Redevelopment Royal Hobart Hospital
K Block Energy Infrastructure Works – Traffic Management Strategy

1. Purpose of this Report

This report has been prepared to present and assess the costs and benefits of managing traffic and pedestrian impact on Campbell Street, and the broader area, during energy infrastructure works for the RHHR (Royal Hobart Hospital Redevelopment).

The works being undertaken by Tas Networks are to install the high voltage cables that will provide power to the new K Block RHH Building. The timing of these works is critical and must be undertaken without interrupting JHFJV concrete and finishes/ Fit out works occurring in parallel.

On behalf of Tas Networks as the proponent of the energy infrastructure works, John Holland - Fairbrother Joint Venture (JHFJV) are proposing partial road closures of Campbell St between Liverpool and Collins Streets during 2018 Term 1 School Holidays as the most feasible and reasonable traffic management response during energy infrastructure works.

The justification for proposed traffic management arrangements is to **ensure safety of public and site staff** whilst maintaining delivery continuity for the largest and most complex project ever undertaken in Tasmania. It is very important to note that these works are unavoidable – they must be undertaken to provide power not only to the RHH K Block, but also to several other buildings in the CBD area surrounding RHH. In addition to this, JHFJV cannot stop the construction works during the period of Tas Networks activities, and whilst traffic disruption is not ideal, the school holiday period has been targeted to minimise impacts.

2. Project Background Information

2.1. Significance of the RHHR Project

The RHHR is the largest single infrastructure project ever undertaken in Tasmania. The scale and complexity of this project exceed all other of Hobart's most recent largest projects. At a $389M MC Contract value, and carrying with it the intricacies of a modern, multi-discipline Category 1 Tertiary Hospital, the project's anticipated impacts should not be understated. A critical objective of the JHFJV in managing impact is ensuring completion is achieved safely and within the program deadlines – the Hobart community has been anticipating delivery of this facility for an extended duration.

At 10 stories high, over 33,000m2 of new floor area, 11,000m2 of refurbished space, the new complex will offer the Tasmanian public access to an additional 195 overnight beds, 4 high spec operating theatres and many other state of the art medical procedure spaces.

During the latter part of design development, a roof-top Helipad was added, along with the complexity of a 25-person Hyperbaric Chamber.

The illustration below (Figure 1), illustrates the scale of this project when compared some more recent projects such as the Menzies Medical Research Centres Stages One and Two.

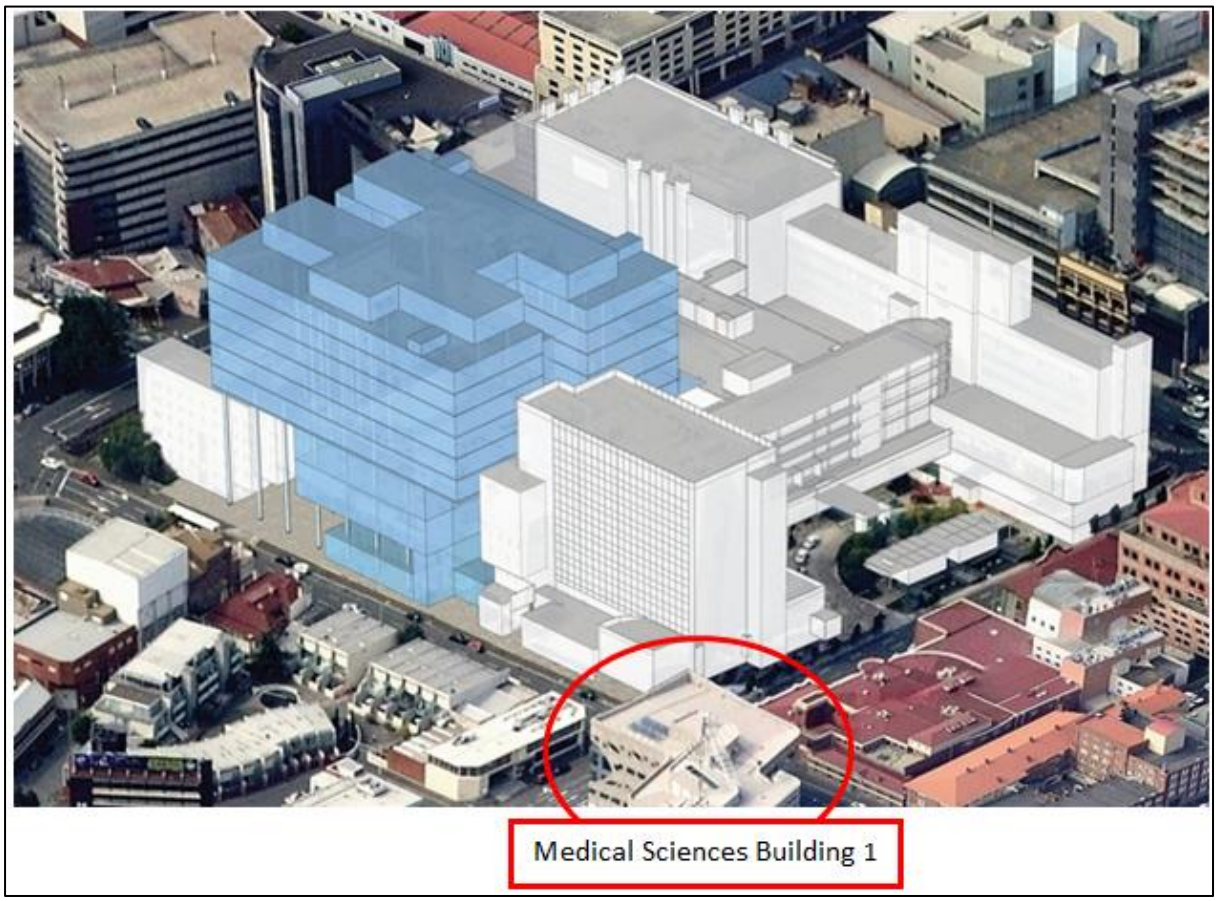


Fig.1: K Block in comparison with Menzies Medical Research Centres Stages 1 and 2.

2.2. Site Management Safety

Due to the scope and scale of the RHH Redevelopment project, there are several safety management requirements directly related to the construction activities. The overall safety management aspects that JHFJV need to consider during all construction activities, but are not limited to:

- The risk to public traffic moving past the site during the construction of K Block will require street area to establish exclusion and safety zones to separate public from construction activities.
- The risk to public traffic from project delivery vehicles moving through CBD – JHFJV need to maintain an appropriately sized Construction Access Zone to both ensure that public streets are not congested with construction vehicles and materials are provided to site in an efficient manner.
- Safety risk to site staff – it is imperative that JHFJV maintain a safe working environment for all site staff, contractors and delivery vehicles. This safe working environment will require a

minimum area of Campbell St to ensure high risk factors such as plant/people interaction, unloading trucks with cranes and separation from public traffic lanes can be managed

2.3. Site Access Constraints

The construction site area can only be accessed from one live face as the remaining 3 sides of the site are occupied by hospital areas that are required to remain operational throughout the project. This site access constraint means JHFJV will need to undertake all deliveries of construction materials via the Campbell Street side of the RHH campus.

The limited site access is further complicated by a relatively small area for material laydown which results in construction materials being supplied to site using a 'just-in-time' strategy.

Some deliveries, such as precast delivery trucks will not be unloaded quickly. A delivery of precast will typically carry 2-4 elements of precast. The time between off-loading panels must also consider the time taken to install. Particularly in the case of pre-finished façade panels, these must be handled in a careful, methodical manner, and will likely take more than 45 minutes to complete the lift and install.

JHFJV's strategy for supplying construction materials to the site is to utilise two (2) tower cranes located east and west of the new K Block, and a third mobile crane (for periods) located on the Campbell St. directly in front of site (refer to Figure 2 and 3 below). Crane analysis studies have been completed and findings conclude the two tower cranes will be utilised at full capacity requiring the third mobile to be engaged to ensure productivity is achieved.

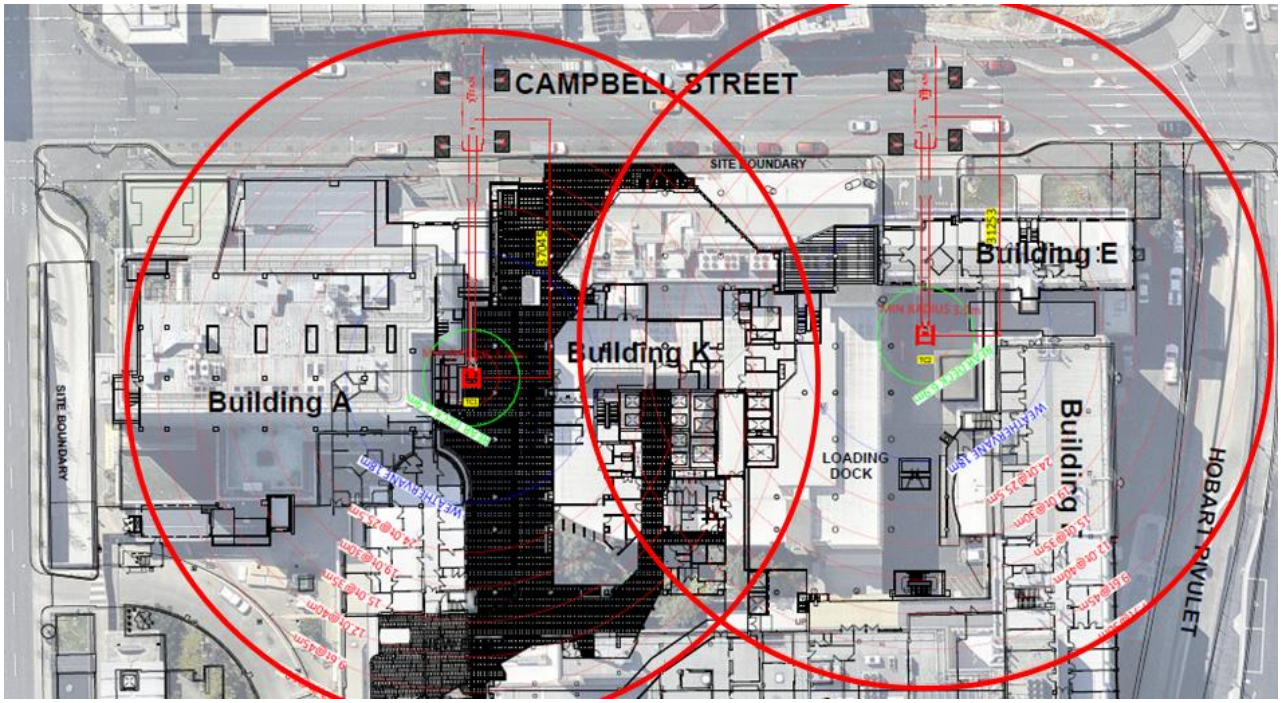


Fig. 2: Overview of tower crane radius

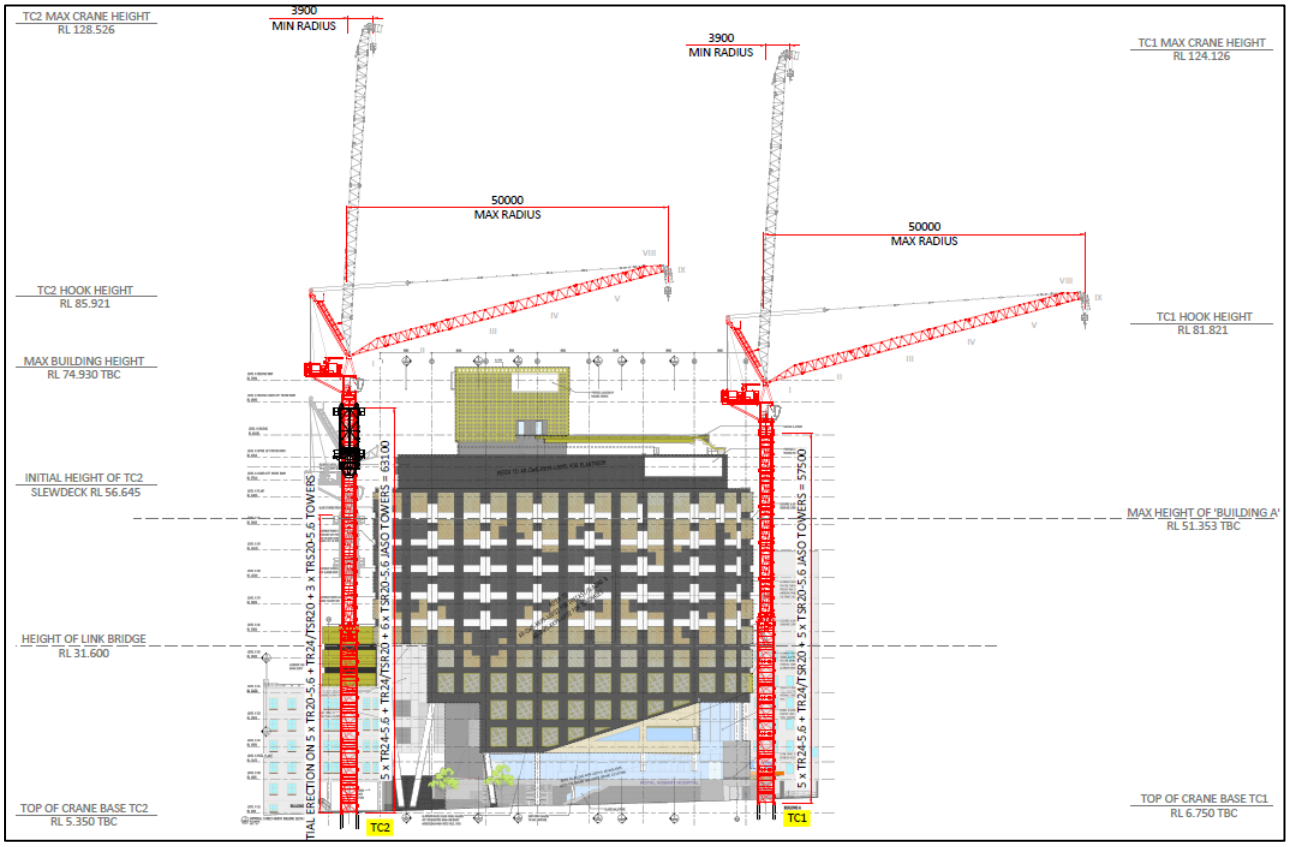


Fig.3: Campbell Street view of tower crane locations and new K Block

3. Traffic Management – Background Information

3.1. In Principal Agreement

JHFJV were awarded the RHHR project as Managing Contractor in October 2015. As part of the JHFJV submission, a strategy of site access was presented. The key driver for this strategy was to establish a Construction Access Zone that provided sufficient area for large vehicles (heavy ridged/semis) to deliver materials and equipment in a safe and efficient manner. This was considered critical to servicing the site with material and equipment at a rate that allows the construction to proceed as planned. The original site layout requirement was reflected by an 'In Principal Agreement' provided by HCC (dated 29th October 2015).

3.2. Traffic Observations and Data to Date

A series of road closures have been implemented within Campbell Street as part of project works to date

JHJFV Traffic Engineering Consultant GHD have undertaken a range of traffic monitoring and modelling activities during the project works to date, and results have been presented within Construction Traffic Impact Assessment reports as follows:

1. *Royal Hobart Hospital Redevelopment Construction Traffic Impact Assessment, September 2015*
2. *Royal Hobart Hospital Redevelopment Services Headworks Construction Traffic Impact Assessment, September 2016*
3. *Royal Hobart Hospital Redevelopment Stage 6 (Substantive Works) Construction Traffic Impact Assessment, November 2016*
4. *Royal Hobart Hospital Redevelopment Campbell Street Partial Closure Construction Traffic Impact Assessment, September 2017*

Further information regarding the summary and conclusions from the respective GHD Traffic Impact Assessments is listed below:

1. The September 2015 covered works and associated traffic management for works in the RHH Forecourt, Liverpool St and are therefore not directly relevant to Campbell St traffic movements

2. The September 2016 report was prepared to specifically assess the impacts of the original Services Headworks which was undertaken in three (3) stages:

   "Stage 3 of the works will last for up to 3 weeks and will require the full-time closure of Campbell Street to general traffic, with only buses and emergency vehicles able to use the block between Liverpool Street and Campbell Street. The first two weeks of the Stage 3 works will coincide with the school holidays, when traffic volumes are generally reduced across the network, which will improve the capacity of alternative routes to accommodate diverted traffic."

3. The November 2016 assessment noted the details of the closures for the Services Headworks in September 2016 as follows:

   Stage 3 of the Services Head Works (September 2016) involved road closures illustrated within Figure 4, below. The Stage 3 headworks commenced on Sunday 25th September 2016, the first day of school holidays. The headworks concluded on Sunday 16th October, one full week after the end of the school holidays.

Figure 4 Proposed Campbell Street Cross Section During Demolition

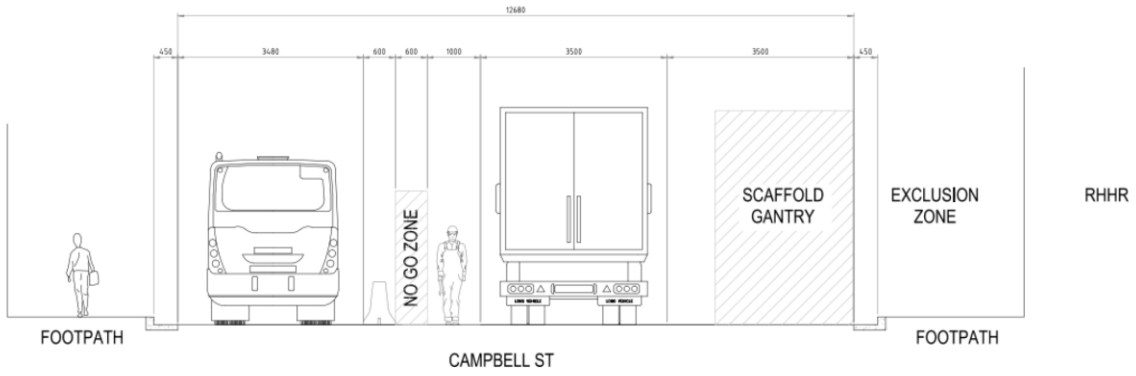


Image Source: John Holland Fairbrother Joint Venture

The November 2016 assessment also included the following conclusions:

"the implementation of a similar scheme in September and October of 2016 for the Stage 3 headworks indicated that the network generally continued to operate satisfactorily with the closures in place. While travel time on some routes were higher than normal, they were generally not significantly slower than conditions that could be experienced at other times".

