Transport for NSW

Sydney Light Rail

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CBD AND SOUTH EAST LIGHT RAIL PROJECT
ENVIRONMENTAL IMPACT STATEMENT

NOVEMBER 2013

VOLUME 2
Technical Papers 1 and 2

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Transport for NSW

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ENVIRONMENTAL IMPACT STATEMENT – VOLUME 2

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Contents of the EIS

This volume

CBD AND SOUTH EAST LIGHT RAIL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2

Technical papers

TECHNICAL PAPER 1: TRANSPORT OPERATIONS REPORT

TRANSPORT OPERATIONS REPORT

FINAL
REPORT

TRANSPORT
FOR NSW

6 NOVEMBER
2013

SYDNEY

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Table of Contents

List of Figures

List of Tables

Executive Summary

Purpose of the Report

This report documents the traffic and transport assessments undertaken for the permanent (operational) changes associated with the CBD and South East Light Rail (CSELR) proposal, including:

- The management and operation of:
  - traffic and transport integration;
  - access to key light rail stops and interchanges (considering customer access by bus, private vehicle, foot, bicycle, light rail, heavy rail, and ferry);
  - traffic once the CSELR proposal is in operation; and
  - pedestrian, cyclist and traffic and transport safety[1]
- The integration of traffic and light rail within the road environment
- Intersection analysis validating the proposed traffic management changes for intersections directly along the corridor
- Parking and access strategy including an assessment of the impact of light rail on:
  - vehicular access to properties located along the proposal corridor;
  - kerbside access including parking, loading zones, bus zones; and
  - the provision for emergency vehicle access, refuse collection vehicles and other service vehicles
- Special events analysis, to assess the compatibility of light rail with special events (such as street parades, major sporting and cultural events) along the proposal corridor.

It is one of a number of technical documents prepared to support the planning approvals process for Transport for NSW's (TfNSW) State Significant Infrastructure Application for the CSELR proposal under Part 5.1 of the NSW Environmental Planning & Assessment Act 1979 (EP&A Act).

Strategic Context

Since November 2011, the NSW Government has been developing a number of transport strategies to underpin the NSW Long Term Transport Master Plan (LTTMP) – the guiding blueprint for the allocation of infrastructure investment and delivery of transport services in NSW. As illustrated in Figure 0-1 one key supporting document is the Sydney City Centre Access Strategy (CCAS), which outlines a suite of initiatives to dramatically and meaningfully improve the way the CBD transport system operates. Two critical projects which form part of the CCAS are the CSELR project and pedestrianisation of George Street. Planning approval for these two projects is currently being sought as part of the CSELR Environmental Impact Assessment.

Other components of the CCAS are anticipated to be implemented over a number of years, but complementary to and in coordination with the CSELR proposals. One component of the CCAS of particular relevance to the CSELR is the city centre bus network redesign. These bus changes are being prepared in parallel with development of the CSELR proposal and will be consistent with the CSELR proposal. These will not, therefore, form part of the EIS for the CSELR proposal, with the exception of cumulative impact considerations.

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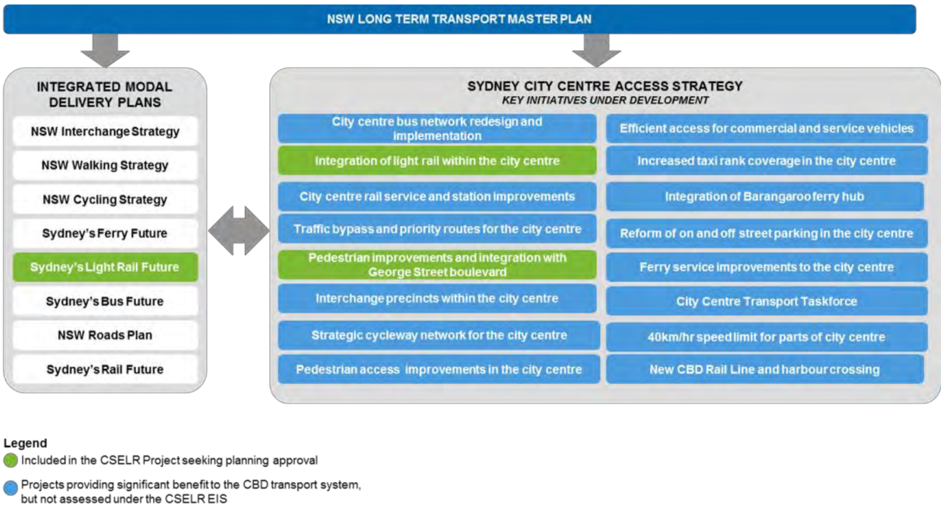
[1] For detailed guiding principles for light rail customer safety, please refer to the Light Rail Operational Service Plan Report by Interfleet.

Figure 0-1: Transport for NSW Strategic Framework



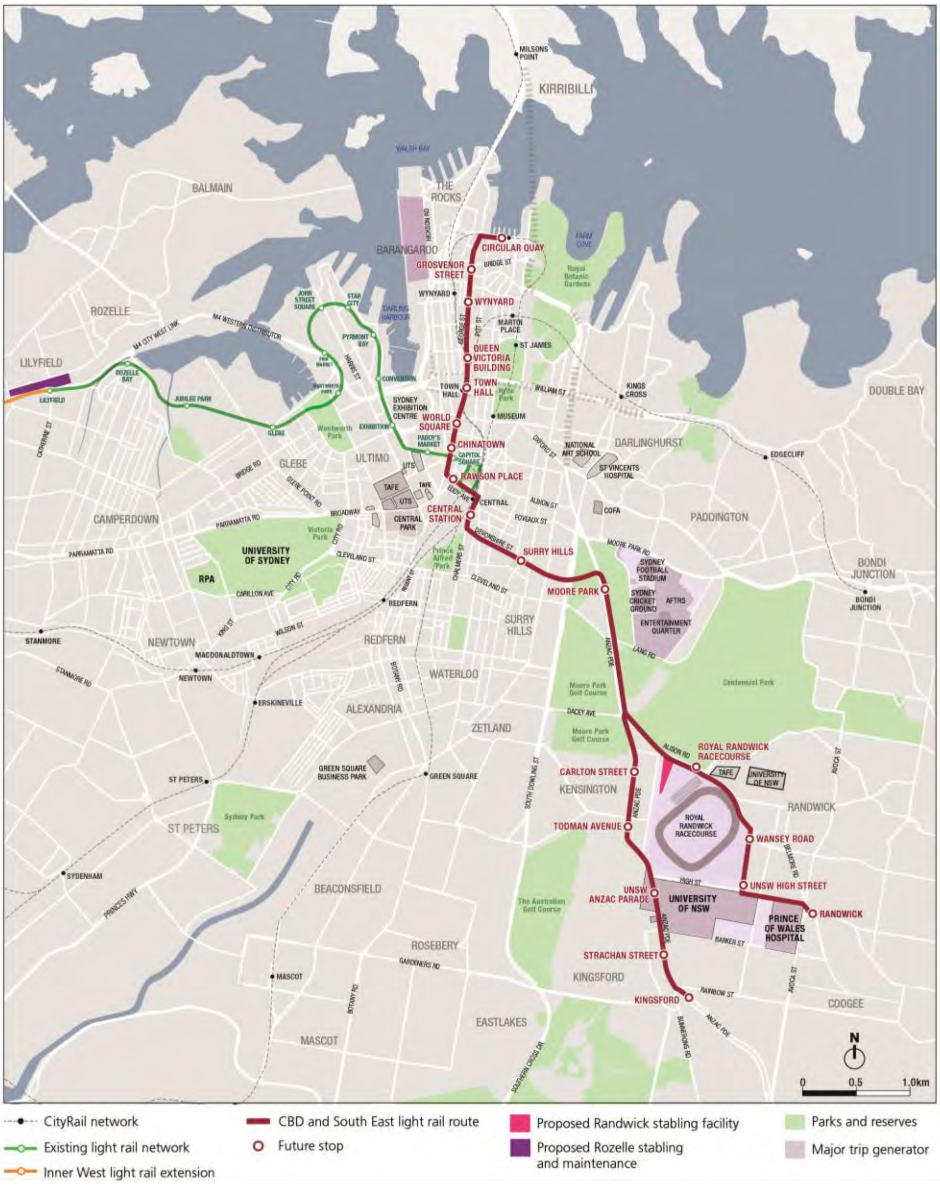
The CCAS will provide an integrated solution aimed at improving amenity, transport capacity and reliability within the CBD and South East.

The introduction of light rail will fundamentally change the way transport services are delivered and used within Inner Sydney. Aligned with the NSW 2021 transport goals, the construction of a new high-capacity, frequent and reliable mode of transport presents a rare opportunity to integrate the surrounding road and public transport system to unlock additional capacity and provide a better experience to customers who rely on the system every day through providing safe journeys and reduced travel times. Historically, Sydney has relied on a radial public transport system where each ‘spoke’ entered the City Centre independently. With light rail as a ‘trunk’ line, it can be integrated with a reorganised surrounding surface public transport system to provide significant customer benefits, including enhanced accessibility and mode share connectivity, and improve the efficiency of the network as a whole.

The CSELR Project

In December 2012, the NSW Government announced that it would extend light rail from Circular Quay to Kingsford and Randwick, through the heart of the Sydney CBD via George Street as illustrated in Figure 0-2. The Project comprises 20 stops, and will integrate with both the bus network and heavy rail stations at Circular Quay, Wynyard, Town Hall and Central. Services will be provided by 45 metre low-floor light rail vehicles, providing capacity for up to 300 customers (the equivalent of five standard length buses). The line will operate in a dedicated light rail lane, minimising competition with other modes of transport such as cars and buses. In addition, light rail will be given signal priority at intersections where possible to deliver a 97% level of service reliability – substantially better than existing bus services.

Figure 0-2: Route of the CBD South East Light Rail Project



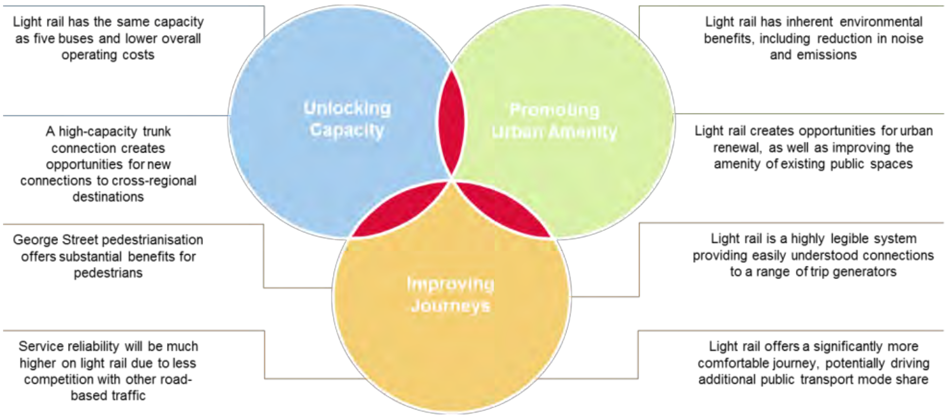
Case for Change

Delivery of the CSELR project addresses a number of deficiencies of the existing transport system in Inner Sydney, which highlight the cost of doing nothing. The key deficiencies include:

- Current levels of congestion are restraining economic development, with the avoidable cost of congestion in Sydney equalling more than $3.5 billion per year and predicted to rise to $7.8 billion by 2020;
- The capacity of buses to continue providing the lion's share of service is limited due to the significant number of services currently operating in the City Centre (around 1,600 in the 2 hour morning peak) causing service quality to substantially degrade on a regular basis;
- The CBD and South East (CSE) corridor does not have the capacity to support the growth of the existing bus-based transport system due to limited road space, constrained access to the CBD and the impracticality of constructing additional surface road capacity;
- The performance of the existing public transport system in the CSE corridor is not meeting community expectations. Analysis suggests the proportion of bus services arriving at the CBD within 2 minutes of their scheduled time is between 19 and 34 per cent; and
- Significant growth in Inner Sydney – including an additional 99,000 residents and 140,000 workers in the City of Sydney as well as 24,000 new residents and 13,000 new workers in the Randwick Local Government Area (LGA) – will place increasing pressure on Sydney's ageing public transport infrastructure.

The CSELR project offers a number of benefits that can address these challenges, summarised in Figure 0-3.

Figure 0-3: Potential Benefits from the Introduction of the CSELR[2]



These benefits are substantial, and flow from a co-ordinated and well-planned shift to a higher order transport system. This is because:

- Light rail provides substantial additional capacity compared to the existing bus solution. A single light rail vehicle can carry the equivalent of five standard rigid buses while using the same road length as just three buses;
- It also provides significantly improved reliability – by operating in a segregated environment without competition for road space, light rail can achieve service reliability of 97 per cent;
- Light rail can facilitate the reorganisation of the public transport network to provide additional cross-regional connections and improved access to key destinations;

[2] Booz & Company analysis

- Light rail is also more legible than the current transport system, attributable to comprehensible signage and clarity in the fixed design of the routes and stops, making it much easier for customers unfamiliar with the system to travel with ease.

Light rail as a catalyst for change

Introduction of the CSELR project provides a once-in-a-generation opportunity to transform the structure, operation and performance of the CBD and South East transport system to improve efficiency and deliver substantially improved customer outcomes. With light rail providing significant line haul capacity and reliability compared to buses on the trunk routes of Alison Road and Anzac Parade, an opportunity exists to redesign the surface transport system to provide simple, fast connections to CBD destinations and more direct cross-regional connections without the need to pass through the CBD.

Of course, as with introduction of any project of this scale into a congested urban environment there are a number of impacts on existing surface transport system users. These constraints are summarised in Table 0-1.

Table 0-1: CSELR Traffic & Transport Constraints[3]

Category	Traffic & Transport Constraints
Network Operations	▪ General traffic lanes occupied by light rail ▪ Potential for increased competition for road space between private vehicles and public transport in some locations ▪ Capacity of alternate streets to absorb displaced traffic ▪ Continued operation of bus priority with changes to bus lanes ▪ East-west traffic flow might be impacted where traffic has to intersect with light rail
Access	▪ Road operations changed which may limit access to some destinations ▪ Potential for bus diversions that limit convenient and direct access to CBD rail stations for interchanging customers ▪ Ability of local residents to access bus stops and local facilities ▪ Footpath width and layout may constrain access to light rail stops
Amenity	▪ Noise generated by light rail operations and passengers accessing light rail ▪ Noise generated through diversion of traffic onto secondary streets
Customer Experience	▪ Slower journey times for some customers ▪ General traffic lanes occupied by light rail ▪ Some customers might experience have to interchange due to changes in bus services ▪ Pedestrians required to adopt changes in behaviour to ensure personal safety
Kerbside Uses	▪ Loss of parking in some areas ▪ Limitations on kerbside uses (taxi ranks, service deliveries etc.)
Supporting Infrastructure	▪ Footpath capacity in some locations ▪ Ability to provide cycling infrastructure

[3] Booz & Company analysis

This report documents the significant investigations that were undertaken to determine the best way to integrate light rail into the surface public transport system, while managing those constraints. In particular, integration and network design issues were examined for:

A. Road network design including benefits, impacts and mitigations in the CBD, Surry Hills, Moore Park, Randwick and Kingsford;

B. Road network performance including indicative assessments of the impact of CSELR on road network carrying capacity;

C. Improvements to bus network design including cross-regional connections;

D. Delivery of integrated and convenient multi-modal access at each light rail stop; and

E. Assessment of the impacts experienced by a range of kerbside uses and proposed mitigation strategies to manage those impacts.

These five areas are discussed in more detail below to determine appropriate mitigations to the impacts of the Project. Potential mitigations were examined in three categories to determine the best approach to manage project effects on the community. These are summarised in Figure 0-4. This framework was used when examining and determining the best response to project impacts in each of the categories described above.

Figure 0-4: Traffic & Transport Impact Management Framework[4]

- Where practical, project impacts will be avoided to reduce the likelihood and magnitude of their impacts on the community
- For instance, if it is possible to avoid reduction of general traffic lanes through design specification, this would be pursued
- In addition, where impacts can be avoided during particular time periods or construction phases (for instance through reducing the time span in which particular turns are banned) this would also be pursued in the first instance

- Where possible, project impacts will be mitigated or controlled to ensure the negative effect on the community is minimised
- For instance, traffic displaced from existing routes may degrade the performance of other corridors. This could be mitigated through provision of alternate routes or targeted traffic management measures.

- Finally, if it is not possible to avoid or mitigate project impacts these will be accepted and alternatives provided to ensure the community still has appropriate access to the transport network and key destinations
- This may involve provision of alternative transport modes along key corridors, or through temporary access routes to stops and interchanges for pedestrians

[4] Booz & Company analysis

(A) Integrating with the road network

A light rail system, by its nature as a road based public transport mode, needs to be designed into the road network and requires detailed consideration of all modes and associated management issues in all precincts along the corridor. Ultimately, the objective of this project is to maximise the level of passenger carrying capacity along the corridor and ensure a superior customer experience that encourages a mode shift from private vehicles. To achieve this, a number of key network changes are proposed including:

- A notable increase in public transport carrying capacity along the corridor;
- Pedestrianisation of sections of George Street and Alfred Street in the CBD;
- Development of significant transport interchanges at Circular Quay, Rawson Place, Chalmers Street, Randwick and Kingsford; and
- Re-prioritisation of the road hierarchy and kerbside uses in the CBD, Surry Hills, Randwick, Kensington and Kingsford.

CBD Precinct

The most significant change in the CBD is the transformation of George Street from a vehicle-based north-south corridor in the CBD to a part-pedestrianised public transport spine for the City, dedicated to the efficient delivery of light rail services to the heart of the City.

The pedestrianised zone delivered in conjunction with light rail yields substantial sustainability and amenity benefits through the provision of high-quality, safe and comfortable pedestrian connections through the heart of the CBD. However, the impacts on displaced traffic need to be acknowledged, and this report examines appropriate mitigation strategies to manage those consequences. Within the pedestrianised zone, no through traffic lanes are provided on George Street with vehicle restrictions ensuring only local access, service and emergency vehicles are permitted. Those vehicles that do access this section of George Street will travel adjacent to the light rail alignment in a shared zone environment. Cross-city connections in the East-West direction will be maintained through the pedestrianised zone.

Outside of the pedestrianised zone, the standard George Street cross section will consist of a single kerbside traffic lane in each direction with centre running light rail. This will reduce the importance of George Street as a route for through running traffic.

Chalmers Street has been designed as a major interchange between light rail and heavy rail at Central Station. The stop will be located on the western side of Chalmers Street, which will reduce the number of lanes available to buses and general traffic. Current planning allows from buses to be retained in Chalmers Street (using the third – special events only – light rail lane). These services will be permitted to proceed into Elizabeth Street. To compensate for the removal of general traffic lanes in this location, Randle Street will be reversed from one-way southbound to one-way northbound to enable a connection to the northbound lanes introduced on Elizabeth Street.

In addition to the significant changes on George Street, other changes in the CBD will affect the flow of vehicle based traffic through the City. These include:

- Conversion of Pitt Street to two-way operation between Bridge and Alfred Streets;
- Addition of a turning circle at the northern terminus of Pitt Street;
- Conversion of Hunter Street between Pitt and George Street to two-way operation providing enhanced connectivity to the east and west;
- Construction of a significant bus-light rail interchange in Rawson Place facilitating cross-platform interchange between bus and light rail for a significant number of customers travelling south-west of Railway Square along Broadway;

- Construction of the light rail line on the southern side of Eddy Avenue, requiring the relocation of existing coach facilities to a dedicated 4.5 metre wide island coach platform accessed (by coaches) from the existing Eddy Avenue traffic lanes.

Surry Hills Precinct

In the Surry Hills precinct, (on Devonshire Street) significant changes are required to facilitate provision of light rail in the southern lanes. The primary changes include:

- Delivery of a single eastbound traffic lane;
- Existing right turn movements for vehicles travelling eastbound along Devonshire Street wishing to head south are consolidated to Elizabeth Street and Crown Street only;
- A number of connecting streets will be closed at the Devonshire Street intersection; and
- No provision for parking would be accommodated along Devonshire Street.

To mitigate these local access impacts, a number of network changes are proposed to improve accessibility whilst maintaining the benefits to light rail operations including:

- Signalising of the intersection of Devonshire Street and Marlborough Street;
- Signalising of the intersection of Devonshire Street and Bourke Street;
- Reinstatement of the Cooper Street connection to Riley Road; and
- Introduction of a westbound service lane connection between Bourke Street and Crown Street.

Moore Park Precinct

Light rail is anticipated to exit Surry Hills through the site currently occupied by Olivia Gardens, a residential apartment block, crossing South Dowling Street at grade before entering a cut and cover tunnel across Moore Park. The alignment will then be tunnelled under Anzac Parade to minimise traffic impacts to Anzac Parade during construction. To manage traffic in this area, southbound and northbound traffic on South Dowling Street will be controlled by signals. The light rail will then travel within Moore Park until it reaches the Alison Road / Anzac Parade intersection, where it splits into two branches.

Randwick Precinct

On Alison Road, light rail is proposed to operate within the existing busway alignment on the north/east side of the road as far as Doncaster Avenue, facilitating the retention of existing traffic movements and lane configurations in the northern section of Alison Road. At Doncaster Avenue the alignment crosses Alison Road to run adjacent to the racecourse, and continues on the southern side of Alison Road before turning into Wansey Road. Corridor width restrictions have restricted city bound traffic to two through lanes adjacent to the Darley Road/Alison Road intersection. On-street parking has also been restricted in this section of the corridor.

The design alignment for Wansey Road is located on the western edge of Wansey Road. Two-way traffic is retained, but on-street parking is removed. The cycleway and footpath will be retained on the western side.

Light Rail operates in the eastern section of High Street between Wansey Road and the Randwick terminus adopting a 'centre-running' arrangement with a single kerbside traffic lane in each direction. High Street is an important cross-regional bus route, and is used by a significant number of students, staff and visitors seeking to access the University of New South Wales (UNSW) and Prince of Wales Hospital. Other key design issues include:

- Introduction of traffic signals at the intersection of High Street and Hospital Road, as well as the intersection of High Street and Clara Street;

- Consolidation of the vehicular entrance at the Adult hospital to a four way intersection at Clara Street;
- Restriction of access to Eurimbla Avenue to Left in Left out;
- Additional parking restrictions and removal of parking spaces on High Street and Wansey Road;
- Provision for indented bus bays for westbound buses on High Street adjacent to the Adult hospital and between Botany Street and Wansey Road;
- Provision of bus stops in Clara Street;
- Removal of the eastbound bus stop in High Street, between Wansey Road and Botany Street is required. Eastbound buses will use the existing bus stop in High Street, west of Wansey Road and the new stop in Clara Street; and
- Relocation of the westbound bus stop adjacent to the Children's Hospital emergency entrance to Clara Street, with access to the hospital via a signalised intersection.

Kingsford Precinct

On Anzac Parade, light rail is proposed to operate in the median for virtually the full length of the alignment except for the section next to Moore Park, where light rail will run adjacent to the existing bus roadway (which will be retained). The significant available width of this corridor has permitted the retention of at least two general traffic lanes in each direction, with a third lane provided for peak hour bus priority and off-peak local parking where possible.

Due to the operation of light rail in the median, a reduction in permitted right turn locations has been required south of Alison Road. Right turns off Anzac Parade would be restricted to:

- A southbound right turn into Dacey Avenue;
- A southbound and northbound right turn into Todman Avenue;
- A northbound right turn into High Street; and
- A southbound and northbound right turn into Barker Street.

Existing right turn movements from signalised side roads into Anzac Parade will be retained.

Other design considerations in this area included:

- A fully integrated station design at the Kingsford terminus, permitting cross-platform interchange for the significant volume of customers expected to access the CSELR by bus;
- A shared running arrangement between the Kingsford terminus and Meeks Street, providing an opportunity to deliver operational priority for buses while also improving the functioning of the Gardeners Road/Anzac Parade intersection.

(B) Road Network Performance

Introduction of the CSELR and associated bus network changes in the CBD and South East will result in a considerable change to current traffic operating patterns. Providing a segregated route for the light rail to maximise public transport network carrying capacity will necessarily displace some road-based traffic. Traffic is expected to adopt one of three alternative behaviours:

- **Change mode** – current road users may change mode from private vehicles to public transport, taking advantage of reduced journey times and improved reliability provided by the light rail system;
- **Change time of travel** – increasingly flexible working arrangements provide some commuters with the ability to adjust their time of travel to avoid the most congested periods of the day; and
- **Reroute to other corridors** – displaced traffic will seek alternative routes that provide a lower level of delay, though the levels of congestion in the region provide limited alternative options.

The reallocation of road space from traffic lanes to light rail operation will result in a change to existing traffic patterns on and around the corridor. These traffic volume impacts have been assessed and determined through the mesoscopic modelling traffic assessment independently undertaken. This model provides an indication of key flow changes across the wider road network, specifically identifying those corridors that experience a significant change in traffic volumes to existing levels.

By the year 2021 traffic volumes in the study area are forecast to grow by 7% without the implementation of light rail. As a result of this growth on the network average vehicle speeds would likely reduce by approximately 10% from current levels.

Implementation of light rail is forecast to reduce this level of traffic growth by 1% as a result of the positive effect it has on public transport mode share. Whilst the reallocation of road space from general traffic to light rail reduces traffic capacity on the corridor modelling indicates it does not significantly impact functionality of the wider network.

Broadly speaking the traffic analysis demonstrates that the CSELR project can be introduced into the road network without significant detrimental impact to general traffic and buses. A number of key intersections have been identified where further design and optimisation work is underway, to provide increased capacity.

To address the effects of the identified future traffic patterns, TfNSW and RMS are working together to develop an appropriate Network Management Plan (NMP). This includes intersection modifications, traffic signal changes and traffic management measures that integrate to deliver the overall strategy for network operations with CSELR in place. This work is ongoing and the modelling assessment undertaken to date represents the first stage in the development of this wider NMP. As this plan is refined further improvement to the operation of the network is likely to be achieved.

(C) An improved and connected bus network

Light rail presents a significant opportunity to redesign bus routes in the corridor around the principles of a 'connected' network – providing high frequency and reliable connections to a light rail system that acts as a higher capacity, reliable and fast trunk line to the CBD. This will free up existing buses to service other destinations and unlock greater capacity in the transport network, as well as delivering sustainability benefits of reduced buses within the congested Sydney CBD. These changes are being developed as a separate project, however a summary of the future bus network is provided in this report to illustrate light rail's position within an integrated transport system.

The South East bus network has been developed based on a number of principles developed in consultation with Transport for NSW to ensure that in specifying the future bus network, the overall objective of maximising public transport network performance and usage, and successfully integrating bus and light rail services, was upheld.

Overview of the proposed network

The broad features of the proposed bus network for the CSELR in the South East area are summarised as follows:

- The majority of existing All-Stop CBD bus services which operate along Alison Road and Anzac Parade in duplication of the CSELR will no longer operate to the CBD but become feeder routes for the Light Rail;
- The only exceptions to the above are Routes 372 and Route 339 which are retained to provide bus service coverage in Cleveland Street and Albion/Foveaux Streets respectively;
- Cross-regional bus service connections are improved to provide greater access to the CSELR and to provide new cross regional connections which reduce the need for customers to travel through the CBD to access major centres such as Bondi Junction, Green Square and the Airport;
- University Express Bus Services provided between Central Station and the UNSW would be replaced by the CSELR;
- School Special Bus Services provided between Central Station and Sydney Boys High School and Sydney Girls High School would be replaced by the CSELR; and
- Special Event bus services provided between Central Station and the Moore Park Precinct and Randwick Racecourse during events would be replaced by the CSELR and may be reallocated to provide new connections to the special events precincts and together with light rail grow public transport mode share to major events.

Sydney City Centre Bus Network Redesign

In conjunction with the development of the south east corridor bus network the Sydney city centre bus network redesign was undertaken to develop the bus network within the Sydney CBD. The redesign seeks to provide improved legibility and access for existing and future customers to use buses, while the buses are operated more efficiently on city streets and into the City Centre via the gateways. The objectives are summarised below (with additional detail available in the City Centre Access Strategy):

- Create a simpler, all-day City Centre bus network;
- Accommodate high volumes of buses through the City Centre more efficiently with fewer turns and more bus priority; and
- Minimise the need for terminating services in the City Centre and provide sufficient capacity at conveniently located layover facilities.

(D) Delivering integrated and convenient multi-modal access

Ensuring delivery of a successful and well-utilised light rail system requires consideration of the full suite of access modes for the entire system. Demand modelling undertaken for the Project provides an indication of the preferred mode of access to each light rail stop in the future and was used to guide the development of multi-modal access strategies for each stop. These would ensure that pedestrian, cycling, bus transfer, kiss-and-ride, local parking, taxis, heavy and light rail, ferries and car share access were all considered during the Project design phase.

Development of these multi-modal access strategies identified a number of issues for further investigation, and these were addressed directly and resolved satisfactorily with the design team. Some of the key issues included:

- Chalmers Street stop design to ensure its suitability for the large volume of rail transfer passengers, particularly university students, accessing the stop during the weekday as well as significant crowds anticipated during major events;
- Rail replacement bussing arrangements at Central Station;
- Accommodating coach facilities at Central Station;
- Kingsford interchange design to cater for the more than 2,000 bus transfer passengers expected to use the interchange in the 2021 AM peak hour[5];
- Randwick interchange design to similarly cater for the more than 1,600 bus transfer passengers anticipated to use the interchange in the 2021 AM peak hour[6];
- Rawson Place interchange design to ensure its capacity to handle the substantial volume of bus transfer passengers travelling to destinations south-west of Railway Square;
- Bus priority and shared running options between Kingsford terminus and UNSW;
- Future operations of the Anzac Parade bus roadway;
- Devonshire Street traffic and local access issues;
- Anzac Parade – Alison Road intersection operation;

(E) Providing a practical mix of kerbside uses

Finally, a project parking and kerbside use strategy was developed to devise measures that balance project design requirements with corridor movement function and access requirements of land uses and stakeholders along the corridor. Fundamentally, this requires the re-allocation of road space to maximise the efficiency of these corridors for the benefit of all users. Throughout the corridors this will impact on, and necessitate changes to, parking and kerbside access. The key policy measures developed to ensure efficient use of road space and balancing the needs of network users with adequate opportunity for access include:

- Retaining existing parking and loading provision where feasible on the alignment.
- Considering replacement of impacted parking and loading on the alignment or in adjacent streets, within the same precinct where appropriate.
- Consolidation of parking and loading to ensure efficiency of road space allocation where appropriate.
- Defining a hierarchy of kerbside access for parking and loading provision including disabled, servicing & loading, short stay (commercial) and long stay (residential/commuter) parking - ordered from highest priority to lowest)

[5] Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report*, 2013
[6] *Ibid*

In total, the CSELR alignment will impact on most existing spaces directly on the corridor. Detailed investigations into the usage of these spaces and other kerbside spaces in the surrounding precinct have concluded that the impact of this loss can be addressed through effective demand management measures. Existing parking and loading supply alternatives have been identified in the surrounding precincts to manage this loss, notwithstanding the ability of existing supply to meet the demand. Occupancy surveys conducted in each precinct has identified sufficient latent (I.e. unused) capacity to continue to meet the demand for kerbside uses following construction of the CSELR. Specific local impacts and treatments are also explored in Section 6.

Conclusion

The CSELR project presents an opportunity to shift Sydney's inner-urban public transport system to a higher order network design. With high-capacity, high-frequency, sustainable and reliable trunk services, as well as a redesigned suburban bus network and substantial pedestrian improvements in the CBD, Sydney will experience a step-change in transport service provision. Evolving to this next level of transport service provision in the congested heart of Sydney offers a number of benefits to improve journeys, create new capacity and deliver a sustainable and liveable city.

Of course, any change as significant as the introduction of light rail into a constrained urban environment will undoubtedly have impacts. The significant reprioritisation of the road hierarchy in the CBD, adjustments to the suburban bus system requiring some customers to interchange modes and the realignment of kerbside uses and parking availability will all impact on residents, retailers and commuters in different ways. However, the impacts of these changes have been examined and appropriate mitigation strategies developed to maximise the benefits available without unacceptable burdens falling on any single group of surface transport system users.

To ensure the road hierarchy in the CBD is appropriately reprioritised, George Street has been proposed to primarily cater for pedestrian and light rail use. To ensure optimal traffic operations in the CBD are achieved, priority traffic routes have been identified and will be upgraded as part of the CCAS.

Impacts on existing customers of suburban bus services have been mitigated through the provision of additional cross-regional routes to satisfy demand to key destinations and easy interchange access to light rail. Some existing CBD services have been changed to feeder routes for light rail, to avoid duplication of public transport services within the CBD.

The necessary balance between competing demands on kerbside uses and parking supply have been considered to ensure efficient use of public road space. Retention of existing parking and loading supply has been accommodated for where feasible and appropriate priority has been considered on streets immediately adjacent to the light rail corridor where commercial land uses are present for loading and short term parking.

The opportunity presented by the CSELR project is exciting – it will leave Inner Sydney with a fundamentally reformed urban transport system. Significant benefits and a range of impacts are the reality of any project of this scale, but the cost of doing nothing is far more significant than the challenge of introducing such a major shift in transport service provision. The benefits 400 cities[7] globally have accrued through introduction of light rail system can be achieved in Sydney.

[7] *International Association of Public Transport, 2013*

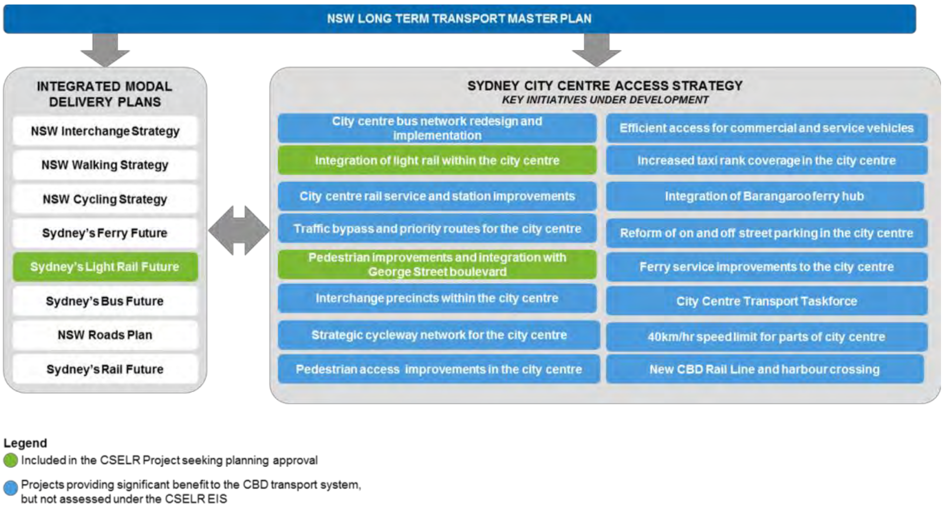
1. Introduction

1.1. Strategic Context

The NSW Government has developed a number of strategic priorities to guide infrastructure investment and service planning in New South Wales. At the highest level, strategic transport planning is led by the NSW Long Term Transport Master Plan, released in December 2012. The Master Plan guides transport planning and investment in the State, and includes 220 short, medium and long-term actions underpinned by a four-year investment framework of over $50 billion in roads and public transport improvements.

The Master Plan is supported by specific modal plans and regional access strategies, depicted in Figure 1-1, that explore the specific design, implementation and operation of transport improvements. In Inner Sydney, integrated modal delivery plans are guiding the development of the Sydney City Centre Access Strategy – a suite of initiatives designed to dramatically improve the delivery of transport services in the congested heart of Sydney.

Figure 1-1: Transport for NSW Strategic Framework[8]



Two projects at the centre of the Sydney City Centre Access Strategy are the integration of light rail within the City Centre, as well as pedestrian improvements and integration with a George Street pedestrian zone. These projects have been extensively considered by the Government as potential solutions to many of Sydney's congestion challenges, and are explored in more detail in the next section.

However these improvements were not developed in isolation. Other access strategies support the Projects – including re-designed and improved bus networks, better interchange precincts in the City Centre and traffic bypass and priority routes for the City Centre. These bus changes are being prepared in parallel with development of the CSELR proposal and will be consistent with the Project, but are an independent initiative. The proposed changes will undergo a separate public consultation process. These will not, therefore, form part of the EIS for the CSELR proposal, with the exception of cumulative impact considerations.

[8] *Transport for NSW, unpublished data, 2013*

The Project also aligns with a number of goals outlined in the NSW 2021 State Plan. Specifically, the Project is expected to align with:

- *Goal 1: Improve the performance of the NSW economy* - by creating construction jobs, improving journey times to support a more productive workforce and providing better connections to key job centres at Moore Park, UNSW and the Randwick health precinct;
- *Goal 2: Rebuild State finances* – by realising substantial economic benefits through a value-for-money project;
- *Goal 7: Reduce travel times* – by providing fast, convenient and reliable connections with reduced wait times for key destinations in the CBD and South East
- *Goal 8: Grow patronage on public transport by making it a more attractive choice and Goal 9: Improve customer experience with transport services* – by introducing a comfortable, frequent and reliable mode of transport to a currently congested part of Sydney;
- *Goal 19: Invest in critical infrastructure* – by delivering a key piece of infrastructure central to improving the transport system in central Sydney;
- *Goal 20: Build liveable centres* – with the CSELR anticipated to stimulate urban regeneration and consolidation;
- *Goal 27: Enhance cultural, creative, sporting and recreation opportunities* – by building a frequent and convenient mode of access to destinations such as the SCG, NIDA, Centennial Park and the Entertainment Quarter.

1.2. Sydney's Light Rail Future

The development of a strategy to improve access to the Sydney CBD has been a key policy question for Governments over recent years. The introduction of a light rail system to the CBD and surrounding suburbs has been considered as one potential solution to Sydney's congestion challenges.

To consider whether light rail is the appropriate solution for Sydney, the Government has undertaken an extensive program of investigation and consultation to assess the feasibility of light rail in three high priority corridors – the CBD, the University of Sydney and the UNSW. A shortlist of 11 route options were selected and investigated in consultation with councils, universities, business groups, Technical and Further Education (TAFE), hospitals, major sporting and entertainment precincts and other key groups.

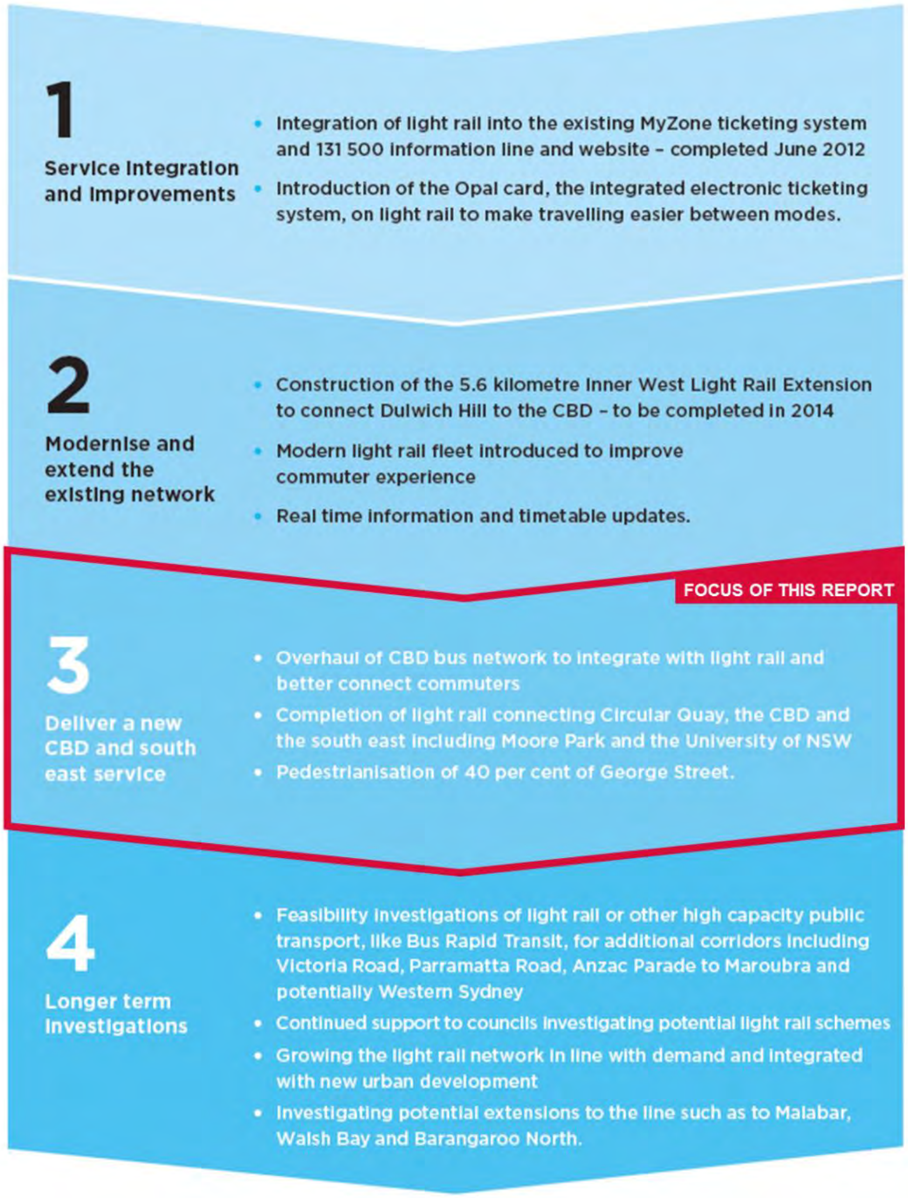
The 11 route options were developed and analysed, taking into account substantial work previously carried out. For each option, the following factors were considered:

- Ability to meet key objectives
- Costs and benefits
- Anticipated demand.

For the CBD to UNSW corridor it was also considered whether light rail or buses would be best suited to the corridor.

Ultimately, the Government decided to implement *Sydney's Light Rail Future*, which contains four stages to develop light rail as a high-quality and integrated element of Sydney's transport mix, described in Figure 1-2.

Figure 1-2: Stages of Sydney's Light Rail Future[9]



This report focuses on Stage 3 – the introduction of new light rail infrastructure in the CBD and South East and considers the broader traffic and transport implications of such a fundamental shift in the provision of transport for the region.

9 Transport for NSW, *Sydney's Light Rail Future,* 2012

1.3. Purpose of the report

Following the Government's decision to proceed with the CSELR project (CSELR or 'the Project'), detailed investigations were undertaken to determine the impact of the Project on what is a complex, congested and critical part of Sydney's transport network.

Booz & Company and AECOM were commissioned as Integrated Transport & Land Use Advisors supporting the Project Development Phase (Stage 2) of the Sydney Light Rail Program. The objective of this project phase was to better define the Project scope, develop a business case and eliminate enough uncertainty to allow the Project to proceed to delivery. Production of a Transport Operations Report (this report) was a key component of our work and would be a key input to development of the Environmental Assessment. It is intended to support Transport for NSW's application for planning approval to begin construction of the Project across a number of areas:

- The design of traffic and light rail integration within the CSELR corridor;
- Intersection analysis for all intersections in the corridor;
- Review and feedback on the Transport for NSW bus strategy in the Sydney CBD;
- Development of a bus network strategy for the remaining (non-CBD) project corridor;
- Development of a project parking and access strategy;

In summary, the report outlines a proposed approach for the redesigned traffic and transport system in the CBD and eastern suburbs to support the introduction of light rail, and move to a more evolved transport system that makes best use of available assets to provide a world-leading experience for customers.

This report identifies the substantial capacity, sustainability and reliability benefits that can accrue following construction of the CSELR project, but also seeks to quantify and mitigate the impacts of the Project on the broader traffic and transport system; such as the private traffic displaced from key streets in the CBD. To facilitate this process, a framework of impacts on the existing surface transport system was developed (presented in Table 1-1) for examination.

Table 1-1: CSELR Traffic & Transport Constraints[10]

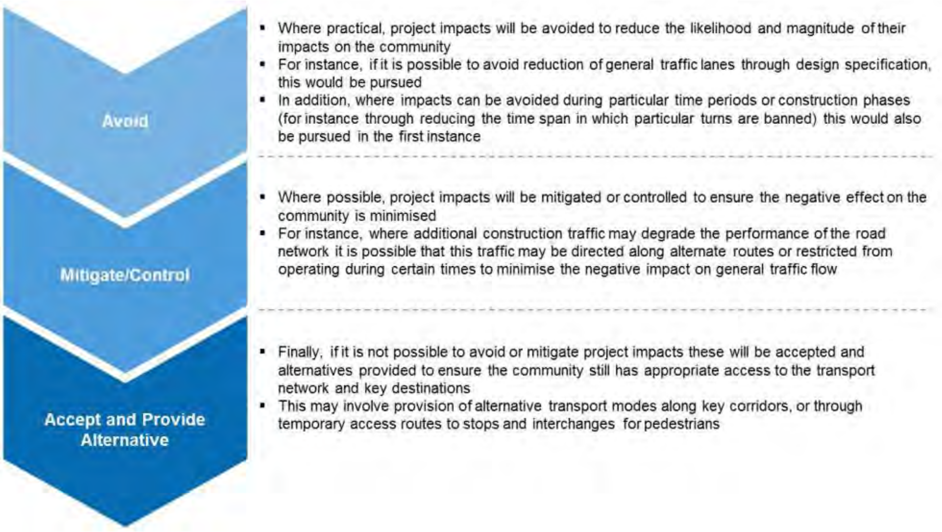
Category	Operational Constraints
Network operations	▪ General traffic lanes occupied by light rail ▪ Potential for increased competition for road space between private vehicles and public transport in some locations ▪ Capacity of alternate streets to absorb displaced traffic ▪ Continued operation of bus priority with changes to bus lanes ▪ Light rail might impact east-west traffic flow
Access	▪ Road operations changed which may limit access to some destinations ▪ Potential for bus diversions that limit convenient and direct access to CBD rail stations for interchanging customers ▪ Ability of local residents to access bus stops and local facilities ▪ Footpath width and layout may constrain access to light rail stops
Amenity	▪ Noise generated by light rail operations and passengers accessing light rail ▪ Noise generated through diversion of traffic onto secondary streets

[10] Booz & Company analysis

Category	Operational Constraints
Customer Experience	▪ Slower journey times for some customers ▪ General traffic lanes occupied by light rail ▪ Some customers might have to change a current one seat journey to a two seat journey due to changes in bus services
Kerbside Uses	▪ Loss of parking in some areas ▪ Limitations on kerbside uses (taxi ranks, service deliveries etc.)
Supporting Infrastructure	▪ Footpath capacity in some locations ▪ Ability to provide cycling infrastructure

These constraints were then quantified, and appropriate mitigation strategies developed within a framework of three categories – avoidance, mitigation or control and acceptance as presented in Figure 1-3. This report outlines the specific impact and their appropriate mitigation strategies through each of the sections described in Section 1.4.

Figure 1-3: Traffic & Transport Impact Management Framework[11]



1.4. Report structure

The report contains 7 Chapters:

- This Chapter (Chapter One) outlines the proposed project and its role in the Government's strategic planning for the transport system, including:
  - The Government's strategic planning framework;
  - The current surface transport challenges facing the Inner Sydney Region;
  - The opportunity presented by light rail to solve some of those challenges.
- Chapter Two outlines the structure and performance of the existing traffic and transport system at a network level as well as across five precincts, including:
  - Road network, parking and access issues;
  - Design and performance of the existing bus network;
  - Current cycling infrastructure;

[11] Booz & Company analysis

- Current pedestrian infrastructure and flows; and
- Special events and their effect on the transport system.

■ Chapter Three addresses the drivers of future transport network needs including:

- Summarising anticipated future changes in demand that will accompany the introduction of CSELR;
- Exploring land use changes and major developments expected to change travel patterns in the future; and
- Summarising anticipated patterns of special events in the future, and how those might be managed at the strategic level.

■ Chapter Four summarises the design of the future bus network in both the South East and CBD including coach and rail replacement bus requirements in the Central Station precinct.

■ Chapter Five addresses specific aspects of the future state for the road network including:

- The strategy development process and principles underpinning network design;
- An explanation of the proposed future road network operations and analysis of anticipated network performance; and
- Explanation of the proposed property access arrangements.

■ Chapter Six develops the Project parking strategy to help the community understand the change in parking arrangements and other kerbside uses along the length of the corridor following introduction of light rail.

■ Chapter Seven provides light rail stop precinct access plans for each light rail stop to demonstrate consideration and mitigation of the variety of multi-modal access constraints that may exist at each light rail stop.

1.5. The CSELR project

1.5.1. Overview

In December 2012, the NSW Government announced that it would extend light rail from Circular Quay to Kingsford and Randwick, through the heart of the Sydney CBD via George Street. The Project comprises 20 stops, and will integrate with both the bus network and heavy rail stations at Circular Quay, Wynyard, Town Hall and Central (Figure 1-4). Services will be provided by 45 metre low floor light rail vehicles, providing capacity for up to 300 customers (the equivalent of five standard length buses). The line will operate in a dedicated light rail lane, minimising competition with other modes of transport such as cars and buses. In addition, light rail will be given signal priority at intersections to deliver a 97% level of service reliability – substantially better than existing bus services.

Figure 1-4: Route of the CSELR project[12]

1.5.2. Project definition

The detailed project definition is documented and contained within the Supporting Documentation for Transport for NSW's State Significant Infrastructure Application made under Part 5.1 of the NSW *Environmental Planning & Assessment Act* 1979.

In summary the CSELR proposal comprises construction and operation of a light rail service from Circular Quay to Kingsford and Randwick via Surry Hills. The route of the CSELR proposal is illustrated in Figure 1-4. The key features of the proposal include:

12 Transport for NSW, *Sydney's Light Rail Future,* 2012

- 13 kilometres of new light rail track from Circular Quay to Central and Kingsford and Randwick via Surry Hills and Moore Park (including track at the depot facilities)
- ‘Turn up and go’ services every three minutes during peak periods within the CBD
- A pedestrianised zone on George Street between Hunter and Bathurst Streets, with light rail vehicles (LRVs) operating wire-free in this zone
- 20 light rail stops along the alignment with platforms at all stops to accommodate 45 metre long light rail vehicles, except at Chalmers Street and Moore Park, where platforms will be provided to accommodate both 45 metre and 90 metre long light rail vehicles (double-length vehicles) running during special event services between Central Station and Moore Park
- Depot facilities adjacent to Royal Randwick Racecourse and at Rozelle for light rail vehicle stabling and/or general maintenance (including wash-down)
- Interchange with heavy rail, bus and ferry services in the CBD corridor at Circular Quay, Wynyard, Town Hall and Central stations
- Bus interchange at the Kingsford and Randwick stops
- Integration with the existing light rail system
- Special event services between Central Station and event venues such as Moore Park and Royal Randwick Racecourse
- A fleet of 30 electric-powered light rail vehicles, 45 metres long, featuring temperature control and accessible low-floor design
- Capacity for approximately 100 seated and 200 standing passengers
- Public domain improvements on George Street, as a result of the pedestrianised zone, including concepts for paving, street trees, lighting and furniture
- A new bridge structure overpassing the eastern distributor and an underground alignment in the form of a cut-and cover tunnel across Moore Park
- Special events sidings at Circular Quay, Eddy Avenue, Chalmers Street, Moore Park and Royal Randwick Racecourse and turn back facilities at the Circular Quay, Wynyard, Kingsford and Randwick

1.5.3. Current situation

The Sydney CBD has very high transport demand and limited capacity to accommodate the additional public transport required to serve future growth in customers without a step change in service provision. Over 180,000 people enter the Sydney CBD during the morning peak hour between 8:00am and 9:00am, with public transport accounting for 80 per cent of these trips. This is expected to grow to 225,000 trips in 2031. Buses carry the highest travel demand of the street-based modes, and to accommodate this demand growth, the bus system has and continues to grow; there are now over 192 bus routes across the City Centre, and on a typical weekday morning around 1,600 buses enter the CBD in just two hours[13].

The sheer volume of buses entering the CBD is reaching a critical point in Sydney’s highly congested urban environment, with the addition of further buses unlikely to provide substantially new capacity without degrading service provision. Light rail in Sydney’s CBD has been studied by both the NSW Government and the City of Sydney in recent years as a potential solution to meet this demand, revitalise CBD streets and improve the public domain.

[13] *NSW Bureau of Transport Statistics, 2012*

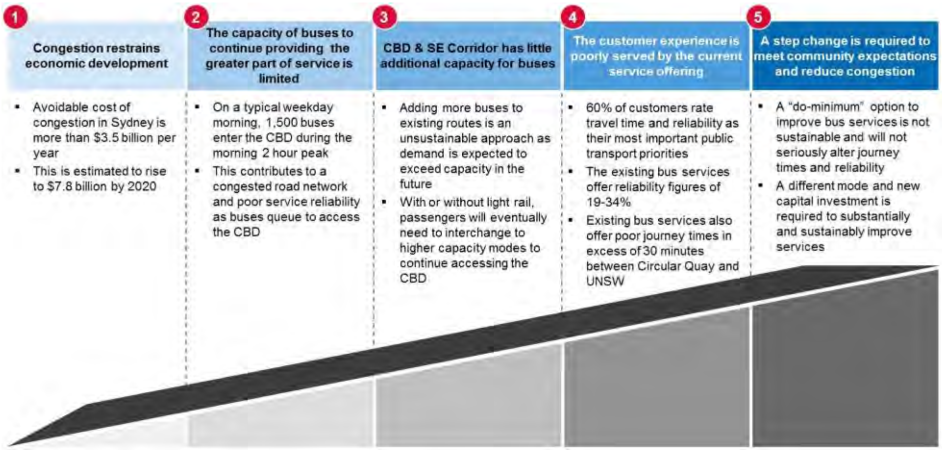
In addition, the UNSW corridor services several regional attractions, including the major sporting precincts at Sydney Football Stadium (SFS), Sydney Cricket Ground (SCG), Royal Randwick Racecourse, recreation and entertainment facilities of Centennial Parklands, and the Randwick Education and Health Specialised Centre including the UNSW and the Randwick precinct Hospitals. It serves high density centres in Surry Hills, Randwick and Kensington and is a corridor that currently relies exclusively on buses for public transport.

The UNSW campus and major events generate large travel demand in both directions during peak and off-peak periods. These features help to support high quality public transport as the infrastructure is more highly utilised than in a single direction peak service.

1.5.4. Current surface transport challenges

The Sydney CSE corridor is highly constrained, with the current public transport offering suffering from slow journey times and poor, variable reliability[14]. In addition, bus reliance in this corridor is a factor in levels of surface congestion estimated to cost the economy $7.8 billion in 2020[15]. The current and forecast demand for public transport in this area is exceeding the levels that can be comfortably and reliably served with an on-road bus solution. Incremental expansion of supply through the addition of new bus routes and expansion of existing routes are expected to provide a solution only at the margins. Dealing with the fundamental lack of supply in this corridor requires a step-change in the provision of public transport.

Figure 1-5: Problems with the current public transport service offering in the CSE corridor[16]



1.5.4.1. Sydney's congestion is restraining economic development

Cities offer immense opportunity for productivity growth; however poor planning, accessibility and management can also stifle productivity. The Bureau of Infrastructure, Transport and Regional Economics (BITRE) has estimated that the avoidable cost of congestion in Australia's capital cities is equivalent to one per cent of GDP and is forecast to more than double 2005 levels ($9.4 billion) to reach $20 billion per year by 2020 if nothing is done. Sydney has the highest level of congestion in Australia at about $3.5 billion in 2005, a figure estimated to rise to $7.8 billion by 2020, as shown in Figure 1-6.

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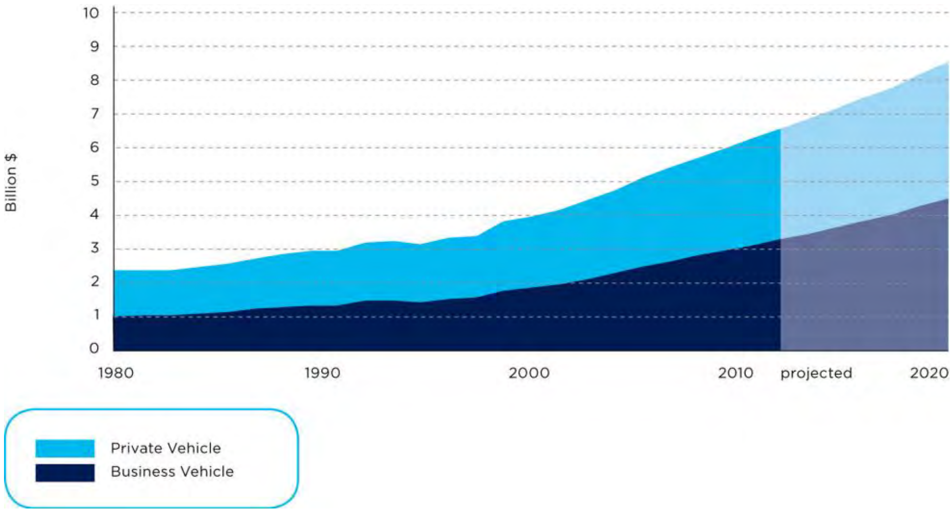
14 NSW Bureau of Transport Statistics, *Public Transport Information and Priority System (PTIPS)*, 2011

15 Bureau of Infrastructure Transport and Regional Economics, *Estimating urban traffic and congestion cost trends for Australian cities Working Paper No. 71,* 2007

16 Transport for NSW, *Sydney's Light Rail Future*, December 2012; Booz & Company analysis

Figure 1-6: The economic cost of congestion 1980-2020[17]

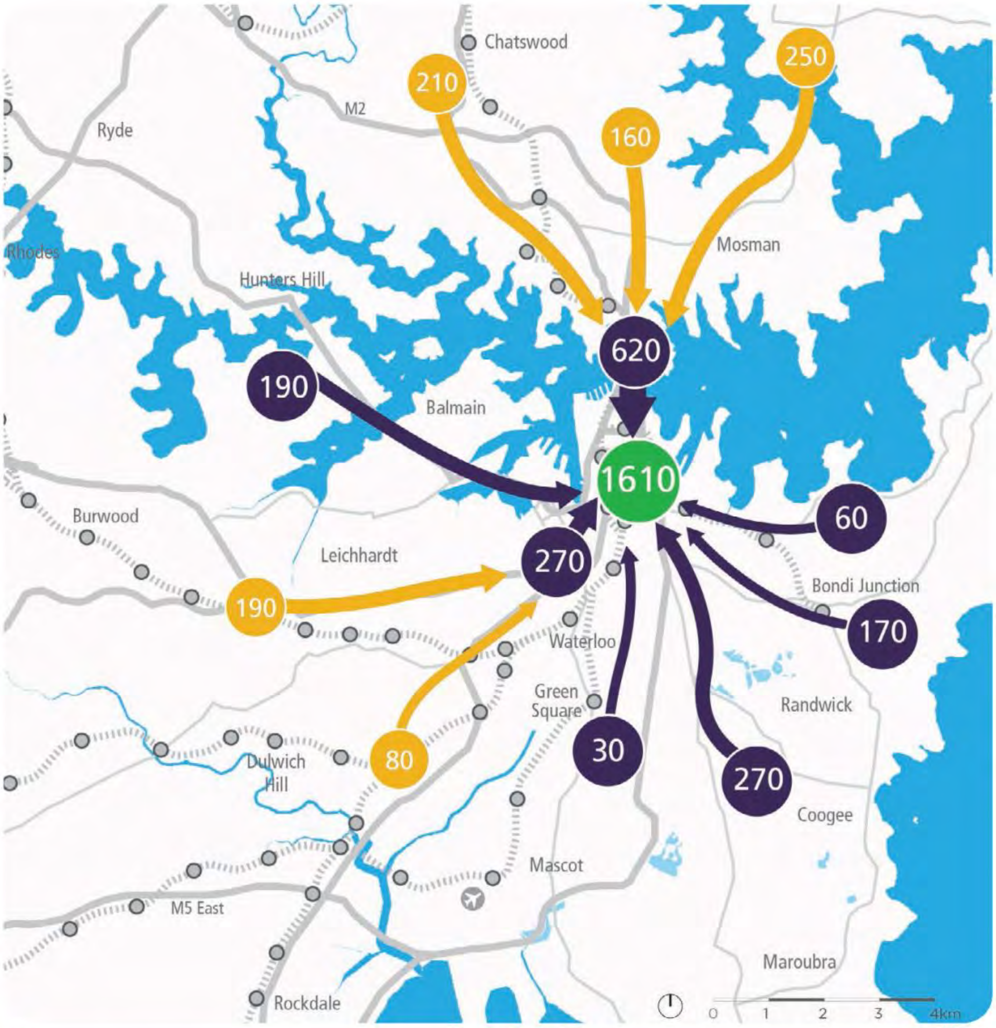


1.5.4.2. The capacity of buses to continue providing the lion's share of service is limited

While an important component of the transport mix, the sheer volume of buses in the city (shown in Figure 1-7), especially on major corridors such as the Harbour Bridge, York Street, George Street and Elizabeth Street, is now so great that service quality has begun to degrade on these routes on a regular basis. The capacity of buses to continue growing to meet an ever-increasing transport task has begun to be exhausted, with buses now caught in congestion on a regular basis.

[17] Bureau of Infrastructure, Transport and Regional Economics, *Estimating urban traffic and congestion cost trends for Australian cities,* 2007

Figure 1-7: Bus volumes entering the CBD during the 2 hour morning peak[18]



Principal road | Secondary road | CityRail network | CityRail station

As congestion impacts on journey times and reliability, this results in a poor experience for customers on buses, but also for pedestrians throughout the CBD and South East as they cope with the noise and exhaust caused by queuing buses.

For the South East corridor, buses travel in heightened congestion on the approach to the CBD at Oxford Street as well as on the approach to Martin Place on Elizabeth Street. Addition of further buses to these routes only perpetuates the congestion challenge as buses themselves consume road space and struggle to access limited kerbside stopping space in the CBD.

The presence of multiple major event venues in the South East places pressure on the public transport system to provide sufficient capacity to serve the peak loadings at the beginning and conclusion of these major events. Major events hosted at the SCG and SFS achieve a five to 20 per cent mode share to public transport compared to an average of 55 per cent at Sydney

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[18] Transport for NSW, *NSW Long Term Transport Master Plan,* 2012

Olympic Park which is served by a much higher capacity heavy rail link[19]. Provision of additional capacity to cope with the additional loads will be important if Sydney is to continue attracting hallmark events in the future. Additional capacity will have the added benefit of reducing the often heavy congestion in the area during major events.

Finally, the University of NSW is a major trip generator in the CSE Corridor, and requires a significant volume of buses to transport students and staff – primarily between Central Station and the Kensington campus. Currently, over 340 bus trips per day operate this route in both directions; but even with this volume of buses congestion is regularly experienced at the Eddy Avenue bus stand. The UNSW student population is expected to grow from 37,000 to about 50,000 – an increase of 43 per cent[20]. Though the timeframe for reaching this number is uncertain, it is clear that requiring buses to continue providing the lion's share of transport capacity for UNSW is unsustainable.

1.5.4.3. The CBD and SE corridor does not have the capacity to support the growth of the existing bus transport system

A 'Do Minimum' option of simply adding more buses to existing routes to meet the expected increase in passenger demand is not sustainable due to capacity constraints within the road corridors and will not address customer concerns of journey time and reliability. While provision of additional capacity through a traditional on-road bus solution would be possible for cross regional routes the highly constrained road environment closer to the CBD is an unavoidable limitation on the performance of a bus solution. Indeed, as examined in the previous section, the addition of more buses in this environment would only contribute to congestion further degrading journey times and reliability.

A continuation of this approach will result in passengers eventually needing to interchange onto higher capacity public transport vehicles that serve the CBD – with or without light rail as a solution. Alternatively, road space between private and public transport will need to be reallocated to provide additional capacity for buses. This would have a substantial impact on private vehicles, with average speeds in the AM peak for key roads in the study area currently ranging from 20-28 km/h[21]. The performance of these roads for private vehicles could be expected to be further degraded if road space were reallocated to public transport. In either case, provision of additional capacity through transport services is constrained by the limited road space available on approach to the CBD. Provision of higher capacity services on or under the existing roads is necessary to substantially address the journey time and reliability concerns of customers.

While the CSELR project forms a part of the solution to this challenge, other projects currently being developed as part of the City Centre Access Strategy (such as the re-organised city bus network) will also seek to respond to the growing demands on the CBD transport system.

1.5.4.4. Customers deserve a better travel experience

Nearly 60 per cent of Transport for NSW's customers' rate travel time and reliability as the two most important public transport priorities. However, for Bus Contract Region 9 (the region serving the South East corridor) only 50 per cent of customers report satisfaction with service timeliness – a measure of the service on time performance – while 72 per cent of customers believe travel time is appropriate considering the distance travelled[22].

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[19] *Transport for NSW,* NSW Long Term Transport Master Plan, *2012*
[20] Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report*, August 2013
[21] Roads & Maritime Services, *Key Roads Performance Report,* 2012
[22] Bureau of Transport Statistics, *Transport Customer Survey,* 2012

Analysis suggests the proportion of services arriving at the CBD within two to three minutes of their scheduled time is between 19 and 34 per cent[23] in the Anzac Parade and CBD corridor during the AM peak. This falls well below customer's expectations and highlights the degraded experience for customers in the South East corridor.

To drive additional patronage on public transport in this region, customer research commissioned by Transport for NSW has found that frequency, travel time and being on time are the three most important attributes for customers making decisions about travelling by bus. When asked what is most likely to increase bus patronage, customers identified reduced waiting time, reduced trip time and air-conditioning and heating as the key elements. Future decisions on transport planning in the area will need to take account of these elements to deliver a significant improvement to the experience of customers on public transport.

1.5.4.5. A step-change in the public transport network is needed.

Operating light rail in an area currently served by buses (the Study Area) would underpin a transition to a more efficient transport network. The traditional 'radial' service approach is based on providing a single seat for the duration of the journey. This approach provides a wide range of bus services connecting all parts of the city to its CBD or other major centres. However, it also results in a complicated bus network with high frequencies near the City Centre but low frequencies on the majority of routes further away from the CBD. Trips to local or regional centres are often difficult, as most bus services travel to the CBD.

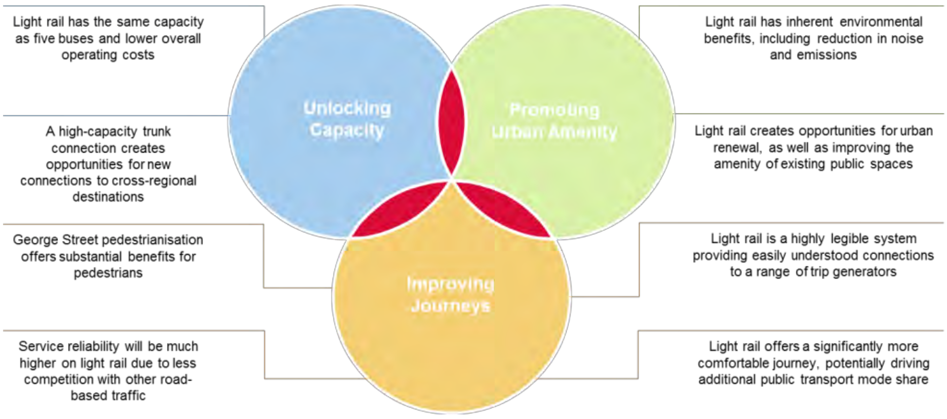
As the public transport system evolves, moving to a 'connected' or 'hub and spoke' network will improve service coverage, allow a higher service frequency and make public transport easier to understand for customers. With a connected approach, a grid-based bus network reallocation becomes possible where light rail and other major bus radial services are supported by local bus feeder services to provide easy connections to multiple destinations across the region's centres. This would improve service coverage, allow for a higher service frequency and make public transport easier to understand for customers. Experience in several major cities suggests this has a positive impact on transport network performance.

1.5.5. Opportunities to improve the surface transport system

Development of a fully integrated and customer-focused light rail system in the CBD and South East Sydney offers a variety of benefits to grow transit capacity and improve the customer experience. The introduction of light rail would add a reliable mode of transport to the network and increase service frequencies leading to a number of benefits summarised in Figure 1-8.

[23] Transport for NSW, *Sydney's Light Rail Future,* 2012; Booz and Company; AECOM; Bureau of Transport Statistics, 2012

Figure 1-8: Benefits of the CSELR System[24]

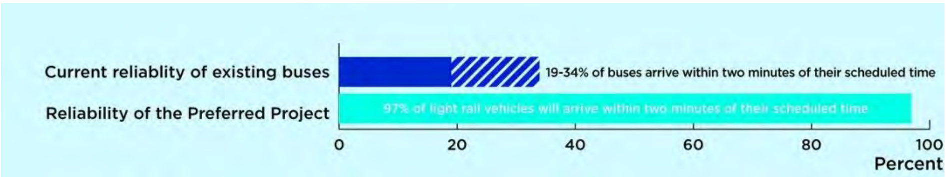


1.5.5.1. Improved journey times and reliability

It is anticipated that light rail will operate in a segregated environment, allowing it to avoid competition for limited road space with buses and private vehicles. This will facilitate comparable journey times during the off-peak and improved journey times for most customers on the CSELR corridor during the peak.

Importantly, light rail offers substantially improved service reliability compared to the existing bus solution. It is anticipated that 97 per cent of light rail services would arrive in the CBD within 2 minutes of their scheduled time (refer to Figure 1-9). The equivalent figure for the existing bus service is less reliable at around 19–34 per cent.

Figure 1-9: Reliability improvements of the CSELR[25]

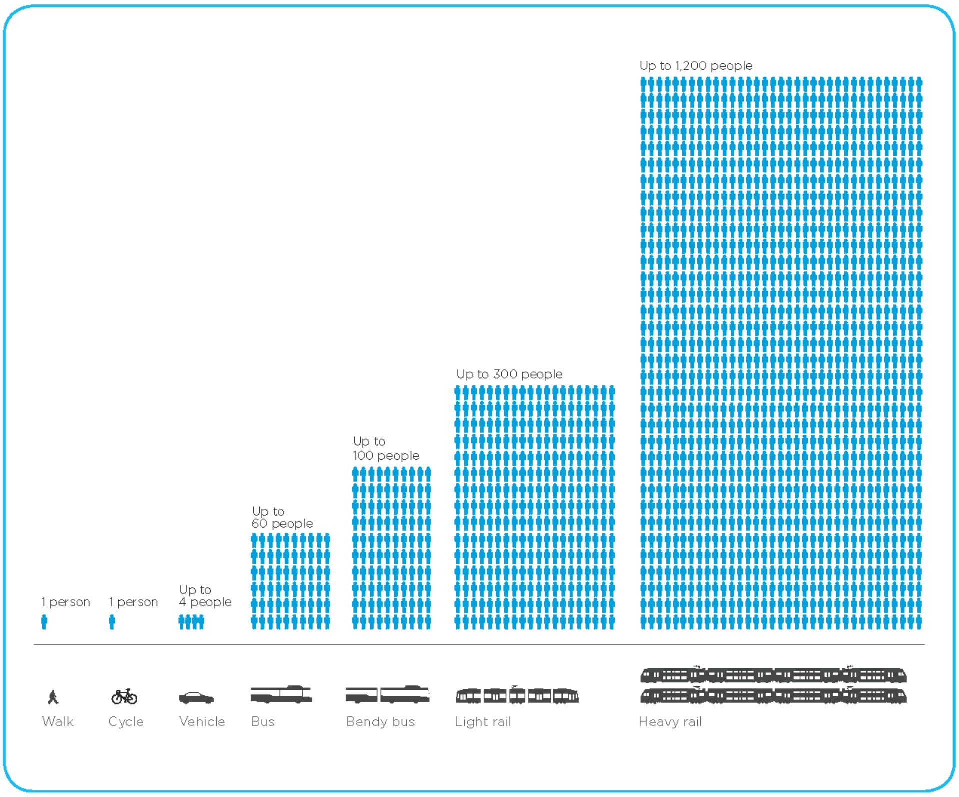


1.5.5.2. Additional capacity

Modern light rail vehicles can provide as much as five times more capacity than a traditional bus, while consuming only about twice as much road space, as shown in Figure 1-10. In addition, the light rail solution is easily scalable for peaks in demand as two 45m LRVs have the potential to be coupled to move up to 18,000 people per hour in each direction[26] – to support public transport service to major events.

[24] Booz and Company analysis
[25] Transport for NSW, *Sydney's Light Rail Future,* 2012
[26] *Ibid*

Figure 1-10: Indicative capacity by mode[27]



1.5.5.3. High frequency service at lower cost

Light rail typically provides 'all-day, all-week' services that can be relied upon to provide good frequencies across the weekday, weekend and evenings. The relatively low operating cost of light rail allows high off-peak service frequency and long hours of operation. This makes best use of the capital investment in light rail infrastructure and vehicles and provides a strong customer value proposition.

The CSELR Operations Adviser, Interfleet, advises that light rail services will run between Circular Quay and Moore Park (via Central) at peak period frequencies of 20 services per hour[28] (approximately 3 minute headway). These services would then split to serve:

- Randwick (via Alison Road, Wansey Street and High Street) – 10 services per hour
- Kingsford (via Anzac Parade) – 10 services per hour

Light rail's improved reliability provides better frequencies when compared with the existing bus solution. Despite high timetabled frequencies for buses, their interaction with road congestion often results in "bunching" of services. This does not align favourably with customer needs. By contrast, light rail offers a true "turn up and go" service with reliable service spacing.

The preferred light rail network is proposed to operate across a long service span (hours of operation). This is achieved by first delivering a base network that works well all day, and then adding peak-only supplemental services commuters may require. Sustained frequencies across the day compare favourably with the existing bus solution.

[27] Transport for NSW, *Sydney's Light Rail Future*, 2012

[28] Interfleet, *Operations Adviser Initial Light Rail Operational Services Plan*, 2013

In terms of operator benefits, while a light rail system has higher initial capital costs than a comparable bus solution it has relatively lower on-going operating costs achieved through less labour intensive operations[29]. To provide similar frequencies and service coverage, a bus solution would require five vehicles and five drivers compared to the single driver required for light rail.

1.5.5.4. Improved access to key destinations

The introduction of light rail would enable a restructure of the surface public transport system (discussed in Section 1.5.4.5) that would deliver customers with improved quality of public transport service to a broader range of key destinations.

The restructured surface public transport system would be based on a high frequency trunk light rail route that integrates with the bus network. It would allow the reallocation of buses from a CBD-centric system to a transfer-based grid that better serves other key destinations with higher frequencies throughout the day and night. In particular, it is envisaged that the introduction of light rail would facilitate the reallocation of buses to serve growing cross-regional demand routes, as documented in Chapter 4 of this report.

The long service span of a light rail network provides sustained, easy access to key destinations in the CSE corridor. An all-day network is justified in active, mixed use, high density areas in which traffic and parking demand is intense. The CSE corridor includes a mix of significant trip attractors such as universities, hospitals, as well as shopping and nightlife districts. These land uses require good service at least 18 hours a day (if not longer), because while they may have some peaks in demand, they also generate trips across the day, night and weekend.

In addition, as highlighted in Section 1.5.5.3, the lower on-going costs of light rail enable efficiencies to be gained for the operator as the network is redesigned to provide greater coverage at lower cost.

1.5.5.5. A more legible and easier to understand system

In addition to providing improved access to key destinations, a high frequency trunk transit system provides a more legible and easier to understand public transport network. There are currently 192 bus services operating in the CBD, illustrating the complexity facing non-regular customers wishing to travel within the CBD, such as tourists and business travellers. Indeed the complexity of the existing network is so great, that even experienced commuters experience difficulty navigating the system – particularly when responding to service disruptions. Recent customer value proposition work by Transport for NSW identified the ease of use – including a legible, simple to use system as the most important attribute for 19% of customers. All customers rated this factor as important to a certain degree, as it built confidence in the ability of the system to deliver them to their destination.

[29]Transport for NSW, *unpublished data*, 2012

2. Existing Situation

2.1. Overview

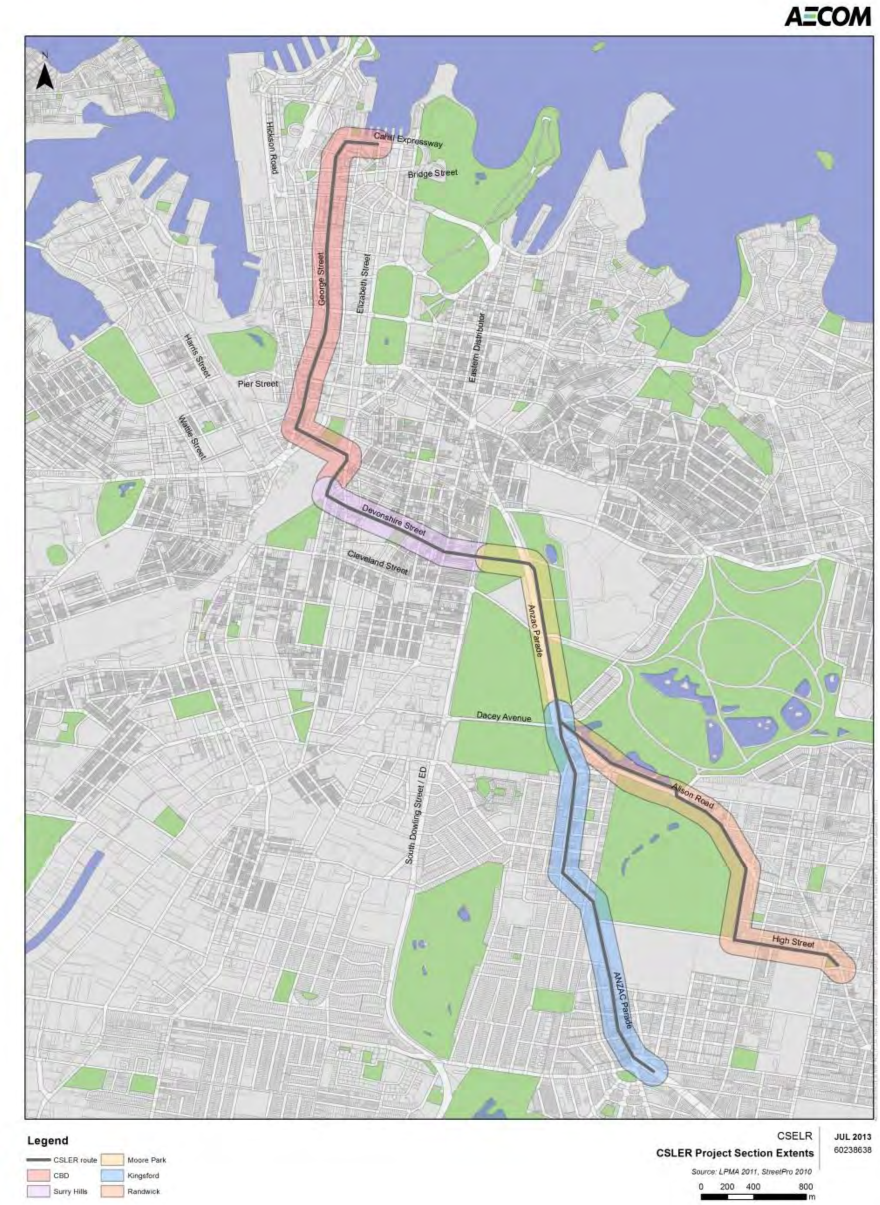
This section provides an outline of the existing traffic and transport situation along the proposed future CSELR corridor. It includes:

- A description of the existing road network and traffic volumes, including parking supply and access arrangements
- An outline of existing bus services focussing on the South Eastern region of the light rail corridor
- A summary of existing cycle networks within the light rail corridor
- An outline of existing pedestrian access arrangements and demand
- A description of existing special event access arrangements with a particular focus on Moore Park, Royal Randwick Racecourse, along with other events that could impact light rail operations and demand

Following assessment of existing bus and special event operations at a network level, all other transport operations have been assessed at the local level. To facilitate this assessment the CSELR corridor has been broken down into five key precincts as illustrated in Figure 2-1 and summarised below:

- The **CBD precinct** represents the CSELR corridor between Circular Quay to Chalmers Street, via George Street, Rawson Place, Eddy Avenue and Chalmers Street including the intersection with Devonshire Street.
- **Surry Hills precinct** represents the Devonshire Street section of the corridor to the east of the intersection with Chalmers Street and as far west as the mid-block pedestrian crossing at South Dowling Street in Moore Park.
- **Moore Park Precinct** represents the section to the east of the mid-block crossing at South Dowling Street and the section of Anzac Parade to the north of Alison Road.
- **Kingsford precinct** includes the intersection of Anzac Parade and Alison Road in the north to the Kingsford interchange in the south, including the suburb of Kensington.
- **Randwick precinct** represents the section along Alison Road, east of Anzac Parade, and includes the corridors along Wansey Road and High Street to the Randwick interchange.

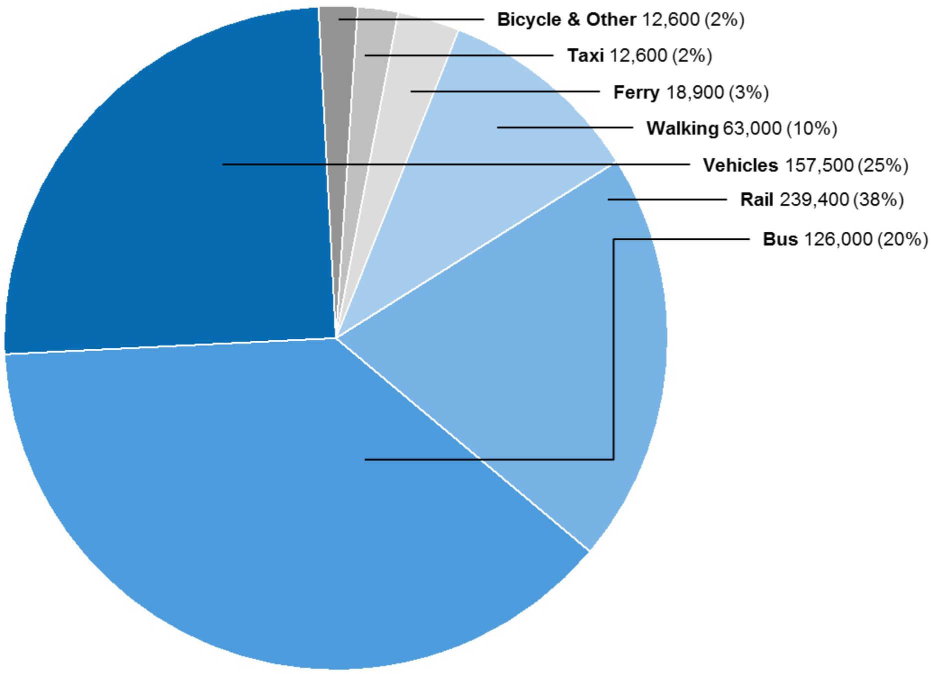
Figure 2-1: Precincts along the light rail corridor



2.1.1. Current transport task

Currently over 600,000 people enter the CBD during the day, with public transport accounting for 61 per cent of trips. Over one-third of the total travel demand (38 per cent) is carried by the underground heavy rail system which places pressure on constrained CBD stations, particularly at Town Hall and Wynyard. Figure 2-2 illustrates current transport mode share for commutes into the CBD during a typical day.

Figure 2-2: Current mode share for trips into the City Centre[30]



The city's congested road network carries the remainder of trips, accommodating a mix of cars, buses, cyclists and pedestrians on relatively narrow streets. Of these street-based modes buses carry the highest travel demand in and out of the CBD, servicing 20% of total trips. Approximately 1,600 buses enter the CBD during the morning peak, congesting bus drop-off locations. As an example, at Railway Square there are 250 inbound buses in the two-hour peak period, which means a bus has to stop, unload/load, and depart almost every 30 seconds. The situation at Wynyard is similar: there are almost 600 inbound buses over the two-hour peak meaning approximately 12 seconds turnaround time per bus while entering the CBD from the Oxford/Flinders Street corridor there are approximately 270 inbound buses over the two-hour peak.

[30] Transport for NSW, *City Centre Access Strategy*, 2013

2.2. Key Assumptions

2.2.1. Intersection analysis

Existing intersection performance along the CSELR corridor has been evaluated using LinSig 3.2, a computer based modelling package designed for the assessment and design of traffic signal junctions either individually or as a network. The LinSig modelling results of existing intersection performance can be found in the relevant precinct chapter (Sections 2.5 - 2.9).

The main performance indicators for LinSig 3.2 include:

- Degree of Saturation (DoS) – the ratio between traffic volumes and capacity (v/c) of the intersection used to measure how close to capacity an intersection is operating. The DoS is a direct measure of the congestion level at the intersection. As DoS approaches 1.0, both queue length and delays increase rapidly. Satisfactory operations usually occur with a DoS range between 0.8-0.9 or below;
- Average Delay – duration, in seconds, of the average vehicle waiting time at an intersection; and
- Level of Service (LoS) – a measure of the overall performance of the intersection. For this purpose, average delay from Roads and Maritime Services (RMS) Level of Service (LoS) calculations has been used. These are listed below in Table 2-13.

Table 2-13: Intersection Level of Service Criteria[31]

Level of Service	Average Delay (secs/veh)	Traffic Signals and Roundabouts
A	Less than 14	Good Operation
B	15 to 28	Good with acceptable delays and spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity
E	57 to 70	At capacity; at signals incidents will cause excessive delays
F	>70	Roundabouts require other control mode

2.2.2. Parking and kerbside access

The subsequent sections provide a description of the existing parking provision by precinct as well as identifying adjacent land uses for on-street parking (e.g. local residential, short stay retail, all-day transit etc.). A detailed assessment of parking demand is provided within the Project Parking Strategy outlined in Section 6.

The following definitions of various parking restrictions have been applied to each precinct:

- Short Stay Parking - clearly signed parking areas for short term period of parking (e.g.: ≤1P).
- Long Stay Parking (Restricted) - clearly signed parking areas for long term period of parking (i.e.: ≥2P).

[31] Guide to Traffic Generating Developments (RMS, 2002)

- Long Stay Parking (Unrestricted) - general parking area outside of other restriction signs or the area with no parking restrictions apply.
- Loading Zone- clearly signed parking areas set aside for short-term use by certain vehicles when loading or unloading goods in the course of business or when dropping off or picking up passengers.
- Disability parking- parking for people with disabilities is in the form of separate appropriately signed and marked parking bays and by ensuring that time-limited bays have sufficient turnover to allow people with disabilities to access them. These parking bays have the effect of a 'No Parking' sign, with the exception of vehicles displaying the disabled persons parking or mobility permit.
- Car Share, Hospital, Mail Zone - parking available only for these uses.
- Taxi zone- parking area for taxis only.

