ Can the appropriate design vehicle and check vehicle be accommodated?<br>▪ Are the central island details satisfactory? (delineation, mountability, conspicuousness)<br>▪ Can pedestrians be seen by drivers in sufficient time?<br>▪ Can pedestrians determine whether vehicles are turning? (no obstructions to sight lines)<br>▪ Are direction markings in approach lanes provided where required?<br>▪ Is the lighting adequate? | NA. |
| **3.4.7 Other intersections**<br>▪ Has the need for kerbed or painted islands and refuges been considered?<br>▪ Do intersections have adequate queue length/storage for turning movements (including in the centre of a staggered intersection)? | Yes. |
| **3.5 Special road users** | |
| **3.5.1 Adjacent land**<br>▪ Are all accesses to and from adjacent land/properties safe?<br>▪ Have the special needs of agriculture and stock movements been considered? | Relevant issues noted. |

| Checklist questions | Comments |
|---|---|
| **3.5.2 Pedestrians**<br>▪ Can pedestrians cross safely at:<br>  ▪ intersections?<br>  ▪ signalised and pedestrian crossings?<br>  ▪ refuges?<br>  ▪ kerb extensions?<br>  ▪ bridges and culverts?<br>  ▪ other locations?<br>▪ Is each crossing point satisfactory for:<br>  ▪ visibility, for each direction?<br>  ▪ use by the disabled?<br>  ▪ use by the elderly?<br>  ▪ use by children/schools?<br>▪ Is pedestrian fencing on reservations and medians provided where required for each crossing?<br>▪ Is fencing adequate on freeways?<br>▪ Are pedestrians deterred from crossing roads at unsafe locations?<br>▪ Are pedestrian related signs appropriate and adequate?<br>▪ Is width and gradient of pedestrian paths, crossings, etc. satisfactory?<br>▪ Is surfacing of pedestrian paths, crossings, etc.satisfactory?<br>▪ Have dropped kerbs been provided for each crossing?<br>▪ Have channels and gullies been avoided at each crossing?<br>▪ Is lighting satisfactory for each crossing?<br>▪ Are crossings sited to provide maximum use?<br>▪ Is avoidance of a crossing unlikely? (for example, by more direct but less safe alternative) | Poor sight lines to pedestrians due to the colonnade support pylons. |
| **3.5.3 Cyclists**<br>▪ Have the needs of cyclists been considered:<br>  ▪ at intersections (particularly roundabouts)?<br>  ▪ especially on higher speed roads?<br>  ▪ on cycle routes and crossings?<br>  ▪ at freeway entry and exit ramps?<br>▪ Are shared cycleway/footway facilities (including subways and bridges) safe and adequately signed? | Yes. |

| Checklist questions | Comments |
|---|---|
| **3.5.4 Motorcyclists**<br>▪ Has the location of devices or objects that might destabilise a motorcycle been avoided on the road surface?<br>▪ Is the roadside clear of obstructions where motorcyclists may lean into curves?<br>▪ Will warning or delineation be adequate for motorcyclists?<br>▪ Has barrier kerb been avoided in high-speed areas?<br>▪ In areas more likely to have motorcycles run off the road is the roadside forgiving or safely yielded?<br>▪ Are all unnecessary poles, posts and devices removed or appropriately shielded?<br>▪ Are drainage pits and culverts traversable by motorcycle? | NA. This is a low-speed environment. |
| **3.5.5 Equestrians and stock**<br>▪ Have the needs of equestrians been considered, including the use of verges or shoulders and rules regarding the use of the carriageway?<br>▪ Can underpass facilities be used by equestrians/stock? | NA. |
| **3.5.6 Freight**<br>▪ Have the needs of truck drivers been considered, including turning radii and lane widths?<br>▪ Have the needs of freight transport been considered, adequately signed and catered for? | NA. |
| **3.5.7 Public transport**<br>▪ Have the needs for public transport been considered, adequately signed and catered for?<br>▪ Have the needs of public transport users been considered?<br>▪ Have the manoeuvring needs of public transport vehicles been considered?<br>▪ Are bus stops well positioned for safety? | NA. |
| **3.5.8 Road maintenance vehicles**<br>▪ Have the needs of road maintenance vehicles been considered, adequately signed and catered for?<br>▪ Can maintenance vehicles be safely located? | Yes. |
| **3.6 Lighting, signs and delineation** | |

| Checklist questions | Comments |
|---|---|
| **3.6.1 Lighting**<br>▪ Has lighting been adequately provided where required?<br>▪ Is the design free of features which interrupt illumination? (for example, trees or overbridges)<br>▪ Is the design free of lighting poles that would present a fixed roadside hazard?<br>▪ Are frangible or slip-base poles to be provided?<br>▪ Ambient lighting: if it creates special lighting needs, have these been satisfied?<br>▪ Is the lighting scheme free of confusing or misleading effects on signals or signs?<br>▪ Does the lighting adequately illuminate crossings, nearby paths, refuges, etc.?<br>▪ Are all gore areas adequately illuminated?<br>▪ Are all merge areas adequately illuminated?<br>▪ Is the scheme free of any lighting black patches?<br>▪ If there are locations with accident problems that are<br>▪ known to be amenable to treatment with improved lighting, has this lighting been provided? | Yes. |
| **3.6.2 Signs**<br>▪ Are signs appropriate for their location?<br>▪ Are signs located where they can be seen and read in adequate time?<br>▪ Will signs be readily understood?<br>▪ Are signs appropriate to the driver's needs? (for example, direction signs, advisory speed signs, etc.)<br>▪ Are signs located so that drivers' sight distance is maintained?<br>▪ Are signs located so that visibility is maintained:<br>  ▪ to/from accesses and intersecting roads?<br>  ▪ to/from pedestrians and important features on the road?<br>▪ Have the consequences of vehicles striking signposts been considered?<br>▪ Are sign supports out of the clear zone?<br>▪ If not, are they:<br>  ▪ frangible?<br>  ▪ shielded by barriers (e.g. guard fence, crash cushions)?<br>▪ Has an over-reliance on signs (in lieu of adequate geometric design) been avoided?<br>▪ Are signs on the new scheme consistent with those on the adjoining section of road (or will the previous signs need to be upgraded)? | Signage issues noted. |