4. GHD's September 2017 assessment noted the following Key Learnings in Section 4.1 of the Report

"The experience of the Stage 3 headworks has identified the following key learnings with regard to traffic management:

- *Travel times on the Brooker Highway, Campbell Street and Murray Street were, while higher than normal, generally not significantly slower than conditions that could be experienced at other times.*
- *The additional traffic that was diverted into Liverpool Street had a significant impact on travel times in that street.*
- *It would appear that traffic that diverted away from Campbell Street during the Stage 3 headworks did not transfer to Murray Street, with the Brooker Highway taking most of the diverted traffic, with volumes on the Highway increasing by up to 150-200 vehicles per hour."*

The September 2017 assessment also included the following conclusions

"The proposed arrangement is similar to what was in place for a 3-week period in September and October 2016. Traffic conditions were monitored during this time, and whilst there were some localised issues observed, the network generally continued to operate satisfactorily, including outside school holiday periods."

The main advantages of the proposed scenario over the alternative are:

- *Consistency and predictability for road users*
- *Reduced impacts of occasional full-road closures*
- *Improved accessibility for buses and emergency services*

After an initial period of uncertainty, as drivers become accustomed to the changed conditions, traffic activity is anticipated to settle down into a "new normal" situation.

3.3. Stakeholder Consultation

In the preparation for previous proposals, HCC and JHFJV have met with Tas Fire Service, Ambulance Tas and Metro Buses to discuss proposed traffic management changes. Each of these organisations provided 'in-principal' support for the Construction Access Zone and one Bus/Emergency Vehicle lane arrangement as described in Section 4, below.

4. Traffic Management for Energy Infrastructure Works

JHFJV are planning the following traffic management for the energy infrastructure works:

a) Closure of Campbell St between Liverpool St and Collins St from 14th April to 29th April 2018
b) Establishment of a single lane for Emergency Services and Metro Buses between Liverpool St and Collins St
c) Maintenance of pedestrian access on northern side of Campbell St between Liverpool St and Collins St
d) Maintenance of Emergency Service access to RHH Emergency Department, and
e) Maintenance of access for other activities including Theatre Royal and BOC Gas deliveries

The primary aspects of the traffic arrangement proposal, and the constraints that have created this proposal, are summarised in Table 1 below.

Table 1: Traffic Arrangement – Aspects and Constraints

Site Management Aspect	Proposed Traffic Management	Site Management Constraints	Justification for Proposal
Emergency Vehicle and Metro Bus Access	Ongoing via far left-hand lane of Campbell St between Liverpool and Collins Sts	N/a – services maintained	JHFJV are committed to continuity of access for Emergency Services and Metro Buses throughout works to mitigate public impacts as much as practicable.
Public Traffic Access	Campbell St closed to public traffic between Liverpool and Collins Sts	• Location and extent of Tas Networks excavations within Campbell St • Impact of Tas Networks excavation work on JHFJV construction activities, • Requirement to maintain current schedule of equipment and material deliveries for JHFJV construction activities • Risk of public traffic impacts on JHFJV site activities	Existing barriers need to be relocated towards northern side of Campbell St to allow adequate space within the construction site for: - Tas Networks to undertake their works in a safe manner - Tas Networks and JHFJV activities to be undertaken concurrently - The safe site access and egress of JHFJV construction delivery trucks - The unloading of JHFJV delivery trucks in a safe manner, and - Maintaining minimum separation between Tas Networks and JHFJV site construction workers and public traffic.

Site Management Aspect	Proposed Traffic Management	Site Management Constraints	Justification for Proposal
Pedestrian Access	Ongoing via footpath on northern side of Campbell St between Liverpool and Collins Sts	N/a – existing arrangement maintained	JHFJV are committed to continuity of access for pedestrians throughout works to mitigate public impacts as much as practicable.
Site Security	Ongoing use of combination of concrete barriers with hoarding, and temporary fence panels	Effectiveness of existing arrangement needs to be maintained at all times, including after hour periods	Site security is an important consideration for how traffic and other aspects of site are managed. JHFJV are obligated to ensure the construction site is fully secure at all times to prevent: - Public safety impacts resulting from unsupervised entry, and - Malicious damage of theft of construction facilities, equipment and materials
Access for neighbours	Ongoing access for neighbouring facilities, including but not limited to: - RHH Emergency Department - RHH Gas Deliveries - Theatre Royal - UTAS Hedberg Site	Existing arrangements for access to neighbouring facilities needs to be maintained	JHFJV are committed to continuity of access for all neighbouring facilities and operations throughout works to mitigate public impacts as much as practicable. Where impacts have potential to occur due to traffic management changes in Campbell St, JHFJV will work with all neighbouring stakeholders to ensure these impacts are minimised.

Additional detail regarding the primary aspects and associated constraints are provided in Sections 4.1 to 4.3 below.

4.1. Street Closure

The energy infrastructure activities to be undertaken by Tas Networks include significant excavations within the existing Campbell St footprint. Figure 4 below shows the area dimensions and locations of excavations. Each of these excavations will be at least 1,500mm in depth.

These excavation works are a high-risk task, and all practicable measures must be put in place to mitigate the safety risk to public and workers. Statutory guidelines and JHFJV Management System provide minimum protection provisions necessary when undertaking excavations, and these provisions result in Tas Networks activities occupying a significant area within the JHFJV construction zone.

In order to maintain safe access and egress for JHFJV construction vehicles during the time of Tas Networks activities, additional construction zone space within Campbell St will be required. JHFJV consider a set-out as detailed in Figure 5 (providing one through lane external of site) would provide the necessary additional space to accommodate Tas Networks activities and JHFJV construction work in a safe and timely manner.

4.2. Emergency Services and Metro Buses

JHFJV and Tas Networks are committed to maintaining access for Emergency Services and Metro Buses to ensure public services are not directly disadvantaged due to proposed street closure as described above.

Traffic management arrangements are planned to include the following controls to facilitate safe and efficient access for Emergency Services and Metro Buses:

- Traffic controllers stationed at entry to Metro Bus Stop on Liverpool St, immediately before Campbell St intersection to manage bus access to Stop, and redirect public traffic
- Traffic controllers stationed within Campbell St to manage interaction between Emergency Services, Metro Buses and construction delivery access/egress at JHFJV Construction Zone gates, and
- Placement of concrete barrier end-treatment at appropriate location to allow Metro Bus turning path when making left hand turn from Liverpool St to Campbell St.

Figure 4 – Survey of Tas Networks Excavation Sites

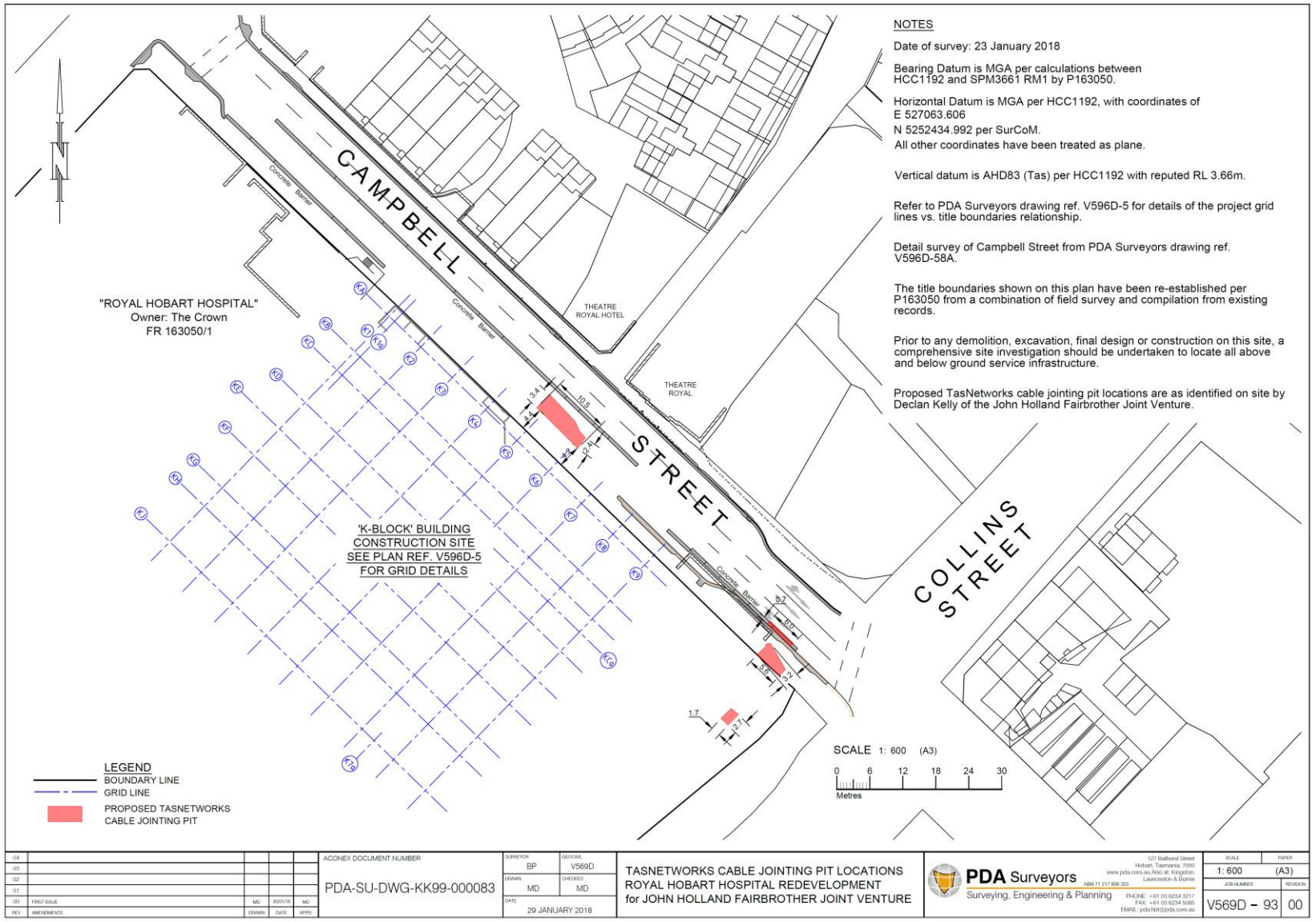
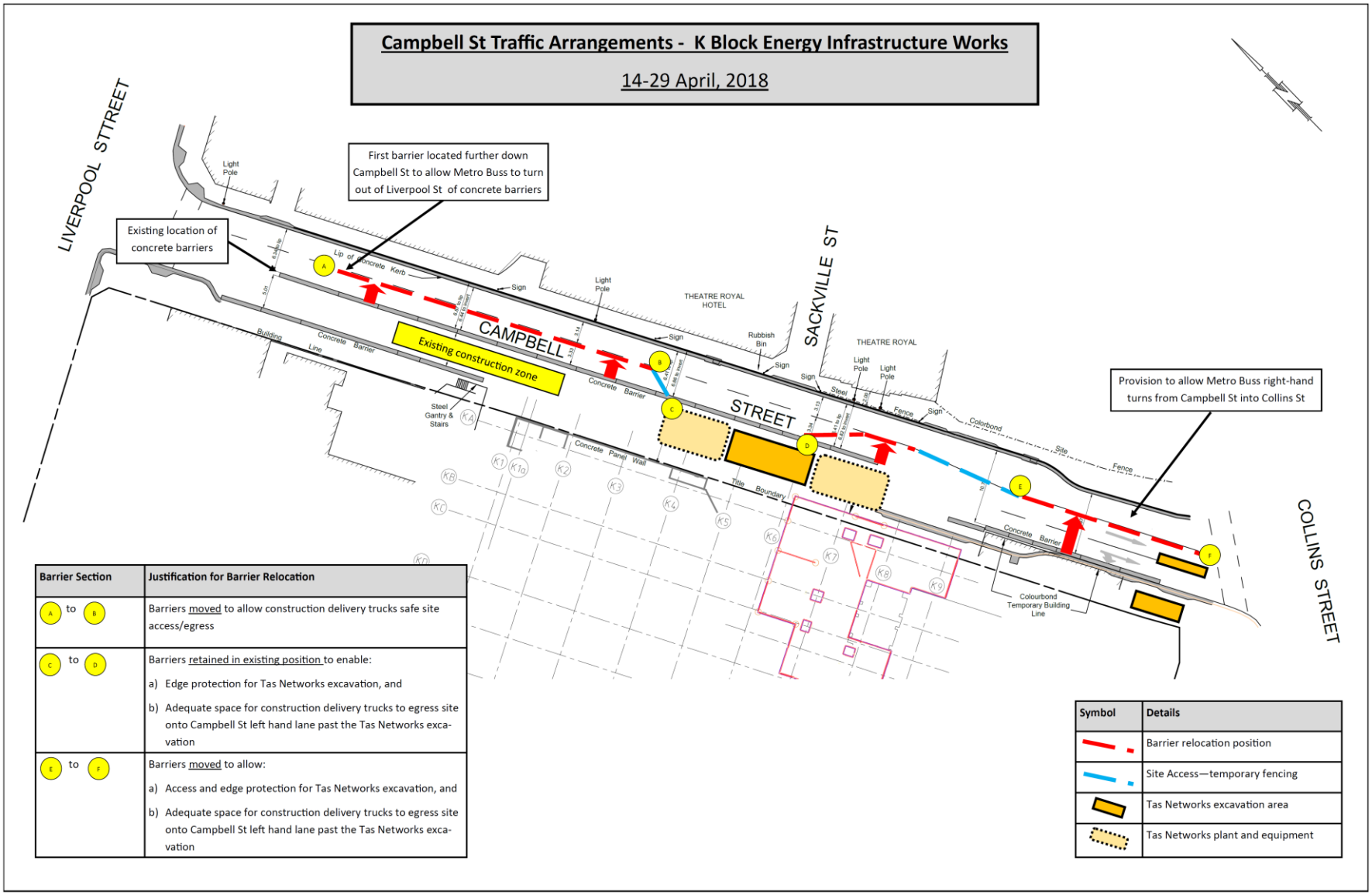


Figure 5 – Campbell St Traffic Arrangements for K Block Energy Infrastructure Works



4.3. Maintenance of Stakeholder Access

In addition to the site management requirements detailed above, JHFJV also need to manage the traffic set up to accommodate:

- Access for Ambulance services and public vehicles to RHH Emergency Department
- Pedestrian access on northern Campbell St footpath between Liverpool and Collins Streets
- Fortnightly RHH BOC Gas Deliveries to E Block driveway (scheduled for 14th and 28th April)
- Theatre Royal delivery vehicle movements from Sackville Street into Campbell Street (as required), and
- Construction access and deliveries to UTAS Hedberg Project

Each of these activities will require a specific management response within the proposed traffic management arrangements for Tas Networks activities.

5. Traffic Impact Assessment Information

GHD have reviewed monitoring and modelling information collated from previous assessment activities and have provided a Strategy (*Royal Hobart Hospital Redevelopment TasNetworks Road Closure Traffic Management Strategy, February 2018*) to identify potential traffic impacts that may arise during the construction activities, and to propose treatments as required to mitigate traffic impacts. A copy of this Strategy is included as Appendix A.

Key points noted in the GHD Strategy include the following:

<u>School Holiday Traffic Volumes and Likely Impacts</u>

> *"….peak hour volumes are substantially reduced during school holidays, by up to 25% (~200 vehicles per hour) in the morning peak, and 17% (~150 vehicles per hour) in the afternoon."*
>
> *"The timing of the works during school holiday periods, when traffic volumes on the CBD road network are lower than normal, will contribute to the improved potential for significant impacts to be avoided."*

<u>Traffic Adjustment and Adaptation</u>

> *"Upon commencement of the works, there may be a short period of driver uncertainty and localised congestion, moderating as drivers become more familiar with changes and adjust their behaviour accordingly. It is likely that some drivers will choose an alternative route, or timing their journey to avoid the busiest times."*

"The work zone and associated traffic control will remain static for the duration of the works, reducing potential for ongoing uncertainty amongst drivers, and allowing traffic behaviour to settle into a pattern relatively quickly."

Mitigation Measures

"The following mitigation measures will be put in place to manage traffic and minimise disruption to the network:

- *Consistent traffic management arrangements during the works, to allow motorists to adjust behaviour to suit the changed conditions*
- *Left lane must turn left from Campbell Street into Bathurst Street, supported by changes to pavement marking and signage*
- *Lane closures to reduce Campbell Street to a single lane of general traffic past Melville Street*
- *Keep Clear pavement marking at the Campbell Street / Melville Street to improve emergency vehicle egress*
- *Retention of a single lane for use of buses, bicycles, emergency services and authorised vehicles to remain on Campbell Street between Bathurst Street and Collins Street – A traffic controller would be placed to direct general traffic away from this lane as required*
- *The Campbell Street footpaths opposite the hospital will remain open*
- *Advanced warning given to motorists via Variable Message Signs placed on approach routes*
- *Management of traffic signals to retain Macquarie Street / Davey Street / Tasman Highway traffic flow, with traffic metered on the Brooker Highway and Campbell Street approaching the works*

With these measures in place, it is considered that the proposed works will not have a significant adverse impact on the Hobart road network."

6. *Justification Summary*

The changed traffic arrangements proposed in this Submission are required to allow TasNetworks excavation and associated works safely and efficiently. Construction activities for the RHH Redevelopment, utilising the JHFJV construction zone in Campbell Street, will also continue throughout this period.

The following list provides a summary of cost and benefits associated with road closure options presented above.

Topic	Costs	Benefits
Timing of traffic changes	N/a	Closure is planned to coincide with 2018 Term 1 School Holidays, and the associated reduction in CBD traffic movements
Emergency Services:	N/a	The partial road closure best facilitates access for emergency services
Metro Bus Services:	Na/	The partial road closure best facilitates access for buses
Public Traffic	Reduced access for public traffic moving down Campbell St towards Collins St and other southern CBD areas	Partial road closure establishes certainty for public traffic as opposed to consistent Stop/Go situations on Campbell St at JHFJV site (i.e. closure encourages alternative route selection)
Local Community	Potential limitations regarding access to neighbouring facilities	Continuity of Metro Bus access to local areas Access to RHH Emergency Department maintained
Health and Safety of Public and Workers:	Traffic changes could create confusion for site staff	Partial road closure provides greater delineation between site staff undertaking construction activities and public traffic

Appendix A: *Royal Hobart Hospital Redevelopment TasNetworks Road Closure Traffic Management Strategy, GHD, February 2018*

John Holland Fairbrother Joint Venture

Royal Hobart Hospital Redevelopment

TasNetworks Road Closure Traffic Management Strategy

February 2018

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Appendices

Appendix A – Stage 3 Headworks Evaluation

1. Introduction

GHD were engaged by the John Holland Fairbrother Joint Venture (JHFJV) to prepare a Construction Traffic Impact Assessment for the Royal Hobart Hospital (RHH) Redevelopment Project.