2.3. Bus Services

Approximately 1,600 bus services enter the Sydney CBD during the two-hour morning peak, through the primary CBD cordon points at the Sydney Harbour Bridge, Anzac Bridge, Broadway, Oxford Street, William Street and Elizabeth Street.

In the South East CSELR Corridor, the bus network can be segmented into three broad service types:

- CBD All-Stop Services: stop frequently from their suburban origin to the CBD, operating all day in both directions and primarily using Oxford, Cleveland or Foveaux Streets to access the CBD. These services carry over 9,000 passengers in-bound during the AM Peak (more than 5,000 during the intense peak 1 hour);
- Cross-Regional Services: these services generally do not enter the CBD, but rather provide links between key centres, such as Bondi Junction and the Airport and operate all-day;
- CBD Express Services: stop frequently on suburban routes before reaching a key node (Kingsford town centre at Gardeners Road, and Randwick town centre at Belmore Road) and running direct to the CBD without stopping. These services operate during the peak periods only in the peak direction. The bulk of these services use the Eastern Distributor to access the CBD and operate contra-peak south along Elizabeth Street.

2.3.1. CBD bus issues

The substantial volume of buses entering the CBD which was illustrated in Section 1, combined with high volumes of general traffic (i.e. private vehicles, commercial and service vehicles), contribute to congestion on major streets in the City Centre, which deteriorates the reliability of bus services and negatively impacts the amenity for all road users.

George Street in particular carries up to 290 buses in the peak direction during the AM peak (7am – 9am) and this is expected to increase to over 310 by 2015. The congested bus network - combined with the demands of other road users - impacts on customer service and delays essential business functions.

As illustrated in Figure 2-3 below, the bus reliability issues for the combined inbound and outbound bus movements along the key corridors are most prominent during the AM peak. However, travel time reliability continues to be impacted throughout other times of the day. The lower activity lunch hour still demonstrates 2-3 minutes delays and the busier afternoon peak 3-4 minutes.

Figure 2-3: Average variance to bus timetable in minutes includes both directions (i.e. inbound & outbound combined)[32]

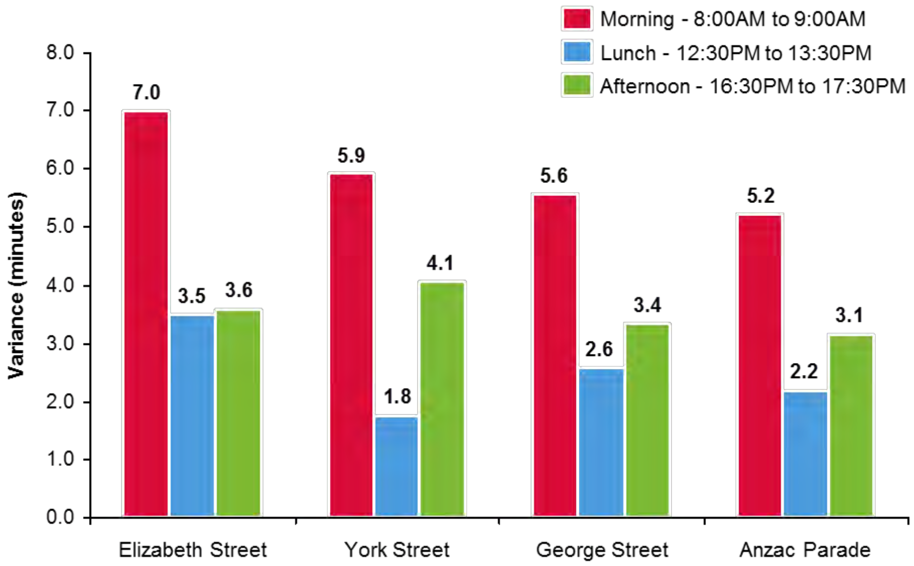


Figure 2-4 illustrates average bus variability during the AM peak hour along key access routes through the CBD which are on average between 5 – 7[33] minutes behind schedule. Key findings from the analysis by corridor are summarized as follows:

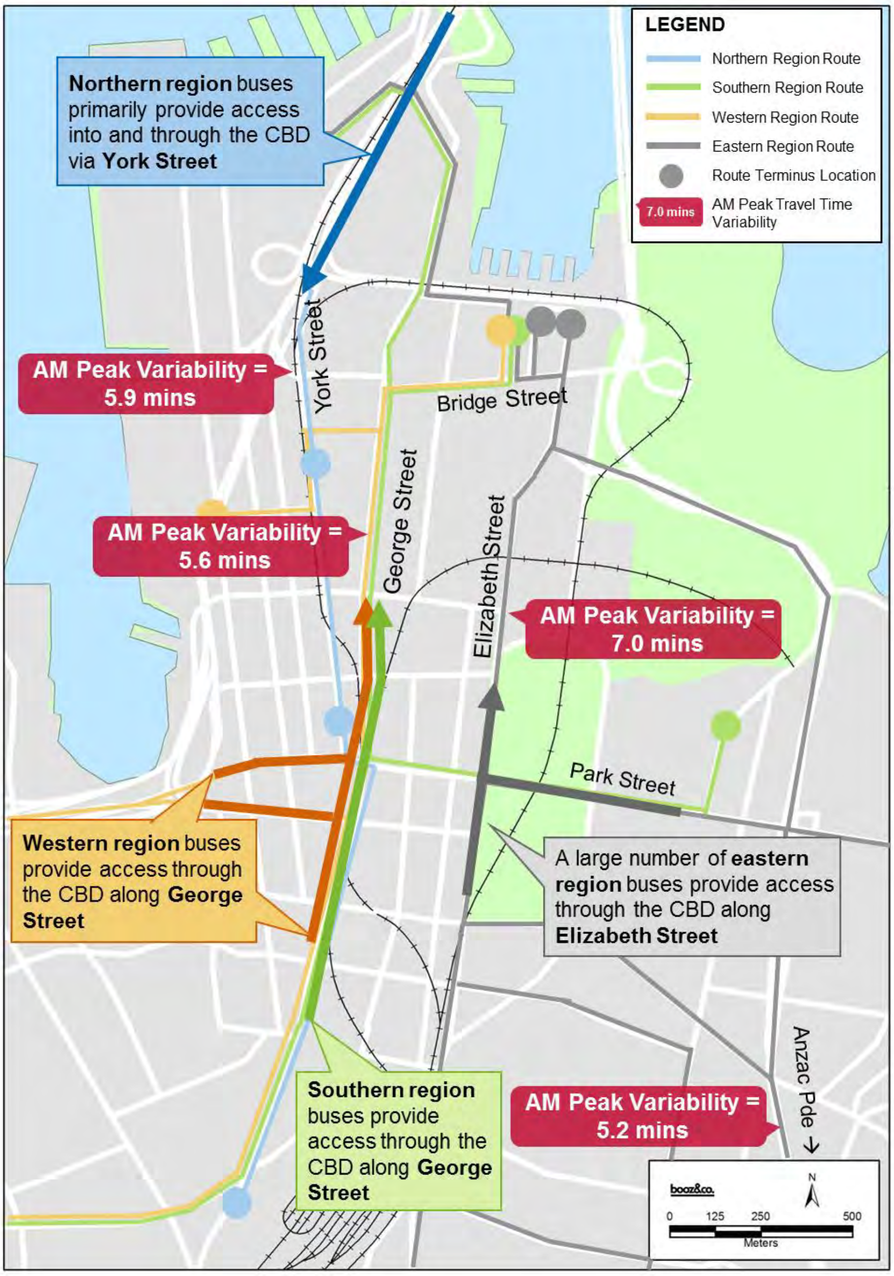
- Elizabeth Street – a large number of buses approaching the CBD from the east merge with general traffic on Elizabeth Street, causing high levels of congestion which results in bus services experiencing average delays of 7.0 minutes in the AM peak.
- York Street - many inbound buses from northern Sydney travel on the Harbour Bridge and through the CBD via York Street. Buses travelling along York Street experience average delays of 5.9 minutes in the AM peak.
- George Street - is a main corridor for western and southern region buses travelling through the CBD, along with the free shuttle bus (555). Buses travelling along George Street experience average delays of around 5.6 minutes in the AM peak.
- Anzac Parade - is a key corridor providing access in to the CBD for a large number of South Eastern Region buses. Buses travelling along the Anzac Parade corridor experience average delays of around 5.2 minutes in the AM peak.

The forecast growth in bus demand will increase bus congestion within the CBD putting more vehicles onto our roads and increasing congestion. The need to meet growing demand without further increases in bus volumes within the CBD and the associated increases in congestion and travel time variability are key drivers for the introduction of the CSELR project.

[32] Public Transport Information and Prioritisation System (PTIPS) via internal systems made available to NSW BTS; Booz & Company Analysis.

[33] *Ibid*

Figure 2-4: CBD Buses - AM Peak Timetable Variance for Both Directions in Minutes by Street[34]



[34] NSW BTS Public Transport Information and Prioritisation System (PTIPS) 2011; Booz & Company Analysis

2.3.2. Bus services in the South East study area

Outside of the CBD the proposed CSELR project will operate through the South Eastern suburbs where buses are currently the primary public transport mode. This corridor is within Transport for NSW's Metropolitan Bus System Contract (MBSC) Region 9 which is the most heavily patronized bus region in the Sydney metropolitan area. The existing bus services reviewed as part of this study are illustrated within Figure 2-5 with the full range of regular bus routes in the South East region examined as part of the network planning for the CSELR project summarised in Table 2-1.

Figure 2-5: In Scope Bus Routes Reviewed

Table 2-1: Eastern Suburbs LRT Bus Services under examination[35]

Route	Description	2011 Frequency (AM Peak hour)	Service Type
339	Clovelly-City	11	Suburban
410	Rockdale-Bondi Junction	2	Cross-Regional
400	Burwood-Bondi Junction	10	Cross-Regional
X39	Clovelly-City	8	CBD Express
370	Leichhardt-Coogee	5	Cross-Regional
372	Coogee-Railway Square	6	Suburban
373	Coogee-Circular Quay	12	Suburban
374	Coogee-City	7	Suburban
376	Maroubra Beach-Circular Quay	9	Suburban
375	Maroubra Beach-Sydney Uni	-	Suburban
377	Maroubra Beach-Circular Quay	4	Suburban
395	Maroubra Beach-Circular Quay	4	Suburban
396	Maroubra Beach-Circular Quay	3	Suburban
397	Maroubra South-Circular Quay	2	Suburban
M10	Maroubra Junction-Leichhardt	6	Cross-Regional
M50	Drummoyne-Coogee	6	Cross-Regional
X73	Coogee-City	15	CDB Express
X74	Coogee-Circular Quay	9	CBD Express
X77	Maroubra Beach-City	10	CBD Express
X96	Maroubra Beach-City	4	CBD Express
X97	Maroubra South-City	2	CBD Express
391	La Perouse-City	5	Suburban
392	Little Bay-Circular Quay	6	Suburban
393	La Perouse-Railway Square	8	Suburban
394	La Perouse-Circular Quay	9	Suburban
399	Little Bay-Circular Quay	2	Suburban
L94	La Perouse-Circular Quay	4	Suburban
X92	Little Bay-City	5	CBD Express
X94	La Perouse-City	5	CBD Express
X99	Little Bay-City	2	CBD Express
303	Eastgardens-Circular	7	Suburban
313	Coogee-Bondi Junction	2	Cross-Regional
314	Coogee-Bondi Junction	3	Cross-Regional
316	Eastgardens-Bondi Junction	2	Cross-Regional
317	Eastgardens-Bondi Junction	2	Cross-Regional
348	Wolli Creek-Bondi Junction	2	Cross-Regional
353	Eastgardens-Bondi Junction	4	Cross-Regional
357	Sydenham-Bondi Junction	3	Cross-Regional
343	Maroubra Beach-City	8	Suburban

The existing regular bus routes within the South East area can be segmented into three broad service types which are summarised together with their existing service numbers and average loadings in Table 2-2.

[35] *Transport for NSW, unpublished data from Public Transport Project Model, 2013*

Table 2-2: Existing Bus Service Types

Bus Service Type	Service Characteristics	Existing Bus Trips (2010 AM Peak Hour)	Average Loading (per Bus during 2010 AM Peak Hour)
1. CBD All-stop Services	▪ Stop frequently from their suburban origin to the CBD ▪ Operate All Day in both directions ▪ Primarily use Oxford, Cleveland or Foveaux Street to access the CBD from the South East	135	36
2. CBD Express Services	▪ Stop frequently on suburban routes before reaching a key node and running direct to the CBD without stopping ▪ Typically operate during the peak periods only in the peak direction ▪ The bulk of these services utilise the eastern distributor to access the CBD and operate contra peak south along Elizabeth Street	62	55
3. Cross-Regional Services	▪ Do not enter the CBD but rather provide links between key centres, such as Bondi Junction ▪ Operate All Day	47	-

The bulk of existing bus services within the south east CSELR corridor are CBD All Stop services (135 trips per hour) which operate to the CBD throughout the entire day. This includes the existing Metro Bus Routes M10 and M50. These services are supplemented when demand increases during the peak period by express bus services (62 trips per hour) which generally pick up until Randwick or Kingsford and then run express into the northern end of the CBD via the Eastern Distributor (Note the X39 is the only express service in the study area not operating via the ED).

Existing bus services within the CSELR corridor operating to the CBD carry approximately 8,300 customers during the AM peak hour. The bulk of CBD bus customers (59%) in the CSELR corridor use the All-Stop services although the loadings per bus trip are significantly lower when compared to express services. The express CBD express services are currently experiencing the strongest growth in patronage, a trend anticipated to continue.

Cross regional services are also provided to create connections to other key centres as well as linking the numerous education, shopping and health precincts.

In addition to regular route services, express university buses are provided to the UNSW, school special services to Sydney Boys and Girls High School, and Special Event services are provided to the Moore Park precinct and Royal Randwick Racecourse during events. These are also discussed within this report.

2.4. Special Events

2.4.1. Overview

Special events are an important contributor to economic activity, with the NSW Events calendar generating an estimated $600 million per annum in direct expenditure for NSW in 2011 and business events generating a further $778 million[36]. In addition, the events industry attracted 2 million overnight event visitors (staying, on average, 3 nights each), and 5.2 million day-trip event visitors. The economic value of events is substantial and proper planning and delivery of transport services for these events can have a serious impact on their success.

To inform planning for future special event transport operations, an assessment of events currently held at Moore Park, Royal Randwick and other major events within the corridor was undertaken to determine the role the CSELR project would have in the future. Additionally an assessment was undertaken of events currently held along the CSE corridor, primarily within the CBD, which impact transport operations. Detailed planning will be required in order to minimise the operational impact on the CSELR of these events, particularly given the fixed infrastructure nature of the light rail transport solution.

Due to the inner city location of the Moore Park precinct and the relatively low public transport mode share, it regularly experiences congestion associated with events in excess of 15,000 spectators. The precinct currently has a total supply of 5,800 off-street car spaces and one of the highest car parking spaces to venue capacity ratios in Australia[37] and relies heavily on event buses as the public transport solution.

Sydneysiders have demonstrated their willingness to use public transport to travel to events at the city's two major sports and entertainment precincts. A more balanced and sustainable approach to transport and access to this important event precinct can lead to positive urban amenity outcomes. CSELR provides the opportunity to improve the non-car transport mode share from 47% to around 70% which is more in line with what is achieved at Sydney Olympic Park and other major stadia in Australia[38].

2.4.2. Moore Park

2.4.2.1. Event and demand overview

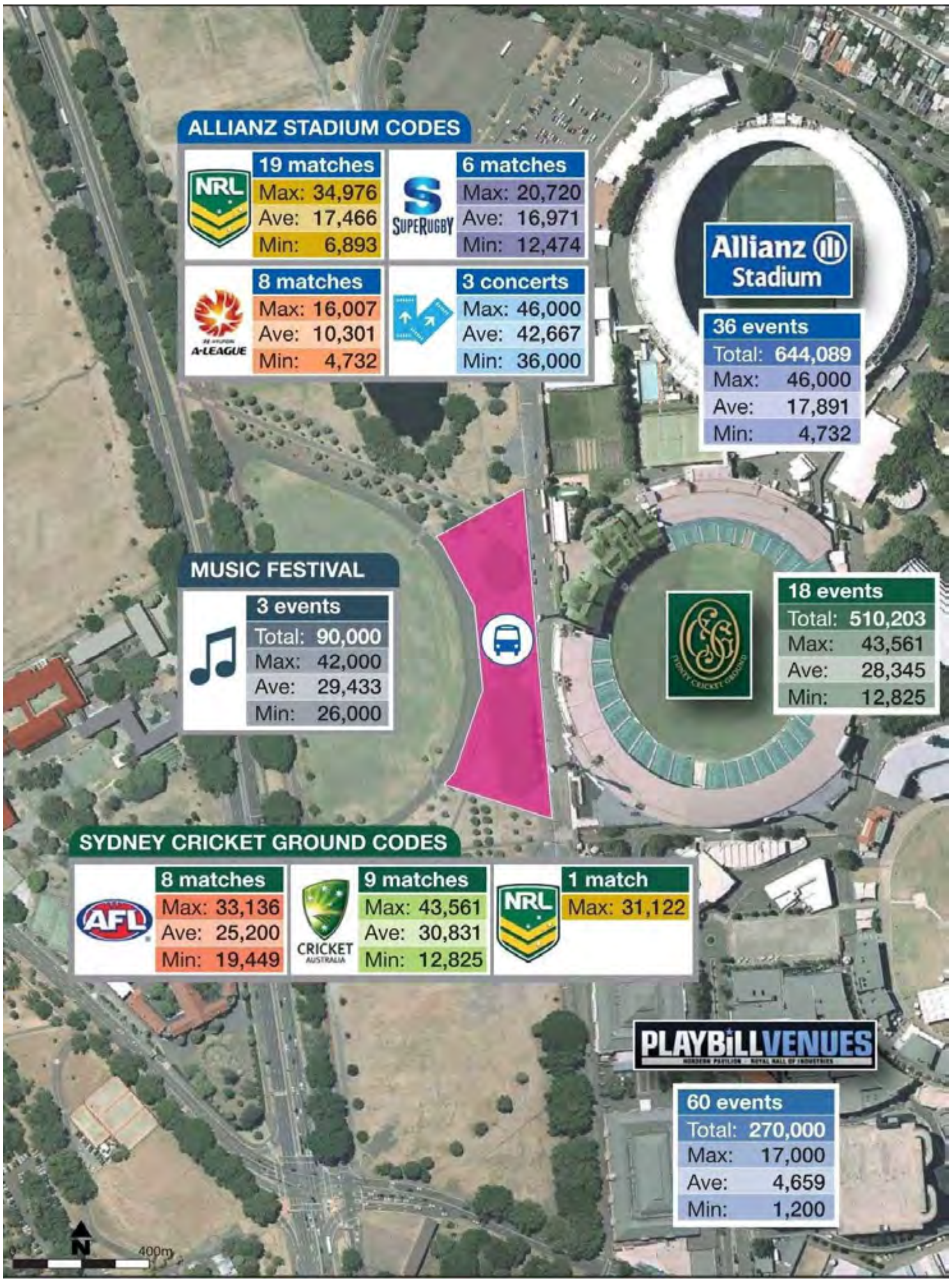
Moore Park consists of three major precincts, Allianz Stadium, the SCG and Playbill venues (the entertainment quarter) holding a diverse array of events with varied transport requirements. The sporting stadiums receive the lion's share of patrons; however the Playbill venues (such as the Hordern Pavilion and Royal Hall of Industries) hold a greater number of smaller events. Key 2011 event statistics are summarised in Table 2-3 with a full breakdown of attendance and frequency for the Moore Park precinct presented in Figure 2-6.

[36] *Final Report of the Visitor Economy Taskforce, Destination NSW*
[37] Parsons Brinckerhoff, *Sydney Light Rail Program Moore Park Precinct – All Modes Study,* June 2013
[38] *Ibid*

Table 2-3: Moore Park 2011 Key Event statistics

	Sports Stadiums	Playbill Venues
Total Events	50	60
Total Attendance	1,150,000	270,000
Peak Attendance	46,000	17,000
Average Attendance	18,000	5,000

Figure 2-6: Moore Park 2011 Event Attendance and Frequency[39]



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[39] *Transport for NSW special event bus data for 2011 and Moore Park Operations Plan (2004) as cited in Parsons Brinckerhoff, Sydney Light Rail Program Moore Park Precinct Study, January 2013*

The majority of events at Moore Park are characterised by a 'bump in-bump out' demand profile with a large surge in demand for transport services prior to and, particularly, at the conclusion of events such as sports games or concerts. While pre-game entertainment and opening acts tend to spread the demand for transport as patrons arrive, 75% to 85% of attendees leave venues within 20 minutes of events finishing. Longer events such as cricket and the Australian Football League (AFL) experience higher numbers of patrons leaving before the event finishes.

2.4.2.2. Mode share

Across the spectrum of events held at the sporting stadiums walking, driving and event bus are the main modes with:

- 40% to 50% walking, including approximately 12,000 spectators estimated to walk to/from Central Station for a capacity event;
- 35% to 50% driving; and
- 5% to 20% catching an event bus.

Estimated event bus mode share for music festivals is significantly higher at 35%, likely due to the younger average age of music festival attendees when compared with other event types. Mode share data for the Playbill venues is unavailable however special event buses are not provided due to the relatively small crowd sizes. Estimated transport mode share is presented in Table 2-4.

Table 2-4: Moore Park 2011 Transport Mode Share[40]

Mode of Transport	Music Festival[3]	Cricket[1]	AFL[1]	Concert (Allianz Stadium)[3]	NRL[2]	Rugby Union[1]	Soccer[1]
Car (driver and passenger)	20%	40%	37%	35%	39%	42%	48%
Event bus	35%	18%	17%	12%	10%	6%	4%
Drop-off							
▪ Taxi/hire care/bus	2%	2%	2%	4%	2%	2%	2%
▪ Private car	1%	1%	1%	2%	1%	1%	1%
Walk	42%	39%	43%	47%	48%	49	45%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

1. Estimated from 2011 event bus data, car park numbers and 2004/2005 Moore Park Event Operations Plan Study.
2. Estimated from surveys undertaken for match between the Sydney Roosters and the South Sydney Rabbitohs at Allianz Stadium on the evening of Friday 11 March 2011. The match was a local derby on the first round of the season and attracted an official crowd of 28,703 people.
3. Estimated from other events.

Walking

Significant numbers of customers walk to Moore Park, many of which walk to access rail services at Central Station. Upwards of 10,000 people attending a typical cricket or AFL game arrive on foot, of which approximately 30% travel along Fitzroy and Foveaux streets from Central Station. The walk between Central Station and Allianz Stadium is 1.65 km or approximately 25 minutes.

[40] *Parsons Brinckerhoff, Sydney Light Rail Program Moore Park Precinct Study, January 2013*

Driving

A typical cricket match currently attracts upward of 12,000 attendees arriving by car. Maximum car parking capacity is estimated at 5,700 spaces spread between a number of locations including on-grass, temporary and permanent facilities. Permanent parking facilities are available and supplemented by on-grass parking as follows:

Permanent parking:

- SFS Members Car Park (~700 spaces); and
- Entertainment Quarter (~2,000 spaces).

Temporary parking:

- Kippax and Area 2 on-grass parking areas (~2,500 spaces); and
- Sydney Boys High School (~500 spaces)

Vehicles leaving Moore Park following an event cause congestion on the surrounding road network, frequently resulting in egress times from the precinct of 50 to 75 minutes.

Special event buses

Event bus mode share varies significantly by event type with music festivals, cricket and AFL matches boasting the highest shares.

Routes operate between Moore Park and Central, Circular Quay, Goulburn Street car park and the UNSW however not all routes service every event. Further information on event bus operations is provided in Section 2.4.2.3.

2.4.2.3. Special event bus operations

Special event buses operate during sporting events, concerts and music festivals. In 2011 over 6,000 bus trips operated to serve special events at Moore Park accruing approximately 20,000 service kilometres. The routes and levels of service offered differ by event based on expected attendance levels and travel patterns of the attendees. A summary of event bus services to Moore Park is presented in Table 2-5.

Table 2-5: Event Bus Services to Moore Park[41]

Route Number	Destination	Stops/Route	Event Type
1	Central	Connecting to suburban rail, Airport Line and intercity trains	All
3	Circular Quay	Via Flinders Street, Oxford Street and Elizabeth Street – connecting to North Shore buses at Wynyard and ferries	All
3	Martin Place	Stops also at St James and Museum	All
15A	Castle Hill	Stops at The Hills Centre, Baulkham Hills, M2 Barclay Road, M2 Oakes Road	AFL and Rugby Union
18	Dural	Stops at Round Corner, Glenhaven, Cherrybrook, West Pennant Hills, Beecroft	AFL and Rugby Union

[41] Parsons Brinckerhoff, *Sydney Light Rail Program Moore Park Precinct – All Modes Study,* June 2013

Route Number	Destination	Stops/Route	Event Type
30	TG Milner Sportsground Marsfield	Stops also at Chatswood and St Leonards	Rugby Union
40	Kings Cross		AFL
50	Warringah Mall	Stops at Balgowlah, Seaforth, Mosman, Cremorne and Neutral Bay	Rugby Union, Rugby League
52	Goulburn Street Car Park	To augment car parking at Moore Park	AFL
60	Randwick Racecourse	To augment car parking at Moore Park	AFL, Rugby League
62	University of NSW	To augment car parking at Moore Park	AFL
80	Chatswood		Rugby Union

For instance, Route 3 buses are offered at Manly Sea Eagles National Rugby League (NRL) games held at the SFS to cater for supporters transiting from the north shore and northern beaches. Available 2011 statistics on special event buses to and from Moore Park are provided in Table 2-6.

Table 2-6: Moore Park Average Event Bus Statistics (2011)[42]

	Music Festival	Cricket	AFL	Concert	NRL	Rugby Union	Soccer
Bus Trips	256	208	176	193	63	61	20
Service Kilometres	986	673	575	603	197	200	61
Passengers Forward	4,987	4,416	3,551	5,126	1,346	979	339
Route 1	*4,987*	*3,767*	*2,854*	*4,894*	*1,289*	*881*	*381*
Route 3	-	*834*	*232*	*348*	*271*	*123*	-
Route 52	-	-	*409*	-	-	-	-
Route 62	-	-	*226*	-	-	-	-
Passengers Return	6,862	5,315	4,180	5,166	1,360	959	383
Route 1	*6,862*	*4,039*	*2,876*	*3,930*	*1,278*	*772*	*431*
Route 3	-	*1,640*	*568*	*1,236*	*388*	*187*	-
Route 52	-	-	*446*	-	-	-	-
Route 62	-	-	*290*	-	-	-	-

[42] *Transport for NSW annual special event bus data for 2011. Average values shown for each measure. Average total passengers may not equal the sum of each route as Route 3 supports only selected events.*

Buses disembark passengers at a specially designed high-capacity bus hub located adjacent to the SCG and short walking distance from Allianz Stadium and the Entertainment Quarter (shaded in Figure 2-6). Following large events passenger queues extend toward Driver Avenue and into the Area 2 parking area.

2.4.3. Royal Randwick

2.4.3.1. Event and demand overview

Historically Royal Randwick Racecourse has only been heavily utilised by major events on designated race days. In 2011 this comprised 12 race days ranging in size from around 5,000 to over 25,000 attendees for the Randwick Derby and the Epsom Handicap. However there is a growing trend toward hosting significant non-racing events at Royal Randwick, for example UNSW bi-annual examinations, and the annual Future Music festival which began in 2006. It is expected this trend will continue following the development of the site as discussed in Section 3.1.2.4.

Figure 2-7: Alison Road at Royal Randwick[43]

Race days are characterised by a greater 'spread' in their transport demand profile when compared with other major sporting and music events, with a much less pronounced peak demand in both the access and egress periods. In addition, races tend to be held on weekends and rarely coincide with the regular commuter peak making events at Randwick easier to manage from a transport perspective.

2.4.3.2. Mode share

Event bus mode share for Saturday race days averages 8% of total attendance. Mode share increased for race days with higher attendance; those with greater than 15,000 attendees averaged 11% bus share. Additionally, mode share is typically higher on the return leg away from Randwick. Taxis play a particularly significant role as a mode of access on race days.

Event bus mode share was significantly higher at the Future Music Festival, averaging 33% overall comprised of 27% on the forward leg and 40% on the return leg. This higher mode share is likely a result of the lower average age of attendees to the music festival.

[43] *ATC, Sydney Carnival 2012 Coordinating Instructions: Traffic and Pedestrian Management, April 2012*

2.4.3.3. Special event bus operations

Special event buses operate to support transport to Saturday race days and Melbourne Cup day. Saturday race days attract on average 14,000 attendees, with major race days attracting up to 25,000 patrons. Additionally, event buses have supported the annual Future Music Festival which in 2011 had over 40,000 attendees.

In 2011 nearly 1,400 bus trips served events at Royal Randwick accruing approximately 6,500 service kilometres. A shuttle service, the Route 32, is offered between Central Station (Eddy Ave) and the racecourse. Buses disembark passengers at the Alison Road bus terminus at the northern edge of the site, as marked in Figure 2-7.

2011 statistics on special event buses to and from Royal Randwick are provided in Table 2-7.

Table 2-7: Royal Randwick Average Event Bus statistics (2011)[44]

	Music Festival	Races
Bus Trips	471	73
Service Kilometres	2,090	371
Passengers Forward	11,234	787
Route 32	*11,234*	*787*
Passengers Return	16,874	1,992
Route 32	*16,874*	*1,992*

2.4.4. Events impacting CSELR operations

Sydney regularly hosts cultural events including parades, running festivals and religious celebrations which impact traffic flows along the CSELR corridor. These events are concentrated in the CBD and predominantly impact traffic along George Street. Existing annual events impacting the CSELR corridor are listed in Table 2-8, however historically there have been additional events such as a parade in 2012 to celebrate the Sydney Swans winning the AFL Premiership.

Table 2-8: Annual Events Directly Impacting the CSELR

Indicative Month	Event	Comment
January	Australia Day Wheelchair Race	Course runs west along Alfred Street at Circular Quay
January	Chinese New Year Twilight Parade	Parade down George Street between Park and Goulburn Streets
March	St Patricks Day Parade	Parade down George Street between Park and Bathurst Streets
April	Anzac Day Parade	Parade down George Street between Martin Place and Bathurst Street
May	May Day March	Parade down George Street between Park and Bathurst Streets
May	SMH Half Marathon	Course runs west along Alfred Street at Circular Quay
June	MS Walk / Run	Short section of the run along George Street near Martin Place
June	Procession of the Blessed Sacrament	Procession moves down George Street between Bridge and Hunter Streets
September	Sydney Running Festival	Course runs west along Alfred Street at Circular Quay, and east through the pedestrian section of Circular Quay

[44] *Transport for NSW unpublished special event bus data for 2011. Average values shown for each measure.*

Indicative Month	Event	Comment
November	Sydney Christmas Parade[45]	Parade down George Street between Hunter and Liverpool Streets
December	New Year's Eve	Closure of George Street between Grosvenor and Alfred Streets, closure of Alfred Street at Circular Quay
N/A	Olympic / Sporting Parades	I.e. Sydney Swans celebratory parade 2012

Buses are typically diverted during these events, from George Street to Elizabeth Street. Following the construction of the CSELR, the operational impact of these events could be minimised by shutting the impacted portion of the line and supplementing with buses travelling along an alternate route. Detailed planning is required to minimise the impact of these events and is revisited in Section 3.3 of this report. In addition to planned events, detailed operating plans will be developed to respond to the impact of unplanned events (such as major accidents or emergency service operations in the corridor) that temporarily suspend operations of the CSELR.

2.4.5. Other events impacting demand

In addition to special events held at Moore Park and Royal Randwick, Sydney hosts a number of other special events which will impact demand for transport along the CSELR corridor to varying degrees. A list of events indirectly impacting the CSELR is presented in Table 2-9. Many of these events are held in the Sydney CBD and surrounding areas, such as the Rocks, Botanic Gardens or Domain, and draw in attendees from across Sydney. Operational management of these events following introduction of light rail is explored in Section 3.3 of this report.

Table 2-9: Annual Events Indirectly Impacting the CSELR

Indicative Month	Event	Impact
January	Sydney Festival – Festival First Night	High
January	Sydney Festival	Medium
February	Opera in the Domain	Low
February	Tropfest	High
March	Good Life Music Festival	High
March	Mardi Gras Parade	Medium
March	Mardi Gras Party	Medium
May	Vivid Festival	Medium-High
May	Mother's Day Classic	Low
June	Sydney Film Festival	Low
July	Reserve Forces Day	Low
August	City 2 Surf	High
October	Navy International Fleet Review	Low
October	International Motor Show	Low
December	Carols in the Domain	Low
N/A	Major Sporting Events	Medium

[45] Continuation of this event subject to review by the City of Sydney

2.5. CBD precinct

Sydney's CBD is the commercial heart of the city with substantial office-based daytime employment. It is a key retail and entertainment destination and, also, has a growing residential population. As a result the CBD road network supports high levels of peak travel demand, as well as a broader range of travel markets. It also represents the core of Sydney's predominantly radial public transport system. The CBD precinct runs from Alfred Street in Circular Quay to Chalmers Street, via George Street, Rawson Place, Eddy Avenue and up to the intersection of Chalmers Street / Devonshire Street (Refer to Figure 2-1). Eddy Avenue / Chalmers Street within the precinct is a complex area home to the major New South Wales rail network terminus of Central Station and a major bus interchange at Railway Square, Eddy Avenue and Chalmers Street.

2.5.1. Road network

The key roads within the CBD precinct that will be directly impacted by the CSELR include:

- George Street
- Alfred Street
- Rawson Place/Eddy Avenue
- Chalmers Street/Elizabeth Street

A summary of the key network characteristics for each of these roads is provided in Table 2-10.

Table 2-10: CBD precinct road network characteristics

Road	Key Characteristics
George Street	George Street is a major two-way collector road under the care and control of City of Sydney. It operates in a north-south direction through the Sydney CBD and it provides access between the Sydney City precincts. George Street is a key bus corridor, with kerb side bus lanes as well as driveway access to number of car parks; limited on-street parking; loading/unloading zones; dedicated turning lanes at key intersections; and pedestrian and cyclist access.
Alfred Street	Alfred Street is a local road under the care and control of City of Sydney. The section between George Street and Pitt Street operates as a two-way road with two westbound lanes and a single eastbound lane. The section of the road east of Pitt Street operates in a one-way westbound direction. The major traffic along this road is associated with taxi and bus service trips. Alfred Street is considered a key bus / rail and ferry interchange.
Rawson Place/Eddy Avenue	Rawson Place/Eddy Avenue is a two way east-west running local road under the care and control of City of Sydney. This is the one of the key access roads to the Central Station precinct. A section of the corridor operates with three traffic lanes in each direction whilst the remaining sections caters for two traffic lanes and separate dedicated bus lanes are provided. A provision for short duration on-street parking is available along Rawson Place. Eddy Avenue operates as a bus/light rail (elevated on the station colonnade), heavy rail and coach interchange.
Chalmers Street/ Elizabeth Street	Chalmers Street is a four lane local road running one-way northbound and Elizabeth Street is a four lane local road running one-way southbound with a dedicated kerbside bus lane and parking lane (from Redfern Street to Foveaux Street). This road connects the suburbs of Redfern, Surry Hills, Sydney CBD, and the southern suburbs and provides access to the Central Station precinct.

Traffic operating patterns

The Sydney CBD is a highly constrained urban environment with substantial levels of congestion on virtually all corridors. In particular, George Street, as the primary north-south corridor through the CBD for pedestrians, general traffic, taxis, busses and commercial vehicles, is a highly congested. It supports 290 buses in the peak direction during the morning peak hour, which is anticipated to grow further to over 310 buses per hour by 2015.

George Street plays a significant role in the transport system, as well as in Sydney's identity as the natural connection through the heart of the city. It forms the central spine through the CBD, linking key locations such as Circular Quay, Town Hall and Railway Square.

Table 2-11 provides a summary of the key characteristics and constraints associated with existing general traffic and public transport operations of the CSELR corridor along the key roads within the CBD precinct.

Table 2-11: CBD precinct existing operational characteristics

Road	Constraints	Description
George Street	General Traffic	George Street is currently operating at capacity. The general traffic taxis and buses travelling along George Street contribute to a high level of traffic congestion within this precinct. Taxi volumes are significant and include a large proportion of empty vehicles seeking a fare.
	Bus Services	There are numerous bus services operating along George Street in dedicated bus lanes. There are 290 bus services in the peak direction along the corridor. Tourist Coach Buses: currently Sydney Sightseeing tourist coaches operate along the George Street corridor
Alfred Street	General Traffic	Alfred Street provides a connection between George and Pitt Streets that facilitates access to the northern end of Pitt Street. As such, traffic is mainly local access and taxi trips.
	Bus Services	Approximately 22 bus services run along Alfred Street, with services operating to the eastern, north western, western and southern suburbs.
Rawson Place	General Traffic	The majority of traffic travelling along this route is associated with the Central Station precinct and traffic connecting to key north, south and CBD corridors.
	Bus Services	Currently one bus service travels along Rawson Place (Route 555). All other buses from Eddy Avenue turn onto Pitt Street.
Eddy Avenue	General Traffic	The majority of traffic travelling along this route is associated with the Central Station precinct and it is an important connection linking eastern suburbs traffic on Foveaux and Chalmers Streets in to the CBD.
Eddy Avenue	Bus/Coach/light rail Services	Currently there is a coach/ light rail terminal located on the colonnade on the southern side (Central Station side) of the road. Coach services operate along a narrow island within Eddy Avenue then travel along Pitt Street. There are currently 18 coach bays that are used by Premier, Firefly, CDC and Greyhound operators. All other bus services along Eddy Avenue either head north to Elizabeth Street or south to Pitt Street utilising stops on Eddy Avenue. The majority of peak bus passenger demand is associated with the UNSW shuttle bus services.

Peak hour traffic composition and volumes

A summary of the peak traffic volumes travelling along George Street and Eddy Avenue is provided in Table 2-12, with network composition illustrated in Figure 2-8.

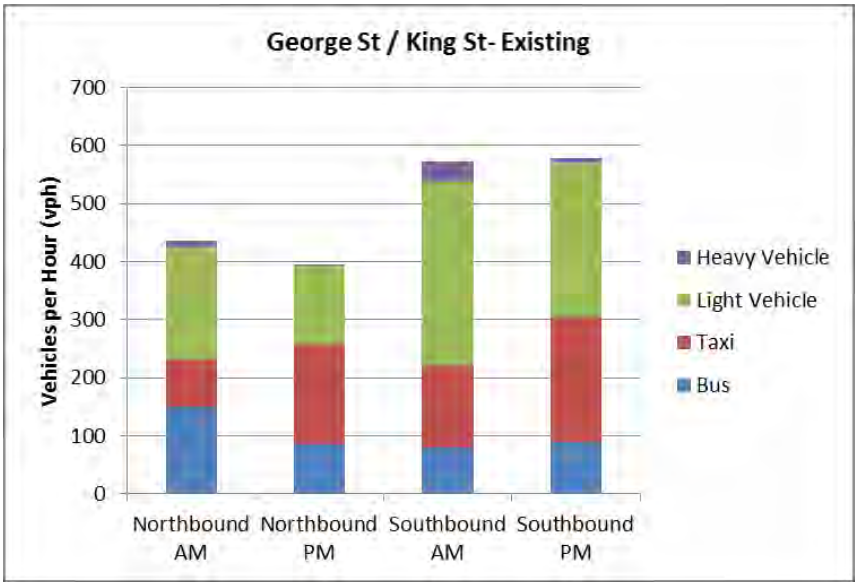
Both George Street and Rawson Place have traffic volumes in excess of 2,000 vehicles during both the AM and PM peak. Along George Street, during the AM peak a large proportion (70 per cent) of these are inbound, whereas the PM peak volumes are more evenly distributed. Eddy Avenue has a relatively even distribution of inbound and outbound traffic during both the AM and PM peak. As illustrated in

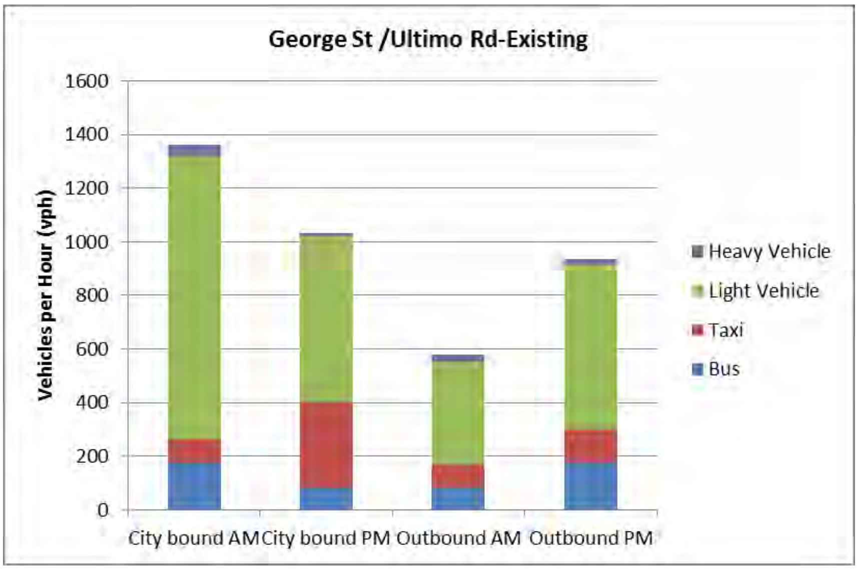
Figure 2-8 the majority of vehicles on the CBD precinct corridors are light vehicles, including a significant proportion of taxis.

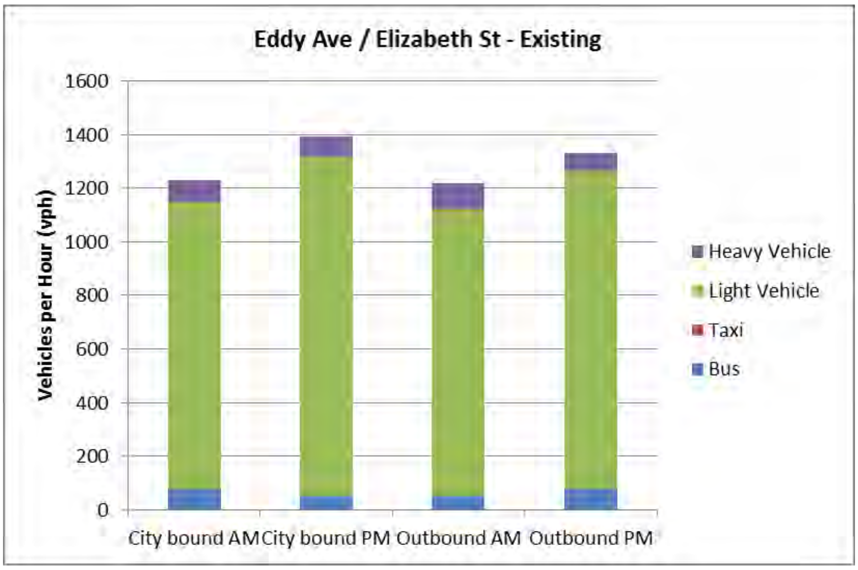
Table 2-12: CBD precinct average weekday AM and PM peak traffic volumes

Intersection	AM Peak			PM Peak		
	City Bound	Out Bound	Peak Direction Split	City Bound	Out Bound	Peak Direction Split
Alfred Street (near George St)	153	232	60% out bound	111	241	68% out bound
George Street (near King Street)	573	435	57% city bound	579	395	59% city bound
George Street (near Ultimo Rd)	1361	577	70% city bound	1032	936	52% city bound
Eddy Ave (near Elizabeth Street)	1230	1218	50% city bound	1391	1330	51% city bound

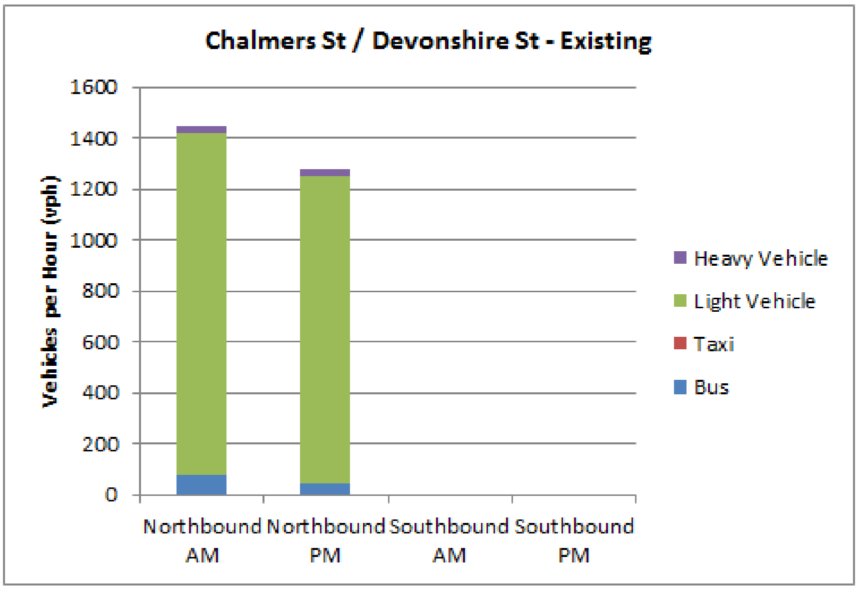
Figure 2-8: CBD precinct existing traffic composition







** No surveyed taxi volumes available*



** No surveyed taxi volumes available*

Intersection performance

A summary of the performance of key intersections along George Street, Rawson Place and Elizabeth Street is provided in Table 2-13. The AM and PM peak key intersection performance results include an overall intersection Level of Service (LoS), intersection delay and Degree of Saturation (DoS) from the base case models. The results are focused on those corridors currently experiencing capacity constraints. Refer to Section 2.2 for the global assumptions used in the intersection analysis.

Table 2-13: CBD precinct key intersection performance[46]

Intersection	Peak Hour	Existing		
		LoS	DoS (volume/capacity)	Av. Delay (seconds)
Bridge Street / Grosvenor Street / George Street	AM	F	1.00	96.8
	PM	F	1.00	81.1
Hunter Street / George Street	AM	D	0.72	43.7
	PM	B	0.64	26.4
Market Street / George Street	AM	C	0.87	35.6
	PM	D	0.88	52.2
Park Street/Druitt Street/ George Street	AM	E	0.90	63.5
	PM	E	0.91	62.2
Bathurst Street / George Street	AM	D	0.92	45.2
	PM	D	0.91	51.9
Rawson Place / George Street	AM	D	0.76	52.7
	PM	E	0.87	59.9
Elizabeth Street / Foveaux Street / Eddy Avenue	AM	C	0.93	37.2

As illustrated in Table 2-13, the intersections between Bridge Street / Grosvenor Street / George Street and Park Street/Druitt Street/ George Street have the lowest level of service, with average delays greater than 1 minute during both the AM and PM peak.

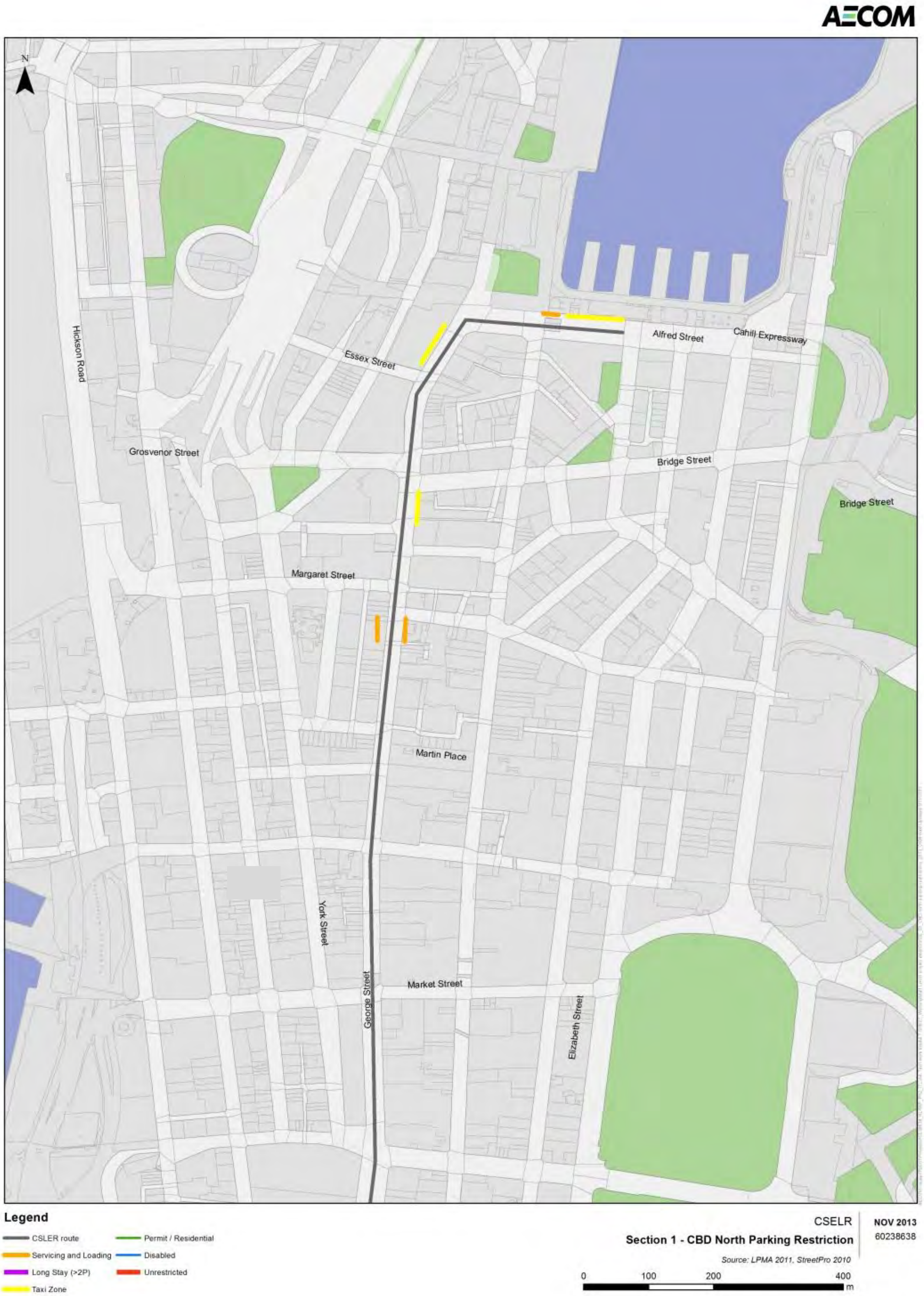
2.5.2. Parking and kerbside access

The existing kerbside parking restrictions in the CBD precinct are shown in Figure 2-9 and Figure 2-10.

The northern section of the CBD, from Circular Quay at Alfred Street along George Street to the intersection of George Street and Park Street, is characterised by high density commercial and hotel development as well as retail and food and beverage uses. Kerbside lanes between Essex Street at Circular Quay and Park Street at Town Hall are used as bus lanes throughout the day (operation hours vary by location with multiple hours and days- generally 6am -8pm Mondays to Fridays). At night, parts of these lanes are used as mail, loading and taxi zones. A westbound bus stop is also located on Alfred Street between Loftus Street and Pitt Street. Additional taxi zones include one eastbound on Alfred Street and another northbound at the Four Seasons Hotel.

[46] *Source: LinSig modelling undertaken as part of ITLU Milestone Option Assessment*

Figure 2-9: CBD north parking restrictions [47]



47 *AECOM, 2013*

The southern section of the CBD corridor runs from the intersection of George Street and Park Street to the intersection of Chalmers Street and Devonshire Street via Rawson Place / Eddy Avenue as shown in Figure 2-10. The dominant land uses are high density residential and commercial as well as retail and entertainment along with the major rail terminus of Central Station and major bus interchange at Railway Square. On George Street there are existing kerbside bus lanes which are operational generally during the hours between 6am – 8pm Monday – Friday (certain sections operate 24 hour bus lanes), which will be replaced by the introduction of light rail. At night and on weekends the majority of on-street parking is permitted on both George Street south and Rawson Place. There are also some strategically located taxi and loading zones along the southern section of George Street close to major land uses such as World Square, Town Hall Station and various hotels located between Park Street and Ultimo Road and Central Railway Station at Eddy Avenue-Chalmers Street. Eddy Avenue provides space for buses and taxis whilst Chalmers Street has on-street parking on the eastern side with bus and taxi stops on the western side.

Figure 2-10: CBD south parking restrictions

Table 2-14: CBD precinct special kerbside uses and parking supply

CBD Kerbside Restriction	Special Kerbside Uses and Parking Supply by Time Period		
	Pre-AM Peak	Inter Peak	Post-PM Peak
Car Share, Hospital, Mail Zone	4	4	4
Disability Parking	5	5	5
Loading Zone	6	42	39
Taxi Zone	15	19	26
Total – Special Kerbside Uses	**30**	**70**	**74**
Short Stay Parking (≤1P)	20	41	20
Long Stay Parking (Restricted)	7	22	43
Long Stay Parking (Unrestricted)	0	0	0
Total – General Parking	**27**	**63**	**63**

The special kerbside uses and general parking supply in the CBD precinct by time of day is illustrated in Table 2-14. The available loading and parking zones in the southern section of the CBD corridor are all operating at effective capacity during peak periods. Further discussion on the Project parking strategy to mitigate impacts on existing supply can be found in Section 6.

2.5.3. Property access

Currently there are a number of property accesses (private car parking or loading dock) along the light rail corridor within the CBD precinct. Existing property accesses along George Street are shown in Table 2-15.

Table 2-15: George Street vehicular accesses and redevelopment sites

Access Type	George Street Accesses
Private car park access	▪ Four Seasons Hotel (west side, Essex Street to Alfred Street) porte cochere is located on George Street, with a back of house, coach/ car drop off zone located on Harrington Street. ▪ 176-186 George Street (east side, access through Blue Anchor Laneway) ▪ Westin Hotel /GPO car park (east side, King Street and Martin Place) ▪ Private car park and loading dock on 420 George Street (east side between King Street and Market Street) ▪ Swissotel and Tower Apartment car park shared with Myer loading dock (east side, Market Street - King Street) ▪ Hilton Hotel Valet parking currently exits one way westbound to George Street ▪ A private garage at 583 George Street(west side between Liverpool and Goulburn Street) ▪ A private car park next to Central Baptist Church (west side- Goulburn Street - Campbell Street) ▪ St Andrews House-(Park Street to Bathurst Street) - Existing access with lockable bollards is located on George Street. Alternate access available via driveway to St Andrews Church on Bathurst Street.
Public car park access	▪ Nil
Courier/delivery loading dock access	▪ Dymock's loading dock (east side King Street - Market Street) ▪ Energy Australia building loading dock (east side, Park Street to Bathurst Street) ▪ A Loading dock access via Wilmot Street (Between Bathurst Street and Liverpool Street)

Access Type	George Street Accesses
Footpath/ramp access to street	■ Hunter Connection - De Mestre Place (east side, Hunter Street - Wynyard Street) ■ 478 George Street /State Theatre Annex (east side, Market Street-Park Street)
Total Identified	**14**

Figure 2-11 highlights the key traffic generating driveways accesses along George Street corridor. The total vehicle counts identified from the key driveways, based on the City of Sydney vehicle survey are outlined in Table 2-16.

Figure 2-11: CBD precinct property accesses

Table 2-16: Total vehicle counts for key accesses along George Street[48]

Driveway Access	Total Daily Volumes
Westfield Loading Dock/Swissotel car park	355
420 George Street (Mid City) car park	170
Hilton Hotel car park	649
GPO Loading Dock/Westin Hotel car park	123

Figure 2-11 and Table 2-16 highlight a significant level of commercial usage of driveways along George Street particularly focused in the block between King and Market Streets. In the case of the Westfield loading dock these vehicle movements include occasional deliveries by 19m articulated trucks.

Currently, when larger vehicles turn into these driveways off George Street they are required to swing out across the adjacent traffic lane which presents a potential safety hazard. The major docks at Mid-City and Westfield also utilise traffic controllers to halt pedestrian movements when vehicles are accessing the driveways due to the heavy pedestrian flows on George Street. When turning off George Street vehicles provide additional low level delays to buses, particularly when periods of heavy pedestrian demand require the traffic controllers to regulate their access.

2.5.4. Pedestrians & cyclists

Pedestrian access

In the Sydney CBD, walking is the predominant mode of transport used for accessing the various centres and land uses. Existing pedestrian access along the light rail route within the CBD is facilitated by footpaths, marked and signalised pedestrian crossings and kerb ramps as summarised in Table 2-17. Pedestrians walking within the CBD precinct experience numerous challenges which include excessive delays at signalised intersections, crowded and narrow footpaths, footpath interruptions, driveway crossovers and undulating topography.

[48] *City of Sydney – George Street Driveway counts 4 August 2010*

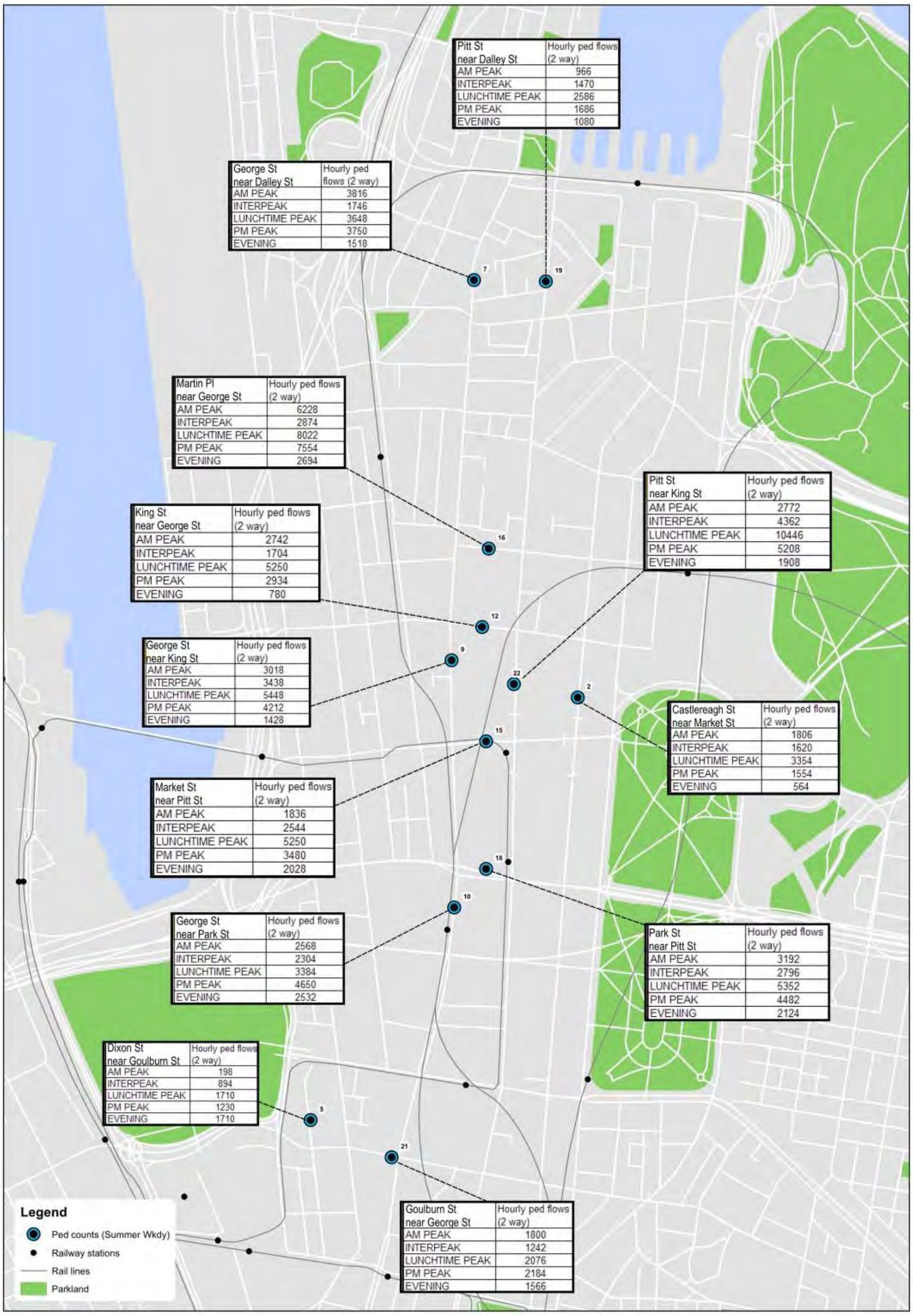
Table 2-17: Existing pedestrian access within the CBD precinct

Precinct	Corridor Location	Description	Pedestrian Access Type
CBD	**Alfred Street**	Circular Quay pedestrian mall, Wharf and public transport interchange which attract significant volumes of pedestrians along Alfred Street. Alfred Street is closed to traffic during major events (e.g.: Sydney New Year's Eve celebrations, Vivid Sydney etc.) period.	Alfred Street is a major passenger transfer location between rail, ferry and bus transport modes. There are signalised intersections, sealed footpaths, a pedestrianised mall and kerb ramps to facilitate the pedestrian movements.
	George Street	George Street is a major hub for employment and businesses specialising in commercial, retail, entertainment and cultural activities as well as major commuter interchange which attract a significant volumes of pedestrians.	Pedestrian connections other than at intersections include the Strand, Mid City, QVB, Hilton, Galleries Victoria, Hunter Connection, Martin Place, World Square etc. Existing pedestrian facilities such as footpaths, pedestrian crossings at signalised intersections (approx. 17 x signalised intersections), and kerb ramps to facilitate pedestrian movements across George Street.
	Rawson Place	Pedestrian activities associated with Rawson Pl are mainly influenced by Central Station (train / bus) commuters and Sydney Central YHA.	The pedestrian facilities such as footpaths, pedestrian crossings at signalised intersections (George Street / Rawson Pl & Eddy Ave / Pitt Street), and kerb ramps are provided to facilitate pedestrian movements across Rawson Place.
	Eddy Avenue	Eddy Avenue is a major passenger transfer location between Sydney Trains, light rail and bus transport modes and highly influenced by commuter activity.	Footpaths on both sides, pedestrian crossings at signalised intersections (Eddy Ave / Pitt Street and Eddy / Elizabeth Street), mid-block crossing and kerb ramps are to facilitate pedestrian movements across Eddy Ave. In addition, pathways through Prince Alfred Park provide good connections with areas to the south of Cleveland Street.
	Chalmers Street/ Elizabeth Street	Pedestrian activity associated with Chalmers Street is mainly influenced by commuter activity, small cafes and businesses.	Chalmers Street and Elizabeth Street are active pedestrian corridors due to their close proximity to Central Station and other residential and retail land uses. Footpaths, pedestrian crossings at signalised intersections and kerb ramps are provided to facilitate pedestrian movements across Chalmers and Elizabeth Streets. A designated pathway along Alfred Street Park attracts significant number of pedestrians to the area.

Pedestrian volumes

Figure 2-12 illustrates the existing pedestrian volumes at selected intersections within the precinct.

Figure 2-12: Existing Pedestrian Volumes within the CBD precinct[49]



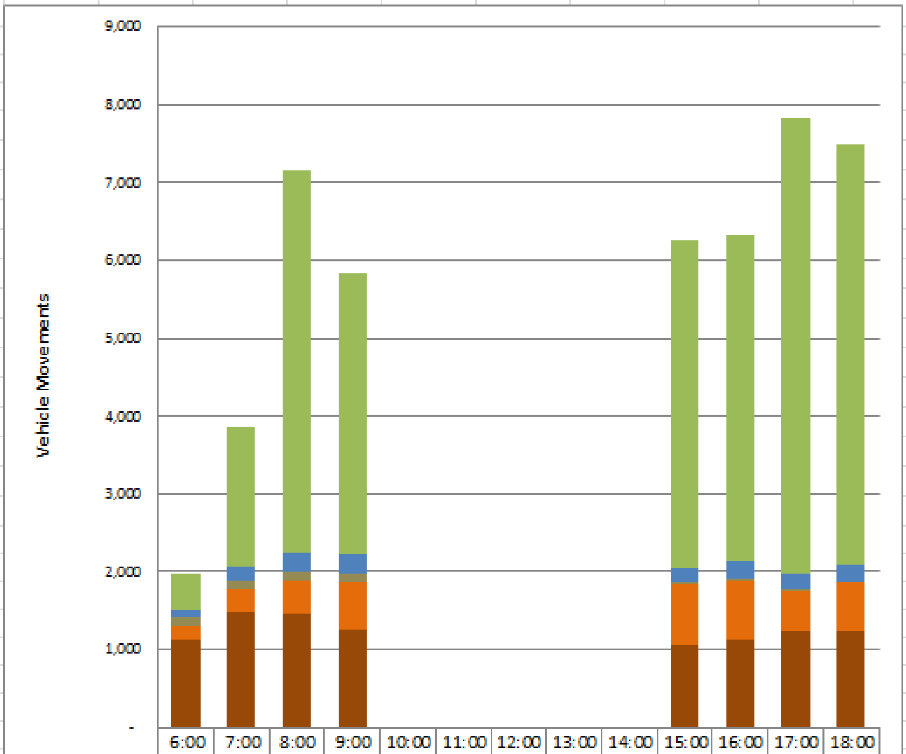
[49] City of Sydney, 2010

As illustrated in Figure 2-12 the points along George Street with the highest pedestrian numbers include:

- Martin Place (approx. 8,000 peak period 2-way flows)
- King Street (approx. 5,500 peak period 2-way flows)
- Park Street (approx. 4,700 peak period 2-way flows

Within the CBD, Transport for NSW has undertaken a number of surveys that highlight the volume of pedestrians in relation to other traffic passing through selected intersections. This analysis for the sites located along the CSELR corridor is shown below in Figure 2-13.

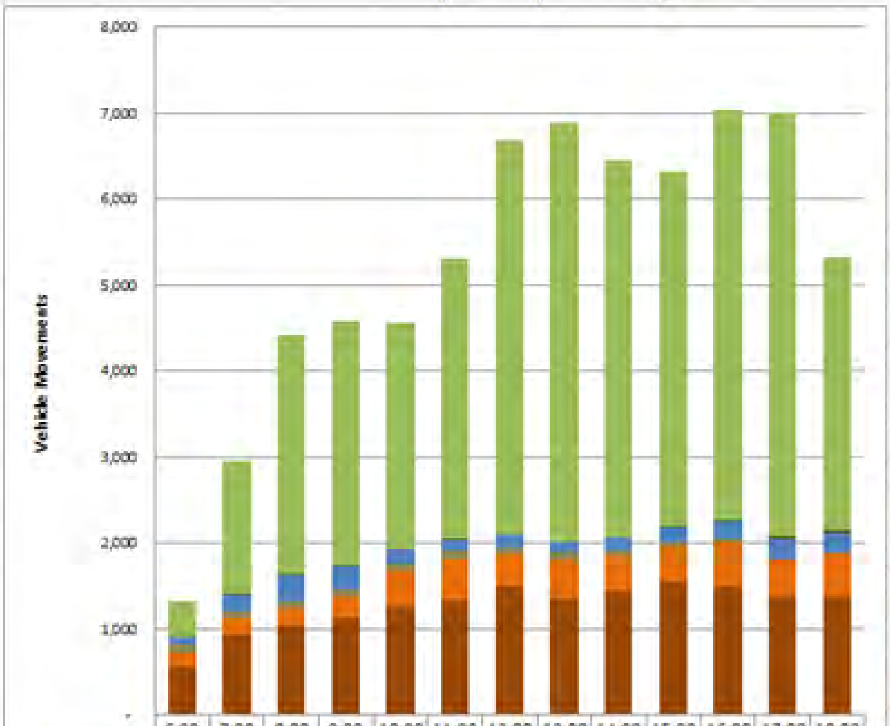
Figure 2-13: George St / King St- Total Intersection number of movements by mode by hour[50]



	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
Pedestrians	467	1,78	4,91	3,60						4,20	4,19	5,84	5,40
Cyclists													
Buses	84	167	252	252						178	215	215	212
Trucks	111	113	100	115						35	23	17	14
Taxis	183	305	438	594						775	774	523	615
Cars	1,12	1,47	1,46	1,26						1,05	1,12	1,23	1,24

50 Transport for NSW, 2013

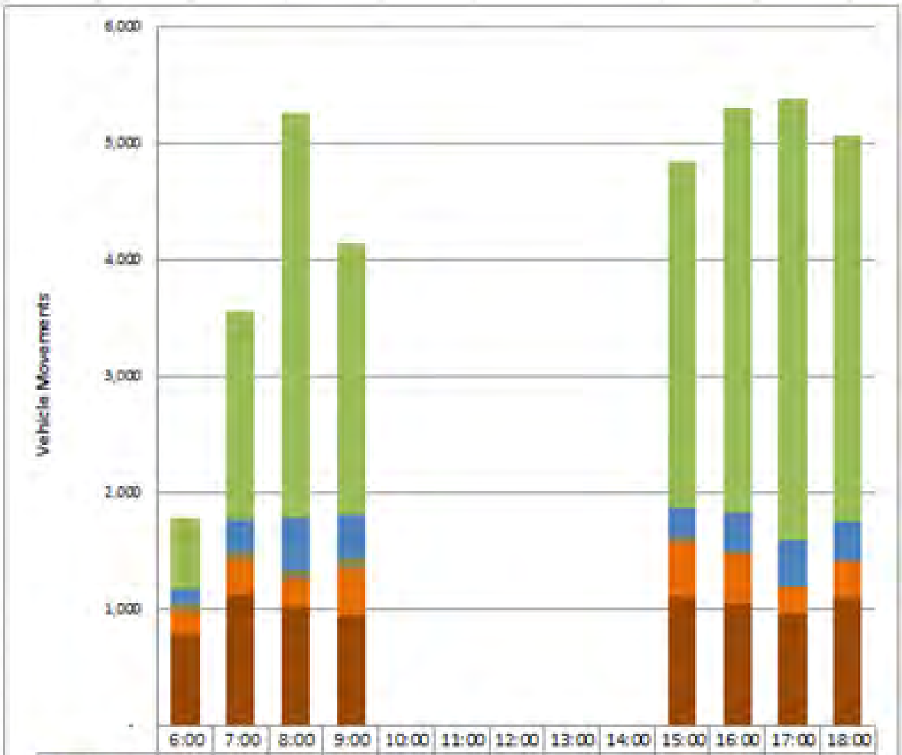
Figure 2-14: George St / Market St- Total Intersection number of movements by mode by hour[51]



	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
Pedestrians	412	1,54	2,76	2,85	2,63	3,25	4,58	4,87	4,38	4,12	4,76	4,91	3,18
Cyclists	9	12	25	5	9	13	5	4	6	13	19	30	33
Buses	84	177	306	277	159	129	154	109	144	174	200	240	213
Trucks	93	86	78	90	94	94	59	107	62	45	33	21	13
Taxis	150	196	208	247	415	490	384	452	408	429	520	414	520
Cars	568	930	1,03	1,12	1,25	1,32	1,49	1,33	1,44	1,53	1,49	1,37	1,36

[51] Transport for NSW, 2013

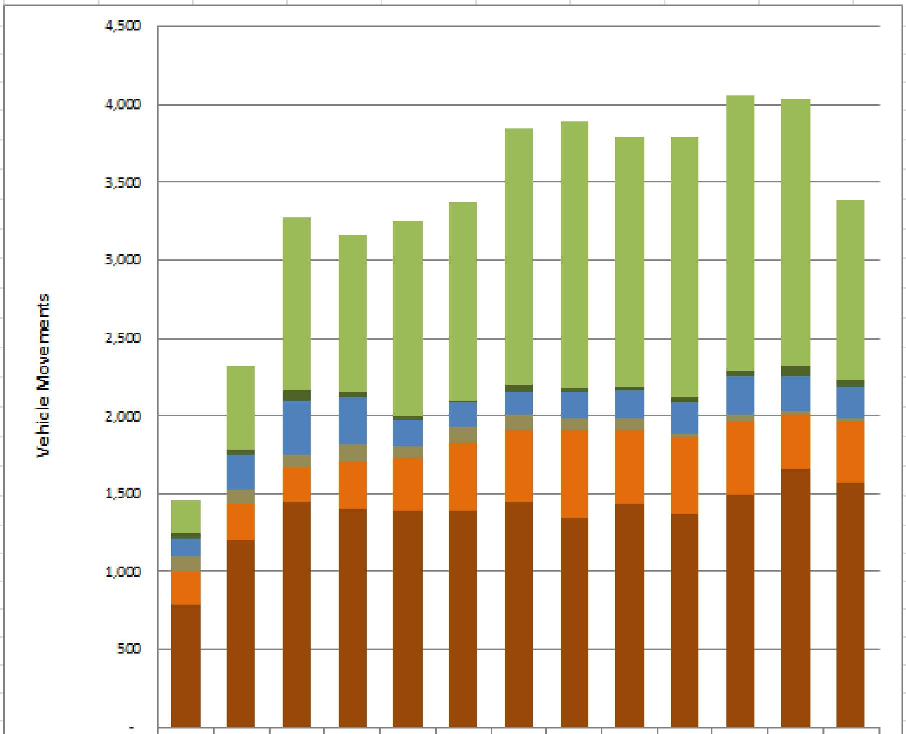
Figure 2-15: George St / Druitt St- Total Intersection number of movements by mode by hour[52]



	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
Pedestrians	618	1,78	3,47	2,33						2,96	3,48	3,79	3,32
Cyclists													
Buses	114	271	443	380						255	331	379	331
Trucks	76	83	77	77						39	24	18	12
Taxis	191	285	245	411						461	431	232	314
Cars	781	1,13	1,01	942						1,11	1,04	955	1,09

[52] Transport for NSW, 2013

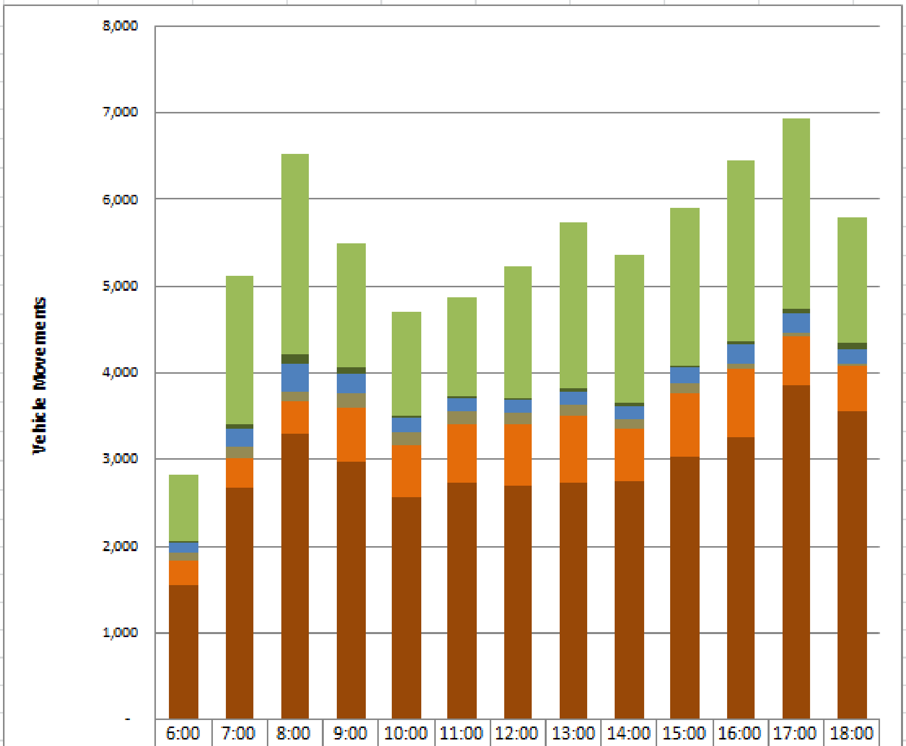
Figure 2-16: George St / Rawson Pl- Total Intersection number of movements by mode by hour[53]



	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
Pedestrians	215	533	1,11	1,00	1,25	1,26	1,65	1,71	1,59	1,67	1,76	1,71	1,15
Cyclists	35	39	63	31	21	11	35	24	26	32	37	60	39
Buses	113	229	356	305	176	164	153	164	169	197	246	230	204
Trucks	92	85	79	105	81	94	93	76	80	30	35	23	21
Taxis	214	230	224	305	331	441	469	561	474	486	479	345	394
Cars	791	1,20	1,44	1,40	1,39	1,39	1,44	1,34	1,43	1,37	1,48	1,66	1,56

[53] Transport for NSW, 2013

Figure 2-17: Elizabeth St / Eddy Ave/ Foveaux St- Total Intersection number of movements by mode by hour[54]



	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
Pedestrians	766	1,70	2,30	1,42	1,20	1,14	1,52	1,91	1,71	1,81	2,08	2,18	1,46
Cyclists	22	65	113	62	21	20	16	30	34	28	24	58	64
Buses	98	196	313	237	172	148	145	141	147	190	236	239	173
Trucks	98	139	119	167	149	143	126	130	107	104	62	37	25
Taxis	286	330	375	607	599	680	728	770	610	728	779	556	525
Cars	1,54	2,68	3,29	2,98	2,56	2,72	2,68	2,74	2,74	3,03	3,25	3,85	3,55

The above analysis demonstrates that pedestrians make up the predominant mode at key intersections, particularly in the northern section of Alfred Street and George Street where they account for as much as 70%-80% of total traffic.

Intersection performance

Pedestrian Level of Service (LoS) assessment at key existing intersections within the proposed pedestrianised zone has been undertaken based on the available footpath space and peak hour pedestrian flows. The results of this analysis are shown below in Table 2-18.

[54] *Transport for NSW, 2013*

Table 2-18: Pedestrian Level of Service

Intersection	Pedestrian Level of Service			
	NW corner	NE corner	SE corner	SW corner
Hunter Street / George Street	D	E	F	E
King Street / George Street	D	D	E	D
Market Street / George Street	E	F	F	F
Park Street/Druitt Street/ George Street	C	C	C	C
Bathurst Street / George Street	D	B	B	E

The above results clearly demonstrate a number of intersections along the George Street corridor suffer from severe levels of congestion that may result in increased journey times and safety issues due to overcrowded footways.

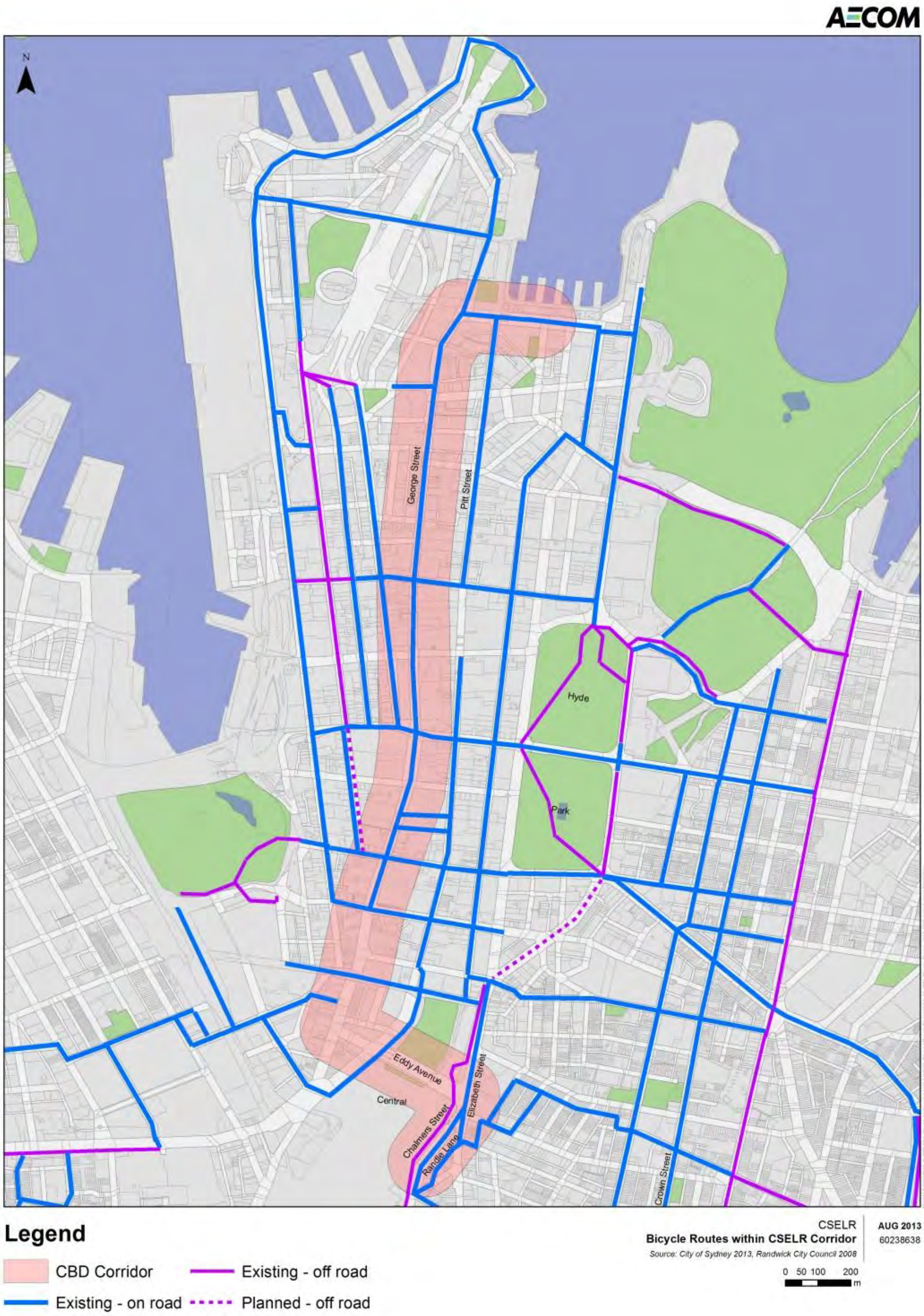
Bicycle access

Under the City of Sydney Cycle Strategy and Action Plan 2007-2017, the Council is committed to making cycling a major mode of transport along with walking and public transport to develop a sustainable transport system. The NSW Government, in the *NSW* 2021 plan has also expressed its commitment to double the mode share for cycling by 2016. The City of Sydney Cycle Strategy indicates that the current percentage of trips between 2 and 5 kilometres in length undertaken by bicycle is approximately 25%, of which the most common purpose of the trips is recreational cycling. There are several networks of on-road and off-road cycleways in the vicinity of the proposed light rail corridor. Figure 2-18 presents the bicycle network within the CBD precinct.

The overall estimated mode share for bicycle trips in the Greater Metropolitan Area is 3.37%[55].

[55] Bureau of Transport Statistics, *Sydney Cycling Survey 2012 Methods and Findings*, 2013

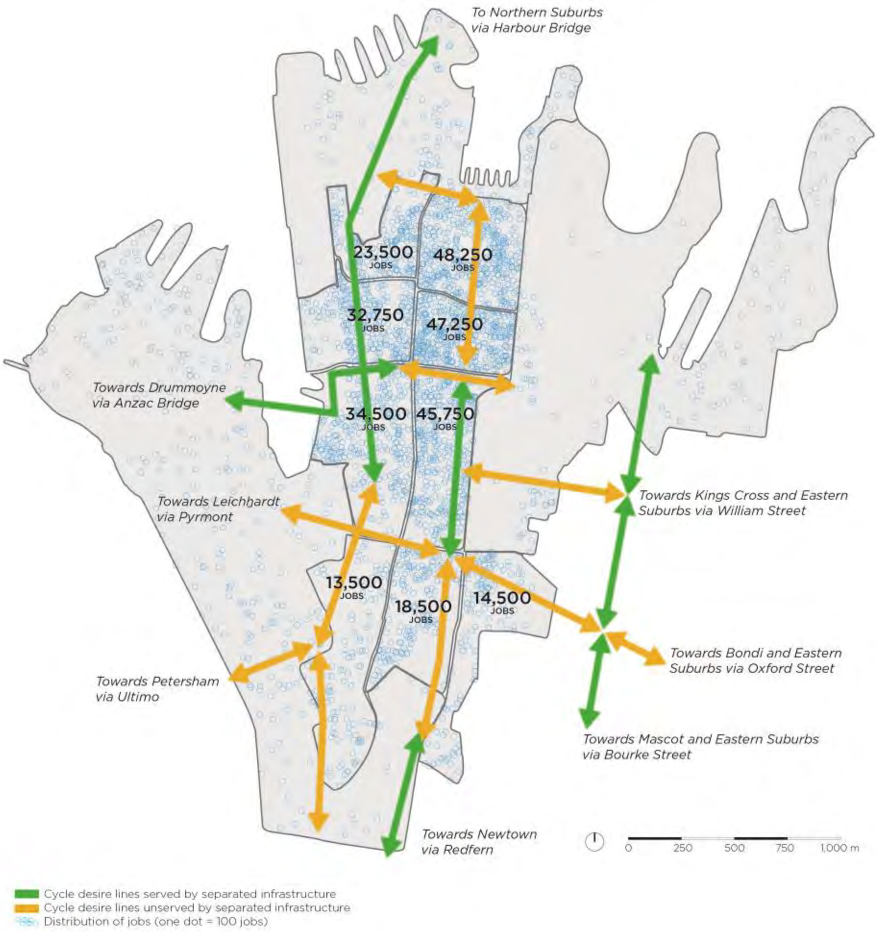
Figure 2-18: Existing bicycle network in the CBD precinct[56]



[56] Source: City of Sydney, Sydney Cycle Map (available from http://sydneycycleways.net/maps-and-tools/maps-routes-sydney-cycling-map)

Key cycling desire lines into the CBD are illustrated in Figure 2-19.

Figure 2-19: Cycle Gateways Job Density



Source: Transport for NSW unpublished data

Cycle counts for 2013 collected by the City of Sydney at King Street show approximately 1,850 bicycle trips on this corridor on an average weekday. The existing bicycle networks in place within the CBD precinct are outlined below in Table 2-19.