| Checklist questions | Comments |
|---|---|
| **3.6.3 Marking and delineation**<br>▪ Are markings (lines, arrows, etc.) consistent with standard markings?<br>▪ Have any locations where standard markings might be confusing or misread been identified and treated in a way which considers road users' likely responses?<br>▪ Are barrier lines (no overtaking) provided where required?<br>▪ Are raised retroreflective pavement markers (RRPMs) provided where necessary?<br>▪ Are curve warning signs, advisory speed plates or chevron alignment markers provided where required?<br>▪ Are markings on the new scheme consistent with those on the adjoining section of road (or will the previous markings need to be upgraded)?<br>▪ Are diagonal markings or chevrons painted where required?<br>▪ Will markings and delineation be visible at night-time?<br>▪ Will markings and delineation be visible in wet weather?<br>▪ Has the need for profiled (audible) line marking been considered?<br>▪ Have both high and low-beam cases been considered?<br>▪ Are guide posts of the frangible type? | Yes. |
| **3.7 Physical objects** | |
| **3.7.1 Median barriers**<br>▪ Have median barriers been considered and properly detailed?<br>▪ Have all design features that require special attention (for example, end treatments) been considered? | NA. |
| **3.7.2 Poles and other obstructions**<br>▪ Are all poles located well away from moving traffic?<br>▪ Have frangible or breakaway poles been included where required?<br>▪ Are median widths adequate to accommodate lighting poles or trees?<br>▪ Is the position of traffic signal controllers and other service apparatus satisfactory?<br>▪ Is the roadside clear of any other obstructions that may create a safety hazard?<br>▪ Have all necessary measures been taken to remove, relocate or shield all hazards?<br>▪ Can roadside drains and channels be safely traversed by any vehicle that runs off the road? | The colonnade support pylons may obstruct driver sight lines to pedestrians commencing the crossing movement from behind the pylon. |

| Checklist questions | Comments |
|---|---|
| **3.7.3 Crash barriers**<br>▪ Are crash barriers provided where necessary and properly detailed? (for example, at embankments, structures, trees,<br>▪ poles, drainage channels, bridge piers, gore areas) Is the crash barrier safe? (i.e. unlikely to create a danger for road users including pedestrians, cyclists, motorcyclists, etc.)<br>▪ Are the end conditions of the crash barrier safe and satisfactory?<br>▪ Is the guard fence designed according to standards for:<br>  ▪ end treatments?<br>  ▪ anchorages?<br>  ▪ post spacing?<br>  ▪ block outs?<br>  ▪ post depth?<br>  ▪ rail overlap?<br>  ▪ stiffening at rigid obstacles?<br>▪ Is all guard fence necessary? (i.e. what it shields is a greater hazard than the fence)<br>▪ Where pedestrians and cyclists travel behind guard fence, is the rear of the fence safe for them? | Yes. |
| **3.7.4 Bridges, culverts and causeways/ floodways**<br>▪ Are bridge barriers and culvert end walls safe regarding:<br>  ▪ visibility?<br>  ▪ ease of recognition?<br>  ▪ proximity to moving traffic?<br>  ▪ the possibility of causing injury or damage?<br>  ▪ collapsible or frangible ends?<br>  ▪ signs and markings?<br>  ▪ connection of crash barriers?<br>  ▪ roadside hazard protection?<br>▪ Is the bridge railing at the correct level and strong enough?<br>▪ Is the shoulder width on the bridge the same as on the adjacent road lengths?<br>▪ Is safe provision made for non-vehicular traffic over structures? (for example, pedestrians, pedal cycles, horses/stock, etc).<br>▪ Are all culvert end walls (including driveway culverts) drivable or outside the clear zone?<br>▪ Have causeways/floodways etc. been given correct signing and adequate sight distance? | Yes. |
| **3.8 Additional questions to be considered for development proposals** | Questions omitted as this audit was only with regards to the external road interface, not the internal traffic/ access issues. |
| **3.9 Any other matter** | |

| Checklist questions | Comments |
|---|---|
| **Safety aspects not already covered**<br>▪ Is the road able to safely handle oversize vehicles, or large vehicles like trucks, buses, emergency vehicles, road maintenance vehicles?<br>▪ If required, can the road be closed for special events in a safe manner?<br>▪ If applicable, are special requirements of scenic or tourist routes satisfied?<br>▪ Have all unusual or hazardous conditions associated with special events been considered?<br>▪ Have all other matters which may have a bearing on safety been addressed? | Yes. Within reason. |