This report specifically addresses the impacts of a proposed partial closure of Campbell Street, to be in place for approximately 2 weeks during school holidays in April 2018, to facilitate installation of high voltage power cables by TasNetworks.

1.1 Purpose of this report

The purpose of this report is to identify potential traffic impacts that may arise during the construction activities, and to propose treatments as required to mitigate traffic impacts.

1.2 Scope and limitations

This report has been prepared by GHD for John Holland Fairbrother Joint Venture and *may only be used and relied on by John Holland Fairbrother Joint Venture for the purpose agreed between GHD and the John Holland Fairbrother Joint Venture as set out in section 1.1 of this report.*

GHD otherwise disclaims responsibility to any person other than John Holland Fairbrother Joint Venture arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by John Holland Fairbrother Joint Venture and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has not been involved in the preparation of the overall road closure application and has had no contribution to, or review of the overall road closure application other than in the Construction Traffic Impact Assessment. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the overall road closure application.

2. Proposed Works

The proposed works are for the installation, by TasNetworks, of high voltage cables that will provide power to the new K Block RHH Building. The works involve excavations up to 1500mm deep within Campbell Street, including the area currently occupied the JHFJV construction zone. In order to maintain egress from the JHFJV construction zone it is necessary to also impact one of the adjacent general traffic lanes.

The resulting traffic management will allow a single lane in Campbell Street to remain open, for the use of buses, bicycles and emergency vehicles only. This is similar to the arrangement in place during the September 2016 school holidays, associated with services headworks for the RHH Redevelopment.

3. Evaluation of Previous Works

The proposed construction footprint and the effective width available for non-construction traffic, is essentially the same as what was in place for a 3-week period in September and October 2016, associated with services headworks in preparation for the RHH Redevelopment. These works were known as the “Stage 3 Headworks”.

The Stage 3 Headworks commenced on Sunday 25th September 2016, the first day of school holidays. The headworks concluded on Sunday 16th October 2016, one full week after the end of the school holidays.

The similarities between the Stage 3 Headworks and the proposed arrangement provide a unique opportunity for what was effectively a live trial of the proposed scenario. An analysis of traffic conditions during that period is contained in Appendix A.

3.1 Key Learnings

The experience of the Stage 3 Headworks has identified the following key learnings with regard to traffic management:

- Travel times on the Brooker Highway, Campbell Street and Murray Street were, while higher than normal, generally not significantly slower than conditions that could be experienced at other times without the influence of the headworks.
- The additional traffic that was diverted into Liverpool Street had a significant impact on travel times in that street.
- It would appear that traffic that diverted away from Campbell Street during the Stage 3 Headworks did not transfer to Murray Street, with the Brooker Highway taking most of the diverted traffic, with volumes on the Highway increasing by up to 150-200 vehicles per hour.

As a result of conditions observed during the Stage 3 Headworks, some modifications have been made to the proposed arrangement, as detailed in Section 1.

4. Traffic Volumes

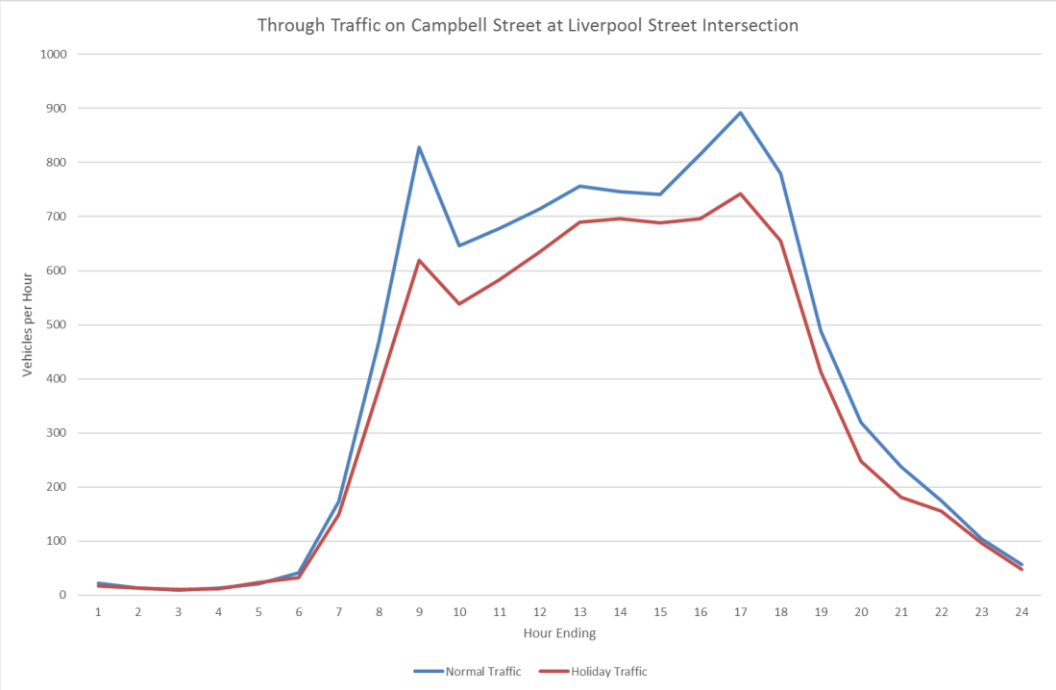
A comparison of traffic conditions during the April school holidays, and the adjacent non-holiday periods, has been undertaken for Campbell Street, using SCATS volume data sourced from the Department of State Growth.

The data was for the period 3 April 2017 to 5 May 2017, which includes the April school holidays and non-holiday weeks on either side. It also included Easter, although public holidays (including Easter Tuesday) have been excluded from the analysis. Monday 24th April, being the day before the Anzac Day public holiday, was also excluded. This data gives a direct indication of likely traffic conditions at the same time of year as the proposed works.

The results show that in Campbell Street, crossing Liverpool Street (a malfunctioning detector resulted in the right turn lane from Campbell Street into Liverpool Street not being counted), the average weekday volume outside of the school holiday periods was 9,739 vehicles per day. Within the school holiday period this reduced by 15% to 8,322 vehicles per day.

The profile of traffic across a typical weekday is shown in Figure 1. It can be seen that peak hour volumes are substantially reduced during school holidays, by up to 25% (~200 vehicles per hour) in the morning peak, and 17% (~150 vehicles per hour) in the afternoon.

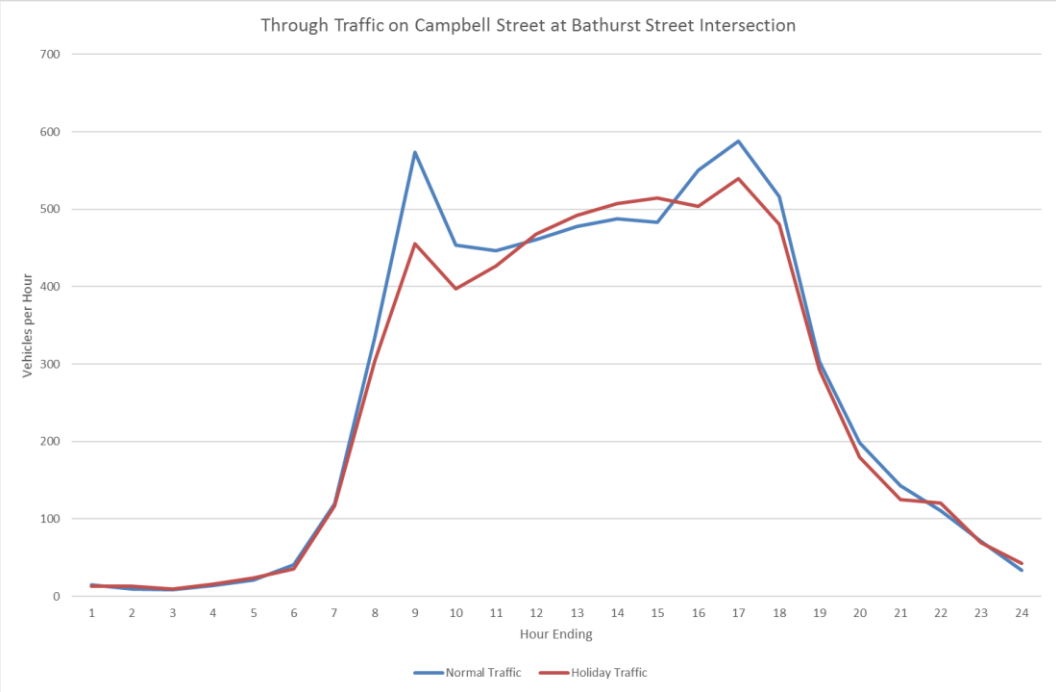
Figure 1 Campbell Street Daily Profile at Liverpool Street



At Campbell Street crossing Bathurst Street (excluding the left hand lane which is largely used by left turning vehicles), the average weekday volume outside of the school holiday periods was 6,460 vehicles per day. Within the school holiday period this reduced by 5% to 6,148 vehicles per day.

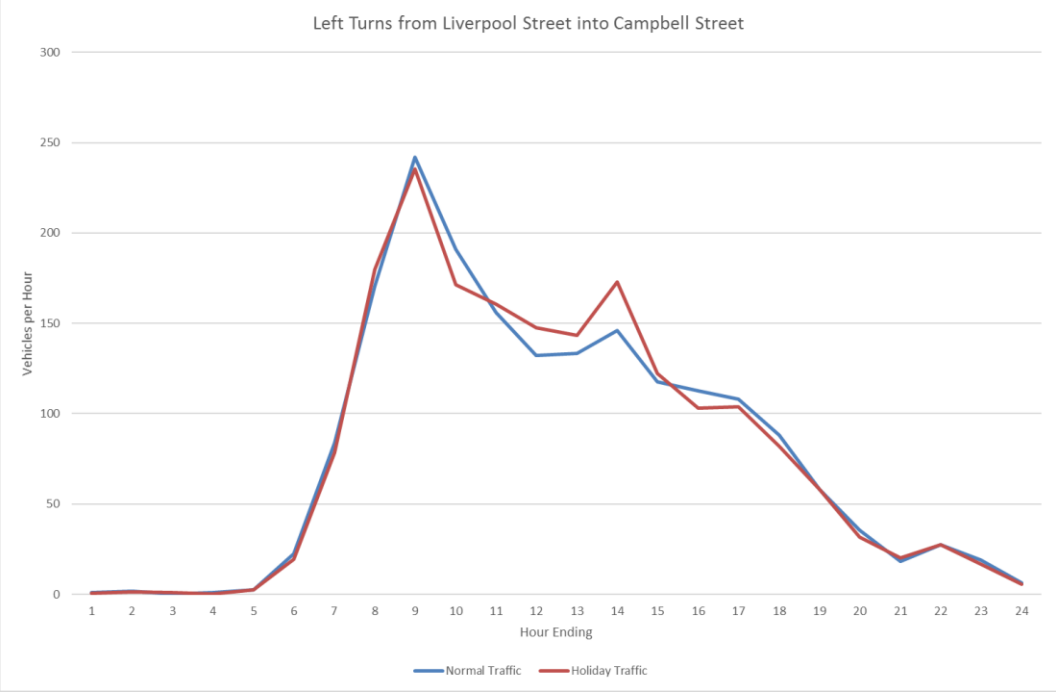
The profile of traffic across a typical weekday is shown in Figure 2. It can be seen that peak hour volumes are reduced during school holidays, by up to 21% (~120 vehicles per hour) in the morning peak, and 8% (~50 vehicles per hour) in the late afternoon.

Figure 2 Campbell Street Daily Profile at Bathurst Street



The profile of traffic turning left from Liverpool Street into Campbell Street is shown in Figure 3. Most of this traffic (noting that this turn is on a major bus route to access the CBD from the Brooker Highway and Eastern Shore) would be required to divert to a different route, most likely to travel straight along Liverpool Street.

Figure 3 Liverpool Street Left Turn into Campbell Street Daily Profile



A comparison of holiday and non-holiday traffic shows very similar profiles and volumes for this movement. It is likely that the regularity of timetabled buses on this route adds to the consistency from day to day.

5. Traffic Management Strategy

5.1 Lane Management

The proposed lane management strategy is an evolution of the Stage 3 Headworks arrangement. Whilst those works did not result in significant impacts in most cases, one of the more substantial impacts was on travel times in Liverpool Street.

The currently proposed arrangements are to reduce the volume of traffic diverting to Liverpool Street, by not allowing traffic to turn from Campbell Street into Liverpool Street. Traffic from the inner northern suburbs wishing to access the CBD will need to do so via either Elizabeth Street or Murray Street, or alternatively divert to the Brooker Highway.

Figure 4 Lane Management: Brisbane Street to Bathurst Street

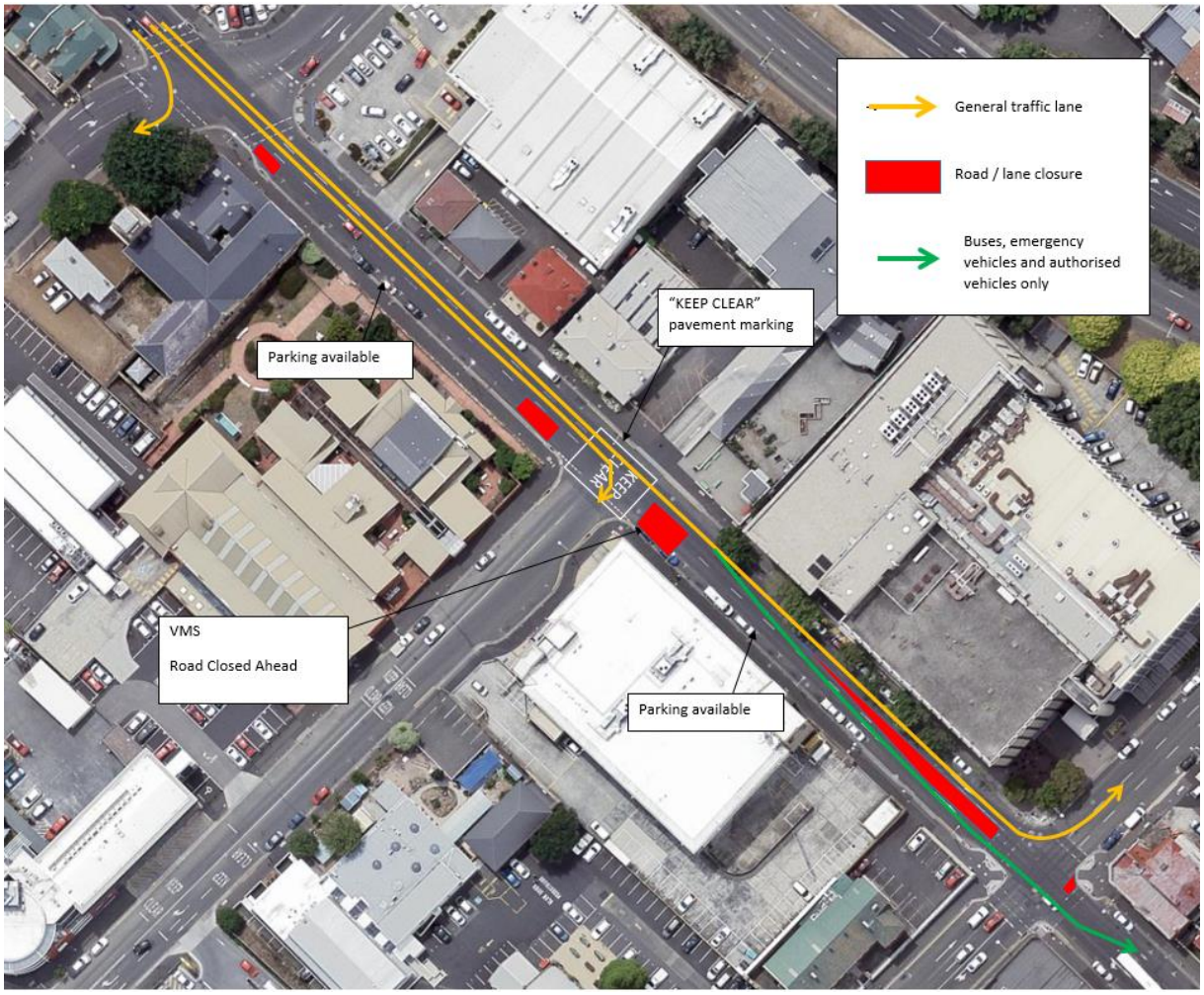


Image source: LISTMap © State of Tasmania

The proposed lane management strategy, shown in Figure 4 and Figure 5, is to minimise situations where two or more traffic lanes must merge together. This is achieved firstly by closing the right-hand lane in Campbell Street immediately south of Brisbane Street. This lane commences only a short distance prior to the Brisbane Street junction, and so preventing access to it is not likely to have a significant impact on traffic efficiency.

Between Brisbane Street and Melville Street the right-hand lane would be closed. Parking on the right hand side of Campbell Street can be retained, even though the adjacent lane is closed, by only physically blocking the lane intermittently, as shown in Figure 4. Parking on the left hand side of the road would remain available as per the existing situation.

A further benefit of this unused right hand lane is additional manoeuvring room for emergency vehicles if required.

The left lane would continue past Melville Street. On approach to Bathurst Street, this lane would be designated as “Left lane Must Turn Left”.

The middle lane in Campbell Street would terminate at Melville Street, with all traffic turning right.

Downstream of Melville Street, a lane would be added for “buses, bicycles, emergency services and authorised vehicles only”. This lane could also be used to access the RHH Emergency Department.