Table 2-19: Existing bicycle routes along Key roads within the CBD precinct

Precinct	Corridor Location	Bicycle Route Type	Description
CBD	**George Street**	On-road	The section from Goulburn Street to Hickson Road is considered as an existing on -road cycle route (within bus lanes) under the City of Sydney bicycle route map.
	Rawson Place	Not an official bicycle route	Rawson Place is not considered as a bicycle route within the current City of Sydney's bicycle route map.
	Eddy Avenue	Not an official bicycle route	Eddy Avenue is not identified as a bicycle route within the current City of Sydney's bicycle route map.
	Chalmers Street	Off-road	A section of Chalmers Street (north of Devonshire Street) is considered as an existing on road bicycle route by the City of Sydney. An off-road route runs parallel to Chalmers Street, connecting Prince Alfred Park and Belmore Park via a signalised crossing on Eddy Avenue. Chalmers Street is an active pedestrian / cyclist corridor due to the proximity to Central Station and other residential and retail land uses. There is a direct connection between Central Station and Moore Park through Chalmers Street and Devonshire Street corridors.
	Elizabeth Street / Randle Lane	On-road	The section of Elizabeth Street between Campbell Street and Randle Lane is considered an existing on-road cycle route by the City of Sydney. Randle Lane provides a one-way southbound route to the Chalmers Street and Devonshire Street intersection.

2.6. Surry Hills precinct

The Surry Hills precinct runs from the intersection of Chalmers Street and Devonshire Street along Devonshire Street up to the mid-block crossing at South Dowling Street as shown in Figure 2-1. Devonshire Street's dominant land uses are medium and high density residential terraces and apartment buildings, along with smaller commercial (office) premises and ground floor cafes, restaurants and retail. Ward Park is located on the southern side of Devonshire Street, approximately 100 metres west of Crown Street. St Peter's Church is also situated on Devonshire Street.

2.6.1. Road network

The key road within the Surry Hills precinct that will be directly impacted by the proposed light rail corridor is Devonshire Street which has the key characteristics as presented in Table 2-20.

Table 2-20: Surry Hills precinct road network characteristics

Road	Key Characteristics
Devonshire Street	Devonshire Street is an east-west running two-way two lane local road under the care and control of City of Sydney and mainly serves the suburb of Surry Hills. There are provisions for intermittent parking along both sides and a number of property accesses along the corridor. The Devonshire Street corridor includes traffic signal control at Elizabeth Street and Crown Street. The remaining side road accesses along Devonshire Street are priority controlled. The City of Sydney bicycle route map designates Devonshire Street as a signed on-road bicycle route, however no major fixed infrastructure is provided. The corridor features pavement marking and a 40km/hr posted speed limit to the east of Riley Street and 50km/hr to the west.

Traffic operating patterns

Traffic and transport operations in this area are characterised by the interaction of public and private transport through key links entering and bypassing the CBD such as Cleveland Street, Eddy Avenue, Elizabeth Street and Chalmers Street.

Devonshire Street is one of a number of east-west connections through Surry Hills towards Moore Park. The traffic travelling along Devonshire Street is mainly generated by the medium - high density residential terraces and apartments, along with smaller commercial (office) premises, cafes, restaurants and retail facilities within Surry Hills.

Table 2-21 provides a summary of the key characteristics and constraints associated with existing general traffic and public transport operations along Devonshire Street.

Table 2-21: Surry Hills precinct existing operational characteristics

Road	Constraints	Description
Devonshire Street	General Traffic	Traffic on Devonshire Street is mainly generated by local land uses. Devonshire Street does also provide an alternative east-west corridor to Cleveland Street for through traffic. There are provisions for intermittent parking along both sides and a number of property accesses provided along the corridor mainly serving residential and small business uses.
	Bus Services	The section of Devonshire Street east of Crown Street is part of an existing bus route (Route 355) and bus stops are provided at Crown Street and Bourke Street for eastbound travel.

Peak hour traffic composition and volumes

A summary of the peak traffic volumes travelling along Devonshire Street is provided in Table 2-22, with vehicle compositions illustrated in Figure 2-20. Total traffic volumes along Devonshire Street are around 574 vehicles during the AM Peak and 631 vehicles during the PM peak. As illustrated in Figure 2-20 the majority of vehicles travelling along Devonshire Street are light vehicles.

Table 2-22: Surry Hills precinct average weekday AM and PM peak traffic volumes

Key Intersection	AM Peak			PM Peak		
	City Bound	Out Bound	Peak Direction Split	City Bound	Out Bound	Peak Direction Split
Devonshire Street (near Riley Street)	338	236	59% inbound	278	353	44% out bound

Figure 2-20: Surry Hills precinct existing traffic composition

**Note: No surveyed taxi volumes available*

2.6.2. Parking and kerbside access

On-street parking is widespread within the wider Surry Hills precinct, comprising multiple restrictions, serving the mix of land uses identified. A loading zone is located east of Waterloo Street and another east of Holt Street. Between Chalmers Street and Elizabeth Street, Devonshire Street has several kerbside loading zones as well as a mail zone and late night taxi zone.

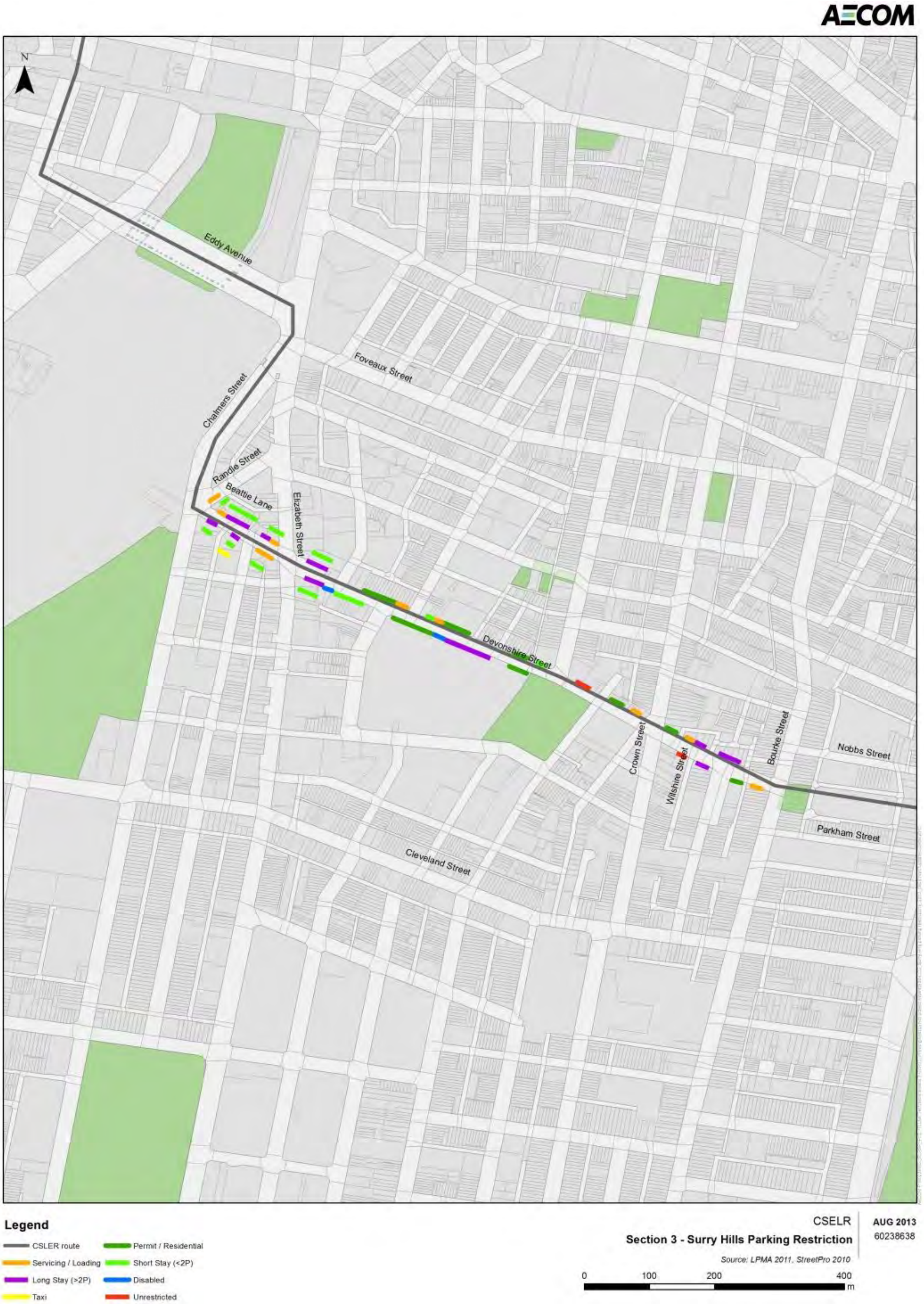
As illustrated in Table 2-23 and Figure 2-21 the Surry Hills precinct currently caters for a range of private vehicle parking.

Table 2-23: Surry Hills special kerbside uses and parking supply

Surry Hills Kerbside Restriction	Special Kerbside Uses and Parking Supply by Time Period		
	Pre AM Peak	Inter Peak	Post PM Peak
Car Share, Hospital, Mail Zone	3	3	3
Disability Parking	5	5	5
Loading Zone	15	15	15
Taxi Zone	0	0	0
Total – Special Kerbside Uses	**23**	**23**	**23**
Short Stay Parking (≤1P)	54	72	72
Long Stay Parking (Restricted)	48	48	48
Long Stay Parking (Unrestricted)	26	8	8
Total – General Parking	**128**	**128**	**128**

Further discussion on existing parking demand and the project parking strategy to mitigate impacts on existing supply can be found in Section 6.

Figure 2-21: Surry Hills precinct existing parking restrictions[57]

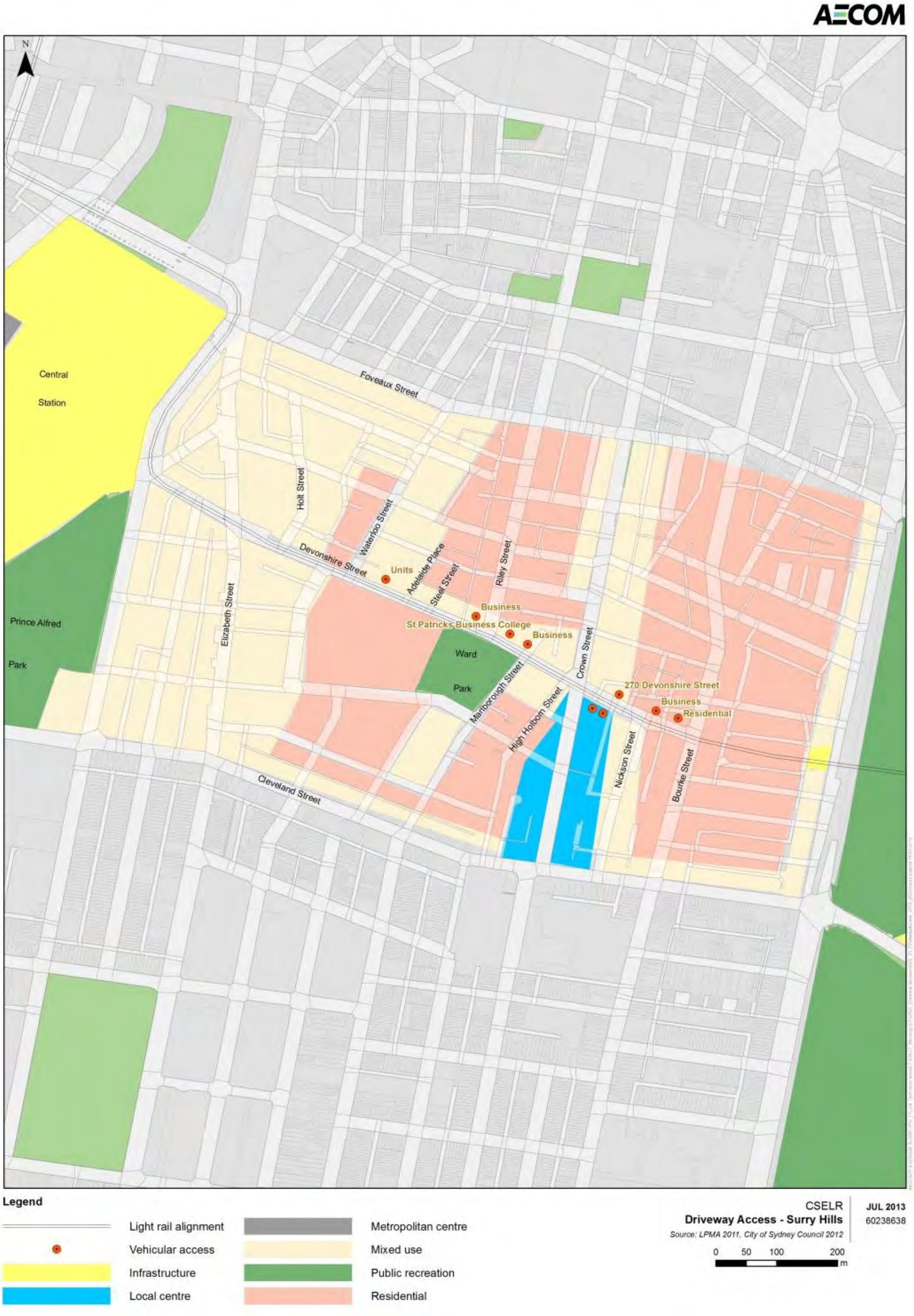


[57] AECOM, 2013

2.6.3. Property access

Existing property accesses along Devonshire Street are as shown in Figure 2-22.

Figure 2-22: Surry Hills precinct property accesses



A total of nine vehicle accesses and driveways are present on Devonshire Street. The majority (seven) are located on the northern side. The majority of these are small local businesses with the exception of St Patrick's Business College and some residential off-street parking driveways.

2.6.4. Pedestrians & cycling

Pedestrian access

Devonshire Street is considered as an active pedestrian corridor due to its close proximity to Central Station through Chalmers Street and the residential and retail land uses. The Devonshire Street pedestrian tunnel connecting Central Station to Lee Street on the western side provides an important pedestrian access route to the CBD and education precincts. A designated pathway along Ward Park also provides a dedicated pedestrian connection to the area.

Existing pedestrian access along the light rail route within the Surry Hills precinct is facilitated by footpaths, marked and signalised pedestrian crossings and kerb ramps as shown in Table 2-24.

Table 2-24: Existing pedestrian access within the Surry Hills precinct

Precinct	Corridor Location	Description	Pedestrian Access Type
Surry Hills	**Devonshire Street and South Dowling Street**	The pedestrians on this corridor are mainly generated by Central Station, medium - high density residential terraces and apartments, commercial premises, cafes, restaurants and retail facilities.	Existing pedestrian facilities on Devonshire Street include footpaths on both sides, 3 x marked pedestrian crossings (east of Steel Street, Riley Street and Marlborough Street) and crossings at the signalised intersection of Crown Street / Devonshire Street. It is noted that the footpath capacity is restricted in a number of areas due to trees and tree roots and provision of kerb ramps are limited on this corridor. The Devonshire Street tunnel provides pedestrian access underneath Central Railway Station to Lee Street on the western side. A mid-block crossing at South Dowling Street and a pedestrian bridge over Eastern Distributor provides direct connection between Surry Hills and Moore Park.

Bicycle access

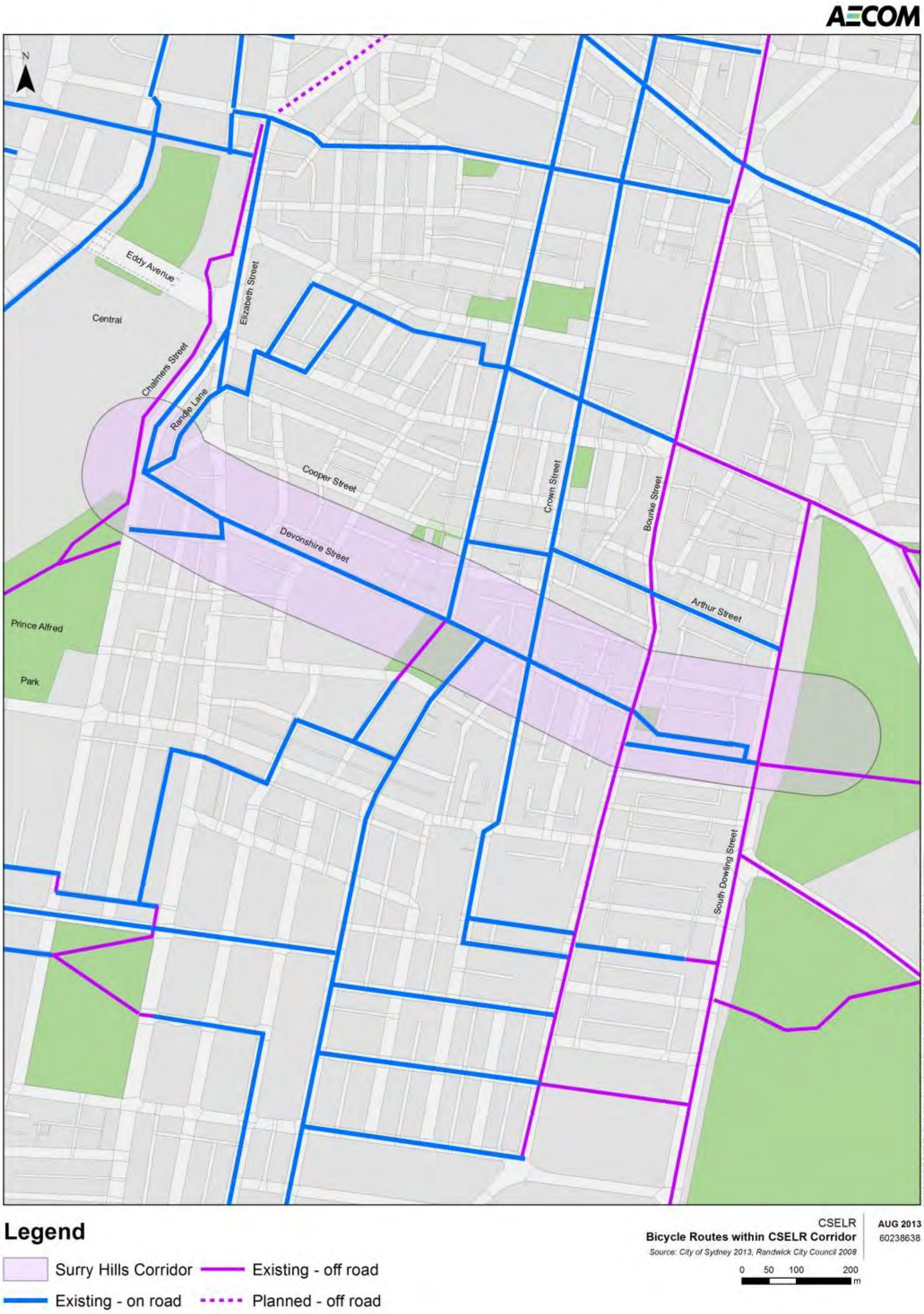
The existing bicycle networks in place within the Surry Hills precinct are outlined below in Table 2-25.

Table 2-25: Existing bicycle routes along key roads within the Surry Hills precincts

Precinct	Corridor Location	Bicycle Route Type	Description
Surry Hills	**Devonshire Street**	On-road	Devonshire Street is an active pedestrian / cyclist corridor. The City of Sydney bicycle route map designates Devonshire Street as an existing on-road bicycle route. This route connects with an off-road cycle path running perpendicular to Devonshire Street, on the western side of Bourke Street. The direct connection between Central Station and Moore Park via Devonshire Street is currently a strong desire line.
	Cooper / Arthur Street	On-road	The City of Sydney designates Arthur Street as an on-road cycle route between Riley Street and South Dowling Street. At Riley Street, Arthur Street links with Cooper Street. Between Riley Street and Elizabeth Street, the City of Sydney does not identify Cooper Street as a current on-road cycle route, however line marking and signage indicates a suitable route.
	Bourke Street	Off-road	Bourke Street provides an off-road cycle route between Lachlan Street in Waterloo and Cowper Wharf Road in Woolloomooloo. Bourke Street connects with several east-west on-road cycle routes that provide direct access to the Sydney CBD. These include; ▪ Devonshire Street ▪ Campbell Street ▪ Oxford Street ▪ Liverpool Street
	Riley Street	On-road	Riley Street is designated as an on-road cycle route between Devonshire Street in Surry Hills and Cathedral Street in Woolloomooloo. Like Bourke Street, Riley Street connects with several east-west routes that provide direct access to the Sydney CBD.

Table 2-25 and Figure 2-23 present the bicycle network within the Surry Hills precinct.

Figure 2-23: Existing bicycle network in the Surry Hills precinct[58]



[58] *City of Sydney, Sydney Cycle Map*

Bicycle counts for 2013 collected for Bourke Street by City of Sydney shows that approximately 1500 bicycles use the Bourke Street corridor on an average weekday, with some of these potentially accessing via Devonshire Street.

2.7. Moore Park Precinct

The Moore Park precinct represents the section of the alignment to the east of the mid-block crossing at South Dowling Street and the section of Anzac Parade south of Moore Park Road and north of Alison Road. The mid-block crossing at South Dowling Street and the pedestrian bridge over the Eastern Distributor provides a direct connection between Surry Hills and Moore Park. The Anzac Parade corridor is an important north-south transport link between the eastern suburbs and the CBD. The section of Anzac Parade within the Moore Park precinct includes the Moore Park sports and entertainment area, which is a significant land use and trip generator for large volumes of private vehicles, public transport and pedestrian trips, particularly during special events. The precinct also represents a very active pedestrian and cyclist corridor. The pedestrian / cyclist facilities consist of pathways across Moore Park and an off road pedestrian / cycle path along Anzac Parade.

2.7.1. Road network

The key roads within the Moore Park precinct that will be impacted by the proposed light rail corridor include:

- The section of Anzac Parade south of Moore Park Road up to the intersection of Alison Road / Anzac Parade detailed in Table 2-26.

Table 2-26: Moore Park precinct road network characteristics

Road	Key Characteristics
Anzac Parade	Anzac Parade is a major north-south State arterial road under the care and control of Roads and Maritime Services (RMS) running through the suburbs of Moore Park, Kensington and Kingsford. The section of Anzac Parade south of Moore Park Road and north of Alison Road is a divided two-way six lane road with an additional segregated bus way in operation on the eastern side which runs parallel to the road. Dedicated turning lanes are provided at intersections at Lang Road and Alison Road. A northbound entry ramp to the Eastern Distributor is located at the intersection at Moore Park Road and a southbound exit ramp is located south of Moore Park Road. The existing posted speed limit is 70km/hr except the section where the 40 km/hr school zone is applicable for Sydney Girls and Boys High School. Bus services utilise the dedicated bus roadway adjacent to Moore Park between Alison Road and Moore Park Road, as well as general traffic lanes along Anzac Parade. There is no provision for on-street parking along this section of Anzac Parade. An off road shared pedestrian/bicycle path also runs in parallel to Anzac Parade from Moore Park Road to Alison Road. The path is located along the eastern side of the corridor, which then continues along Alison Road to the south. The Moore Park precinct consists of various sporting and entertainment land uses such as the Sydney Football (Allianz) Stadium, the Sydney Cricket Ground and Playbill venues (the entertainment quarter). Additional events are also held at Centennial Park such as Listen Out (Park Life), Australian Garden Show, etc. The diverse array of events in this precinct have varied transport requirements.

Traffic operating patterns

Anzac Parade is a strategic link within the eastern suburbs road network and currently operates at degraded levels of performance for general traffic during weekday peak travel periods. Recent data describes average vehicular travel speeds of 28km/h for Anzac Parade during the AM peak period.

Anzac Parade experiences two way traffic volumes of approximately 3,700 vehicles in both the AM and PM peak hours. Currently, the corridor experiences a high level of congestion with large delays to vehicles at the intersections of Dacey Avenue/Alison Road, Cleveland Street/Lang Road, Moore Park Road and Oxford Street. It is the large east-west cross movements from the eastern suburbs that conflict with the Anzac Parade corridor at these intersections ultimately causing significant delays.

A segregated bus way from Alison Road to Moore Park Road provides priority to a number of bus routes. These selected buses however, still experience delays while crossing the Cleveland Street, Lang Road and Moore Park Road intersections.

Table 2-27 provides a summary of the key characteristics and constraints associated with existing general traffic and public transport operations of the light rail corridor along Anzac Parade between south of Moore Park Road and north of Alison Road.

Table 2-27: Moore Park precinct existing operational characteristics

Road	Constraints	Description
Anzac Parade	General Traffic	Anzac Parade provides a significant connection for bus and general traffic accessing the Sydney CBD. The corridor also facilitates access to areas west of the City and Anzac Bridge and to the north via the ED and Sydney Harbour Tunnel. The traffic along this road is mainly generated by the traffic accessing the City from the suburbs of Moore Park, Kensington, Kingsford, Randwick, Eastlakes, Maroubra, Chifley, Malabar and Little Bay.
	Bus Services	A segregated bus way running in parallel to Anzac Parade corridor from Moore Park Road to Alison Road is a major bus route for number of city services (including express and cross regional bus services). The dedicated bus way caters for approx.80 bus services during peak hours.

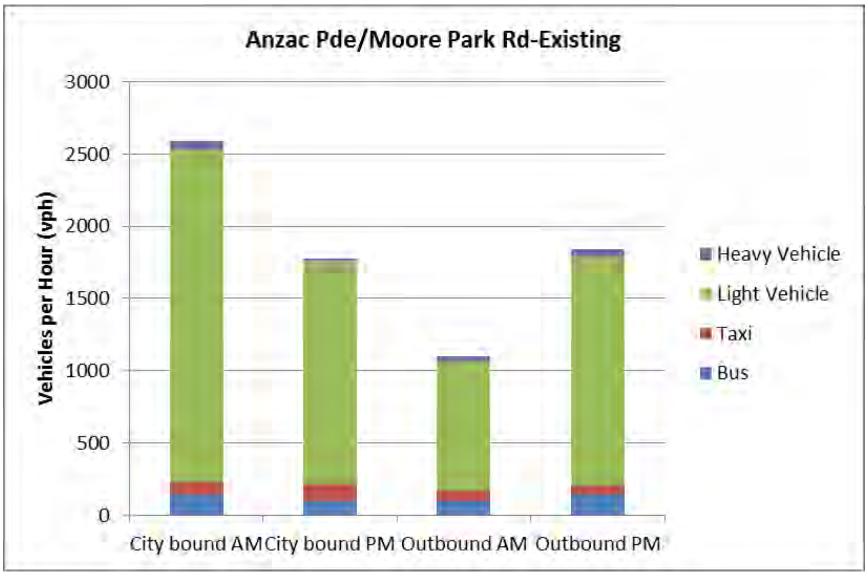
Peak hour traffic composition and volumes

A summary of the peak traffic volumes travelling along Anzac Parade between south of Moore Park Road and the intersection of Alison Road / Anzac Parade is provided in Table 2-28, with vehicle compositions illustrated in Figure 2-24.

Table 2-28: Moore Park precinct average weekday AM and PM peak traffic volumes

Key Intersection	AM Peak			PM Peak		
	City Bound	Out Bound	Peak Direction Split	City Bound	Out Bound	Peak Direction Split
Anzac Parade (at Moore Park Road/entry to the Eastern Distributor)	2588	1101	70% inbound	1774	1844	51% out bound

Figure 2-24: Moore Park precinct existing traffic composition



Intersection performance

A summary of the performance of key intersections along Anzac Parade is provided in Table 2-29. The AM and PM peak intersection performance results include an overall intersection LoS, intersection delay and DoS from the base case models. The results are focussed on those intersections that represent the key constraints. Refer to Section 2.2 for the global assumptions used in the intersection analysis.

Table 2-29: Moore Park precinct key intersection performance[59]

Intersection	Peak Hour	Existing		
		LoS	DoS (vehicle/capacity)	Av. Delay (seconds)
Anzac Parade / Lang Road	AM	F	0.98	73.5
	PM	F	1.01	128.0

The intersection of Anzac Parade and Lang Road currently performs at LoS F with average delays greater than 70 seconds during both the AM and PM peak hours.

[59] *Source: LinSig modelling undertaken as part of ITLU Milestone Option Assessment*

2.7.2. Parking and kerbside access

Currently there are no parking provisions available along the Anzac Parade section of the Moore Park precinct.

2.7.3. Property access

A total of three vehicular driveways to the Sydney Girls and Boys High Schools are present on the western side of Anzac Parade within the Moore Park precinct. However, the proposed light rail alignment does not impact on these accesses as the light rail alignment runs along the eastern side of Anzac Parade.

2.7.4. Pedestrians & cyclists

Pedestrian access

Existing pedestrian access within the Moore Park precinct is facilitated by footpaths, pathways through parks including a designated pathway across Moore Park, an off-road pedestrian / cycle path along the eastern side of the road, mid-block signalised crossings, crossings at the signalised intersections and kerb ramps. Table 2-30 identifies the existing pedestrian access types along the light rail route within the Moore Park precinct.

Table 2-30: Existing Pedestrian Access within the Moore Park precinct

Precinct	Corridor Location	Description	Pedestrian Access Type
Moore Park	**Anzac Parade**	The section on Anzac Parade between Moore Park Road and Alison Road is considered as an active pedestrian area due to its proximity to the Sydney Boys and Girls High schools, and Moore Park sporting and entertainment venues. The Moore Park sport and entertainment venue consists of various sporting and entertainment land uses such as Allianz Stadium, the SCG and Playbill venues which contribute significant pedestrian trips, particularly during special events. The mid-block signalised crossings and signalised intersections provide opportunities for pedestrians to cross Anzac Parade. The staged mid-block crossing at South Dowling Street and pedestrian bridge over Eastern Distributor provides direct connection to Moore Park from Surry Hills and the CBD precincts.	Existing pedestrian facilities include: ▪ segregated shared path on the eastern side and footpath on western side, a ▪ signalised mid-block crossing in the vicinity of Sydney Girls and Boys High Schools, ▪ signalised mid-block crossing near the near Alison Road bus stop, ▪ two signalised intersections and kerb ramps to facilitate pedestrian movements across Anzac Parade

Bicycle access

There are several networks of on-road and off-road cycleway in the vicinity of the proposed light rail corridor along Anzac Parade. Figure 2-25 presents the bicycle network within the Moore Park precinct. Cycle counts for 2012 collected by Roads and Maritime Services at Anzac Parade near Lang Road show that approximately 1,277 cyclists use this corridor on an average weekday.

Figure 2-25: Existing bicycle network within the Moore Park precincts[60]

[60] *Randwick City Council, Cycling and Walking Map for Randwick City*

The existing bicycle networks in place within the Moore Park precinct are outlined below in Table 2-31.

Table 2-31: Existing bicycle routes along key roads within the Moore Park precinct

Precinct	Corridor Location	Bicycle Route Type	Description
Moore Park	Anzac Parade	Off-road path	The section of Anzac Parade from Moore Park Road to Alison Road is identified as an off-road cycle route under the City of Sydney/Randwick City Council's bicycle route network maps.

2.8. Kingsford precinct

The Anzac Parade corridor within the Kingsford precinct consists of major land uses such as the University of New South Wales, medium to high density residential apartments, single dwelling houses along with smaller commercial (office) premises, cafes, restaurants, retail shops and service stations. The precinct also contributes to a very active pedestrian and cyclist corridor through the provision of pathways through parks and off-road pedestrian / cycle paths along Anzac Parade.

2.8.1. Road network

The key roads within the Kingsford precinct that will be impacted by the proposed light rail corridor include:

- Anzac Parade between Alison Road and up to nine ways (Gardeners Road/Rainbow Street intersection)

A summary of the key network characteristics for each of these roads is provided in Table 2-32.

Table 2-32: Kingsford precinct road network characteristics

Road	Key Characteristics
Anzac Parade	Anzac Parade is a major north-south State arterial road under the care and control of Roads and Maritime Services (RMS) running through the suburbs of Moore Park, Kensington and Kingsford. The section between Alison Road and Nine Ways is a divided two-way four lane road with additional dedicated kerbside bus/parking lanes along the entire north-south length of the corridor. A number of dedicated turning lanes are provided at key intersections. The road is used by numerous bus services to Sydney CBD and other cross-regional connections along the dedicated bus lanes which operate in the peak direction by time of day. Bus services also utilise the dedicated bus roadway adjacent to Moore Park between Alison Road and Moore Park Road, as well as general traffic lanes along Anzac Parade. There is provision for on-street parking and loading/unloading zones within the bus lane during the off-peak hours. The precinct is characterised by medium density residential apartment buildings and detached dwellings as well as education facilities, the UNSW.

Traffic operating patterns

Anzac Parade provides a direct link to the eastern suburbs road network and currently operates at capacity during weekday peak hour periods. Anzac Parade experiences high volumes of two way traffic, approximately 5,700 vehicles per hour north of Alison Road in both the AM and PM peak hours. Currently, the corridor experiences a high level of congestion with large delays to vehicles at the major intersections of Dacey Avenue/Alison Road and High Street. Bus only lanes along the main carriageway from Gardeners Road to Alison Road provide priority to buses in both peaks. However, the buses still experience significant delays at signalised intersections along Anzac Parade.

Table 2-33 provides a summary of the key characteristics and constraints associated with existing general traffic and public transport operations of the preferred light rail corridor along Anzac Parade between Alison Road and up to Nineways (Gardeners Road/Rainbow Street intersection).

Table 2-33: Kingsford precinct existing operational characteristics

Road	Constraints	Description
Anzac Parade	General Traffic	The route provides a significant connection for general traffic accessing the Sydney CBD. The traffic along this road is mainly generated by the trips to UNSW and the City from the eastern suburbs including Moore Park, Kensington, Kingsford, Randwick, Eastlakes, Maroubra, Chifley, Malabar and Little Bay.
	Bus Services	The Anzac Parade corridor is a major bus route for city services (including express) and cross regional bus services. Dedicated peak hour bus lanes along Anzac Parade provide priority to buses in the peak direction (approx.80 bus services during peak hours). During off-peak hours, the bus lanes are utilised for time-restricted parking. Parking is permitted along Anzac Parade outside of the weekday peak periods (6am-10am & 3pm-7pm).

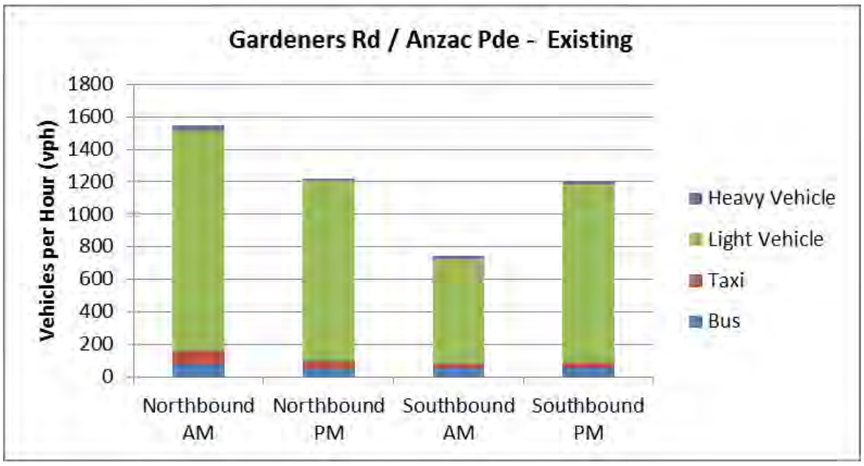
Peak hour traffic composition and volumes

A summary of the peak traffic volumes travelling along Anzac Parade is provided in Table 2-34, with vehicle compositions illustrated in Figure 2-26. Anzac Parade carries significant traffic volumes. As illustrated in Figure 2-26 the majority of vehicles travelling along Anzac Parade are private light vehicles.

Table 2-34: Kingsford precinct average weekday AM and PM peak traffic volumes

Key Intersection	AM Peak			PM Peak		
	City Bound	Out Bound	Peak Direction Split	City Bound	Out Bound	Peak Direction Split
Anzac Parade/Alison Road	**3448**	**2284**	**60% city bound**	**2515**	**2966**	**54% out bound**
Anzac Parade/Gardeners Road	**1548**	**746**	**67% city bound**	**1220**	**1208**	**50% city/out bound**

Figure 2-26: Kingsford precinct existing traffic composition



Intersection performance

A summary of the performance of key intersections along Anzac Parade is provided in Table 2-35. The AM and PM peak intersection performance results include an overall intersection LoS, intersection delay and DoS from the base case models. The results are focussed on those intersections that represent the key constraints. Refer to Section 2.2 for the global assumptions used in the intersection analysis.

Table 2-35: Kingsford precinct key intersection performance[61]

Intersection	Peak Hour	Existing		
		LoS	DoS (vehicle/capacity)	Av. Delay (seconds)
Anzac Parade / High Street (Anzac Parade Alignment)	AM	B	0.83	28.0
	PM	D	0.94	44.3
Anzac Parade / Dacey Avenue / Alison Road	AM	F	0.98	73.5
	PM	D	0.90	50.2

The intersection of Anzac Parade and Alison Road / Dacey Avenue has the lowest level of performance with average delays greater than 60 seconds and poor Level of Service during the AM peak hour.

[61] *Source: LinSig modelling undertaken as part of ITLU Milestone Option Assessment*

2.8.2. Parking and kerbside access

For the purpose of parking assessment, the Kingsford precinct has been split into two sections:

- Anzac Parade North –runs from the intersection of Alison Road / Dacey Avenue south along Anzac Parade to High Street (refer to Figure 2-27).
- Anzac Parade South - runs from the intersection of Anzac Parade and High Street along Anzac Parade to Nine Ways (refer to Figure 2-28).

Anzac Parade North

This section of Anzac Parade is characterised by medium density residential apartment buildings and detached dwellings as well as sporting facilities (ES Marks Athletics Field, Moore Park Golf Course), street level retail and food premises. Kerbside bus lanes run the entire north-south length of the corridor, with on-street parking permitted in signed locations outside of the weekday peak periods (6am-10am & 3pm-7pm).

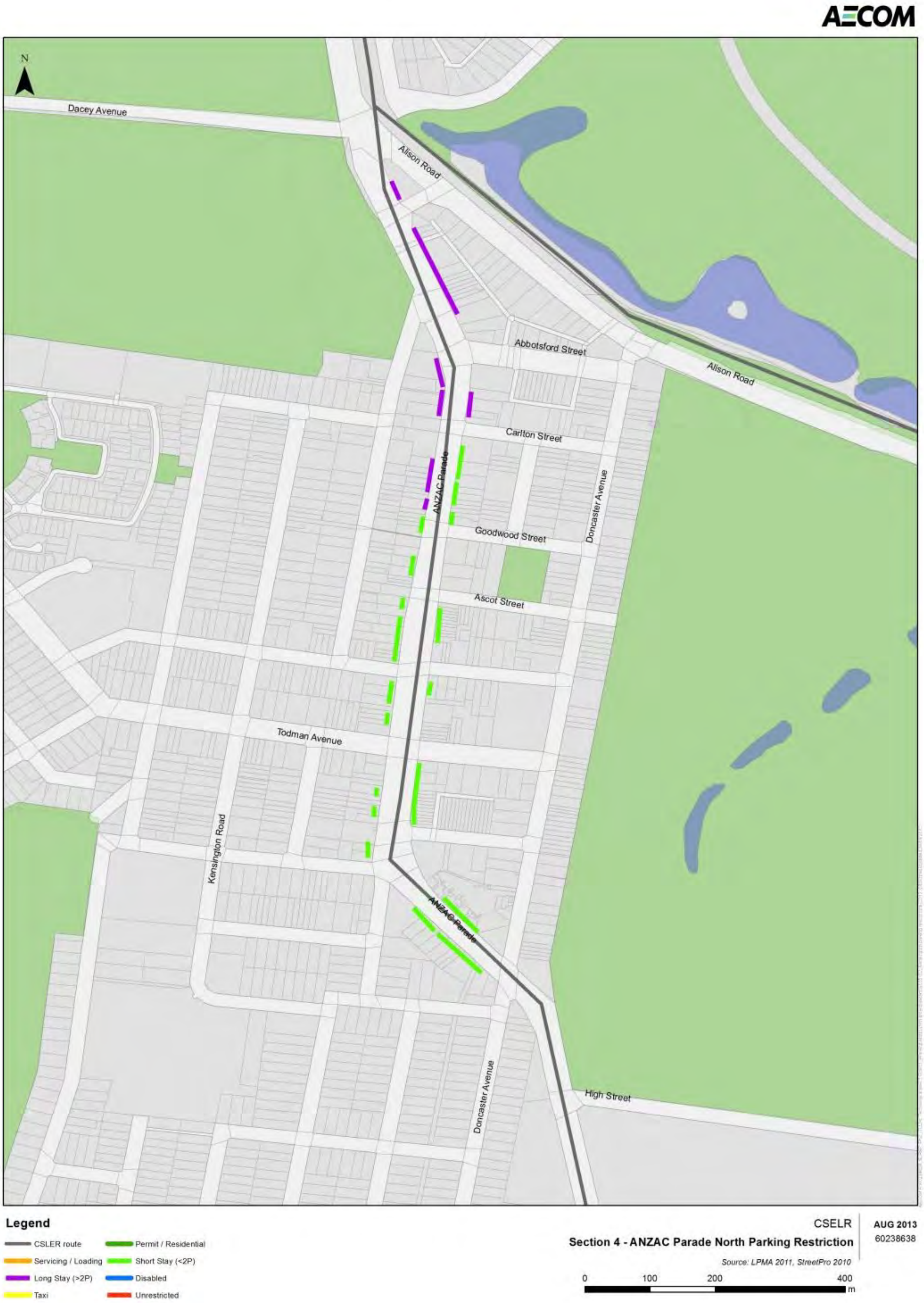
The number of parking spaces along Anzac Parade north is provided in Table 2-36.

Table 2-36: Anzac Parade North special kerbside uses and parking supply

Anzac Parade North Kerbside Restriction	Special Kerbside Uses and Parking Supply by Time Period		
	Pre AM Peak	Inter Peak	Post PM Peak
Car Share, Hospital, Mail Zone	1	1	1
Disability Parking	0	0	0
Loading Zone	0	0	0
Taxi Zone	0	0	0
Total – Special Kerbside Uses	**1**	**1**	**1**
Short Stay Parking (≤1P)	4	52	31
Long Stay Parking (Restricted)	7	7	0
Long Stay Parking (Unrestricted)	73	94	119
Total – General Parking	**84**	**153**	**150**

Further discussion on existing parking demand and the project parking strategy to mitigate impacts on existing supply can be found in Section 6.

Figure 2-27: Anzac Parade North existing parking restrictions[62]



62 AECOM, 2013

Anzac Parade South

The land uses in the Anzac Parade South precinct include medium and high density residential apartment buildings as well as education facilities (the UNSW and the National Institute of Dramatic Art), street level retail, restaurants and cafes. Kerbside bus lanes run the entire north-south length of the precinct with on-street parking permitted in signed locations after hours.

As outlined in Table 2-37 the Anzac Parade South precinct has a number of private vehicle parking spaces along with 4 loading zones.

Table 2-37: Anzac Parade South special kerbside uses and parking supply

Anzac Parade South Kerbside Restriction	Special Kerbside Uses and Parking Supply by Time Period		
	Pre AM Peak	Inter Peak	Post PM Peak
Car Share, Hospital, Mail Zone	0	0	0
Disability Parking	0	0	0
Loading Zone	4	4	2
Taxi Zone	2	2	2
Total – Special Kerbside Uses	**6**	**6**	**4**
Short Stay Parking (≤1P)	32	68	25
Long Stay Parking (Restricted)	20	20	4
Long Stay Parking (Unrestricted)	173	173	232
Total – General Parking	**225**	**261**	**261**

Further discussion on existing parking demand and the project parking strategy to mitigate impacts on existing supply can be found in Section 6

Figure 2-28: Anzac Parade South existing parking restrictions[63]

63 AECOM, 2013

2.8.3. Property access

There are a number of property accesses along the light rail corridor within the Kingsford precinct as shown in Figure 2-29.

Figure 2-29: Kingsford precinct property accesses

Within the Kingsford precinct major driveway accesses are predominantly to high density units, found in concentration at the northern end of the precinct. There are also numerous lower density residential accesses, four service stations and access to two local businesses along the corridor. All movements are restricted to left-in-left-out arrangements through physical separation by a central median.

2.8.4. Pedestrians & cyclists

Pedestrian access

Existing pedestrian facilities within the Kingsford are described in Table 2-38. The precinct contributes to a very active pedestrian and cyclist corridor.

Table 2-38: Existing Pedestrian Access within the Kingsford precinct

Precinct	Corridor Location	Description	Pedestrian Access Type
Kingsford	**Anzac Parade**	The Anzac Parade corridor consists of residential and commercial properties, small businesses, sporting grounds, a high school and UNSW campus. The walking trips from the surrounding public transport stops around the university result in a significant number of pedestrians on the network during a typical peak hour.	Existing pedestrian facilities such as sealed footpaths, 5 x signalised mid-block crossings, crossing at 7 x signalised intersections and kerb ramps are to facilitate pedestrian movements across Anzac Parade

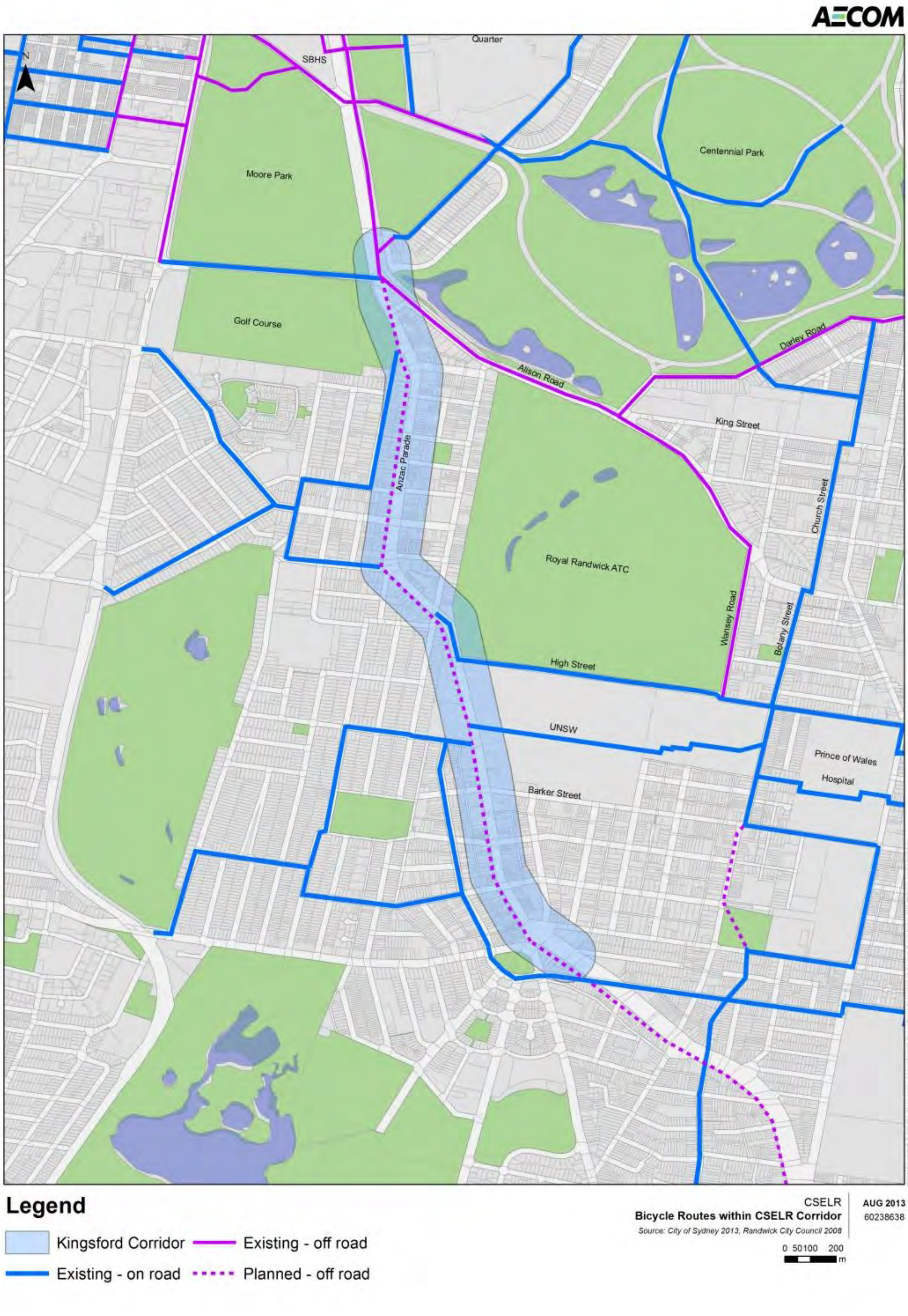
Bicycle access

Within the Kingsford precinct there are no dedicated bicycle facilities, although cyclists are permitted to use the available bus lanes. The existing bicycle networks in place within the Kingsford precinct are outlined below in Figure 2-30 and Table 2-39.

Table 2-39: Existing bicycle routes along key roads within the Kingsford precincts

Precinct	Corridor Location	Bicycle Route Type	Description
Kingsford	**Anzac Parade**	On-road - partially	A section of Anzac Parade from Cleveland Street to Dacey Ave is identified as an off-road cycle route and the remaining sections are considered as a planned off-road route by Randwick City Council.

Figure 2-30: Existing bicycle network within the Kingsford precincts[64]



64 *Randwick City Council, Cycling and Walking Map for Randwick City*

2.9. Randwick Precinct

The Randwick precinct runs from the Anzac Parade / Alison Road intersection to the High Street / Belmore Road / Avoca Street intersection as shown in Figure 2-1. The alignment follows Alison Road, Wansey Road and High Street.

The land uses in this precinct include detached dwellings and apartment buildings, as well as major trip generators such as UNSW, Royal Randwick Racecourse and the Prince of Wales Hospital.

2.9.1. Road network

The key roads within the Randwick precinct that will be directly impacted by the proposed light rail corridor include:

- Alison Road
- Wansey Road
- High Street

A summary of the key network characteristics for each of these roads is provided in Table 2-40.

Table 2-40: Randwick precinct road network characteristics

Road	Key Characteristics
Alison Road	Alison Road is a divided two-way collector road under the care and control of Randwick City Council. The section between Doncaster Avenue and Darley Road is operating with three traffic lanes in each direction and the remaining sections have parking permitted on the kerb side. The land uses in this precinct include detached dwellings and apartment buildings, as well as major trip generators such as Royal Randwick Racecourse, the Prince of Wales Hospital and the UNSW. Limited on-street parking is provided between Anzac Parade and Darley Road. On-street parking around Royal Randwick Racecourse is located predominantly on the eastern edge of Alison Road. Bus stops, on-street parking and property accesses are common along the rest of the corridor. An off-road pedestrian / cycle path also operates along this route. The connection to the bus way is provided via the Doncaster Avenue intersection.
Wansey Road	Wansey Road is a two-way local road under the care and control of Randwick City Council. The major traffic on Wansey Road is mainly generated by the residential properties, UNSW campus as well as some traffic accessing the Prince of Wales Hospital. There are provisions for parking available along both sides and a number of property accesses provided along the corridor. The side road accesses along Wansey Road are priority controlled. The Randwick City Council bicycle route map designates Wansey Road as an off-road pedestrian/bicycle route, which runs along the western side of the corridor.
High Street	High Street between Wansey Road and Belmore Road is a two-way local road with a single lane in each direction. Parking and bus stops are provided along the kerbside in both directions. There are two signalised intersections and two marked pedestrian crossing within this section of High Street. The road provides a connection for cross regional bus services and general traffic between Randwick and UNSW / Anzac Parade. The High Street corridor provides the major access to the Randwick Health Campus, including access to Prince of Wales Hospital, most notably the Children's Hospital emergency department. Access to the Adult and Children' Hospitals are currently via two separate porte cocheres, accessed via High Street.

Traffic operating patterns

Alison Road is a major link connecting the eastern suburbs road network and currently operates at capacity during weekday peak travel periods. Recent data describes average vehicular travel speeds of 21km/h for Alison Road during the AM peak period. A separated bus way is in operation on the northern side, which runs in parallel to Alison Road. The connection to the bus way is provided via the Doncaster Avenue intersection.

Table 2-41 provides a summary of the key characteristics and constraints associated with existing general traffic and public transport operations of the preferred light rail corridor along the key roads within the Randwick precinct (i.e., Alison Road, Wansey Road, High Street).

Table 2-41: Randwick precinct existing operational characteristics

Road	Constraints	Description
Alison Road	General Traffic	Traffic is generated mainly by land uses such as Royal Randwick Racecourse, Randwick TAFE, the Prince of Wales Hospital and the UNSW as well as the residential dwellings and apartments within the Randwick precinct.
	Bus services	A separated bus way is in operation on the eastern side, which runs parallel to Alison Road. The connection to the bus way is provided via the Doncaster Avenue intersection.
Wansey Road	General Traffic	The major traffic on Wansey Road is generated by the residential properties, UNSW campus as well as some traffic accessing the Prince of Wales Hospital. The side road accesses along Wansey Road are priority controlled.
	Bus Services	Wansey Road is not an official bus route identified in the eastern region bus route map. However, the 891 UNSW bus service currently utilises this corridor when out of service.
High Street	General Traffic	High Street provides a connection for cross regional bus and general traffic between Randwick and UNSW / Anzac Parade. The general traffic along this corridor is associated with the Prince of Wales Hospital, Children's Hospital emergency department and UNSW.
	Bus Services	High Street provides an important east west connection for 10 different bus routes, including university express services.

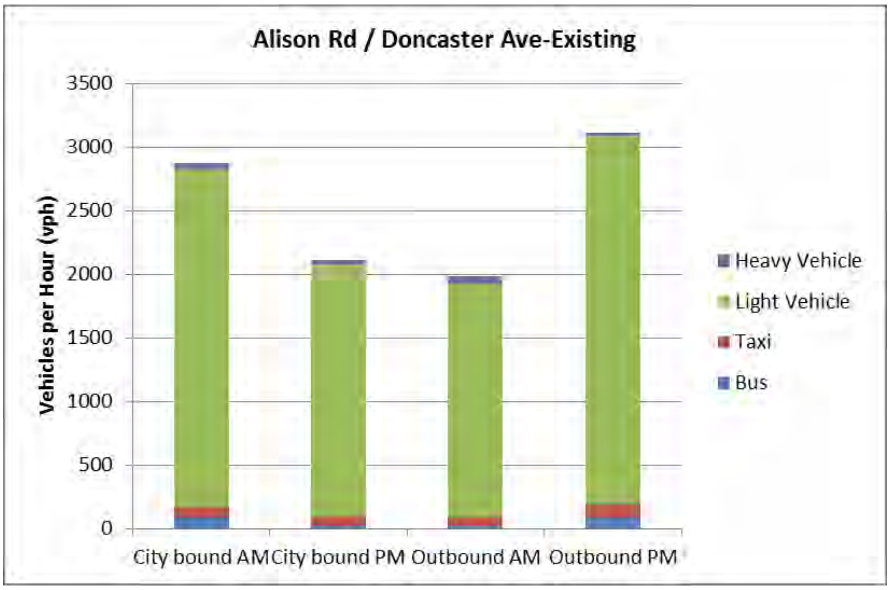
Peak hour traffic composition and volumes

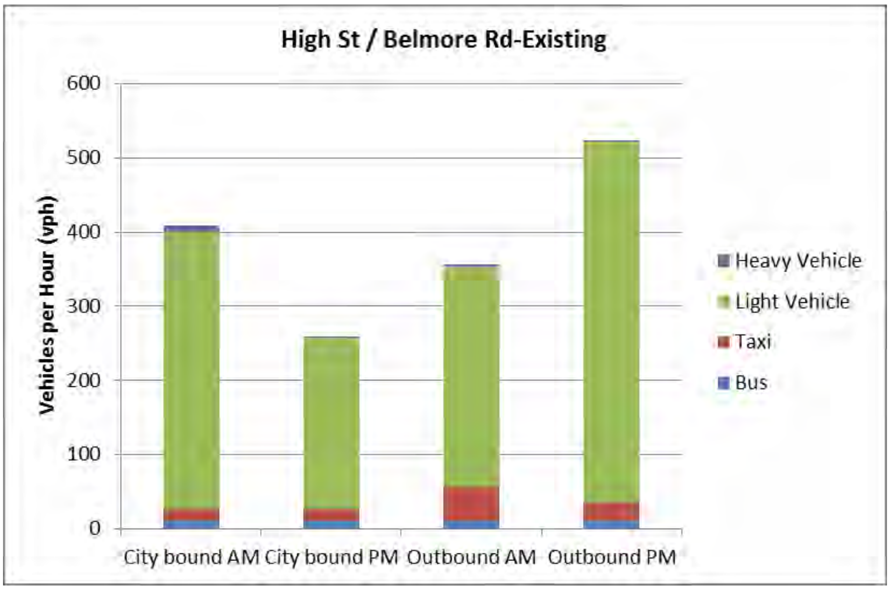
A summary of the peak traffic volumes travelling along Anzac Parade, Alison Road and High Street is provided in Table 2-42, with vehicle compositions illustrated in Figure 2-31. Anzac Parade and Alison Road have by far the highest traffic volumes. As illustrated in Figure 2-31 the majority of vehicles travelling along Alison Road and High Street are light vehicles.

Table 2-42: Randwick precinct average weekday AM and PM peak traffic volumes

Key Intersection	AM Peak			PM Peak		
	City Bound	Out Bound	Peak Direction Split	City Bound	Out Bound	Peak Direction Split
Alison Road (near High Street)	2880	1987	59% inbound	2114	3114	60% out bound
High Street (near Belmore Rd)	409	357	53% inbound	258	523	67% out bound

Figure 2-31: Randwick precinct existing traffic composition





Intersection performance

A summary of the performance of key intersections along Alison Road and High Street is provided in Table 2-43. The AM and PM peak intersection performance results include an overall intersection LoS, intersection delay and DoS from the base case models. The results are focussed on those intersections currently experiencing capacity constraints. Refer to Section 2.2 for the global assumptions used in the intersection analysis.

Table 2-43: Randwick precinct key intersection performance[65]

Intersection	Peak Hour	Existing		
		LoS	DoS (vehicle/capacity)	Av. Delay (seconds)
Alison Road / Darley Road	PM	B	0.86	25.0
High Street / Belmore Road / Avoca Street	AM	E	1.00	68.0
	PM	F	1.00	82.9

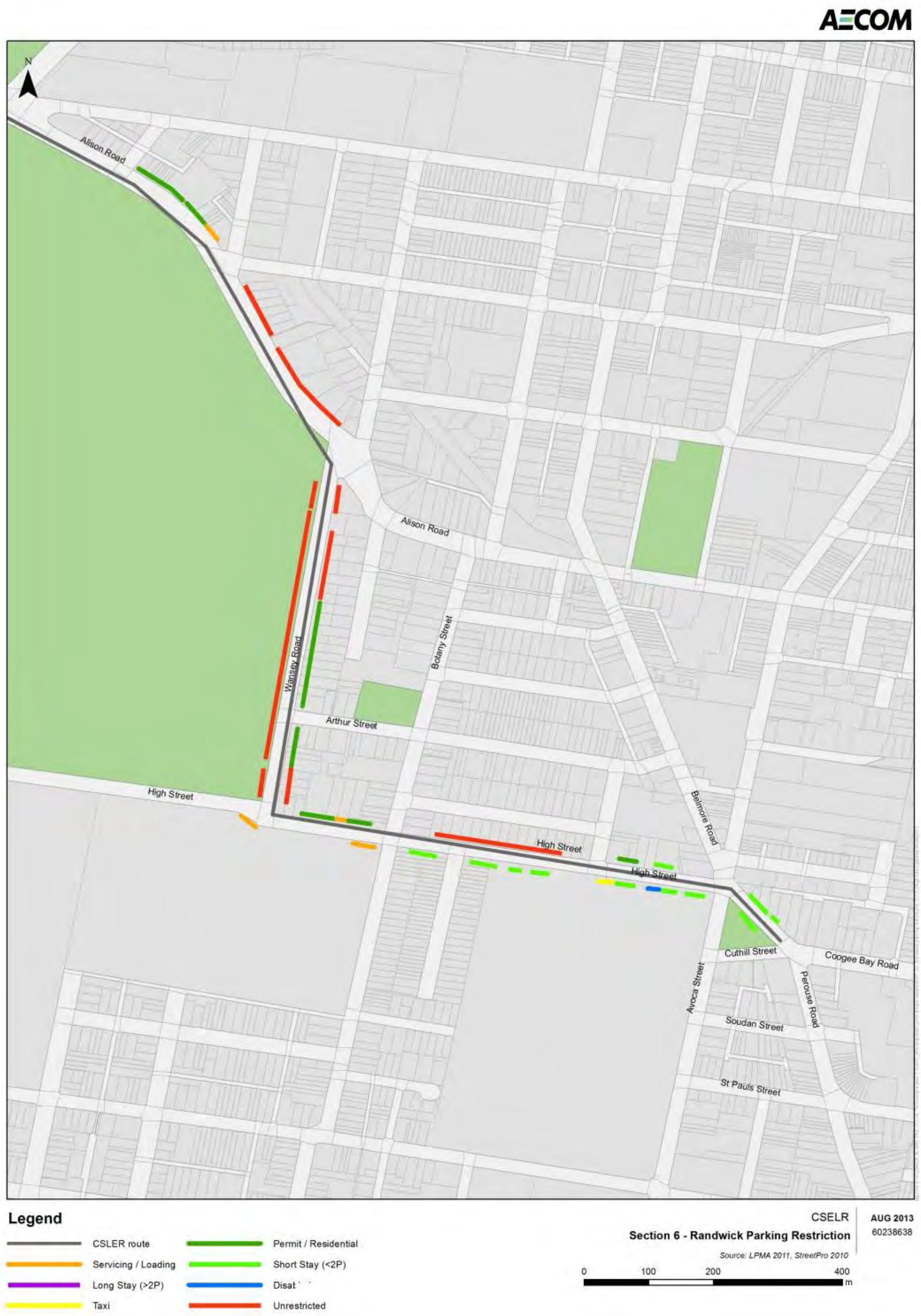
The intersection of High Street, Belmore Road and Avoca Street have the lowest level of performance with average delays greater than 60 seconds during both the AM and PM peak.

2.9.2. Parking and kerbside access

Limited on-street parking is provided on Alison Road between Anzac Parade and Darley Road. On-street parking around Royal Randwick Racecourse is located predominantly on the eastern edge of Alison Road. Bus stops and on-street parking are common along the rest of the corridor. The Randwick precinct currently caters for a range of private vehicle parking (refer to Figure 2-32).

[65] *Source: LinSig modelling undertaken as part of ITLU Milestone Option Assessment*

Figure 2-32: Randwick precinct existing parking restrictions[66]



66 AECOM, 2013

As outlined in Table 2-44 the Randwick precinct has a number of private vehicle parking spaces.

Table 2-44: Randwick precinct special kerbside uses and parking supply

Randwick Kerbside Restriction	Special Kerbside Uses and Parking Supply by Time Period		
	Pre AM Peak	Inter Peak	Post PM Peak
Car Share, Hospital, Mail Zone	3	3	3
Disability Parking	2	2	2
Loading Zone	1	1	1
Taxi Zone	1	1	1
Total – Special Kerbside Uses	**7**	**7**	**7**
Short Stay Parking (≤1P)	70	64	64
Long Stay Parking (Restricted)	45	45	45
Long Stay Parking (Unrestricted)	187	193	193
Total – General Parking	**302**	**302**	**302**

Further discussion on the project parking strategy to mitigate impacts on existing supply can be found in Section 6.

2.9.3. Property Access

Currently there are a number of property accesses along the light rail corridor within Randwick precinct. Driveway access maps of the Randwick precinct are provided in Figure 2-33.

Figure 2-33: Randwick property accesses

Within the Randwick precinct, driveway accesses are predominantly to private residential addresses which are located at regular intervals along its length. Figure 2-33 above highlights the higher order driveway accesses i.e. to businesses, major land uses or high density unit dwellings.

Alison Road accesses are predominantly related to the racecourse (four access points) and residential driveways (six). The racecourse's main entrance is accessed off Alison Road and includes a short right turn bay for vehicles approaching from the west. Access to the racecourse for buses during event days is via the four-way intersection with Darley Road (entry only) and by a left out further west along Alison Road. The area experiences significant congestion when events are hosted at the racecourse, particularly around the bump-in and bump-out periods when there is a heavy demand on these main access points. Two service stations are also located on the northern side of Alison Road between Darley and Cowper Streets.

Wansey Road driveways are predominantly associated with the low density housing along the eastern side. In addition, the racecourse has a further two accesses on the western side to service the stables, which attract activity throughout the working day.

High Street has a number of major driveway accesses related to the predominant land uses of UNSW and Prince of Wales Hospital. Gate 9 to UNSW acts as a secondary access to the University's Botany Street parking station and is located to the east of the Wansey Road intersection. Three separate hospital accesses are provided, including emergency vehicle access to the Children's Hospital that requires efficient access 24 hours a day.

2.9.4. Pedestrians & cyclists

Pedestrian access

The existing pedestrian accesses to the Randwick precinct are facilitated by footpaths, marked and signalised pedestrian crossings and kerb ramps. Table 2-45 identifies the existing pedestrian access types along the light rail route within Randwick precinct.

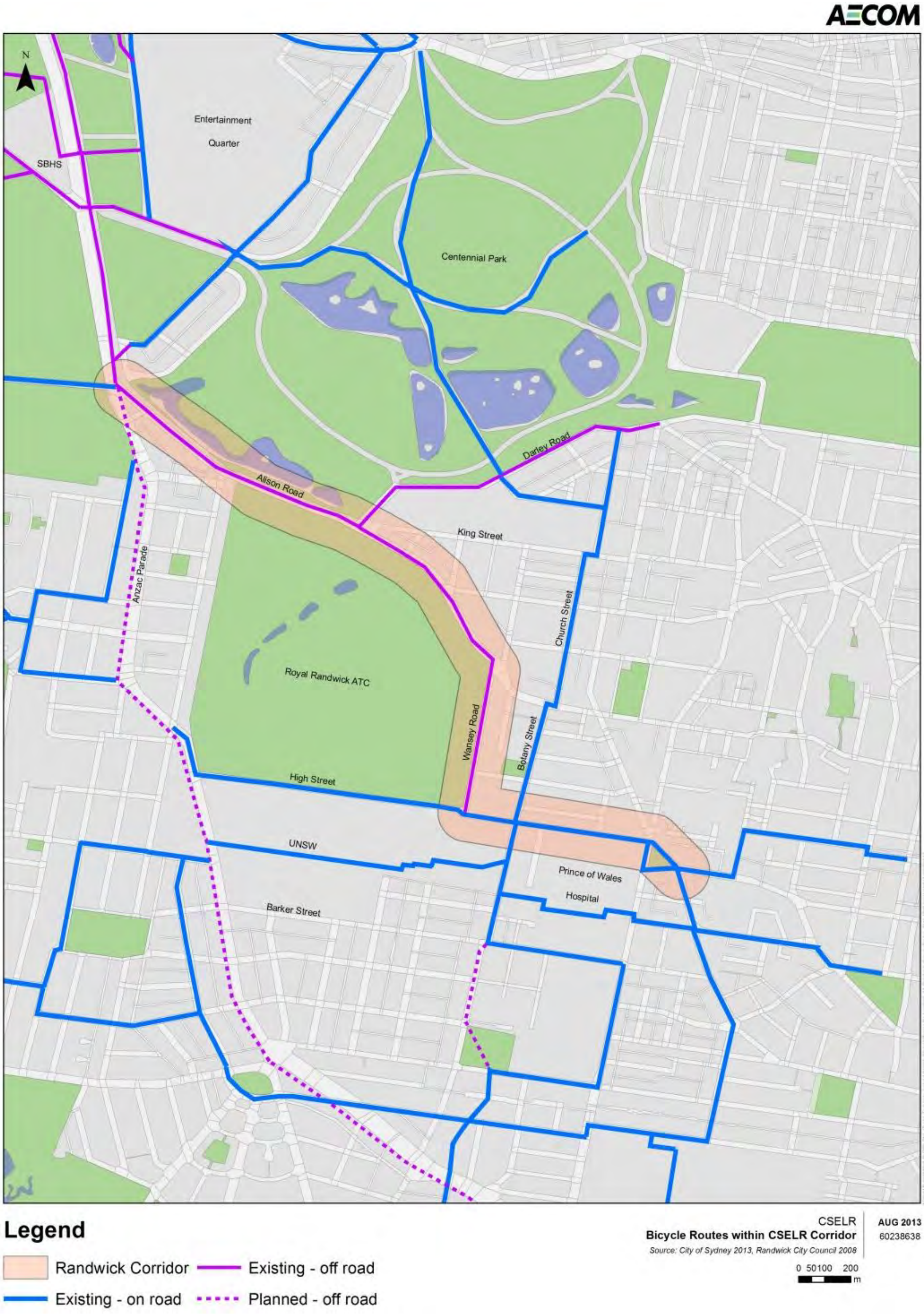
Table 2-45: Existing Pedestrian Access within the Randwick precinct

Precinct	Corridor Location	Description	Pedestrian Access Type
Randwick Precinct	**Alison Road**	Pedestrian traffic is mainly generated by the Prince of Wales Hospital, the UNSW, Royal Randwick Racecourse, hotels and residential properties.	Sealed footpaths, pedestrian crossings at 3 x signalised intersections and kerb ramps are provided to facilitate pedestrian movements across Alison Road.
	Wansey Road	Pedestrian traffic within Wansey Road is mainly generated by the residential properties, recreational activities, the UNSW in the area.	The pedestrian facilities such as sealed shared path on eastern side, footpath on western side and kerb ramps are provided to facilitate pedestrian movements across Wansey Road.
	High Street	Pedestrian activity associated with High Street is highly influenced by the trips made to UNSW, the hospitals and residential properties within the area.	Two signalised intersections and two marked pedestrian crossing are located within the High Street corridor. The marked pedestrian crossings are located in front of the UNSW campus and Prince of Wales Hospital. The hospital crossing is used by a high number of disabled and elderly people who require extended crossing times. Other pedestrian facilities such as footpaths and kerb ramps are also provided to facilitate pedestrian movements across High Street.

Bicycle access

There are several on-road and off-road cycle paths in the vicinity of the proposed light rail corridor within the Randwick precinct. Figure 2-34 and Table 2-46 describe the bicycle network within the Randwick precinct. The cyclist facilities consist of designated pathways across Centennial Park, and off-road routes along Alison Road, Darley Road and Wansey Road.

Figure 2-34: Existing bicycle network within the Anzac Parade/Alison Road precincts[67]



[67] *Source: Randwick City Council, Cycling and Walking Map for Randwick City (available from http://www.randwick.nsw.gov.au/Looking_after_our_environment/Sustaining_our_city/Greenhouse/sustainable_transport_options/index.aspx)*

Table 2-46: Existing bicycle routes along key roads within the Randwick precinct

Precinct	Corridor Location	Bicycle Route Type	Description
Randwick Precinct	Alison Road	Off-road	Randwick City Council identifies an off-road pedestrian / cycle path which runs along the corridor from Anzac Parade to Wansey Road. Between Anzac Parade and Darley Road, the route runs on the north side of Alison Road. Between Darley Road and Wansey Road, the route runs on the south side. A signalised crossing at Darley Road enables cyclists to cross from one side of Alison Road to the other.
	Wansey Road	Off-road	The Randwick City Council bicycle route map designates Wansey Road as an off-road pedestrian/bicycle route, which runs along the western side of the corridor.
	Botany Street / Church Street	On-road	Between Darley Road and Barker Street, Randwick City Council identifies Botany Street and Church Street as on-road cycle routes.
	High Street	On-road	The Randwick City Council bicycle route map designates High Street as an on-road route.
	UNSW	On-road	An on-road cycle route through UNSW comprising the University Mall, Library Road, Library Walk and Samuels Avenue provides an east-west connection between Botany Street and Anzac Parade.

3. Future Transport Network Needs

3.1. Review of land use and planned major developments

Under the direction of Government planning instruments such as the NSW Metropolitan Strategy, the face of Sydney is constantly shifting. Changes in land-use, employment patterns, major developments and increasing densities influence travel patterns across Sydney – a trend that is particularly evident in the CSE corridor.

Major trip generators – employers, hospitals, Universities, schools and special events – are evolving in this corridor at a rapid rate and catering for the changing profile of demand has been a key area of examination through the development of the CSELR Project.

3.1.1. Inner Sydney's growth

Sydney's CBD caters for hundreds of thousands of workers, residents and visitors every day, generating enormous economic value for both NSW and Australia. On a typical weekday, the Sydney City Centre grows from about 60,000 residents to half a million people representing the highest concentration of people and trips in the country. This includes approximately 330,000 people working in the City Centre daily[68].

In the future, increasing travel demand across Sydney's transport network will be driven by on-going growth in population and employment, and the accompanying major trip generating land uses including retail, tourism, health and education.

NSW Government forecasts depict strong growth in both population and employment in the Study Area. Table 3-1 categorises this growth, while

Figure 3-1 illustrates the population and employment growth projections between 2006 and 2031.

Key changes within the City of Sydney and Randwick LGAs are expected to include:

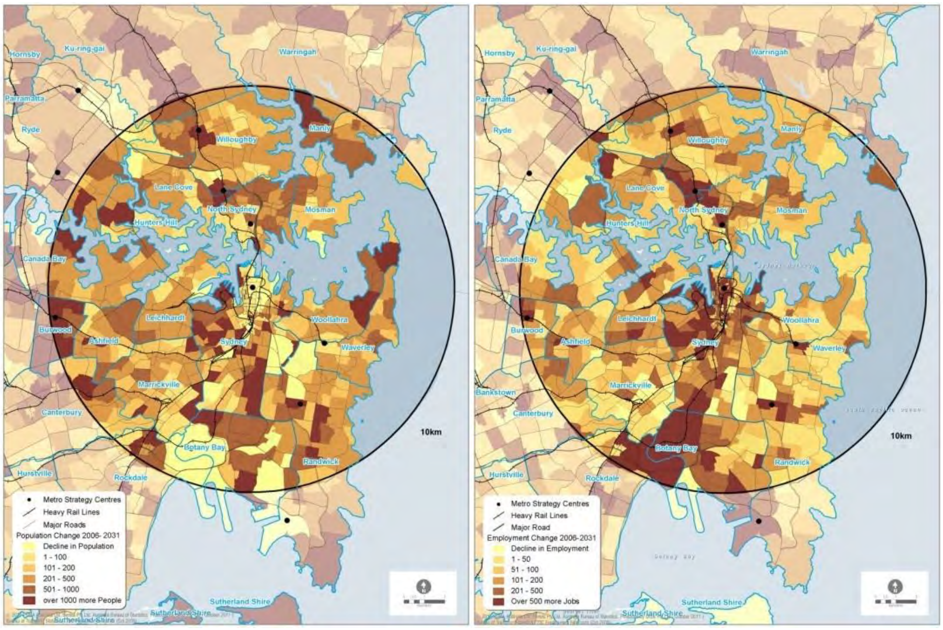
- Large population increases expected in both the City of Sydney (99,000, growth of 60 per cent) and Randwick (24,000, growth of 19 per cent) LGAs. These population changes are expected to result in a large increase in residential density (persons/hectare) in the Sydney LGA and a moderate increase in the Randwick LGA.
- Employment increase of 140,000 workers in the Sydney LGA, up from 430,000 to 570,000 (growth of 33 per cent), and an employment increase of 13,000 in Randwick LGA (growth of 31 per cent). These employment changes are expected to result in a large increase in employment density (persons/hectare) in the Sydney LGA and a moderate increase in the Randwick LGA.

[68] Transport for NSW, *NSW Long Term Transport Master Plan*, December 2012

Table 3-1: Forecast growth in the Study Area[69]

Category	Current (2012)	Future (2031)
Residential population	292,000 residents in the City of Sydney and Randwick LGAs. Residential density of 62 persons/hectare in the City of Sydney LGA and 35 in Randwick LGA.	425,000 residents in the City of Sydney and Randwick LGAs. Densities expected to increase to 99 persons/hectare in the City of Sydney LGA and 41 in Randwick LGA.
Employment	473,000 workers in the City of Sydney and Randwick LGAs.	626,000 workers in the City of Sydney and Randwick LGAs.
Economy	$50 billion in Sydney's CBD. $3.5 billion in retail sales for the CBD, which is 9 per cent of retail turnover in metropolitan Sydney.	$60 billion in Sydney's CBD. Importance of retail in Sydney CBD expected to continue with more flagship stores and continuing residential and employment growth.
Tourists	Sydney received nearly 7.6 million domestic overnight visitors in 2011, up 5.6 per cent on 2010, and 2.6 million international overnight visitors in 2011.	Ongoing growth in visitor nights of 3 – 4 per cent per annum predicted by the State Tourism Forecasts, compiled by the Commonwealth Government.
Special Events	Buses to Moore Park and Randwick affected by congestion, resulting in low mode share to special events.	Significant growth in demand at sporting and entertainment precinct, driven by continued investment and greater usage of these regionally important venues.

Figure 3-1: Population and employment growth projections in Inner Sydney between 2006 and 2031[70]



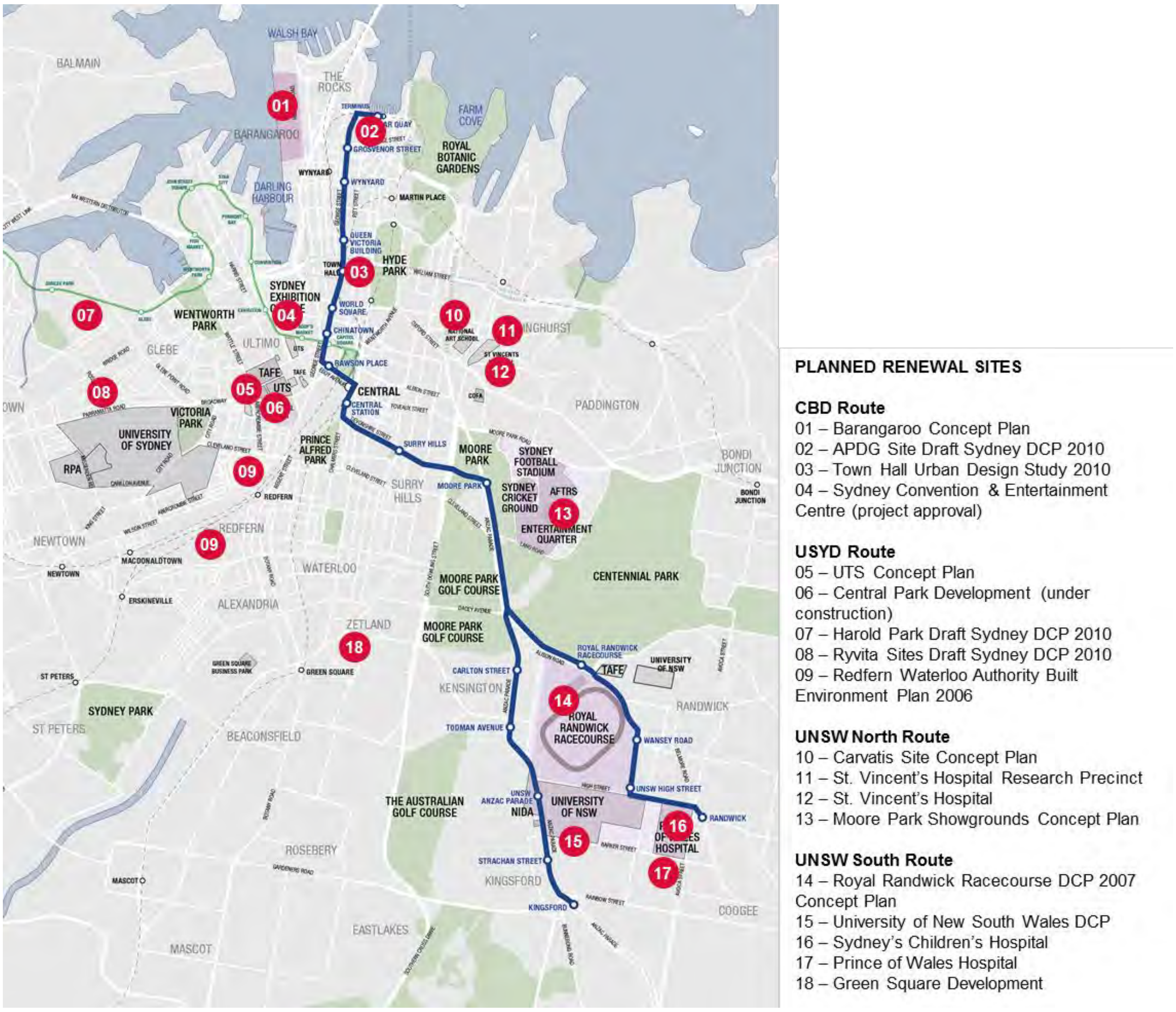
[69] *Urbis, 2011 and Destination NSW, 2012*
[70] *Urbis, 2011*

3.1.2. Urban renewal and growth in travel demand

The CBD and South East contains a wide variety of land uses, incorporating residential areas, employment areas, retail, educational centres, health precincts and major recreational destinations, all within a short to moderate distance from the Sydney CBD. As Sydney's CBD continues to expand due to population growth and development the number of people commuting daily to and from the city will swell. The need to move large numbers of people into and through a constrained area within a narrow time period places strain not only on the transport network in the City Centre, but on the whole metropolitan transport system. Car, bus and rail networks all experience congestion in the Sydney CBD and on major approaches from the South East.

To capture the current state of urban renewal in the region, a review was undertaken that considered existing built form typologies in the area, existing and draft Local Environmental Plans, available master plans, local planning strategies, high level planning strategies for the subregion including the *Metropolitan Plan for Sydney 2036* and the Sydney City, east and Inner west Draft Subregional Strategies. A summary of significant sites currently under development or planned for renewal is presented in Figure 3-2.

Figure 3-2: Planned Renewal in the Study Area[71]



[71] *Hassell, 2012*

Of the major developments planned within / adjacent to the Study Area, a number of key sites are discussed below:

- Barangaroo;
- Sydney International Convention, Exhibition and Entertainment precinct (SICEEP);
- UNSW Campus Development;
- Royal Randwick Master Plan; and
- Green Square Town Centre.

3.1.2.1. Barangaroo

Formerly constituting 22 Ha of disused container wharves, the Barangaroo site is located on the western side of the CBD. The site is owned by the NSW Government and managed by the Barangaroo Delivery Authority (BDA). Development of the site is valued at over $6 billion and will completely transform the site with new parkland, residential, and commercial sectors dividing the site into three distinct zones:

- Headland Park (Barangaroo north) – landscaped with parklands and pedestrian pathways, this 5 Ha sector of the site includes a cultural centre and 300 space underground car park and is scheduled to open in 2015;
- Barangaroo Central – while the development brief is currently being progressed with public consultation having begun in April 2013, it is expected this zone will include low-rise residential, commercial and civic buildings; and
- Barangaroo south – a 7.5 Ha extension of the CBD incorporating high-rise retail, corporate and housing, this area of the site is currently under development in partnership with Lend Lease. The first building is scheduled for completion in 2015, and by full completion in 2020 the site will include a 6 star luxury hotel, 800 apartments, 320,000 sqm of office space, and up to 33,000 sqm of mixed retail and leisure.

Figure 3-3 illustrates the three zones within the Barangaroo site.

Figure 3-3: Barangaroo Development Concept Plan[72]

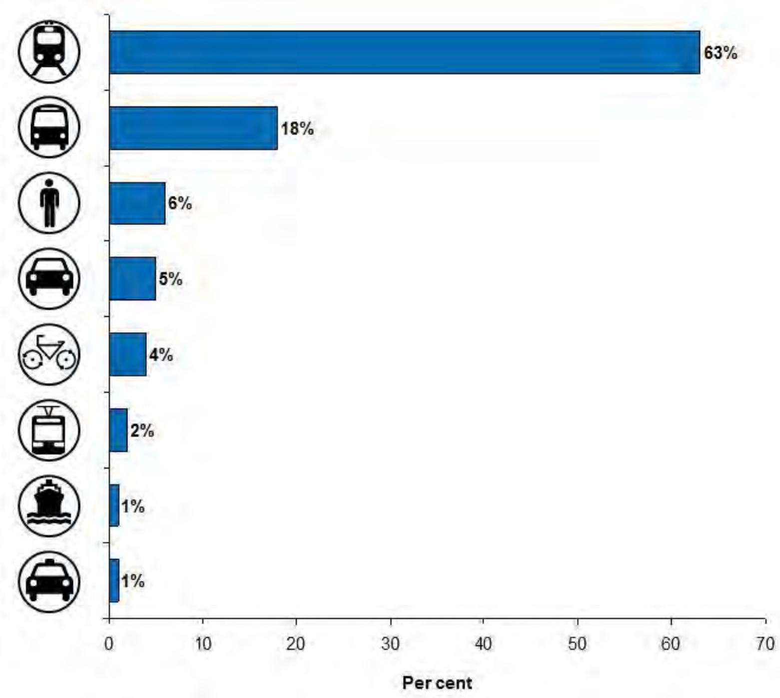
When fully occupied, Barangaroo is forecast to generate about 22,000 trips in the AM peak 2 hours, and about 25,000 trips in the PM peak 3 hours, based on the ‘moderate growth’ scenario.

[72] *PWP Landscape Architecture*

It is forecast by BDA that 33,000 visitors per day (business and leisure) will arrive at the site. The majority are expected to be travelling off-peak and to come from many directions, not only via Wynyard. This leads to a demand profile with a greater 'spread' into the off-peak than is typical for the northern CBD; however the development is still anticipated to contribute to growing peak hour demand and will contribute to a growing concentration of financial and professional service jobs in the northern CBD.

To ensure that Barangaroo did not contribute to additional CBD surface transport congestion, planning approval for Barangaroo south (the commercial, 'CBD extension' component of the Project) was based on the principle of achieving high usage of public transport to the site. Shown in Figure 3-4, these targets anticipate only 5% of trips will be undertaken by private vehicle.

Figure 3-4: Barangaroo Mode Share Targets[73]



Note that the 2% light rail mode share assumed no light rail stop at Wynyard, requiring customers to change either to bus at Haymarket or heavy rail at Central.

Given the significant numbers of people commuting to and from the development it is imperative that appropriate transport solutions are in place. The CSELR project will positively contribute to linking Barangaroo with Sydney's South East. Customers travelling to the development will disembark at Wynyard light rail stop and proceed on foot via Wynyard Walk.

3.1.2.2. SICEEP

The NSW Government has embarked on a redevelopment and expansion strategy for the Entertainment Centre, the Exhibition Centre and the Convention Centre, collectively the SICEEP, located in the southern sector of Darling Harbour. The works aim to create an integrated entertainment facility in the heart of Sydney with additional commercial, retail, hotel and residential floor space. The new International Convention Centre Sydney (ICC Sydney) will compete more effectively in the global convention and exhibition market, further enliven the southern part of Darling Harbour and improve linkages with surrounding areas, especially Chinatown.