Figure 5 Lane Management: Bathurst Street to Liverpool Street

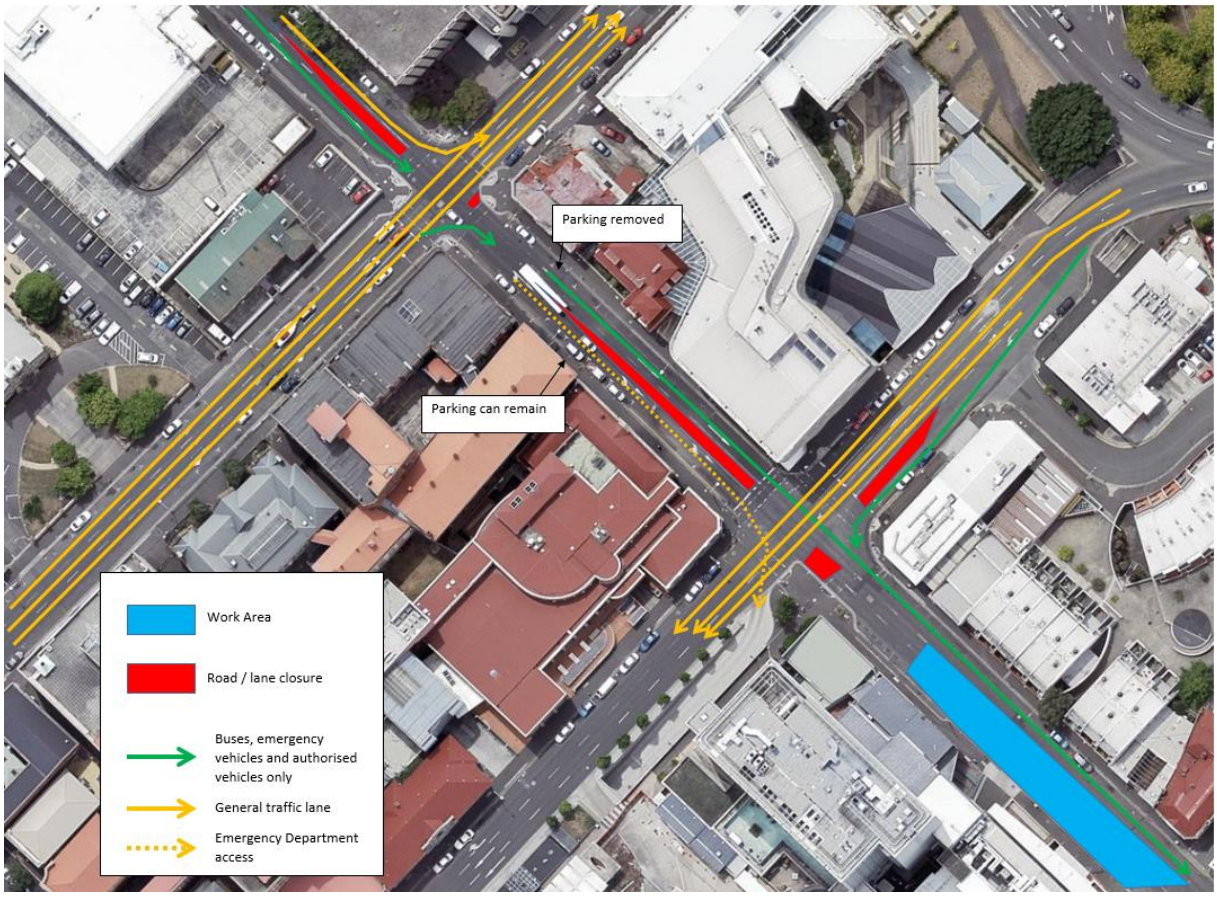


Image source: LISTMap © State of Tasmania

On the downstream side of Bathurst Street, shown in Figure 5, traffic activity would be limited to buses, bicycles, emergency services and construction trucks only. The right-hand lane would be used only be those vehicles accessing the RHH Emergency Department. All other vehicles would use the left-hand lane.

In Liverpool Street, the three lanes would be retained for through traffic. The left turn lane at Campbell Street would be designated for buses and authorised vehicles only. A physical separation from the adjacent lane is required to ensure that general traffic does not attempt to also turn left in parallel with a bus. This measure will limit turning traffic to a single lane.

In Bathurst Street three lanes would remain open, although construction works on the Brooker Pedestrian Bridge may alter this. Timing of the bridge works, and the extent of construction traffic management required for that project, have not been confirmed and are therefore not shown in Figure 5. It is not expected that these works would significantly impact on traffic management in Campbell Street.

5.2 Pavement Marking and Traffic Management Devices

The proposed arrangement would generally utilise existing lane alignments on approach to the works. However the following changes are recommended:

- "Keep Clear" markings at the intersection of Campbell Street and Melville Street, to improve the ability of emergency vehicles to turn out of Melville Street if traffic is queued in Campbell Street.
- Changes to lane arrows
  - Left lane of Campbell Street approaching Bathurst Street to be left turn only
  - Right lane of Campbell Street approaching Liverpool Street to be right turn only

It is recommended that lane closures be implemented using physical barriers affixed to the road. Rubber separation strips with spring-back bollards and/or chevron panels would be appropriate, as these could be traversed by emergency vehicles if necessary. These areas are shown red in Figure 4 and Figure 5. During detailed planning for these areas the manoeuvring requirements of large fire trucks and other emergency vehicles will need to be confirmed and considered.

Lane status signage, as well as other signage as required by AS1742.3 (Works on Roads) will also be in place to reflect these arrangements. Access to the RHH Emergency Department will be clearly signposted.

Traffic control personnel would be deployed at key upstream locations for an extended period at the commencement of the new operations, to enforce access restrictions and manage traffic as required.

5.3 Parking

Changes to on-street parking in Campbell Street, between Liverpool Street and Collins Street, and on Liverpool Street between Brooker Highway and Campbell Street, have previously been approved and parking removed from these areas. Additional parking impacts would be as follows:

- Eastern side of Campbell Street (UTAS side of road) between Bathurst Street and Liverpool Street – parking removed to maintain capacity for buses and authorised vehicles to manoeuvre.
- Northern side of Melville Street, between Ambulance Tasmania entrance and Campbell Street – PM peak period clearway (4:30-6:00 pm) to provide additional capacity and flexibility to allow emergency services vehicles to enter Campbell Street.

Parking on other sections of Campbell Street would remain available.

5.4 Advance Warning Signage

It is proposed to provide advance warning signage at key locations in the form of Variable Message Signs, which would advise of the reason for works and the alternative routes that may be available. Such signage is proposed to be placed:

1. On Argyle Street, north of Burnett Street, where traffic is able to divert to the Brooker Highway.
2. On the Brooker Highway, north of Burnett Street, to encourage traffic to remain on the Brooker Highway.
3. In Campbell Street to allow diversion up Patrick, Brisbane or Melville Streets, or to the Brooker Highway via Bathurst Street.

4. On the Tasman Highway north of McVilly Drive, where traffic is able to continue to Davey Street instead of Liverpool Street.
5. On Campbell Street between Brisbane Street and Melville Street, on approach to the works.
6. On Campbell Street between Liverpool Street and Collins Street, on the section of road to be closed.

Proposed messaging for the various time periods is detailed in Table 1. After the initial period of works it would be appropriate to replace the variable signage with permanent static signage. This will also allow temporary VMS to be erected leading up to variations to the substantive arrangement, such as for full road closures.

Table 1 VMS Plan

	Pre-works	From start of closure
VMS 1	Not required	CAMPBELL ST CLOSED / AT BATHURST ST / DETOUR VIA BROOKER HWY
VMS 2	Not required	CAMPBELL ST CLOSED / AT BATHURST ST / DETOUR VIA BROOKER HWY
VMS 3	CAMPBELL ST CLOSED / AT BATHURST ST / FROM 14 APR	CAMPBELL ST CLOSED / AT BATHURST ST / DETOURS IN PLACE
VMS 4	CAMPBELL ST CLOSED / FROM 14 APR / DETOUR VIA DAVEY ST	CAMPBELL ST CLOSED / AT LIVERPOOL ST / DETOUR VIA DAVEY ST
VMS 5	CAMPBELL ST CLOSED / FROM 14 APR / DETOUR VIA DAVEY ST	ROAD CLOSED AHEAD / BROOKER HWY ← CBD → / EMERGENCY DEPT OPEN
VMS 6	CAMPBELL ST CLOSED / FROM 14 APR / RHH WORKS	Not required

Figure 6 VMS Locations

Image source: LISTMap

5.5 Traffic Signal Coordination

The Transport Systems Group of the Department of State Growth has been consulted with regarding traffic signal timing at intersections around the works, in order to best manage the change in traffic patterns.

It is considered critical to maintain traffic flow on Macquarie Street and Davey Street as a means of minimising network-wide impacts. The proposed management strategy is to use the

southbound approach of the Brooker Highway to the signalised roundabout at Bathurst Street as a metering point, in order to control the volume of traffic approaching the Macquarie Street / Davey Street / Tasman Highway intersection. As was the case during the Stage 3 Headworks (see Appendix A) this may result in delays on the Brooker Highway and Campbell Street, particularly during peak periods, but should maintain traffic flow elsewhere, including on Bathurst Street.

Any additional green time that could be given to the Brooker Highway or Campbell Street would be beneficial, but only as long as traffic continues to flow on Macquarie Street, Bathurst Street and Tasman Highway.

It is noted that the change in traffic volumes at the Campbell Street intersections with Bathurst Street and Liverpool Street may allow for additional green time to be allocated to Bathurst Street and Liverpool Street, subject to the needs of pedestrians crossing at these signals, and the needs of vehicles remaining in Campbell Street.

5.6 Demand Management

A critical strategy for minimising any network impacts of the proposed works is to moderate the volume of traffic that is diverting to alternative routes simultaneously. Relatively short peaks in traffic demand is one of the factors leading to unstable flow in some conditions. While demand would be expected to moderate itself over time in response to conditions, it is appropriate to intentionally seek to affect the demand for travel to and through the CBD, and to manage the expectations of road users, by communicating the following key messages to road users:

- Changing the time of travel to avoid peak periods
  - Highlighting the benefits of travelling before or after the peak period
- Re-routing to avoid the road closures
  - Changing route early in the journey, rather than waiting until reaching the worksite
- Switching from car to bus or bike
  - Bus and bike will have priority access down Campbell Street, and will be faster and for many people just as convenient as travelling by car and parking

Communications of these messages will be led by the John Holland Fairbrother Joint Venture, in collaboration with Council, the Department of State Growth, Metro and other organisations as appropriate.

6. Impact Assessment

The proposed works would retain a single lane in Campbell Street between Liverpool Street and Collins Street, reserved for the use of buses, bicycles, emergency services and authorised vehicles only.

6.1.1 Through Traffic

The proposed arrangements will have significant impacts on traffic routes available to CBD traffic, with all vehicles except buses, bicycles, emergency services and authorised vehicles required to divert away from Campbell Street between Bathurst Street and Collins Street.

The SCATS volume data presented in Section 4 suggests that in the order of 600 vehicles per hour may be diverted away from Campbell Street north of Bathurst Street. This matches the experience of the Stage 3 Headworks, where the estimated volume diverting away from Campbell Street was 650 vehicles per hour. It is expected that the Brooker Highway will be the main alternative route used. Murray Street did not appear to have been used by a significant volume of traffic diverting away from Campbell Street during the Stage 3 Headworks.

One key difference between the Stage 3 Headworks and the current proposal is that Campbell Street will effectively be closed at Bathurst Street, which will increase the volume of traffic to be diverted into the CBD via alternative routes, up to approximately 1,000 vehicles per hour. It is likely that the additional diversion of approximately 350 vehicles per hour will occur via Melville Street, Brisbane Street or other east-west connections to Elizabeth Street, Murray Street or Barrack Street. The Brooker Highway may also attract some additional trips.

The Stage 3 Headworks experience indicates that generally the network is able to accommodate the diverted traffic, albeit with some increased delays. The current proposal seeks to alleviate some of the more significant impacts by reducing traffic being funnelled into Liverpool Street.

The precise impact of the works on the road network is difficult to predict, with individual responses to the changed conditions likely to vary markedly. The focus on this assessment therefore is on identifying ways of managing the impacts, more so than on quantifying them. The timing of the works during school holiday periods, when traffic volumes on the CBD road network are lower than normal, will contribute to the improved potential for significant impacts to be avoided.

Upon commencement of the works, there may be a short period of driver uncertainty and localised congestion, moderating as drivers become more familiar with changes and adjust their behaviour accordingly. It is likely that some drivers will choose an alternative route, or timing their journey to avoid the busiest times.

The work zone and associated traffic control will remain static for the duration of the works, reducing potential for ongoing uncertainty amongst drivers, and allowing traffic behaviour to settle into a pattern relatively quickly.

Alternative Routes

The primary alternative route available to traffic currently using Campbell Street is the Brooker Highway. Other opportunities to filter through the CBD via Elizabeth Street, Murray Street and Barrack Street are shown in Figure 7.

Figure 7 Campbell Street Alternative Routes

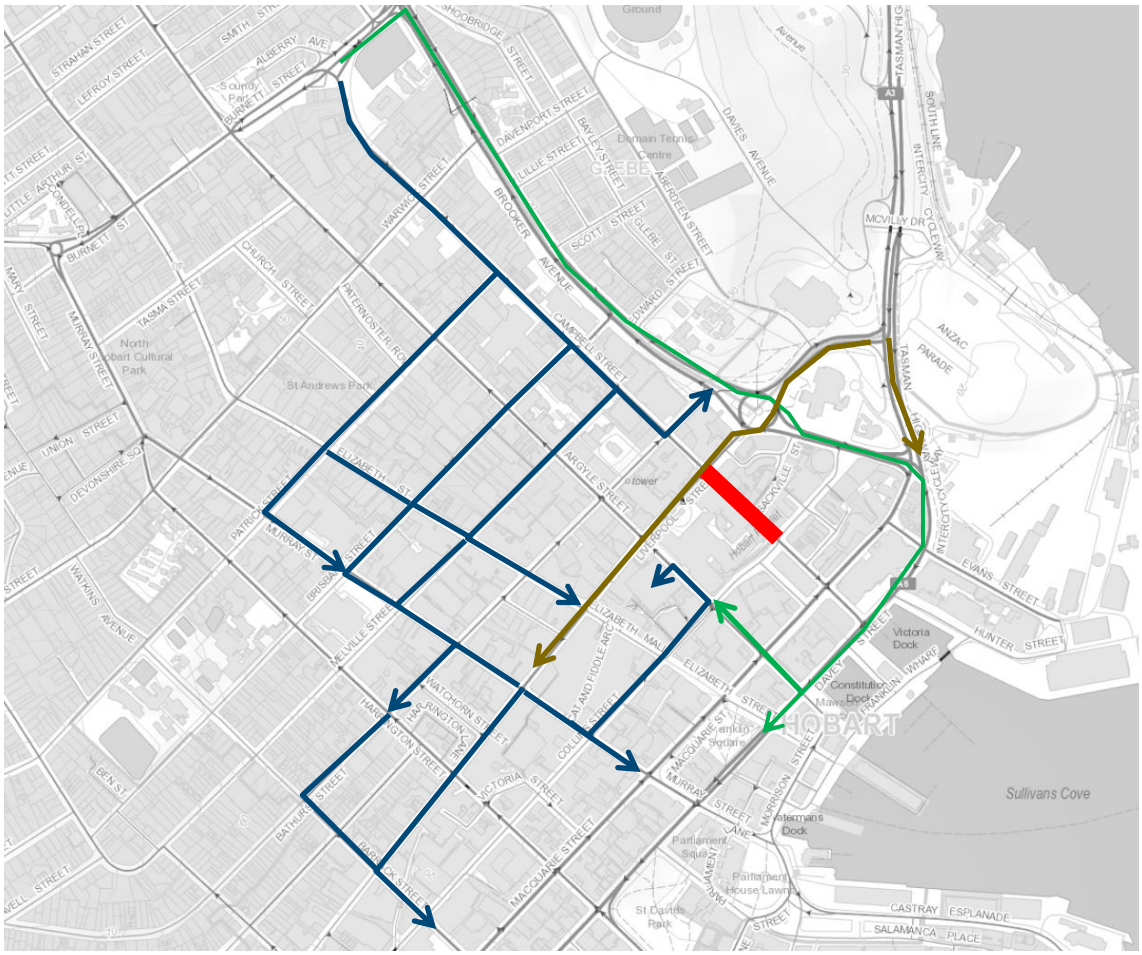


Image source: LISTMap

6.1.2 Public Transport

The retention of a single lane in Campbell Street past the works, that is able to be used by buses, will mean that no bus route diversions are required. Buses will continue to use Campbell Street as per the existing route arrangements.

- The existing bus stops in Campbell Street outside the Menzies Centre, and in Liverpool Street between Mistral Place and Campbell Street, will continue to be available at all times.
- The work zone will commence sufficiently south of Liverpool Street to allow buses to turn into the single lane of Campbell Street.

Buses approaching the works are primarily travelling along Elizabeth Street before turning left into Bathurst Street. Elizabeth Street generally has spare capacity, particularly in the PM peak, in which to accommodate diverted traffic as well as buses. As above, it is planned that capacity on Bathurst Street be maintained as much as possible which will allow buses to access Campbell Street. For buses from the eastern shore, maintenance of Tasman Highway capacity will allow them access directly into Liverpool Street.

The measures taken to reduce traffic volumes in Liverpool Street are expected to benefit outbound buses to the northern suburbs, which experienced delays in Argyle Street during the Stage 3 Headworks.

6.1.3 Pedestrians and Cyclists

Pedestrian access along the Theatre Royal side of Campbell Street will be maintained during the works.

Cyclists will be able to utilise the bus and emergency vehicles lane past the works in Campbell Street. They will also be able to alight and walk on the open footpaths on Campbell Street.

6.1.4 Emergency Services

Emergency services will be able to use the single lane past the worksite, shared with buses and construction traffic.

Access to the RHH Emergency Department and the Tasmania Police Remand Centre will be unaffected by the works.

The proposed lane closure arrangements in Campbell Street, upstream of the closure, would provide an empty lane between Brisbane Street and Bathurst Street. This lane, while it would be blocked intermittently, would provide space into which vehicles could move if required to make way for an emergency vehicle. Between Bathurst Street and Liverpool Street, there would be additional width in the left-hand lane, where the bus stops outside the MS2 building, to allow buses to pull over and make way for an emergency vehicle if required.

6.1.5 Theatre Royal

As per existing arrangements, there will be no public vehicular access available to Campbell Street in front of the Theatre Royal. Pedestrian access to the Theatre will be maintained, with the footpath on the northern side of Campbell Street open at all times.

During the works, the Theatre Royal has advised that there will be no large vehicle movements out of Sackville Lane, which would be impacted by the proposed works.

7. Conclusions

This report presents a traffic management strategy for the proposed partial closure of Campbell Street, between Liverpool Street and Collins Street, for a period of 2 weeks during the April 2017 school holidays. The proposed partial closure would involve providing a single lane for traffic on Campbell Street, and restricting use of this lane to buses, bicycles and emergency services.

The changed traffic arrangements are required to allow TasNetworks to undertake excavations and associated works safely and efficiently. Construction activities for the RHH Redevelopment, utilising the JHFJV construction zone in Campbell Street, will also continue throughout this period. The proposed arrangement would allow trucks to enter the worksite from the Liverpool Street end, and depart north of Sackville Street. Additional access to the construction zone would be from the Collins Street end, under traffic control.

The implementation of a similar scheme in the school holidays of September and October 2016 for the Stage 3 Headworks indicated that the network generally continued to operate satisfactorily with the closures in place. While travel times on some routes were higher than normal, they were generally not significantly slower than conditions that could be experienced at other times. Liverpool Street appeared to be the most affected section of the network, due to the additional traffic diverted to this street.

The current proposal seeks to reduce the volume of traffic diverted to Liverpool Street by commencing the effective closure of Campbell Street at Bathurst Street.

In addition, the following mitigation measures will be put in place to manage traffic and minimise disruption to the network:

- Consistent traffic management arrangements during the works, to allow motorists to adjust behaviour to suit the changed conditions
- Left lane must turn left from Campbell Street into Bathurst Street, supported by changes to pavement marking and signage
- Lane closures to reduce Campbell Street to a single lane of general traffic past Melville Street
- Keep Clear pavement marking at the Campbell Street / Melville Street to improve emergency vehicle egress
- Retention of a single lane for use of buses, bicycles, emergency services and authorised vehicles to remain on Campbell Street between Bathurst Street and Collins Street
  - A traffic controller would be placed to direct general traffic away from this lane as required
- The Campbell Street footpaths opposite the hospital will remain open
- Advanced warning given to motorists via Variable Message Signs placed on approach routes
- Management of traffic signals to retain Macquarie Street / Davey Street / Tasman Highway traffic flow, with traffic metered on the Brooker Highway and Campbell Street approaching the works

With these measures in place, it is considered that the proposed works will not have a significant adverse impact on the Hobart road network.

Appendices

Appendix A – Stage 3 Headworks Evaluation

Travel Times

One of the key points of comparison was the effect of the headworks on travel times in the Hobart CBD. To allow this comparison, travel time data was collected for the week prior to the Stage 3 Headworks commencing, for the 3 weeks of the headworks, and for the period Monday – Wednesday of the week following completion of the Stage 3 Headworks (prior to the Hobart Show Day public holiday).

During the Stage 3 Headworks, travel time data was collected on key routes through the Hobart CBD:

- Route 1: Brooker Highway between Burnett Street and Bathurst Street
- Route 2: Campbell Street between Burnett Street and Liverpool Street
- Route 3: Murray Street between Burnett Street and Liverpool Street

A fourth route was added in response to observed conditions, for the final 2 weeks of monitoring:

- Route 4: Liverpool Street between Campbell Street and Murray Street

Travel times were collected using multiple methods, as detailed in Table 2.

Table 2 Travel time monitoring during Stage 3 Headworks

Week	Description	Date Commencing	Travel time Methodology
0	Prior to commencement of works Last week of school term	19 September	Manual surveys
1	Works commence School holidays	26 September	Bluetooth
2	Works continue School holidays	3 October	Bluetooth
3	Works continue First week of school term	10 October	Bluetooth
4	Works complete Campbell Street partially reopened Show Day public holiday 20 October	17 October	Bluetooth

The manual survey of travel times involved the “floating car” method of surveying, with travel times recorded to specific locations (generally intersections). Surveys were carried out on Wednesday and Thursday of Week 0 only.

For the remainder of the evaluation period Bluetooth technology was used. This recorded the times between specific points for a sample of vehicles which included any Bluetooth-enabled device within range of the receivers. This may include mobile phones, smart watches / fitness trackers, and some cars. The only information collected was the start and end times for each device, and no information is available about what happens in the intervening period. Thus the data set includes some travel times that are significantly longer than others, potentially due to a stop made along the route, a detour taken, or because the trip was made by a pedestrian or cyclist. The results have been filtered to exclude obvious outliers.

Due to the effect of school holidays (Weeks 1 and 2) on traffic volume across the network, the most revealing comparison will generally be between the results of Week 3 (schools returned,

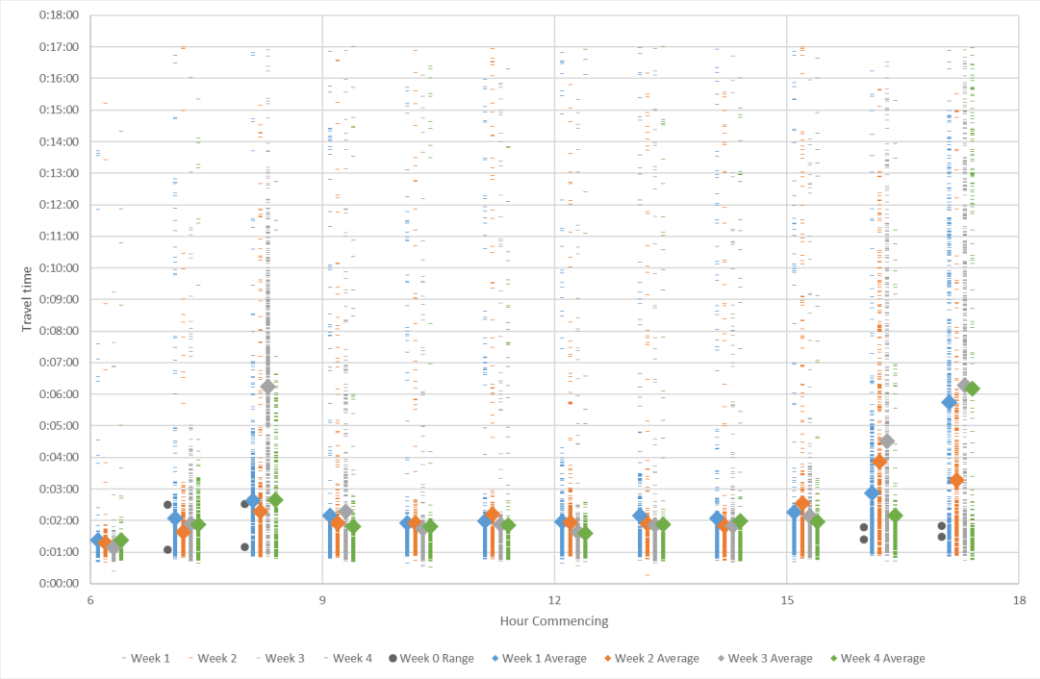
headworks continuing) and Week 4 (headworks complete and Campbell Street re-opened to traffic).

Route 1 – Brooker Highway

For the Brooker Highway, travel times over 17 minutes were excluded from analysis, based on the distribution of values. Weekend data has also not been considered.

Figure 8 shows the range of travel times observed, and an average travel time in each hour of the day in each week (6:00 am – 6:00 pm weekdays). The morning and afternoon peak periods, when longer travel times are observed in all weeks, are clearly apparent. The range of travel times surveyed in Week 0, from a significantly smaller sample size than for the other weeks, is consistent with the travel times observed in subsequent weeks.

Figure 8 Brooker Highway Range of Travel Times



On the Brooker Highway in the morning peak, average travel times in Week 3 were substantially higher than the preceding two weeks. Average travel times in Week 4 also returned to Week 1-2 levels. During the day, travel times were similar in all weeks. In the PM peak, however, there was greater variability. In the 4:00 – 5:00 pm period, Week 4 average travel times were less than any of the previous weeks, with average travel times highest in Week 3. In the 5:00 – 6:00 pm period, Week 3 and Week 4 had similar average travel times.

Figure 9 shows the individual travel times for Week 1. Vertical “columns” of data points are indicative of occasions where travel times were higher than for surrounding periods. The data shows that on Tuesday of Week 1 travel times in the PM peak were higher than on other days in that week, up to approximately 15 minutes.

Figure 9 Brooker Highway Travel Times Week 1

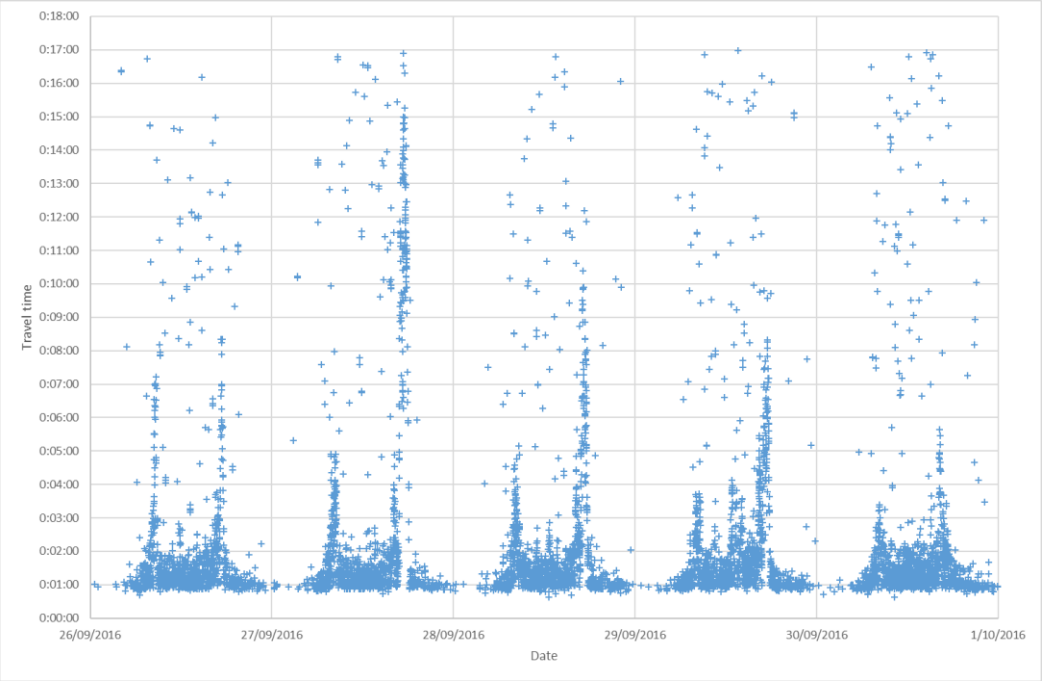
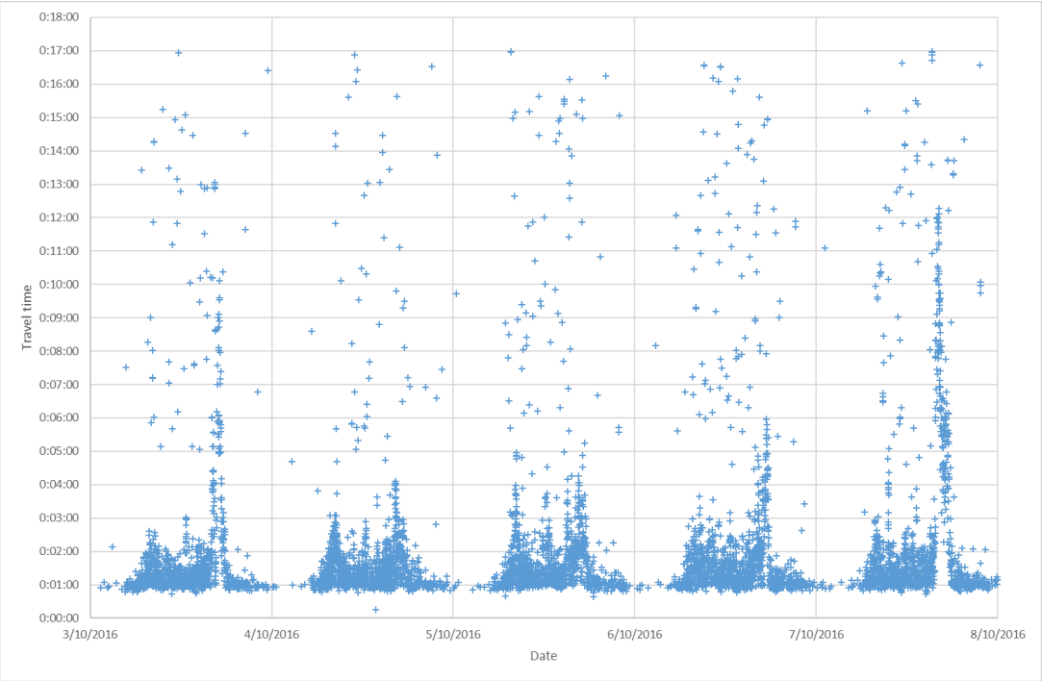


Figure 10 shows that Week 2 patterns were similar to Week 1, with travel times up to 12 minutes on the Friday.

Figure 10 Brooker Highway Travel Times Week 2



In Week 3, as shown in Figure 11, PM peak period travel times were high on Wednesday and Friday. Higher travel times were also experienced in the morning peak on most days.

Figure 11 Brooker Highway Travel Times Week 3

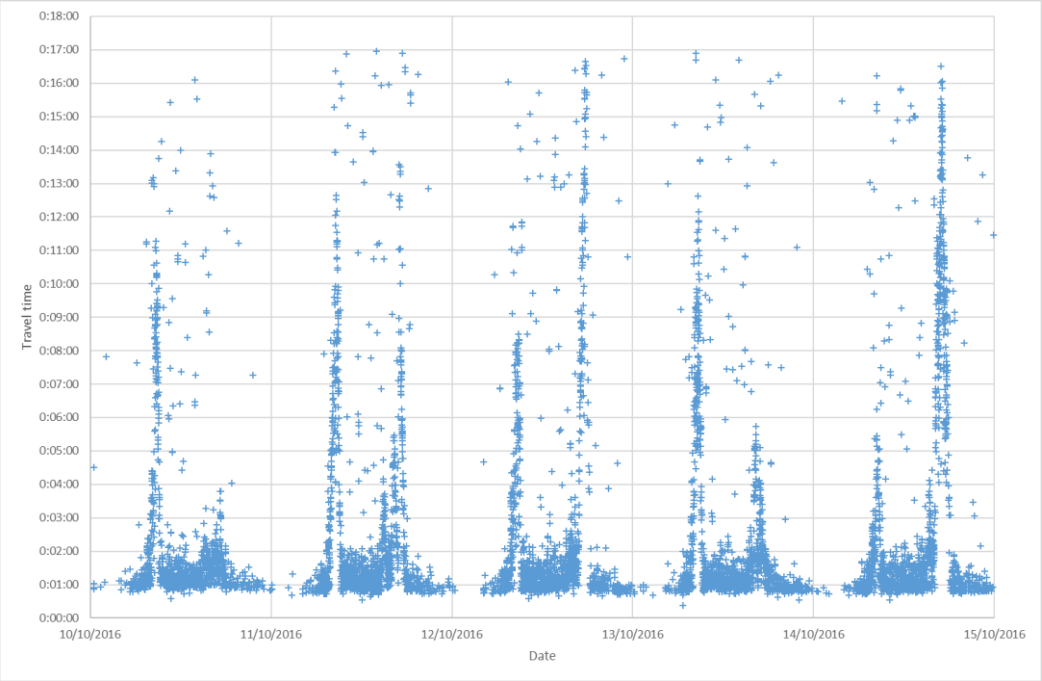
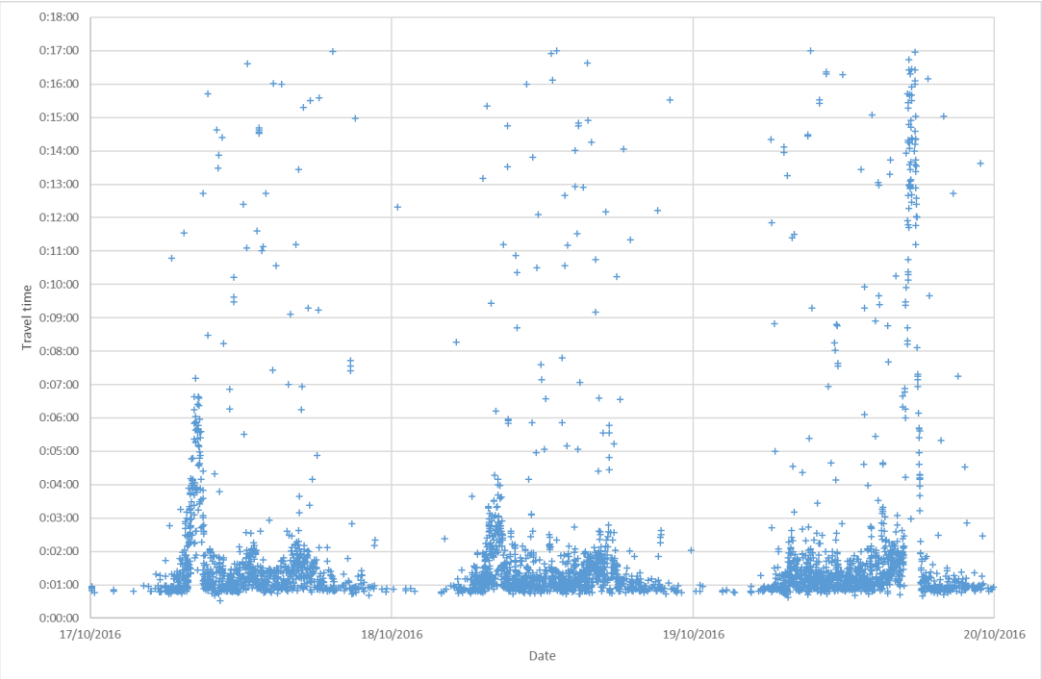


Figure 12 shows that in Week 4, travel times returned to a situation with similarities with Week 2. However Wednesday of Week 4 experienced high travel times in the PM peak period.

Figure 12 Brooker Highway Travel Times Week 4



Route 2 – Campbell Street

For Campbell Street, travel times over 10 minutes were excluded from analysis, based on the distribution of values. Weekend data has also not been considered.

Figure 13 shows the range of travel times observed, and an average travel time in each hour of the day in each week (6:00 am – 6:00 pm weekdays). Compared to the Brooker Highway results, the morning and afternoon peak periods are less obvious, with similar travel times across the day. The range of travel times surveyed in Week 0, from a significantly smaller sample size than for the other weeks, is consistent with the travel times observed in subsequent weeks.