[73] *Barangaroo Integrated Transport Plan*

The scheduled completion date for core cultural facilities is 2016, with the remaining retail, commercial, hotel and residential development expected to finish in 2021.

Figure 3-5: Concept Designs of the ICC Sydney and Multi-Function Entertainment Centre[74]

The redevelopment of the SICEEP is anticipated to increase off-peak demand to the Darling Harbour precinct as increasingly large events are hosted in Sydney. Transport services to the precinct were assessed through the Environmental Assessment process for that project, however it is worth recognising that the construction of CSELR will complement the existing Inner West light rail system adjacent to the precinct and provide for a simple connection to the primary CBD spine and key areas of accommodation for international and interstate visitors who are anticipated to be major users of the site.

The precinct will on completion be Australia's largest exhibition space to date with increased space to accommodate for previously unmet excess demand. Banqueting and meeting facilities are estimated to double the current capacity, whilst there will be a reduction in capacity for entertainment facilities, indicating a focus on international and national conventions and exhibitions as key economic drivers, with aims to generate more and bigger events than current capacity constrictions permit. Event attendee increases will be combined with both short-term and long-term increases in the precinct's population, with anticipated employment generation of 1,600 jobs during construction and 4,000 ongoing positions, and 2,100 construction jobs and 2,000 ongoing positions associated with the consequential city hub 'The Haymarket'.

The SICEEP recognises the increase in transport demand resulting from the higher activity-levels within the precinct, with the responding environmentally sustainable design strategy that promotes the use of public transport, specifically through supporting accessibility to existing light rail stations on Darling Drive via new pathways and pedestrian crossings. Parking provisions will concurrently be reduced by around 500 spaces to promote a shift towards sustainable transport modes. The initiatives will promote patronage of light rail and support investments such as the IWLR extension and the CSELR. The SICEEP and CSELR are projects with undeniable interdependencies and mutually beneficial impacts, with promotion of the precincts increasing light rail demand, and light rail network providing easy access to the precinct from surrounding areas and key strategic locations such as the CBD.

[74] *Infrastructure NSW*

3.1.2.3. UNSW campus development

Cumulatively between 25,000 and 30,000 people arrive at the UNSW Kensington campus by bus during semester times and the Central Station to UNSW Kensington campus bus route is one of the busiest point to point bus routes in Sydney.

The University of New South Wales has more than 50,000 students including approximately 12,000 international students that generate between $350m - $400m of export income for the State each year. UNSW is regularly ranked in the top 100 universities in the world.

The continuation of reliable transport services throughout the construction process is vital to the operation of the University and the ability to attract and retain students. This includes not only connections to Central Station but also cross regional bus services that connect to the UNSW Kensington campus.

In addition to delivery of a high-quality piece of transport infrastructure, the University is investing approximately $400 million across three major projects at its Kensington campus:

- $110 million Kensington Colleges development
- $145 million Wallace Wurth building redevelopment
- $145 million Materials Science and Engineering Building (MS&EB)

An overview of each of these projects is provided below.

Kensington Colleges development

Construction of five new colleges to replace the three colleges previously demolished. The colleges will provide housing for up to 920 students and are expected to open in early 2014 at a total cost of $110 million.

Wallace Wurth building redevelopment

Redevelopment of the existing Wallace Wurth building will modernise facilities and expand floor space from 13,000 to 21,000 square metres. The building will house the Kirby institute and contribute to creating a biomedical research precinct on UNSW's upper campus. Scheduled for completion in March 2014, the building is expected to accommodate over 1250 students and 750 research personnel at a total cost of $145 million.

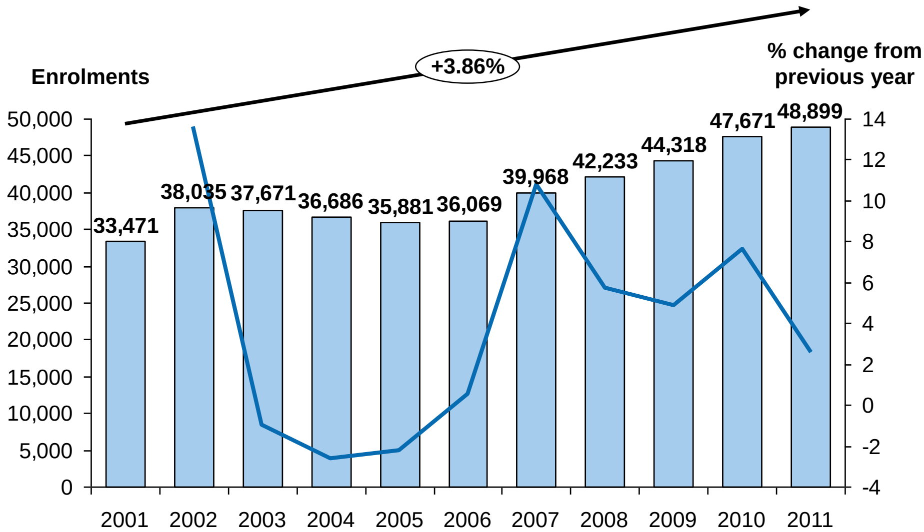
MS&EB

Construction of a new building will support the teaching and research of materials science and engineering. The building will be ten stories high with approximately 20,000 square metres floor space. Planned for completion in 2015, the expected total cost of the Project is $145 million. Figure 3-6 shows the concept design for the MS&EB.

Figure 3-6: UNSW's Planned MS&E Building[75]

Historic growth in trips to UNSW has been relatively strong, with internal enrolments at UNSW (reflecting the majority of Kensington campus students) increasing at a rate of 3.9% over the past decade as illustrated in Figure 3-7. However, there has been significant variability in year to year growth over that time – particularly due to changes in Commonwealth Government policy settings. The removal of the cap on Commonwealth Supported Places in 2009 saw a reinvigoration of demand that may be expected to continue as Universities seek to ensure secure sources of funding in the future.

Figure 3-7: Number and Change in Internal Enrolments at UNSW, 2001-2011[76]



An increasing majority of students are using public transport to access the campus, as the supply of nearby parking spaces has remained static, with around half of students accessing the campus between 8am and 10am. In the evening, peak student departure time more closely aligned with the regular peak period with 51% of students departing between 4pm and 7pm[77].

[75] *UNSW*
[76] *Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2012*
[77] *UNSW Travel Survey, 2012*

It is anticipated that this profile of demand will continue in the future, with public transport assuming an increasing share of the transport task due to ongoing limitations to parking supply in the precinct. Light rail is well-positioned to take up this task, with the current design including stops near the University Mall on Anzac Parade and Gate 9 on High Street, used by more than half of students and staff to access the University.

3.1.2.4. Royal Randwick Master Plan

The Australian Turf Club (ATC) has recently invested approximately $150 million on a new grandstand and amphitheatre which opened for the 2013 racing season. The facilities increase the seating capacity of the venue by 112% and aims to modernise the race day experience.

The ATC has developed a Royal Randwick Master Plan which is currently going through the development approval process. The master plan includes construction of a 170 room hotel (expected completion 2015), six new 100 stable buildings, a convention centre and a centre of excellence / lifestyle centre. These new facilities are expected to enhance the experience of racegoers and expand the scope of events held at Royal Randwick.

Figure 3-8: Royal Randwick's New Grandstand[78]

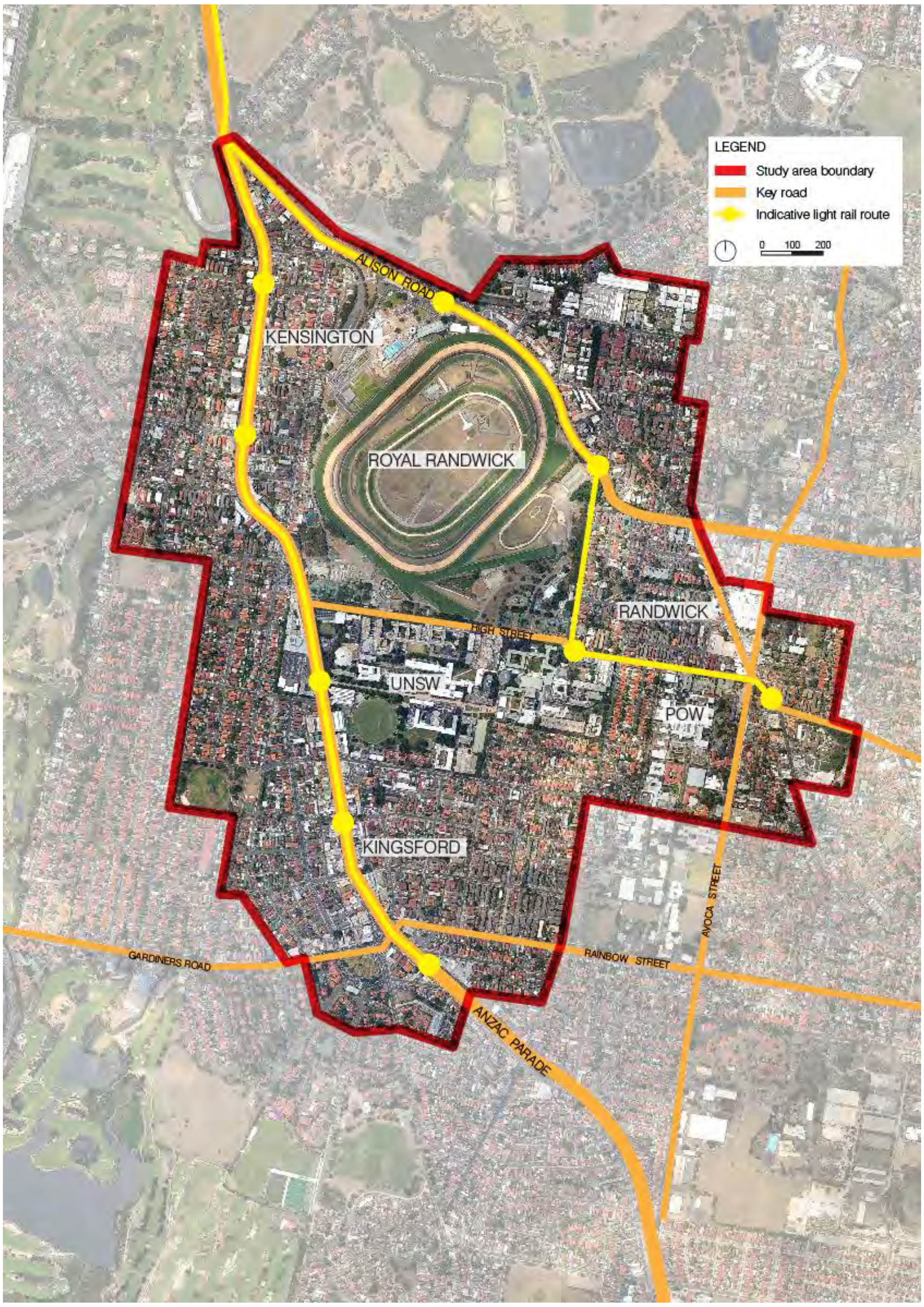
Royal Randwick's development will primarily impact transport demand for special events, which is discussed in more detail in Section 3.3 of this report. At a high-level, the development of Royal Randwick is expected to shift transport patterns from their current focus around a small number of race days to a more diverse range of events from major music festivals to smaller corporate conferences.

3.1.2.5. Randwick Urban Activation Precinct

In March 2013, the NSW Government announced an Urban Activation Precincts (UAP) Program as part of a wider package of housing and jobs initiatives. The UAP Program seeks to improve the delivery of in-fill development through a structured approach to housing release and infrastructure development. Anzac Parade South, within Randwick City Council, as well as Randwick itself are two of the first eight precincts identified for inclusion in the UAP Program. The area under examination is shown in Figure 3-9.

[78] *Australian Turf Club*

Figure 3-9: Boundary of Randwick Urban Activation Precinct Study Area[79]



While still in the early stages of planning, the NSW Government has recognised that the construction of light rail in the precinct will provide a catalyst for urban renewal and consolidation. The delivery of a high-capacity and reliable mode of transport through the area will support the additional social and community infrastructure being delivered through the UAP program.

79 *NSW Department of Planning & Infrastructure*

3.1.2.6. Green Square Town Centre

Green Square Town Centre is an $8 billion development located 3.5km south of the City Centre and 2km west of Royal Randwick Racecourse. The development covers a 278 Ha area and includes planned construction of residential and commercial buildings, and community facilities including a community hall, exhibition galleries, multi-purpose recreation area and aquatic centre, and a 6,500 square metre park.

Following the initiation of site works in 2013, the first residents are expected to move in between 2015 and 2016. The town centre building sits at the heart of the Project and is planned to accommodate approximately 6,800 residents and 8,600 workers. On completion in 2030 the development is expected to attract up to 40,000 new residents and 22,000 new workers to the Green Square precinct. Concept design cross-sections of the development are provided in Figure 3-10.

Figure 3-10: Green Square Town Centre Cross-sections[80]

This project will significantly alter transport patterns in the precinct from a primarily industrial and manufacturing use to a mixed-use commercial and residential precinct. While employment growth in the area is more moderate than residential growth, the nature of employment purposes in the precinct will change as the nature of businesses shifts from current industrial use to more generic commercial and retail. In addition, the peak flow nature of transport movements in the area driven by employment purposes will moderate and residents who live in the Green Square precinct but work outside it begin to increase demand for contra-peak transport flows.

Despite the significant increase in travel demand as a result of the development, the precinct is already relatively well-served by public transport with a mix of buses and heavy rail services nearby. While Green Square will shift travel patterns over the time, the transport task is not unmanageable through a reorganisation of the transport system and mode hierarchy in the future. The introduction of CSELR can play a part in this as a reduction in demand for bus fleet in the eastern suburbs permits the reallocation of fleet for other purposes including, if necessary, supplementary services along the Botany Road corridor.

[80] *Landcom*

3.2. Future Demand

On-going population and employment growth in major developments, land release areas and urban regeneration sites will all drive additional demand for transport services within the study area. To guide the transport planning process, Transport for NSW commissioned the development of a demand model specific to the requirements and intricacies of the CSELR project. This model – the Public Transport Project Model (PTPM) – extended the capabilities of existing models such as the Strategic Travel Model (STM) to deal with key aspects of anticipated future demand. The PTPM uses inputs including land-use patterns, rail operating plans, bus operating strategies, road network plans and parking availability and charging to understand the anticipated profile of demand under a range of future scenarios.

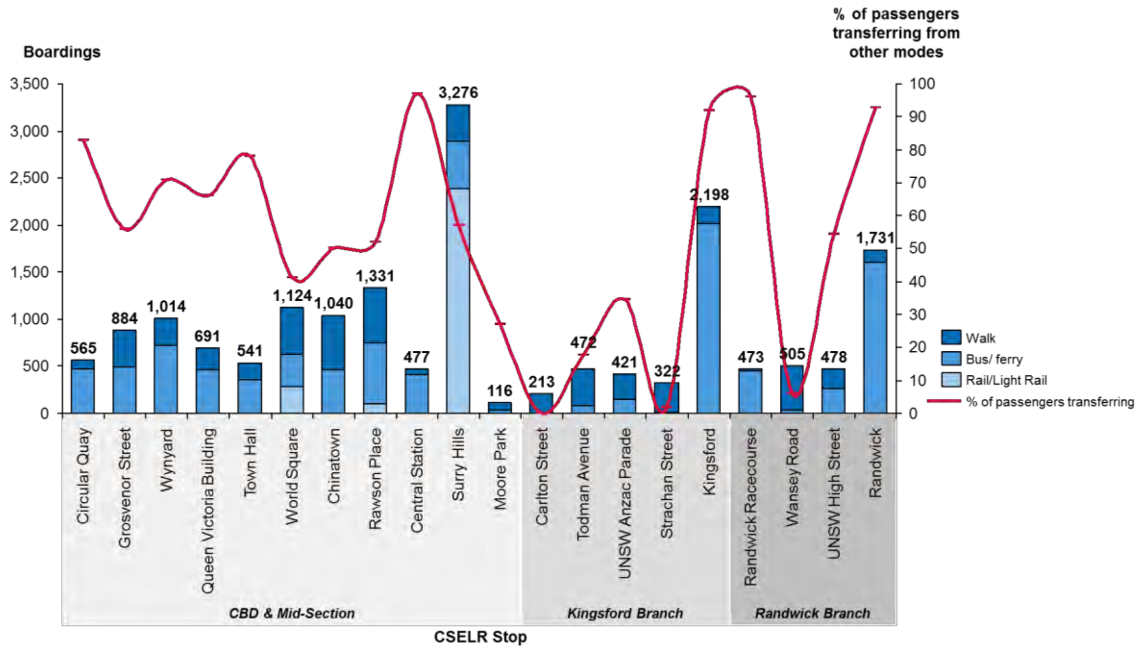
The PTPM provides transport planners with a tool to understand future travel requirements and demand patterns to ensure an appropriate level of service is provided to meet community expectations. Outputs from the PTPM were used in a number of stages to inform the development of the future traffic and transport network. Key elements of the profile of future demand are summarised below. More detail can be found in Transport for NSW's Demand Report.

- The Project is expected to attract about 18,000 AM peak hour boardings in both directions in 2021, growing to around 23,000 by 2036[81];
- Line load on the CSELR peaks at more than 5,300 passengers per hour in the 2021 AM peak on the approach to Central Station[82];
- Driven primarily by student travel to UNSW, there is strong demand for contra-peak travel with line loads of approximately 4,100 passengers per hour in the 2021 AM peak hour and just over 3,300 alightings at the two UNSW stops[83]; and
- In the 2021 AM peak hour, over 2,000 passengers are forecast to transfer from buses to light rail at the Kingsford terminus and over 1,600 passengers at the Belmore Road (Randwick) terminus[84].
- Total demand to the CBD on the CSELR is expected to total almost 40,000,000 trips by 2036[85];

While the effect is more pronounced at the key interchange stops of Central Station, Randwick and Kingsford, intermodal use will be a key feature of the CSELR at all stops. As shown in Figure 3-11, most stations anticipate transfers from other modes to varying degrees depending upon the nature of the catchment and style of stops.

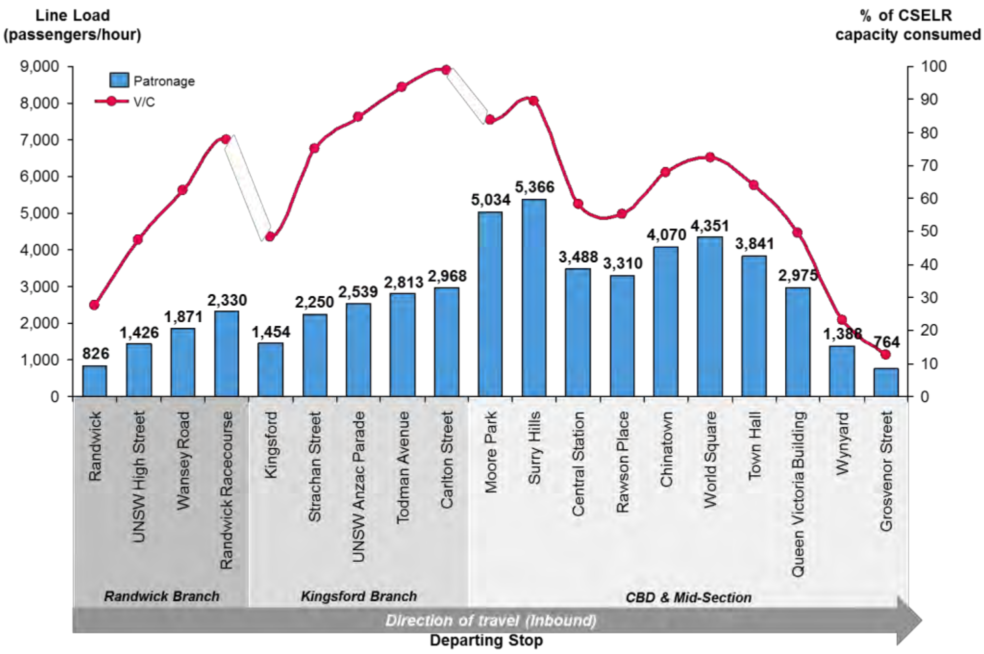
81 Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report*, 2013
82 *Ibid*
83 *Ibid*
84 *Ibid*
85 *Ibid*

Figure 3-11: 2021 AM Peak CSELR Boardings and Mode of Access by Light Rail Stop[86]



The CSELR is also anticipated to take a significant proportion of the growth in future demand from the eastern suburbs to the CBD. As shown in Figure 3-12, peak line loads inbound (based on the preliminary service specifications outlined by the Operations Adviser[87]) exceed 5,300 passengers per hour in the 2021 AM Peak Hour[88].

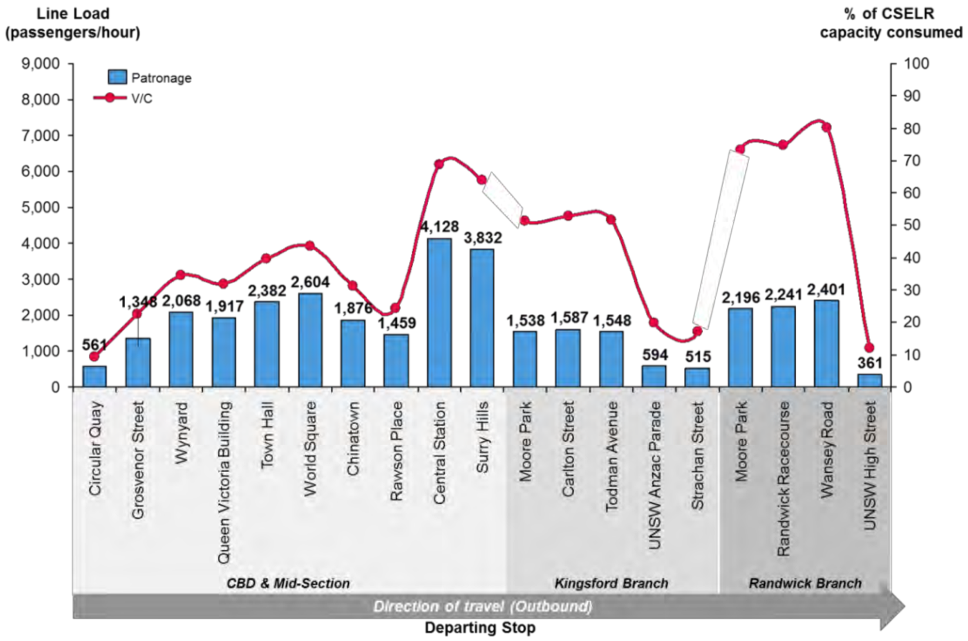
Figure 3-12: 2021 Inbound AM Peak CSELR Line Load and Capacity Consumed[89]



86 Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report,* 2013; Booz & Company analysis
87 Interfleet, *Operations Adviser Initial Light Rail Operational Services Plan*, 2013
88 Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report,* 2013
89 Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report,* 2013; Booz & Company analysis

As shown in Figure 3-13, peak line loads outbound (based on the preliminary service specifications outlined by the Operations Adviser[90]) while lower than inbound, still exceeds 4,100 passengers per hour in the 2021 AM Peak Hour[91]. This represents a good balance of demand, with the fixed and rolling infrastructure assets well-utilised in both directions due to the significant demand for access to the University of NSW and Randwick Health Precinct.

Figure 3-13: 2036 Outbound AM Peak CSELR Line Load and Capacity Consumed[92]



Finally, because trips on light rail may well be part of a longer journey, the PTPM provides an indication of the anticipated travel zone origin for trips beginning at particular light rail stops. Due to the relevance of this information to bus and road network planning, a summary of trip origins for the Kingsford and Randwick termini is shown in Figure 3-14 and Figure 3-15 respectively, however numerous origin/transfer plots were utilised during the development of the transport strategies for the South East.

[90] Interfleet, *Operations Adviser Initial Light Rail Operational Services Plan*, 2013
[91] Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report,* 2013
[92] Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report,* 2013; Booz & Company analysis

Figure 3-14: Anzac Parade terminus (Nine Ways) stop trip origins (2036)[93]

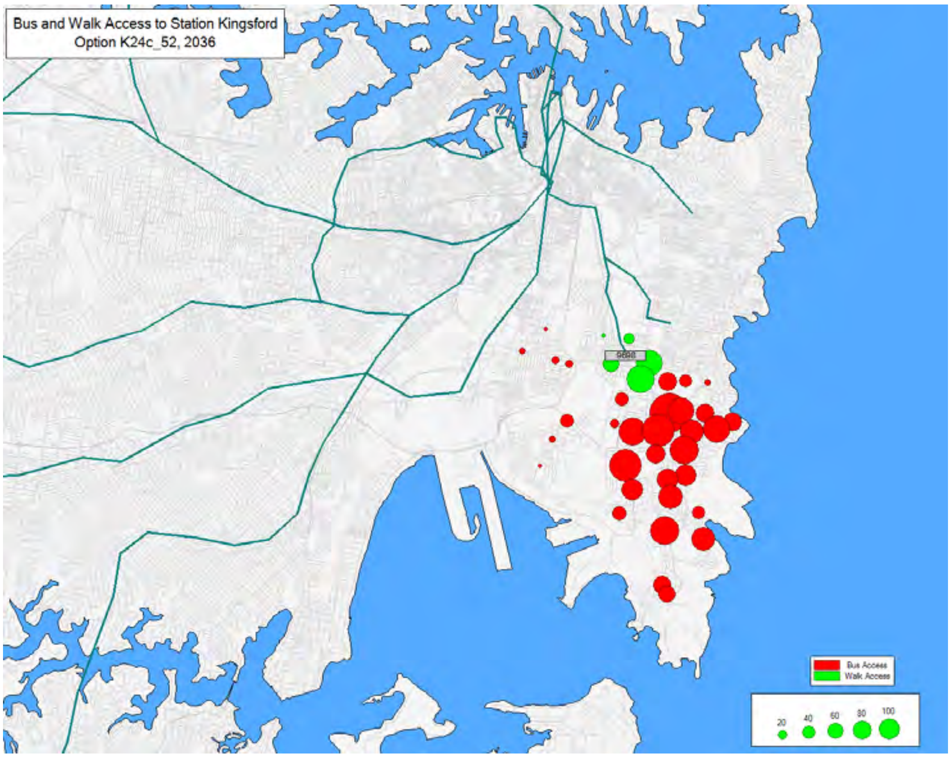
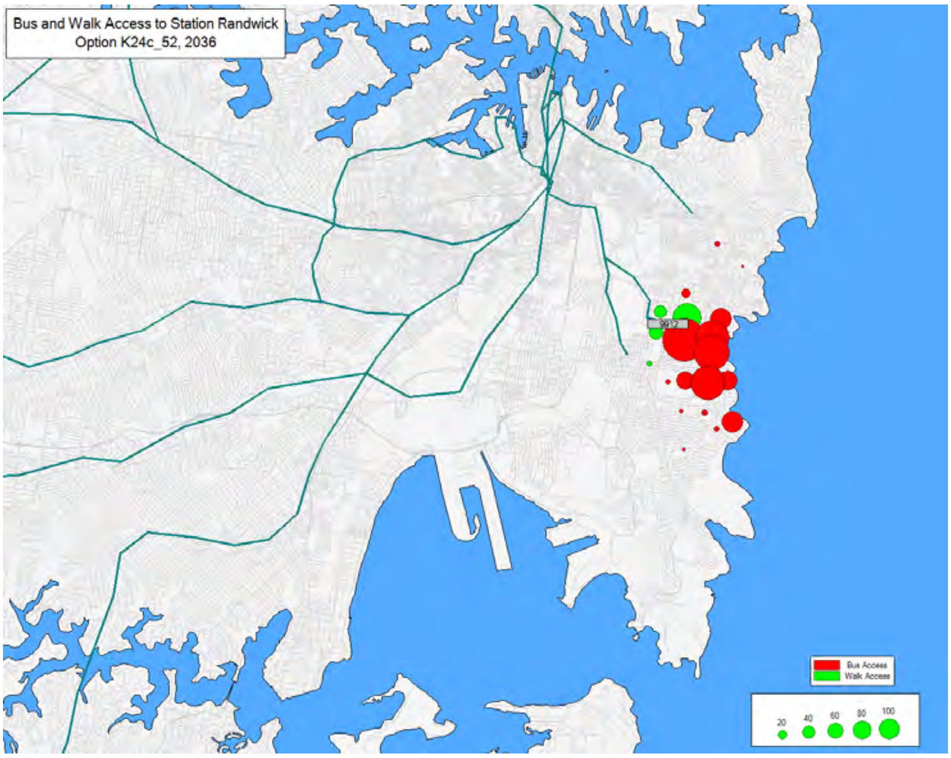


Figure 3-15: Belmore Road terminus stop trip origins (2036)[94]



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[93] Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report,* 2013
[94] Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report,* 2013

3.3. Special Events

The introduction of the CSELR provides an opportunity to significantly enhance access to the major event precincts within the corridor, increase public transport mode share and reduce congestion. The CSELR corridor is, however, on the major CBD parade route on George Street and identification of appropriate public transport management strategies are required to minimise their impact on CSELR operations.

This section of the report discusses the benefits the CSELR can provide to existing and future special events at Moore Park and Royal Randwick, and sets out appropriate first steps for minimising the operational impact of CBD events.

3.3.1. Public transport mode share

Public transport mode share to special events along the CSELR corridor, particularly to Royal Randwick, has historically been relatively low in comparison with other major special event locations. Sydney Olympic Park at Homebush, which offers a multi-modal transport solution, averaged public transport mode share of 69% in 2010.[95]

CSELR presents a number of benefits over the existing special event bus transport solution. Light rail will be more reliable and more comfortable than event buses, which would contribute to higher customer satisfaction and should serve to increase mode share. Public transport mode share could further benefit from redeployment of duplicated bus services to link events to new areas of Sydney. In all instances, increasing public transport mode share will ultimately result in reduced congestion around event venues.

3.3.2. Moore Park

A traffic and transport services strategy for Moore Park was developed by Parsons Brinckerhoff[96] (PB) with the purpose of providing an integrated transport master plan for the precinct for both event and regular transport operations. It is expected that Moore Park will continue to host a significant number and wide variety of special events in future years of a similar complexion to the current mix. To understand the appropriate mix of modes and services required to satisfy the future demand at these events, PB has undertaken analysis of these requirements to suggest an appropriate Moore Park event strategy. Detailed analysis and specific infrastructure requirements are summarised in the PB report, a summary of which is provided in this section.

Special events at Moore Park will target the following mode share target following the introduction of light rail:

- Cricket/AFL capacity event (48,000 attendees) with 45m LRV – 68% non-car
- Cricket/AFL typical event (34,000 attendees) with 45m LRV – 66% non-car
- Rugby League/Rugby Union/Football typical event (34,000 attendees) with 45m LRV – 63% non-car
- Cricket/AFL capacity event (48,000 attendees) with 90m LRV – 71% non-car

Mode share targets for individuals modes under capacity events with 45 metre and 90 metre light rail vehicles in use are shown in Figure 3-16 and Figure 3-17. Note that these figures show total (not hourly) mode share to the event.

[95] *Parsons Brinckerhoff,* Sydney Light Rail Program Moore Park Precinct – All Modes Study, *June 2013*
[96] *Ibid*

Figure 3-16: Proposed Moore Park event transport mode share with LRT (48,000 - AFL) 45m LRV

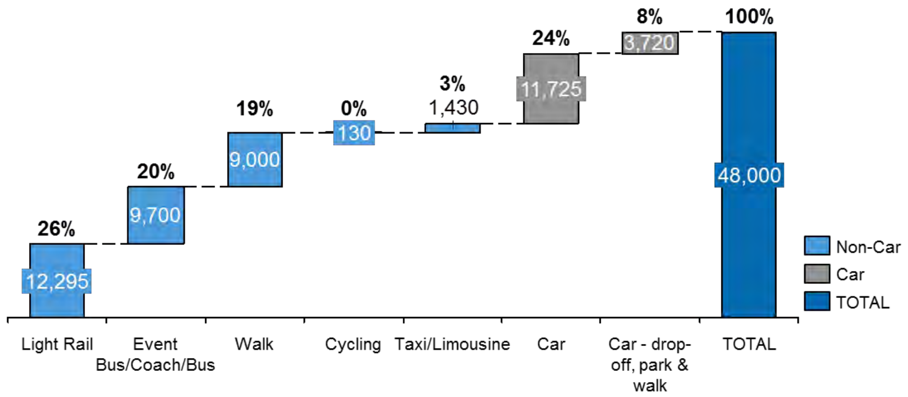
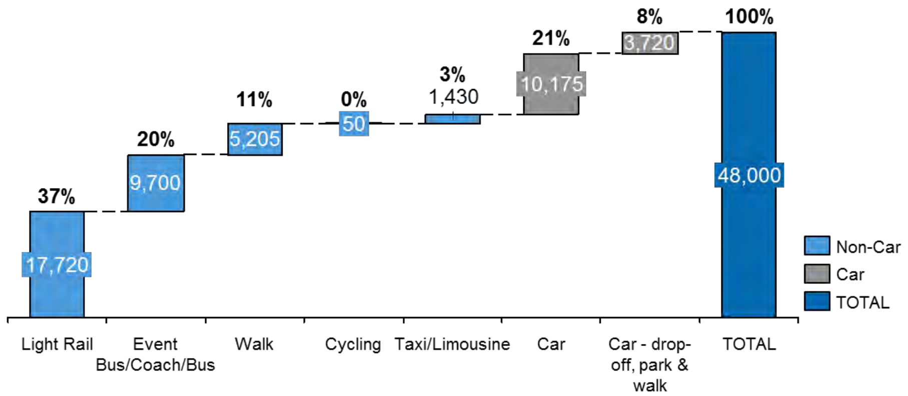


Figure 3-17: Proposed Moore park event transport more share with LRT (48,000 - AFL) 90m LRV



It is intended that light rail will replace the current special event bus operations between Moore Park and Central station. Regular light rail services will also replace the operation of dedicated park-and-ride shuttle to the University of NSW and Randwick Racecourse that operate for some events. With a combination of event shuttles and regular services, a maximum headway of 2.5 minutes can be achieved in the peak direction during the post-match period. With passenger capacity of 5 passengers per square metre, a total hourly capacity is possible of:

- 45 metre LRV – 9,836 passengers/hour (both directions combined)
- 90 metre LRV – 14,175 passengers/hour (both directions combined)

Based upon maintaining a 36% mode share to light rail for all crowd sizes, the likely duration of event specials will range from 20-55 minutes following an event depending on capacity required and operational strategy employed.

In addition to light rail, buses will continue to play an important role in the event transport task in the Moore Park precinct. The current major event bus hub at Moore Park is required to be relocated to facilitate the construction of a light rail stop in its place. The new facility is proposed to be located north of Tramway Oval between the bus roadway and Kippax Lake (shown in Figure 3-18). The facility is proposed to be 235m long and 37m wide, with sufficient capacity for 10 standard buses or 4 standard and 5 articulated buses.

While the main event bus connection between Central and Moore Park will be replaced by light rail, it is envisaged by Parsons Brinckerhoff that a number of bus routes will remain to provide access to catchments in the Sydney metropolitan area not well served by the heavy or light rail network. These include:

- Existing event bus services between Circular Quay and Moore Park (Route 3);
- Castle Hill to Moore Park (Route 15A);
- Dural to Moore Park (Route 18);
- Warringah Mall to Moore Park (Route 50);

This results in Routes 1, 52, 60 and 62 being replaced by the CSELR.

Walking has always been a popular mode of access to Moore Park, with up to 9,000 spectators expected to walk to the precinct for a capacity event, including people walking the 1.5-2 km's from Central station and other transport nodes. The PB study recommended that a pedestrian bridge across Anzac Parade be provided to improve the pedestrian connections between Central Station and Moore Park.

The complete event transport plan for Moore Park is shown in Figure 3-18.

Figure 3-18: Moore Park precinct Integrated Event Transport Plan

3.3.3. Royal Randwick

Royal Randwick is currently served by special event buses (Route 32) during Saturday race days throughout the year, and Future Music festival held annually in March. While bus mode share to Future Music festival averages 33%, race day mode share averages fewer than 10%.

The CSELR presents an opportunity to increase public transport mode share to Royal Randwick events. Given the CSELR will duplicate the event bus transport solution provided by the Route 32, these bus services could either be redirected elsewhere on the network or redeployed to supplement the new light rail service, linking the venue with other parts of Sydney. Redeployed services could run from other key transport hubs, resulting in increased public transport mode share to events at Royal Randwick.

The venue is currently undergoing a major development including construction of a 170 room hotel (expected completion 2015), a convention centre and a centre of excellence / lifestyle centre. The development is expected to increase attendance and attract a more diverse array of events. Future transport solutions will have to meet both the changing needs of existing events, as well as the transport demand from new events.

The addition of new facilities and modernisation of existing facilities is likely to increase attendance of currently held special events, as well as facilitating a shift in the type and number of special events held at Royal Randwick. Increases in attendance for future race days will be better supported under the new light rail transport solution, as compared with the existing event buses. In addition, the higher capacity, improved reliability and simple scalability of a transport solution involving light rail makes it better positioned to respond to the shifting nature of events to be held at Royal Randwick.

The active promotion of Royal Randwick as a prime location for non-racing events such as music festivals could see significant spikes in peak transport demand, albeit over only a one or two day period. As seen with Future Music festival currently held at the venue, music festivals tend to have a much higher public transport mode share.

3.3.4. CBD

There are currently a large number of events held in the CBD which impact traffic along George and Alfred streets. A list of these events and a short description of their impact is provided in Figure 3-19. Due to the fixed nature of light rail infrastructure, these events (which force diversions of existing bus services) may require partial or full closure of the CSELR in the CBD.

Figure 3-19: Annual Events Directly Impacting the CSELR

Indicative Month	Event	Comment
January	Australia Day Wheelchair Race	Course runs West along Alfred Street at Circular Quay
January	Chinese New Year Twilight Parade	Parade down George Street between Park and Goulburn Streets
March	St Patricks Day Parade	Parade down George Street between Park and Bathurst Streets
April	Anzac Day Parade	Parade down George Street between Martin Place and Bathurst Street
April	Sydney Easter Parade	Parade down George Street between Park and Bathurst Streets
May	May Day March	Parade down George Street between Park and Bathurst Streets
May	SMH Half Marathon	Course runs West along Alfred Street at Circular Quay
June	MS Walk / Run	Short section of the run along George Street near Martin Place
June	Procession of the Blessed Sacrament	Procession moves down George Street between Bridge and Hunter Streets
September	Sydney Running Festival	Course runs West along Alfred Street at Circular Quay, and East through the pedestrian section of Circular Quay station (?)
October	Moveable Feast	Closure of George Street between Park and Bathurst Streets
November	Sydney Christmas Parade	Parade down George Street between Hunter and Liverpool Streets
December	New Year's Eve	Closure of George Street between Grosvenor and Alfred Streets, closure of Alfred Street at Circular Quay
N/A	Olympic / Sporting Parades	I.e. Sydney Swans celebratory parade 2012

To minimise the impact of CBD special events on CSELR operations, Government should review events held along George and Alfred streets to assess the capacity of those events to be suitably relocated elsewhere in the CBD. In cases where events must retain use of the CSELR corridor, operations along the line will be impacted and may need to be supplemented with bus services.

The current CSELR design includes a cross-over at Town Hall which may facilitate short-running of light rail services between Central and Town Hall if events are held on George Street north. Under these circumstances, replacement bus services may not be required as sufficient regular bus services exist on adjacent streets supplemented by heavy rail services on the City Circle line.

However, if the event requires the full closure of the CSELR between Eddy Avenue and Circular Quay, replacement bus services may be required to provide sufficient capacity and accessibility to destination along the CBD light rail alignment. Under these circumstances, replacement bus services would be anticipated to operate north-south on the Elizabeth Street/Castlereagh Street pair.

Assessment of the necessity to provide alternative transport arrangements would be made through the normal processes involving Transport for NSW, the Transport Management Centre, Roads & Maritime Services, Destination NSW, the City of Sydney and event organisers taking into account:

- The nature of the event;
- The timing and location of the event;
- The magnitude of demand expected to be attracted to the event;
- The capacity of the base public transport system to cater for the event, including the ability of other modes to 'scale up' to provide additional capacity;
- Other conflicting events that may multiple the load experienced by the transport system; and
- The presence of integrated ticketing or other arrangements that improve the efficiency of the transport system at times of ultra-peak loadings.

4. Bus Strategy

4.1. Context

The CSELR proposal represents two components of the Sydney City Centre Access Strategy (CCAS) – light rail and pedestrianisation of George Street. One other component of the CCAS of particular relevance to the CSELR is the bus network redesign to deliver a fully-integrated and coherent public transport system in Inner Sydney.

Bus service changes have been developed in parallel with the development of the CSELR proposal and are consistent with the CSELR proposal to ensure a fully integrated transport solution. However any changes to bus services and infrastructure in the CBD and South East, as well as traffic management changes and other impacts associated with these changes, will be assessed as part of the CCAS. These will not, therefore, form part of the EIS for the CSELR proposal, with the exception of cumulative impact considerations.

The detailed bus strategy is documented in the CCAS*. G*iven the particular relevance of buses to the CSELR (i.e. both being road based public transport systems which are being designed to integrate) the proposed bus network is discussed in this section, including a summary of the redesigned CSELR corridor bus network as well as the Sydney city centre bus network redesign.

4.2. Definition of the future network

4.2.1. Sydney city centre bus network redesign

The redesign of the Sydney city centre bus network aims to create an integrated public transport solution for the Sydney CBD through the coordination of light rail, rail and bus services. It includes rationalisation of Sydney bus services to accommodate the introduction of the North West Rail Link, expansion of light rail services, and the pedestrianisation of George Street.

The bus network redesign is a key element for the delivery of the CSELR project, in particular the relocation of existing bus services from George Street. It was developed in parallel to the development of South East bus networks with a focus on aligning the networks developed in response to the CSELR project.

A summary of the key objectives and proposed network for the city centre bus network redesign is provided in this section.

A key objective of the redesign is to provide improved legibility and access for existing and future customers to use buses while the buses are operated more efficiently on the city streets and into the City Centre. Some objectives of Sydney's Bus Future[97] specific to the City Centre were identified as follows:

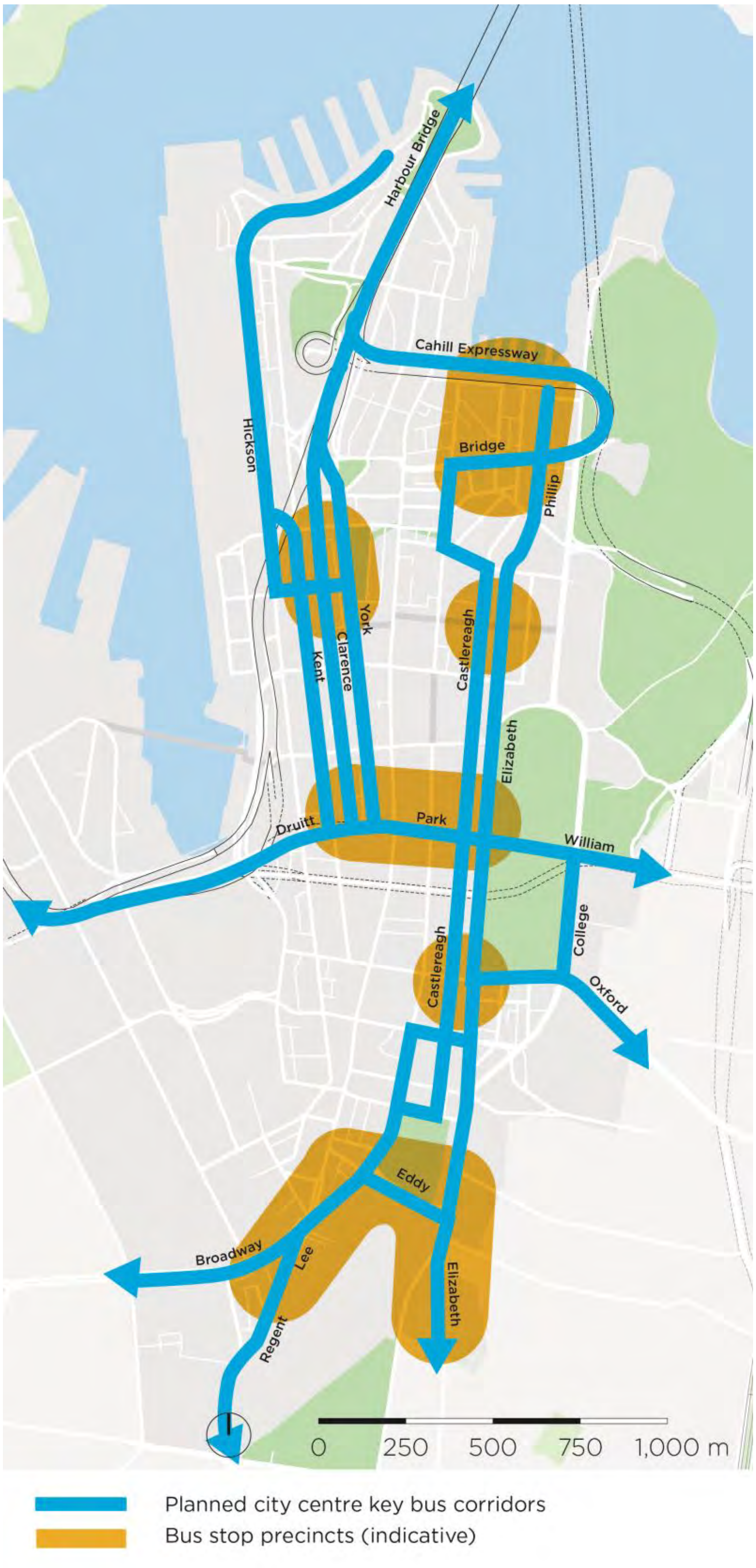
- Create a simpler, all-day City Centre bus network;
- Accommodate high volumes of buses through the City Centre more efficiently with fewer turns and more bus priority; and
- Minimise the need for terminating services in the City Centre and provide sufficient capacity at convenient located layover facilities.

[97] *Accurate at time of writing, document still in draft*

The key bus route paths and interchange precincts for the new Sydney city centre bus network redesign are illustrated in Figure 4-1 and key features are summarised as follows:

- No buses to travel along George Street between Rawson Place and Hunter Street to be consistent with the planning for the Sydney CBD light rail project.
- In-service buses will only be allowed to access George Street within the City Centre to cross at Park Street/Druitt Street, to turn left from Rawson Place south into George Street and to turn left and right at Bridge Street/George Street. Out of service or dead running services will also be allowed to cross George Street at Market Street, Bathurst Street and Goulburn Street.
- Turning movements would be reduced at the Elizabeth Street and Park Street intersection. This would help simplify bus movements through the city centre.
- Sydney Harbour Bridge services will operate either via York Street to Town Hall/QVB or via the Cahill Expressway and Castlereagh Street/Elizabeth Street
- Buses from the Eastern Suburbs via William Street would run to Barangaroo and Walsh Bay to Pyrmont.
- About 50% of Inner West bus routes will terminate after stopping at the Rawson Place light rail stop and in Campbell Street north of Belmore Park. The remaining Inner West bus routes will continue to northern end of City Centre via the Elizabeth Street/Castlereagh Street couplet.
- Routes from the south-east suburbs and from the Oxford Street corridor will only use Elizabeth Street to and from Circular Quay.
- Several routes would be connected to operate as through-routed services to reduce the overlap of bus services on city centre streets and the need for bus lay-over in the city centre.
- Victoria Road bus routes that currently use George Street and terminate at Circular Quay would either continue through the city centre via Druitt Street and Park Street to lay-over outside the city centre or terminate at Wynyard.

Figure 4-1: Key Bus Route Paths in the Sydney City Centre[98]



[98] Transport for NSW, *Sydney City Centre Access Strategy*

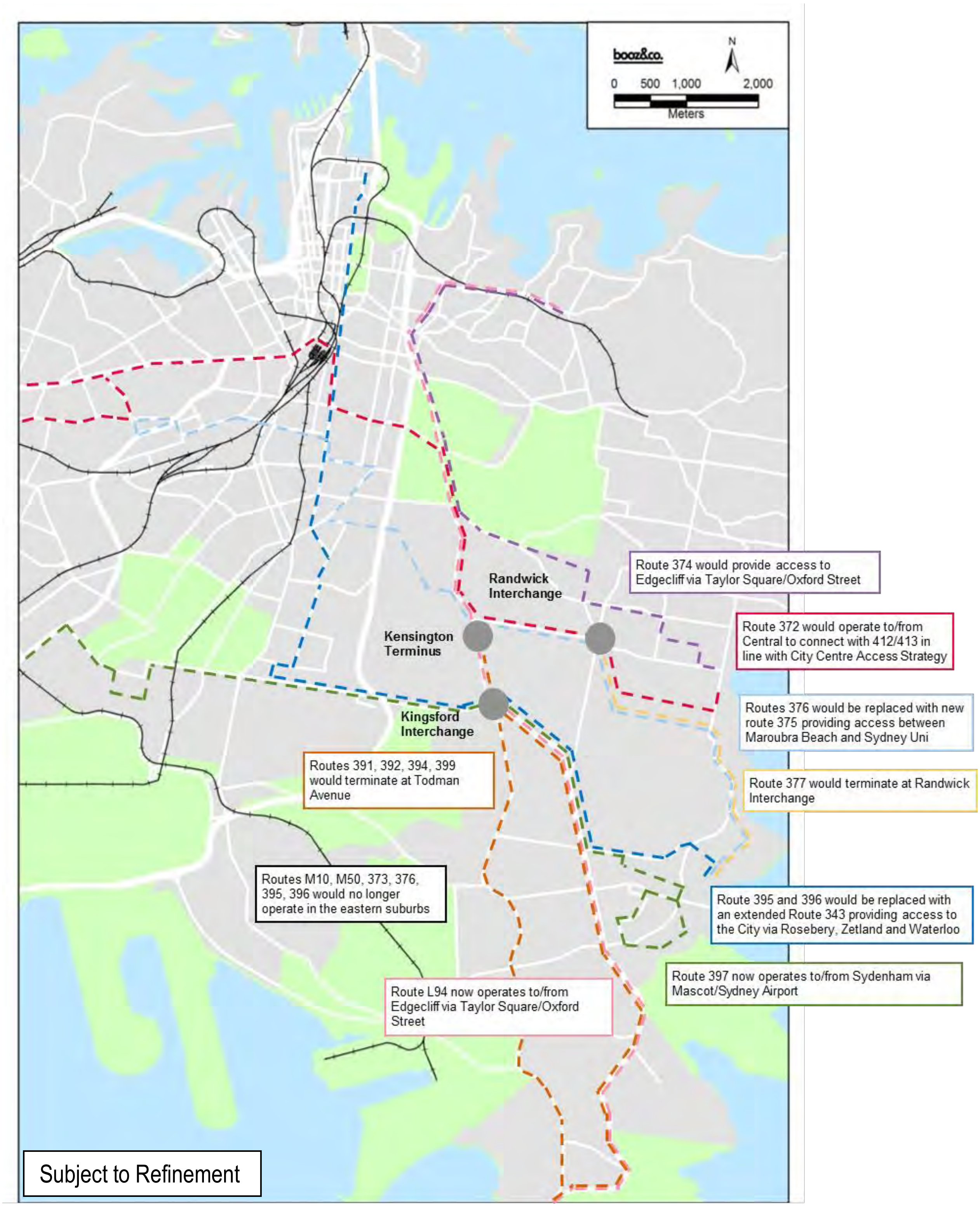
4.2.2. South East bus network

This section provides an overview of the bus service changes that will deliver an integrated bus and light rail public transport network in the South East CSELR corridor. The key elements of the South East Bus Network are described below with the route changes illustrated in Figure 4-2 and summarized in Table 4-1. Those bus routes not mentioned should be assumed to continue operating on their existing routes. At this stage the proposed bus service changes in the South East are draft and will be subject to further refinement through community consultation.

In general the changes propose the establishment of an all ‘day network’ of light rail trunk services to the city with feeder and cross regional bus services. The strategy proposes to retain selected express buses during the peak periods to the northern end of the Sydney CBD to complement the ‘all day’ network. The key features include:

- The majority of existing All-stop CBD bus services which operate along Alison Road and Anzac Parade in duplication of the CSELR are proposed to no longer operate to the CBD but change to become feeder routes for the light rail. These provide all day connections to light rail stops in the eastern suburbs. Examples include:
  - Some Anzac Parade services (Routes 391, 392, 394, and 399) feed the CSELR at Kingsford but continue on to Todman Avenue, Kensington providing direct connections from the south to the UNSW;
  - Randwick bus services feed the CSELR at Randwick but instead of terminating they generally extend to Bondi Junction or other new cross regional links, or terminate on Belmore Road at Alison Road.
- Additional cross-regional routes would be introduced to satisfy growing demand between key trip generators such as the Airport, Green Square, the University of Sydney, Edgecliff and Paddington as well as provide improved connections to the CSELR;
- UNSW will be served by cross-regional routes via High Street including routes 348, 370, 375, 400 and 410;
- CBD express bus services which operate via the eastern distributor are proposed to be retained to provide a direct journey for customers travelling to destinations in the northern CBD during the peak periods only;
- In the PM peak, CBD Express services are proposed to operate via Elizabeth Street and Oxford Street rather than through the Eastern Distributor (as existing);
- University Express Bus Services provided between Central Station and the UNSW would be replaced by the CSELR;
- School Special Bus Services provided between Central Station and Sydney Boys High School and Sydney Girls High School would be replaced by the CSELR;
- Special Event bus services provided between Central Station and Moore Park precinct and Royal Randwick Racecourse are expected to be redesigned to provide new links during events to supplement the CSELR and increase public transport mode share for special events as discussed in Section 3;
- Metrobus routes M10 and M50 are not proposed to operate in the Eastern Suburbs as their function is largely undertaken by the CSELR.

Figure 4-2: Proposed Key South East Bus Network Changes (AM Peak inbound)[99]



[99] *Note: Only illustrates bus routes changed. Those bus routes not mentioned should be assumed to continue operating on their existing routes.*

Table 4-1: South East Bus Network Scenario Route Changes (AM Peak)

Route Number	Old Route	New Route
372	Coogee-Railway Square via Cleveland Street	Coogee-Railway Square via Cleveland Street, through-routed with 412/413 to align with the city centre bus network redesign
373	Coogee-Circular Quay via Oxford Street	Route cancelled
374	Coogee-Circular Quay via Foveaux Street	Operates existing route to Anzac Parade, then travels to Edgecliff via Darlinghurst Road and William Street (subject to detailed implementation planning on routing)
375	N/A	New service operating Maroubra Beach-Sydney University via Randwick Junction, High Street and Todman Avenue
376	Maroubra Beach-Circular Quay via Marine Parade, Alison Road and Foveaux Street	Route cancelled, replaced with 375
377	Maroubra Beach-Circular Quay via Marine Parade, Alison Road and Oxford Street	Operates existing route to Alison Road via Belmore Road and terminates
395/396	Maroubra Beach-City via Maroubra Junction and Anzac Parade	Routes cancelled, to be replaced with extended Route 343
343	Kingsford-City via Gardeners Road and Elizabeth Street	Route extended to operate to/from Maroubra Beach along old 395/396 alignment
397	South Maroubra-City via Anzac Parade	Operates existing route to Kingsford interchange, then Gardeners Road to Sydenham via Mascot/Sydney Airport
M10	Metrobus route between Maroubra Junction and Leichhardt	No longer operates in the eastern suburbs to align with the city centre bus network redesign
M50	Metrobus route between Drummoyne and Coogee	No longer operates in the eastern suburbs to align with the city centre bus network redesign
391	La Perouse-City via Bunnerong Road and Anzac Parade	Operates existing route to Todman Avenue, Kensington and terminates
392	Little Bay-City via Anzac Parade	Operates existing route to Todman Avenue, Kensington and terminates
393	La Perouse-City via Bunnerong Road and Anzac Parade	Operates existing route to Todman Avenue, Kensington and terminates
394	La Perouse-City via Bunnerong Road and Anzac Parade	Operates existing route to Todman Avenue, Kensington and terminates
399	Little Bay-City via Anzac Parade	Operates existing route to Todman Avenue, Kensington and terminates
L94	La Perouse-City via Bunnerong Road and Anzac Parade	Operates existing route to Anzac Parade, then travels to Edgecliff via Darlinghurst Road and William Street (subject to detailed implementation planning on routing)

4.2.3. Precinct Specific Bus Management

4.2.3.1. Central Station rail replacement buses

Rail track work is an on-going necessity for Sydney Trains and NSW Trains to maintain required safety levels, and ensure reliability and efficiency of services. Most scheduled maintenance is undertaken during times of lower patronage, such as weekends. During these times, rail replacement buses are required to minimise disturbance to customers' travel patterns by providing a convenient alternative travel mode.

Rail replacement bus operations

Contracted operators provide rail replacement bus service operations, including the provision of bus marshals responsible for directing passengers to appropriate replacement service. Bus service operations are currently provided with limited infrastructure. Requirements include:

- Legibility for customers to aid their understanding of reasons for the shutdown.
- Provision of clear replacement directions for customers.
- A bus layover area and pick up stands with sufficient kerb side space.
- Wheelchair transport accessibility and a temporary shelter for waiting services.

Figure 4-3: Chalmers Street Rail Replacement Buses, 2011[100]

Impacts of Light Rail

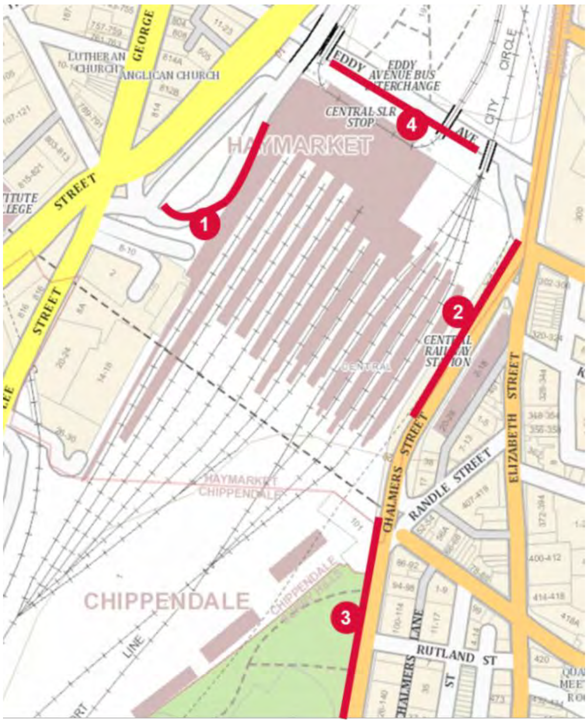
Construction and operation of the CSELR project will have impacts on rail replacement bus arrangements on Chalmers Street and Eddy Avenue as existing space used for layover and pick-up by rail replacement buses is required for the CSELR. Figure 4-4 below shows the current locations for pick-up and drop-off when rail replacement buses are required. The CSELR project impacts bussing operations at Central Station through:

- Full closure of position 2 for construction and operation of the Central Station light rail stop and light rail special event operations;

[100] Booz & Company

- Closure of position 4 for construction and operation of the light rail line in the Eddy Avenue kerbside lane;
- Restrictions on use of position 3 as this moves from being primarily a layover zone to an intensive pick-up zone.

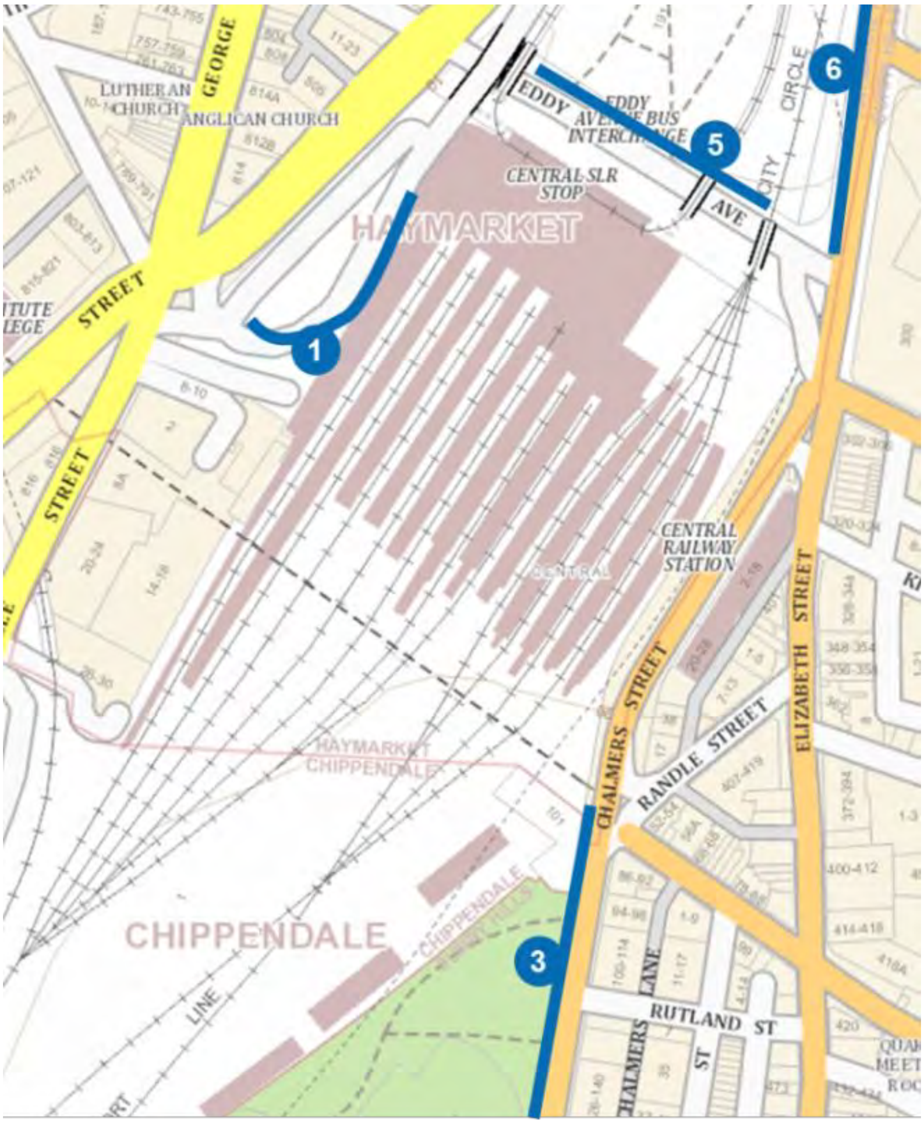
Figure 4-4: Rail Replacement Bus Operations, 2013



Future rail replacement bus scenarios

To facilitate rail replacement bussing arrangement following the introduction of CSELR, a high-level review of Sydney Trains and NSW Trains future track possession and bussing expectations was undertaken, as well as consultation with Sydney Trains and NSW Trains. This process yielded four potential locations for layover and pick-up during rail replacement scenarios, shown in Figure 4-5.

Figure 4-5: Rail Replacement Bus Operations, 2021



The specific operation and use of each position is dependent on Sydney Trains and NSW Trains line 'possession' configurations (the railways lines and services taken out of operation for track work). At Central, there are four configurations requiring the introduction of rail replacement that were considered to be significantly impacted by the light rail. The specific arrangements for each configuration are a function of the demand to be experienced as a result of the possession as well as the desired destinations of the customers affected. The four configurations are:

- **Configuration 1 –** this configuration suspends rail services on the Illawarra and Eastern Suburbs lines between Bondi Junction and Dapto;
- **Configuration 1a –** this is a variation of the above configuration which suspends services between Bondi Junction and Dapto, plus services between Central and Sydenham on the Bankstown Line;
- **Configuration 9 –** this configuration suspends rail services on the Newcastle & Central Coast Line between Central, Newcastle, Scone and Dungog;
- **Configuration 15 –** this configuration requires the suspension of rail services on the City Circle, Airport & East Hills line between Sydenham and Central and Inner West line between Ashfield and Central.

Proposed alternative transport arrangements for each configuration are described below.

Configuration 1: Bondi-Dapto possession

Eastern suburbs rail services are high activity services and have to provide replacement buses for a high number of commuters, which will put pressure on the layover capacity at Prince Alfred Park for future arrangements, and provide challenges for future arrangements.

Buses serving the South Coast will continue to operate from position 1 as currently, while services to Bondi will operate at position 3 instead of position 2 due to the introduction of light rail. Services to Cronulla/Waterfall will continue to operate from position 3. Detailed analysis of layover capacity, with investigation of alternative nearby layover space (particularly for standby buses) will need to be undertaken by Sydney Trains to determine the suitability of this arrangement.

Configuration 1a: Bondi-Dapto plus Central-Sydenham possession

The above scenario combined with buses to provide Sydenham services (currently operated at position 4) will put significant pressure on position 3, which will be unable to accommodate demand for replacement buses after the layout change in 2021.

Alternative options have been investigated to provide Transport for NSW and Sydney Trains/NSW Trains with a range of operational responses including:

- Realignment of Configuration 1a possessions to permit operation of Eastern Suburbs line services to either Central or Town Hall, thereby mitigating the need to provide substantial numbers of buses to replace these services;
- Operating Sydenham bus services at newly configured positions 5 and 6 which would take pressure off position 3 at Prince Alfred Park noting, however, this arrangement has some drawbacks including:
  - Poor legibility of alternative arrangements due to a lack of line-of-sight access to the temporary bus pick-up position, and
  - Potentially hazardous road crossings due to the lack of a signalized intersection at the corner of Eddy Avenue and Elizabeth Street. Customers may be tempted to run across the road illegally, rather than back-track to the signalized intersection further west on Eddy Avenue.

Further examination of possible arrangements for this configuration by Sydney Trains is necessary to determine the best method of accommodating rail replacement services in the future.

Configuration 9: Central-Newcastle/Scone/Dungog possession

Replacement services for Newcastle, Scone, and Dungog do not pose significant challenges for future arrangements, due to substantially lower levels of patronage. Buses will continue to drop off at position 1, before circling the block to pick-up northbound passengers at position 3.

Configuration 15: City Circle, Airport & Inner West possession

Configuration 15 is a high-impact possession arrangement requiring significant numbers of replacement buses to provide alternative transport arrangements at the heart of the transport network. Following CSELR introduction, management of this configuration will become simpler with a high-quality, frequent and high-capacity transport mode already providing a convenient alternative. It is anticipated that City Circle rail services would be replaced with the light rail, with regular weekend frequencies increased to match the anticipated demand. It is also recommended that further investigation of trips currently using Museum and St James stations be undertaken by Sydney Trains to determine whether the CSELR adequately serves destination nearby those stations, or whether a replacement bus service should be provided.

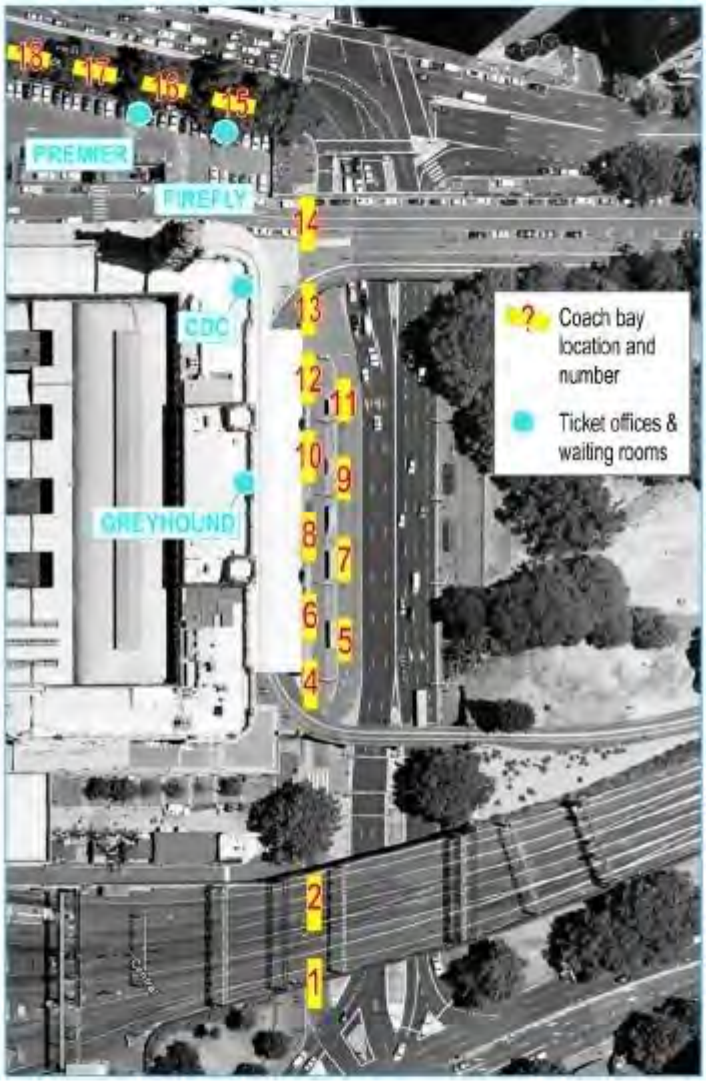
Inner West bus services will operate from position 1 and airport buses will shift operation from position 4 to now operate exclusively at position 3.

4.2.3.2. Central Station coach terminal

Existing situation

The Central Station bus coach terminal currently operates with 18 bays in three main areas; along the eastern side of Pitt Street, along the southern side of Eddy Avenue, and on a narrow island amid Eddy Avenue as illustrated in Figure 4-6. Coaches currently stop away from the kerb in existing bays adjacent to the walkway on Pitt Street and Eddy Avenue, to allow for luggage doors to open. The terminal is accessible from the Pitt Street and Eddy Avenue intersection, and the Elizabeth Street, Eddy Avenue, and Chalmers Street intersection.

Figure 4-6: Current Coach Facilities at Central Station[101]



Forecast growth and requirements

The Coach Terminal study undertaken in 2010 by MR Cagney as commissioned by Transport for NSW estimated current operational requirement at 7 bays with no time restrictions, and 6 bays with time restrictions. Allowing for future growth increases the number of bays to 9 and 8 bays without or with time restrictions respectively.

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[101] McCormick Rankin Cagney, *Sydney Coach Terminal Scoping Study,* 2010

Light Rail design - Central precinct

The recommended design option for light rail on Eddy Avenue includes three light rail tracks on the southern side of Eddy Avenue and a 45 metre turn back track to allow light rail services to efficiently turn back for services to Moore Park.

Impacts of Light Rail Operations

With the introduction of light rail there will be loss of existing coach parking, although this will be mitigated by a proposed 4.5 metre wide dedicated island coach platform that allows for up to four coaches to load in indented bays. This platform would be accessible from existing traffic lanes, and the existing six traffic lanes would be retained as current.

Operations of light rail on Eddy Avenue would require reducing the number of bays to 8, which meets the medium term requirement of 8-9 bays to accommodate for growth.

Mitigation strategies for layover facility

To accommodate for demand increases, bays would only be used for active passenger pick up and set down (not layover), while layover facilities are required in alternative locations. The MR Cagney 2010 study discussed options for relocation of the current coach terminal. This study provides insights into possible locations for layover facilities should the need arise, with the locations to be discussed with coach operators to determine suitability.

Central Station Western Forecourt

The Western Forecourt is situated along Pitt Street adjacent to the Western entrance to Central Station. The northern section of the forecourt is currently used for parking, passenger set-down, and a taxi rank, while the southern section is used mainly for parking, and temporary bus stops for rail-replacement services.

This location would be possible for a layover facility due to its proximity to the coach terminal, however would require minor surface levelling for safe vehicle movement and agreement with Sydney Trains to confirm available space and impact on current uses.

Chalmers Street

For short term layover, a site has also been identified on Chalmers Street adjacent to Prince Alfred Park. The western kerb side lane could only be used outside of peak periods as it is zoned as a Bus Lane for regular route buses during the AM and PM peak periods. Longer-term layover would not be appropriate in this location and alternative sites outside the CBD or at the King Street coach layover facility should be utilised.

5. Road Network, Traffic and Access

5.1. Context

A light rail system, by its nature, needs to be designed into the road network and requires the detailed consideration of all surface transport modes. This integration of light rail within the urban road environment requires a reallocation of road space from other uses which includes parking/loading (see Section 6 for further detail), general traffic lanes and bus only lanes. In this context a balance needs to be achieved between offering a fast, reliable light rail service while minimising any adverse effects.

Ultimately the objective of the light rail project is to maximise the level of passenger carrying capacity along the corridor and ensure a superior customer experience that encourages mode shift from private vehicles.

The introduction of light rail and the pedestrianisation of George Street will fundamentally alter the nature of the corridor with a shift in priority from private vehicles to public transport, walking and other sustainable travel modes. In doing so it will generate significant benefits including improved journey times, greater reliability and amenity, and reduced environmental impacts such as greenhouse gas emissions. It will however require changes to the existing road network, traffic and access arrangements which could potentially have a negative impact on some users of the system, particularly general traffic. It will also require changes in travel behaviour as people adjust to the new network.

The proposed changes to the existing road network, traffic and access operating arrangements that are required to accommodate the introduction of light rail have been developed with an overarching objective to maximise transport system performance and deliver the best outcome for the community as a whole. The Traffic and Transport Management Framework, as illustrated previously in Figure 1-3, guided the development of these changes. It ensured that, wherever possible, negative impacts were either avoided or mitigated, or in cases where this was not possible, alternative arrangements were developed to ensure that the community will continue to have appropriate access to the transport system.

Safety for all road users is important. It has been given a high priority in the scheme design and development of mitigation measures. A Road Safety Audit has been undertaken to review the safety of the Project.

The proposed changes to the road network and alternative operating arrangements are discussed below in Section 5.3, with an assessment of the future road network performance outlined in Section 5.5.

5.2. Road network strategy development principles

Principles were defined to guide the development of the future road network strategy. The principles were designed to ensure that, in specifying the road network, the overall objective of maintaining safety for all users, maximising transport system performance and usage, and successfully integrating the light rail network with the road network, was upheld. The key principles are outlined below:

- Consolidation of right turn movements across the alignment which would only be permitted at signalised intersections. This provides light rail reliability benefits as well as traffic capacity and safety improvements by minimising uncontrolled conflicting vehicle movements;

– However some exceptions would apply on George Street for local property access.

- Balancing the future needs of the various transport modes within the limited cross sectional road space available;
- Providing signal controlled pedestrian crossing access to stops. This ensures less mobile passengers or those with a disability are given audible and visual invitations to cross traffic under full signal protection;
- Providing high quality interchange functionality with sufficient capacity for future operations;
- Minimising traffic capacity reduction;
- Providing sufficient capacity on footways and crossing points to accommodate the growth in pedestrian traffic (particularly around light rail stops);
- Providing bus lanes where bus volumes are such that bus priority measures are warranted; Retaining all current property accesses on the corridor, although time or movement restrictions may be applied in specific locations.

5.3. LRV Road Network Integration

An essential feature of the CSELR is the operation of Light Rail Vehicles (LRVs) within the road network. The safe interaction of LRVs with other road users has been a major consideration of the development to date. Furthermore, this interaction influences the overall journey time and service reliability.

A key feature of the CSELR is that, for the majority of the proposed route, LRVs will operate within an exclusive right of way. This provides an operating environment that is both safe and free from the adverse effects of road congestion. However, at intersections and at a limited number of other locations, LRVs will share the right of way with other road users.

It is proposed that LRVs will progress through intersections under signal control. Traffic signals will be designed to detect the approach of an LRV in sufficient time to activate a (“call”) green signal for the LRV as it approaches the intersection. The traffic light controller would ensure that other conflicting movements (i.e. cross roads and pedestrian crossings) face red or stop signals. The design intent is for LRVs to be able to proceed through all intersections with minimal delay.

However, the design of each intersection will have regard to all road users and the overall performance of the transport network. The Sydney Coordinated Adaptive Traffic System (SCATS) is designed to ensure the operation of each intersection achieves the optimal performance for the network as a whole. The road network management system will be expanded in future to accommodate LRV operation as well.

In practice, LRVs are expected to experience small delays at some intersections depending on the direction of travel and the time of day. This is due to the need to maintain effective signal coordination for the road network. Estimates of these delays to LRVs have been factored into the proposed light rail journey time forecasts. The amount of delay will depend on the final design of the intersections and traffic light control system which will be completed during the detailed design phase of the project.

There are limited locations where LRVs will operate in a shared environment, as described below:

- LRVs will share the existing (modified) busway from Anzac Parade to Doncaster Avenue
- Buses will share the LRV right of way from the Kingsford terminus through to UNSW
- Right turning vehicles will also be permitted to share the LRV right of way in High Streeet at Botany Street.

In each case these arrangements are proposed to avoid increasing the land required for the project and to avoid unreasonable impacts on other road users.

5.4. Future road network and access

Light rail will be integrated within the surface street environment and as such requires a number of significant changes to the way in which the road network operates and is designed. The key functional changes and high level operational characteristics are detailed below by precinct.

5.4.1. CBD precinct

The functional characteristics of the CBD precinct are shown in Figure 5-1 and Figure 5-2 with additional detail provided in the following sections.

Figure 5-1: CBD North proposed functional Characteristics

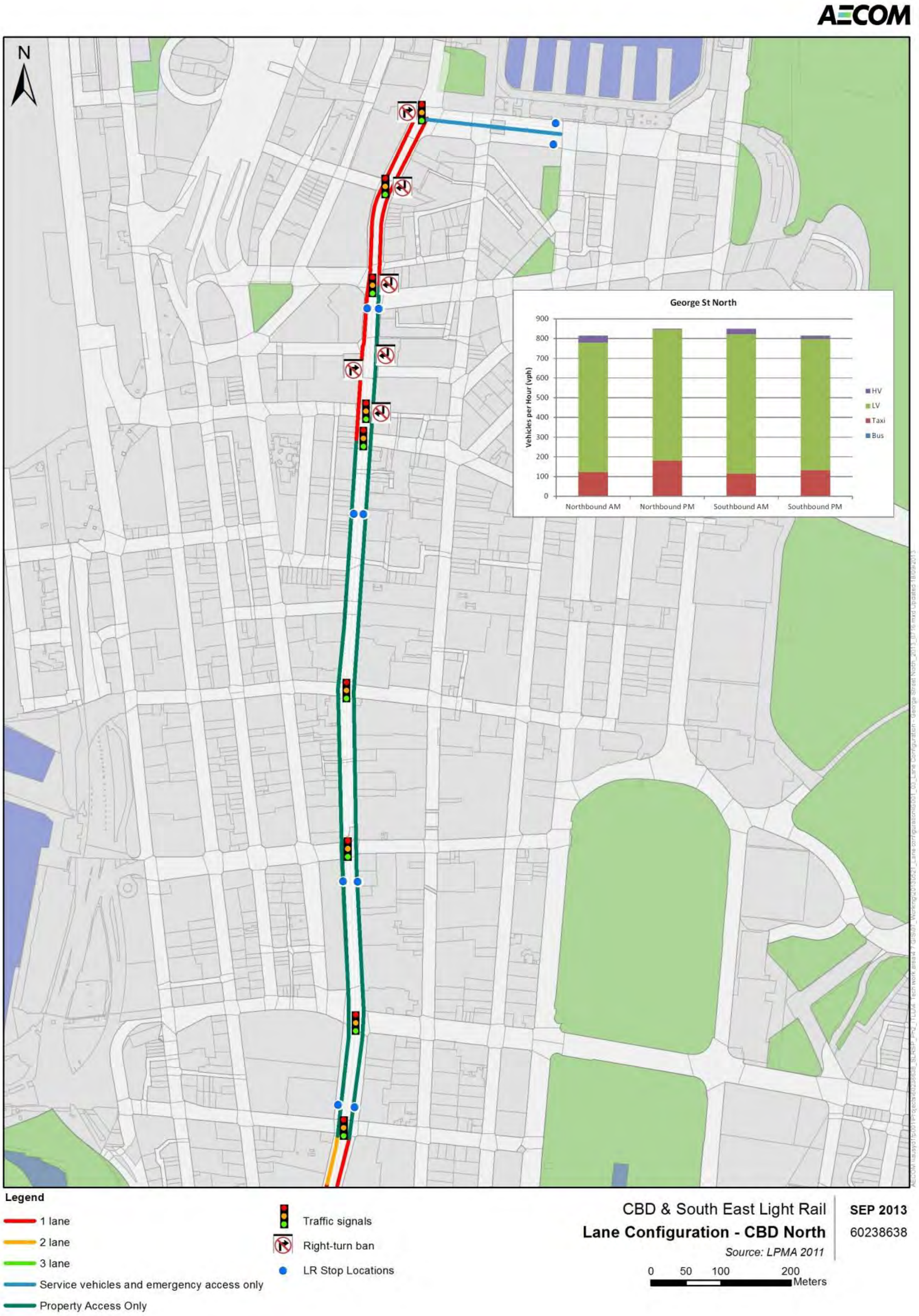
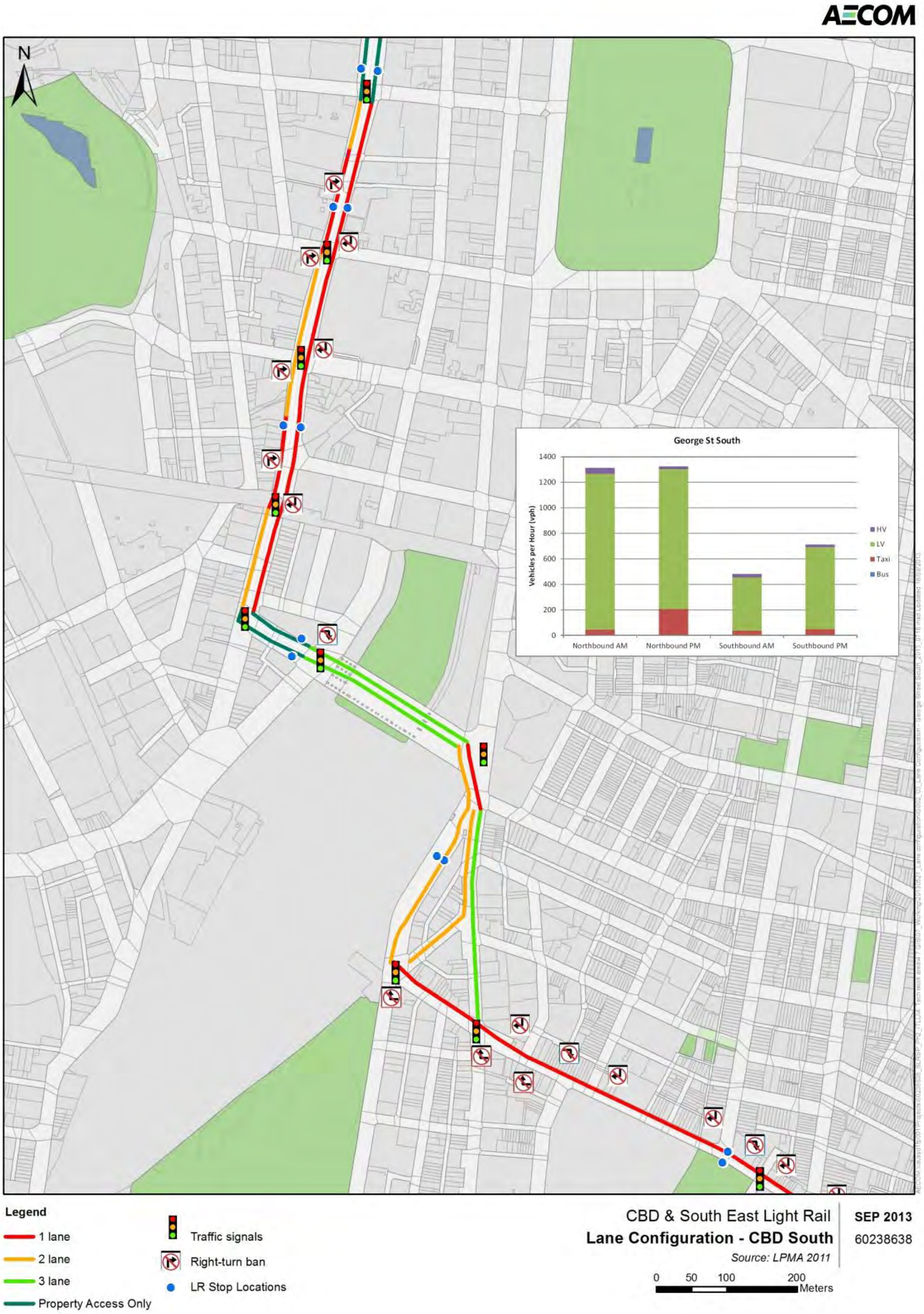


Figure 5-2: CBD South proposed functional characteristics



5.4.1.1. George Street

As outlined previously, George Street forms the north–south spine for light rail through the CBD. Significant changes to the functional characteristics of George Street will be required to accommodate light rail. A major change will be the pedestrianisation of George Street between Hunter and Bathurst Streets and at Alfred Street. The functional changes along George Street both outside and within the pedestrianised zones are outlined below, along with the functional changes associated with complimentary works on Pitt and Hunter Streets.

Functional changes

Outside the pedestrianised zones

Outside of the pedestrianised zone, the standard George Street cross section will consist of a single kerbside traffic lane in each direction with centre running light rail. The reallocation of existing traffic lanes to dedicated light rail running will serve to reduce the importance of George Street as a route for through running traffic.

Where cross sectional width permits, additional traffic lanes will be provided, particularly on the approach to intersections to ensure turning vehicles do not unnecessarily delay through traffic. Those locations that deviate from the single traffic lane cross sections are detailed below:

- Between Rawson Place and Hay Street two northbound and a single southbound traffic lane will be provided;
- North of the Chinatown stop to Liverpool Street will operate with two northbound lanes;
- The northbound approach to Bathurst Street will operate with two right turn lanes; and
- Between Hunter and Grosvenor Streets a single northbound lane and no southbound lane will be provided. This is due to the limited cross sectional width being unable to accommodate two-way traffic movements past the Grosvenor Street stop.

Within the pedestrianised zones

On George Street between Bathurst and Hunter Streets a pedestrian and vehicle shared zone is proposed adjacent to the Light Rail corridor. This shared zone allows vehicles to utilise an area of the pedestrianised zone to travel down the side of the light rail corridor (at a maximum speed of 10km/hr) to access driveways and loading areas where vehicles can park to service properties on either side of George Street.

Where the shared zone is adjacent to building entrances and street furniture, urban design would be used to guide vehicles away from pedestrian conflict points to maintain safe sight distances.