On Campbell Street, Week 4 average travel times are lower than in all previous weeks. However the difference between Week 3 and Week 4 average travel times is less than 1 minute in all cases. Week 1 average travel times were generally the highest of the analysis period, most likely as motorists adjusted to the changed conditions in Campbell Street.

Figure 13 Campbell Street Range of Travel Times

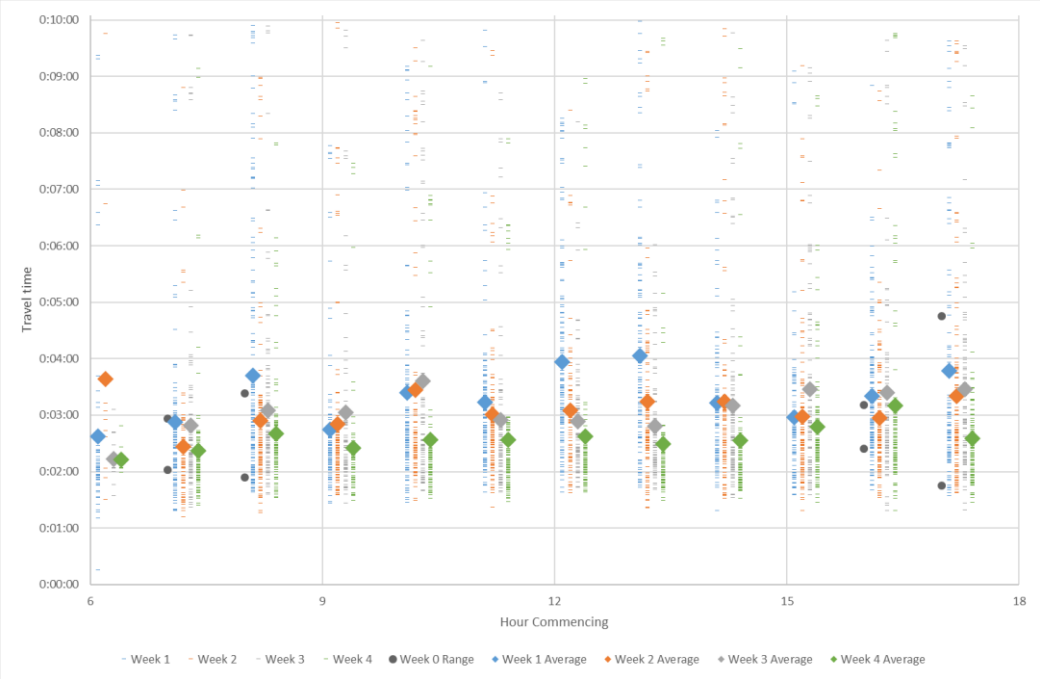


Figure 14 shows the individual travel times for Week 1. Observations are generally clustered around 2-4 minutes, with slightly higher results on the first day of the headworks.

Figure 14 Campbell Street Travel Times Week 1

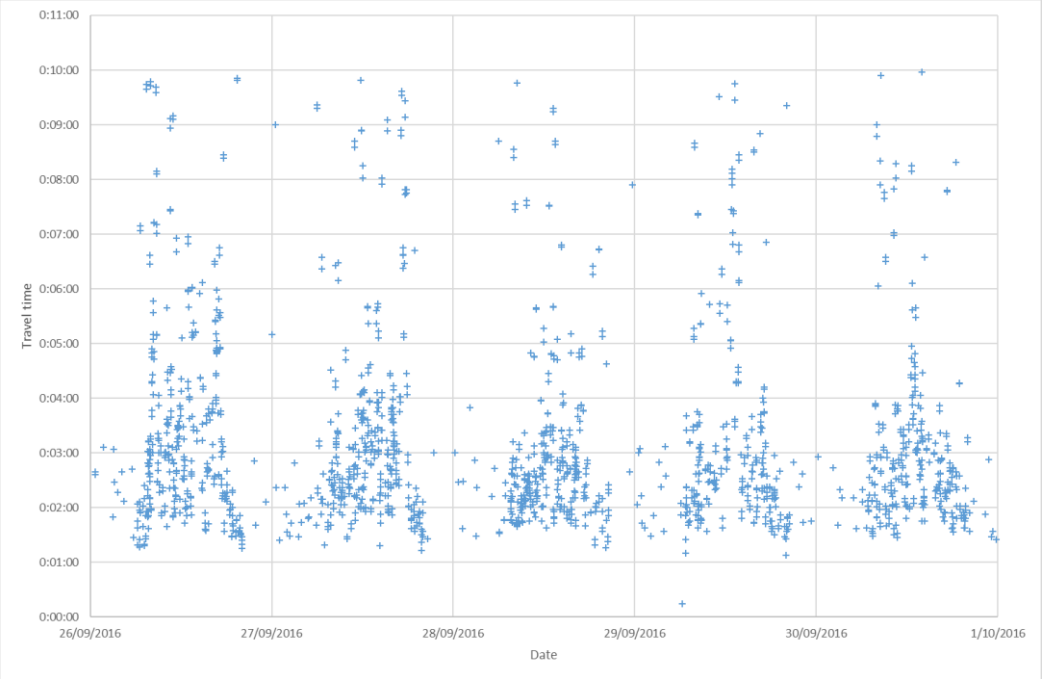
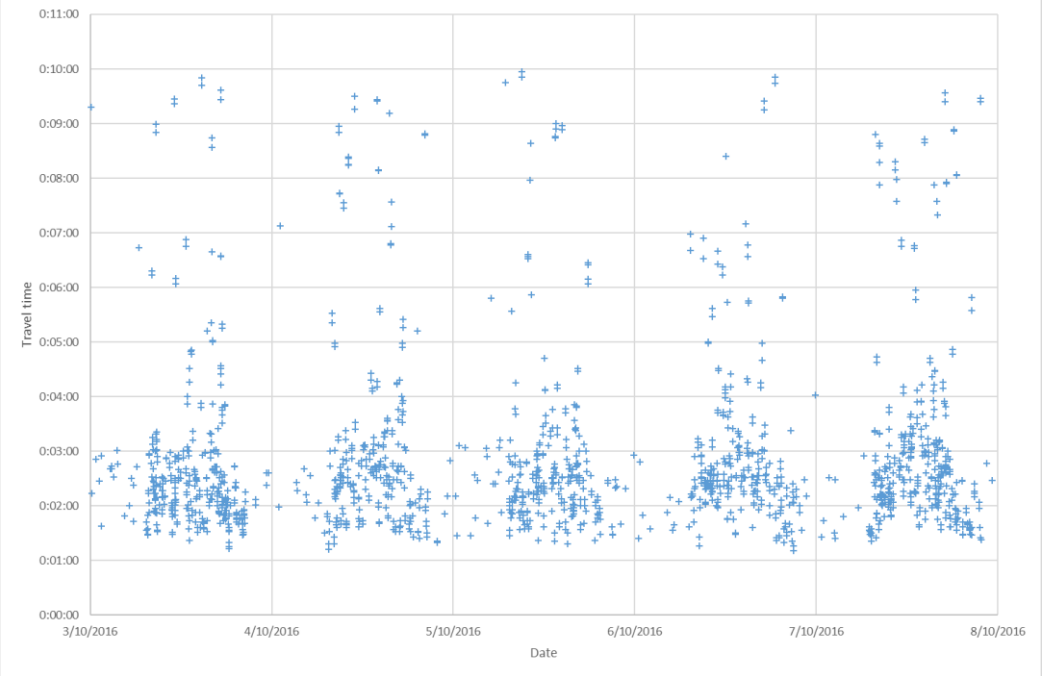


Figure 15 shows that Week 2 patterns were similar to Week 1, although with reduced variability.

Figure 15 Campbell Street Travel Times Week 2



In Week 3, as shown in Figure 16, a similar pattern continues.

Figure 16 Campbell Street Travel Times Week 3

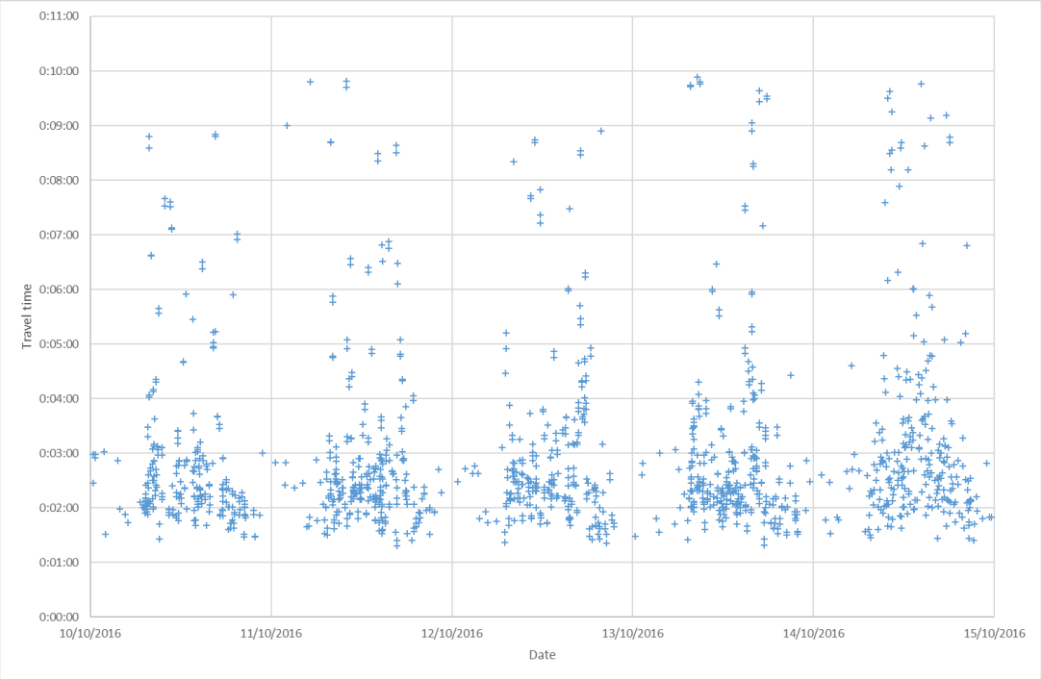
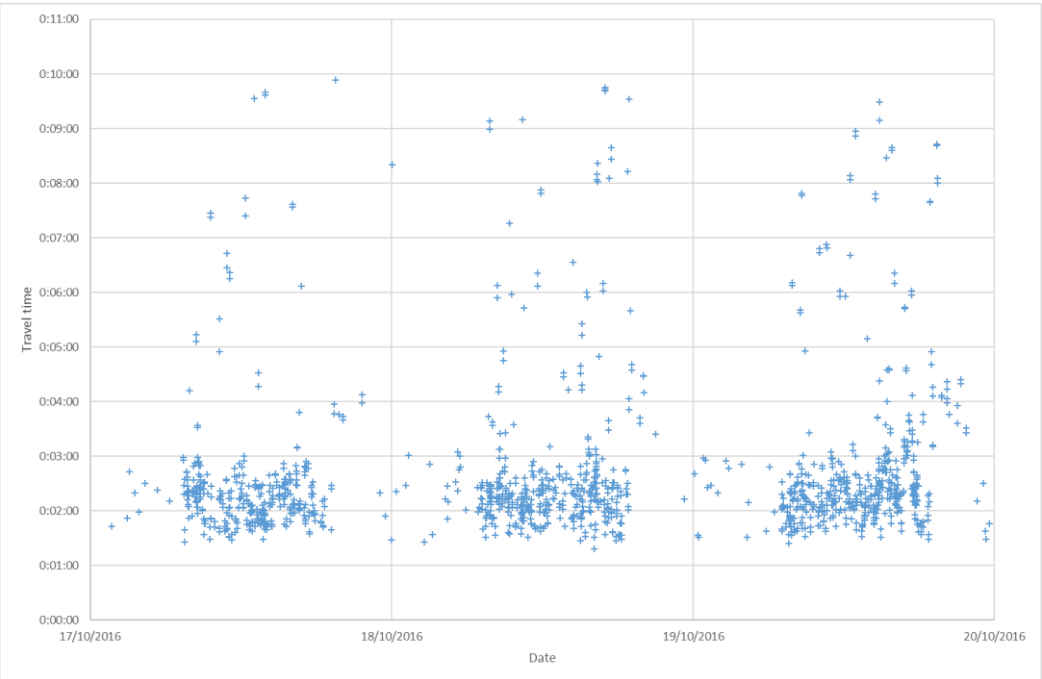


Figure 17 shows that in Week 4, travel times were clustered around 1.5-3 minutes, indicating faster travel times once the headworks were completed.

Figure 17 Campbell Street Travel Times Week 4



Route 3 – Murray Street

For Murray Street, travel times over 15 minutes were excluded from analysis, based on the distribution of values. Weekend data has also not been considered.

Figure 18 shows the range of travel times observed, and an average travel time in each hour of the day in each week (6:00 am – 6:00 pm weekdays). Like Campbell Street, the morning and afternoon peak periods are not obvious, with similar travel times across the day. The range of travel times surveyed in Week 0, from a significantly smaller sample size than for the other weeks, is consistent with the travel times observed in subsequent weeks.

On Murray Street, Week 4 average travel times are lower than previous weeks during the middle of the day. Morning results are similar between Weeks 3 and 4, while in the PM peak period the results are inconsistent.

It is noted that travel times in Murray Street would also have been affected by the traffic management arrangements associated with the Myer redevelopment, which has a lane closed during off-peak times, and traffic is stopped regularly to allow truck entry and exit into the construction site. It is assumed that Myer activity was relatively consistent across the evaluation period.

Figure 18 Murray Street Range of Travel Times

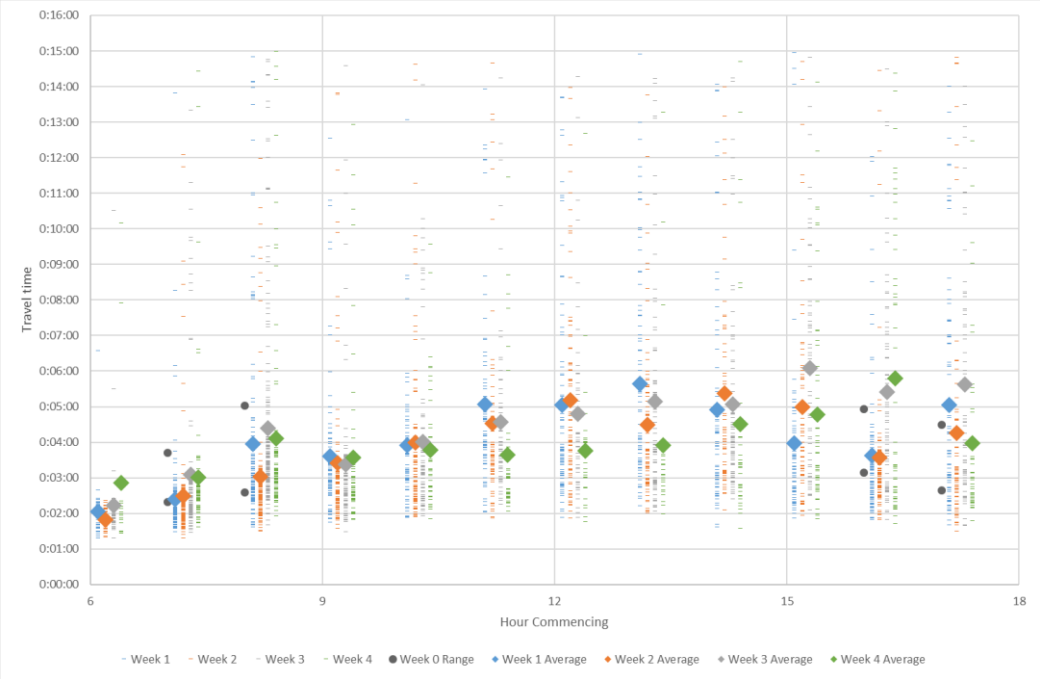


Figure 19 shows the individual travel times for Week 1. Observations are generally clustered around 2-4 minutes, consistent across the week.

Figure 19 Murray Street Travel Times Week 1

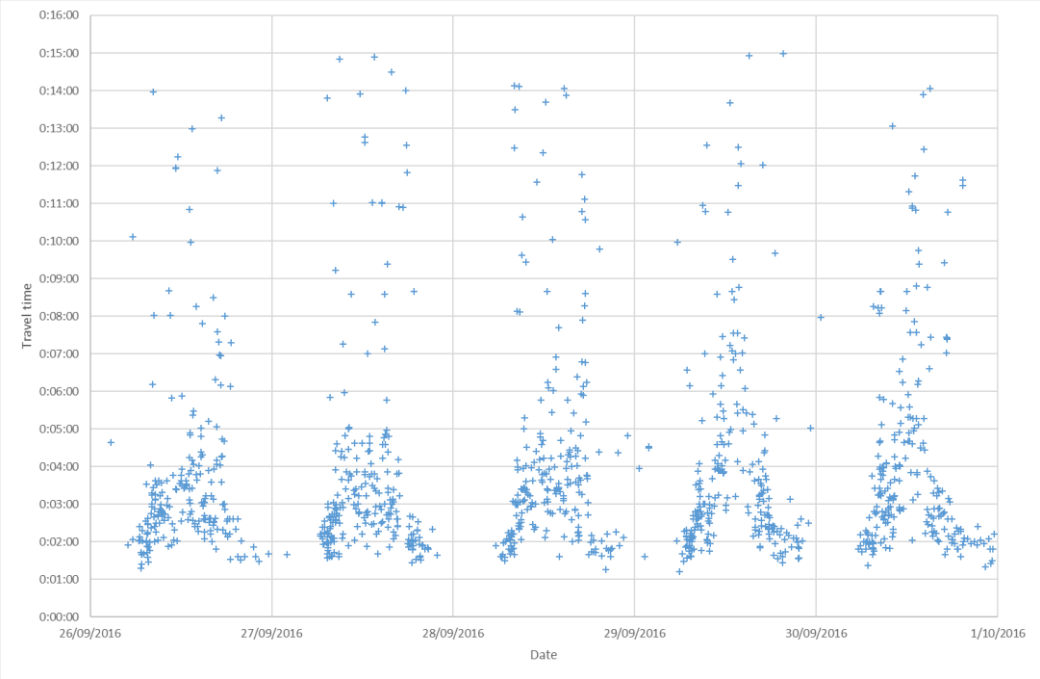
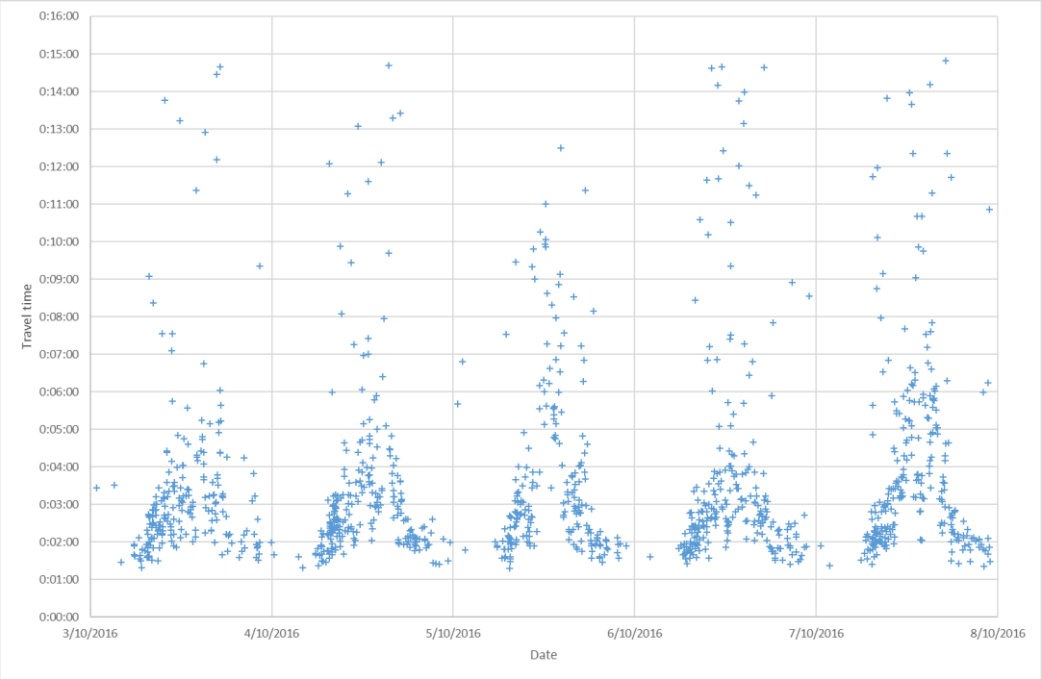


Figure 20 shows that Week 2 patterns were similar to Week 1, although with reduced variability.

Figure 20 Murray Street Travel Times Week 2



In Week 3, as shown in Figure 11, a similar pattern continues.

Figure 21 Murray Street Travel Times Week 3

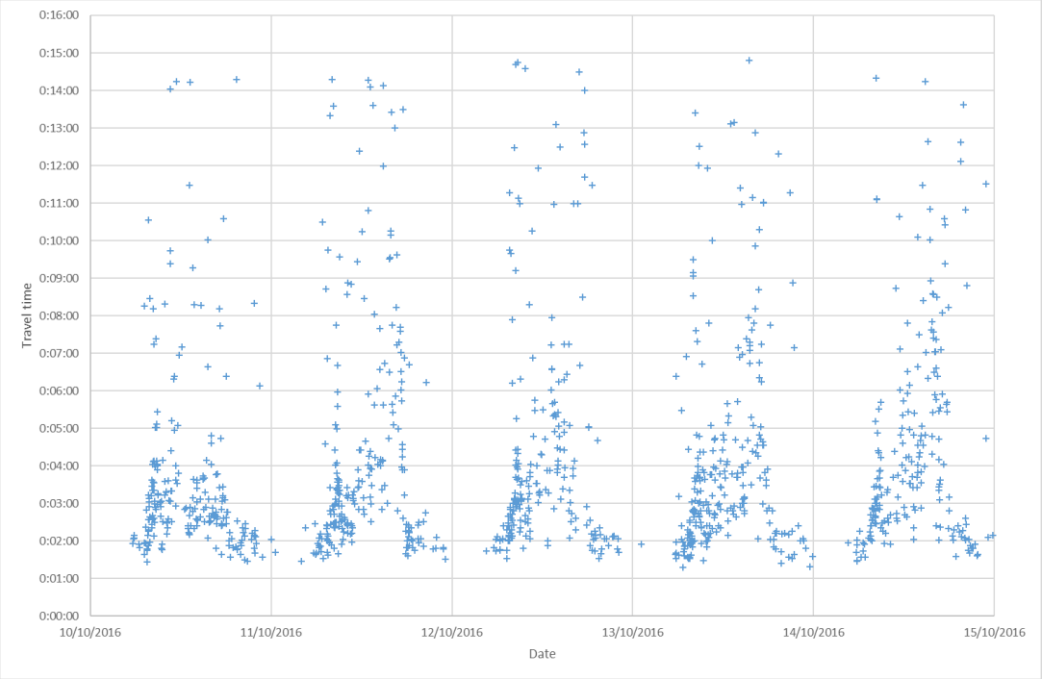
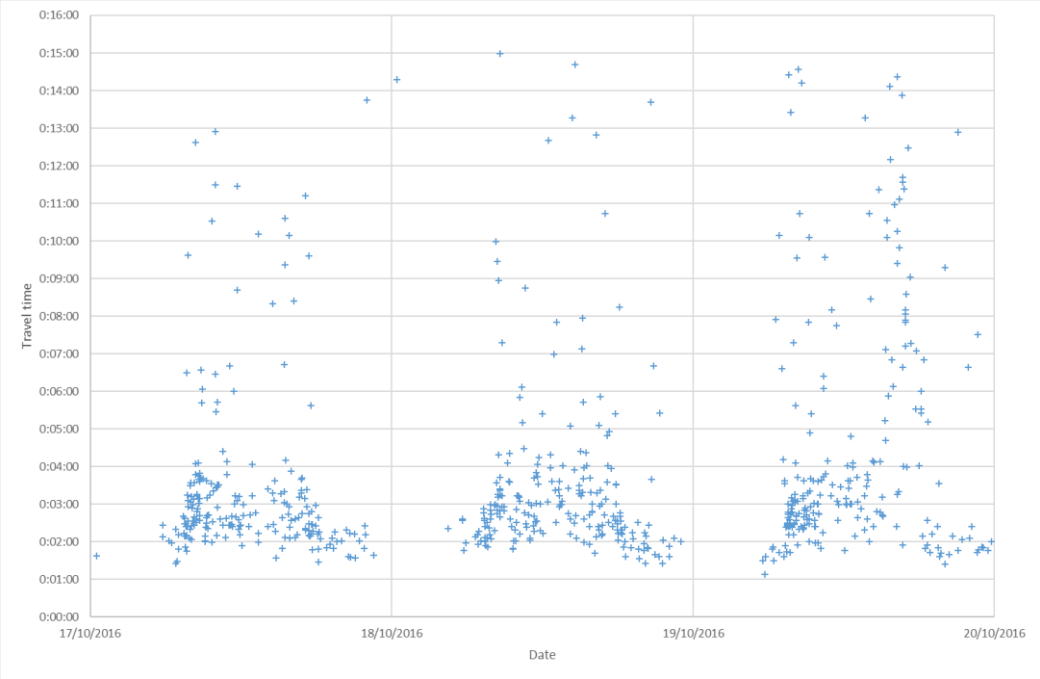


Figure 12 shows that in Week 4, travel times were more tightly clustered than in previous weeks.

Figure 22 Murray Street Travel Times Week 4



Route 4 – Liverpool Street

In response to observed conditions during the first two weeks of the Stage 3 Headworks, an additional route was able to be collected for Week 3 and Week 4.

For Liverpool Street, travel times over 15 minutes were excluded from analysis, based on the distribution of values. Weekend data has also not been considered.

Figure 23 shows the range of travel times observed, and an average travel time in each hour of the day in each week (6:00 am – 6:00 pm weekdays). Travel times tended to be higher during the day and in the PM peak, consistent with the role of Liverpool Street for local access to shops and other CBD facilities. Lane closures associated with the Myer works in Murray Street would also impact on travel times during these times.

Week 4 average travel times were consistently faster than in Week 3, with an improvement of up to 4 minutes in the PM peak period.

Figure 23 Liverpool Street Range of Travel Times

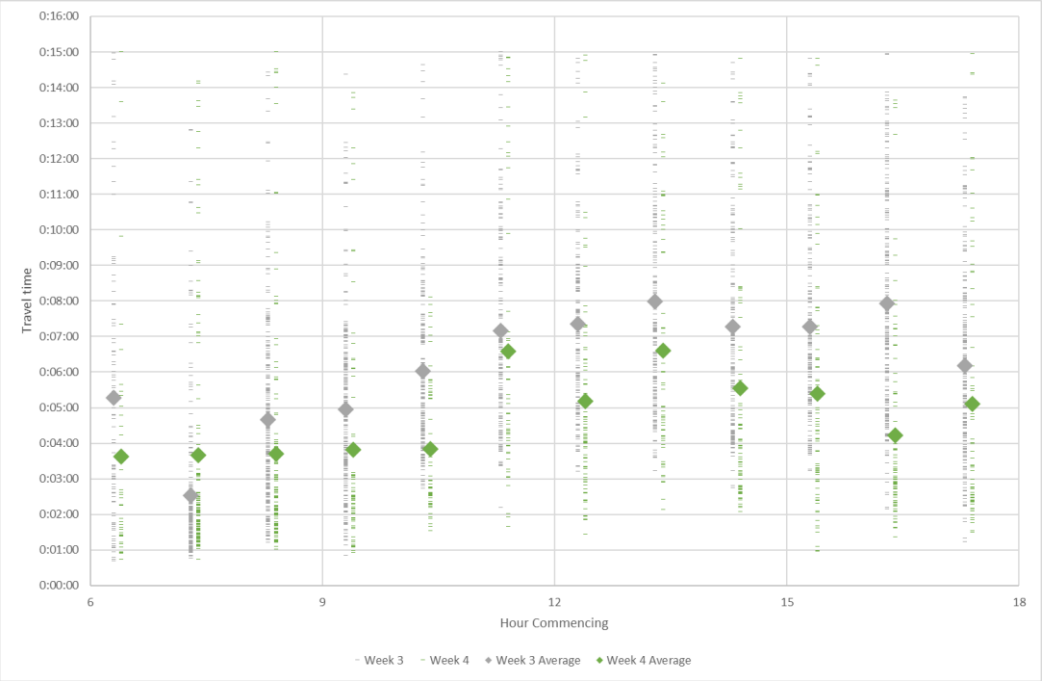
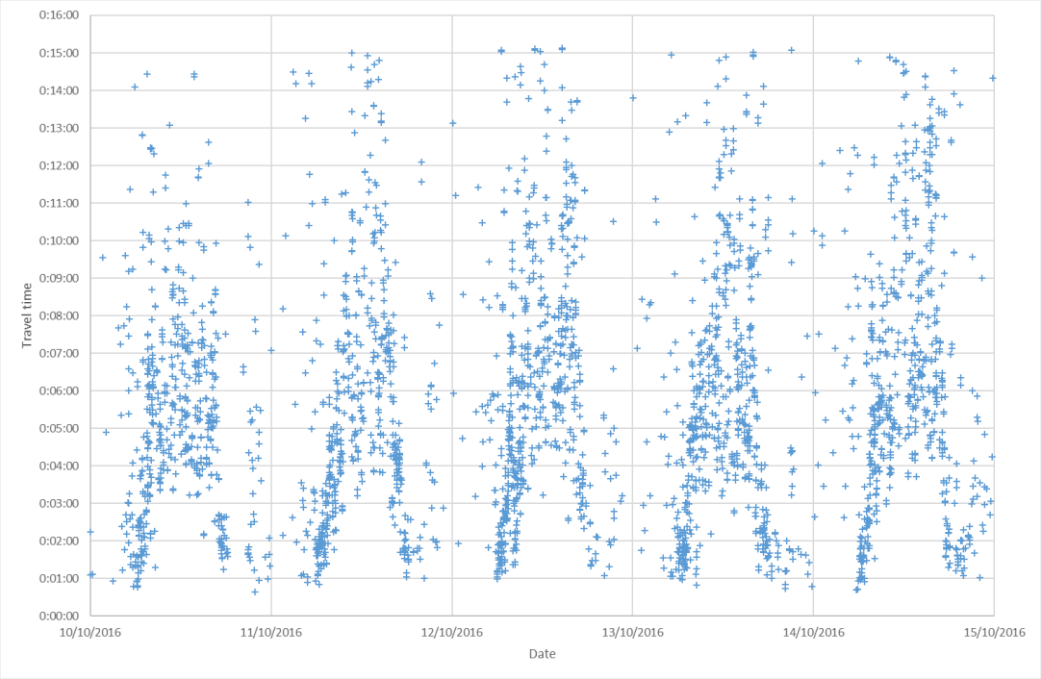


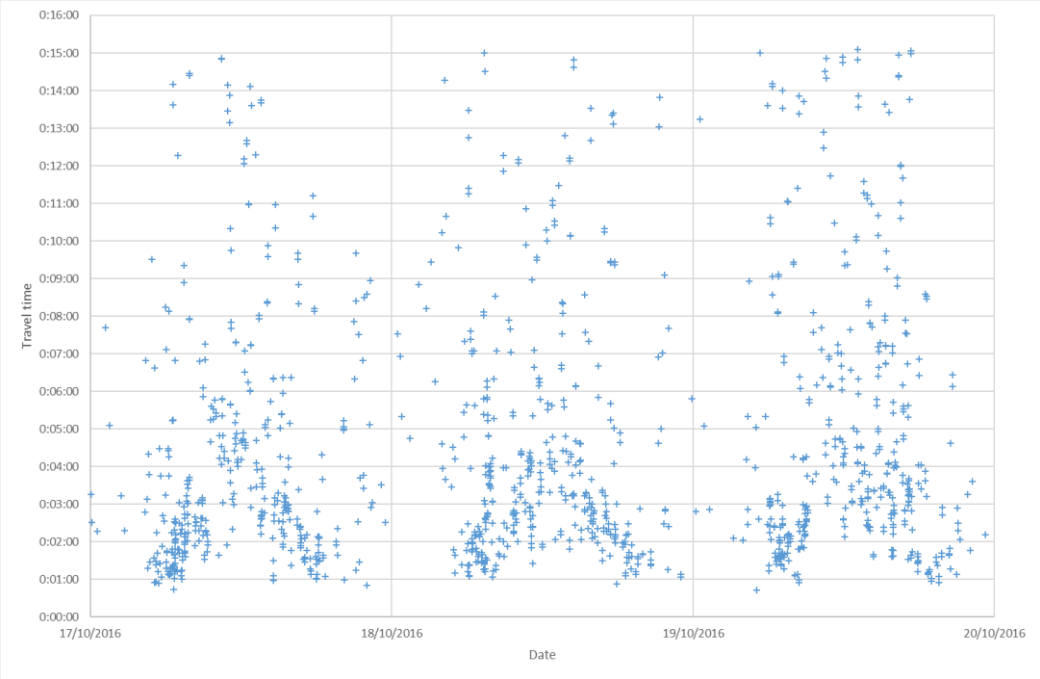
Figure 24 shows the individual travel times for Week 3. Travel times during the middle period of each day are consistently higher than at the beginning and end of each day.

Figure 24 Liverpool Street Travel Times Week 3



In Week 4, as shown in Figure 25, observations are more tightly clustered, without such a large range of values.

Figure 25 Liverpool Street Travel Times Week 4



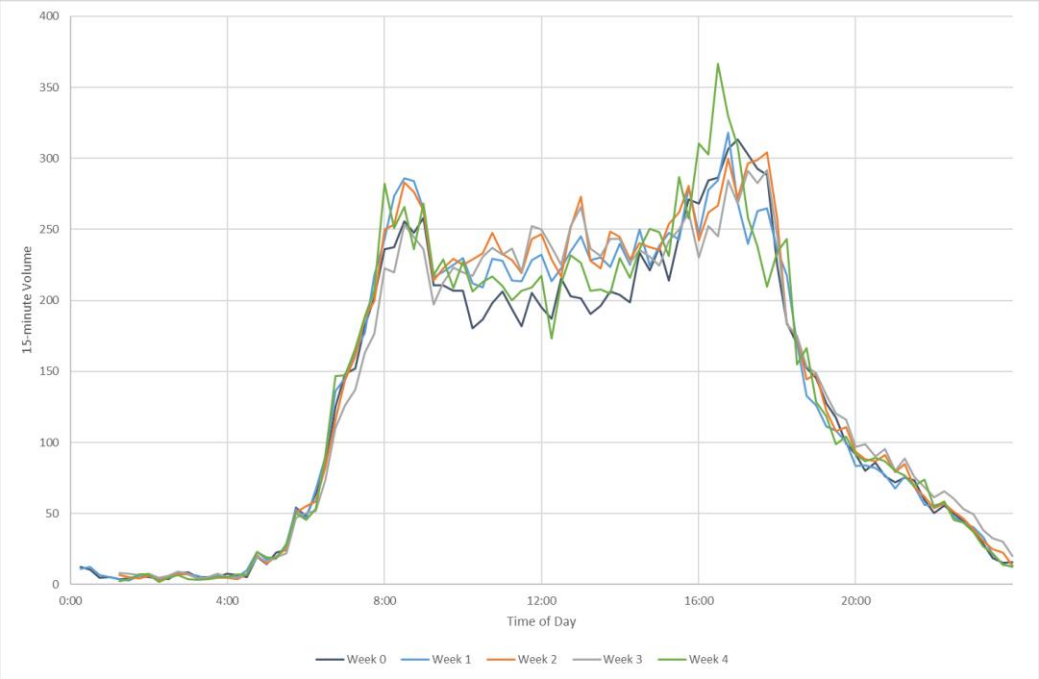
Traffic Diversion

Traffic volume data was obtained from the Department of State Growth for key intersections affected by the Stage 3 Headworks. The volumes were obtained from SCATS loop detectors at traffic signals. It is noted that these do not necessarily provide an accurate vehicle count, but their use in evaluating relative volumes from one week to the next is considered appropriate. Data presented is in 15-minute blocks.

Brooker Highway

The daily traffic profile on the Brooker Highway approaching Bathurst Street is shown in Figure 26. Traffic activity did not vary substantially from week to week, although Week 4 volumes were generally lower than during the Stage 3 Headworks.

Figure 26 Brooker Highway Volumes at Bathurst Street



The estimated increase in traffic using the Broker Highway was approximately 150-200 vehicles per hour in the peak.