At signalised intersections and stop lines, queuing and turning movements will be controlled. Signposting and traffic restrictions would be determined by the relevant road authority and could be flexible depending on policy. Vehicles could be discouraged from travelling further than one block by signposting.

Vehicle restrictions will ensure only local access, service and emergency vehicles are permitted. The detailed streetscape design of George Street should include defined areas for pedestrians and light rail vehicles through visual cues, such as changing pavement types. This is important to provide a safe environment for all road users. Signalised pedestrian crossing facilities will be provided on all arms of existing signalised intersections to provide controlled crossing points of the light rail alignment. This provides protection and improved amenity and accessibility for visually, hearing or mobility impaired pedestrians.

Pitt and Hunter Streets complementary works

As a result of the pedestrianisation of Alfred Street, access to properties along the northern section of Pitt Street between Hunter Street and Alfred Street would be via Loftus Street and the narrow laneway of Reiby Place. To improve access from the west and reduce the total traffic volumes on Reiby Place, which has a substandard footpath and is used by pedestrians connecting through to Circular Quay station, alternative access is required.

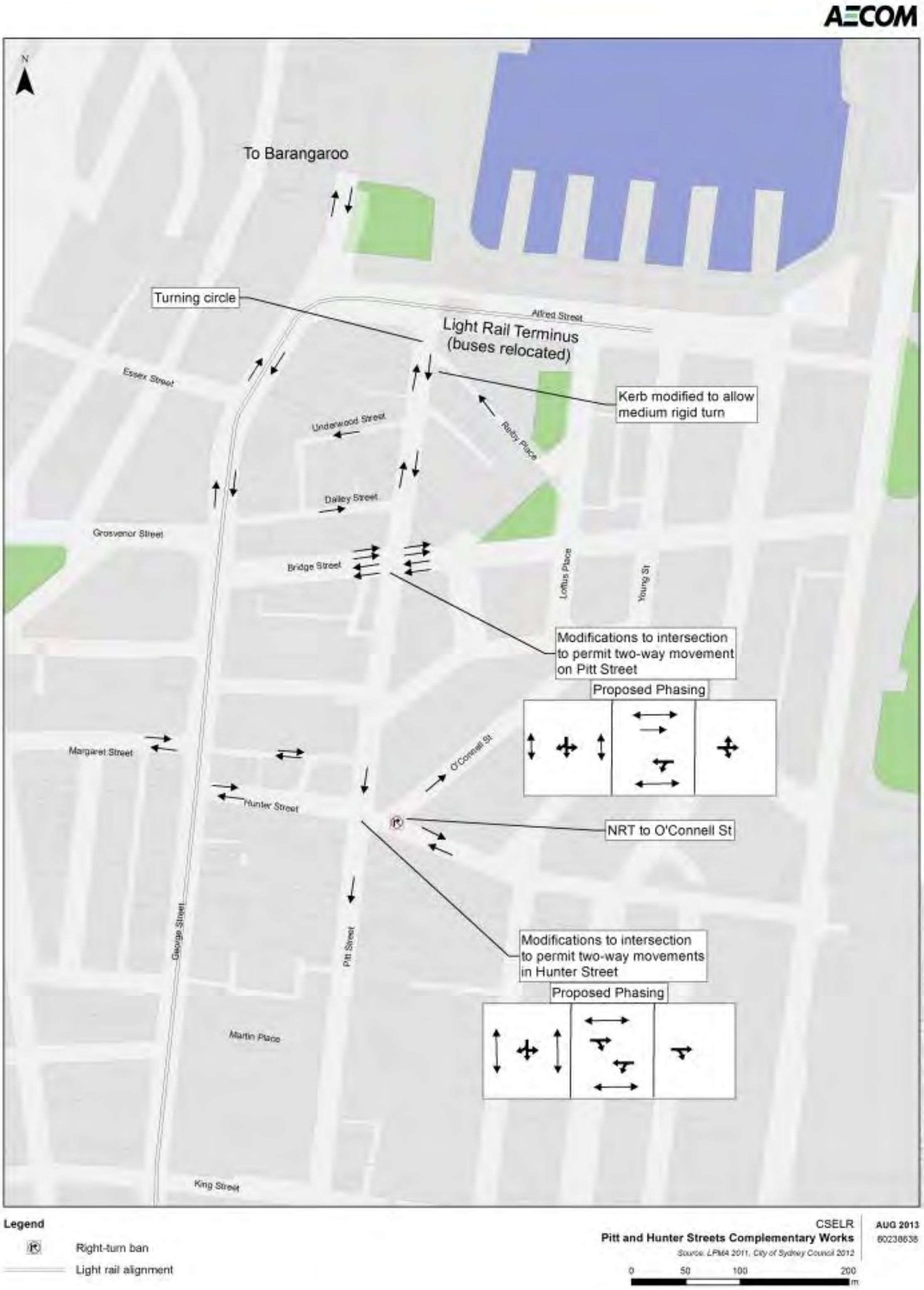
This can be achieved through conversion of Pitt Street to two-way operation between Alfred Street and Bridge Street as shown in Figure 5-3. Introduction of a northbound traffic lane in Pitt Street will enable direct property access to the northern end of Pitt Street. It will require the following changes to traffic operations:

- Provision of a turning circle at the northern terminus of Pitt Street;
- A reduction in a southbound traffic lane; and
- Modification of traffic signals at the Pitt Street / Bridge Street intersection (Refer to Figure 5-3).

Hunter Street is also proposed to be converted from one-way operation (westbound) to two-way operation between Pitt Street and George Street. This will provide enhanced traffic connectivity to the east and west via the dogleg movement between Hunter and Margaret Streets.

Hunter Street is currently four lanes wide on approach to George Street, but with future pedestrianisation south of Hunter and a single traffic lane north of Hunter, only one of these four available lanes will be required. Two-way operation of Hunter Street would therefore maximise the utilisation of road space, whilst still providing an enhanced pedestrian environment and the opportunity to provide loading/parking on Hunter to offset losses to this type of kerbside activity along George Street.

Figure 5-3: CBD North Traffic Proposed Management Changes



Proposed network characteristics

An outline of the effects the proposed functional changes along George Street will have on road network uses is provided in Table 5-1. In summary the functional changes along George Street, required to accommodate light rail, will place some restrictions on general traffic movements, require a re-allocation of bus services and result in a reduction in parking spaces, loading/unloading bays and taxi zones. It will however create an enhanced pedestrian environment and increase passenger capacity on the corridor.

Table 5-1: George Street - Potential Road Network Characteristics

Use	Future network characteristics
General traffic	General traffic movements will be significantly restricted through road closures, banned turning movements and implementation of the pedestrianisation. Key changes are being investigated and may include: ▪ The closure of Alfred Street between Pitt Street and George Street. ▪ Pedestrianised zone between Hunter Street and Bathurst Street with local and emergency access via a shared traffic and pedestrian area. ▪ Banned right turn movement from George Street into Essex Street. ▪ Removal of southbound traffic between Bridge Street and Hunter Street due to the enhancement of footpath along the eastern kerb. ▪ Establish two-way movement along Pitt Street between Hunter Street and Alfred Street to improve connectivity. (Parking and loading zones to be retained). ▪ Reverse the operation of O'Connell Street to improve the intersection performance at Hunter and Pitt Street. ▪ Central Street traffic flow reversal to one-way eastbound with access from George Street left-in only. ▪ Wilmot Street traffic flow reversal to one-way westbound to George Street with left-out only. Two-way operation from middle of Wilmot Street to Pitt Street.
Bus services	With the introduction of light rail along George Street the existing bus services will be relocated in accordance with the city centre bus network redesign. The majority of north-south services are transferred to the Elizabeth Street / Castlereagh Street corridor.
Property accesses	All existing property accesses along George Street would be maintained during the operational phase of the CSELR proposal; however, certain turning restrictions are likely to apply. These would be developed and implemented by the relevant road authority and could include: ▪ Access restrictions implemented by the City of Sydney to provide for appropriate safety and amenity for pedestrians. These measures would be determined by City of Sydney, in consultation with Transport for NSW. ▪ Limitations on driveway access along the proposed CSELR corridor to left-in left-out only, where feasible.
On-street parking	The central running light rail alignment and pedestrianisation zone between Bathurst Street and Hunter Street removes the opportunity to provide extensive parking along George Street with the only potential being for off-peak parking along the western kerb of George Street between Rawson Place and Pitt Street.
Loading/ unloading spaces	To accommodate light rail, the existing provision of loading zones along the George Street will not be retained. Outside of the pedestrianised zone, the constrained George Street cross-section at most provides a single through traffic lane in each direction. Network changes to George Street intersections provides an opportunity to mitigate the impacts by relocating loading zones to the additional kerb provided at the cross streets .e.g.: turn bays no longer required. The current design allows for the loading zones to be relocated adjacent to the following intersections: ▪ Essex Street ▪ Bridge Street ▪ Jamison Street ▪ Margaret Street ▪ Hunter Street ▪ King Street ▪ Market Street ▪ Bathurst Street ▪ Liverpool Street ▪ Ultimo Road

Use	Future network characteristics
Pedestrian access	The pedestrian environment along George Street will transform with the introduction of light rail. The pedestrianisation between Hunter Street and Bathurst Street improves connectivity by removing conflicts and barriers to pedestrian movements. The following summarise the key pedestrian improvements with the introduction of light rail: ▪ Pedestrianisation of George Street between Hunter Street and Bathurst St. ▪ Widening of footpath along the eastern kerb between Bridge St and Hunter St. ▪ Widening of footpath along the eastern kerb between Liverpool Street and Bathurst Street. ▪ Significant reduction in general traffic along George Street currently in conflict with pedestrians. ▪ Opportunity to reduce pedestrian crossing distances at signalised intersections along George Street.
Cyclist access	▪ George Street would no longer be promoted as a bicycle route, with cyclists being directed to alternative existing north-south corridors such as Pitt Street, Castlereagh Street and York Street. ▪ Existing City of Sydney bicycle routes crossing George Street would be maintained ▪ The CSELR proposal presents an opportunity to provide additional priority to east west cycle movements crossing George Street.
Taxis zone	The affected taxi zones along George Street could potentially be relocated to: ▪ George Street, eastern kerb on approach to the Alfred Street intersection. ▪ Bridge Street, northern kerb on the western side of George Street. ▪ George Street, western kerb on approach to Rawson Place intersection. Locations to be confirmed based on the SSCAS.
Tourist coach buses	The operation of tourist coaches along George Street would not be precluded with the introduction of light rail. However, no coaches will be permitted within the pedestrianised zone of George Street.

5.4.1.2. Rawson Place

Functional changes

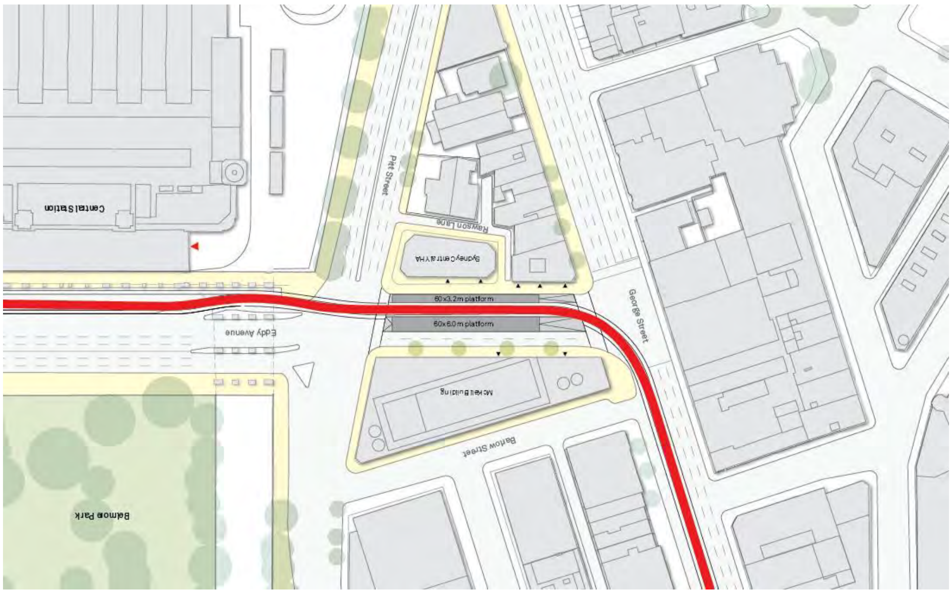
With the implementation of light rail on George Street and the city centre bus network redesign, Rawson Place will become a major interchange for bus and light rail passengers (Figure 5-4). To facilitate efficient bus and light rail movements Rawson Place will only accommodate bus (westbound only) and light rail. As such, the functional changes to Rawson Place have been designed to complement the city centre bus network redesign and to provide the required bus stopping and turn around capacity required to operate reliable bus services to the CBD. Existing local traffic that uses Rawson Place will be diverted via Pitt and Barlow Streets, whilst through traffic is likely to divert via alternative corridors such as Elizabeth and Goulburn Streets.

Buses will be provided with a bus stopping lane adjacent to the light rail platform (i.e. provides cross platform interchange) and an additional passing lane to the north. Traffic signals at the eastern end of Rawson Place will provide controlled access for turning buses into Rawson Place from Pitt Street and Eddy Avenue. At the western end of Rawson Place traffic signals will permit buses to turn left into George Street and across the light rail alignment. Both sets of traffic signals will provide convenient pedestrian access to Rawson Place and across George and Pitt Streets.

Due to the volume of bus services in this precinct, additional stops for city bound bus services will be provided on the western side of Pitt Street just north and south of Rawson Place. These stop locations enable bus passengers to transfer to light rail without crossing any traffic movements.

Eddy Avenue cannot be used by the bus routes that are stopping adjacent to, or at, Rawson Place as it is not possible to turn right from Pitt St into Eddy Ave from the kerbside lane or north of Rawson Place. This is consistent with the city centre bus network redesign.

Figure 5-4: Light rail alignment along Rawson Place corridor



Proposed network characteristics

An outline of the effects the proposed functional changes along Rawson Place will have on road network uses is provided in Table 5-2. In summary, whilst the functional changes required along Rawson Place to accommodate light rail would displace general traffic, it will facilitate efficient bus and light rail operations and interchange.

Table 5-2: Rawson Place - Potential Road Network Impacts

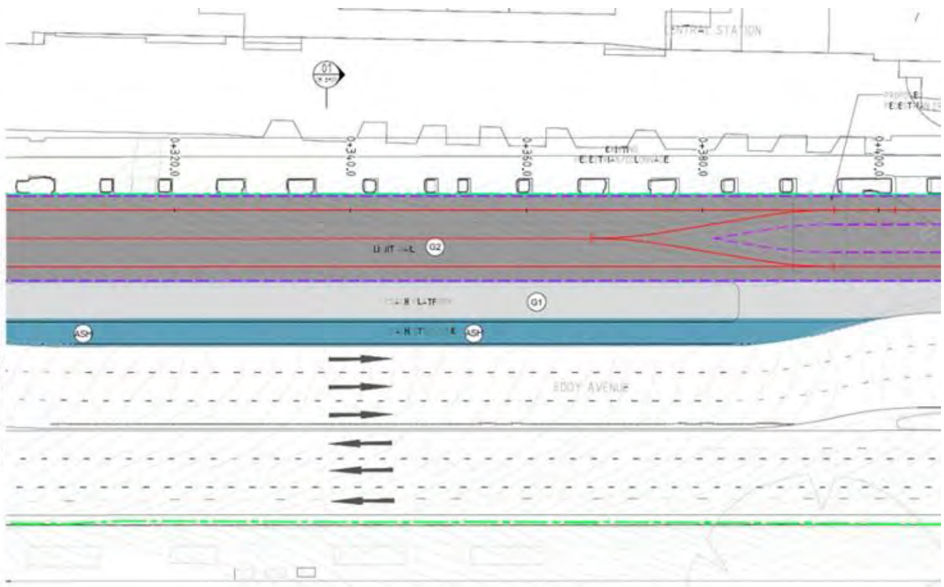
Use	Future network characteristics
General traffic	The key changes to general traffic operation in the vicinity of Rawson Place include: ▪ No general traffic access to Rawson Place. ▪ Introduction of right turn movement from Eddy Avenue to Pitt Street. ▪ To accommodate light rail and bus interchange, Rawson Ln between Rawson Place and Pitt St will be closed to general traffic.
Buses	With the introduction of light rail along George St the existing bus services will be relocated in accordance with the city centre bus network redesign. The future changes to the bus services include: ▪ City bound bus services currently using George St will be rerouted to Pitt St and Elizabeth St. ▪ Out bound bus service will be rerouted via Pitt St and Rawson Pl. ▪ Major interchange between bus and light rail at the Rawson Pl.
Property access	Access to Rawson Lane from Rawson Place would not be possible due to the light rail stop location. It has been observed that current service vehicles are able to turn around within the lane way.
On-street parking	The closure of Rawson Pl necessitates the removal of short stay parking and loading zones along Rawson Pl. However, opportunities to relocate the loading zones include: ▪ Pitt St, south of Eddy Avenue ▪ Barlow St, east of George St ▪ George St, south of Rawson Pl

5.4.1.3. Eddy Avenue

Light rail will occupy the southern side of Eddy Avenue, utilising the existing bus only lanes through the southernmost arch of the rail bridge. The light rail alignment will occupy the current kerbside coach stops, which will be relocated between the light rail and traffic lanes (Figure 5-5). A dedicated 4.5m wide island coach platform will be accessed from the existing Eddy Avenue traffic lanes, with retention of the existing 6 traffic lanes (three in each direction). By relocating coaches away from the kerb, any conflict between coach and light rail vehicle movements will be removed. A turn back track will be accommodated alongside the colonnade to optimise operations and enable light rail vehicles to turn back during special events and short running of services.

Pedestrian access to the coach station island platform will be provided via the existing Eddy Square pedestrian crossing at the eastern end and a new crossing at the western end will allow pedestrian movement between the existing coach booking office and the coach platform. The 4.5m wide coach platform complies with all Disability Standards for Accessible Public Transport (DSAPT). Excluding seating and platform furniture, the island platform will have 3700mm clear width which also allows for coach luggage loading / unloading and represents an improvement over current space available.

Figure 5-5: Light rail alignment along Eddy Avenue corridor[102]



Proposed network characteristics

An outline of the effects the proposed functional changes along Eddy Avenue will have on road network uses is provided in Table 5-3. In summary, the functional changes required to accommodate light rail will require the relocation of coach bus services from the southern kerb of Eddy Avenue.

Table 5-3: Eddy Avenue - Potential Road Network Future Network Characteristics

Use	Future network characteristics
General traffic	Reconfiguration of Eddy Ave intersections to cater for the introduction of light rail. The key changes include: Pitt St – The through movement from Eddy Ave into Rawson Pl will be no longer permitted due to the closure of Rawson Pl to general traffic. – Introduce right turn movement from Eddy Ave into Pitt St. Elizabeth St – Reconfigure the Chalmers St approach to permit bus and left turn Eddy avenue movements only, with the northbound through movement directed to the proposed two way movement on Elizabeth St via Randle St.

[102] Transport for NSW, *Draft Design Drawings (Unpublished), 2013*

Use	Future network characteristics
Coach/buses/ light rail	The proposed light rail alignment along Eddy Ave utilises the space along the southern kerb currently used by coach services. – Coach operations no longer permitted on the southern kerb of Eddy Ave within segregated section. – Right turn bus only movement from Elizabeth St to the southern rail bridge arch no longer permitted. – Potential mitigation measures include an indented coach layover adjacent to the westbound traffic lanes.
Property access	Loading dock access on the southern side of Eddy Avenue will require management across the light rail alignment through time restricted access and/or audio visual warnings
On-street Parking/loading/ unloading	There are no parking / loading provisions available along this section. Therefore no impact.
Taxis	Light rail alignment along the southern kerb of Eddy Ave precludes the provision of taxi zones. However, potential to utilise space within the median separating the westbound traffic lanes and light rail alignment for taxi zone.
Pedestrian access	Eddy Avenue will continue to provide a major pedestrian connection for the transfers between Sydney Trains, NSW Trains and bus services, in particular during special event modes. However, with the introduction of light rail the major passenger interchange is expected to be undertaken at the Central Station light rail stop on Chalmers St.

5.4.1.4. Chalmers and Elizabeth Streets

Chalmers Street will become the major interchange between light rail and heavy rail at Central Station. The functional changes required to accommodate light rail along Chalmers Street are discussed below.

Functional changes

The light rail stop will be located on the western side of Chalmers Street, which will reduce the number of lanes available to buses and general traffic (as illustrated in Figure 5-6). The design shown requires a potential realignment and reconfiguration of the traffic lanes in the Chalmers Street precinct to assist with the introduction of the light rail interchange. Three platform faces will be provided, with the eastern most track and platform face only being utilised during special event operations. This provides additional capacity to enable a light rail shuttle service with 90m vehicles to operate between Moore Park and Central.

Outside of special event operations the easternmost track would operate as a bus lane to provide bus priority during most times of the day and maximise usage of the available road space. A 45m northbound bus stop would be integrated with the northern end of the light rail stop to provide convenient interchange between bus and light rail. During special events, this bus stop would not be available for regular bus services.

The existing bus stop in Chalmers Street near Devonshire Street will also be retained. This stop would be used during special events, and would be the boarding location for passengers previously using the Chalmers Street near Eddy Avenue stop.

To offset the reduction in northbound traffic lanes within Chalmers Street, Randle Street will be reversed from one-way southbound to one-way northbound. Two northbound traffic lanes will be provided which will continue into Elizabeth Street (which currently operates as southbound only). Provision of two northbound traffic lanes could be provided in Elizabeth with the loss of only one southbound lane through kerb and lane adjustments.

The above traffic operations in Chalmers, Elizabeth and Randle Streets will require advance signage on approach to the newly signalised Chalmers Street / Randle Street / Devonshire Street intersection to direct drivers to Elizabeth Street via Randle Street. Signalisation of the Chalmers Street, Elizabeth Street and Randle Street intersection is required to manage light rail, traffic and pedestrian movements, whilst providing improved pedestrian access to Central Station and light rail transport hubs.

Due to the two way movements in Elizabeth Street, direct access to Randle Lane from the north will not be possible, but will be maintained via Rutland, Chalmers and Randle Streets.

Figure 5-6: Proposed light rail alignment along Chalmers Street corridor[103]

These modifications to the precinct's operation will require a change to the existing parking provisions which are detailed in Section 6 of this report.

Impact on cycle routes

The City of Sydney currently designates Chalmers Street as both an on-road and off-road cycle route. The on-road cycle route is northbound only, between Devonshire Street and Elizabeth Street. The two-way off-road cycle route is located on the western side of Chalmers Street. A signalised pedestrian crossing on Eddy Avenue connects the off-road cycle route with Belmore Park, providing an important link between the CBD and the city's inner south.

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[103] Transport for NSW, 2013

The current location of the off-road cycle route would act as an impediment for customers trying to interchange between heavy and light rail at the Central Station stop. Consequently Transport for NSW proposes realigning the cycle route to segregate cyclists from pedestrians. The new alignment would link with the signalised pedestrian crossing on Eddy Avenue, maintaining the important north-south link between Belmore Park and Prince Alfred Park.

Proposed network characteristics

An outline of the effects the proposed functional changes along Chalmers Elizabeth Street will have on road network uses is provided in Table 5-4. In summary, whist the introduction of light rail will displace general traffic movements, measures such as alternative arrangements along Randle Street have been proposed to mitigate and impacts.

Table 5-4: Chalmers Street / Elizabeth Street Future network characteristics

Use	Future network characteristics
General traffic	Chalmers Street will continue to provide a general traffic connection to Elizabeth Street, however the key local network changes include: ▪ Introduce a signal control at the intersection of Chalmers St, Randle St and Devonshire St. ▪ Reverse the one-way operation of Randle St to eastbound only. ▪ Elizabeth St converted to two-way between Randle St and Chalmers St. ▪ All Chalmers St northbound through traffic diverted to Elizabeth St via Randle St. ▪ Only Elizabeth St buses to remain on Chalmers St north of Randle St intersection.
Buses	Under normal light rail operation, the bus only lanes will continue along Chalmers St, however during special event mode, the bus only lane will cease on approach to the Randle St intersection. The existing Elizabeth St southbound bus lane will remain unaffected by the proposed two way operation traffic operation north of Randle St.
Property access	The existing access to the Sydney Trains car park located opposite Devonshire Street will be integrated with the new traffic signals at this location.
On-street parking / loading / unloading	The location of the Central light rail stop on Chalmers St reduces the available carriageway width and precludes on-street parking north of Randle St. The existing provision of short and long stay parking available along Chalmers St south of Devonshire St will be retained.
Taxis	The existing taxi zones are located within the footprint of the Central light rail stop. Potential to relocate the taxi zone on Chalmers St south of Devonshire St.
Pedestrian access	Pedestrian activity along Chalmers Street is primarily associated with commuter traffic crossing Chalmers St at Devonshire St and Elizabeth Street to access the City Rail network. The proposed light rail alignment and local network changes ensure the existing and future pedestrian desire lines receive priority to cross Chalmers St.
Cyclists	Chalmers Street is currently identified as having both on and off-road cycle routes. Transport for NSW proposes realigning the off-road cycle route, segregating cyclists from pedestrians whilst maintaining the important north-south link between Belmore Park and Prince Alfred Park.

5.4.2. Surry Hills Precinct

The functional characteristics of the Surry Hills precinct are shown in Figure 5-6 and described in more detail in the following sections.

Figure 5-7: Surry Hills precinct proposed functional characteristics

5.4.2.1. Devonshire Street

The objective of the Devonshire Street functional changes has been to ensure safe, reliable and efficient light rail operation can occur, whilst maintaining necessary access for residents and businesses, including consideration of light rail operations during Special Event scenarios. A summary of these changes is provided below.

Functional Changes

The proposed functional changes to accommodate light rail along Devonshire Street alignment will include:

- A single eastbound traffic lane
- The existing right turn movements for vehicles travelling eastbound along Devonshire Street wishing to head south are consolidated to Elizabeth Street and Crown Street only
- Closure of a number connecting streets at the intersection of Devonshire Street, including:
  - Buckingham Street
  - Holt Street
  - Waterloo Street
  - High Holborn Street
  - Clisdell Street
- No provision for parking provided along Devonshire Street (see Section 6 for further detail regarding mitigation)
- Light rail alignment precludes access to the existing Langton Centre off-street car park at Parkham Place.

To mitigate the impacts to local access the following network changes are proposed to improve accessibility whilst maintaining the benefits to light rail operation:

- Signalise the intersection of Devonshire Street and Marlborough Street
- Signalise the intersection of Devonshire Street and Bourke Street
- Reinstate the Cooper Street connection to Riley Street to provide access for local residents
- Introduce a westbound service lane connection between Bourke Street and Crown Street.
- Provision of relocated Langton Centre off-street parking within the general vicinity of the clinic.

The proposed signal control at Marlborough Street and Bourke Street intersections will improve pedestrian access to the Ward Park stop, providing safe, efficient interchange to Crown Street buses and ensure light rail and traffic interactions are effectively managed.

The consolidation of direct access onto Devonshire Street reduces the potential for general traffic and light rail conflicts. The closure treatments will need to provide appropriate turnaround facilities or service road access to adjacent streets.

Uncontrolled priority intersections along Devonshire Street will be limited to left in / left out operation only. With the exception of Chalmers Lane, which will become one-way northbound with a right turn out onto Devonshire Street. Swept path turning assessments were undertaken at the side roads to identify potential impacts associated with the reduced cross section available to general traffic. The swept paths assessment identified the following:

- Kerb adjustments at Adelaide Place, Steel Street and Little Riley Street are required to provide light vehicle access to minor lanes without encroaching on the light rail alignment

- Service vehicles are capable of undertaking left in left out turning movements from the significant side road accesses, namely Elizabeth Street, Riley Street, Marlborough Street, Crown Street and Bourke Street
- Heavy Rigid Vehicles (12.5m) may potentially encroach onto the eastbound light rail alignment when entering or exiting side roads
- The provision of service lane connection on the southern side of Devonshire Street between Bourke Street and Crown Street will provide access for Nickson Street and Nickson Lane

As illustrated in Figure 5-8 the introduction of a service lane along the southern kerb of Devonshire Street between Bourke Street and Crown Street will ensure access to the side roads is maintained. The service road will permit left in left out movements from Nickson Lane and Nickson Street to be undertaken clear of the light rail alignment.

Figure 5-8: Light rail alignment along Devonshire Street corridor

The proposed light rail alignment along Devonshire Street does not have sufficient available width to accommodate a dedicated cycle facility. Chalmers Street to the west is already a challenging interface for cyclists and will become more so following the implementation of light rail. Alternative parallel cycle corridors with better gateway entries to the CBD have been assessed by RMS[104], and the preferred alternative is via Cooper Street and Arthur Street. Appropriate signposting would be required to direct cyclists from the crossing location at Devonshire Street and Bourke Street.

Pedestrians will benefit from improved amenity, particularly where streets are closed at their intersection with Devonshire Street as this presents an opportunity to increase footpath area.

During special events 90m light rail vehicles may be in operation between Central and Moore Park. To ensure traffic and pedestrians are not adversely affected by these larger vehicles waiting at traffic signals and blocking adjacent intersections, light rail priority will be in place along Devonshire Street. This will ensure that vehicles are detected on their approach to the Devonshire Street corridor and once they enter this section of the alignment they are given signal

[104] *Strategic concept study: Improved pedestrian and cyclist access between Central Railway Station and Moore Park, RMS, 2013*

priority through the signalised intersections. This will ensure that, where possible, light rail does not stop at any of the signalised intersections along Devonshire Street.

South Dowling Street and Eastern Distributor crossing

At the eastern end of the Devonshire Street alignment, light rail will cross South Dowling Street at grade, pass over the Eastern Distributer and enter Moore Park. The alignment will pass through the site currently occupied by Olivia Gardens. To manage light rail conflicts with pedestrian and traffic movements safely, signalised control of the South Dowling Street southbound and northbound traffic lanes will be provided. The bridge structure will provide pedestrian and cyclist access into Moore Park and will replace the existing pedestrian/cyclist bridge and associated crossings located adjacent to Parkham Street.

Assessment of the traffic capacity impacts of an at grade light rail crossing at the proposed location was conducted under standard operations and Special Event operations, when 90m vehicles may be utilised. Details of this analysis can be found in Section 5.5.2.

Impact on cycle routes

The City of Sydney currently designates Devonshire Street as an on-road cycle route. Devonshire Street will be limited to a single eastbound traffic lane with the introduction of light rail, reducing its capacity as a suitable cycle route. Consequently, the following east-west corridors were assessed to replace the Devonshire Street cycle route;

- Option one; Foveaux Street
- Option two; Arthur and Cooper Streets
- Option three; Cleveland Street

Through RMS' Central Railway Station to Moore Park Pedestrian Access Study[105], option one was found to be the steepest corridor and only operates in one direction (westbound). Option three was found to have high volumes of traffic and thus would result in an unpleasant cycling experience. Therefore option two has been determined as the most suitable replacement cycle route for Devonshire Street.

Arthur Street is already classified as an on-road cycle route by the City of Sydney. It connects Surry Hills to Moore Park via a pedestrian / cycle bridge over South Dowling Street. In order to make the new east-west corridor more legible for cyclists, Cooper Street would require pavement markings, paint and signage to function as an on-route cycle route. The Cooper Street / Elizabeth Street intersection would also need to be reconfigured to be safer for cyclists. Randle Street would provide access to Cooper Street from the south and west, with Elizabeth Street the northern connection.

The existing pedestrian and cycle crossing linking Arthur Street to Moore Park will be retained to provide a continuous cycle link between Moore Park and Central Station through Surry Hills.

Proposed network characteristics

An outline of the effects the proposed functional changes along Devonshire Street will have on the road network uses is provided in Table 5-5. In summary, the functional changes along Devonshire Street will displace general traffic, however pedestrians and public transport users will benefit from improved amenity and accessibility.

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105 Strategic concept study for improved pedestrian and cyclist access between Central Railway Station and Moore Park, SKM, Feb 2013

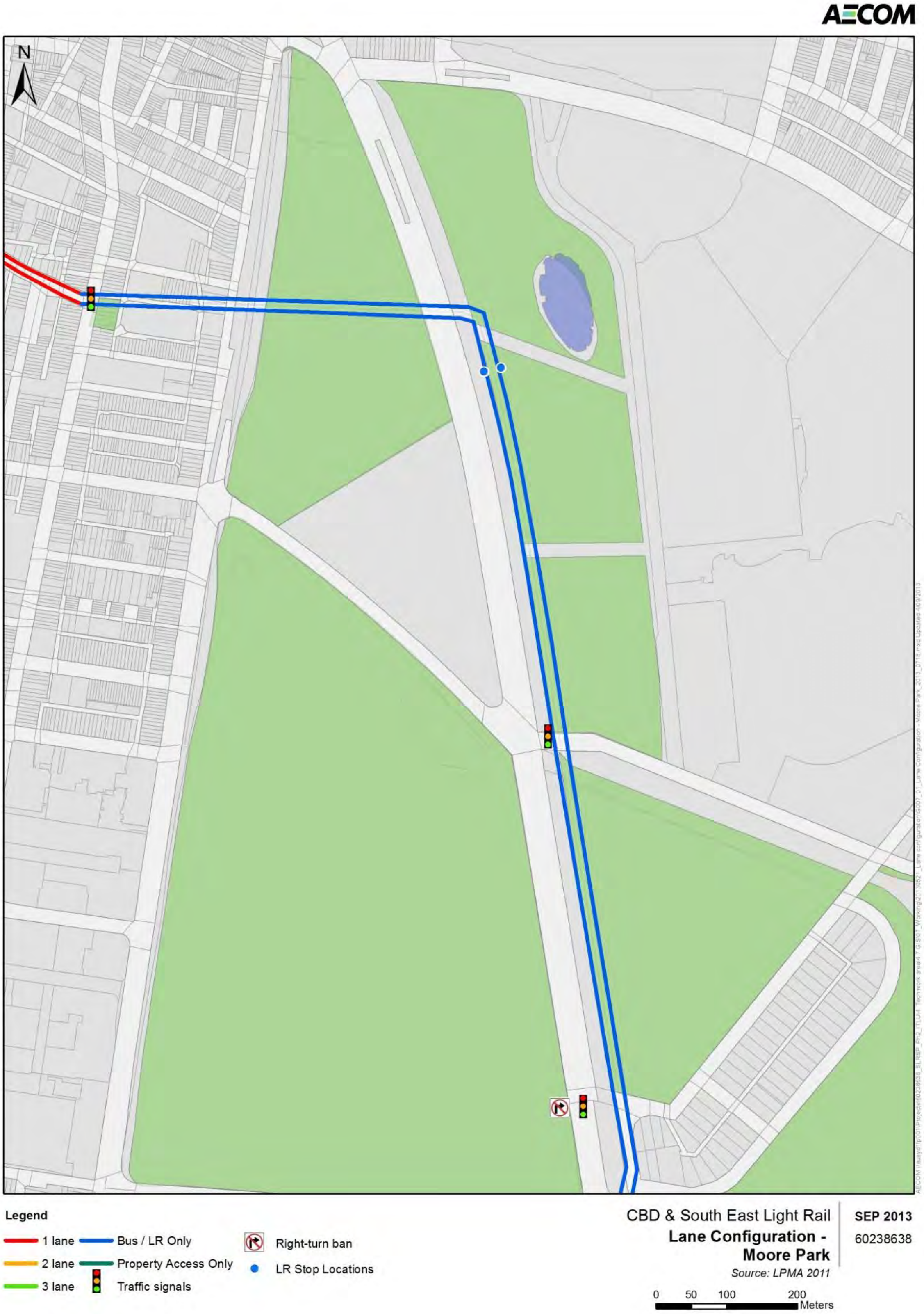
Table 5-5: Devonshire Street – Future network characteristics

Use	Future network characteristics
General traffic	With the introduction of light rail along Devonshire Street corridor the following provides a summary of the key impacts to general traffic: ▪ The Devonshire Street carriageway is limited to a single eastbound traffic lane between Chalmers Street and Bourke Street. ▪ Introduce one-way operation northbound along Chalmers Lane ▪ Close Buckingham Street access to Devonshire Street. ▪ Close Clisdell Street access to Devonshire Street ▪ Introduce signal control at Devonshire Street and Marlborough Street. ▪ Provide a westbound service lane connecting Bourke Street to Crown Street. ▪ Introduce signal control at Devonshire Street and Bourke Street.
Property accesses	Access to existing driveways along Devonshire Street will be limited to left in left out. The off-street parking provided within the existing Langton Centre may be replaced with a similar number of spaces within the vicinity of the clinic.
On-street Parking	With the introduction of light rail, the Devonshire Street carriageway is limited to a single eastbound traffic lane with no provision of on-street parking.
Loading / unloading	With the introduction of light rail, the Devonshire Street carriageway is limited to a single eastbound traffic lane with limited provision for loading.
Pedestrian access	The Devonshire Street corridor with light rail will continue to provide a strong east west pedestrian connection through Surry Hills.
Cyclist access	With the introduction of light rail, the Devonshire Street carriageway is limited to a single eastbound traffic lane. Cyclist access between Central Station and Moore Park would be provided via Cooper Street and Arthur Street. Bourke Street and Riley Street can both be emphasised as key north-south routes that connect with east-west routes, providing direct cyclist connections into the Sydney CBD.
Taxi zone	No taxi zones would be located along Devonshire Street

5.4.3. Moore Park precinct

The functional characteristics of the Moore Park precinct are shown in Figure 5-9 and described in more detail in the following sections.

Figure 5-9: Moore Park precinct proposed functional characteristics



Functional changes

The light rail alignment through Moore Park West will be in tunnel to minimise impact to the park and existing bike and pedestrian pathways. This tunnel will continue under Anzac Parade to the eastern side where Moore Park station will be located. The alignment will surface on the eastern side of the existing bus way, but will not impact on its operation. The existing bus loop used for special events will be relocated to the north.

As a result the only changes to Anzac Parade in this precinct will be at the intersection with Lang Road where the alignment running adjacent to the existing bus way will widen the intersection footprint as shown in Figure 5-10. This will result in a small increase to the intersection clearance times, and a corresponding reduction to intersection efficiency.

Figure 5-10: Lang Road intersection changes[106]

Proposed network characteristics

An outline of the effects the proposed functional changes in the Moore Park precinct will have on the road network users is provided in Table 5-6.

[106] *CSELR Draft Definition Design Report – Volume 3 – South East Corridor, 2013*

Table 5-6: Moore Park precinct – Future network characteristics

Use	Future network characteristics
General traffic	The only impact to general traffic in this precinct will be a small reduction in operational efficiency at the Lang Road intersection due to an increased footprint
Property accesses	No change to existing property accesses
Buses	No change to the existing busway, special event bus loop to be relocated to the north
On-street Parking	No change to existing parking provisions
Loading / unloading	No change to existing loading facilities
Pedestrian access	Existing pedestrian crossing facilities will be retained and additional signalised facilities provided for safe crossing of the at grade alignment
Cyclist access	Existing cycle facilities on both sides of Anzac Parade will be retained, with the western off-road cycle route running adjacent to the light rail corridor.
Taxi zone	No taxi zones would be located in the Moore Park precinct

5.4.4. Kingsford precinct

The functional characteristics of the Kingsford precinct are shown in Figure 5-11 and Figure 5-12 and described in more detail in the following sections.

Anzac Parade

Anzac Parade is a key arterial connection providing access between CBD and South East Sydney. The Anzac Parade corridor design has been developed to achieve maximum utilisation of the available corridor width, improve public transport reliability, accessibility and retain existing parking opportunities where possible. A summary of the proposed functional changes along Anzac Parade required to accommodate light rail are outlined below.

Figure 5-11: Anzac Parade (North) proposed functional characteristics

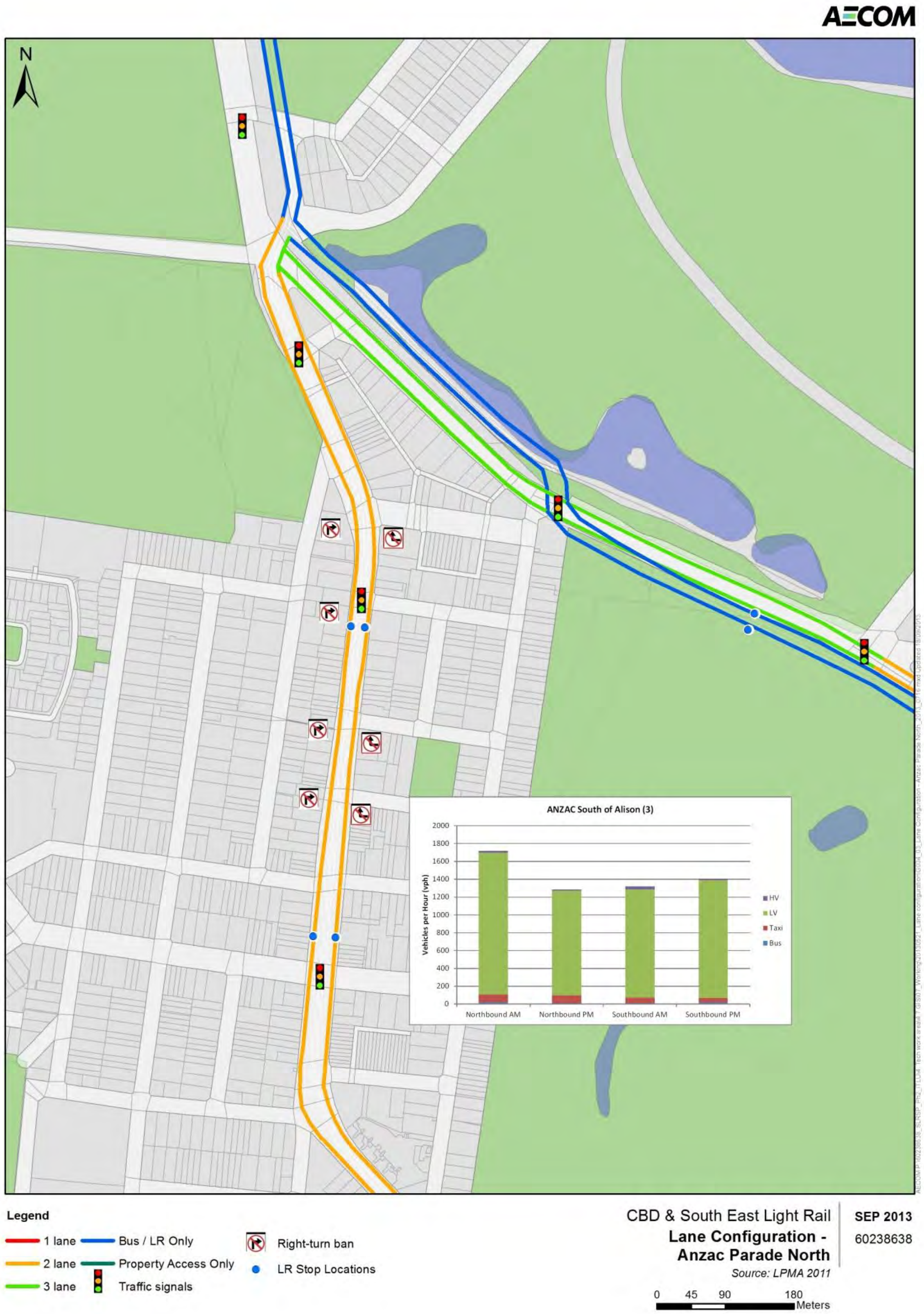
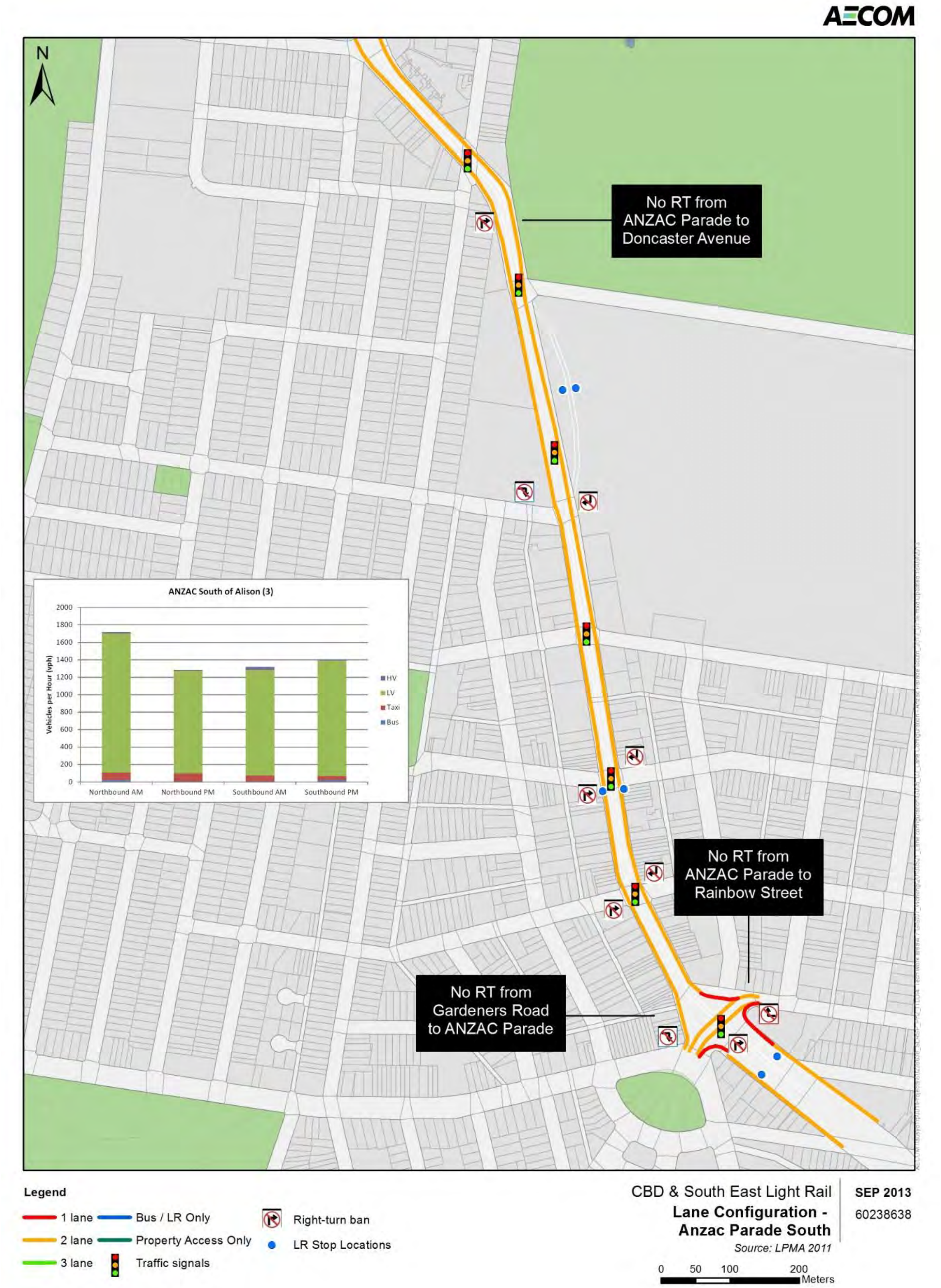


Figure 5-12: Anzac Parade (South) proposed functional characteristics



Functional changes

The key changes along Anzac Parade have been developed taking into consideration the constrained Anzac Parade cross section and the need to accommodate stops at strategic locations to service the residential catchments and other land uses in the area. The functional changes along Anzac Parade will include:

- Retention of a minimum of two traffic lanes along Anzac Parade in each direction. Where achievable an additional city-bound lane will be been provided which operates as a peak period bus only lane and off-peak parking
- 3.5m wide shared bus and light rail running lanes between the Kingsford interchange and Meeks Street for normal bus services. Includes an additional short bus only lane adjacent to the light rail track on approach to Meeks Street (southbound)
- A minimum 4.4m wide light rail island platform will be located along the middle of the corridor
- Right turn movements that provide access to Doncaster Avenue will be consolidated into a single right turn at Todman Avenue, as illustrated in Figure 5-13.
- The right turn from Anzac Parade into Day Avenue will be banned. This will require rerouting of bus services that currently make this manoeuvre. Pending further Council approval and investigation of impact to bike lanes this route will likely to be via Doncaster Avenue
- Right turn movements from Anzac Parade between Barker Street and Meeks Street will be consolidated into a single right turn at Barker Street, as illustrated in Figure 5-13.
- The existing signalised pedestrian crossing will be relocated to be adjacent to the Carlton Street stop.
- The existing Nineways roundabout intersection will be upgraded to signal control
- There will potentially be a need for physical separation between light rail and general traffic, particularly at locations where right turns off Anzac Parade were previously permitted but will be prohibited in the future
- An off-line UNSW Anzac Parade stop to cater for the large light rail travel demand to the University.

These measures aim to maximise utility of the available road space whilst ensuring light rail, bus and traffic operations are balanced as effectively as possible.

Due to the operation of light rail in the median, a reduction in existing right turn locations has been required south of Alison Road, however, the following right turns would be permitted in the future :

- Southbound right turn into Dacey Avenue;
- Southbound and northbound right turns into Todman Avenue;
- Northbound right turn into High Street;
- and Southbound and northbound right turn into Barker Street.

Figure 5-13 shows the permitted right turn provisions from Anzac Parade.

Figure 5-13: Proposed right-turning provisions from Anzac Parade

Anzac Parade / Alison Road intersection

To minimise traffic capacity reduction at the Anzac Parade / Alison Road intersection a two stage transition will be adopted to transfer the light rail alignment from the eastern side of Anzac Parade into the median, south of Alison Road. This two stage crossing will allow light rail to run concurrently with key traffic movements which will in turn provide a 20%-35% reduction in light rail delays at the intersection and an increase in traffic capacity of 5% when compared to a single transition through the intersection. The specific design details of this intersection and the transition are currently under review by RMS and the CSELR team.

Bus and Light Rail shared running

In order to maintain bus priority, an option for 'shared running' of bus and light rail has been explored. The design would allow for buses and light rail to share the same road space in the centre of Anzac Parade between Rainbow Street and the UNSW Mall. Shared running north of Meeks Street would only be made available to those express bus services proposed to be retained to minimise the operational impacts to light rail. This would equate to a total of 16-20 buses during the AM peak hour in 2021. It is anticipated that the retained express services would re-join the main traffic flow adjacent to the UNSW mall crossing and would do so during the dedicated light rail phase at this crossing point. Buses would not stop while undertaking shared running to avoid delays to CSELR.

Non-express services would exit the shared running alignment at the Meeks Street intersection via a bus only signal phase to allow them to access the kerbside bus stops along Anzac Parade.

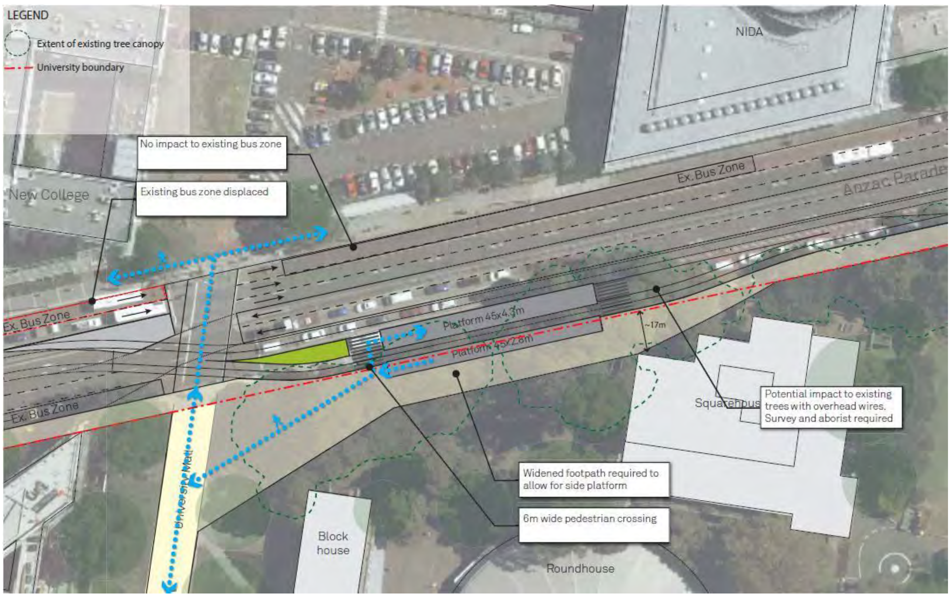
If they were to operate, PTPM model forecasts expect the Anzac Parade express bus services (X92, X94, X96, X97, and X99) to carry approximately 2,800 passengers in the AM peak hour[107], which is similar to the forecast light rail patronage at Kingsford. The need to efficient light rail operations at the same time as priority for these bus routes was therefore an important consideration for this corridor.

UNSW Anzac Parade Stop

UNSW Anzac Parade is one of the busiest stops along the alignment in terms of forecast boarding and alighting passengers. As such the stop design deviates from the centre alignment of Anzac Parade and interfaces directly with the campus on the eastern side, with the objective of creating a safe and direct access for students and staff, without the need to cross Anzac Parade in either direction. The use of University land to accommodate part of the stop infrastructure also provides an opportunity to minimise impacts to the existing road cross section.

[107] Transport for NSW, *Sydney Light Rail Round 5.1 Demand Report*, 2013

Figure 5-14: UNSW Anzac Parade Stop[108]



Proposed network characteristics

An outline of the effects the proposed functional changes along Anzac Parade will have on road network uses is provided in Table 5-7. In summary, the functional changes required to accommodate light rail will displace general traffic and reduce the level of parking and loading/unloading bays. No major impacts on cycle or pedestrian access are expected, pedestrian access could potentially improve, particularly during special events.

Table 5-7: Anzac Parade Future network characteristics

Use	Future network characteristics
General traffic	Anzac Parade will continue to provide the major arterial connection between the CBD and the South Eastern suburbs. The proposed alignment includes a combination of off-street, kerbside and centre running alignment aimed to minimise impact to the existing traffic network. The key impacts to general traffic are summarised below: ▪ The Anzac Parade corridor maintains a minimum two through general traffic lanes in each direction. ▪ City bound bus lane retained in the AM peak, except for adjacent to the Carlton St stop due to the limited cross sectional width. ▪ Redesign of the Anzac Pde /Alison Rd intersection to allow a two stage transition of the alignment from the eastern side to centre running. ▪ At-grade light rail crossing of Lang Rd adjacent to the existing bus-way. ▪ At-grade crossing of Alison Rd and Anzac Parade intersection ▪ Restrict Anzac Parade access to Abbotford St to Left-in Left-out. ▪ Relocate the northbound right turn movement from Anzac Parade into Doncaster Ave. further north to the intersection of Anzac Parade and Todman Ave. ▪ Restrict Anzac Parade access at Day Ave to Left-in Left-out at ▪ Consolidate right turn movements within Kingsford town centre to the Barker St and Anzac Parade intersection. ▪ Introduce signal control to the Kingsford 9-ways intersection. Consolidate signal phasing by prohibiting right turn movements from Rainbow St and Gardeners Rd into Anzac Parade.

[108] *Source: ERSUD, 2013*

Use	Future network characteristics
Buses	Introduction of light rail along the Anzac Parade corridor reduces the cross section available for general traffic and bus priority lanes, To mitigate the impacts to existing bus priority the following ▪ In locations where the cross-section permitted five traffic lanes, the design introduces a dedicated city-bound bus only lane. ▪ Kingsford interchange provides direct platform interchange for bus and light rail passengers. ▪ Shared running of bus and light rail movement through the proposed signalised nine-ways intersection.
Property accesses	The proposed light rail alignment for Anzac Parade is predominately along the centre of the median as such: ▪ Existing access is maintained throughout the corridor
On-Street parking	▪ During off-peak hours, on-street parking within the proposed bus only lanes will be retained. The city bound bus only lane extend along Anzac Parade between UNSW and Alison Rd, except adjacent to the Carlton St stop where the carriageway is restricted to two traffic lanes in each direction (refer to section 6 for further detail)
Loading / unloading	▪ On-street loading/unloading zones will be retained wherever possible within the western kerbside bus lanes outside of peak hours. (refer to section 6 for further detail)
Pedestrian access	There are seven signalised intersections and five signalised pedestrian crossing within this section of the Anzac Parade. ▪ Pedestrian activity is expected to increase in the vicinity of the proposed light rail stops and crossing facilities will be provided to permit safe access. ▪ Enhancement to the pedestrian environment surrounding the Moore Park light rail stop, particularly during special events.
Cyclist access	The existing off-road path along the eastern kerb of Anzac Parade between Moore Park Rd and Alison Rd will be retained with the introduction of light rail. ▪ Provision of cycle storage facilities at the Kingsford light rail terminus.
Taxi zone	No Taxi zones are located along Anzac Parade

5.4.4.1. Kingsford Interchange

At its southern end, the light rail terminus at Kingsford will operate as the key interchange between South Eastern suburb buses and light rail. A summary of the functional changes to the road network required to accommodate the light rail terminus at Kingsford along with a summary of the likely impacts is provided below.

Functional changes

The Kingsford Interchange, as illustrated in Figure 5-15 and Figure 5-16, will be a critical bus to light rail transfer point, as the southern terminus on the Anzac Parade corridor, servicing approximately 90 buses per hour in the peak direction during the AM and PM peaks. The interchange must provide for highly legible, efficient bus to light rail and light rail to bus transfers as this will shape customer experience and hence has formed a key design consideration.

Whilst serving the immediate catchment of Kingsford, the interchange is also designed to service a wider catchment, including La Perouse, Maroubra and suburbs to the south. The Kingsford Interchange is therefore planned to operate as the primary interchange for customers from the South Eastern suburbs, some of whom are anticipated to change modes from bus to light rail for their journey to the CBD. It is expected that the light rail service will reduce the need for existing bus services to connect to the CBD, although express bus services to the north of the CBD are proposed to remain in operation to continue to provide passengers a direct connection to the north of the CBD.

PTPM modelling[109] forecasts 1,454 passengers will access light rail at Kingsford during the AM peak hour, with 1,277 (88%) transferring from bus and 177 (12%) from walk up.

Figure 5-15: Light rail alignment at Kingsford Interchange (AM Peak)[110]

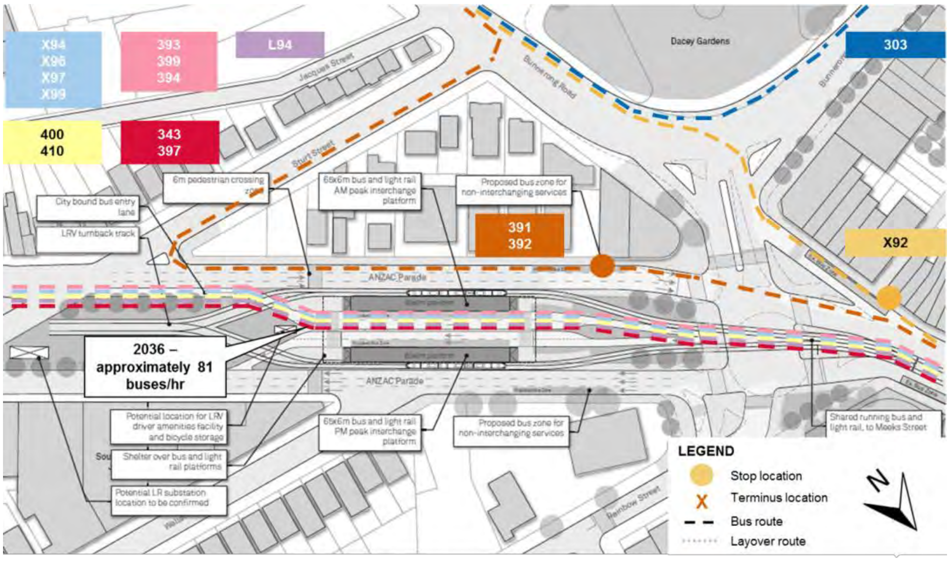
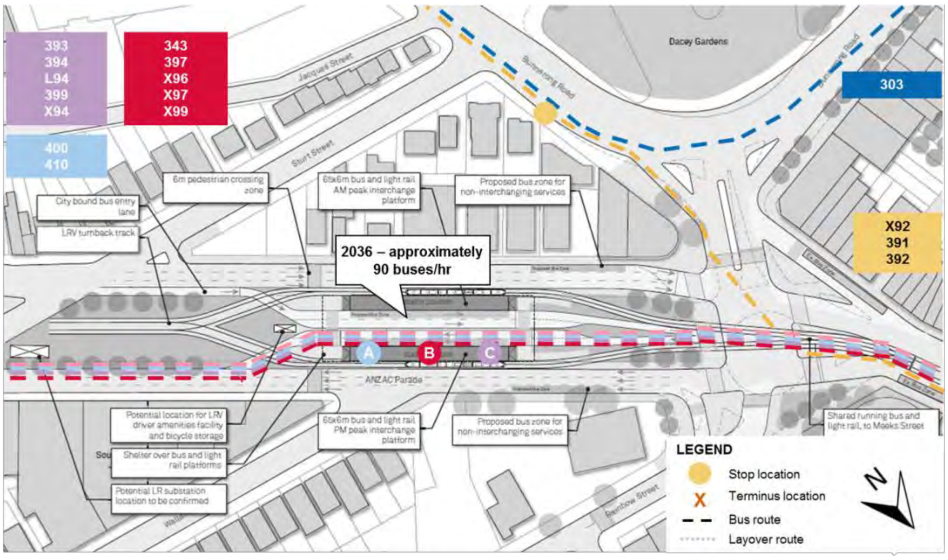


Figure 5-16: Light rail alignment at Kingsford Interchange (PM Peak)[111]



New stop on Bunnerong Road subject to consultation with Randwick Council and State Transit Authority

The design will provide a guaranteed cross platform interchange between bus and light rail in both directions of travel. The interchange will be located in the centre median of Anzac Parade to the south of the Nineways intersection. This design will provide separation of bus and light rail movements between the platforms and the Nineways intersection, before converging into a shared bus and light rail running arrangement to ensure bus passengers continue to receive a degree of priority over general traffic as at present.

[109] Transport for NSW, *Sydney Light Rail Round 5.2 Demand Report*, 2013

[110] *2036 bus frequencies*

[111] *2036 bus frequencies*

Conversion of the Nineways roundabout to a signalised intersection is required to allow integration of the Kingsford interchange and to provide safe, controlled pedestrian access points across Anzac Parade. Initial modelling of the intersection by Transport for NSW indicates the current intersection design will operate at a LoS E in the AM peak and LoS C in the PM peak. This indicates that whilst the intersection operates with spare capacity in the PM peak, it will be operating at capacity in the AM peak. Further design work is ongoing to optimise the intersection in consultation with Transport for NSW and RMS.

A priority Light Rail / Bus phase city bound at the Nineways intersection, coordinated with the main north/south traffic phase at Meeks Street will ensure light rail priority and safe merging of these movements. Shared running of all bus services and light rail will continue between the Nineways intersection and Meeks Street. Non-express (local) bus services will then merge/diverge from the light rail alignment on approach to the Meeks Street intersection via short bus "turn" bays adjacent to the light rail lanes on the Anzac Parade approaches to the intersection. The bus only lanes would operate in separate phase to light rail to allow co-ordinated movements into and out of the central alignment.

A turn back tail track will be provided to allow light rail vehicles to operate via dedicated inbound and outbound platforms, which are co-located with inbound and outbound bus services respectively.

Proposed network characteristics

An outline of the effects the proposed functional changes at the Kingsford interchange will have on road network uses is provided in Table 5-8.

Table 5-8: Kingsford Interchange Future network characteristics

Use	Future network characteristics
General traffic	▪ Conversion of the existing roundabout at nine-ways into a signalised intersection ▪ Restriction to right turning movements at the new nine-ways intersection, with local alternative routes available
Property accesses	▪ Property accesses retained
On-Street parking	▪ Loss of median and kerbside parking in vicinity of light rail
Loading / unloading	▪ No designated loading zones currently within the vicinity of the interchange, but may be introduced as part of parking strategy (see section 6)
Pedestrian/cyclist access	▪ Pedestrian access to the interchange will be provided via signalised crossings on all approaches to the nine-ways intersection ▪ Cyclist facilities will be provided at the interchange (details provided in Section 7)
Taxi zones	▪ Taxi bays would be provided at the terminus (see Section 7)

5.4.5. Randwick precinct

The functional characteristics of the Randwick precinct are shown below in Figure 5-17 and discussed in further detail in the following sections.

Figure 5-17: Randwick precinct proposed functional characteristics

5.4.5.1. Alison Road

Functional changes

The proposed functional changes along Alison Road to accommodate light rail are discussed below, with a particular focus on:

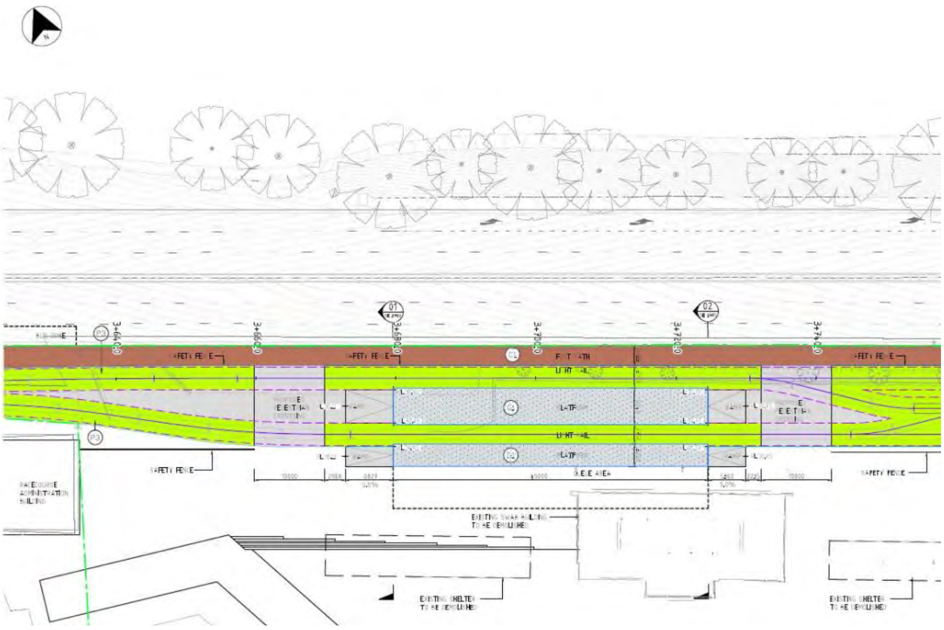
- Alignment adjacent to Randwick Racecourse
- The bus roadway
- Stabling and maintenance facility adjacent to Randwick Racecourse

Alignment adjacent to Royal Randwick Racecourse

The key design parameter for the alignment through this section of Alison Road is the major event stop at Royal Randwick Racecourse. Due to the level of pedestrian activity during events it is vital the stop is located adjacent to the racecourse, therefore removing the major pedestrian conflict associated with crossing Alison Road. This will require a transition of the alignment from the northern side of Alison Road to the southern, which will be undertaken at Alison Road / Doncaster Avenue which has a greater level of spare capacity when compared to Alison Road / Darley Road. Utilising the intersection at Doncaster Avenue will minimise the impacts (delay) to light rail, traffic and bus operations by providing the light rail crossing of Alison Road at a location where existing traffic lane geometry will not be constrained by the light rail alignment. There is also the opportunity to incorporate the light rail crossing at Doncaster Avenue into the signal phase for the existing off-line bus way, therefore maintaining the current three phase operation.

This light rail stop will cater for Royal Randwick Racecourse, Randwick TAFE, UNSW Randwick campus on King Street, Centennial Park via the Randwick Gate on Darley Road and the residential catchment between Alison Road and Darley Road. Located within the ATC site the stop will be configured as a 45m island platform with a trailing pocket track cross-over to allow special event shuttle services to turn back, with an additional event-only side platform for post event loading. The stop layout is shown in Figure 5-18.

Figure 5-18: Randwick stop layout[112]



[112] *CSELR Draft Definition Design Report – Volume 3 – South East Corridor, 2013*

By locating the stop within the ATC site, customer safety will be addressed during an event as customers can board and alight the light rail without the need to cross Alison Road and can be marshalled safely within the ATC site.

The light rail alignment will diverge from the Alison Road busway at Doncaster Avenue and run parallel to the existing footpath along Alison Road within the ATC site. The alignment will clear the existing ATC administration building, and then diverges to allow the stop to be located south of the administration building, allowing sufficient length for the pocket track, before the alignment swings back onto the southern kerb lanes of Alison Road at the Darley Road intersection.

To enable sufficient area to marshal special events, and to maintain safe, clear access and sight lines around the light rail stop, the existing Swab building will need to be demolished.

Local bus services will stop on the kerbside adjacent to the light rail stop for passengers interchanging from eastern suburbs buses in the inbound direction. Outbound bus interchange will require light rail passengers to cross Alison Road to reach the closest bus stop. This configuration is unchanged from the existing.

Further work is needed to determine the optimum location for special event buses, although it is currently envisaged that these services will be able to stop on the southern side of Alison Road kerbside, between the Administration building and Doncaster Road. During special events a bus and taxi staging area will be made available on the kerbside lane of Darley Road.

Bus roadway

The existing bus roadway adjacent to Anzac Parade is utilised by express and stopping bus services operating between the City and Coogee-Randwick. It is anticipated that Routes 339, 374 and L94 which will operate all day would stop in the roadway totalling 23 services in the 2036 AM peak hour.

Despite fewer stopping services, it is suggested to retain the Anzac Parade Bus Roadway for a number of reasons.

- Provision of bus priority is required to maintain efficient and reliable journey times for bus services and is practically achieved without further infrastructure investment by the existing bus roadway making best use of a scarce resource, in particular:
  - The Alison Road, Anzac Parade, Dacey Avenue intersection is congested during the peak periods operating at a degraded Level of Service F. The bus roadway allows bus services operating from the Coogee-Randwick precinct to avoid the congested intersection.
  - During special events, roads in the Moore Park precinct become heavily congested and use of the roadway will be essential to maintain reliability for regular timetabled services operating through the precinct.
- Retention of the bus roadway provides for a degree of ‘future-proofing’ as Express services (if retained) are anticipated to continue growing strongly with the express buses from Randwick forecast to carry 3,300 passengers in the 2021 AM peak.
- Passenger transport to special events at Moore Park and Randwick Racecourse are proposed to be provided by both Light Rail and supplementary special event bus services.

The roadway is currently fenced in response to accidents previously experienced where pedestrians conflicted with buses operating at high speeds. Fencing breaks are provided at stop locations to facilitate pedestrian access. With the light rail operating adjacent to the roadway, provision of access to bus stops across the light rail alignment is to be considered as part of the detailed design process.

Impact on cycle routes

Between Darley Road and Wansey Road, the light rail alignment will run on the southern side of Alison Road. As a result, the off-road cycle route would be realigned between the light rail corridor and the Australian Turf Club site. At the signalised intersection of Alison Road and Darley Road, cyclists would still be able to move between off-road cycle routes, however they would also need to cross the light rail alignment.

Proposed network characteristics

An outline of the effects the proposed functional changes along Alison Road will have on road network uses is provided in Table 5-9. The functional changes required to accommodate light rail will impact general traffic movements. On the other hand however, it will generate significant public transport and pedestrian access improvements to key locations such as Randwick Racecourse, Randwick TAFE and UNSW Randwick.

Table 5-9: Alison Road Future network characteristics

Use	Future network characteristics
General traffic	Several changes to the existing local road network are required to introduce light rail along Alison Road. The key local network changes include: ▪ Geometric and traffic signal changes to Alison Rd and Anzac Parade. Existing traffic movements and lane configuration retained. ▪ Geometric and signal changes to the Doncaster Ave and Alison Rd intersection to permit the light rail to cross Doncaster Ave between Abbotford St and the Racecourse. ▪ Geometric and signal changes to the Darley Rd and Alison Road intersection to accommodate the light rail and access to Randwick Racecourse site. City bound through movement along Alison Rd reduced to two through traffic lanes. ▪ Introduce signal control to the Alison Road and Wansey Rd intersection to improve pedestrian access to the adjacent stop.
Property accesses	Property accesses located on the eastern side of Alison Road would be unaffected by CSELR. ▪ The gate access to Royal Randwick Racecourse (RRR) located on the eastern side of Alison Road may be subject to restrictions or controls.
On-Street parking	No provision for on-street parking along Alison Rd between Darley Rd and Wansey Rd due to the constrained cross section with the light rail alignment along the southern kerb.
Loading / unloading	▪ There are no loading/unloading spaces available within the corridor.
Pedestrian/cyclist access	▪ The existing off-road shared path running along the northern side of Alison Road will be retained. ▪ The off-road shared path between Darley Rd and Wansey Rd will be reinstated between the light rail alignment and the racecourse. ▪ Randwick Racecourse stop location within existing ATC land will ensure a safe and direct connection into the racecourse, particularly during special events. ▪ The Alison Road alignment will encroach upon the western side of Tay Reserve (existing parkland), which will require the relocation of the existing pedestrian footpath on that side. This footpath could be relocated to the eastern side of the track within the park, and the park could be re-designed to tie-in with the future light rail track.
Taxi zones	Provision for a taxi zone may be provided on Alison Road adjacent to the Racecourse stop during special events.
Bus	The existing westbound bus stop on the southern side of Alison Road adjacent to Darley Road would be displaced with this alignment – passengers would be expected to utilise the stop to the west.

Stabling and maintenance facility adjacent to Randwick Racecourse

The Randwick stabling and maintenance facility is located adjacent to Randwick racecourse, backing onto properties facing Doncaster Avenue. Based on the Final Fleet Stabling Requirements and Operating Protocols Report prepared by the Light Rail Network Operations and Management Service Provider (Interfleet), it is proposed that stabling and maintenance work on CSELR light rail vehicles would be undertaken at the Randwick stabling facility. It is identified that the facility would be expected to provide office space, a workshop, stores and approximately 100-120 car parking spaces for staff and visitors. An internal road network would cater for independent heavy vehicle movement and be designed to RMS and AS standards and guidelines.

Vehicle access to the facility would be via an existing vehicular access located at a roundabout intersection at Ascot Street and the exit point would be on the eastern side of Doncaster Avenue, south of the intersection with Alison Road. The current AM peak hour traffic volume at the intersection of Anzac Parade / Doncaster Avenue is 3,700 vehicles and Alison Road / Doncaster Avenue is 4,800 vehicles, with both intersections are operating at Level of Service (LoS) C or better during the peak hours. This traffic is mainly generated by local land uses but also consists of some through traffic rat running to avoid the congested Anzac Parade / Alison Road intersection. At present, parking is permitted along both sides of the Doncaster Avenue. The Randwick Council bicycle route map designates Doncaster Avenue as an existing signed on-road bicycle route. This route connects with a segregated cycle path running along the northern side of Alison Road.

It is considered that the existing vehicular crossings at Doncaster Avenue can be adapted for use during operation of the maintenance facility. During the operation of the stabling facility, peak traffic generation would be attributable to periods of shift changeovers where staff vehicles would be entering and exiting the site. The 100-120 parking spaces proposed on site would be sufficient to accommodate all traffic associated with each shift of the maintenance facility; therefore the impact on adjacent on-street parking provisions would be minimal. It is assumed that the shift change over period would be outside peak periods for the road network and as such is unlikely to impact existing intersection performance and traffic conditions.

The impact of the additional traffic generated by the maintenance facility is considered low for the following reasons:

- Peak movements to the site associated with the shift changeover period would likely occur outside of the network peak;
- Use of existing accesses with no anticipated requirement for significant upgrade;
- Entry and exit arrangements to the facility through existing separate vehicular access points would reduce the vehicle conflicts.

5.4.5.2. Wansey Road

The functional road network changes required to accommodate light rail along Wansey Road and the potential impacts associated with these changes are outlined below.

Functional changes

The light rail design alignment is located on the western edge of Wansey Road. The light rail stop runs parallel to Wansey Road near the corner of Alison Road (see Figure 5-19), whilst The UNSW High Street stop is parallel to Wansey Road near the corner of High Street (see Figure 5-20). The outbound track is in the approximate location of the existing kerbside parking lane and the inbound track is located on the off-road pedestrian/cycle path.

Two-way traffic will be retained but no provision for on-street parking will be possible due to the reduced road cross section along Wansey Road. The off-road pedestrian/cycle path will be realigned on the western side.

Figure 5-19: Light rail alignment Wansey Road north

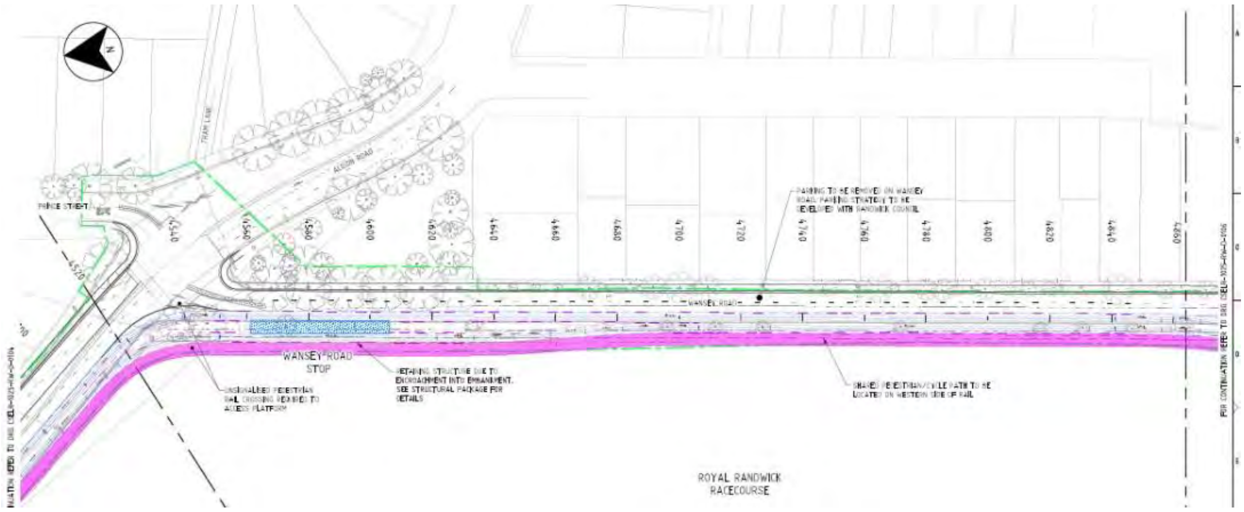


Figure 5-20: Light rail alignment Wansey Road south

This design will require regrading towards the southern end of Wansey Road, which will result in the stop being in a slight cutting. Sections of the existing Wansey Road corridor are supported on a masonry retaining wall which will likely require reconstruction to accommodate light rail.

To provide pedestrian access from the residential catchments in the north and east to the Wansey Road stop, the intersection of Wansey Road / Alison Road will be signalised. The signalised intersection will provide pedestrian crossing points on all arms. Alternatives to provide a signalised pedestrian crossing offset from the intersection, were investigated, but would not satisfy the pedestrian desire lines and could not be accommodated safely in close proximity to the existing intersection.

The intersection of High Street / Wansey Road will also require signalisation to accommodate pedestrians and the light rail turning movements between Wansey Road and High Street. Pedestrian crossings will be provided across Wansey Road and the eastern arm of High Street as a minimum, which will replace the existing zebra crossing on High Street. This provides enhanced pedestrian facilities as pedestrians currently have no protected facilities to cross Wansey Road.

Impact on cycle routes

The existing off-road cycle route on Wansey Road would be relocated between the light rail alignment and the ATC site. This is consistent with the treatment of the Alison Road off-road cycleway, ensuring the route remains connected and segregated from vehicular traffic between Darley Road and High Street. A signalised intersection with pedestrian crossings at Wansey Road and High Street would improve connections to UNSW.

Proposed network characteristics

An outline of the effects the proposed functional changes along Wansey Road will have on road network uses is provided in Table 5-10. In summary, the main impacts to general traffic will be the introduction of traffic signals which would result in a slight increase in delay during off-peak periods, but would improve access and safety for traffic accessing Wansey Road, particularly during peak times. The existing on-street parking along Wansey Road would also be lost due to the limited road space available, the parking mitigation measures are discussed further in section 6 of this report. The shared cycleway and footpath on the western side of Wansey Road would be retained.

Table 5-10: Wansey Road Future network characteristics

Use	Future network characteristics
General traffic	Wansey Road will continue to provide access to residents with all existing movements maintained. The impacts to general traffic movements include: ▪ Traffic signals introduced at Wansey Rd and Alison Rd to improve pedestrian access. ▪ Traffic signals introduced at Wansey Rd and High St to provide necessary access for light rail.
Property accesses	The proposed light rail alignment impacts access to property along the western side of Wansey Rd. The accesses directly impacted include: ▪ Two existing driveway accesses into Randwick Racecourse. Alternative access is available through the internal racecourse road network via High Street
On-Street parking	There will be no parking available along the corridor (see section 6 for mitigation measures).
Pedestrian / cyclist access	▪ Pedestrians within Wansey Rd are mainly generated by the residential properties, recreational activities and the University of New South Wales. ▪ The Wansey Rd off-road shared path between Alison Rd and High St will be reinstated between the light rail alignment and the ATC site.

5.4.5.3. High Street

The functional road network changes required to accommodate light rail along High Street and the potential impacts associated with these changes are outlined below.

Functional changes

Due to nature of the land use and access requirements along High Street, the following key design parameters guided the design development in this area:

- Maintain a minimum single traffic lane along High Street in each direction (as existing)
- Provide signal control at intersections where general traffic movements are permitted to cross the light rail alignment
- Relocate existing bus stops or provide indented bus bays that allow general traffic to pass a stopped bus
- Maintain access for emergency vehicles to the hospital

These measures will optimise the operational efficiency for all modes within the available corridor width, improve public transport reliability and maintain access to land uses along High Street.

As illustrated in Figure 5-13 the light rail alignment will operate in a dedicated light rail 'centre running' configuration along High Street with a single kerbside traffic lane in each direction. This will necessitate changes to parking, loading and kerbside access, consistent with other sections of the corridor. Mitigation measures to address this issue are proposed in Section 6 of this report.

A summary of the key road characteristics are:

- A traffic signal control will be introduced at the intersection of High St and Hospital Road
- A traffic signal control will be introduced at the intersection of High St and Clara Street
- Access to Eurimbla Avenue will be restricted to Left In Left Out
- An intended bus bay for westbound buses on High Street will be introduced adjacent to the Adult hospital
- The westbound bus stop adjacent to the Children's Hospital emergency entrance will be relocated to Clara Street, with access to the hospital via a signalised intersection
- An indented bus bay for westbound buses will be provided on High Street between Botany Street and Wansey Road. This will require a localised diversion of the footpath into UNSW land.
- As a result of these changes, there is a significant spacing between bus stops utilised by the 370 and 372 considered necessary to avoid unacceptable congestion on High Street

Driveway accesses

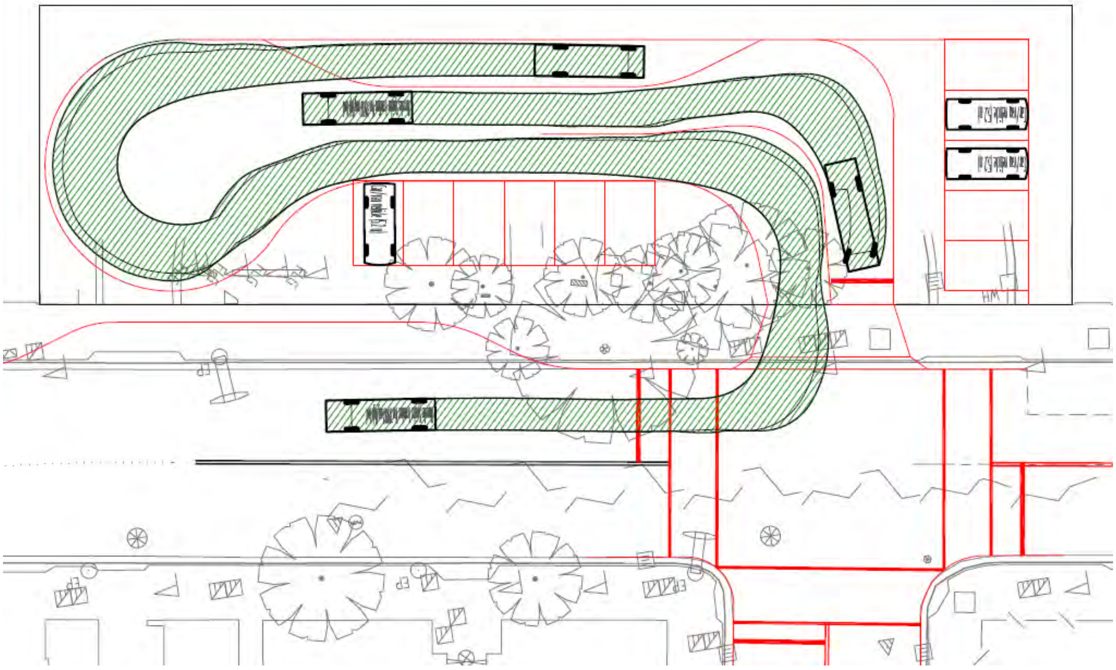
The introduction of signal control at Hospital Road and Clara Street will enable right turn movements into and out of the side roads to be maintained. The signals will ensure traffic movements in conflict with the light rail alignment are controlled. Access to Eurimbla Avenue and driveways along High Street will be restricted to left in left out only.

The consolidation of accesses along the High Street corridor is necessary to minimise turning vehicle conflicts with light rail which would represent a significant safety and reliability issue for operations. Essential accesses to the Prince of Wales Hospital from High Street will been maintained as follows:

- The porte cochere entrance to the Adult Hospital will be modified and integrated with a four way signalised intersection at Clara Street. The design will also provide an indented westbound bus bay on High Street (as shown in Figure 5-21).
- The operation of the porte cochere entrance to the Children's Hospital will be reversed to provide entry via Hospital Road. Exit would be limited to a left turn only onto High Street
- Emergency vehicle access to the Children's hospital will remain the same.

Right turning movements off High Street at the signalised intersections with Wansey Road, Botany Street, Hospital Road Clara Street and Belmore Road / Avoca Street will be undertaken from a short shared section of the light rail alignment on approach to each of these intersections. At the Belmore Road / Avoca Street intersection these right turn movements will be restricted to buses only.