Campbell Street

Figure 27 shows the average daily profile of traffic in Campbell Street approaching Bathurst Street, for each week of the evaluation. It can be seen that a similar profile is followed each week, although with less pronounced peaks in Weeks 1, 2 and 3. Week 0 and Week 4 showed the highest volumes, although Week 4 was not as busy as Week 0, suggesting that some traffic which had diverted away from Campbell Street during the works had not returned by Week 4. Figure 28 shows that, on approach to Bathurst Street, there is a more significant difference between Weeks 0 and 4 and the weeks when the Stage 3 Headworks were underway.

Note that during Week 4, night works in Campbell Street resulted in no traffic being able to use Campbell Street downstream of Bathurst Street after 7pm.

Figure 27 Campbell Street Volumes at Bathurst Street

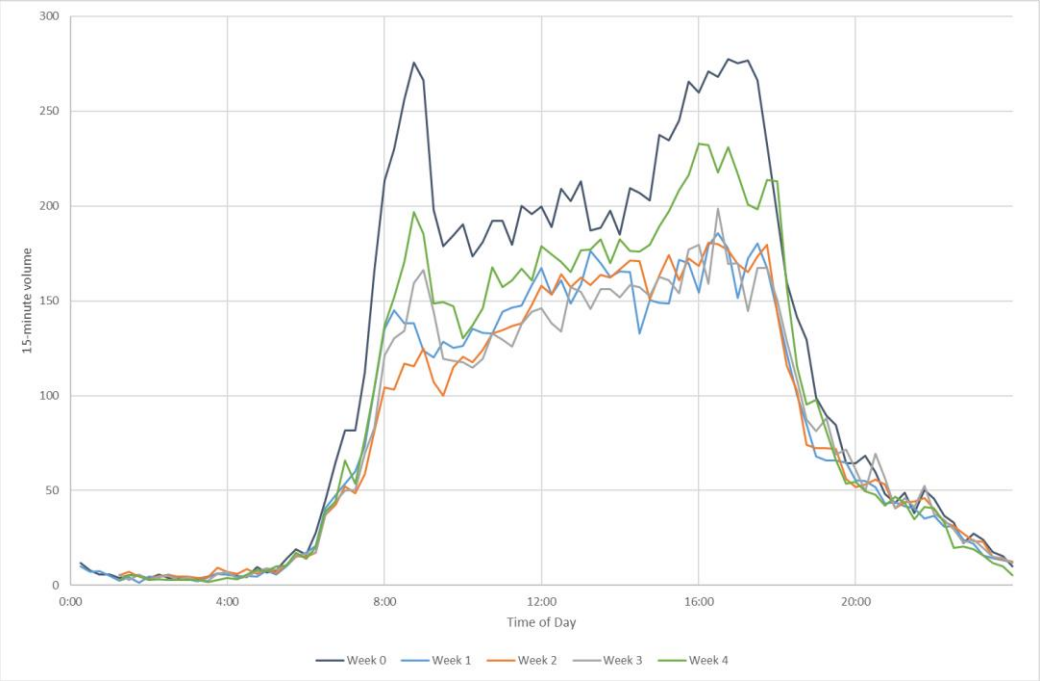


Figure 28 Campbell Street Volumes at Liverpool Street

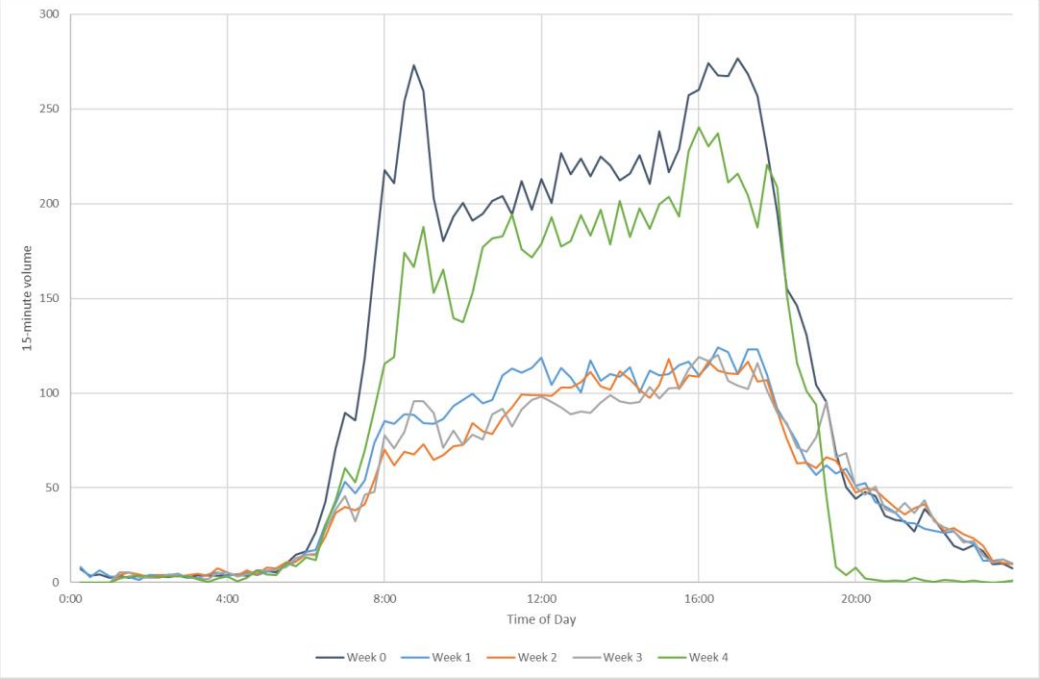
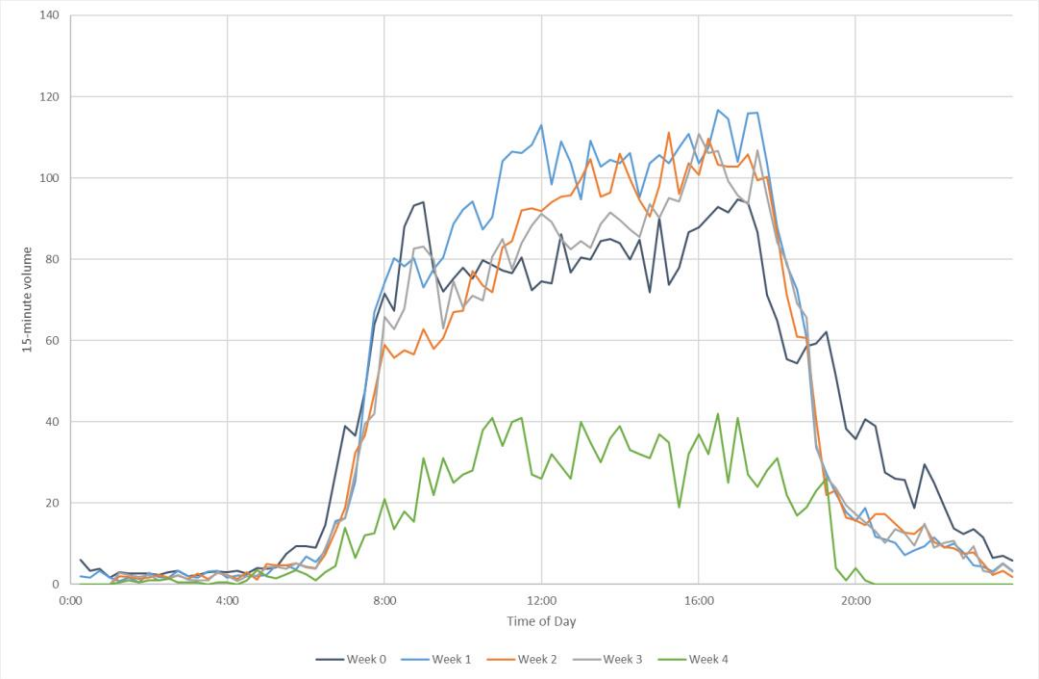


Figure 29 shows the profile of traffic using the right hand lane of Campbell Street at Liverpool Street, which was converted to a right turn lane during the Stage 3 Headworks.

A key feature of this figure is the significant difference in volume between Week 4 and the earlier weeks. In Week 4 traffic was able to continue travelling along Campbell Street, reducing the demand for the right turn into Liverpool Street. In Weeks 1, 2 and 3, all non-bus traffic was being diverted into this lane to turn right. Week 0 volumes in Figure 29 include some traffic which continued along Campbell Street, as this lane is a shared through and right turn lane.

Figure 29 Campbell Street Right Turn Volumes into Liverpool Street



Liverpool Street

Liverpool Street remained open during the Stage 3 Headworks, but Figure 30 illustrates the impacts of the left turn into Campbell Street being unavailable (buses excepted). An AM peak of over 80 vehicles per 15 minutes was recorded in Week 0, with all of these vehicles needing to divert to either another route, or continuing straight ahead on Liverpool Street.

Figure 30 Liverpool Street Left Turn Volumes into Campbell Street

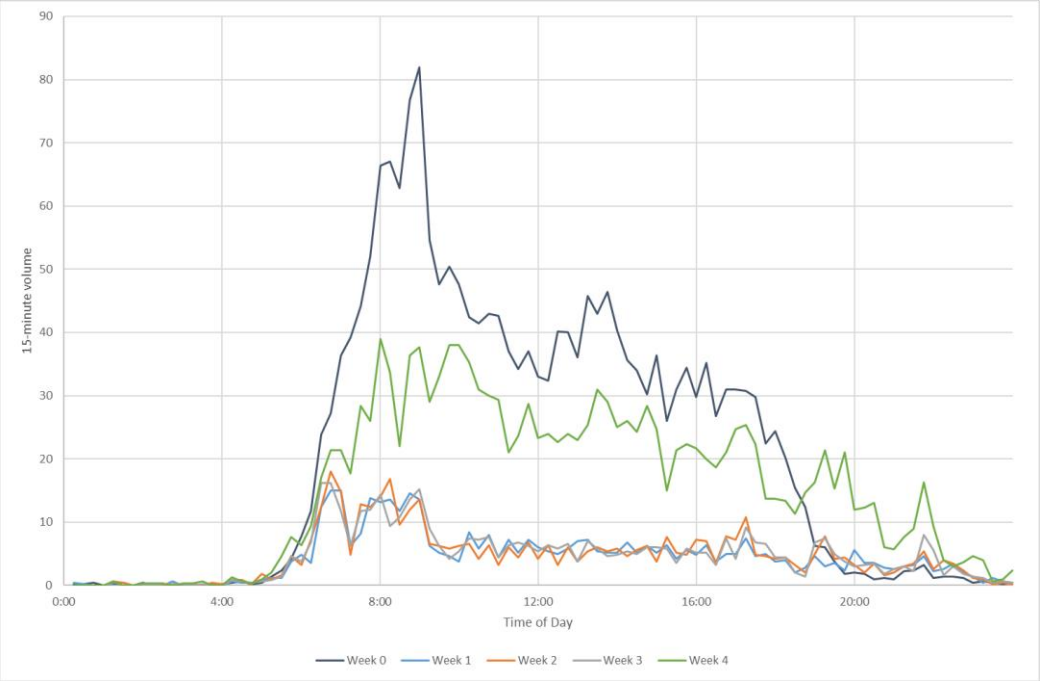
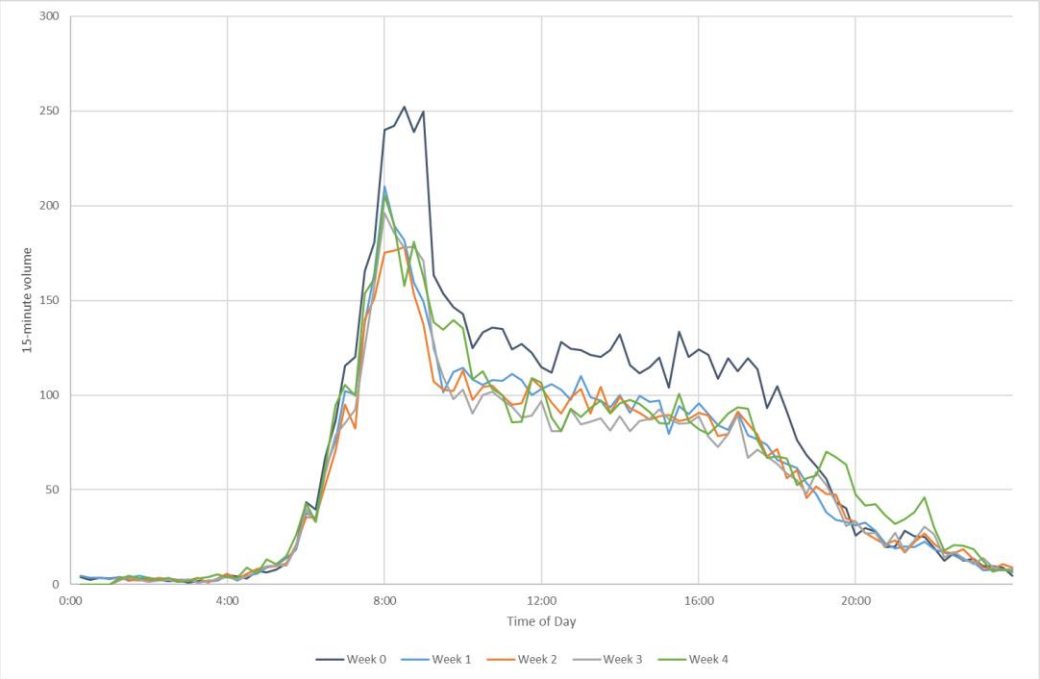


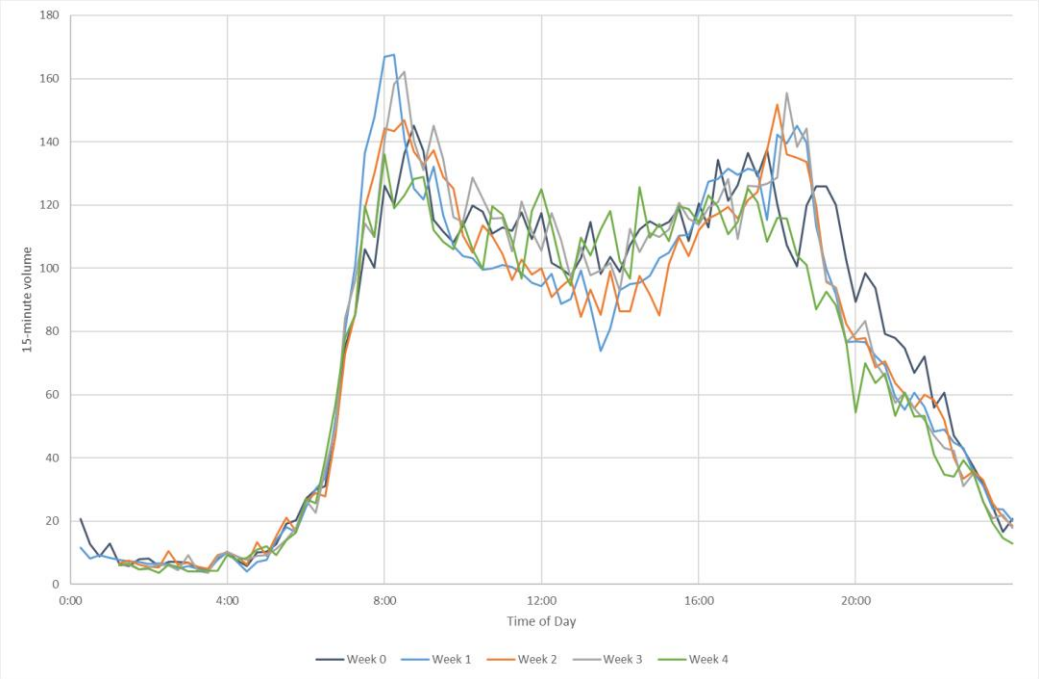
Figure 31 shows that total volumes in Liverpool Street followed a similar daily profile as Week 0 in Figure 30, despite the absence of the left turn. This suggests that most traffic that previously turned left into Campbell Street continued along Liverpool Street instead.

Figure 31 Liverpool Street Volumes at Campbell Street



Interestingly, as shown in Figure 32, volumes in Liverpool Street at Murray Street were relatively consistent week to week, despite the increase in volume at Campbell Street. This may be due to the presence of slow-moving traffic (refer Section 0) that limits the accuracy of the SCATS loop detectors for counting. More likely is that traffic diverted away from Liverpool Street to either Argyle Street or Elizabeth Street.

Figure 32 Liverpool Street Volumes at Murray Street



Bluetooth Records

Although the Bluetooth data is only of a sample of road users, if it is assumed that the relative sample is consistent from one week to another, then the number of records obtained can be tracked to provide an alternative measure of changes in traffic activity.

Table 3 and Table 4 show a comparison of the number of Bluetooth records obtained along each route compared to Week 4, in the AM and PM peak periods respectively.

Weeks 1 and 2 were during the school holidays, when a reduced traffic volume is expected. Therefore Week 3 provides the best indication of diversion as a result of the Stage 3 Headworks. In the AM Peak period, there were 30% fewer records in Campbell Street compared to the following week once the Stage 3 Headworks were completed. The Brooker Highway recorded an additional 13% (equivalent to the 30% reduction in Campbell Street in terms of Bluetooth records), while the number of records in Murray Street and Liverpool Street were similar to Week 4, suggesting that there was minimal diversion to these routes.

Table 3 Bluetooth Records (average day) as a proportion of Week 4 – AM Peak Period

Route	Week 1	Week 2	Week 3	Week 4
Brooker Highway	-6%	-3%	+13%	100%
Campbell Street	-19%	-33%	-30%	100%
Murray Street	-21%	-25%	-2%	100%
Liverpool Street	n.a.	n.a.	-2%	100%

In the PM peak, Campbell Street records were reduced by almost 50% compared to Week 4, while the Brooker Highway increased by 24%.

Table 4 Bluetooth Records (average day) as a proportion of Week 4 – PM Peak Period

Route	Week 1	Week 2	Week 3	Week 4
Brooker Highway	-15%	0%	+24%	100%
Campbell Street	-35%	-33%	-48%	100%
Murray Street	-14%	-29%	-17%	100%
Liverpool Street	n.a.	n.a.	+43%	100%

The reasons for the lower number in Murray Street, and higher number in Liverpool Street, is not readily apparent.

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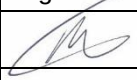
Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	T. Bickerstaff	M. Petrusma		T. Bickerstaff		23/2/18

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