Figure 5-21: Modification to porte cochere entrance to the Adult Hospital



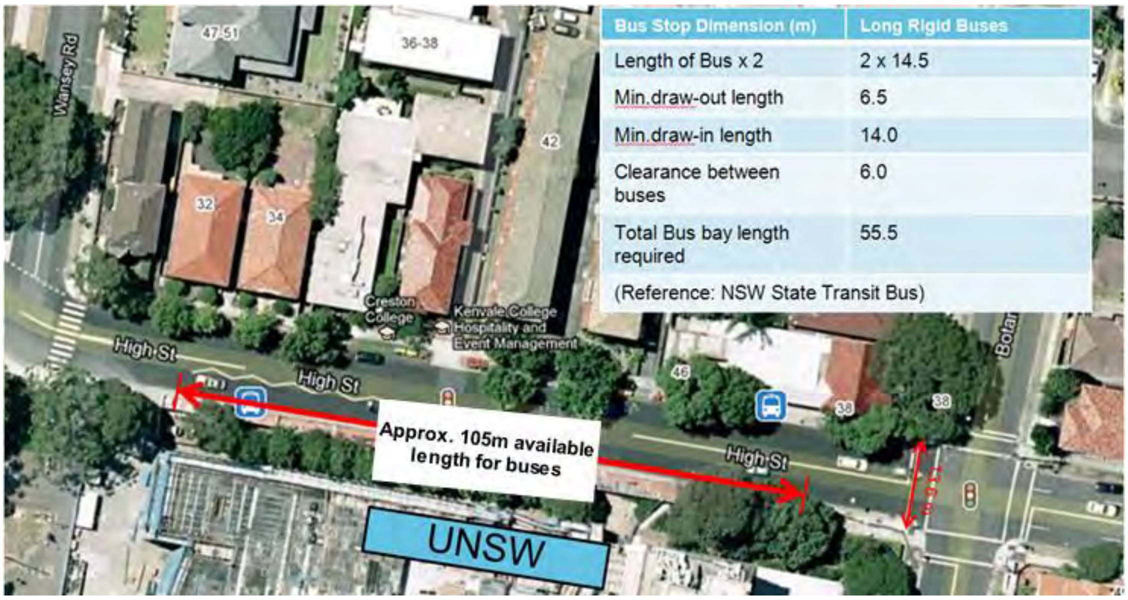
High Street bus stops

The implementation of light rail in the High Street corridor will necessitate the relocation of existing bus stops on High Street. Currently stops are provided at the following locations in this section of High Street:

- Outside UNSW frontage (westbound only)
- West of Botany Street (eastbound only)
- West of Clara Street (eastbound and westbound)

The current westbound UNSW stop will be replaced by an indented bay within University land as shown in Figure 5-22. It is anticipated that the bay will be required to accommodate two buses due to the forecast bus numbers.

Figure 5-22: Proposed Bus Bay along High St Corridor near UNSW



Bus Stop Dimension (m)	Long Rigid Buses
Length of Bus x 2	2 x 14.5
Min.draw-out length	6.5
Min.draw-in length	14.0
Clearance between buses	6.0
Total Bus bay length required	55.5
(Reference: NSW State Transit Bus)	

The bus stop west of Botany Street cannot be retained due to the need to provide an unimpeded traffic lane. It is anticipated passengers currently utilising this stop will be required to use the stop west of Wansey Road.

Outside the hospital, the eastbound stop currently located on High Street cannot be retained to the limited cross sectional width on High Street. The stop location will therefore be reconfigured along Clara Street as shown in Figure 5-23. The stops relocated within Clara Street will benefit from safe pedestrian access to the hospital via the newly signalised Clara Street intersection. This will however, require those customers on bus routes that continue along High Street, to access their bus services at the Randwick Interchange The requirement for suitable eastbound alternative stop locations will be investigated further with Randwick Council and the Prince of Wales Hospital.

Figure 5-23: Proposed bus stop locations outside the hospital

Impact on cycle routes

The light rail alignment would run on High Street between Wansey Road and the Randwick terminus. High Street is currently identified as an on-road cycle route, linking Belmore Road and Anzac Parade. Future light rail operations on High Street are incompatible with an on-road cycle route. Therefore, in order to maintain cyclist access to the Randwick town centre, Arthur Street would be designated as an on-road cycle route between Wansey Road and Belmore Road. Cyclists using the off-road cycleway on Wansey Road would cross the light rail alignment and Wansey Road to access Arthur Street. Arthur Street connects with Belmore Road, providing cyclists with access to on-road cycle routes to the south and east.

Proposed network characteristics

An outline of the effects the proposed functional changes along High Street will have on road network uses is provided in Table 5-11.

Table 5-11: High Street Future Network Characteristics

Use	Future network characteristics
General traffic	With the introduction of light rail along the High St corridor the following provides a summary of the key impacts to general traffic: ▪ Traffic signal control will be introduced at the intersection of High St and Hospital Rd ▪ Traffic signal control will be introduced at the intersection of High St and Clara St ▪ Access to Eurimbla Avenue will be restricted to Left In Left Out
Buses	Bus services will be affected in the following way: ▪ Right turn movements out of Clara Street will now be under signal control ▪ An intended bus bay for westbound buses on High Street will be introduced adjacent to the Adult hospital ▪ The westbound bus stop adjacent to the Children's Hospital emergency entrance will be relocated to Clara Street, with access to the hospital via a signalised intersection ▪ An indented bus bay for westbound buses will be provided on High Street between Botany St and Wansey Rd adjacent to UNSW . ▪ 800m spacing between eastbound bus stops utilised by the 370 and 372, an increase of approximately 500m.
Property accesses	Most property access arrangements will be restricted to left-in-left-out operation with the exception of the right turn accesses into the hospital, which will be maintained. This requires reconfiguration of the existing access configurations
On-Street parking	There are will be no provision for parking on High Street between Wansey Road and Belmore Road
Loading/unloading	There are will be no provision for parking on High Street between Wansey Road and Belmore Road during light rail operational hours.
Pedestrian access	Pedestrian crossing facilities will be provided at the new signalised intersections with: ▪ Wansey Road ▪ Hospital Road ▪ Clara Street ▪ Belmore Road Existing zebra crossings will be replaced by the new signalised pedestrian crossings.
Cyclist access	No dedicated cycle facilities will be provided on High Street. An alternative on-road cycle route would be established on Arthur Street to provide cyclist access to the Randwick town centre, and to link with the on-road Botany Street and off-road Wansey Road cycle routes.
Taxi zone	There is no provision for a taxi rank on High Street between Wansey Road and Belmore Road. However space(s) could be allocated within the reconfigured porte cochere subject to consultation.

5.4.5.4. Randwick interchange

The light rail and bus interchange, located adjacent to High Cross Park at Randwick will be a critical transport interchange that provides an integrated, seamless modal change between bus and light rail for public transport passengers. A summary of the functional changes to the road network required to accommodate the light rail terminus at Randwick along with a summary of the likely impacts is provided below.

Functional changes

The interchange is located within the civic precinct of Randwick as well as servicing the Prince of Wales Hospital and surrounding residential and retail areas. The terminus will also serve a wider catchment of the South Eastern suburbs extending to Coogee and Maroubra through interconnecting bus services.

It is expected that this interchange will achieve high patronage in the AM and PM peak periods. The interchange has been designed for compatibility and future capacity requirements for the South East bus network, as described in Section 4.

The design provides two 45m light rail platforms on the eastern side of High Cross Park, optimised for passenger interchange with AM peak period buses. The eastern platform will operate as a cross-platform bus-light rail interchange, providing for efficient transfer of passengers in the AM peak.

Figure 5-24 and Figure 5-25 present the proposed bus operating volumes and stopping arrangements in both peak periods. The 45m platforms will allow for an additional bus lane within Cuthill Street, providing for an additional bus zone to service the PM peak buses. This creates a short walk across High Cross Park for interchanging passengers in the PM peak.

Figure 5-24: Randwick Interchange AM Peak

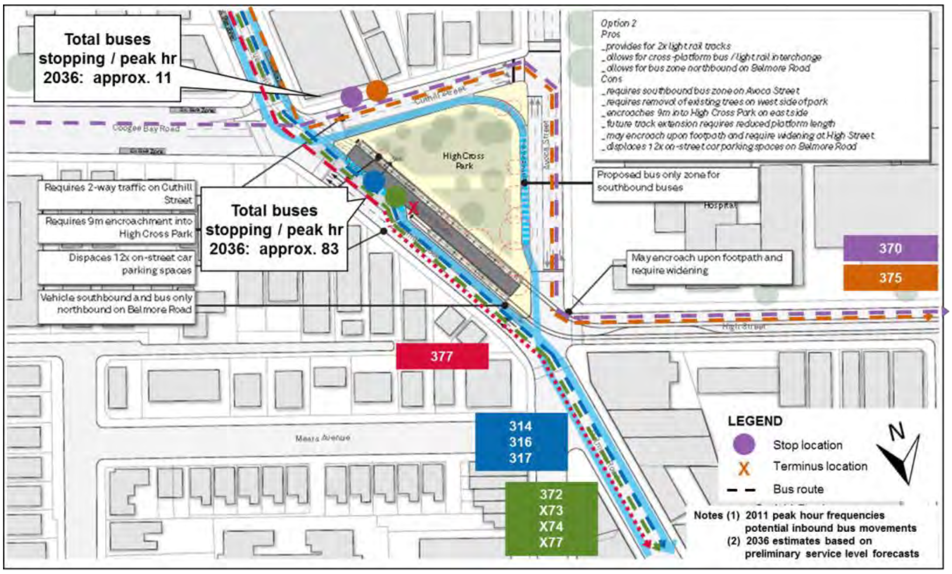
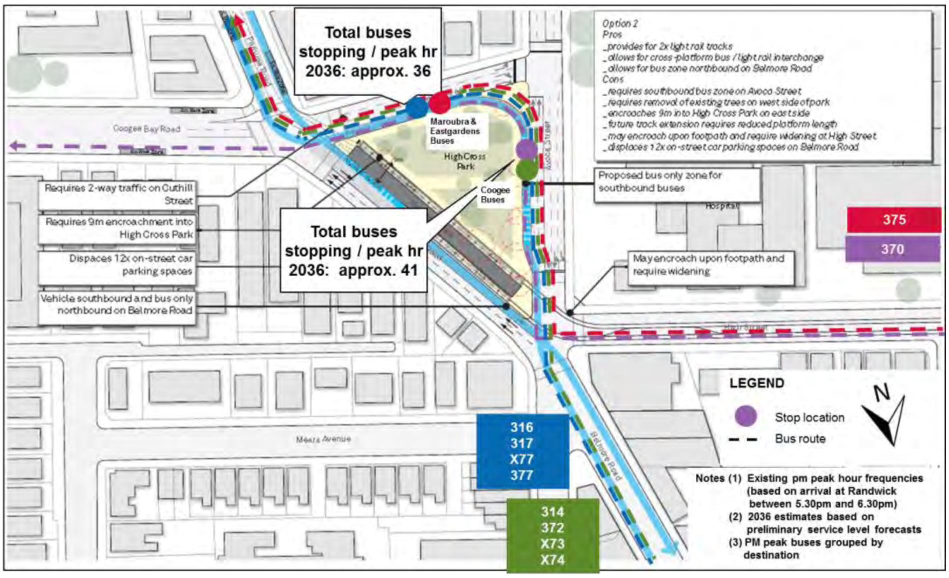


Figure 5-25: Randwick Interchange PM Peak



The proposed design provides a safe, highly efficient passenger interchange in both AM and PM peak periods.

Opportunities exist to fully integrate the interchange within the existing park – partially offsetting the impact of construction with improvements such as new tree planting, a public plaza and new landscaping. This is an opportunity to create an active ‘transit park’ integrated with Randwick’s civic, retail and health precinct.

Proposed network characteristics

An outline of the effects the proposed functional changes at the Randwick interchange will have on road network uses is provided in Table 5-12.

Table 5-12: Randwick Interchange Future network characteristics

Use	Future network characteristics
General traffic	▪ Belmore road will be made two-way with the following restrictions: ○ bus only in a northbound direction ○ southbound only for general traffic ▪ Right turn from High Street into Avoca Street will be bus only
Property accesses	▪ Accesses to properties on Belmore Road will be retained as left-in-left-out movements
On-Street parking	▪ Parking on Belmore Road will be lost during peak hours ▪ Existing parking controls retained on Cuthill street
Loading/unloading	▪ No designated loading zones currently within the vicinity of the interchange, but may be introduced as part of parking strategy (see section 7)
Pedestrian/cyclist access	▪ Improved crossing facilities to be provided at the Avoca St/High St/ Belmore intersection.
Taxi zones	▪ No existing taxi zones in the vicinity of the interchange

5.4.6. Rozelle stabling & maintenance facility

The Rozelle maintenance facility is located at the former goods and marshalling yard in Lilyfield, situated adjacent to the existing Lilyfield Light Rail Station. The site is bounded by Lilyfield Road and Citywest Link with mainly residential developments and a mixture of light industrial developments east and south. Based on the Final Fleet Stabling Requirements and Operating Protocols Report prepared by the Light Rail Network Operations and Management Service Provider (Interfleet), it is proposed that maintenance work on light rail vehicles would be undertaken at the Rozelle maintenance facility. The facility would accommodate maintenance facilities to cater for both CSELR and Inner West light Rail operations including:

- Office space;
- Staff facilities;
- An 800 m^2 storage area;
- Plant rooms; and
- Approximately 50 car parking spaces.

An internal road network would cater for independent heavy vehicle movement and be designed to RMS and AS standards and guidelines.

Lilyfield Road adjacent to Catherine Street was formally a major collector road, prior to the installation of the City West Link. Since then, traffic volumes have considerably reduced and the road re-classified to local road status with load restrictions. Traffic volume on Lilyfield Road is significantly lower than City West Link and operates well within its available capacity. At present, parking is permitted along both sides of the street with a large number of Light Rail commuters parking along the southern side of the street. Spanning the entire length of Lilyfield Road are on-street cycle lanes connecting Hawthorne Canal and Anzac Bridge and is well utilised by cyclists during peak periods.

Vehicle access to the facility and adjacent commercial properties within the rail corridor would be maintained via the existing driveway located on Lilyfield Road, east of Catherine Street and the existing internal site access road. The existing driveway located on Lilyfield Road historically accommodated heavy vehicle movements for the purposes of hauling freight and materials to / from Lilyfield Road. As such, the existing vehicular crossing can be adapted for use during both construction and operation of the maintenance facility. The majority of vehicle movements, especially heavy vehicles, would be via the City West Link, with vehicles accessing Balmain Road and Catherine Street for movements in and out of the site. Given the proximity of these links and the low traffic volumes currently on Lilyfield Road, the traffic impact of additional traffic generated by the maintenance facility along Lilyfield Road would be limited.

During the operation of the maintenance facility, peak traffic generation would be attributable to periods of shift changeovers where staff vehicles would be entering and exiting the site. To ensure efficient operation of the system, parking for staff vehicles would be accommodated internally, with approximately 50 parking spaces provided for both staff and visitors. This would be sufficient to accommodate all traffic generated by the maintenance facility and therefore, impact on adjacent on-street parking provisions would be minimal.

Furthermore, as the development of the maintenance facility at Rozelle would wholly be contained within the former good and marshalling yard with minimal changes to the existing access arrangements, it is considered that the traffic impacts on pedestrians, cyclists, existing light rail users and other road users would be minimal

5.4.7. Property access

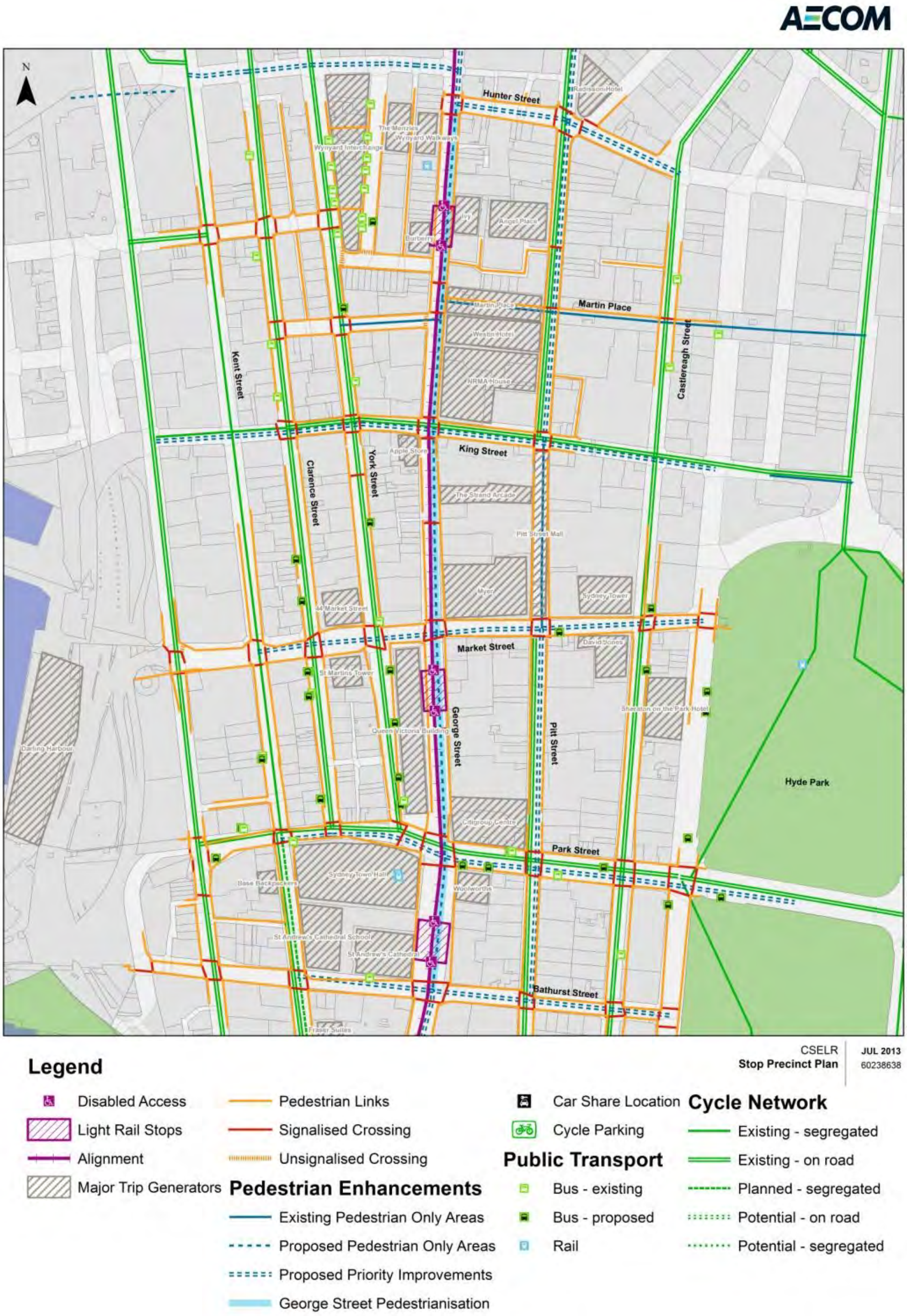
With the introduction of light rail, there are changes to the existing road capacity and new provisions proposed for the operation of general traffic and commercial vehicles within the corridor. Vehicles entering or leaving private driveways have the potential to impact light rail operations and when undertaking turning movements across the alignment represent a safety hazard. In order to manage these impacts effectively, the following measures are proposed for the treatment of private and commercial vehicle driveways within the light rail corridor:

- General traffic access to the pedestrianised section of George Street between Bathurst Street and Hunter Street will be under restrictions to be developed as part of the city centre access plan. No Entry controls with appropriate exceptions for residents, light commercial deliveries, emergency vehicles and taxis.
- Introduction of restricted operating hours for heavy vehicles to the existing accesses within the pedestrianised section of George Street between Bathurst Street and Hunter Street. Heavy vehicles would be subject to time restrictions between 11-2pm to minimise risk to lunch time crowds, while further restrictions may be appropriate in the light rail peak operation periods. Articulated trucks will not be permitted at any time.
- Maintain taxi access to key hotels and other areas within the light rail corridor.
- Where feasible limit driveway accesses to left in / left out arrangements.
- Access for emergency vehicles will be maintained at all times. Emergency vehicle access is required to all building frontages along George Street. In the event of fire, access for snorkel appliances for building evacuation and/or fire fighting would require the ability to position the vehicle at the frontage.
- These controls will result in some increased travel distances for service vehicles as their approach routes will be affected by the right turn bans. However all accesses onto the corridor will be maintained. Any controls would be subject to further consultation between the affected parties, Transport for NSW and the appropriate local council (City of Sydney Council or Randwick Council).

5.4.8. Pedestrians and cyclists

Sustainable travel modes such as walking and cycling will benefit from the light rail scheme, particularly in the newly pedestrianised area of George Street. Integration of these networks with light rail is essential to developing a sustainable transport solution. Section 7 details how each of the stops will be integrated with these travel modes and Figure 5-26 below highlights the key connections in the pedestrianised zone.

Figure 5-26: Pedestrian & cyclist integration in the pedestrianised zone



Pedestrians

With the introduction of light rail alignment along CBD and south-eastern suburbs, trips made by light rail will generate additional pedestrian flows along the proposed corridors. As part of the light rail project, pedestrian facility improvements will be provided on the corridor and the existing pedestrian access points will be retained. The Sydney City Centre Access Strategy will further develop the pedestrian and cycle network in the CBD to ensure integration with light rail.

The pedestrianisation of Alfred Street and George Street between Hunter and Bathurst Streets will provide safe pedestrian access, with only local access & service vehicles (during restricted hours) and emergency vehicles permitted along this section. Pedestrian analysis undertaken in the pedestrianised zone and shown in Table 5-13 demonstrates the improved level of service pedestrians will experience as a result of the light rail project. A number of intersections that currently experience extensive congestion and crowding at LoS F (such as George Street / Market Street) will operate at LoS C or better which will result in improved pedestrian amenity, safety and reduced journey times.

This is a significant improvement given up to 80% of the total traffic that passes through these intersections are pedestrians. Such an improvement to the CBD pedestrian environment will also contribute to the NSW 2021[113] goal 8, which specifies a target to "Increase the mode share of walking trips made in the Greater Sydney region, at a local and district level, to 25% by 2016".

[113] NSW Government, *NSW 2021 A Plan to Make NSW Number One*, *2011*

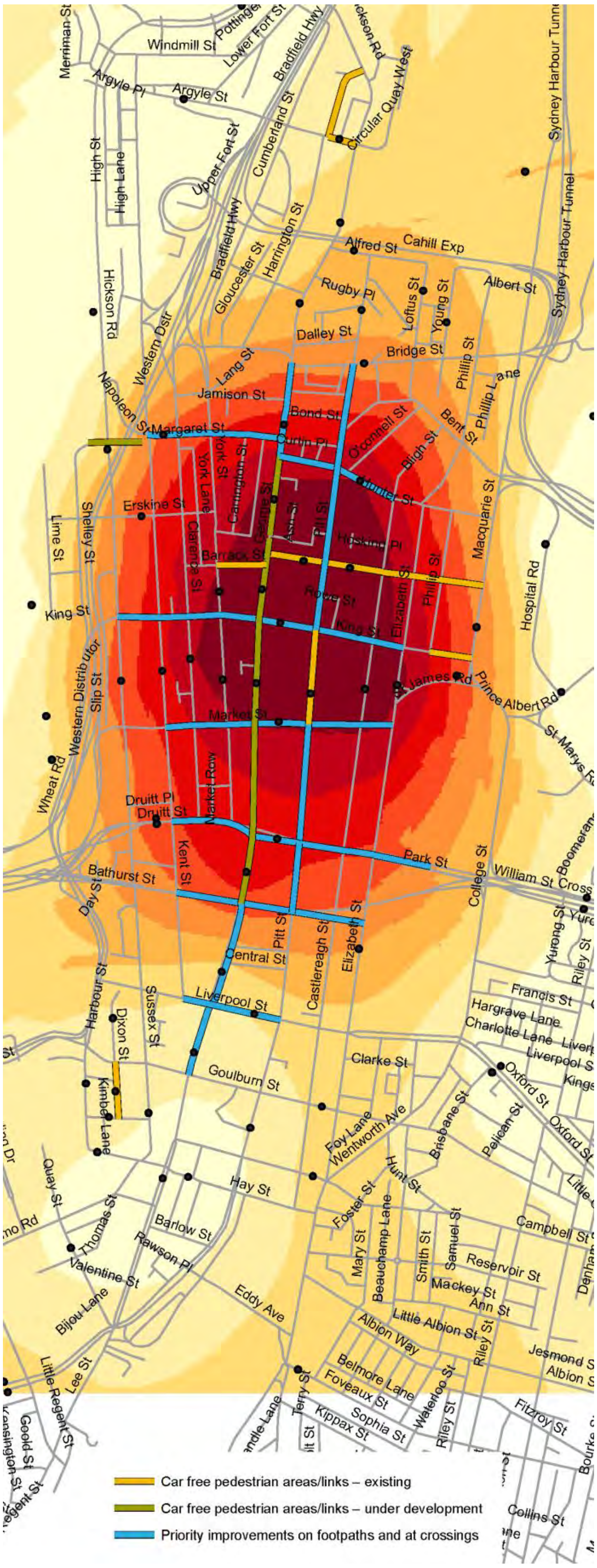
Table 5-13: Pedestrian peak hour LoS analysis

Intersection	Corner	Pedestrian Analysis			
		Existing		Proposed	
		LoS	Waiting Area	LoS	Waiting Area
Hunter Street / George Street	NW	D	25	D	25
	NE	E	20	D	25
	SE	F	20	C	60
	SW	E	25	C	45
King Street / George Street	NW	D	20	C	35
	NE	D	20	C	35
	SE	E	20	C	45
	SW	D	25	A	80
Market Street / George Street	NW	E	25	C	50
	NE	F	20	C	45
	SE	F	20	C	60
	SW	F	20	C	60
Park Street / George Street	NW	C	25	A	55
	NE	C	25	A	60
	SE	C	25	A	115
	SW	C	30	A	130
Bathurst Street / George Street	NW	D	20	A	70
	NE	B	30	A	65
	SE	B	35	A	100
	SW	E	20	C	45

As illustrated in Figure 5-26 priority improvements, by way of signalised pedestrian crossing facilities, will be provided on all arms of existing signalised intersections to provide controlled crossing points of the light rail alignment. This provides protection and improved amenity for visually, hearing or mobility impaired pedestrians.

The wider CBD improvements proposed as part of the CCAS are illustrated in Figure 5-27 and Figure 5-28 to cater for the CBD areas with greatest pedestrian demand. The CSELR project contributes to this wider strategy through the transformation of the George Street corridor.

Figure 5-27: CBD Pedestrian activity areas and proposed improvements[114]



[114] Transport for NSW, *(Unpublished Analysis), 2013*

Figure 5-28: Proposed pedestrian improvement corridors[115]

Pedestrian areas, links and boulevards
Priority pedestrian improvements

115 Transport for NSW, *(Unpublished Analysis), 2013*

Cyclists

The proposed light rail stations and associated pedestrian / cyclist improvement developments around the corridor would create significant opportunities to encourage cycling for short trips to key destinations including employment, residential, health and educational precincts in the vicinity of the light rail stations. Whilst cycle routes along the light rail corridor will be impacted, all will be relocated and the reduction in private vehicle trips that will occur as a result of implementing light rail will create an improved cyclist environment in the wider network. The strategic bicycle network within Sydney CBD is illustrated in Figure 5-29 below.

Figure 5-29: Proposed Bicycle Network surrounding the George Street Light Rail Corridor[116]

[116] Transport for NSW, 2013

As illustrated in Figure 5-29, the proposed strategic cycleway network provides cycleway access within and through the CBD avoiding George Street and thus interaction with light rail operations. The as yet undetermined route between Prince Alfred Park and Elizabeth Street will not be precluded by light rail.

5.5. Road network performance assessment

5.5.1. Methodology

Implementation of light rail on the defined corridor, along with the wider associated bus network changes in the CBD and South Eastern suburbs (as discussed in Section 4), will result in a considerable change to current traffic operating patterns. The light rail project objective is to provide a step change in public transport carrying capacity and journey time reliability that is achieved through reallocation of available road space and providing segregated running of light rail wherever possible. As such a likely outcome of the Project is that existing traffic on the light rail corridor will be displaced. This traffic will adopt one of three alternative behaviours:

- **Change Mode** – Current road users could be expected to change mode from private vehicles to public transport, taking advantage of the reduced journey times and improved reliability the light rail system will provide through the CBD.
- **Change time of travel** – Increasingly flexible working arrangements provide some commuters with the ability to adjust their time of travel to avoid the most congested periods of the day.
- **Reroute to other corridors** – Displaced traffic will seek alternative routes that provide a lower level of delay. However, given much of the network is congested during the peak hours, alternative options are likely to be limited.

Development of a modelling methodology required the above behaviours to be considered, and quantified whilst also providing a tool to provide feedback to the design development process.

As such a two tiered approach has been adopted during the Project life cycle to first address localised design issues and secondly identify the wider network effects.

- Tier 1 – localised design assessment
- Tier 2 – future network assessment

Each of these Tiers is explained in more detail below.

5.5.1.1. Tier 1 - localised design assessment

As part of the Project design process localised intersection models have been developed in areas requiring analysis of traffic performance. These models were developed prior to future year traffic forecasts being available for the light rail project. As such the models use 2011 traffic volumes which enabled relative performance of design options to be assessed, but does not provide accurate future intersection statistics such as level of service to be produced. This first tier of assessment utilised the following modelling packages:

- LinSig – the primary modelling tool used to assess co-ordinated signal operations on sections of the corridor. These models were based on those produced for the SLRSP Milestone 5 report
- SIDRA – used to assess a number of isolated intersection operations and optimise designs

- VISSIM – a single microsimulation model was produced to assess the impacts of an at grade light rail crossing of South Dowling Street in the Surry Hills precinct. This was used due to its ability to model light rail priority through selective vehicle detection and signal actuations

5.5.1.2. Tier 2 – future network assessment

To provide analysis on future network and corridor operations with the introduction of light rail, a second stage of modelling was undertaken by TfNSW.

The modelling platform proposed includes the development of an area wide mesoscopic model with a large part modelled using a hybrid model concept. The hybrid simulator concept allowed for dynamic simulation of an area large enough to account for regional route diversion (as shown in Figure 5-30), as well as micro-simulation modelling of smaller pockets that require representation of individual vehicle dynamics in the detailed road network.

Figure 5-30: Mesoscopic Model Area

5.5.2. South Dowling Street at grade crossing

VISSIM modelling of South Dowling Street between Cleveland Street in the south and Fitzroy Street in the north was undertaken to test the impact of an at grade Light Rail crossing of South Dowling Street. The modelled network consists of South Dowling Street/Cleveland Street, South Dowling Street/Moore Park Road/Fitzroy Street and pedestrian crossings located between these intersections as shown in Figure 5-31.

Figure 5-31: Modelled Network

The AM and PM peak periods were identified as the periods where the greatest midblock northbound/southbound volume was experienced along South Dowling Street between Fitzroy Street and Cleveland Street. The volumes were extracted from SCATS flow data received for Wednesday the 21st of November 2012. The AM peak was identified as 6:15 – 7:15 AM, while the PM peak was identified as 15:45 – 16:45.

It should be noted that the peak periods identified may not be consistent with the peaks for the intersections. However, these periods were chosen due to the maximum midblock volume occurring on South Dowling Street, which would have the greatest impact on the Light Rail crossing. Traffic signal timings for the AM and PM peak hour models were based on SCATS IDM data provided for the 15th of April 2013.

In the Light Rail scenario models, provision of a Light Rail crossing was assumed near the existing southernmost pedestrian crossing and adjacent to Olivia Gardens.

5.5.2.1. Key model assumptions

The following key assumptions were adopted in the models:

- Based on IDM data the existing pedestrian crossing was called (on average) every third cycle of the South Dowling Street/Cleveland Street traffic signals
- Based on existing (2012) traffic volumes. Future traffic patterns likely to be affected by light rail and should be assessed once wider area modelling by Transport for NSW is available
- No Special Events traffic volume data available at this stage, further analysis of special event traffic conditions may be required
- Frequency of Light Rail: every 2 minutes in each direction with element of variability in arrival pattern
- Assumed Light Rail Line Speed: 30km/hr
- Length of modelled Light Rail car: 45 metres
- No Priority Option: Phase for Light Rail is called only during green phase for Cleveland Street at the South Dowling Street/Cleveland Street intersection (Phase D)
- Medium Priority Option: Phase for Light Rail is called at any time during Phases D, E and F at the South Dowling Street/Cleveland Street intersection
- Special Event Option: 90m Light rail vehicles were tested in the PM peak only under the medium light rail signal priority. No AM peak modelling was undertaken for this scenario as special event, 90m shuttles, will only coincide with the PM peak hour.

5.5.2.2. Model output parameters

Comparison of the Base and Scenario models was undertaken using the following statistics:

- Vehicle travel times on South Dowling Street (northbound and southbound)
- Vehicle maximum queue lengths, and
- Intersection Level of Service
- Delay experienced by Light Rail
- Green time distribution at the Light Rail intersection

5.5.2.3. Model results

Table 5-14 to Table 5-18 detail the network performance statistics for the network.

Table 5-14 compares vehicle travel times along South Dowling Street under existing conditions with the expected travel times with the introduction of light rail under the “no priority” and “medium priority” scenario (during both the AM and PM peak).

Table 5-14: Comparison of vehicle travel times (seconds)

Travel time (s)	AM peak			PM peak			Special Events
	Base	No Priority	Med. Priority	Base	No Priority	Med. Priority	
South Dowling Street NB	107	111	114	132	136	132	138
South Dowling Street SB	97	99	106	109	106	115	122

Table 5-13 indicates that (relative to existing operation (i.e. base)) under the medium priority scenario vehicle travel times on South Dowling Street experience a 7% increase in the AM peak and show no change in the PM. Under the special event scenario the PM peak travel times increase further, showing a 5% increase when compared to existing operation.

Table 5-15 compares the maximum queue lengths at key intersections under existing conditions with the queue lengths expected with the introduction of light rail under the "no priority" and "medium priority" scenario.

Table 5-15 indicates that maximum queue lengths at the South Dowling Street/Cleveland Street intersection and South Dowling Street/Moore Park Road/Fitzroy Street intersection can be seen to be unaffected by the light rail crossing. Maximum queue lengths on the integrated Light Rail/Pedestrian crossing can be seen to increase up to maximum of 158m in the Special Event Scenario. These queue lengths can be contained within the existing storage space available and does not impact upon network operations.

Table 5-15: Comparison of Maximum queue lengths (m)

Queue lengths (m)	AM peak			PM peak			Special Events
	Base	No Priority	Med. Priority	Base	No Priority	Med. Priority	
South Dowling Street NB	233	232	231	219	224	218	214
Cleveland Street EB	130	126	133	118	114	116	117
South Dowling Street SB	71	78	78	144	130	158	135
Cleveland Street WB	224	225	225	128	126	122	126
Pedestrian Crossing NB	29	96	158	65	85	122	139
Pedestrian Crossing SB	20	55	63	49	112	109	119
South Dowling Street NB	122	99	118	93	81	84	73
South Dowling Street SB	39	39	39	80	78	78	78
Moore Park Road	97	95	95	114	104	108	105

Table 5-16 compares the level of services for key intersections under existing arrangements with the expected level of service assuming the introduction of light rail for both the "no priority" and "medium priority" scenario. Table 5-16 indicates that intersection levels of service are largely unaffected by the introduction of light rail.

Table 5-16: Comparison of Level of Service

	AM peak			PM peak			Special Events
Level of Service	Base	No Priority	Med. Priority	Base	No Priority	Med. Priority	
S. Dowling/ Cleveland Intersection	D	D	D	C	C	C	C
Pedestrian Crossing/LR Intersection	A	A	A	A	A	A	A
S. Dowling/Moore Intersection	B	B	B	B	B	B	B

Table 5-17 compares the average delay experienced by light under the "no priority" and "medium priority" scenario. Table 5-17 illustrates that the level of delay experienced by light rail varies considerably depending upon the level of priority offered. Delays of between 11-23 seconds can be achieved with a medium level of priority that maintains traffic coordination of the key north-south intersections. Under the Special Events scenario this delay decreases further to 4-9 seconds as a result of the longer green times provided at the crossing (see Table 5-18 below).

Table 5-17: Comparison of Average Delay experienced by Light Rail (seconds)

	AM peak			PM peak			Special Events
Delays	Base	No Priority	Med. Priority	Base	No Priority	Med. Priority	
Light Rail EB	N/A	44	20	N/A	46	11	9
Light Rail WB	N/A	53	22	N/A	54	23	4

Table 5-18 outlines the green time distribution during the traffic phase and light rail phase for both the "no priority" and "medium priority" scenario.

Table 5-18: Comparison of green time distribution on Light Rail intersection

	AM peak			PM peak			Special Events
Green distribution (s)	Base	No Priority	Med. Priority	Base	No Priority	Med. Priority	
Traffic phase	120	98	59	120	98	50	58
Light Rail phase	N/A	19	22	N/A	21	21	38

5.5.2.4. Conclusions

Analysis of above results shows that introduction of a signalised, at grade crossing for light rail marginally affects current performance of the road network. Introduction of the crossing does increase traffic journey times by up to 7% in this section of the road network, but intersection levels of service and queue lengths are not significantly affected.

It should be noted that further analysis using special event traffic volumes and post light rail traffic assignments would provide a greater level of certainty to the road network impacts.

5.5.3. Network assessment

The reallocation of road space from traffic lanes to dedicated light rail running will result in a change to existing traffic patterns and network performance on and around the light rail corridor. These impacts have been assessed and determined through a mesoscopic modelling assessment undertaken by TfNSW. The following data, findings and mitigation measures are based on the initial modelling analysis undertaken by TfNSW. The modelling and analysis is subject to on-going development and consultation with RMS as the road network is refined for operation with CSELR.

5.5.3.1. Network performance measures

Global performance

The high level network statistics provide a good indication of how the network performs and these can be defined in terms of average speed, vehicle hours travelled (VHT) and vehicle kilometres travelled (VKT) for all vehicles in the network in the defined study area. Such statistics enable a relative comparison to be made between the 'with' and 'without' Light Rail scenarios. Increases in VKT indicate that vehicles are travelling longer distances to avoid congestion and thus minimise delay. Increases in VHT indicate increased delays and build-up of congestion in the network.

In addition, the number of vehicles that passed through and waiting outside the network can provide an indication of the ability of modelled road network to cater for future demands.

Network traffic volumes

The introduction of Light Rail results in a reduction in traffic capacity on several key roads within the CBD and south-east suburbs, including George Street, Rawson Place, Chalmers Street / Elizabeth Street, Devonshire Street, Anzac Avenue and Alison Road. Traffic volume changes on roads are an indicator of traffic redistribution resulting from traffic 'hot spots'.

Network speeds

Complementary to traffic volumes changes, variations to the travel speeds by road segment throughout the network were also assessed. This is a measure of congestion on various roads as indicated by low operating speeds.

Intersection delays

The intersection average delay is the primary criteria for assessing the level of service (LOS) for signalised intersections. The intersection average delay is calculated in the model by determining the average delay for each approach to the node.

5.5.3.2. 2021 assessment year and demand development

An assessment year of 2021 was adopted for consistency with TfNSW's Public Transport Project Model (PTPM) and the Freight Movement Model (FMM). These models provided the basis for future road network demand that was used as a direct input to the mesoscopic modelling. The resulting traffic demand is shown in Figure 5-32. These demand totals indicate there is a 7% increase in traffic demand between 2012 and 2021 without the introduction of Light Rail, and only a 6% increase in the same period with the introduction of Light Rail as a result of increased public transport usage.

It should be noted that due to the level of congestion in the PM peak model, a flat demand profile across the 4 hour period has been assumed. This reflects peak spreading, which is a common driver response to increased congestion during peak periods.

Figure 5-32: Traffic demand [117]

Table 3.1: Growth between 2012 and 2021 (AM four hour peak period)

Scenario	Total Demand	Difference to 2012 Base
2012 Base	286,400	
2021 No Light Rail	305,800	19,400 (7%)
2021 With Light Rail	302,300	15,900 (6%)

Table 3.2: Growth between 2012 and 2021 (PM four hour peak period)

Scenario	Total Demand	Difference to 2012 Base
2012 Base	335,200	
2021 No Light Rail	357,900	22,700 (7%)
2021 With Light Rail	353,900	18,700 (6%)

5.5.3.3. 2021 Do-minimum assessment

To provide a basis for comparative assessment of the future road network impacts of light rail a do-minimum scenario model was developed. This accounts for future traffic growth on the road network without the implementation of the light rail project. The network wide statistics are provided below in Figure 5-33 and Figure 5-34 and compared to the existing situation.

[117] Mesoscopic traffic modeling undertaken by Transport for NSW, 2013

Figure 5-33: 2021 Do-minimum network performance statistics – AM peak[118]

Statistic	2012 Base	2021 Do Minimum Scenario	% Change
Full Model Area			
VHT (8-9am)	11,045hrs	12,776hrs	16%
Normalised VHT (6-10am)	36,338hrs	43,642hrs	20%
VKT (8-9am)	364,316km	381,468km	5%
Normalised VKT (6-10am)	1,259,408km	1,314,229km	4%
Average Speed All (8-9am)	34.0km/h	31.4km/h	-8%
Normalised Average Speed All (6-10am)	34.6km/h	31.4km/h	-9%
Average Speed Bus (8-9am)	18.6km/h	22.2km/h	19%
Average Speed Bus (6-10am)	19.4km/h	22.6km/h	16%
Average Delay (8-9am)	64sec/km	74 sec/km	16%
Average Delay (6-10am)	56sec/km	68 sec/km	21%
Vehicles in Network (at 10am)	8,705	13,015	50%
CBD Cordon			
VHT (8-9am)	2,651hrs	3,103hrs	17%
VHT(6-10am)	8,216hrs	10,288hrs	25%
VKT (8-9am)	72,287km	73,738km	2%
VKT (6-10am)	243,603km	251,814km	3%
Average Speed All (8-9am)	27.2 km/h	23.8 km/h	-13%
Average Speed All (6-10am)	29.6 km/h	24.5 km/h	-17%
Average Speed Bus (8-9am)	10.5 km/h	13.5 km/h	29%
Average Speed Bus (6-10am)	10.9 km/h	13.4 km/h	23%
Vehicles in Cordon (at 10am)	2,112	2,912	38%

118 Mesoscopic traffic modeling undertaken by Transport for NSW, 2013

Figure 5-34: 2021 Do-minimum network performance statistics – PM peak[119]

Statistic	2012 Base	2021 Do Minimum Scenario	% Change
Full Model Area			
VHT (5-6pm)	11,816hrs	15,433hrs	31%
Normalised VHT (3-7pm)	46,278hrsc	60,956hrs	32%
VKT (5-6pm)	370,895km	379,403km	2%
Normalised VKT (3-7pm)	1,429,419km	1,590,409km	11%
Average Speed All (5-6pm)	32.8km/h	28.3km/h	-14%
Normalised Average Speed All (3-7pm)	30.9km/h	26.1km/h	-16%
Average Speed Bus (5-6pm)	16.8km/h	15.4km/h	-8%
Average Speed Bus (3-7pm)	17.2km/h	16.8km/h	-2%
Average Delay (5-6pm)	70sec/km	106sec/km	51%
Average Delay (3-7pm)	69sec/km	99sec/km	43%
Vehicles in Network (at 7pm)	12,057	22,616	88%
CBD Cordon			
VHT (5-6pm)	2,894hrs	4,236hrs	46%
VHT(3-7pm)	10,829hrs	15,031hrs	39%
VKT (5-6pm)	71,778km	71,558km	0%
VKT (3-7pm)	278,874km	279,102km	0%
Average Speed All (5-6pm)	24.8km/h	16.9 km/h	-32%
Average Speed All (3-7pm)	25.7km/h	18.6 km/h	-28%
Average Speed Bus (5-6pm)	9.6km/h	7.4 km/h	-23%
Average Speed Bus (3-7pm)	9.9km/h	8.0 km/h	-19%
Vehicles in Cordon (at 7pm)	2,296	5,443	137%

These statistics clearly demonstrate that by 2021, without the implementation of light rail, the Sydney road network will experience significant increases to delay and congestion compared to existing levels as a result of the forecast increase in traffic demand on the network. Key statistics include a:

- A significant increase of between 4,000 to 10,000 vehicles retained in the network at the end of the peak periods. This indicates that there is a significant shortfall in network capacity that prevents these vehicles from completing their trip by the end of the peak periods.
- 17% reduction in general traffic speeds in the CBD and a 9% reduction in the wider network during the AM peak.
- 23% increase to bus speeds in the CBD and a 16% increase outside the CBD as a result of the do minimum bus changes that would be implemented if CSELR were not to be constructed. The additional improvements within the CBD cordon may also result from the increased congestion on the periphery of the network preventing vehicles from reaching the CBD therefore frees some capacity for buses.
- 28% reduction in general traffic speeds in the CBD and a 16% reduction in the wider network during the PM peak.
- 19% reduction in bus speeds in the CBD and a 2% reduction in the wider network during the PM peak as a result of increased traffic congestion.

[119] Mesoscopic traffic modeling undertaken by Transport for NSW, 2013

5.5.3.4. 2021 with light rail scenario

Network statistics

The network wide statistics of the with Light Rail scenario in 2021 are provided below in Figure 5-35 and Figure 5-36 with a comparison provided to the 2021 Do Minimum scenario.

Figure 5-35: 2021 light rail network performance statistics – AM peak[120]

Statistic	2021 Do Minimum Scenario	2021 Light Rail Scenario Model	% Change
Full Model Area			
VHT (8-9am)	12,776hrs	13,015hrs	2%
Normalised VHT (6-10am)	43,642hrs	43,155hrs	-1%
VKT (8-9am)	381,468km	383,269km	0%
Normalised VKT (6-10am)	1,314,229km	1,366,034km	4%
Average Speed All (8-9am)	31.4km/h	31.2km/h	-1%
Normalised Average Speed All (6-10am)	31.4km/h	31.6km/h	1%
Average Speed Bus (8-9am)	22.2km/h	21.1km/h	-5%
Average Speed Bus (6-10am)	22.6km/h	21.7km/h	-4%
Average Delay (8-9am)	74 sec/km	79 sec/km	7%
Average Delay (6-10am)	68 sec/km	70 sec/km	3%
Vehicles in Network (at 10am)	13,015	10,986	-16%
CBD Cordon			
VHT (8-9am)	3,103hrs	3,224hrs	4%
VHT(6-10am)	10,288hrs	10,115hrs	-2%
VKT (8-9am)	73,738km	74,141km	1%
VKT (6-10am)	251,814km	253,369km	1%
Average Speed All (8-9am)	23.8 km/h	23.0 km/h	-3%
Average Speed All (6-10am)	24.5 km/h	25.0 km/h	2%
Average Speed Bus (8-9am)	13.5 km/h	13.0 km/h	-4%
Average Speed Bus (6-10am)	13.4 km/h	13.6 km/h	1%
Vehicles in Cordon (at 10am)	2,912	2,677	-8%

The AM results indicate the following when compared to the 2021 Do Minimum:

Full Model Area:

- 2% increase in total time travelled by all vehicles
- 4% increase in total distance travelled by all vehicle
- Average speed for all vehicles decreases by 1% from 13.6km/h to 13.4km/h
- A decrease in average speed for buses from 22.6km/h to 21.7km/h (-4%)
- An increase in average delay for all vehicle from 68sec/km to 70sec/km (+3%)
- A 16% reduction in vehicles remaining in the network at the end of the AM peak.

The significant reduction in vehicles contained within the network indicates an overall increase in network capacity as a result of CSELR and the revised bus networks. The above results appear to indicate a 3-4% increase in delay to both buses and general traffic in the wider model area,

[120] Mesoscopic traffic modeling undertaken by Transport for NSW, 2013

however this will in part be due to the increased network capacity permitting additional vehicles to enter the network that were unable to do so in the Do Minimum scenario.

CBD Cordon:

- 2% reduction in total time travelled by all vehicles
- 1% increase in total distance travelled by all vehicles
- Average speed for all vehicles increases by 2% from 24.5km/h to 25.0km/h
- Average speed for buses increases by 1% from 13.4km/h to 13.6km/h
- An 8% reduction in vehicles remaining in the network at the end of the AM peak

In the CBD, a slight increase in the distance travelled by vehicles occurs as a result of changed circulation and diversion of traffic off George Street. However all other statistics demonstrate that the CBD operates more efficiently. Average bus and general traffic speeds are maintained whilst fewer vehicles remain in the network at the end of the AM peak period indicating an increased level of capacity.

Figure 5-36: light rail network performance statistics – PM peak[121]

Statistic	2021 Do Minimum Scenario	2021 Light Rail Scenario Model	% Change
Full Model Area			
VHT (5-6pm)	15,433hrs	14,540hrs	-6%
Normalised VHT (3-7pm)	60,956hrs	58,377hrs	-4%
VKT (5-6pm)	379,403km	379,212km	0%
Normalised VKT (3-7pm)	1,590,409km	1,584,329km	0%
Average Speed All (5-6pm)	28.3km/h	29.9km/h	6%
Normalised Average Speed All (3-7pm)	26.1km/h	27.1km/h	4%
Average Speed Bus (5-6pm)	15.4km/h	16.0km/h	4%
Average Speed Bus (3-7pm)	16.8km/h	16.6km/h	-1%
Average Delay (5-6pm)	106sec/km	96sec/km	-9%
Average Delay (3-7pm)	99sec/km	94sec/km	-5%
Vehicles in Network (at 7pm)	22,616	15,102	-33%
CBD Cordon			
VHT (5-6pm)	4,236hrs	3,630hrs	-14%
VHT(3-7pm)	15,031hrs	13,562hrs	-10%
VKT (5-6pm)	71,558km	71,054km	-1%
VKT (3-7pm)	279,102km	285,792km	2%
Average Speed All (5-6pm)	16.9 km/h	19.6km/h	16%
Average Speed All (3-7pm)	18.6 km/h	21.1km/h	13%
Average Speed Bus (5-6pm)	7.4 km/h	7.9km/h	7%
Average Speed Bus (3-7pm)	8.0 km/h	8.4km/h	5%
Vehicles in Cordon (at 7pm)	5,443	2,885	-47%

[121] Mesoscopic traffic modeling undertaken by Transport for NSW, 2013

The PM results indicate the following when compared to the base case:

Full Model Area:

- 4% reduction in total time travelled by all vehicles
- No change in total distance travelled by all vehicles
- An increase in average speed for all vehicles from 26.1km/h to 27.1km/h (4%)
- A decrease in average speed for buses from 16.8km/h to 16.6km/h (-1 %)
- A decrease in average delay for all vehicles from 99sec/km to 94sec/km (-5%)
- A 33% reduction in vehicles remaining in the network at the end of the PM peak

As with the AM peak, the PM peak modelling indicates a significant increase to the wider network capacity, with 7,000 fewer vehicles remaining in the network at the end of the peak period. This additional capacity is achieved with reduced average delay and increased speeds for general traffic and only a marginal reduction in bus speeds.

CBD Cordon:

- 10% decrease in total time travelled by all vehicles
- 2% increase in total distance travelled by all vehicles
- Average speed for all vehicles increases by 13% from 18.6km/h to 21.1km/h
- Average speed for buses increases by 5% from 8.0km/h to 8.4km/h
- A 47% reduction in vehicles remaining in the network at the end of the PM peak

The CBD experiences an even greater improvement to performance, with approximately half of the residual demand in the network at the end of the peak when compared to the Do Minimum. This improved level of capacity also results in improved speeds for buses (+5%) and general traffic (13%).

Traffic flow changes

The impacts of the proposed Light Rail network along with the new city centre bus network redesign result in a complex and varied change in traffic conditions throughout the average weekday.

These traffic pattern changes can be summarised as follows:

- Traffic accessing the CBD from Parramatta Road/Broadway is likely to divert to Wattle Street/Harris Street to access city via Western Distributor/King Street, William Henry Street/Pier Street and Ultimo Road to avoid George Street/Pitt Street where capacity has been reduced due to the Light Rail.
- Kent Street, Sussex Street and Clarence Street (for buses) will take on a higher order role for access to the northern CBD as well as access to the Harbour Bridge. There will be a need to consider the management of these streets in terms of an arterial function as opposed to local access function.
- Kent Street will take on a more important access role for the Rocks, Dawes Point, and Barangaroo.
- Castlereagh Street and Elizabeth Street will be subject to significant increased usage by general traffic and buses and there is a clear need to develop supplementary north south traffic corridors on the CBD eastern periphery such as Macquarie Street, College Street, and Wentworth Avenue, as per the SCCAP.

- Capacity reduction due to Light Rail along Devonshire Street and the Railway Square precinct is likely to see increased traffic filtering through Surry Hills via Campbell Street, Hunt Street, and Goulbourn Street.
- A east-west traffic diversion to Cleveland Street is forecast, which will call for a management plan to further improve the operation of this already congested corridor.
- In the north-south direction, there are diversions to the Cahill Expressway/Eastern Distributor to avoid the CBD surface road system.
- To the south in Kensington, Randwick and Kingsford, Light Rail implementation will require a number of turn restrictions in Anzac Parade as well as capacity reductions along the entire corridor. This results in forecast traffic diversions to the local street network.

To address the effects of these potential changed traffic patterns, TfNSW and RMS are working together to identify appropriate upgrade measures. These will be developed around the CCAS and associated priority corridors by mode. This work is on-going and includes additional modelling assessment at the strategic and operational levels to refine the optimal solution. This work will be completed prior to construction of CSELR commencing.

Intersection performance statistics

CBD & Surry Hills – light rail corridor

The CBD is subject to other major changes in its functionality as part of the CCAS, of which CSELR and the city centre bus network redesign form part. The CCAS and bus network redesign will undergo a separate public consultation process and therefore do not form part of the EIS for the CSELR. Due to the on-going work to define the network management approach at the intersection level, detailed assessment of the CSELR impacts has been restricted to the corridor, as shown in Table 5-19.

Table 5-19: CBD CSELR corridor intersection performance

Intersection	8-9AM		5-6PM	
	2021 Scenario 1		2021 Scenario 1	
	Delay	LoS	Delay	LoS
George St / Albert St	10	A	8	A
George St / Essex St	14	A	22	B
George St / Grosvenor St / Bridge St	37	C	42	C
George St / Bond St	46	D	71	F
George St / Hunter St	47	D	49	D
George St / King St	15	B	14	A
George St / Market St	39	C	31	C
George St / Park St / Druitt St	52	D	30	C
George St / Bathurst St	27	B	38	C
George St / Central St	6	A	12	A
George St / Liverpool St	12	A	19	B
George St / Goulburn St	12	A	32	C
George St / Campbell St	14	A	14	A
George St / Hay St	31	C	13	A
George St / Ultimo Rd	26	B	37	C
George St / Rawson Pl	55	D	57	E
Pitt St / Rawson Pl	81	F	57	E

Intersection	8-9AM		5-6PM	
	2021 Scenario 1		2021 Scenario 1	
Eddy Ave Crossing	55	D	4	A
Elizabeth St / Eddy Ave / Foveaux St	49	D	19	B
Devonshire St/ Chalmers St	27	B	35	C
Devonshire St/ Elizabeth St	30	C	41	C
Devonshire St/ Crown St	27	B	31	C
Devonshire St/ Bourke St	16	B	20	B

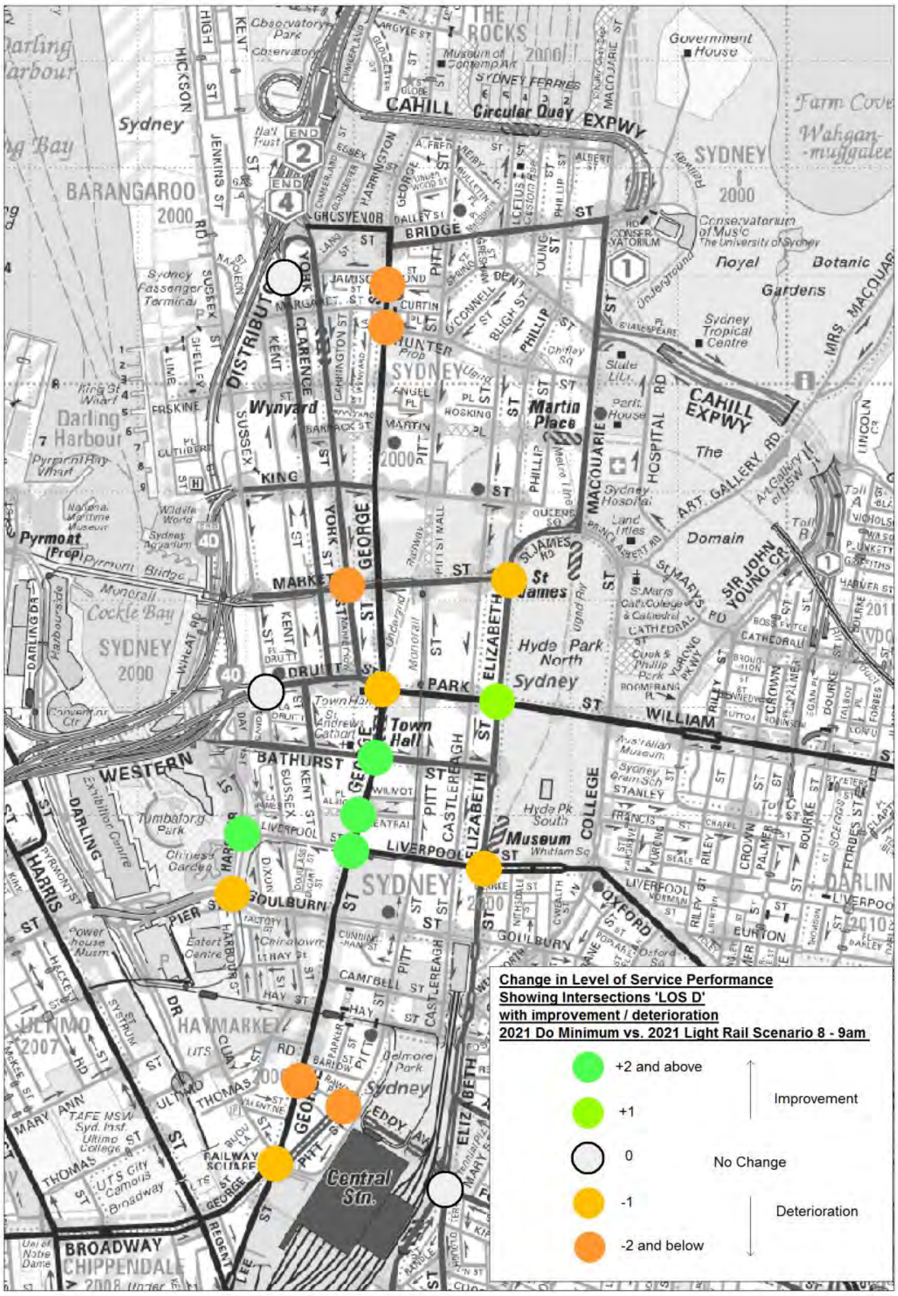
The above statistics demonstrate that of 23 key signalised intersections 22 will operate within capacity at an acceptable LoS (between A-D) in the AM peak, reducing to 20 in the PM peak. Those sites that are operating either at or over capacity are as follows:

- George Street / Bond Street – Is expected to operate at LoS F in the PM peak. This is due to increased demand on Bond Street making use of the westbound connection provided by Bond and Jamison Streets across the light rail corridor.
- George Street / Rawson Place – is expected to operate at LoS E in the PM peak. This is due to the competing bus light rail and traffic movements that occur at this intersection. Opportunities to optimise the phase timings will be investigated to provide improved performance.
- Pitt Street / Rawson Place – Is expected to operate at LoS F in the AM peak and LoS E in the PM peak. This is due to the provision of an additional right turn bus only phase to allow buses to turn right from Pitt Street into Eddy Avenue. The requirement for this phase is under review as part of the bus planning process and its removal would result in improved intersection LoS.

CBD – wider network

In addition to the corridor assessment, the future intersection performance of the wider CBD network with and without the introduction of the CSELR proposal was assessed. The figures below compare the forecast peak hour intersection performance of the 2021 Do Minimum and 2021 light rail scenario. The colour coding illustrates the performance of key intersections that operate at LoS D or worse in either scenario. The green denotes improved level of service with the CSELR proposal, whilst the amber identifies deterioration in level of service. The performance comparisons are shown below in Figure 5-37 and Figure 5-38.

Figure 5-37: Change in CBD intersection level of service – AM peak [122]



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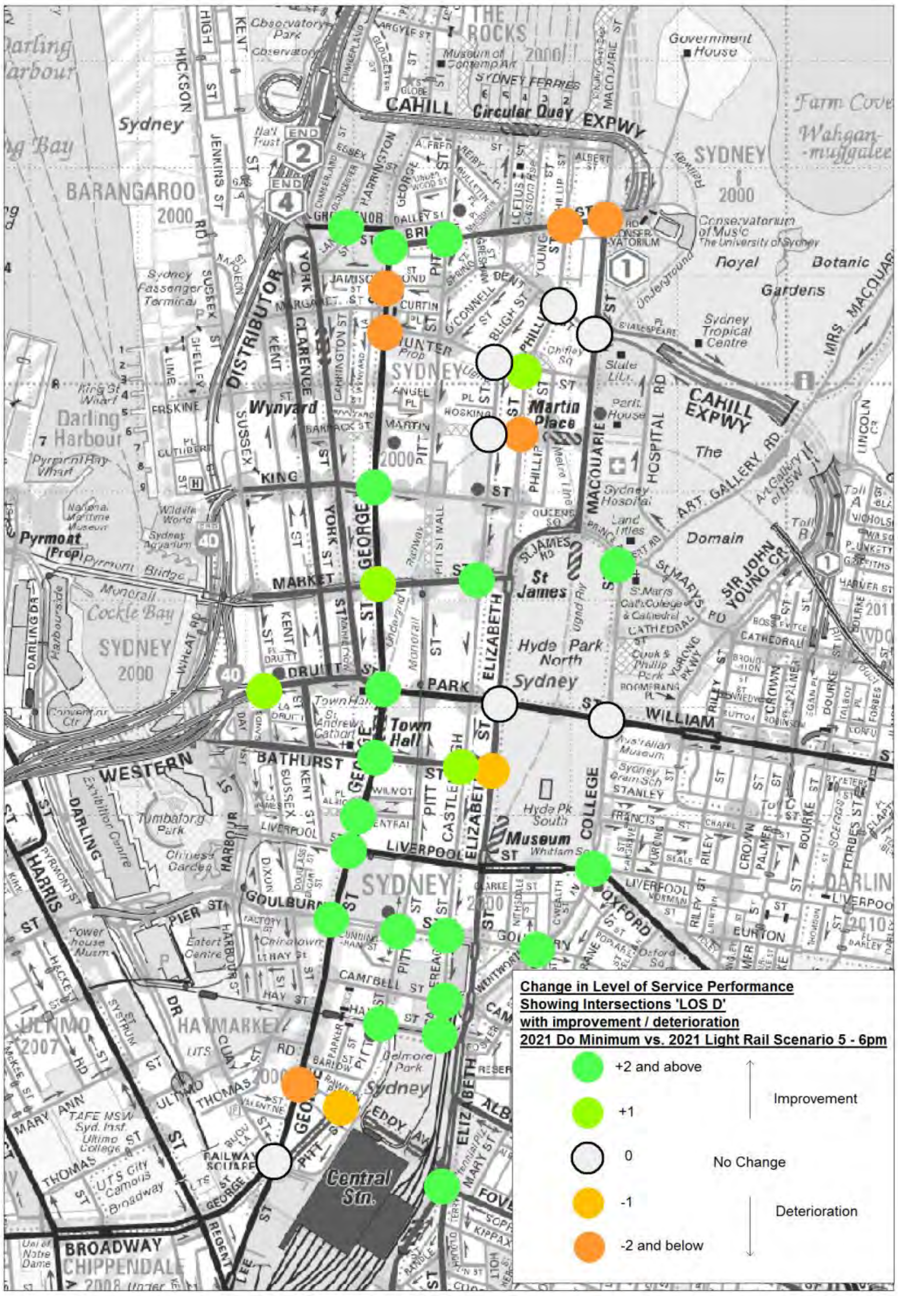
[122] Mesoscopic traffic modelling undertaken by TfNSW, 2013

Figure 5-38: Change in CBD intersection level of service – PM peak[123]



The above statistics demonstrate a shift in intersection delay to the southern section of the CBD, most notably Rawson Place and Pitt Street, and away from the George Street corridor as a result of its reduced importance as a strategic traffic route. The exceptions to this are:

- Bathurst Street – providing an important connection to the CCT and northern most point before the pedestrianised zone.
- Goulburn Street – Experiences additional traffic volumes as a result of the closure of Rawson Place

[123] Mesoscopic traffic modelling undertaken by TfNSW, 2013

- Hunter and Grosvenor Street intersections – These two intersections represent the key northern CBD east-west traffic routes.
- Essex Street – Experiences additional traffic volumes due to its importance in providing access to the Rocks.

The CBD network modelling forecasts that there will be decreased congestion and decreased delay at most intersections in the CBD under a future scenario whereby the project is implemented compared to a scenario in which the project is not implemented (business as usual). The future intersection performance changes in the CBD are as a result of the pedestrianisation of George Street and implementation of light rail and the CBD bus network redesign. These changes will re-prioritise certain north-south CBD routes, notably George Street, Elizabeth Street and Castlereagh Street, diverting some demand onto alternative north-south routes.

The introduction of light rail and the CBD bus network re-design will however facilitate a degree of modal shift from car to public transport and the broader CBD road network changes will result in changes to the distribution and volumes of traffic. If the project is not implemented, and a business as usual scenario eventuates, traffic congestion is forecast to worsen significantly, especially in the PM peak, resulting in increased delay to all modes. The implementation of the proposed road network changes to accommodate light rail, pedestrianisation and the bus network changes is forecast to improve the future year operation of the road network over a business as usual scenario.

The modelling demonstrates that College Street, Castlereagh Street and George Street will perform better in future in the PM peak if these road network changes are implemented whilst some 'hotspots' are shown on Elizabeth Street, notably in the morning peak hour. However it should be feasible to minimise any adverse impacts on the Elizabeth Street corridor through further work currently being undertaken by RMS and TfNSW to refine the modelling and design options presented with the aim of further reducing the impacts across the CBD road network.

South East – light rail corridor

Intersection levels of service and delay for the south eastern corridors are provided in Figure 5-39 and Figure 5-40.

Figure 5-39: South east corridors AM Peak intersection LoS[124]

Intersection	8-9AM					
	2012 Base		2021 Do Minimum		2021 Scenario 1	
	Delay	LoS	Delay	LoS	Delay	LoS
Anzac Pde / Alison Rd	57	E	88	F	83	F
Anzac Pde / Todman Ave	22	B	45	D	55	D
Anzac Pde / Addison St	10	A	24	B	3	A
Anzac Pde / Doncaster Ave	14	A	18	B	23	B
Anzac Pde / High St	12	A	12	A	66	E
Anzac Pde / Barker St	18	B	19	B	42	C
Anzac Pde / Middle St	10	A	11	A	62	E
Anzac Pde / Borrodale Rd	23	B	31	C	41	C
Anzac Pde / Rainbow St	-	-	-	-	62	E
Alison Rd / Doncaster Ave	20	B	18	B	29	C
Alison Rd / Darley Rd	28	B	29	C	44	D
Alison Rd / John St	16	B	24	B	21	B
Alison Rd / Cowper St	14	A	13	A	14	A
Alison Rd / Wansey Rd	-	-	-	-	27	B
High St / Wansey Rd	-	-	-	-	13	A
High St / Botany St	29	B	25	B	22	B
High St / Avoca St	19	B	18	B	25	B
Avoca St / Cuthill St	12	A	14	A	24	B
Belmore Rd / Cuthill St	8	A	9	A	24	B

[124] *Mesoscopic traffic modelling undertaken by TfNSW, 2013 adapted by AECOM*

Figure 5-40: South east corridors PM Peak intersection LoS[125]

Intersection	5-6PM					
	2012 Base		2021 Do Minimum		2021 Scenario 1	
	Delay	LoS	Delay	LoS	Delay	LoS
Anzac Pde / Alison Rd	38	C	57	E	44	D
Anzac Pde / Todman Ave	24	B	37	C	34	C
Anzac Pde / Addison St	14	A	13	A	3	A
Anzac Pde / Doncaster Ave	19	B	25	B	41	C
Anzac Pde / High St	20	B	24	B	63	E
Anzac Pde / Barker St	34	B	50	D	35	C
Anzac Pde / Middle St	13	A	34	C	12	A
Anzac Pde / Borrodale Rd	21	B	18	B	19	B
Anzac Pde / Rainbow St	-	-	-		35	C
Alison Rd / Doncaster Ave	24	B	22	B	26	B
Alison Rd / Darley Rd	21	B	45	D	42	B
Alison Rd / John St	13	A	12	A	20	B
Alison Rd / Cowper St	19	B	17	B	21	B
Alison Rd / Wansey Rd	-	-		-	21	B
High St / Wansey Rd	-	-		-	17	B
High St / Botany St	26	B	20	B	29	C
High St / Avoca St	29	C	35	C	47	D
Avoca St / Cuthill St	12	A	13	A	17	B
Belmore Rd / Cuthill St	6	A	6	A	13	A

These results show that the key intersections experiencing degraded levels of service are:

- Anzac Parade / Alison Road – In the AM peak a LoS F is expected to be achieved. Whilst this is a reduction from existing levels of service it still provides improved performance to the Do Minimum scenario. This intersection is the subject of on-going design refinement to optimize its operation in consultation with RMS.
- Anzac Parade / High Street – This intersection is expected to operate at LoS E in both the AM and PM peak periods. This reduction in LoS from A/B in the existing and Do Minimum scenarios results from the light rail alignment switching from centre running to enter UNSW land on the eastern side of Anzac Parade. This change in the alignment is to ensure the high volumes of passengers can access the light rail stop without crossing Anzac Parade. Further refinement of the design is underway in consultation with RMS to optimize operation.
- Anzac Parade / Middle Street – This intersection is expected to operate at LoS E in the AM peak. This reduction in LoS from A in the existing and Do Minimum scenarios is due to the loss of through traffic lanes on Anzac Parade, combined with increased eastbound demand on Strachan Street. Improved performance may be achievable through further optimization of the signal phasing.

[125] *Mesoscopic traffic modelling undertaken by TfNSW, 2013 adapted by AECOM*

South East – wider network

Intersection levels of service and delay for key intersections in the wider south eastern road network are provided in Figure 5-41 and Figure 5-42.

Figure 5-41: South east wider network AM Peak intersection LoS[126]

Intersection	8-9AM					
	2012 Base		2021 Do Minimum		2021 Scenario 1	
	Delay	LoS	Delay	LoS	Delay	LoS
Anzac Pde / Moore Park Rd	28	B	30	C	57	E
Moore Park Rd / Lang Rd	35	C	41	C	33	C
Oxford St / Ocean St	32	C	31	C	46	D
Oxford St / York Rd	21	B	26	B	44	D
Cleveland St / South Dowling St	48	D	50	D	51	D
Anzac Pde / Lang Rd	38	C	45	D	42	C
Lachlan St / South Dowling St	69	E	63	E	83	F
O'Dea Ave / South Dowling St	49	D	60	E	94	F
Todman Ave / Lenthall St	16	B	15	B	19	B
Alison Rd / Botany St	25	B	24	B	27	B
Alison Rd / Belmore Rd	25	B	27	B	35	C
Alison Rd / Avoca St	33	C	30	C	33	C
Avoca St / Rainbow St	27	B	30	C	31	C
Avoca St / Barker St	30	C	34	C	32	C
Avoca St / Frenchmans Rd	39	C	36	C	34	C
Avoca St / Clovelly Rd	21	B	21	B	21	B
Avoca St / Darley Rd	46	D	52	D	58	E
Gardeners Rd / Eastern Ave	9	A	11	A	19	B

[126] *Mesoscopic traffic modelling undertaken by TfNSW, 2013 adapted by AECOM*

Figure 5-42: South east wider network PM Peak intersection LoS[127]

Intersection	5-6PM					
	2012 Base		2021 Do Minimum		2021 Scenario 1	
	Delay	LoS	Delay	LoS	Delay	LoS
Anzac Pde / Moore Park Rd	38	C	50	D	51	D
Moore Park Rd / Lang Rd	28	B	41	C	29	C
Oxford St / Ocean St	30	C	27	B	28	B
Oxford St / York Rd	10	A	12	A	10	A
Cleveland St / South Dowling St	45	D	81	F	57	E
Anzac Pde / Lang Rd	44	D	65	E	45	D
Lachlan St / South Dowling St	47	D	50	D	41	D
O'Dea Ave / South Dowling St	83	F	86	F	89	F
Todman Ave / Lenthall St	16	B	20	B	20	B
Alison Rd / Botany St	20	B	14	A	19	B
Alison Rd / Belmore Rd	18	B	21	B	23	B
Alison Rd / Avoca St	32	C	29	C	30	C
Avoca St / Rainbow St	31	C	47	D	32	C
Avoca St / Barker St	31	C	39	C	27	B
Avoca St / Frenchmans Rd	35	C	41	C	32	C
Avoca St / Clovelly Rd	26	B	28	B	27	B
Avoca St / Darley Rd	56	D	52	D	43	D
Gardeners Rd / Eastern Ave	7	A	9	A	13	A

These results show that the key intersections experiences degraded levels of service are:

- Anzac Parade / Moore Park Road
- Lachlan Street / South Dowling Street
- O'Dea Avenue / South Dowling Street
- Cleveland St / South Dowling St
- Avoca Street / Darley Road

These reductions in LoS occur as a result of changed traffic patterns on the network once light rail is implemented. These changed traffic patterns require revised traffic signal control plans and corridor strategies to ensure the movements with the heaviest demands are adequately catered for. As part of the network management plan to be implemented with light rail, potential upgrade measures will be considered at these locations or in the surrounding area.

5.5.3.5. Network management plan

The identification of appropriate management measures and coordination of their implementation would be delivered through the CSELR Network Management Plan (NMP). As identified in the CTTMS, this plan would operate in four main phases, with CSLER operations forming the final phase, as shown in Figure 5-43.

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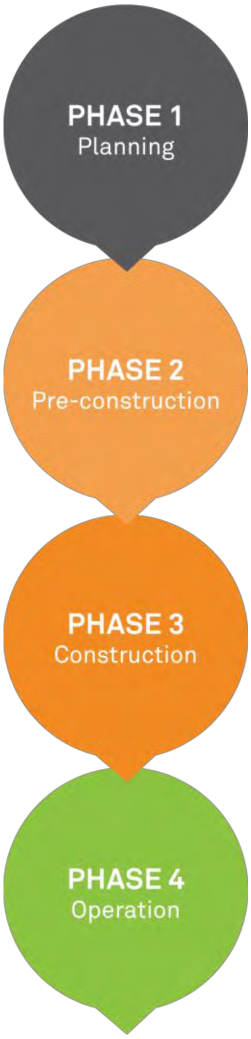
[127] Mesoscopic traffic modelling undertaken by TfNSW, 2013 adapted by AECOM

Figure 5-43: CSELR network management plan phases of operation



The NMP would have the high level objective of maintaining network journey times and congestion levels at acceptable levels, with TfNSW being responsible for developing and maintaining the NMP in consultation with stakeholders.

Through consultation with agencies and assessment of forecast impacts to the transport network, the NMP would result in a holistic approach to mitigate the effects of construction and operation and result in the maximum effectiveness of these measures. The plan would consist of three main elements:

- Incident Management Strategy
- Demand Management Strategy
- Network Optimisation Strategy

The Incident Management strategy would be in place to increase resilience of the road network when unplanned events occur on the network, whilst the Demand Management and Network Optimisation strategies would seek to maximise the efficiency of the network in response to the changed conditions following light rail implementation. The latter two strategies will seek to address the impacts identified through the traffic analysis and will develop as the light rail design is optimised by the PPP Contractor.

5.5.3.6. Demand management strategy

A reduction in travel demand would ensure the changes to the road network bought about by the CSELR project do not lead to a significant increase in congestion on the network. Managing traffic generation by congestion is considered an inappropriate way to reduce demand as it leads to increased travel times, air quality degradation and accidents. Further congestion also adversely impacts on public transport trips, thus deceasing the efficiency of the whole transport system.

TfNSW will work alongside the relevant road authorities to develop appropriate demand management strategies both during construction and operations of CSELR. The successful implementation of these measures will reduce peak hour travel demand and ensure network efficiency is not compromised. These demand management strategies would be integrated with network optimisation measures which are being developed as part of the CCAS, to ensure their maximum effectiveness.

5.5.3.7. Network optimisation strategies

In conjunction with the demand management measures, targeted traffic management upgrades may also be undertaken to improve general traffic circulation in the vicinity of the light rail project. Within the CBD, these measures will also form part of the Sydney City Centre Access Plan which identifies the priority traffic routes as shown in Figure 5-44 and, in part, the city centre bus network redesign. These plans seek to ensure the CBD operates effectively from the perspective of all modes. At the time of writing the specific traffic management interventions were not identified for inclusion in this assessment.

Outside of the CBD TfNSW will continue to work with local Councils and RMS to mitigate the local traffic impacts and potential increased traffic flows that may occur on local roads as a result of the Project.

Figure 5-44: Priority Traffic Routes in the CBD[128]

5.5.3.8. Conclusions

By the year 2021 traffic volumes in the study area are forecast to grow by 7% without the implementation of light rail. As a result of this growth on the network average vehicle speeds are likely to reduce by approximately 10% from current levels.

Implementation of light rail is forecast to reduce this level of traffic growth by 1% due to the positive effect it has on public transport mode share and as a result contributes to improved traffic and bus operations. Whilst the reallocation of road space from general traffic to light rail causes a significant change to existing traffic operating patterns on and around the corridor it does not significantly negatively impact functionality of the wider network.

[128] Draft Sydney City Centre Access Strategy, 2013

In the AM peak, when compared to the 2021 Do Minimum scenario, CSELR would result in only a small reduction in travel speeds for general traffic of 0.2km/hr. Bus speeds also see a small reduction of 4% when compared to the bus plan implemented as part of the Do Minimum scenario. However, when compared to the existing situation, CSELR and the bus plans will deliver a 12-25% increase to existing bus speeds on the network.

In the PM peak, when compared to the 2021 Do Minimum scenario, CSELR would improve general traffic speeds in the wider network by 1km/hr or 4%. Bus speeds remain relatively stable with only a 0.2km/hr (~1%) reduction. In the CBD, light rail results in a general improvement in operations with an increase in general traffic speeds of 2.5km/hr or 13% and bus speeds increasing by 0.4km/hr or 5%.

Broadly speaking the traffic analysis demonstrates that the CSELR project can be introduced into the road network without significant detrimental impact to general traffic and buses. A number of critical intersections have been identified where further design and optimisation work is underway, with potential solutions identified.

To address the effects of the identified future traffic patterns, TfNSW and RMS are working together to develop an appropriate Network Management Plan (NMP). This includes intersection modifications, traffic signal changes and traffic management measures that integrate to deliver the overall strategy for network operations with CSELR in place. This work is ongoing and the modelling assessment undertaken to date represents the first stage in the development of this wider NMP. As this plan is refined further improvement to the operation of the network is likely to be achieved.

TfNSW will continue to work closely with RMS and local Councils to mitigate the potential network and local traffic impacts including potential increased traffic flows that may occur on local roads as a result of the Project.

6. Project Parking Strategy

6.1. Context

As identified in Section 2, the Project corridor has a range of kerbside uses and travel functions along the route. Available kerbside capacity is balanced with travel lanes for general traffic, buses, cyclists and pedestrians with variations in permitted kerbside activity across the day based on the travel demands on the corridor.

Existing kerbside activity includes the following common categories of uses: disability parking; bus stops and bus lanes; loading zones; taxi zones; short stay parking (restricted); long stay parking (both restricted and unrestricted); as well as certain other special designations.

The introduction of light rail on-street through the Sydney CBD and the inner eastern suburbs of Surry Hills, Randwick, Kensington and Kingsford will require re-allocation of road space between transport modes, kerbside uses and travel lanes. This will require changes to kerbside access.

The aim of the Project parking strategy is to develop an appropriate parking policy response complementary to the preferred light rail alignment, with measures balancing project design with corridor movement and access to land uses and for stakeholders along the corridor.

The development of this strategy included assessment of existing supply, demand and utilisation of parking spaces and loading zones along with an assessment of the reduction in parking and loading facilities that will be generated as a result of the introduction of the CSELR. This assessment, along with the Kerbside Access Policy Management Framework (Figure 6-1) was used to develop recommendations as to what alternative arrangements would be required to mitigate any potential project impacts. Management and mitigation of the impact on parking and loading will be critical to stakeholder acceptance, however it is also recognised that a balance needs to be struck between competing demands to ensure efficient use of public road space.

This section sets out the development of the strategy, defines the context of kerbside access related to the Project and identifies the impacts of the Project and how it is proposed that these impacts be manage, including detailed local area proposals for mitigation.

6.2. Parking strategy development

6.2.1. Definition of objectives and policy principles

The objectives and policy principles have been designed to align with best practice in transport and land use planning to ensure the most efficient use of available road space at all times of day for travel along the road corridor as well as access to local land uses.

The key objectives of the parking strategy are:

- To ensure the most efficient use of publicly available road space;
- To provide appropriate levels of access to land uses on the corridor and in surrounding precincts;
- To balance this requirement with the safe people movement function and travel demands on the Project corridor and in these surrounding precincts; and
- To derive an efficient and equitable balance between supply of, and demand for, parking, loading and other kerbside access needs.

The key policy principles to guide the strategy, designed to meet the strategic objectives are set out below:

1. To optimise available capacity, **define a hierarchy of kerbside access for parking and loading supply**.
2. Define a broad range of **policy responses to balance parking demands against supply** and create the environment within which the hierarchy of kerbside access can be maintained and provided for on a precinct by precinct basis.
3. **Emphasise the mass transit function of surface public transport** and its ability to move large volumes of people efficiently within fixed road space and recognise the need to afford due priority to public transport through lane allocation and kerbside infrastructure;
4. Where feasible, **retain all existing parking and loading supply** on the Project corridor;
5. Where feasible, **replace impacted parking and loading supply on the Project corridor with new parking supply** on the corridor although recognising the need to balance efficiency of kerb side space for all modes and uses; or,
6. Where this is not feasible, **consider opportunities to balance efficiency in kerbside access for the corridor and adjacent streets within the same precinct** together by improving overall demand utilisation working within existing supply parameters;
7. In balancing efficiency, **optimise the available capacity on the Project corridor, and in surrounding precincts,** by managing parking and loading supply to ensure overall efficiency of potential kerbside road space and kerbside access.

The following sub-section (Section 6.2.1.1) sets out a kerbside access management hierarchy and policy framework used to determine an appropriate mitigation strategy for retention, replacement and management of demand and supply. This responds to policy principles 1 and 2.

Policy principles 3 to 7 are discussed later under mitigation and management in Section 6.4.1.

6.2.1.1. Kerbside access hierarchy and policy response

A hierarchy of kerbside access for parking and loading has been established which prioritises potential kerbside uses (shown in Table 6-1 and Figure 6-1). This has been developed to ensure the most critical parking and loading functions can be accommodated within the publicly available road space.

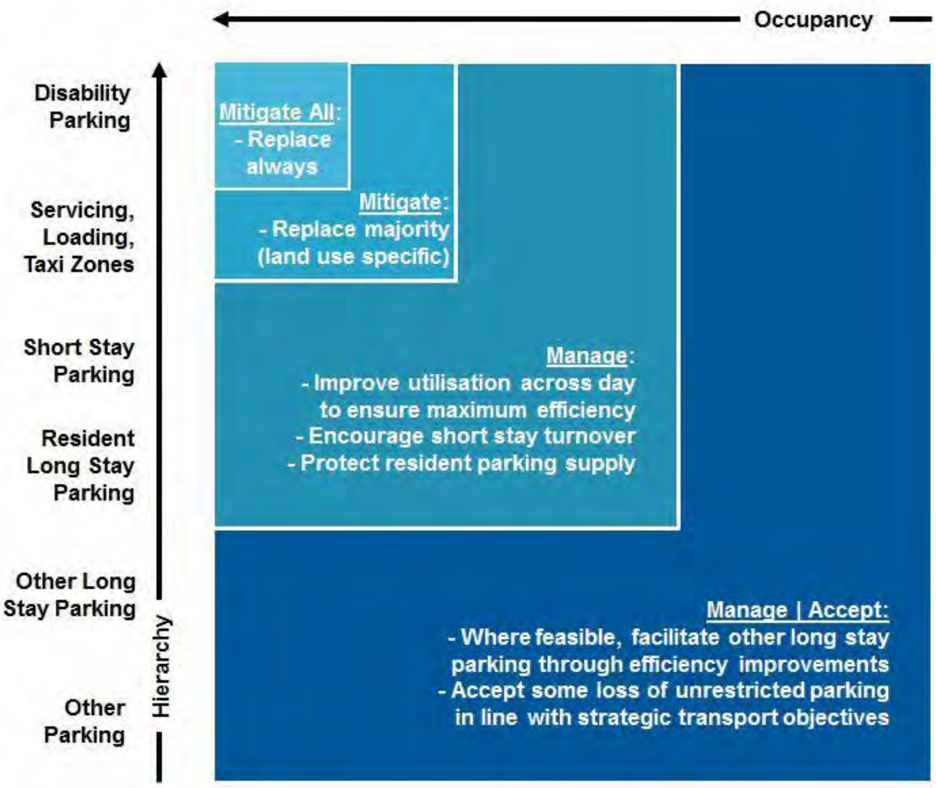
The hierarchy developed includes the following major categories, in order of priority, from highest to lowest: disability parking, servicing & loading, short stay parking, long stay parking, other parking needs.

Table 6-1 defines this hierarchy of kerbside access user requirements hierarchy and the designated preferred mitigation strategy proposed in the strategy development. Figure 6-1 defines the policy responses adopted for the Project based on the defined hierarchy of kerbside access and related to demand utilisation levels (or occupancy).

Table 6-1: Kerbside access hierarchy and preferred mitigation strategy

Kerbside access use class		Preferred mitigation strategy
1	**Disability parking**	Replace all existing spaces which need to be removed with 'like for like' provision as close as possible to existing provision.
2	**Servicing & loading**	Ensure adequate provision of servicing and loading to meet local land use requirements, notably for commercial premises and residential premises with no alternative servicing opportunities. This may require: new loading and servicing zone provision; new taxi zone provision; local consolidation of loading and servicing within precincts; and management of loading and servicing access i.e. time restrictions or localised access provision on the alignment (in limited circumstances).
3	**Short stay**	Provide replacement short term parking along the alignment, within the same precinct and consider additional opportunities outside the corridor, such as in the side streets in commercial zones (potentially as 'dual use' parking shared with residential parking)
4	**Long stay**	Consider alternative long term residential parking opportunities on adjacent streets within the same precinct.
5	**Other**	Provide adequate parking to meet access requirements as deemed necessary on a case by case basis. This category includes but is not limited to: motorbike and scooter parking; and parking for special land uses such as medical uses including emergency vehicles, doctors and nurses.

Figure 6-1: Kerbside access policy management framework



6.3. Parking assessment

6.3.1. Methodology

The parking assessment consisted of five key phases:

1. Assessment of existing parking supply on the corridor and in surrounding precincts;
2. Assessment of the impact of the Project on parking supply on the corridor;
3. Assessment of parking demand, occupancy and utilisation on the corridor and in surrounding precincts;
4. Assessment of the impact on parking demand on the corridor; and
5. Management of parking demand and supply on the corridor and in surrounding precincts.

Each of these phases is explained in more detail below.

This approach was adopted for the four south-eastern precincts impacted by the Project, where a precinct wide approach to assess the impacts of displaced parking was required.

In contrast, the nature of kerbside use within the CBD is inherently different to the south-east precincts with a much greater focus on loading and very short term supply and demand.

Due to the low quantum of parking within the CBD that will be impacted by the Project, the CBD assessment focuses on identifying project impacts and investigating the potential to mitigate all directly impacted loading and other kerbside uses within adjacent streets. In addition, the Sydney City Centre Access Strategy (CCAS) speaks more broadly to the management of kerbside space in the CBD and will be used as the overarching strategy for managing CBD kerbside activity and the implementation of change for all projects impacting the CBD.

6.3.1.1. Phase 1: existing parking supply

Phase 1 of the parking assessment identified the existing parking supply and kerbside uses on the Project corridor and in surrounding precincts. An audit identified the parking restrictions currently operating on the road network within the Project corridor and the surrounding precincts.

The audit was undertaken on a precinct by precinct basis, identifying the type, location and quantum of existing parking restrictions and kerbside activity zones. In addition a review of the land uses surrounding the Project corridor was undertaken.

6.3.1.2. Phase 2: impact of the Project on parking supply on the corridor

Phase 2 considered the potential impacts on kerbside capacity from the introduction of the light rail alignment. The assessment was undertaken to:

- Quantify the magnitude of impact of the Project on kerbside capacity on the corridor
- Assist with definition of appropriate policy responses to mitigate this impact
- Assist in developing measures for further investigation, consultation and implementation

6.3.1.3. Phase 3: demand, occupancy and utilisation

Phase 3 assessed parking demand, utilisation, turnover and occupancy to quantify the impact of the introduction of light rail on parking demand along the corridor and the potential to achieve utilisation efficiencies across the corridor and surrounding precincts.

In addition to the inventory audit undertaken in Phase 1, a parking occupancy survey was undertaken to determine the precinct demand and existing user behaviour. The surveys recorded vehicles parked across three distinct time periods:

- **Pre-AM Peak** (before 7.30am)
- **Interpeak** (between 10:00am and 2:00pm)
- **Post-PM Peak** (after 6.30pm)

Partial number plates were collected to allow for a comparison between time periods to calculate turnover and duration of stay for individual street sections, sub-precincts and precincts.

The survey extent included the Project corridor as well as streets within a walking catchment of light rail stops, the corridor and the major land uses in the precincts surrounding the corridor.

Existing parking demand was quantified with survey data documenting utilisation and turnover of the existing parking supply. The parking demand was categorised into low turnover (residential and commuter demand) reflecting long stay patterns of use and high turnover, short stay demand. For example, a vehicle found to remain within the precinct for the three observed time periods would be categorised as long stay.

A summary of the user categorisations applied within the survey is shown in Table 6-2.

Table 6-2: Parking Categorisation

Turnover	Parking user categorisation
High Turnover	**Short stay parking** ▪ Vehicle present in the Interpeak survey period only ▪ Vehicle present in the Post-PM Peak survey period only
Low Turnover	**Long stay parking (Residential)** ▪ Vehicle present in all three survey periods. ▪ Vehicle present in the Pre-AM Peak and either the Interpeak or the Post-PM Peak. ▪ Vehicle present during the Pre-AM Peak survey only. **Long stay parking (Other)** ▪ Vehicle present during the Interpeak and Post-PM Peak.

6.3.1.4. Phase 4: impact of the Project on parking demand on the corridor

Phase 4 considered the impacts to parking demand as a result of the Project. The assessment examined the demand of the parking directly impacted by the current design. The assessment was undertaken to:

- Provide a quantum of parking demand and occupancy directly impacted by the Project on a precinct by precinct basis
- Provide a quantum of turnover to assess the user type impacted by the Project
- Assist with definition of appropriate policy responses to mitigate the impact on demand
- Recommend steps for further investigation, assessment and consultation

6.3.1.5. Phase 5: assessment of the potential to balance parking supply and demand

Phase 5 of the impact assessment considered the opportunities to mitigate the Project impacts to parking supply and demand within the precincts. The assessment was undertaken to:

- Assess the occupancy of the existing parking supply and demand by sub-precincts
- Assess the capacity of the future parking supply to accommodate existing demand on a sub-precinct basis
- Assist with the development of targeted policy responses to mitigate the impact of the Project at a sub-precinct level

6.3.2. Phase 1: existing parking supply and land use

6.3.2.1. Existing parking supply on the corridor

The overall parking supply within the CSELR corridor was identified as part of an initial study to understand existing parking restrictions affecting the road network within the CSELR corridor.

Table 6-3 provides a summary of the parking provision on the CSELR corridor identified as part of an audit of the kerbside uses on the light rail alignment. It should be noted that not all existing spaces are available at all times, due to clearway and other restrictions.

Table 6-3: Summary of existing special kerbside uses and general parking supply on the corridor

Kerbside Restriction	Special Kerbside Uses and Parking Supply		
	Pre AM Peak	Inter Peak	Post PM Peak
Car Share, Hospital, Mail Zone	11	11	11
Disability Parking	12	12	12
Loading Zone	26	62	57
Taxi Zone	18	22	29
Total – Special Kerbside Uses	**67**	**107**	**109**
Short Stay (<2P) Parking	180	297	212
Long Stay (4-2P) Parking	127	142	140
Unrestricted Parking	459	468	552
Total – General Parking	**766**	**907**	**904**

A more thorough breakdown of the existing parking supply on the corridor on a precinct by precinct basis has been set out earlier in this report in Section 3

6.3.2.2. Existing parking supply in surrounding precincts

The following series of maps show the existing parking supply on the Project corridor and in the surrounding precincts. These maps display the quantum and parking restriction across three time periods for each of the south-eastern precincts. The three time periods illustrate the dynamic nature of parking supply throughout the day. The time periods are:

- Pre-AM Peak (before 7.30am);
- Interpeak (between 10.00am and 2.00pm); and

- Post-PM Peak (after 6.30pm).

The parking supply for each street section is shown in the following precinct maps. Each map illustrates the number of spaces of each restriction type within a discrete street section. It is important to note when reading the following figures that each discrete street section is coloured to represent the most frequently occurring restriction within that street block. This provides a visual representation of the dataset used, however the full suite of available data was used in development of the management strategy.

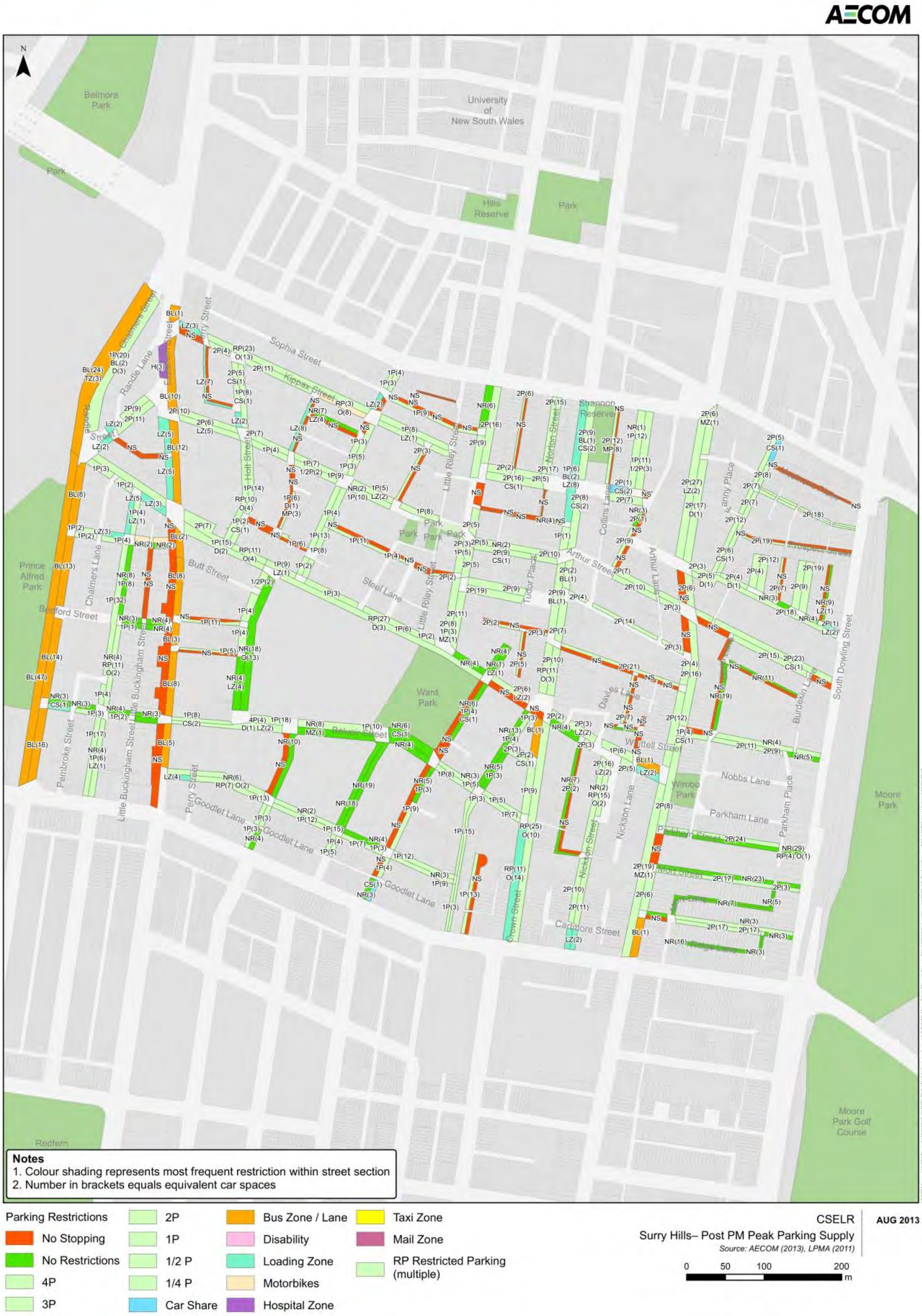
Surry Hills Precinct

Figure 6-2, Figure 6-3 and Figure 6-4 illustrate the parking supply within the Surry Hills precinct for the three time periods.

Figure 6-2 Surry Hills Precinct – Pre-AM Peak Parking Supply

Figure 6-3: Surry Hills Precinct – Interpeak Parking Supply

Figure 6-4: Surry Hills Precinct – Post-PM Peak Parking Supply



Kensington Precinct

Figure 6-5, Figure 6-6 and Figure 6-7 illustrate the parking supply within the Kensington precinct for the three time periods.

Figure 6-5: Kensington Precinct – Pre-AM Peak Parking Supply

Figure 6-6: Kensington Precinct – Interpeak Parking Supply

Figure 6-7: Kensington Precinct – Post-PM Peak Parking Supply

Kingsford Precinct

Figure 6-8, Figure 6-9 and Figure 6-10 illustrate the parking supply within the Kingsford precinct for the three time periods.

Figure 6-8: Kingsford Precinct – Pre-AM Peak Parking Supply

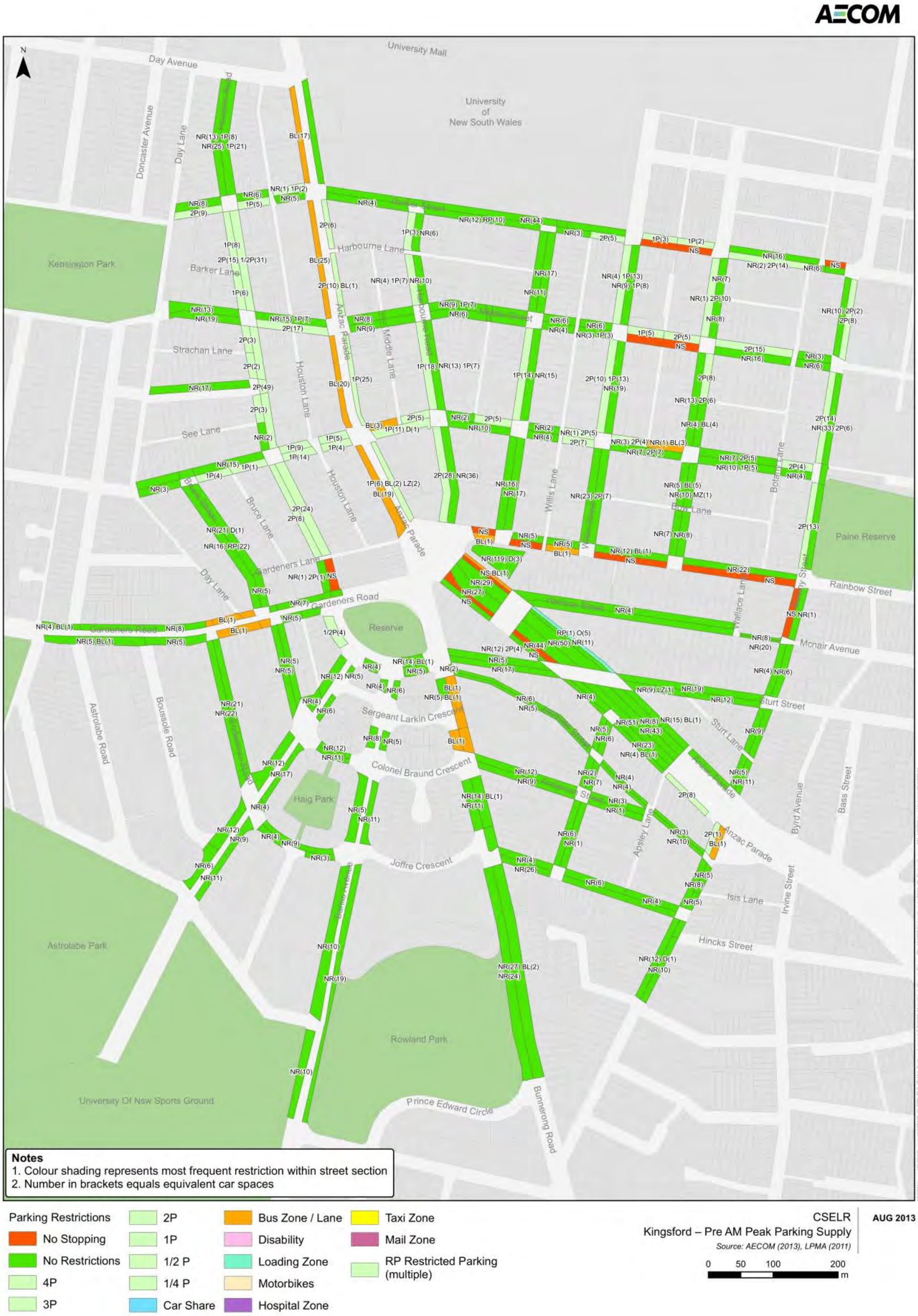


Figure 6-9: Kingsford Precinct – Interpeak Parking Supply

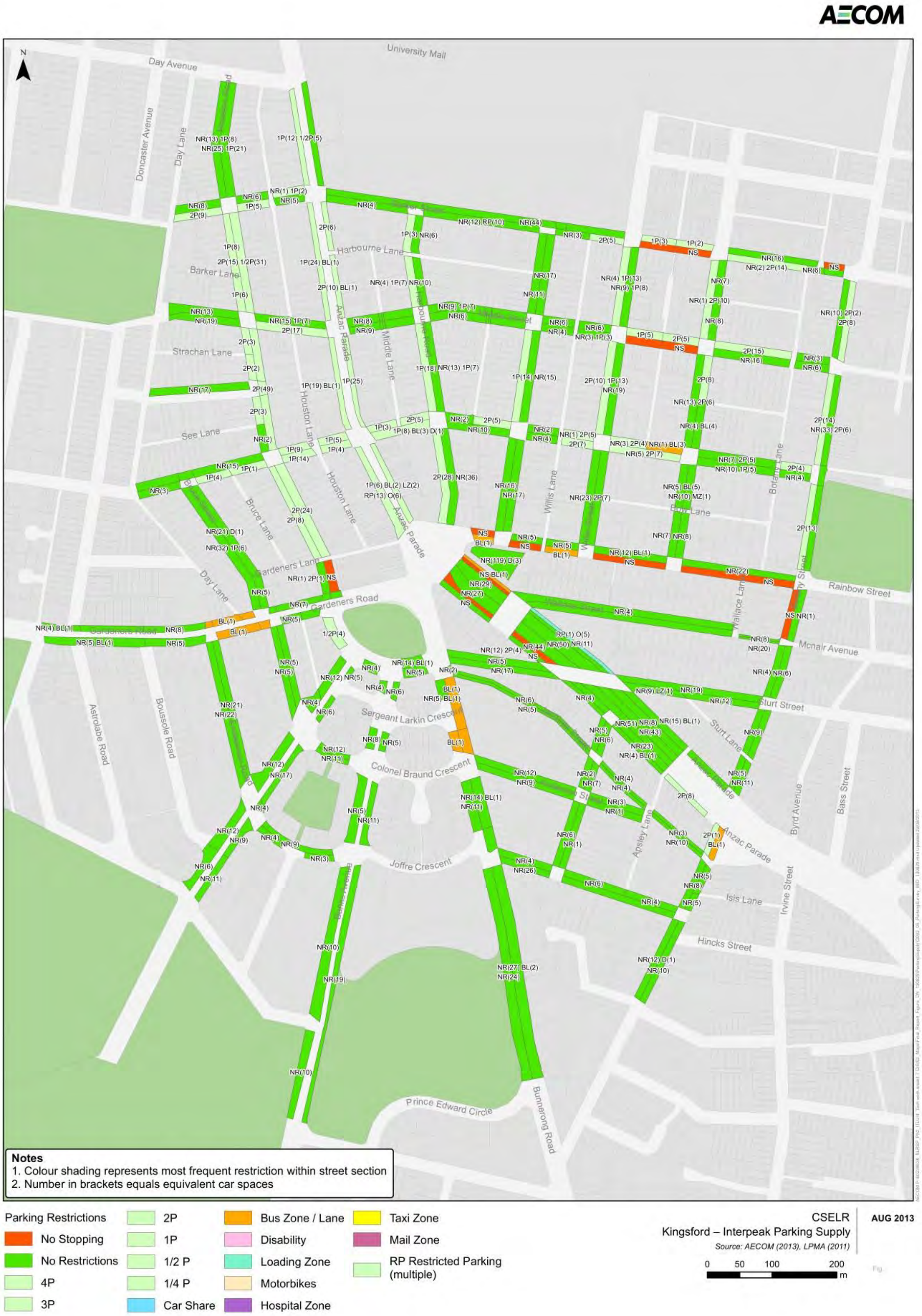
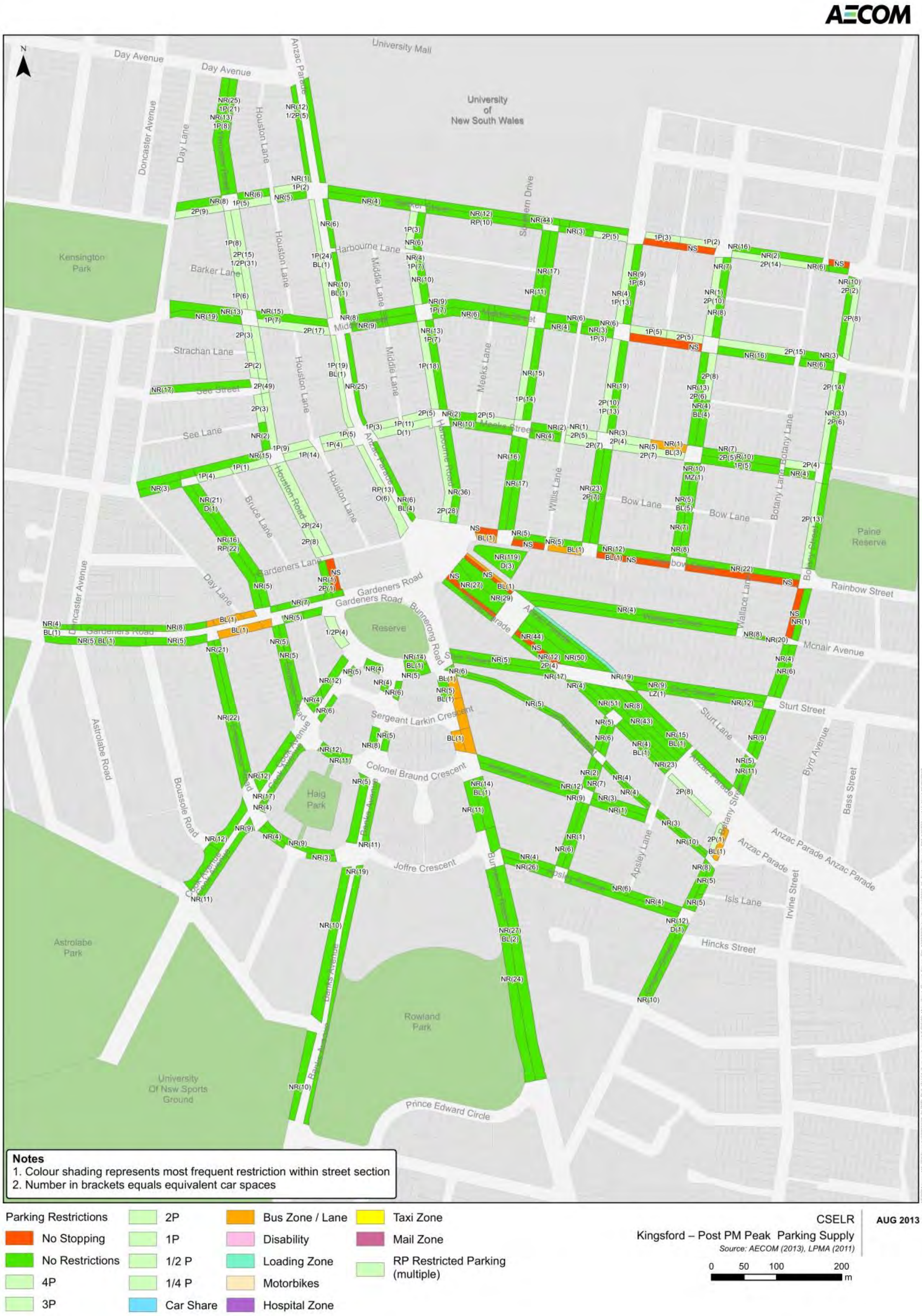


Figure 6-10: Kingsford Precinct – Post-PM Peak Parking Supply



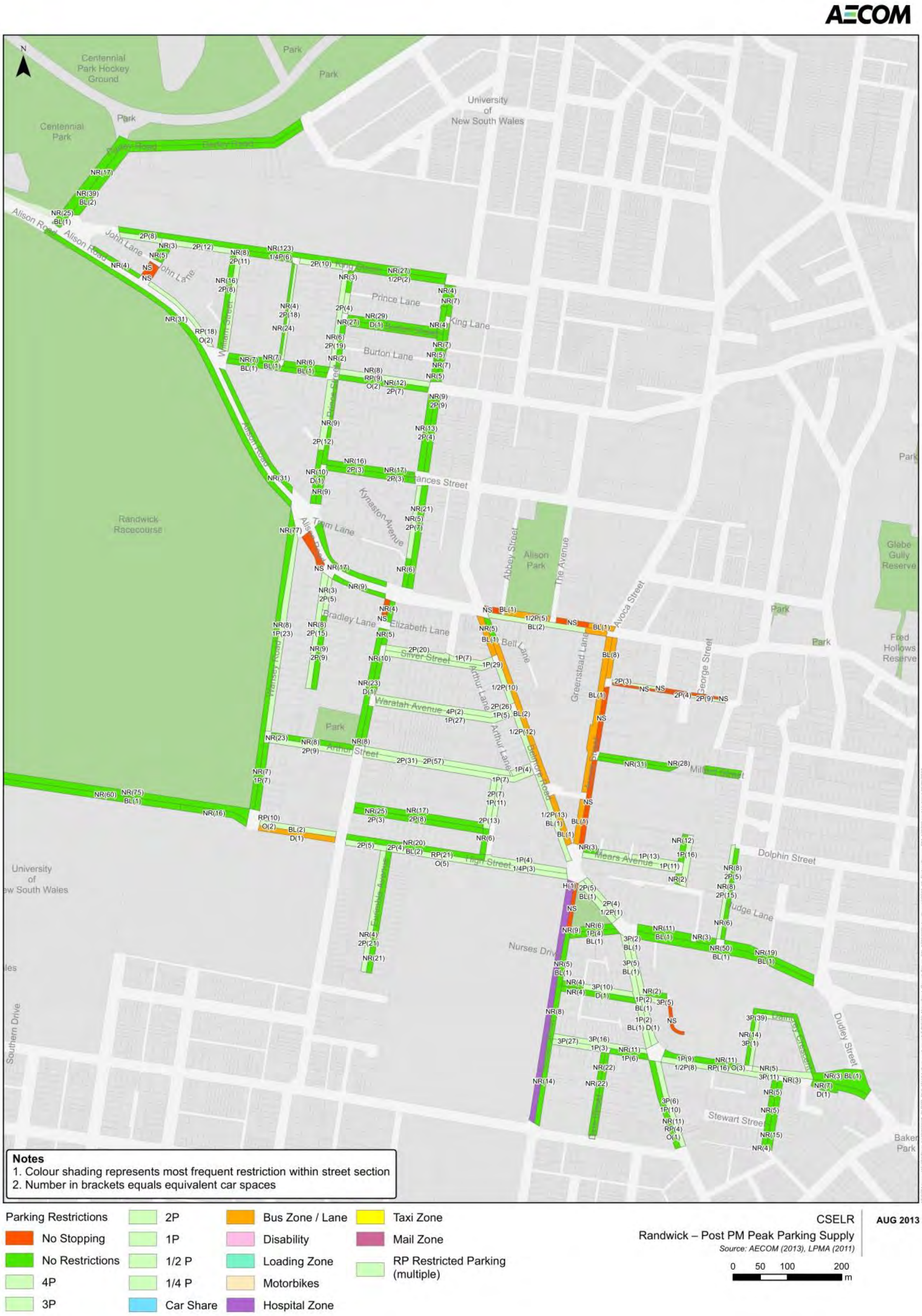
Randwick Precinct

Figure 6-11, Figure 6-12 and Figure 6-13 illustrate the parking supply within the Kingsford precinct for the three time periods.

Figure 6-11: Randwick Precinct Time – Pre-AM Peak Parking Supply

Figure 6-12: Randwick Precinct Time – Interpeak Parking Supply

Figure 6-13: Randwick Precinct – Post-PM Peak Parking Supply



6.3.2.3. Existing Land Uses

The figures in this section describe existing land uses along the Project corridor and in the surrounding precincts.

CBD Precinct

As illustrated in Figure 6-14, the CBD precinct primary land use is “metropolitan centre”.

Figure 6-14: CBD Precinct Existing Land Uses

Surry Hills Precinct

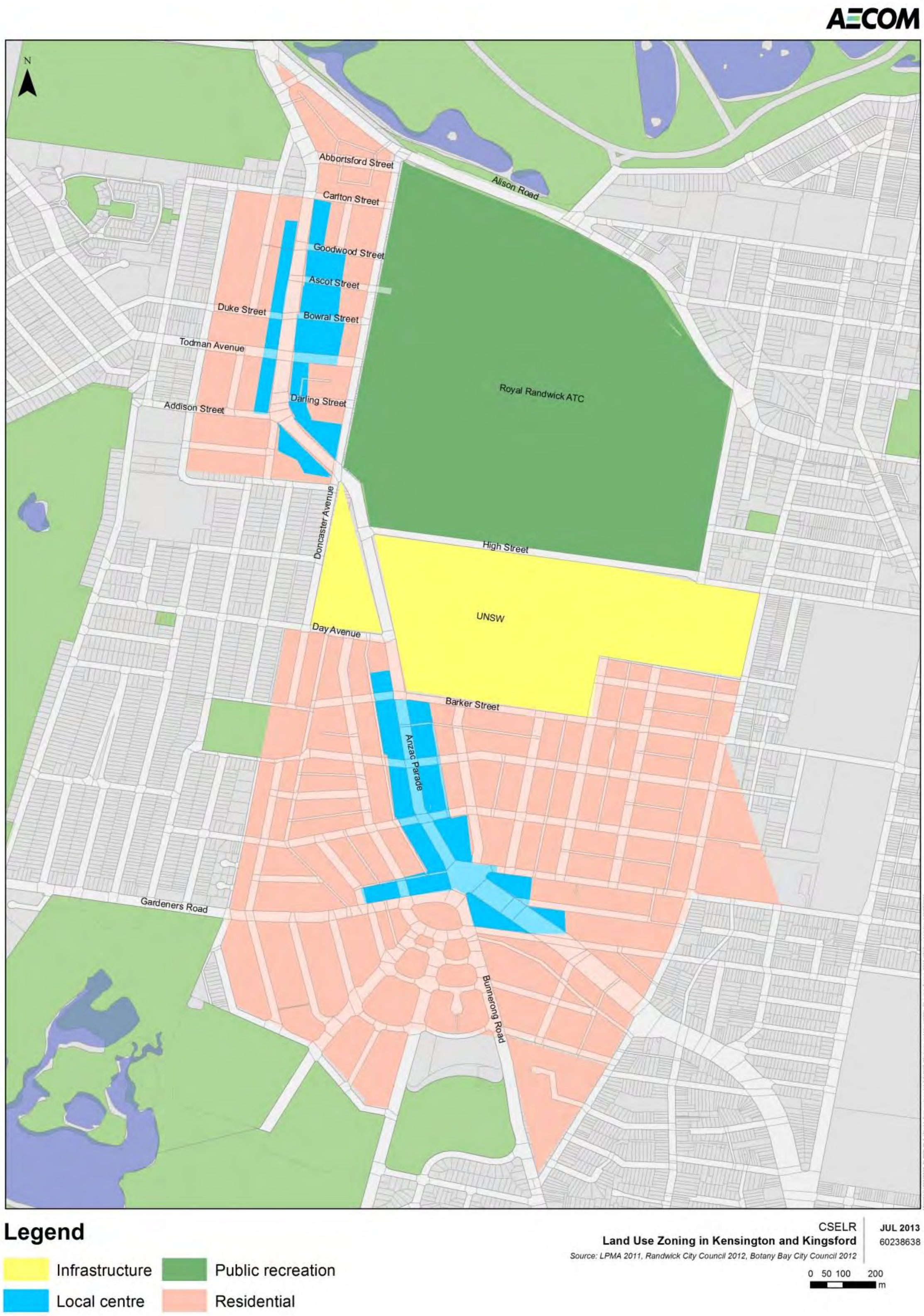
As illustrated in Figure 6-15 the Surry Hills precinct is dominated by public recreation, residential and mixed used land uses.

Figure 6-15: Surry Hills Precinct Existing Land Uses

Kensington/ Kingsford Precincts

As illustrated in Figure 6-16, the Kensington/Kingsford precinct contains residential, local centre, infrastructure and public recreation land uses.

Figure 6-16: Kensington/ Kingsford Precincts Existing Land Uses



Randwick Precinct

As illustrated in Figure 6-17 the Randwick precinct is dominated by residential land uses alongside major, regionally significant health and education infrastructure.

Figure 6-17: Randwick Precinct Existing Land Uses

6.3.3. Phase 2: impact of the Project on parking supply on the corridor

The strategy has assessed the potential impacts of the introduction of the Project with regards to kerbside access in the corridor. Due to the dynamic nature of parking restrictions throughout the day, three discreet time periods were assessed.

A summary table of the potential impacts following the implementation is provided in Table 6-4.

The CSELR alignment will impact the majority of existing roadside capacity in all time periods, due to the re-allocation of road space with centre running light rail and kerbside travel lanes. The impact is most severe during the Inter Peak periods.

Table 6-4: Impact on Special Kerbside Uses and General Parking Supply in the Project Corridor

Kerbside Restriction	Special Kerbside Uses and Parking Supply Impacts by Time Period		
	Pre-AM Peak (retained post implementation)	Inter Peak (retained post implementation)	Post-PM Peak (retained post implementation)
Car Share, Hospital, Mail Zone	11	11	11
Disability Parking	12	12	12
Loading Zone	26	62	57
Taxi Zone	13 (5)	17 (5)	24 (5)
Total – Special Kerbside Uses	**62 (5)**	**102 (5)**	**104 (5)**
Short Stay Parking (≤1P)	179 (1)	282 (15)	197 (15)
Long Stay Parking (Restricted)	123 (4)	138(4)	136 (4)
Long Stay Parking (Unrestricted)	459	468	552
Total – General Parking	**761 (5)**	**888 (19)**	**885 (19)**

The three discrete time periods are necessary to illustrate the dynamic nature of the parking supply throughout the day. Along the Project corridor the parking supply for each precincts will vary throughout the day in response multiple use sign plates, for example where a clearway operate in the peak direction, and part time loading zones. The parking supply impacts on a precinct by precinct basis are shown in Table 6-5, Table 6-6, Table 6-7, Table 6-8, and Table 6-9.

Table 6-5: Impact on Special Kerbside Uses and General Parking Supply within CBD

CBD Kerbside Restriction	Special Kerbside Uses and Parking Supply Impacts by Time Period		
	Pre-AM Peak (retained post implementation)	Inter Peak (retained post implementation)	Post-PM Peak (retained post implementation)
Car Share, Hospital, Mail Zone	4	4	4
Disability Parking	5	5	5
Loading Zone	6	42	39
Taxi Zone	10 (5)	14 (5)	21 (5)
Total – Special Kerbside Uses	**25 (5)**	**65 (5)**	**69 (5)**
Short Stay Parking (≤1P)	20	41	20
Long Stay Parking (Restricted)	7	22	43
Long Stay Parking (Unrestricted)	0	0	0
Total – General Parking	**27**	**63**	**63**

The key parking supply impacts within the CBD precinct include:

- Existing Pre-AM parking supply is limited due to clearways in operation along George Street.
- Short Stay and Long Stay (restricted) parking is primarily impacted by light rail stops located within Rawson Place and Chalmers Street.
- Parking impacts are greatest during the Interpeak and Post-PM Peak due to significant increase in supply once George Street clearways cease.

Table 6-6: Impact on Special Kerbside Uses and General Parking Supply within Surry Hills

Surry Hills Kerbside Restriction	Special Kerbside Uses and Parking Supply Impacts by Time Period		
	Pre-AM Peak (retained post implementation)	Inter Peak (retained post implementation)	Post-PM Peak (retained post implementation)
Car Share, Hospital, Mail Zone	3	3	3
Disability Parking	5	5	5
Loading Zone	15	15	15
Taxi Zone	0	0	0
Total – Special Kerbside Uses	**23**	**23**	**23**
Short Stay Parking (≤1P)	54	72	72
Long Stay Parking (Restricted)	48	48	48
Long Stay Parking (Unrestricted)	26	8	8
Total – General Parking	**128**	**128**	**128**

The key parking supply impacts within the Surry Hills precinct include:

- Five disability parking spaces are impacted along the southern side of Devonshire Street in the vicinity of Clisdell Street.
- The parking supply impacted along Devonshire Street is predominately comprised Short Stay and Long Stay (Restricted)

Table 6-7: Impact on Special Kerbside Uses and General Parking Supply within Kensington

Kensington Kerbside Restriction	Special Kerbside Uses and Parking Supply Impacts by Time Period		
	Pre-AM Peak (retained post implementation)	Inter Peak (retained post implementation)	Post-PM Peak (retained post implementation)
Car Share, Hospital, Mail Zone	1	1	1
Disability Parking	0	0	0
Loading Zone	0	0	0
Taxi Zone	0	0	0
Total – Special Kerbside Uses	**1**	**1**	**1**
Short Stay Parking (≤1P)	4	38 (14)	17 (14)
Long Stay Parking (Restricted)	7	7	0
Long Stay Parking (Unrestricted)	73	94	119
Total – General Parking	**84**	**139 (14)**	**136 (14)**

The key parking supply impacts within the Kensington precinct include:

- Long Stay Parking (Unrestricted) includes parking where no restrictions apply within the analysed time period. The Long Stay Parking (Unrestricted) includes sections of Anzac Parade where no restrictions apply outside of the clearway hours of operation.

Table 6-8: Impact on Special Kerbside Uses and General Parking Supply within Kingsford

Kingsford Kerbside Restriction	Special Kerbside Uses and Parking Supply Impacts by Time Period		
	Pre-AM Peak (retained post implementation)	Inter Peak (retained post implementation)	Post-PM Peak (retained post implementation)
Car Share, Hospital, Mail Zone	0	0	0
Disability Parking	0	0	0
Loading Zone	4	4	2
Taxi Zone	2	2	2
Total – Special Kerbside Uses	**6**	**6**	**4**
Short Stay Parking (≤1P)	32	68	25
Long Stay Parking (Restricted)	20	20	4
Long Stay Parking (Unrestricted)	173	173	232
Total – General Parking	**225**	**261**	**261**

The key parking supply impacts within the Kingsford precinct include:

- The impact to Long Stay Parking (Unrestricted) is primarily confined to the off-street parking within the Anzac Parade median south of Nineways.
- Central running light rail alignment and kerbside travel lanes will impact Short Stay parking along Anzac Parade.

Table 6-9: Impact on Special Kerbside Uses and General Parking Supply within Randwick

Randwick Kerbside Restriction	Special Kerbside Uses and Parking Supply Impacts by Time Period		
	Pre-AM Peak (retained post implementation)	Inter Peak (retained post implementation)	Post-PM Peak (retained post implementation)
Car Share, Hospital, Mail Zone	3	3	3
Disability Parking	2	2	2
Loading Zone	1	1	1
Taxi Zone	1	1	1
Total – Special Kerbside Uses	**7**	**7**	**7**
Short Stay Parking (≤1P)	69 (1)	63 (1)	63 (1)
Long Stay Parking (Restricted)	41 (4)	41(4)	41 (4)
Long Stay Parking (Unrestricted)	187	193	193
Total - General Parking	**297 (5)**	**297 (5)**	**297 (5)**

The key parking supply impacts within the Randwick precinct include:

- The impact to Long Stay Parking (Unrestricted) is primarily confined to the Alison Road and Wansey Road corridors.

6.3.3.1. Changes to parking supply as a result of South East bus network changes

There will be some additional changes to existing parking supply, associated with the SE bus network changes, to accommodate bus layover, as described in section 4. The full details of this, including the number of spaces and exact location, are being developed as part of the separate bus planning review. At this stage it is expected that a small amount of kerbside parking will be changed to a Bus Zone in Todman Avenue and in the vicinity of the light rail termini at Randwick and Kingsford. Further consultation as the changes will be undertaken as part of the Review of Environmental Factors (REF) for the SE bus network changes.

6.3.4. Phase 3: demand, occupancy and utilisation

Occupancy surveys of the precincts directly impacted by the Project were used to calculate the parking demand on the existing network. Analysis of the parking survey data was undertaken on a street by street basis, with the results categorized for each precinct. This analysis was undertaken for the southeastern precincts of Surry Hills, Kensington, Kingsford and Randwick.

The parking survey extents for each precinct are shown in the following figures. The four precincts were divided into sub-precinct zones, illustrated by different colours on the figures, for the purpose of detailed analysis.

Figure 6-18: Surry Hills Survey Precinct – with Sub-Precinct zones

Figure 6-19: Kensington Survey Precinct – with Sub-Precinct zones

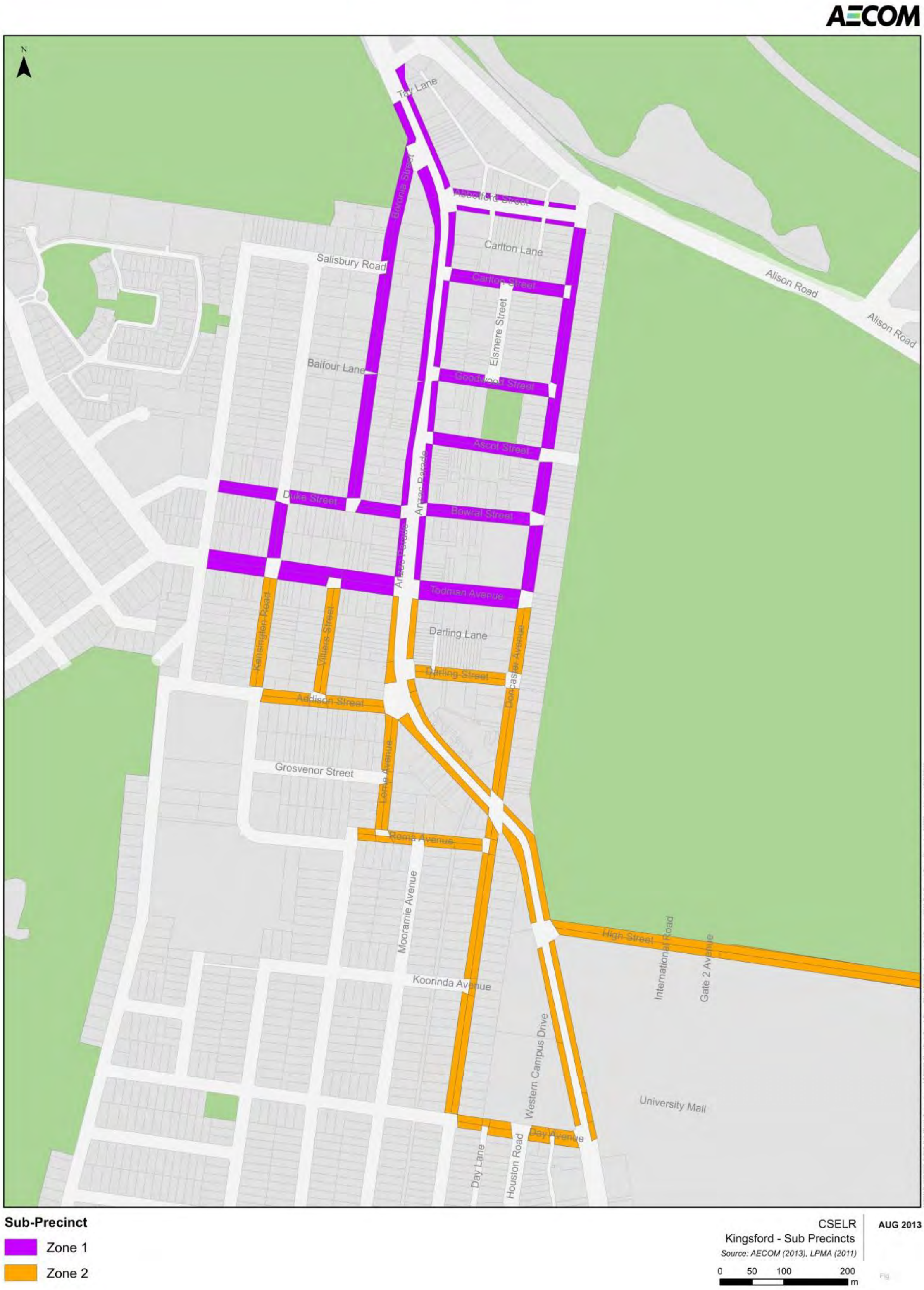


Figure 6-20: Kingsford Survey Precinct – with Sub-Precinct zones

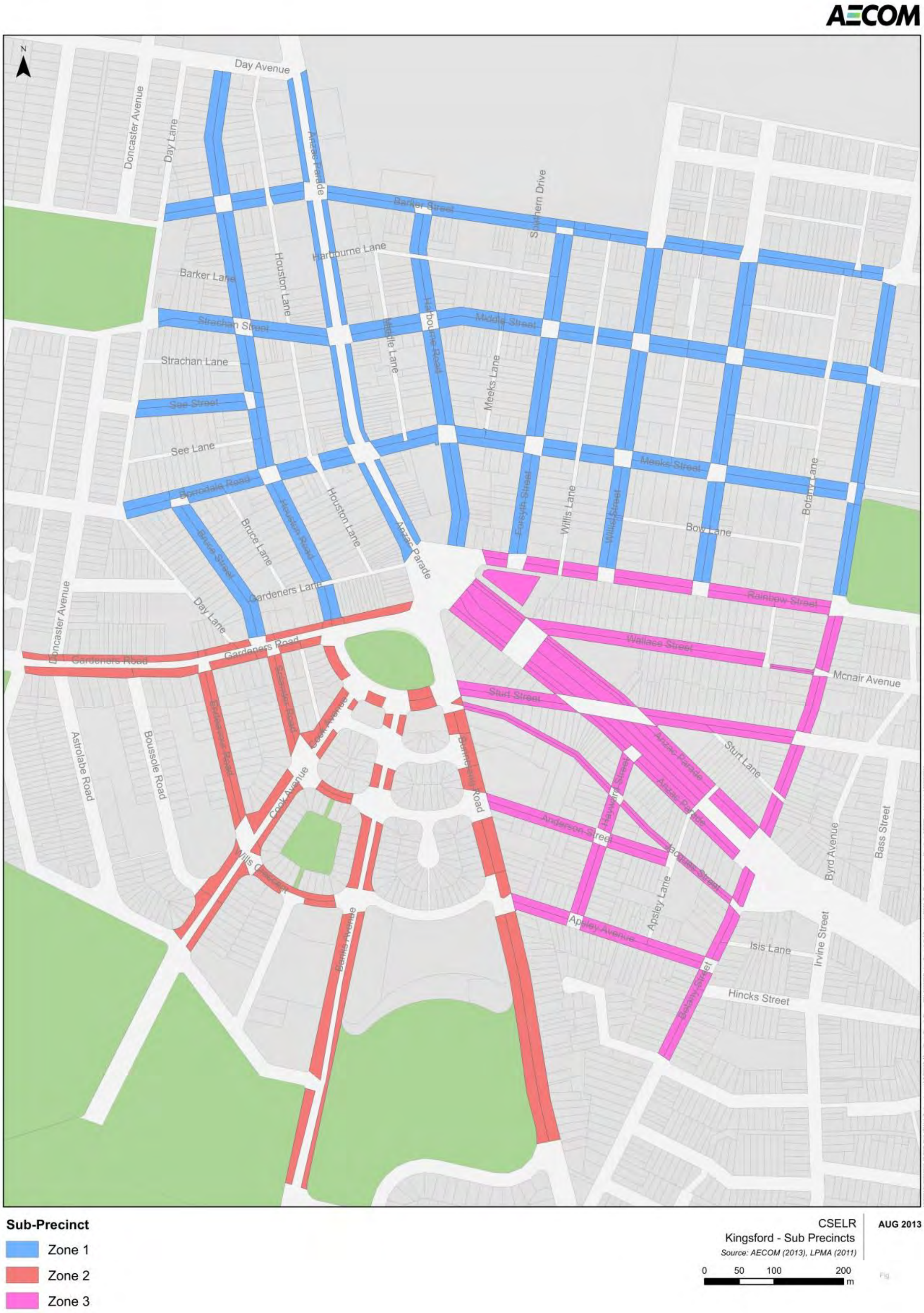


Figure 6-21: Randwick Survey Precinct – with Sub-Precinct zones

The following sections detail the results of the existing parking assessment for the south eastern precincts. The surveys provided occupancy rates for kerbside parking along each of the street within the precincts over the three time periods. The bandwidth colours illustrate the percentage of parking occupancy which was calculated as a measure of the available kerbside parking capacity.

The quantum of parking supply and demand used to determine occupancy were based on parking available for all users, including time-restricted parking and non-restricted parking only; ancillary parking uses such as loading and bus zones were excluded to avoid skewing the average occupancy results.

The average occupancy rates for each of the sub-precinct zones were calculated using a weighted average to ensure the occupancy remains representative for the precinct.

In addition to the occupancy analysis of each precinct, an assessment of the user patterns of the parking demand was also undertaken. The user patterns were derived through analysis of turnover rates for individual vehicles for discrete street blocks of time restricted and non-restricted parking within the precinct.

6.3.4.1. Surry Hills Precinct

The occupancy survey results for the Surry Hills precinct are illustrated in Figure 6-22 to Figure 6-24, with summary data outlined in Table 6-10. The precinct was divided into six zones to provide summary measures for parking demand and turnover, refer to Figure 6-18 for sub-precinct extents.

Figure 6-22: Surry Hills – Pre-AM Peak Occupancy (before 7.30am)

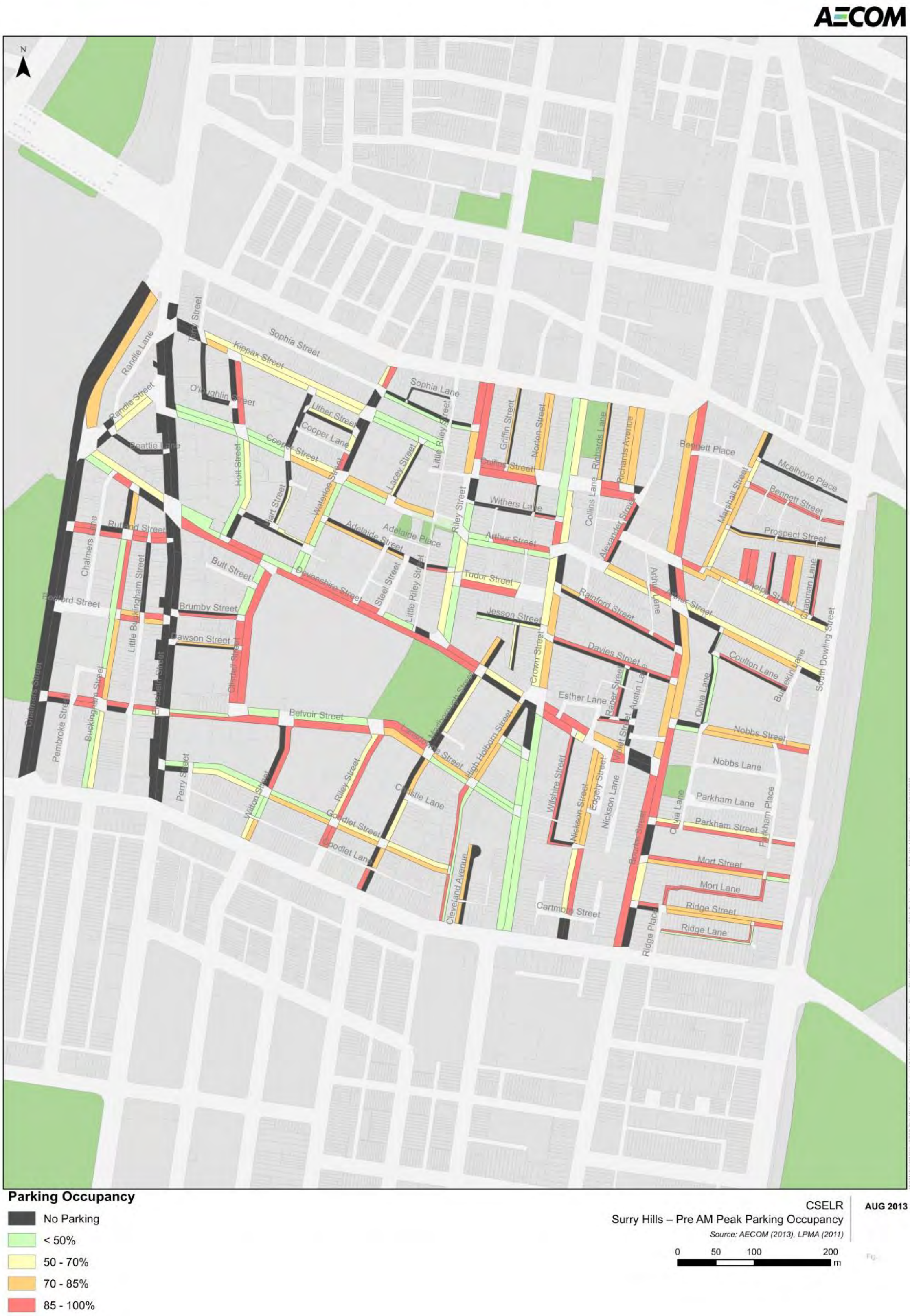


Figure 6-23: Surry Hills – Interpeak Occupancy (between 10.00am and 2.00pm)

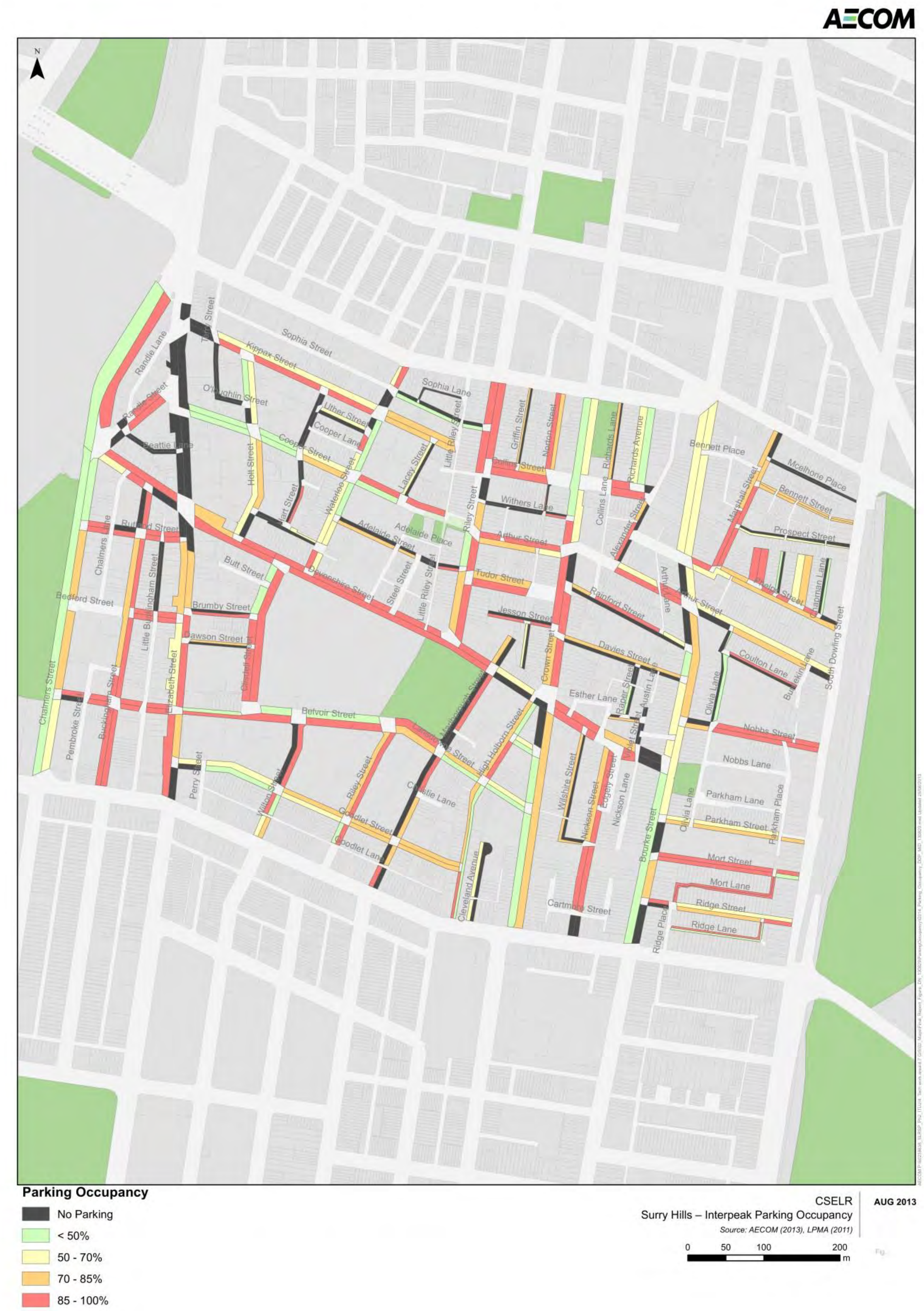


Figure 6-24: Surry Hills – Post-PM Peak Occupancy (after 6.30pm)

On-street parking demands, supply and occupancy for the Surry Hill precinct are summarised in Table 6-10. The table provides a breakdown by sub-precinct zone for the three time periods assessed. The sub-precinct zones were illustrated previously in Figure 6-18.

Table 6-10: Surry Hills – Demand, Supply and Occupancy by Zone

	Pre-AM Peak			Interpeak			Post-PM Peak			Daily
	Demand	Supply	Occupancy	Demand	Supply	Occupancy	Demand	Supply	Occupancy	% High Turnover
Zone 1	129	221	58%	163	221	74%	158	221	71%	48%
Zone 2	292	440	66%	357	440	81%	390	440	89%	41%
Zone 3	438	540	81%	399	540	74%	452	540	84%	25%
Zone 4	147	204	72%	253	328	77%	167	204	82%	42%
Zone 5	254	388	65%	278	388	72%	314	388	81%	31%
Zone 6	210	262	80%	201	262	77%	221	269	82%	23%
Precinct Total	**1,470**	**2,055**	**72%**	**1,651**	**2,179**	**76%**	**1,702**	**2,062**	**83%**	**37%**

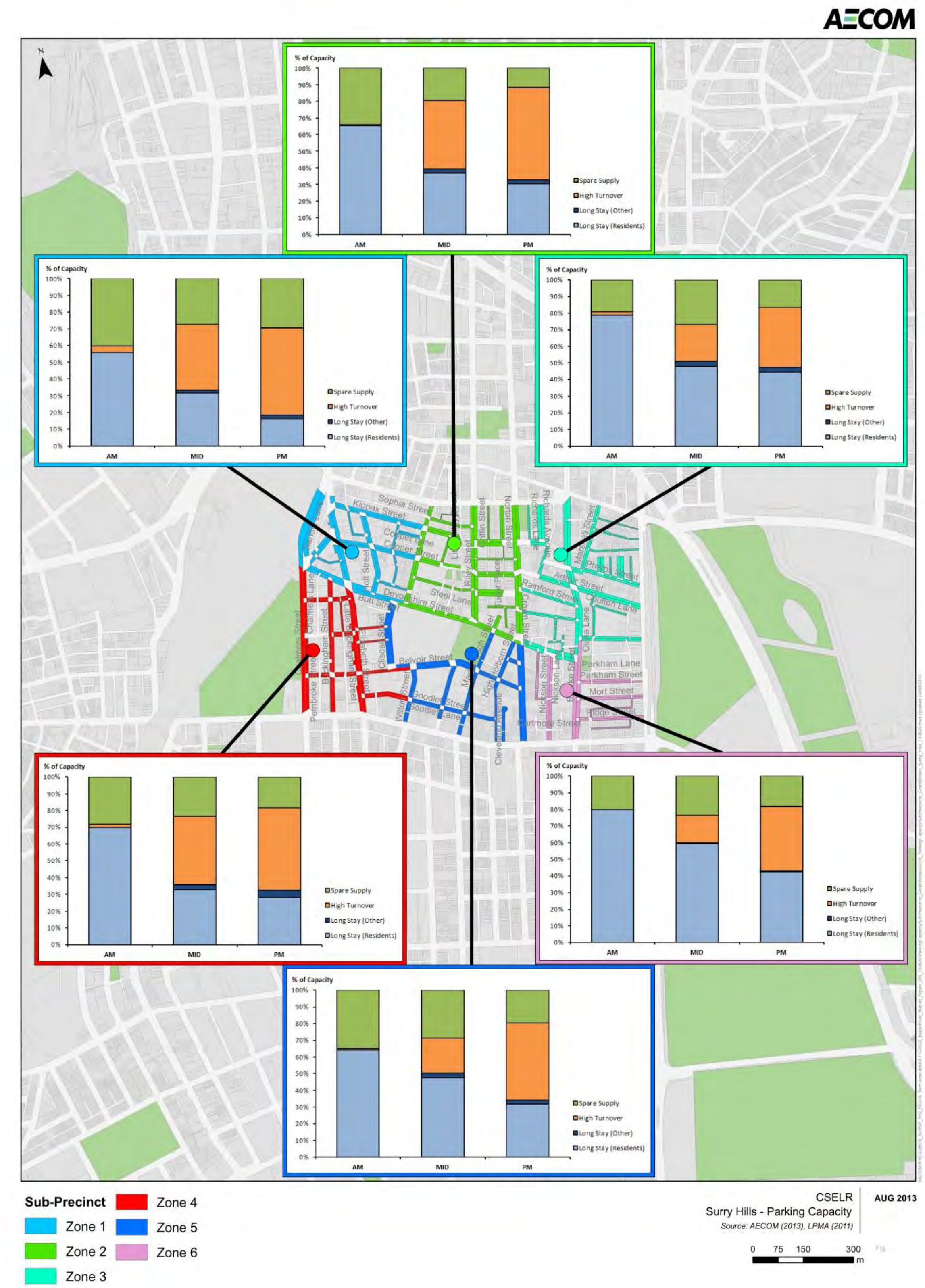
**Note supply and demand includes time restricted and non-restricted parking only.*

In addition to the Surry Hills occupancy analysis, an assessment of the user pattern of the parking demand was undertaken. Figure 6-25 illustrates the total parking demand and supply for available spaces over the three time periods assessed, noting that the parking supply varies across the day. The bars are proportionally split between high turnover and long stay demand, with the available spare supply summing to 100% capacity.

The key trends from the parking occupancy and capacity analysis of Surry Hills are:

- Parking supply within the Surry Hills precinct is greatest during the Interpeak when the least number of parking restrictions apply i.e. due to peak hour bus lanes.
- Occupancy rates are highest in the Post-PM Peak; five zones record average occupancy between 81% and 89%.
- Occupancy rates are generally lower in the western extent of the precinct area (sub-precinct zones 1, 2, 4 and 5), west of Crown Street, and especially so in the Pre-AM peak with average rates of occupancy between 60% and 72%.

Figure 6-25: Surry Hills: Parking Occupancy by User Type



6.3.4.2. Kensington Precinct

The occupancy survey results for the Kensington precinct are illustrated in Figure 6-26 to Figure 6-28 and summarised in Table 6-11. The precinct was divided into two subsections to provide summary measures for parking demand and turnover.

Figure 6-26: Kensington – Pre-AM Peak Occupancy (before 7.30am)

Figure 6-27: Kensington –Interpeak Occupancy (between 10.00am and 2.00pm)

Figure 6-28: Kensington – Post-PM Peak Occupancy (after 6.30pm)

On-street parking demands, supply and occupancy for the Kensington precinct are detailed in Table 6-11. The table provides a breakdown by sub-precinct zone for the three time periods assessed. The sub-precinct zones were illustrated previously in Figure 6-18.

Table 6-11: Kensington – Demand, Supply and Occupancy by Zone

	Pre-AM Peak			Interpeak			Post-PM Peak			Daily
	Demand	Supply	Occupancy	Demand	Supply	Occupancy	Demand	Supply	Occupancy	% High Turnover
Zone 1	**501**	**654**	**77%**	**570**	**706**	**81%**	**510**	**703**	**73%**	**35%**
Zone 2	**538**	**702**	**77%**	**647**	**755**	**86%**	**594**	**732**	**81%**	**33%**
Precinct Total	**1,039**	**1,356**	**77%**	**1,217**	**1,461**	**83%**	**1,104**	**1,435**	**77%**	**34%**

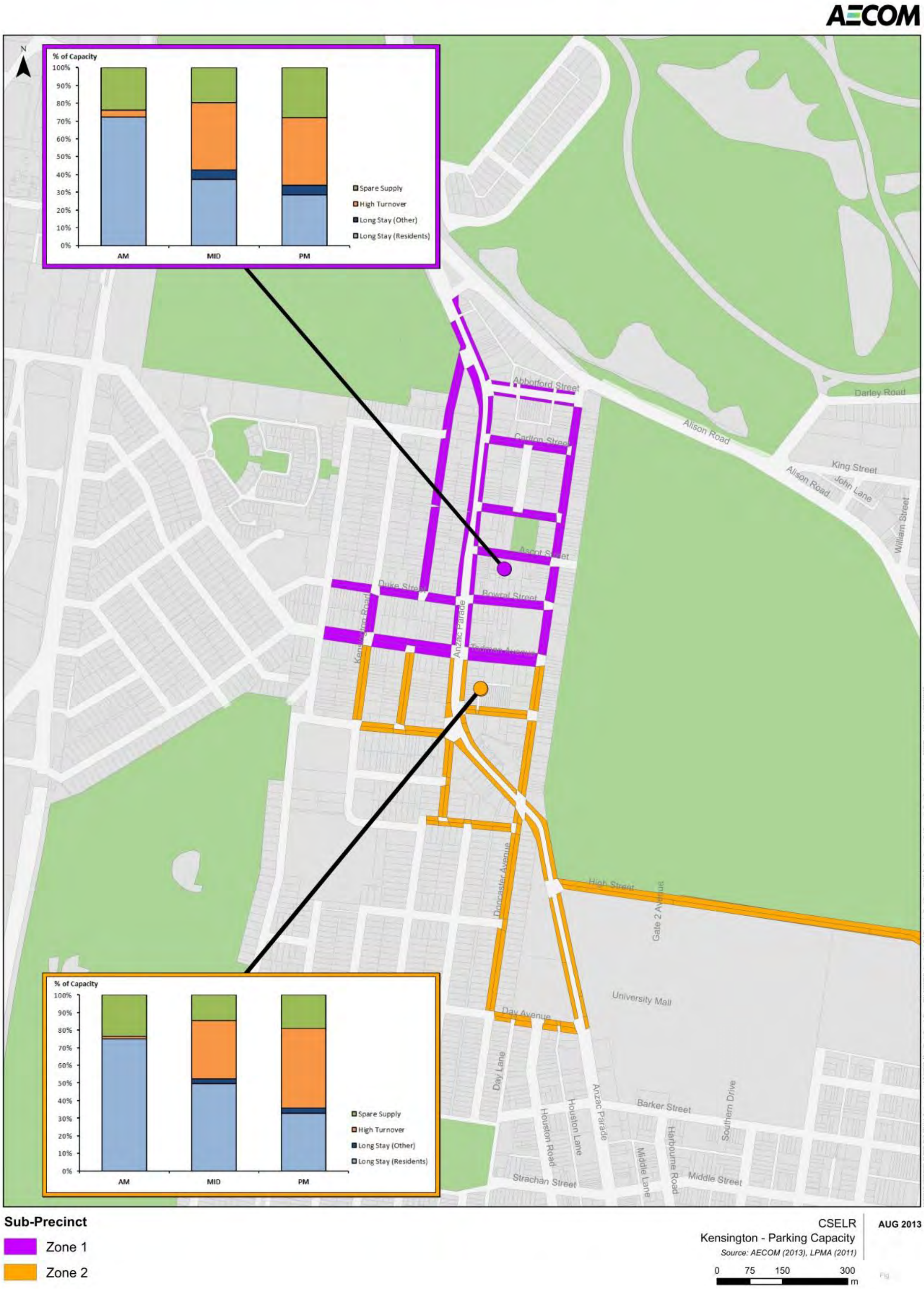
**Note supply and demand includes time restricted and non-restricted parking only.*

In addition to the Kensington occupancy analysis, an assessment of the user pattern of the parking demand was undertaken. Figure 6-29 illustrates the total parking demand and supply for available spaces over the three time periods assessed, noting that parking supply varies across the day. The bars are proportionally split between high turnover and long stay demand, with the available spare supply summing to 100% capacity.

The key trends from the parking occupancy and capacity analysis of the Kensington precinct are:

- Parking supply is lower within the Kensington precinct during the AM, with bus only lanes along the western side of Anzac Parade implementing early morning parking restrictions.
- The parking occupancy for the AM period is consistent across the precinct.
- Parking occupancy is greatest during the Interpeak, with zone 2 showing the greatest increase in demand.

Figure 6-29: Kensington: Parking Occupancy by User Type



6.3.4.3. Kingsford Precinct

The occupancy survey results for the Kingsford precinct are illustrated in Figure 6-30 to Figure 6-32 and summarised in Table 6-12 . The precinct was divided into three zones to provide summary measures for parking demand and turnover.

Figure 6-30: Kingsford – Pre-AM Occupancy (before 7.30am)

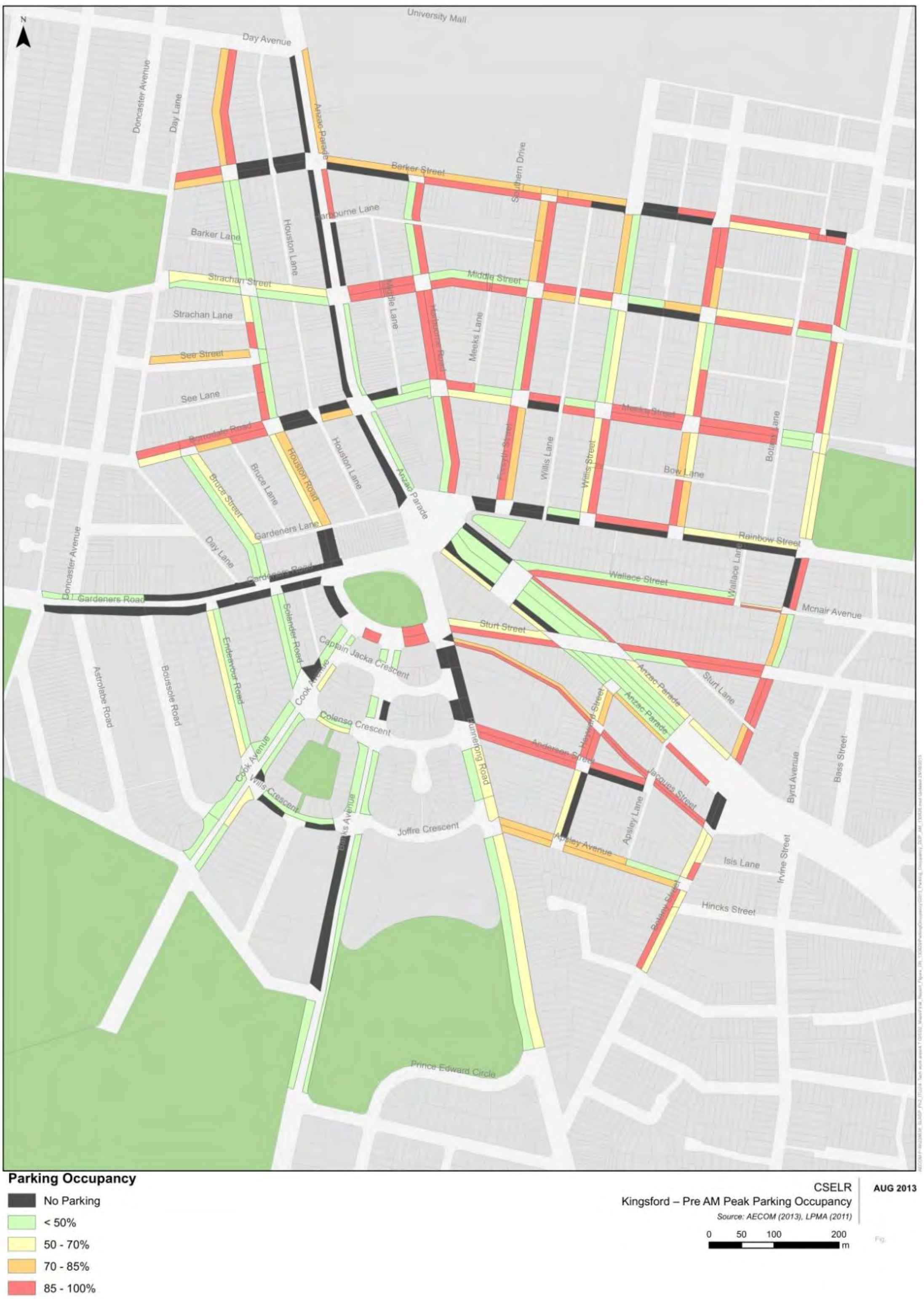


Figure 6-31: Kingsford –Interpeak Occupancy (between 10.00am and 2.00pm)

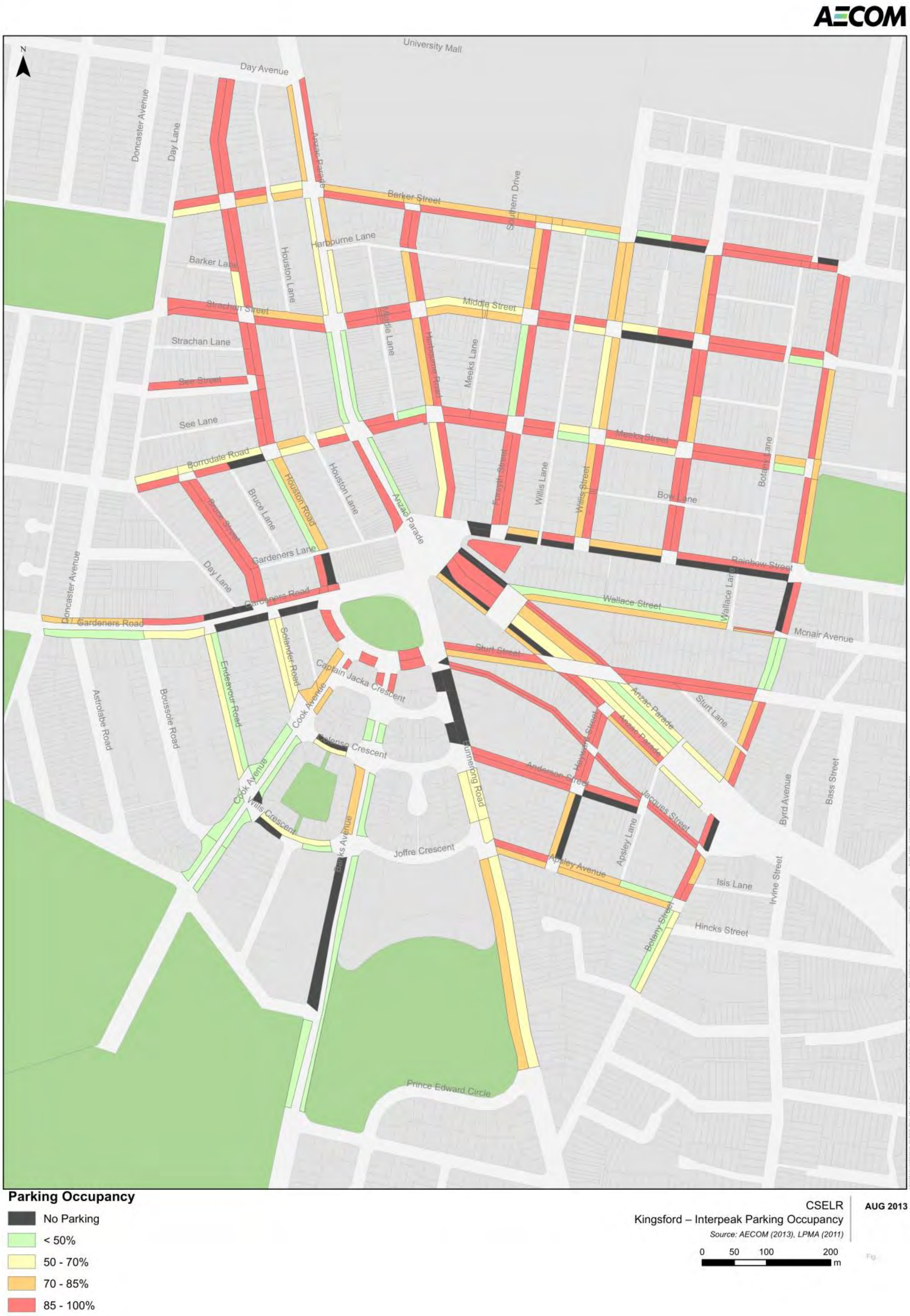


Figure 6-32: Kingsford –Post-PM Peak Occupancy (after 6.30pm)

On-street parking demands, supply and occupancy for the Kingsford precinct are detailed in Table 6-12. The table provides a breakdown by sub-precinct zone for the three time periods assessed. The sub-precinct zones were illustrated previous in Figure 6-18.

Table 6-12: Kingsford – Demand, Supply and Occupancy by Zone

	Pre-AM Peak			Interpeak			Post-PM Peak			Daily
	Demand	Supply	Occupancy	Demand	Supply	Occupancy	Demand	Supply	Occupancy	% High Turnover
Zone 1	822	1,275	64%	1,113	1,335	83%	961	1,335	72%	40%
Zone 2	154	423	36%	230	436	53%	210	439	48%	45%
Zone 3	472	890	53%	732	888	82%	635	888	72%	32%
Precinct Total	**1,448**	**2,588**	**56%**	**2,075**	**2,659**	**78%**	**1,806**	**2,662**	**68%**	**38%**

**Note supply and demand includes time restricted and non-restricted parking only.*

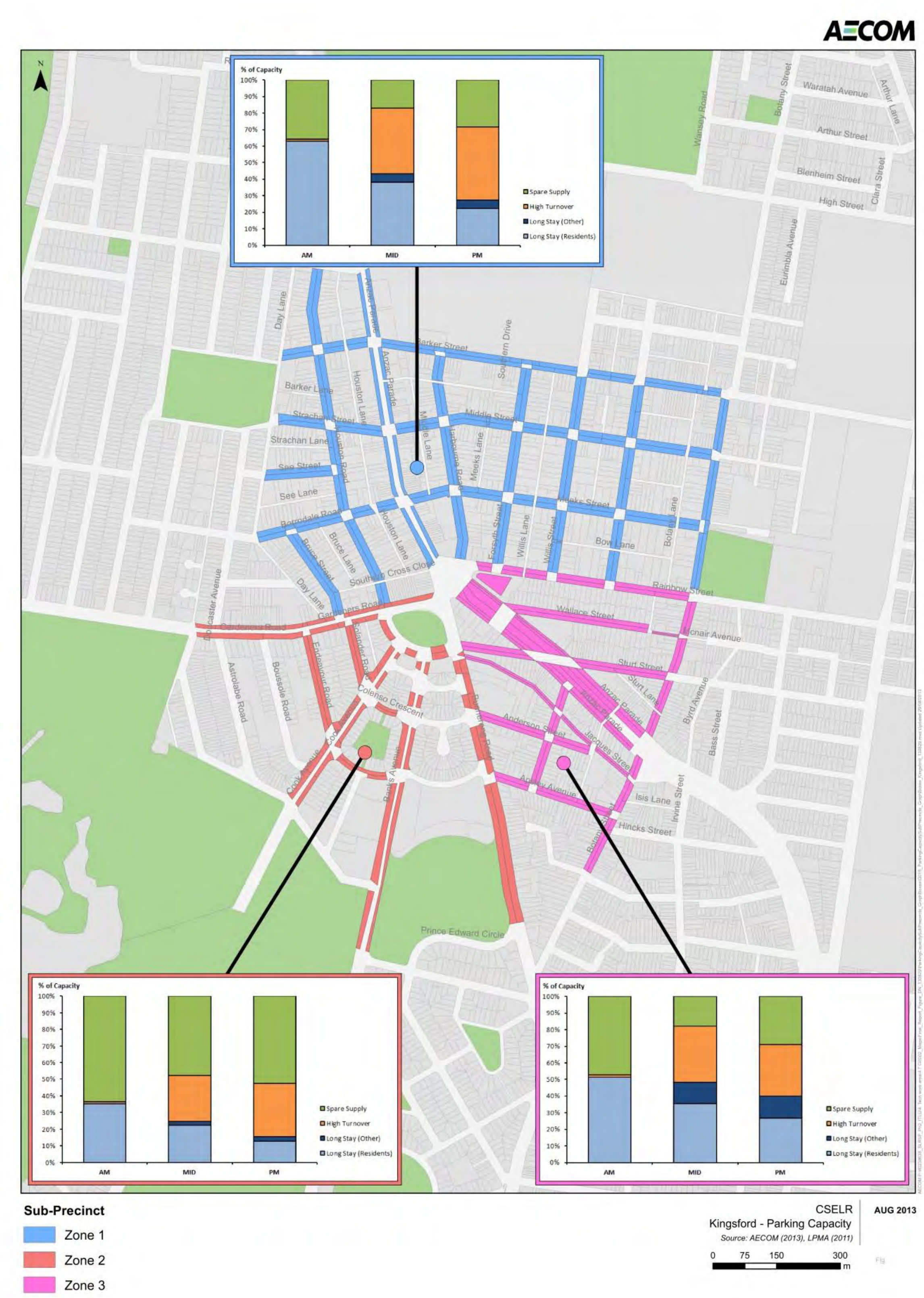
In addition to the Kingsford occupancy analysis, an assessment of the user pattern of the parking demand was undertaken.

Figure 6-33 illustrates the total parking demand and supply for available spaces over the three time periods assessed, noting that parking supply varies across the day. The bars are proportionally split between high turnover and long stay demand, with the available spare supply summing to 100% capacity.

Key trends from the parking occupancy and capacity analysis of the Kingsford precinct are:

- The area designated as sub-precinct zone 1, to the north, contains a large proportion of the parking supply within this precinct.
- Parking occupancy remains low throughout the day within sub-precinct zone 2 (south west) ranging between 36% and 53%.
- The greatest occupancy rates were observed during the Interpeak period, with zones 1 and 3 experiencing the greatest uplift in demand.

Figure 6-33: Kingsford: Parking Occupancy by User Type



In addition to the sub precinct zone analysis of Kingsford, detailed analysis of the immediate walking catchment of the alignment at two key areas was undertaken. The key areas and parking analysis are illustrated in Figure 6-34 and Table 6-13.

Figure 6-34: Kingsford: Sub Area Occupancy by User Type

Table 6-13: Kingsford Sub Area Parking Assessment

	Pre-AM Peak			Interpeak			Post-PM Peak			Daily
	Demand	Supply	Occupancy	Demand	Supply	Occupancy	Demand	Supply	Occupancy	% High Turnover
Area 1	362	623	58%	558	683	82%	518	686	76%	47%
Area 2	124	445	28%	363	445	82%	318	445	71%	48%

**Note supply and demand includes time restricted and non-restricted parking only.*

- During the survey of the Pre-AM Peak, Area 1 and Area 2 both observe low occupancy of available parking spaces at 58% and 28% respectively.
- Occupancy rates of available parking during the Interpeak are consistent between Area 1 and Area 2.

6.3.4.4. Randwick Precinct

The occupancy survey results for the Randwick precinct are illustrated in Figure 6-35 to Figure 6-37 and summarised in Table 6-14. The precinct was divided into four subsections to provide summary measures for parking demand and turnover.

Figure 6-35: Randwick – Pre-AM Peak Occupancy (before 7.30am)

Figure 6-36: Randwick – Interpeak Occupancy (between 10.00am and 2.00pm)

Figure 6-37: Randwick –Post-PM Peak Occupancy (after 6.30pm)

On-street parking demands, supply and occupancy for the Randwick precinct are detailed in Table 6-14. The table provides a breakdown by sub-precinct zone for the three time periods assessed. The sub-precinct zones were illustrated previous in Figure 6-18.

Table 6-14: Randwick – Demand, Supply and Occupancy by Zone

	Pre-AM Peak			Interpeak			Post-PM Peak			Daily
	Demand	Supply	Occupancy	Demand	Supply	Occupancy	Demand	Supply	Occupancy	% High Turnover
Zone 1	661	804	82%	734	804	91%	656	804	82%	32%
Zone 2	275	313	88%	308	313	98%	201	313	64%	26%
Zone 3	414	530	78%	530	630	84%	457	528	87%	45%
Zone 4	412	587	70%	547	633	86%	523	607	86%	41%
Precinct Total	**1,762**	**2,234**	**79%**	**2,119**	**2,380**	**89%**	**1,837**	**2,252**	**82%**	**37%**

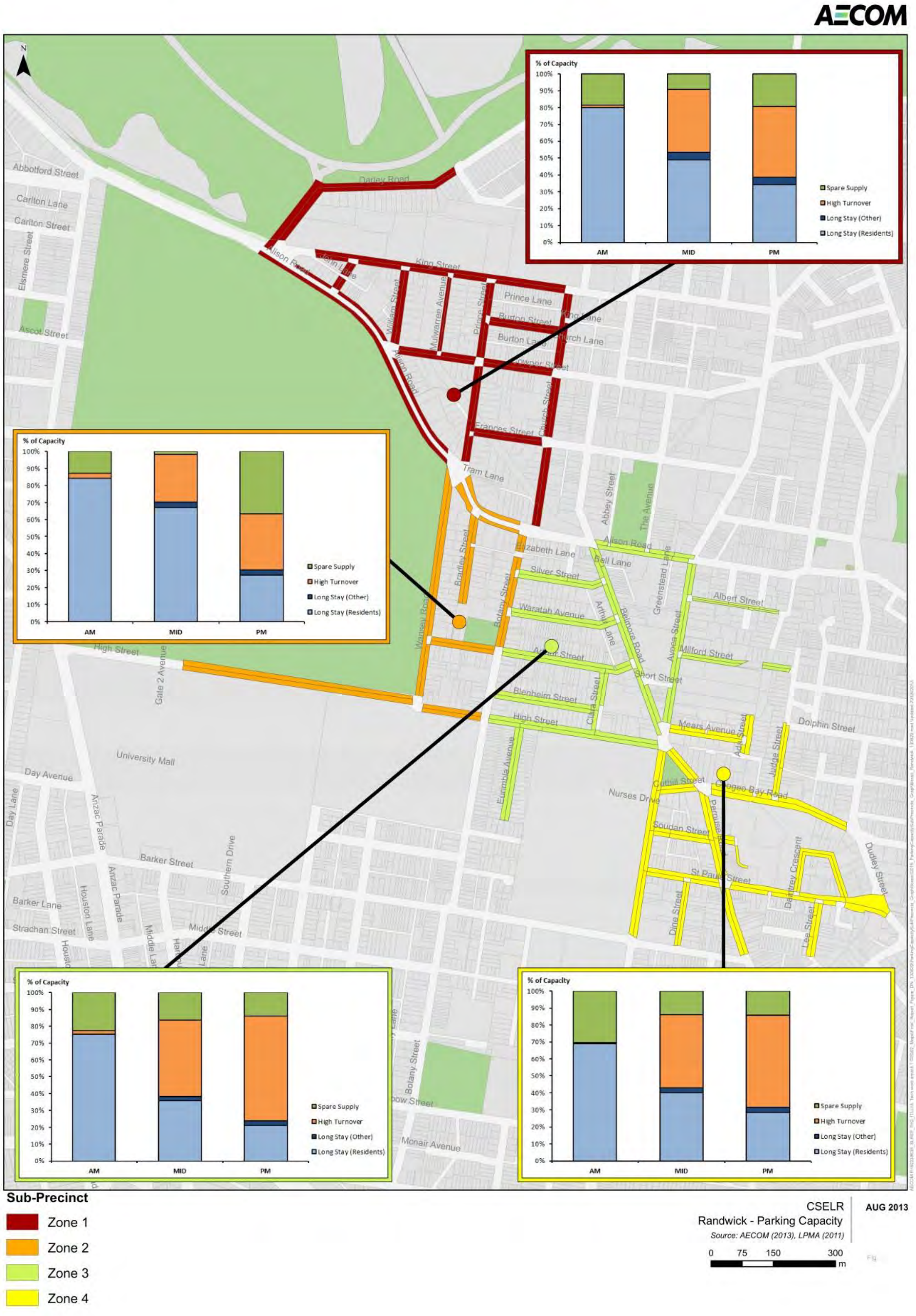
**Note supply and demand includes time restricted and non-restricted parking only.*

In addition to the Kingsford occupancy analysis, an assessment of the user pattern of the parking demand was undertaken. Figure 6-38 illustrates the total parking demand and supply for available spaces over the three time periods assessed, noting the parking supply changes throughout the day. The bars are proportionally split between high turnover and long stay demand, with the available spare supply summing to 100% capacity.

The key trends from the parking occupancy and capacity analysis of the Randwick precinct are:

- Parking supply remains relatively consistent within the Randwick precinct across the day.
- The survey showed occupancy to be highest in the Randwick precinct during the Interpeak period, at an average of 90%. Within this, the highest occupancy of 98% was recorded in sub-precinct zone 2, adjacent to UNSW and Wansey Road.
- The AM peak occupancy rates were higher for zone 1 and zone 2, with 82% and 88% respectively. The zones both comprise a high proportion of unrestricted parking.
- Sub-precinct zones 3 and 4 had slightly lower overall occupancy, but also recorded the greatest proportion of high turnover demand, at 45% and 41% respectively.

Figure 6-38: Randwick Parking Occupancy by User Type



In addition to the sub precinct zone analysis of Randwick, detailed analysis of the immediate walking catchment of the alignment at key areas was undertaken. The key areas and parking analysis are illustrated in Figure 6-39 and Table 6-15.

Figure 6-39: Randwick Sub Area Occupancy by User Type

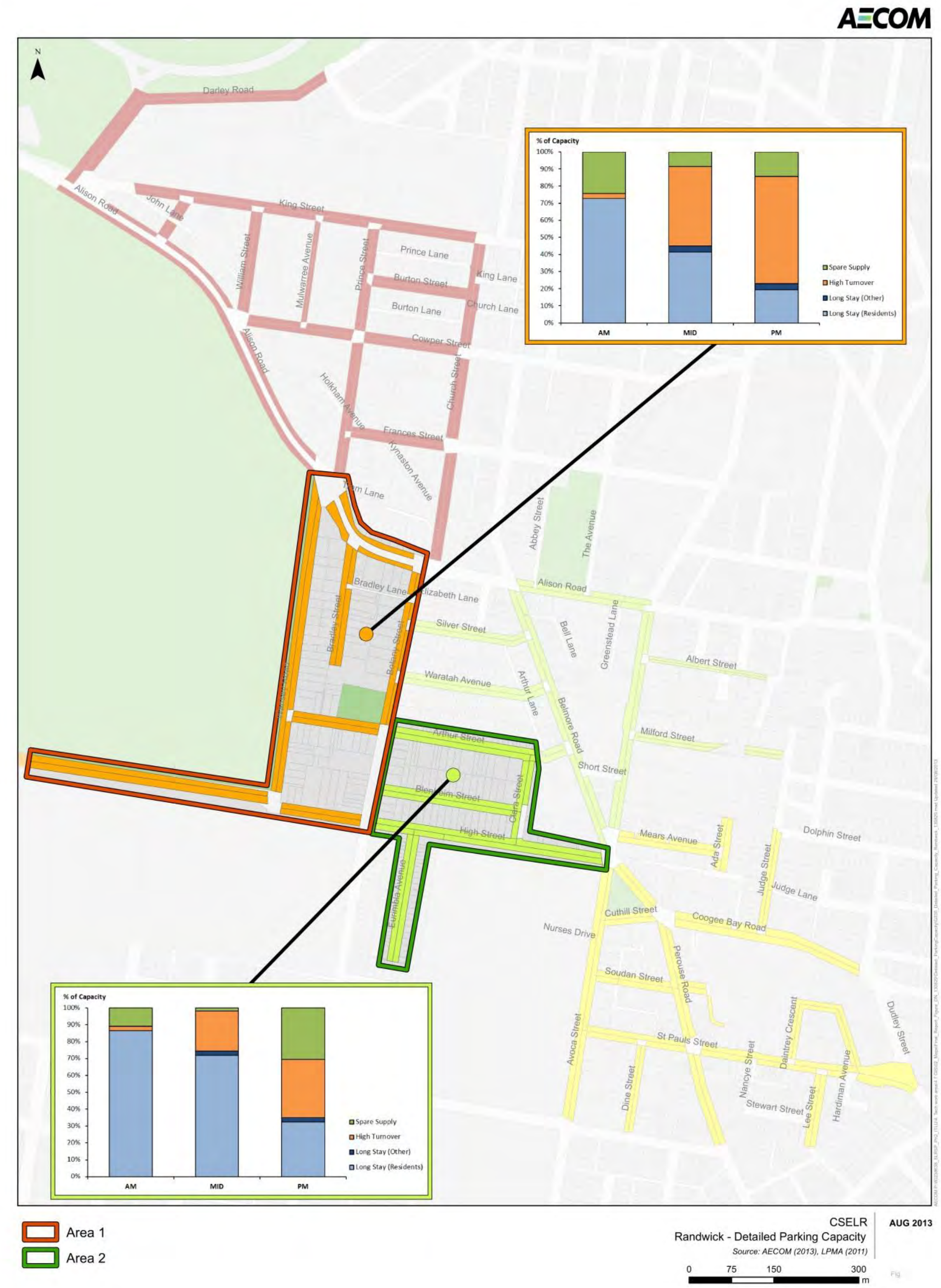


Table 6-15: Randwick – Sub Area Parking Assessment

	AM			MID			PM			Daily
	Demand	Supply	Occupancy	Demand	Supply	Occupancy	Demand	Supply	Occupancy	% High Turnover
Area 1	341	381	90%	374	381	98%	267	381	70%	24%
Area 2	222	292	76%	268	292	92%	252	292	86%	44%

**Note supply and demand includes time restricted and non-restricted parking only.*

- During the survey of the Pre-AM Peak, Area 1 observes a high occupancy of available parking spaces at 90%, it is noted a majority of the parking within the area are categorised as unrestricted for all time periods.
- During the Interpeak period, the occupancy rates of both areas are at the highest with the demand approaching the available supply.

6.3.5. Phase 4: impact of the Project on parking demand on the corridor

As illustrated in Section 6.3.3, following the implementation of the Project a quantum of existing parking demand will no longer be able to be provided within the Project corridor. This section clarifies the quantum of demand which will be impacted by the Project and which needs further consideration in terms of mitigation and demand management.

6.3.5.1. Surry Hills Precinct

Analysis of the parking directly impacted by the light rail alignment through Surry Hills was undertaken. Table 6-16 provides a summary of the demand, supply and weighted occupancy for the parking removal required to accommodate light rail.

The proposed light rail alignment will necessitate the removal of existing parking along Devonshire St to accommodate two segregated light rail tracks. Parking along Chalmers St between Elizabeth St and Randle St will be removed due to the location of the Central light rail stop.

Table 6-16: Surry Hills - Parking directly impacted by the Project

	Pre-AM Peak			Interpeak			Post-PM Peak			Daily
	Demand	Supply	Occupancy	Demand	Supply	Occupancy	Demand	Supply	Occupancy	% High Turnover
Zone 1	39	57	68%	52	57	91%	39	57	68%	64%
Zone 2	38	48	79%	45	48	94%	45	48	94%	60%
Zone 3	21	23	91%	22	23	96%	18	23	78%	64%
Precinct Total	**98**	**128**	**77%**	**119**	**128**	**93%**	**102**	**128**	**80%**	**63%**

Note: Zones 4, 5 and 6 do not include parking directly impacted by the Project.

The key trends from the analysis of the directly impacted parking along the Devonshire St corridor include:

- The directly impacted parking supply along the Devonshire St alignment is greatest during the Interpeak time period.
- The directly impacted parking is generally highly utilized; in particular in the central and eastern sub-precincts (zone 2 and zone 3) east of Waterloo Street. Although it is noted that total supply impacted is very low in zone 3, east of Crown Street.

6.3.5.2. Kensington Precinct

Analysis of the parking directly impacted by the light rail alignment through Kensington was undertaken. Table 6-17 provides a summary of the demand, supply and weighted occupancy for the parking removal required along Anzac Parade to accommodate light rail.

The proposed alignment allows for partial retention of the existing city bound bus only lane to be retained providing parking outside of the morning peak period. The primary parking impacts to the Kensington precinct apply to the loss of parking along eastern kerb of Anzac Parade.

Table 6-17: Kensington - Parking directly impacted by the Project

	Pre-AM Peak			Interpeak			Post-PM Peak			Daily
	Demand	Supply	Occupancy	Demand	Supply	Occupancy	Demand	Supply	Occupancy	% High Turnover
Zone 1	30	34	88%	49	63	78%	34	60	57%	66%
Zone 2	44	50	88%	72	76	95%	59	76	78%	67%
Precinct Total	**74**	**84**	**88%**	**121**	**139**	**87%**	**93**	**136**	**68%**	**66%**

The Surry Hills analysis describes that:

- The parking supply impacted by light rail within zone 2 is more pronounced during the Interpeak and Post-PM Peak due to the parking restriction already in place during the AM peak on Anzac Parade northbound.
- High occupancy levels were observed during the AM and Interpeak periods, especially in sub-precinct 2, south of Todman Avenue.
- % High turnover rates for the Kensington precinct are consistent between zones.

The key trends from the analysis of the directly impacted parking along the Anzac Parade corridor include:

- The parking supply impacted by light rail within zone 2 is more pronounced during the Interpeak and Post PM Peak due to the parking restriction already in place during the AM peak on Anzac Parade northbound.
- High occupancy levels were observed during the AM and Interpeak periods, especially in sub-precinct 2, south of Todman Avenue. Although it is noted that AM demand was lower in comparison to other periods, noting AM supply is restricted.

6.3.5.3. Kingsford Precinct

Analysis of the parking directly impacted by the light rail alignment through Kingsford was undertaken. Table 6-18 provides a summary of the demand, supply and weighted occupancy for the parking removal required to accommodate light rail.

The proposed alignment impacts parking within the Kingsford precinct along Anzac Parade between UNSW and Stuart St due to the removal of the kerbside bus only lanes that provided on-street parking outside of peak periods. The footprint of the Kingsford light rail stop also reduces the supply of parking with the removal of off-street parking within the central median between Rainbow St and Sturt St.

Table 6-18: Kingsford - Parking directly impacted by the Project

	Pre-AM Peak			Interpeak			Post-PM Peak			Daily
	Demand	Supply	Occupancy	Demand	Supply	Occupancy	Demand	Supply	Occupancy	% High Turnover
Zone 1	9	47	19%	46	83	55%	60	83	72%	92%
Zone 3	71	178	40%	148	178	83%	145	178	81%	56%
Precinct Total	80	225	36%	194	261	74%	205	261	79%	64%

Note: Zones 4, 5 and 6 do not include parking directly impacted by the Project.

The Kingsford analysis describes that:

- Sub-precinct zone 3 experiences the greatest impact with the introduction of light rail due to the removal of non-restricted off-street parking.
- The directly impacted parking within sub-precinct zone 3 observed occupancy of 81-83% during the Interpeak and Post-PM Peak.
- Parking directly impacted by the Project within zone 1 observed a high turnover rate (92%) due to the supply of periodic short stay parking only. The analysis showed 8% of High Turnover vehicles were observed to move between the impacted corridor and the greater sub precinct zone.

6.3.5.4. Randwick Precinct

Analysis of the parking directly impacted by the light rail alignment through Kingsford was undertaken. Figure 6-25 provides a summary of the demand, supply and weighted occupancy for the parking removal required to accommodate light rail.

The proposed alignment directly impacts parking within the Randwick precinct along Belmore Rd, High St, Wansey Rd and Alison Rd. The removal of parking along the constrained corridors is necessary to provide segregated light rail operation.

Table 6-19: Randwick – Parking directly impacted by the Project

	Pre-AM Peak			Interpeak			Post-PM Peak			Daily
	Demand	Supply	Occupancy	Demand	Supply	Occupancy	Demand	Supply	Occupancy	% High Turnover
Zone 1	72	84	86%	76	84	90%	62	84	74%	48%
Zone 2	115	132	87%	131	132	99%	65	132	49%	44%
Zone 3	38	57	67%	47	57	82%	52	57	91%	62%
Zone 4	19	24	79%	24	24	100%	22	24	92%	63%
Total	**244**	**297**	**82%**	**278**	**297**	**94%**	**201**	**297**	**68%**	**50%**

The Randwick analysis describes that:

- The existing parking within Randwick directly impacted by light rail recorded a generally high occupancy rate. In particular zones 1, 2 and 4 recording 90% to 100% occupancy during the Interpeak.
- The greatest impact on parking supply is within Zone 2 which features a high number of unrestricted parking.
- The turnover of parking demand within sub-precinct zones 1 and 2, primarily along Alison Road and Wansey Rd, were observed to be low at only 48% and 44% respectively. The majority of the impacted parking demand was observed across multiple periods of the day despite the presence of short stay parking.

6.4. Recommendations for Mitigation and Management

6.4.1. Project policies for mitigation

The policies in this section respond to the kerbside access assessment in Section 6.3 and are designed to meet the policy principles defined in Section 6.2.1, particularly policy principles 3 to 7.

The policy principles are set out below, alongside a description of how these measures have been implemented both at a strategic level and spatially throughout the Project corridor. The order of the policies relates to their hierarchical application to ensure the strategy meets the objectives.

1. Emphasise the mass transit function of surface public transport

The Project planning and design development has considered throughout the various stages of the Project development the most efficient way to utilise available road space to achieve the broader policy objectives as set out in federal, state and local planning policies. This includes, for example, ensuring concordance with the NSW Long Term Transport Master Plan (TfNSW, December 2012) as well as the supporting modal strategy Sydney's Light Rail Future (TfNSW, December, 2012). Both of these documents are described in more detail earlier in this report.

However it is important to consider the aims of these strategies, designed to deliver real customer benefits, which include:

- Expanding the public transport network to address CBD congestion and provide reliable turn up and go services for city commuters.
- Integrating bus and light rail to create an integrated public transport solution to meet the travel demands of Sydney residents.
- Delivering an effective and efficient surface public transport network.

These policies and strategies have guided the development of the Project development from options identification through options assessment and design development to ensure efficient and effective use of public road space. These policy principles have therefore been adopted at a strategic level and at a local level through the design development process.

2. Where feasible, retain existing parking and loading supply on project corridor

The retention of existing parking and loading supply has been accommodated where feasible on the Project corridor balanced with the primary objective stated above to deliver a high quality on-street mass public transit system for Sydney's CBD and inner suburbs which can reliably and efficiently move significant volumes of people.

The assessment undertaken in this strategy has considered a reduced future supply following implementation of the Project against a status quo in parking demand which represents a conservative analytical approach. This is conservative due to the likely potential change in travel patterns and modal shift to public transport which will arise as a result of the implementation of the Project. Any modal shift is likely to be strongest in the Randwick precinct with multiple significant trip generators (TAFE, Hospital and University) and where these major trip generators are currently served only by public buses and have significant unrestricted parking locally.

The travel patterns of people in the future are likely to include a significant modal shift from private car to public transport following the implementation of the Project. This would result in the freeing up of capacity for other kerbside activity which is likely to be of a similar magnitude to the level of directly impacted parking supply on the corridor. This alone would therefore create a scenario whereby the Project has no significant adverse impact on existing levels of kerbside utilisation and occupancy and may indeed positively impact the balance between supply and demand, notwithstanding the potential reduction in overall capacity.

3. Replace impacted parking and loading supply on the Project corridor with new parking supply on the corridor

In addition to retaining existing parking and loading on the Project corridor, consideration has been given through the planning and design process to the potential to accommodate additional spaces on the Project corridor. However due to the road space width constraints within the Project corridor it has not been possible to provide additional parking within the corridor.

4. Consider opportunities to balance efficiency in kerbside access for the corridor and adjacent streets within the same precinct

It has been demonstrated through the assessment of parking supply and demand that there are opportunities to balance the demands for parking and loading on the corridor, which will be impacted by the implementation of the Project with available kerbside capacity in the precincts. What is important to consider is how best to manage the available kerbside capacity, especially in locations where demand and supply could become closer. This is described in more detail below.

5. Optimise available capacity on the Project corridor and surrounding precincts

Introduce parking management measures which facilitate dual use of available parking capacity to maximise efficiency of utilisation; maintaining amenity for local residents and providing capacity during the day for short stay parking.

- Parking permit schemes should be considered, particularly in predominately residential precincts surrounding the Project corridor in Randwick and Kingsford precincts.
- These would be designed to afford priority to local residents to park in the vicinity of their home with an allowance for short term parking for visitors and for vehicle access to commercial land uses and other short stay trip generators.
- The need for parking permit schemes in the vicinity of the termini at Randwick and Kingsford is considered appropriate to minimise the future potential for induced demand for parking which would also generate additional traffic contrary to planning policy and project objectives. The introduction of parking permit schemes in these locations is deemed appropriate in these locations based on the assessment of existing conditions to manage existing demand and supply even without the implementation of the Project.

It may be appropriate for councils to implement greater restrictions on parking on streets immediately adjacent to the Project corridor where commercial land uses are present for loading and short term parking. For example, allocation of kerbside capacity on side streets directly off the corridor for locations where commercial land uses are present both for loading and for short term parking for access to retail shops, cafes and other local services.

6.4.2. Management of impacted disability parking

As stated in the kerbside access hierarchy and policy response, the highest priority was to ensure that any disability parking impacted by the Project would be replaced. There are only two locations with disability parking impacted, covering 4 spaces. These are described below with potential locations identified for re-provision (which will need to be agreed following further consultation with Councils and relevant stakeholder groups):

Table 6-20: Re-location of Disability Parking Spaces

Existing Location	Potential location for re-location
CBD (3 spaces); Rawson Place (1) and Chalmers Street (2)	*Implementation of relocated disability parking in the CBD will be managed through the City Centre Access Strategy (CCAS).*
Randwick (1 space): High St between Clara St and Hospital Rd	Clara St at intersection with High St
Surry Hills (5 spaces): Devonshire St between Marlborough St and Clisdell St (3); and Devonshire St between Clisdell St and Elizabeth St.	Waterloo Rd and Holt St at intersection with Devonshire St

6.4.3. Management of parking demand and supply on the corridor and in surrounding precincts

The following section provides an assessment of the potential opportunities to balance demand with supply in the future following implementation of the Project. This assessment is set out in Table 6-21 which follows.

The table summarises the demand-supply relationships at the sub-precinct level considering the potential for increasing balance and efficiency at the local level, based on the assessment undertaken and observations of impacted demand.

Table 6-21: Potential Opportunities to Balance Demand

Precinct	Opportunities
Surry Hills *Devonshire Street between Chalmers Street and Bourke Street plus the section of Chalmers Street between Eddy Avenue and Devonshire Street*	The existing parking demand in the corridor, which will be directly impacted by the Project, varies throughout the day between 98 and 119 vehicles. This can be broken down as follows: ■ Zone 1 includes impacted parking on Devonshire St from Chalmers St to Waterloo Rd. Demand on this section is between 39 and 52 vehicles. ■ Zone 2 includes impacted parking on Devonshire St between Waterloo Rd and Crown St. Demand on this section is between 38 and 45 vehicles. ■ Zone 3 includes impacted parking on Devonshire St between Crown St and Bourke St. Demand on this section is between 18 and 22 vehicles. Following implementation of the Project the future parking supply within the Surry Hills precinct will reduce by approximately 128 spaces. However, even during the highest occupancy existing peak period there are still 360 unoccupied spaces within the surrounding survey area. Therefore there will be sufficient latent capacity, of approximately 232 spaces equivalent to 11% of potential capacity, across the Surry Hills precinct to absorb any displaced demand within remaining available capacity across all periods of the day within the survey extents. At the more local level, each of the sub-precincts is projected to retain sufficient capacity to accommodate parking demand displaced from the Project corridor within the immediate surrounding local area. *This will be subject to appropriate parking management measures (parking controls) to balance supply and demand being implemented.* The following administrative controls have been determined through consultation with City of Sydney Council to mitigate the potential impacts of the Project on parking demand and supply in Surry Hills: ■ Consolidate City of Sydney Council residential permit precincts to allow resident permit-holders to search further afield when nearby streets are occupied. ■ Expand use of pay-parking (with standard resident exemptions) to encourage turnover and discourage commuting. ■ Provide resident exemptions in nearby spaces where they are not currently exempt. *Transport for New South Wales will work through implementation of these measures to manage kerbside activity with the City of Sydney Council.*
Kensington *Anzac Parade between Alison Road and Day Avenue*	The existing demand for parking in the corridor, which will be directly impacted by the Project, varies throughout the day between 74 and 121 spaces. This is broken down as follows: ■ Zone 1 includes impacted parking along Anzac Parade from Alison Rd through to Todman Ave. Demand on this section is between 30 and 49 vehicles. ■ Zone 2 includes the impacted parking along Anzac Parade between Todman Ave and Day Ave. Demand on this section is between 44 and 72 vehicles.

Precinct	Opportunities
	Following implementation of the Project the future parking supply within the Kensington precinct will reduce by approximately 139 spaces. However, even during the highest occupancy peak period there are still 244 unoccupied spaces. Therefore there will be sufficient latent capacity, of approximately 105 spaces equivalent to 7% of potential capacity, across the precincts surrounding the northern section of Anzac Parade to absorb displaced demand. At the local level, each of the sub-precincts is projected to retain sufficient capacity to accommodate demand within the local area surrounding the Project corridor. *This will be subject to parking management measures to balance supply and demand being implemented. Transport for New South Wales will work through implementation of these measures to manage kerbside activity with Randwick City Council.*
Kingsford *Anzac Parade between Day Avenue and Sturt Street*	The existing demand for parking in the corridor, which will be directly impacted by the Project, varies throughout the day between 80 and 205 spaces. This is broken down as follows: ■ Zone 1 includes the impacted parking along Anzac Parade from Day Ave through to Rainbow St. Demand on this section is between 9 and 60 vehicles. ■ Zone 3 includes the impacted parking along Anzac Parade between Rainbow St and Sturt St, including off-street parking on Anzac Parade, south of Nineways. Demand on this section is between 71 and 148 vehicles. Following implementation of the Project the future parking supply within the Kingsford precinct will reduce by approximately 261 spaces. However, even during the highest occupancy peak period there are still 323 unoccupied spaces, therefore there is latent capacity across the Kingsford precinct to absorb any displaced demand. Furthermore, it is noted that whilst this displaced demand can be absorbed, that it would leave latent capacity in the busiest period of only 2% of potential capacity across the whole of the Kingsford precinct. Therefore, if existing demand levels are maintained then parking utilisation would be close to effective capacity allowing for inefficiency in demand and supply. In order to maximise the benefit of available capacity for high priority users, including disability, servicing and loading, short stay parking for local business and long stay for residents, and noting the potential for induced demand from the Kingsford terminus, it is recommended that controls be adopted to restrict parking to key uses and removing unrestricted parking. *Transport for New South Wales will work through implementation of these measures to manage kerbside activity with Randwick City Council.*
Randwick *Alison Road between Darley Road and Wansey Road plus Wansey Road between Alison Road and High Street plus High Street between Wansey Road and Belmore Road plus Belmore Road between Avoca Street and Coogee Bay Road*	The existing demand for parking in the corridor which will be directly impacted by the Project varies throughout the day between 201 and 278 spaces. This is broken down as follows: ■ Zone 1 includes the impacted parking along Alison Rd from Darley Rd through to Wansey Rd. Demand on this section is between 62 and 76 vehicles. ■ Zone 2 includes the impacted parking along Wansey Rd between Alison Rd and High St. Demand on this section is between 65 and 131 vehicles. ■ Zone 3 includes the impacted parking along High St between Botany St and Belmore Rd. Demand on this section is between 38 and 52 vehicles. ■ Zone 4 includes the impacted parking along Belmore Rd between High St and Perouse Rd. Demand on this section is between 19 and 24 vehicles. Following implementation of the Project the future parking supply within the Randwick precinct will reduce by approximately 297 spaces. During the highest occupancy peak period there are 261 unoccupied spaces. If existing demand levels remain unchanged in future with no modal shift as a result of the implementation of the Project, then demand could potentially outstrip supply. However, this does not take account of any potential change in travel patterns as a result of light rail being implemented. The potential for modal shift to CSELR is high for the major land uses in the precinct such as the TAFE, Hospital and University. Further investigation of the spatial disaggregation of utilisation reveals:

Precinct	Opportunities
	■ Zones 1 and 3 are likely to have sufficient capacity within the local area surrounding the Project corridor in the AM peak to accommodate any displaced demand. Effective capacity could be reached in the inter peak and PM peak. ■ Zone 2 is likely to have sufficient capacity within the local area surrounding the Project corridor in the PM peak to accommodate any displaced demand. Effective capacity could be reached in the AM and inter peak. ■ Zone 4 has sufficient capacity to accommodate the existing demand within the local area surrounding the Project corridor. *Transport for New South Wales will work through implementation of these measures to manage kerbside activity with Randwick City Council.*

6.4.4. Local Area Mitigation for the CBD

The local area mitigation opportunities for the CBD are outlined in Table 6-22.

Table 6-22: Local Area Mitigation for the CBD

Precinct	Local Area Mitigation
CBD	Network changes to intersections along the George Street corridor provide an opportunity to mitigate the impacts by relocating peak and off-peak loading zones and off-peak parking to the additional kerb space provided at cross streets. *It is noted that any potential mitigation identified in this report for CBD loading and parking zones will be subject to the City Centre Access Strategy (CCAS), being prepared by TfNSW in and would be subject to further consultation with the City of Sydney Council prior to implementation.* The current project design creates the potential for the impacted loading and taxi zones to be relocated to the following locations: ■ George Street North – There is the potential to relocate the taxi zone near the Four Season's hotel, north of Essex Street, to the north of Alfred Street. ■ Essex Street – The existing short stay parking on the southern kerbside of Essex Street could be considered for reclassification as a northern CBD loading zone. ■ Bridge Street – The dedicated left turn lane into George Street becomes obsolete due to the removal of southbound traffic lanes. This presents an opportunity to enhance the footpath and potentially provide a replacement taxi zone on Bridge Street, subject to proposed taxi zone ■ Margaret Street – Since George Street northbound is proposed to be reduced to a single lane, there is an opportunity to convert the kerbside left turn lane into a kerbside loading and/ or parking zone. ■ Hunter Street – The proposed design would reduce Hunter Street from 4 lanes to 2 lanes at the intersection with George Street. This creates a potential opportunity for additional loading and/ or parking zones on both sides of Hunter Street. ■ King Street – The design proposes that west of George Street, the eastbound right turn lane into George Street would become obsolete. This presents a potential opportunity for additional kerbside parking and loading along the southern kerb. It is however noted that this would need to be considered alongside other modal initiatives for King Street, such as the potential future extension of the King Street cycleway east to Elizabeth Street. ■ Market Street – The removal of the monorail combined with the network changes removing the need for the left turn lane into George Street creates an opportunity for additional loading capacity on one side of Market Street to the east of George Street. The provision of new loading or parking in this location would need to be balanced against the need for potential future pedestrian footpath capacity enhancements as this location has been shown in **Section 2** to experience significant pedestrian volumes and low levels of service for pedestrians.

Precinct	Local Area Mitigation
	■ Park Street – The dedicated left turn lane into George Street will no longer be required as a result of the network changes associated with the proposed design. This will create a potential opportunity for additional loading and/ or parking capacity along the southern kerb of Park Street. The implementation of any future changes to kerbside activity on Park Street will need to be coordinated with delivery of the city centre bus network redesign and consider bus stop capacity requirements in this key city centre bus stop location. ■ Bathurst Street – The left turn lane onto George Street will be removed under the proposed design creating opportunities for additional loading and/or parking capacity. ■ Ultimo Rd – The dual turning lanes to George Street will no longer be required under the proposed design since George Street is proposed to have only one lane in each direction. Therefore, there is a potential opportunity to create additional loading and/or parking capacity along the northern kerb of Ultimo Road.

6.4.5. Process for implementation

The strategy set out above has described:

- the Project policy measures;
- existing parking supply and demand;
- the potential impact of the Project on both parking supply and demand; and
- a series of measures designed to ameliorate the potential impacts of the Project on parking and loading.

Transport for New South Wales (TfNSW) will continue to work with the key stakeholders involved in the management and operation of the road network and management of kerbside activity to implement the mitigation measures outlined in this report. The City of Sydney Council and Randwick City Council will be key stakeholders in the implementation of any changes to the function and management of on-street kerbside activity within the area of influence of the Project.

The purpose of further consultation and design will be to ensure appropriate and satisfactory measures are implemented which promote better utilisation and efficiency of use for kerbside space, while considering the access requirements of local residents, businesses, sporting, health and education use and all other land uses along and in the vicinity of the corridors.

As set out earlier, the Project approvals process for the CSELR project sits alongside a suite of strategies and plans which together shape the future direction of access into and around the Sydney CBD and broader metropolitan area. These documents include the state government geographical and modal strategies; the City Centre Access Strategy (CCAS) and the Sydney's Bus Future (under development) which sit under the NSW Transport Masterplan. The changes proposed through these strategies, as well as the changes to the broader South East bus network, will need to be considered alongside the CSELR project for the implementation of on-street changes to kerbside activity in specific locations. As noted earlier, the implementation will be undertaken by the two relevant councils so any on-street changes to kerbside activity will also need to be made in accordance with local government planning policies of the two councils and through their normal approvals processes for such changes.

7. Light Rail Stop Precinct Access Plans

7.1. Context

To ensure the success of the light rail project, customers must be able to efficiently access and egress each of the light rail stop precincts. A detailed assessment of how this takes place is vital to ensure identification of potential infrastructure upgrades or new facilities which may be required.

This section identifies, on a stop by stop basis, a number of actions that will be required to support efficient and effective access and egress to light rail stops and ensure that the Project attracts high levels of demand and generates maximum benefits.

The customer experience or 'take home value' of the transport system has two primary elements:

1. The functionality of transporting customers from origin to destination
2. The experience of the journey itself

The key access modes and transfers that would contribute to a successful interchange are outlined below. The design of, and provision for, these access modes, including all associated infrastructure, needs to be both functional and efficient, but also safe, clean, and well-maintained for the customer. The key access and interchange modes for which provision needs to be made are:

- Heavy rail and ferry transfers
- Pedestrian and cycle facilities
- Bus services and set-downs
- Kiss & ride facilities
- Taxi services and facilities

Best practice in interchange design and planning, including the emerging Transport for NSW Interchange Guidelines, focus on the delivery of high quality passenger outcomes for development of future interchanges. These guidelines and principles relate to four key messages:

- Efficiency (covering operations, movement to and within the interchange)
- Usability (accessibility, safety and accident prevention, personal security, protected environment)
- Understanding (legibility, permeability, way finding, information)
- Quality (perception, build design, urban realm, sense of place)

Guidelines and best practice highlight the importance of good design and planning of pedestrian facilities in the success of transport interchanges. Providing easy, attractive and safe pedestrian facilities for access to mass transit nodes helps contribute to an integrated public transport network and deliver a high quality whole-of-journey experience for the passenger.

7.2. Multi-Modal Access Principles

7.2.1. Principles

A number of principles were developed to guide the precinct assessments. The principles are based on NSW Government customer research, and international and Australian examples of best-practice. These principles outline the overall objectives that should be considered in the design, delivery and operation of transport interchanges, include:

- Efficient movement of people
  - This movement relates to customers entering and exiting the interchange, and transferring between different transport modes
- A legible journey
  - Integrated customer information and way finding across a multi-modal system allows people to clearly understand and plan their movement through the interchange, and reduces confusion and disorientation
- Accessibility for all
  - As a public facility, it is critical that interchange allows for access by all people, especially those with reduced mobility, including people with disabilities, the elderly and young, and those with luggage and bicycles
- A positive customer experience
  - Apart from the reliability and convenience of transport services, a positive customer experience will be derived from the more personal aspects of the journey – a sense of feeling safe, comfortable and informed.
  - There are nine key 'customer service drivers' that determine customer satisfaction: Timeliness, Personal Safety/Security, Ticketing, Convenience, Accessibility, Comfort, Cleanliness, Information, Customer Service/Staff.
- A high-quality urban place
  - A well-designed interchange can be the focus of a local community, accommodating a mix of different functions and activities, and be the catalyst for the renewal of existing urban areas
- Sustainable growth and change over time
  - Public transport is an enduring part of a city and the design and operation of an interchange requires a long-term perspective
- Integrated operations and management
  - A coordinated and cooperative approach between these various parties (transport operators, highway authorities and other government agencies) leads to improved service levels, greater responsiveness and increased customer satisfaction

7.3. Stop Precinct Plans

7.3.1. Light rail stop precinct access and egress

Accessibility to light rail will play a significant role in its success. Access to light rail stops will need to cater for all modes including pedestrians, cyclists, bus, heavy rail, light rail and car and provide an easily accessible, legible and attractive public transport system.

7.3.1.1. Key issues to resolve for multimodal access

The key multimodal issues for the stop precincts are;

- Resolving stop access issues for pedestrians
- Enabling a seamless transition from different public transport modes (including ferry, bus, light rail and heavy rail) to light rail
- Positioning bus stops to allow for safe and efficient transfers

Crowding assessment relative to the platform widths was undertaken to confirm platform widths can cater for demand.

7.3.1.2. Stop precinct access mode share

Forecasts of the future access mode share for the CSELR system have been derived from the PTPM developed by the NSW Bureau of Transport Statistics (NSW BTS).

Table 7-1 summarises the anticipated light rail stop mode share across the entire light rail corridor for the assessment year 2021.

Table 7-1: Light Rail Stop Precinct Forecast Mode Share

Year	AM peak light rail trips by access mode				Access mode share		
	Bus / ferry	Walk	Rail / light rail	Total	Bus / ferry	Walk	Rail
2021	9,497	5,589	2,782	17,867	53%	31%	16%

Source: NSW Bureau of Transport Statistics, 2013.

Table 7-1 shows that the anticipated primary mode for access to light rail will be bus - accounting for approximately 53% of all passengers during the AM peak. The second highest forecast mode share for light rail access is walking, with nearly 31% of all passenger access forecast by pedestrians. Heavy rail interchange is expected to provide the next highest at approximately 16%.

There will however be significant variance within the anticipated levels of modal demand for access to light rail across the system, dependent on the stop location and availability of complementary public transport stations, stops and services.

Notable exceptions will be locations such as Town Hall and Central Station stops, both of which will experience a significant heavy rail to light rail interchange due to the proximity of the major, established CBD rail stations.

Vehicular access

Whilst it is not anticipated that there will be a significant need to provide for vehicular access at stops and the intent of the system is to contribute to the delivery of a high quality public transport system, with good local pedestrian access, it is inevitable that there will be a need to provide for some degree of access to the system by private vehicle.

This will be especially critical at the terminus locations. It is proposed, that to cater for the potential for linked car trips, that a small number of car share bays and vehicles be accommodated for such onward journeys. In addition, where appropriate and provision can be made within local conditions, a degree of very short term parking, in the form of kiss and ride bays and taxi bays will be made available to cater for onward travel by private vehicle and taxi.

A review of potentially feasible car share locations has been undertaken based on a review of car share demand profile data. A number of priority locations have been identified and these are set out in Table 7-2.

Table 7-2: Car share priority locations

Priority	Location
1	Circular Quay, Grosvenor Street, Wynyard, QV Building ,Town Hall, World Square, Chinatown, Rawson Place, Central Station, Surry Hills
2	Randwick, Strachan Street, Kingsford
3	Wansey Road, UNSW ANZAC Parade, Carlton Street, Todman Avenue, UNSW High Street

Source: AECOM, 2013.

Bicycle access

Bike u-rails are proposed at Circular Quay and all non-CBD light rail stops, located on the street adjacent to or at the stop. This will cater for demand at strategic points on the light rail system which are also in close proximity to the strategic bicycle network and are estimated to see potential for bicycle to light rail access. Secure lockers will also be provided at the Randwick and Kingsford termini, supplemented by u-rails. The subsequent sections provide further detail on the proposed access arrangements for each stop on the light rail system.

7.3.2. Circular Quay Precinct Access Plan

Access and Safety Improvements

The key actions for multimodal access and customer safety to be resolved at the Circular Quay stop precinct are;

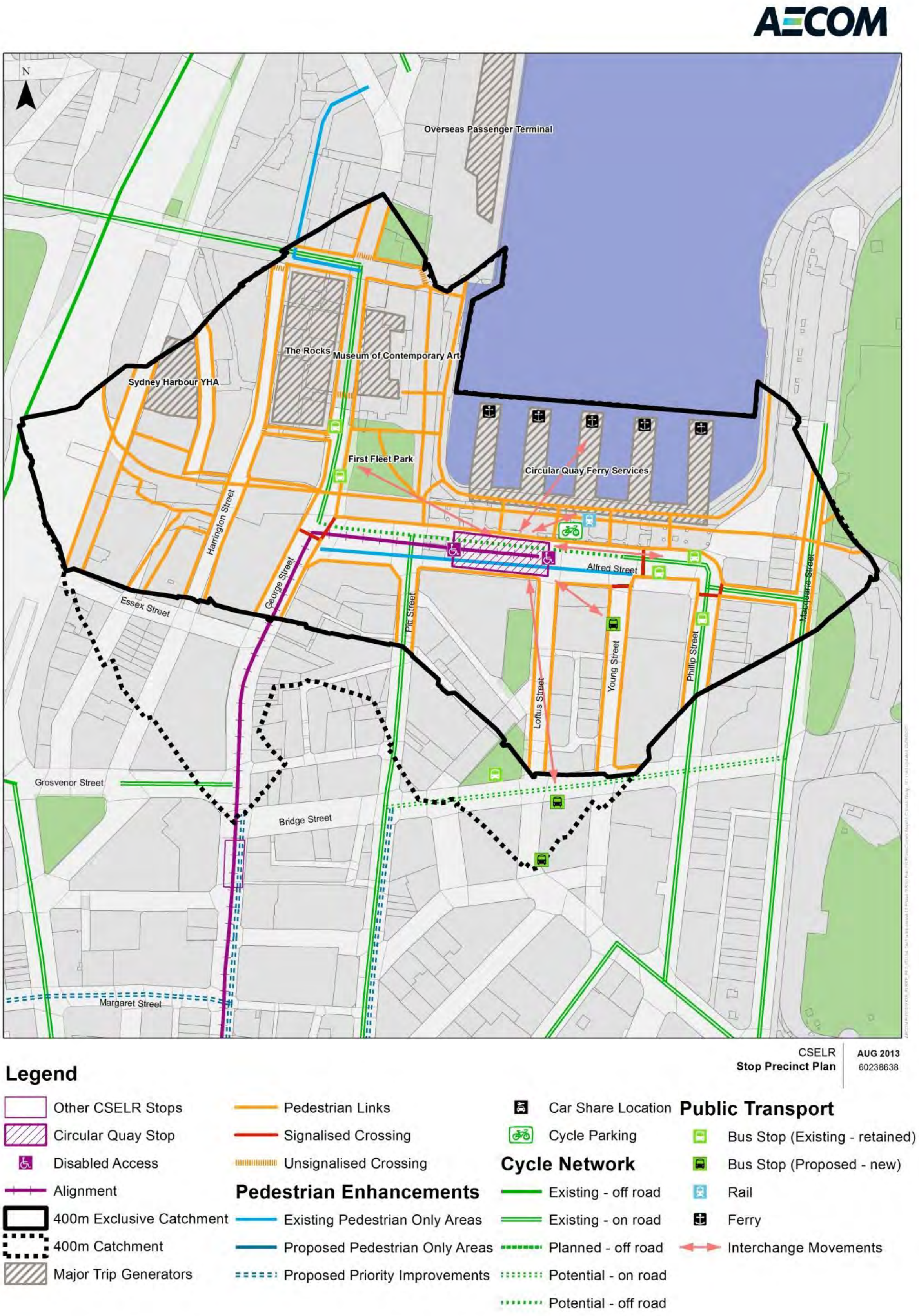
- Close Alfred Street to vehicular traffic between George Street and Young Streets. This will minimise interaction between cars and pedestrians trying to access light rail platforms.
- Locate the Circular Quay light rail stop in close proximity to the ferry terminal and Circular Quay heavy rail station.
- Position new bus stops on Young Street to allow for a ‘round the corner’ seamless transfer from bus to light rail. This would be within the pedestrianised zone of Alfred Street and remove interaction between cars and pedestrians.
- Integrate light rail platforms into Circular Quay pedestrian precinct.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Coordination of bus, ferry and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.
- Investigate the potential for a dedicated cycle parking facility at major light rail terminus.

Table 7-3: Circular Quay Precinct Access Plan

Stop Name
Circular Quay
Land Uses
– Tourist Attractions. – Commercial. – Tourist Accommodation. – Transport. – Retail / food & beverage.
Major Trip Generators
– Tourist Attractions (Sydney Harbour, Sydney Opera House, Sydney Harbour Bridge, Museum of Contemporary Art Australia, Customs House, Overseas Passenger Terminal). – Commercial (Gateway Plaza, AMP). – Tourist accommodation (Four Seasons Hotel, Shangri-La Hotel, Quay West Hotel). – Transport (Circular Quay Station, Circular Quay Ferry Terminal). – Retail / food & beverage (The Rocks, East Circular Quay).
Multi-Modal Stop Access
Patronage
– 561 boardings and 764 alightings forecast for 2021. – 874 boardings and 979 alightings forecast for 2036.
Heavy Rail
– Circular Quay is not forecast to be a major interchange for passengers from heavy to light rail. – 50m west of Circular Quay Station.
Light Rail
– 500m north-east of proposed Grosvenor Street stop on CSELR line.
Ferry
– Estimated AM peak hour interchange patronage from ferry and bus to light rail is 468 (83%) in 2021. The PTPM model does not provide a breakdown of bus and ferry trips, however it can be assumed that the majority of transfers are from ferry to light rail due to the stop's location at the northern end of the CBD. – 50m south of Circular Quay Ferry Terminal.
Bus
– 300m north-west of proposed Young Street stop (both directions). – 350m north-west of proposed Bridge Street stop (both directions).
Pedestrian
– Estimated AM peak hour walk up patronage of 93 (17%) in 2021.
Bicycle

– Off-road cycle paths:
  ▪ Two way; Kent Street (north-south) and Cahill Expressway (east-west).
– On-road routes:
  ▪ Two way; Pitt Street (north-south), Macquarie Street (north-south), Phillip Street (north-south), Grosvenor Street (east-west), Argyle Street (east-west).
  ▪ One way; Bligh Street (southbound), Bent Street (westbound).
– Potential off-road cycle path on Alfred Street (between George Street and Young Street).
– Potential two way on-road route on Bridge Street (between Pitt Street and Macquarie Street).
– Proposed u-rail cycle parking facility with approximately 10 spaces.

Figure 7-1: Circular Quay Precinct Access Plan



7.3.3. Grosvenor Street Precinct Access Plan

Access Improvements

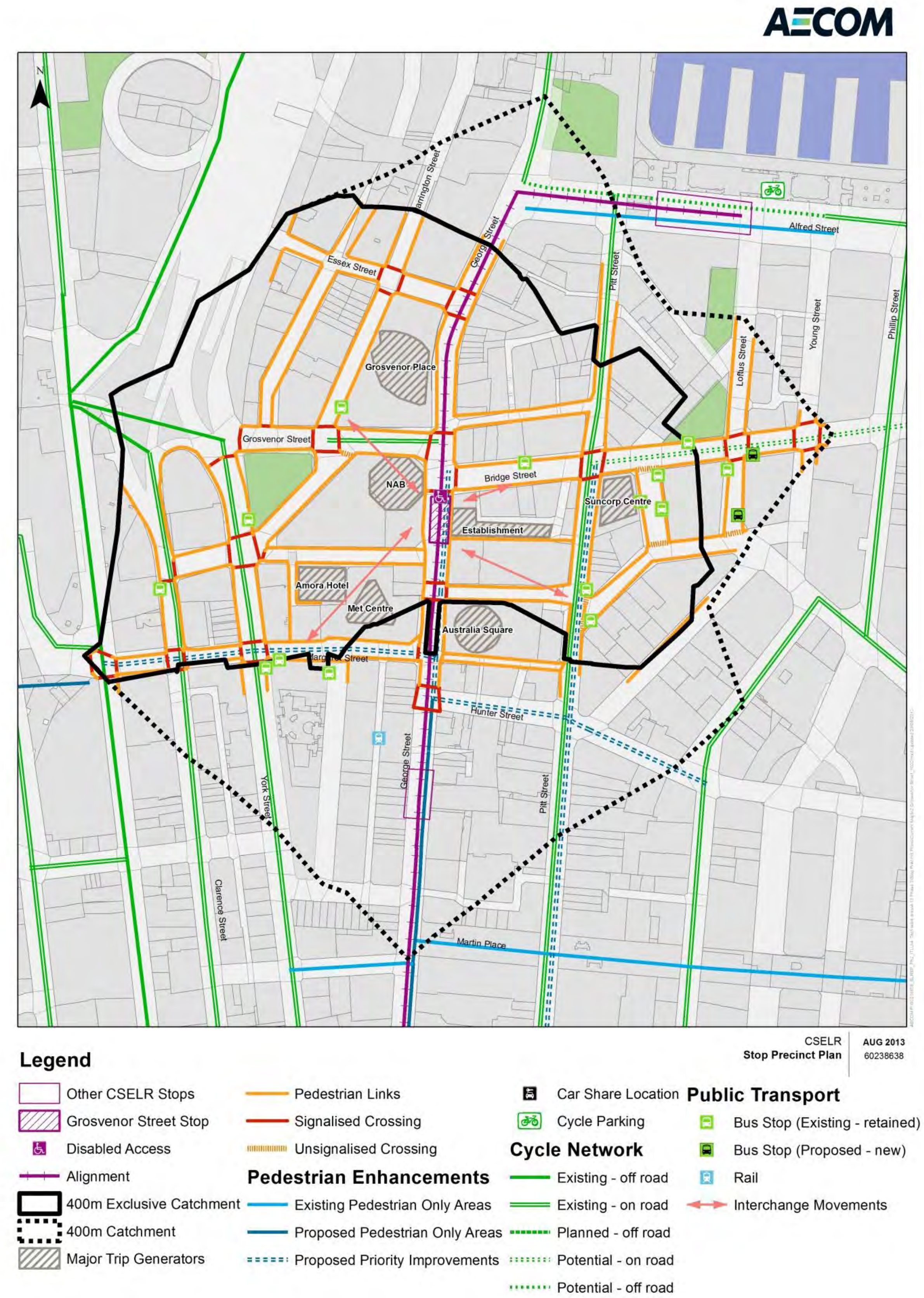
The key actions to resolve the multimodal access issues at the Grosvenor Street stop precinct are;

- Implement pedestrian priority improvements at key signalised intersections. This will reduce walking time for passengers transferring from bus to light rail. Key signalised intersections include;
  - Bridge and Loftus Streets
  - Bridge and Pitt Streets
  - George, Bridge and Grosvenor Streets (the George Street signals will provide customers with safe, direct access to light rail platforms)
- Reduce pedestrian wait times at other key signalised intersections through review of signal operations:
  - George and Bond Streets
  - George and Margaret Streets and Curtain Place
- Potential introduction of new pedestrian signalised crossing at Pitt and Bond Streets for bus to light rail interchange.
- Through the City Centre Access Strategy (CCAS) pedestrian infrastructure upgrades will be considered on links with high pedestrian volumes such as Bridge Street (south side) between George Street and Loftus Street.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Coordination of bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.

Table 7-4: Grosvenor Street Precinct Access Plan

Stop Name
Grosvenor Street
Land Uses
– Commercial – Tourist accommodation – Retail / food & beverage – Entertainment
Major Trip Generators
– Commercial (Suncorp Centre, Grosvenor Tower, Australia Square, NAB Head Office). – Tourist accommodation (Amora Hotel, Establishment Hotel). – Retail / food & beverage (Met Centre). – Entertainment (Establishment).
Multi-Modal Stop Access
Patronage
– 884 boardings and 722 alightings forecast for 2021. – 1,180 boardings and 958 alightings forecast for 2036.
Heavy Rail
– Grosvenor Street is not forecast to be a major interchange for passengers from heavy to light rail. – 300m north of Wynyard Station. – 500m south-west of Circular Quay Station.
Light Rail
– 250m north of proposed Wynyard stop on CSELR line. – 550m south-west of proposed Circular Quay stop on CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 497 (56%) in 2021. – 350m south-east of proposed Bridge Street / Loftus Street stop (both directions). – 400m north-east of proposed Kent Street stop (both directions).
Pedestrian
– Estimated AM peak hour walk up patronage of 387 (44%) in 2021.
Bicycle
- Off-road cycle path: ▪ Two way; Kent Street (north-south). - On-road routes: ▪ Two way; Pitt Street (north-south), Phillip Street (north-south), Grosvenor Street (east-west). ▪ One way; Castlereagh Street (southbound), Bligh Street (southbound), York Street (southbound), Clarence Street (northbound), Bent Street (westbound). ▪ Potential two way on-road route on Bridge Street (between Pitt Street and Macquarie Street).

Figure 7-2: Grosvenor Street Precinct Access Plan



7.3.4. Wynyard Precinct Access Plan

Access Improvements

The key actions to resolve multimodal access issues in the Wynyard stop precinct are;

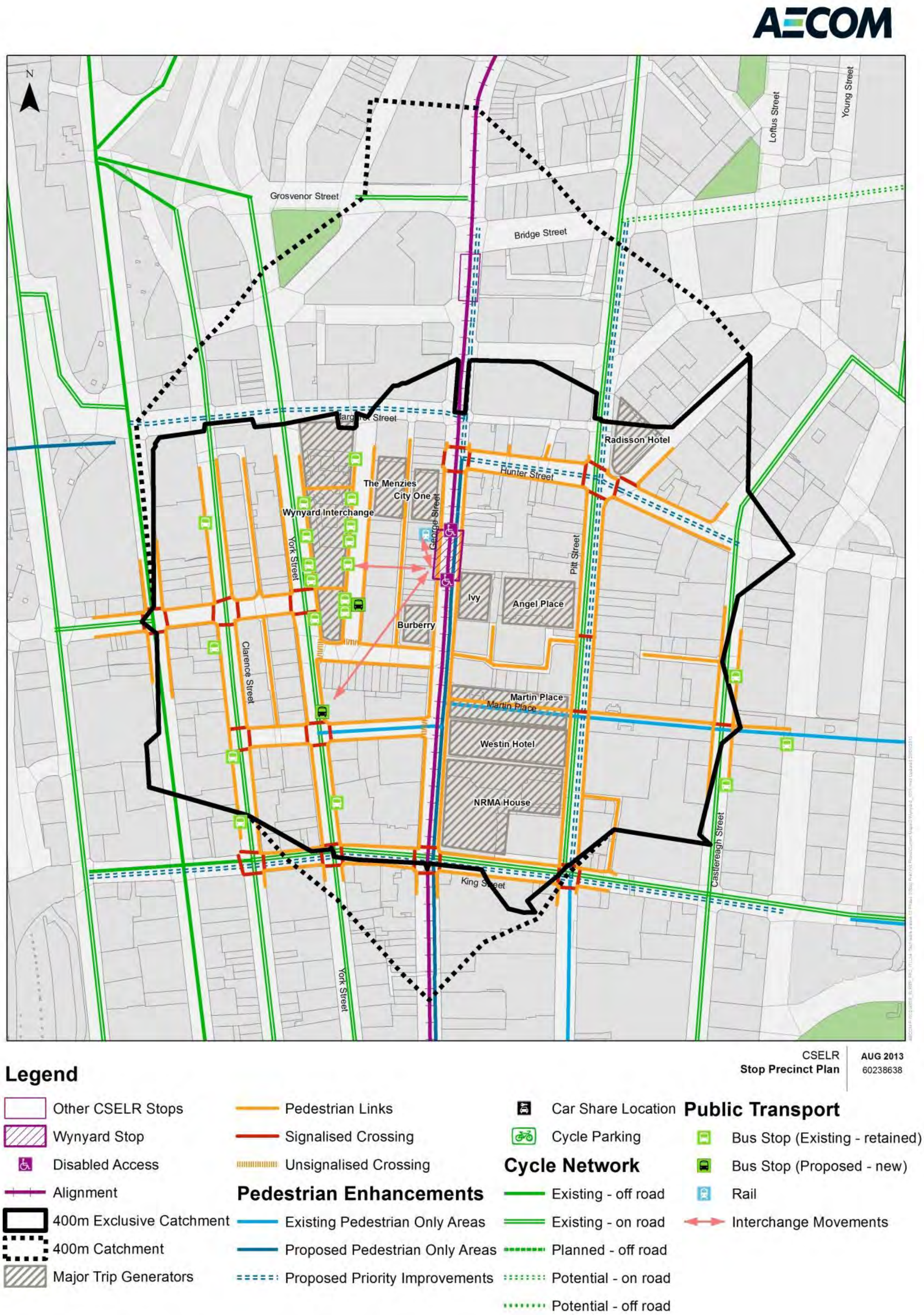
- Strengthen pedestrian links between the Wynyard bus interchange and light rail stop. This could include;
  - Introduce integrated customer information and wayfinding (consistent with the Transport for NSW Wayfinding Strategy) for interchange and connections between light rail and all other modes to make the quickest route more legible. This is particularly important for customers using the new Wynyard Walk to access Barangaroo as well as those interchanging between the Wynyard bus and light rail stops.
  - Through the City Centre Access Strategy (CCAS) pedestrian infrastructure upgrades will be considered, on links with high pedestrian volumes, such as Wynyard Street.
  - Reducing bus / pedestrian conflict on Carrington Street.
- Close George Street to vehicular traffic to improve pedestrian access to and from the light rail stop. This will reduce pedestrian wait times at key signalised intersections;
  - George Street and Hunter Street
  - George Street and King Street
- Coordination of bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.

Table 7-5: Wynyard Precinct Access Plan

Stop Name
Wynyard
Land Uses
– Commercial – Transport (Wynyard interchange for trains and buses) – Tourist accommodation – Retail / food & beverage – Entertainment
Major Trip Generators
– Commercial (Martin Place, Angel Place, NRMA Building). – Transport (Wynyard interchange). – Tourist accommodation (Westin, The Menzies, Radisson Hotel, Travel Lodge Wynyard). – Retail / food & beverage (Wynyard Walkways, Burberry). – Entertainment (City Recital Hall, Ivy).
Multi-Modal Stop Access
Patronage
– 1,015 boardings and 1,882 alightings forecast for 2021. – 1,267 boardings and 2,491 alightings forecast for 2036.
Heavy Rail
– Wynyard is not forecast as a major rail to light rail interchange. – 50m south of Wynyard Station. – 500m north-west of Martin Place Station.
Light Rail
– 250m south of proposed Grosvenor Street stop on CSELR line. – 550m north of proposed Queen Victoria Building stop on CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 724 (71%) in 2021. – 250m east of Wynyard bus interchange (Carrington Street and York Street). – 300m south-west of Pitt Street (corner Bent Street). – 350m west of proposed Castlereagh Street stop.
Pedestrian
– Estimated AM peak hour walk up patronage of 290 (29%) in 2021.
Bicycle

– Off-road cycle paths:
  ▪ Kent Street.
  ▪ King Street (between Clarence Street and Sussex Street).
– On-road routes:
  ▪ Two way; Pitt Street (north-south), Phillip Street (north-south), Grosvenor Street (east-west).
  ▪ One way; Castlereagh Street (southbound), Bligh Street (southbound), York Street (southbound), Clarence Street (northbound), Bent Street (westbound), King Street between Clarence Street and Macquarie Street (eastbound).

Figure 7-3: Wynyard Precinct Access Plan



7.3.5. Queen Victoria Building Precinct Access Plan

Access Improvements

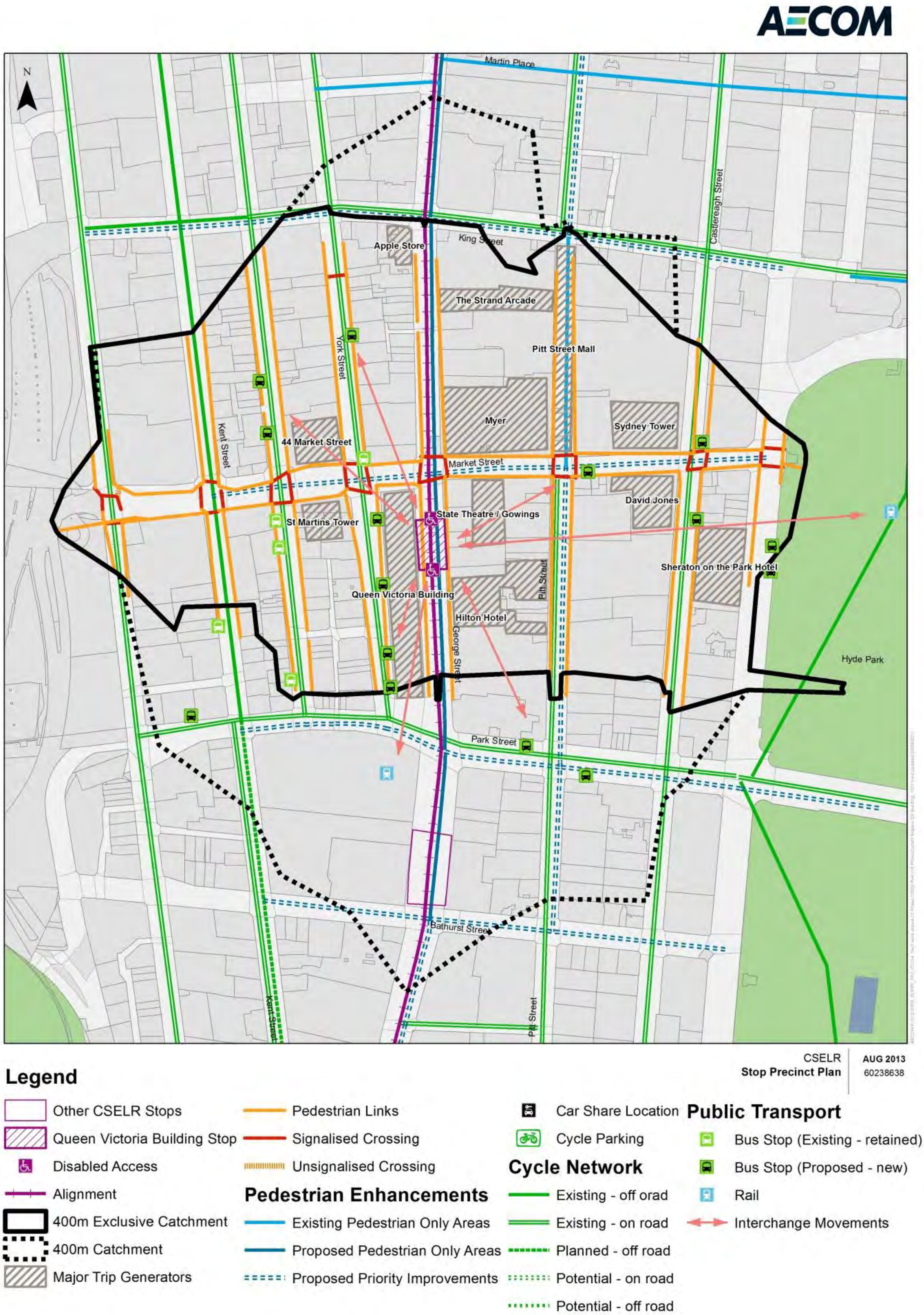
The key actions to resolve the multimodal access issues at the Queen Victoria Building stop precinct are;

- Implement pedestrian priority improvements to reduce pedestrian wait times at key intersections such as;
  - Market Street and Clarence Street
  - Market Street and York Street
  - Market Street and George Street
  - Market Street and Pitt Street Mall
  - Market Street and Castlereagh Street
  - Market Street and Elizabeth Street
- Close George Street to vehicular traffic to improve pedestrian access to and from the light rail stop.
- Through the City Centre Access Strategy (CCAS) pedestrian infrastructure upgrades will be considered, on links with high pedestrian volumes, such as Market Street between George Street and Elizabeth Street.
- Convenience afforded by Queen Victoria Building connection for customers interchanging between bus and light rail.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Coordination of bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.

Table 7-6: Queen Victoria Building Precinct Access Plan

Stop Name
Queen Victoria Building
Land Uses
– Retail / food & beverage – Commercial – Residential – Tourist accommodation
Major Trip Generators
– Retail / food & beverage (Pitt Street Mall, David Jones, Myer, Apple, Topshop, Queen Victoria Building). – Commercial (400 George Street, 420 George Street, 85 Castlereagh Street, Stockland Tower, St Martin's Tower, 44 Market Street). – Tourist accommodation (Hilton, Swissotel, QT Sydney, Sheraton on the Park). – Residential buildings to the east and west of George Street. – Sydney Tower.
Multi-Modal Stop Access
Patronage
– 691 boardings and 1,708 alightings forecast for 2021. – 811 boardings and 2,171 alightings forecast for 2036.
Heavy Rail
– Queen Victoria Building is not forecast as a major interchange for passengers from heavy to light rail. – 250m north of Town Hall Station. – 500m west of St James Station.
Light Rail
– 250m north of proposed Town Hall stop on CSELR line. – 550m south of proposed Wynyard stop on CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 459 (66%) in 2021. – 200m east of proposed bus stops on York Street (southbound only). – 250m south-west of proposed bus stop on Market Street (westbound only). – 300m east of existing bus stops on Clarence Street (northbound only). – 400m south-west of proposed bus stops on Castlereagh Street (southbound only). – 500m west of proposed bus stops on Elizabeth Street.
Pedestrian
– Estimated AM peak hour walk up patronage of 232 (34%) in 2021.
Bicycle
– Off-road cycle paths: ▪ Kent Street. ▪ King Street (between Clarence Street and Sussex Street). – On-road routes: ▪ Two way; Park Street (east-west). ▪ One way; Pitt Street (northbound), Castlereagh Street (southbound), York Street (southbound), Clarence Street (northbound), Sussex Street (southbound, south of King Street), King Street between Clarence Street and Macquarie Street (eastbound).

Figure 7-4: Queen Victoria Building Precinct Access Plan



7.3.6. Town Hall Precinct Access Plan

Access Improvements

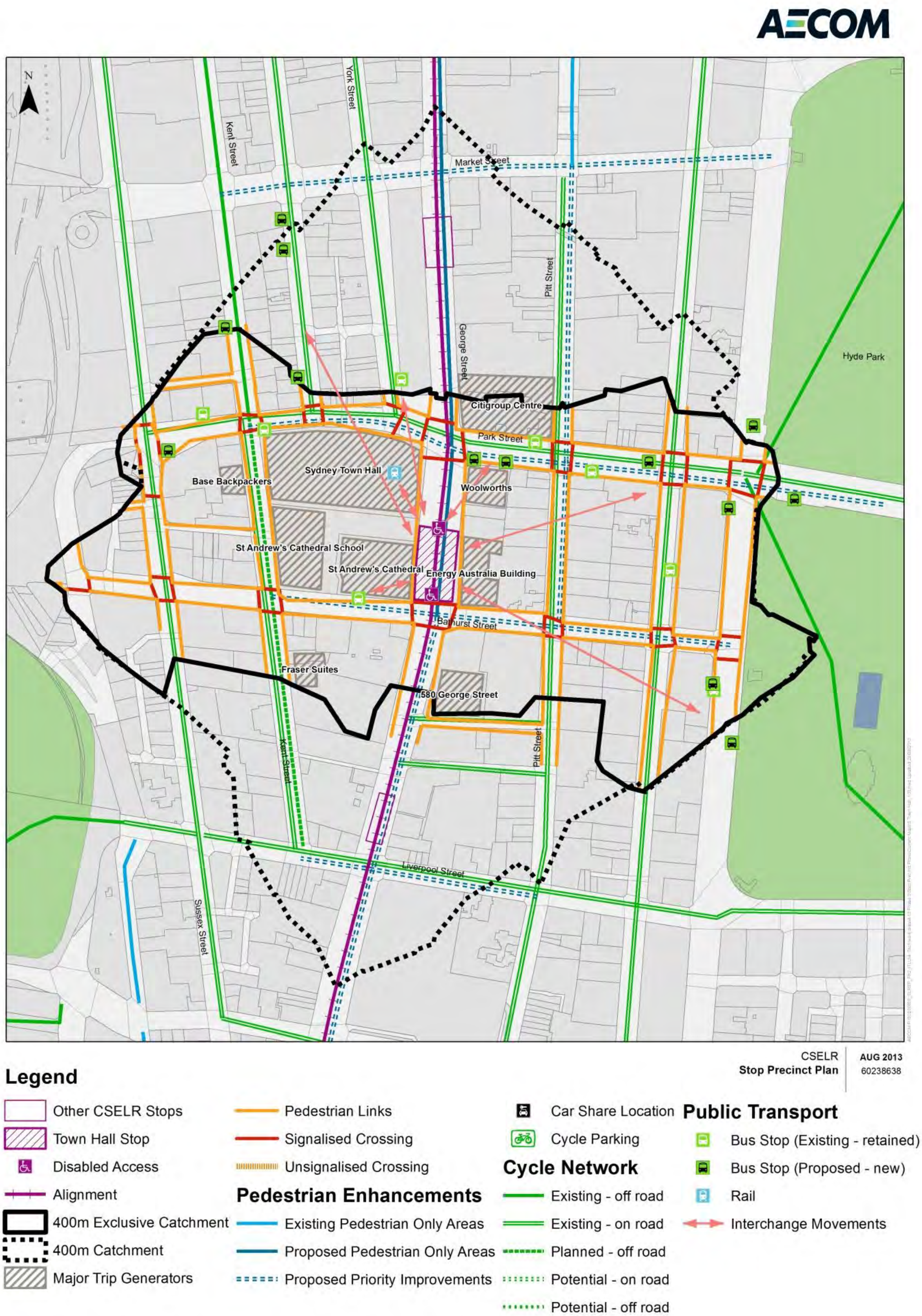
The key actions to resolve the multimodal access issues at the Town Hall stop precinct are;

- Implement pedestrian priority improvements along the Park / Druitt Street 'bus spine' to reduce pedestrian wait times at the following key intersections
  - Park Street and Elizabeth Street
  - Park Street and Castlereagh Street
  - Park Street and Pitt Street
- Close George Street to vehicular traffic to improve pedestrian access to and from the light rail stop.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Coordination of heavy rail, bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.

Table 7-7: Town Hall Precinct Access Plan

Stop Name
Town Hall
Land Uses
– Commercial – Residential – Retail / food & beverage – Tourist accommodation – Civic – Educational
Major Trip Generators
– Commercial buildings (Citigroup Centre, Ausgrid Building, HSBC Building, commercial buildings to east and west of George Street) – Residential buildings (Lumiere, residential buildings to east and west of George Street) – Transport (interchange from heavy rail at Town Hall Station or buses on Park / Druitt Streets to light rail) – Retail / food & beverage (Woolworths, Queen Victoria Building, The Galleries, Regent Place) – Tourist accommodation (Frasers Suites, Base Backpackers) – Civic (Sydney Town Hall, St Andrew's Cathedral) – Educational (St Andrew's Anglican College)
Multi-Modal Stop Access
Patronage
– 827 boardings and 872 alightings forecast for 2021. – 1,149 boardings and 1,129 alightings forecast for 2036.
Heavy Rail
– Estimated AM peak hour interchange patronage from heavy to light rail is 286 (35%) in 2021. – Above Town Hall Station. – 550m north-west of Museum Station.
Light Rail
– 250m south of proposed Queen Victoria Building stop on CSELR line. – 200m north of proposed World Square stop on CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 354 (43%) in 2021. – 100m south of proposed bus stops on Park Street. – 150m north-east of existing bus stop on Bathurst Street. – 300m west of existing and proposed bus stops on Castlereagh Street. – 400m west of existing and proposed bus stops on Elizabeth Street.
Pedestrian
– Estimated AM peak hour walk up patronage of 187 (23%) in 2021.
Bicycle
– Off-road cycle paths: ▪ Kent Street (north of Druitt Street, proposed for extension to Liverpool Street). – On-road routes: ▪ Two way; Park Street (east-west). ▪ One way; Pitt Street (northbound), Castlereagh Street (southbound), York Street (southbound), Clarence Street (northbound), Sussex Street (southbound, south of King Street).

Figure 7-5: Town Hall Precinct Access Plan



7.3.7. World Square Precinct Access Plan

Access Improvements

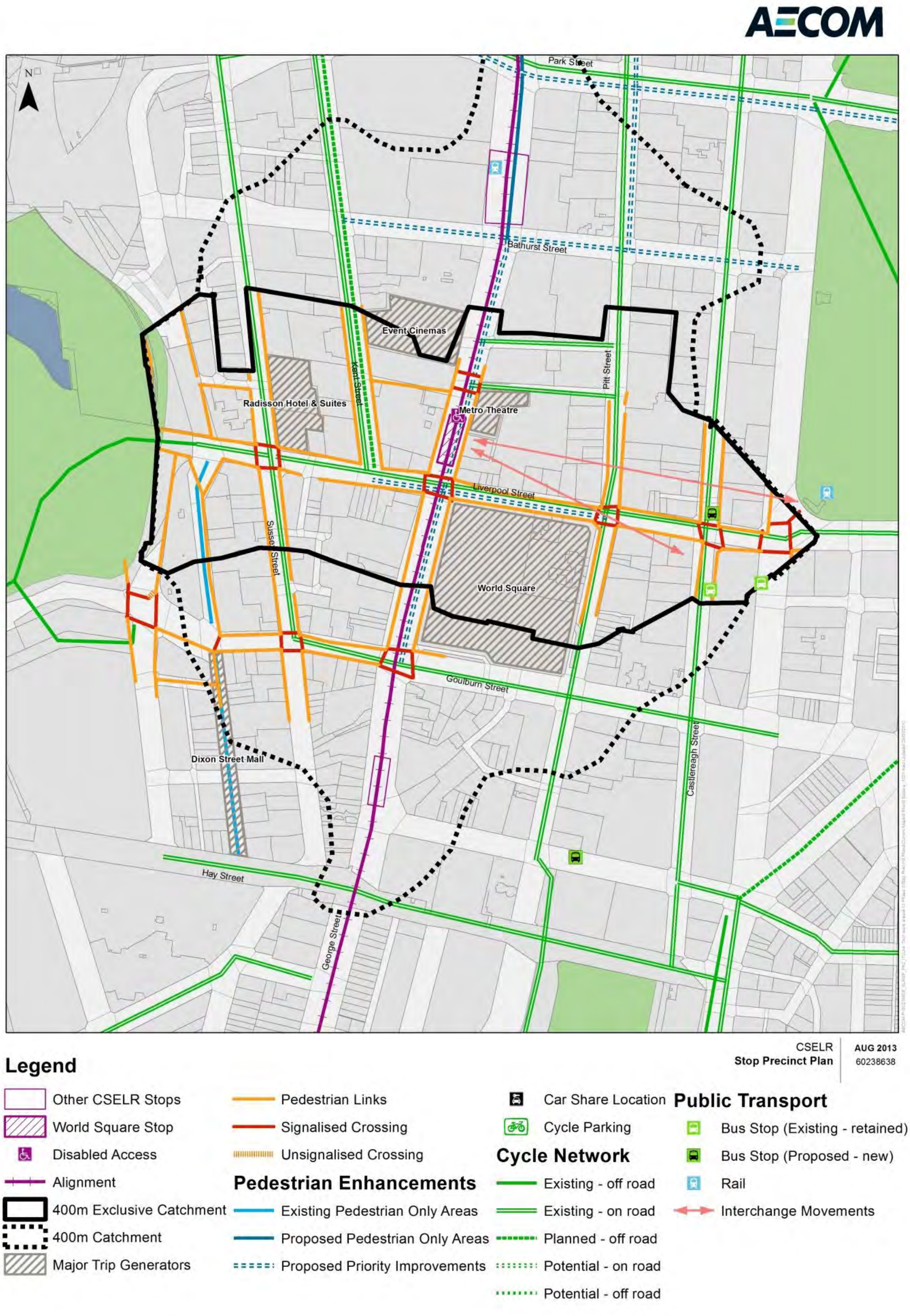
The key actions to resolve the multimodal access issues at World Square stop precinct are;

- Implement pedestrian priority improvements to reduce pedestrian wait times at key intersections such as;
  - George Street and Liverpool Street
  - George Street and Bathurst Street
- Through the City Centre Access Strategy (CCAS) pedestrian infrastructure upgrades will be considered, on links with high pedestrian volumes, such as George Street and Liverpool Street between Kent Street and Pitt Street.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.

Table 7-8: World Square Precinct Access Plan

Stop Name
World Square
Land Uses
– Residential – Commercial – Retail / food & beverage – Tourist accommodation – Entertainment
Major Trip Generators
– World Square (World Tower, Hordern Towers, Ernst & Young Centre, Rydges Hotel, World Square Shopping Centre). – Residential buildings to the east and west of World Square. – Entertainment (Event Cinemas, Metro Theatre). – Retail / food & beverage along George Street and Liverpool Street.
Multi-Modal Stop Access
Patronage
– 838 boardings and 335 alightings forecast for 2021. – 942 boardings and 400 alightings forecast for 2036.
Heavy Rail
– World Square is not forecast as a major interchange for passengers from heavy to light rail. – 400m south of Town Hall Station. – 400m west of Museum Station.
Light Rail
– 250m north of proposed Chinatown stop on CSELR line. – 200m south of proposed Town Hall stop on CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 343 (41%) in 2021. – 300m west of existing and proposed bus stops on Castlereagh Street. – 400m west of existing bus stop on Elizabeth Street.
Pedestrian
– Estimated AM peak hour walk up patronage of 495 (59%) in 2021.
Bicycle
– On-road routes: ▪ Two way; Goulburn Street (east-west). ▪ One way; Pitt Street (northbound), Castlereagh Street (southbound), Kent Street (northbound), Sussex Street (southbound), Liverpool Street (westbound). – Planned off-road cycle path extension: – Kent Street (extension from Druitt Street to Liverpool Street).

Figure 7-6: World Square Precinct Access Plan



7.3.8. Chinatown Precinct Access Plan

Access Improvements

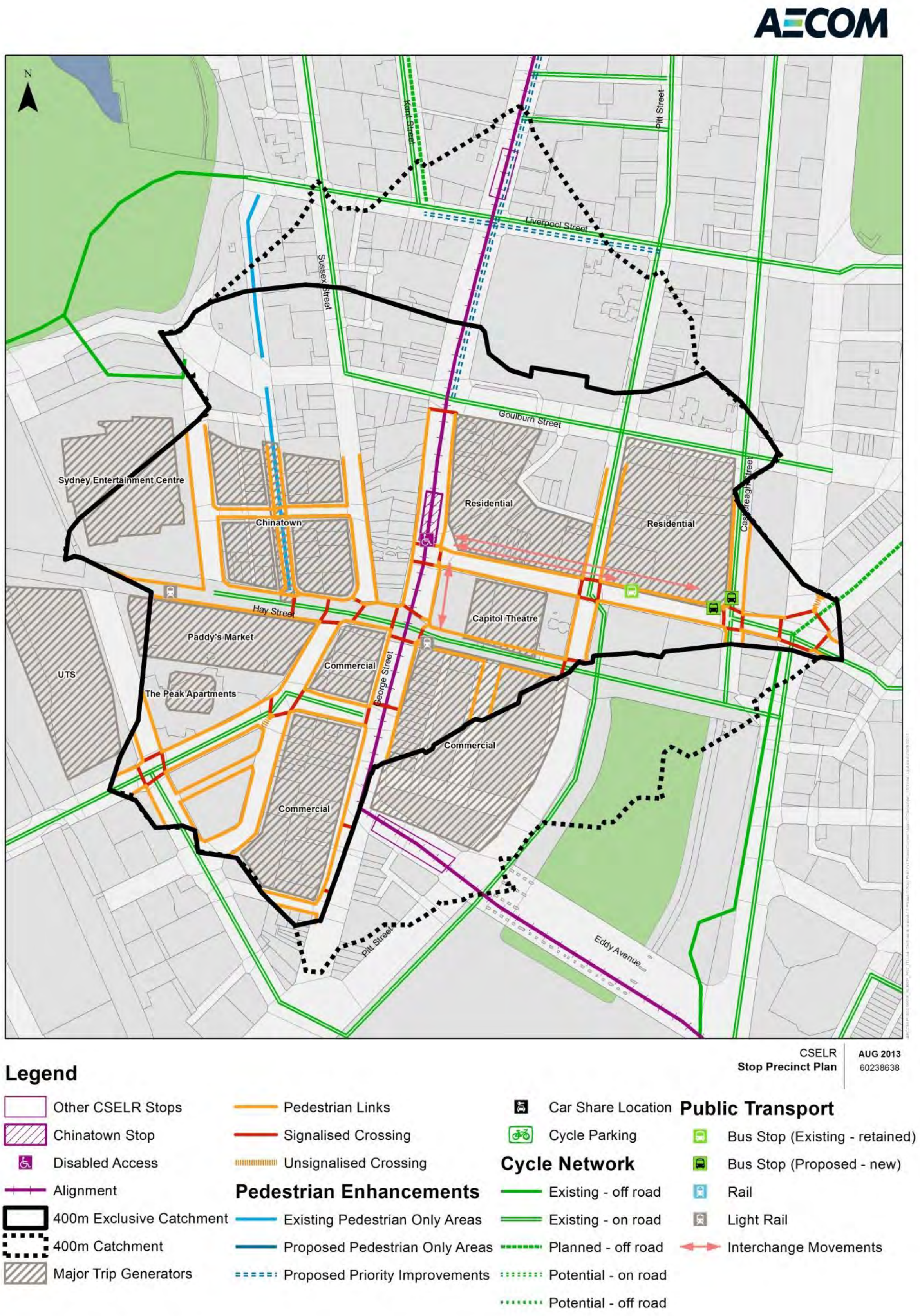
The key actions to resolve multimodal access issues in Chinatown stop precinct are;

- Implement pedestrian priority improvements at key intersections. This will reduce pedestrian walking times for passengers interchanging from bus to light rail at intersections such as;
  - Goulburn Street and George Street
  - Campbell Street and Castlereagh Street
  - Campbell Street and Pitt Street
  - Campbell Street and George Street (the George Street signals will provide customers with safe, direct access to light rail platforms).
- Implement pedestrian priority improvements at the intersection of George Street and Hay Street to reduce pedestrian wait times for passengers interchanging between the Inner West light rail and CSELR.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Coordination of bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.

Table 7-9: Chinatown Precinct Access Plan

Stop Name
Chinatown
Land Uses
– Residential – Commercial – Tourist accommodation – Cultural – Retail / food & beverage
Major Trip Generators
– Capitol Theatre. – Paddy's Markets and Market City. – Dixon Street Mall. – Residential (The Peak, Inmark Tower, Meriton Capitol and buildings bound by Goulburn, Castlereagh, Campbell and Pitt Streets). – Commercial buildings bound by Hay Street, Belmore Park, Rawson Place and George Street.
Multi-Modal Stop Access
Patronage
– 1,149 boardings and 1,116 alightings forecast for 2021. – 1,461 boardings and 1,309 alightings forecast for 2036.
Heavy Rail
– Chinatown is not forecast as a major interchange for passengers from heavy to light rail. – 500m north-west of Central Station. – 750m south-west of Museum Station.
Light Rail
– Estimated AM peak hour interchange patronage from Inner West light rail to CSELR is 109 (10%) in 2021. 100m north-west of existing Capitol Square stop on Inner West line. – 250m north-west of proposed Rawson Place interchange on CSELR line. – 270m south of proposed World Square stop on CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 464 (40%) in 2021. – 200m north of proposed bus stops on George Street (southbound stop only). – 300m north of proposed Rawson Place interchange (both directions). – 300m west of proposed bus stops on Campbell Street & Castlereagh Street (both directions). – 400m north-west of existing and proposed bus stops on Pitt Street (northbound stop only).
Pedestrian
– Estimated AM peak hour walk up passengers of 576 (50%) in 2021.
Bicycle
– On-road routes: ▪ Two way; Goulburn Street (east-west), Hay Street (east-west). ▪ One way; Pitt Street (northbound), Castlereagh Street (southbound), Kent Street (northbound), Sussex Street (southbound).

Figure 7-7: Chinatown Precinct Access Plan



7.3.9. Rawson Place Precinct Access Plan

Access Improvements

The key actions to resolve the multimodal access issues in the Rawson Place stop precinct are;

- Create a new dedicated pedestrianised transit mall with bus and light rail access only on Rawson Place.
- Position new bus stops for 'round the corner' and cross platform interchanges between bus and light rail as shown in Figure 7-8. This will reduce interaction between cars and pedestrians, improving walk time and amenity.
- Implement pedestrian priority improvements to reduce pedestrian wait times at key intersections including;
  - Eddy Avenue, Pitt Street and Rawson Place
  - George Street and Rawson Place
  - George Street and Ultimo Road.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Coordination of bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.

Table 7-10: Rawson Place Precinct Access Plan

Stop Name
Rawson Place
Land Uses
– Residential – Commercial – Tourist accommodation – Transport (Central Station and bus interchange) – Retail / food & beverage – Open space (Belmore Park) – Educational
Major Trip Generators
– Transport interchange (bus to light rail). – Commercial buildings bound by Hay Street, Belmore Park. – University of Technology Sydney. – Commercial buildings on Lee Street. – Tourist accommodation at Railway Square (Adina, Mercure, Rendezvous). – Tourist accommodation around George Street (Great Southern Hotel, Wake Up, Sydney Central YHA).
Multi-Modal Stop Access
Patronage
– 1,222 boardings and 1,817 alightings forecast for 2021. – 1,450 boardings and 2,063 alightings forecast for 2036.
Heavy Rail
– Rawson Place is not forecast as a major interchange for passengers from heavy to light rail. – 100m north-west of Central Station.
Light Rail
– 100m south of Capitol Square stop on Inner West line. – 150m north-west of Central Station stop on Inner West line. – 350m south of proposed Chinatown stop on CSELR line. – 500m north-west of proposed Central Station stop on CSELR line.
Bus
– The city centre bus network redesign will result in forced transfers from bus to light rail for some users – efficient and effective transfer arrangements will be required to mitigate any negative impacts. – Estimated AM peak hour interchange patronage from bus to light rail is 635 (52%) in 2021. – 100m north of proposed George Street bus stop (southbound stop only). – 150m from existing and proposed bus stops on Pitt Street (northbound stop only). – 200m west of existing bus stop on Eddy Avenue. – 300m north of Railway Square interchange.
Pedestrian
– Estimated AM peak hour walk up patronage of 587 (48%) in 2021.
Bicycle
– On-road routes: ▪ Two way; Quay Street (north-south), Hay Street (east-west), Ultimo Road (east-west). ▪ One way; Pitt Street (northbound), Castlereagh Street (southbound).

Figure 7-8: Rawson Place Interchange Design

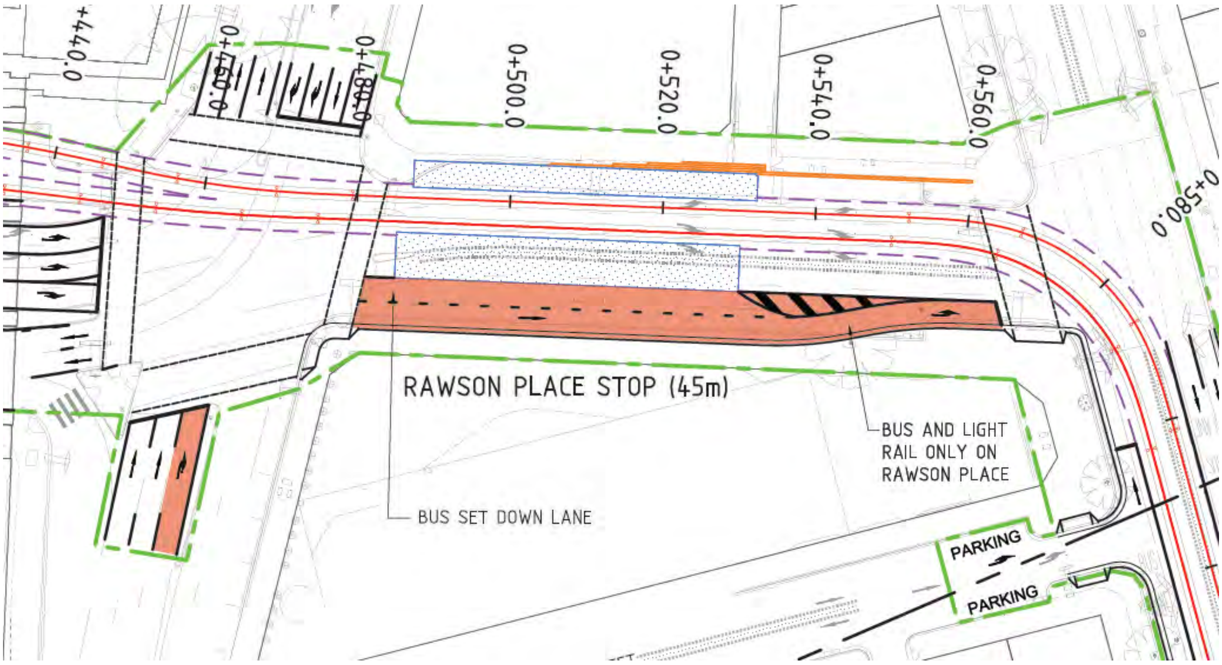
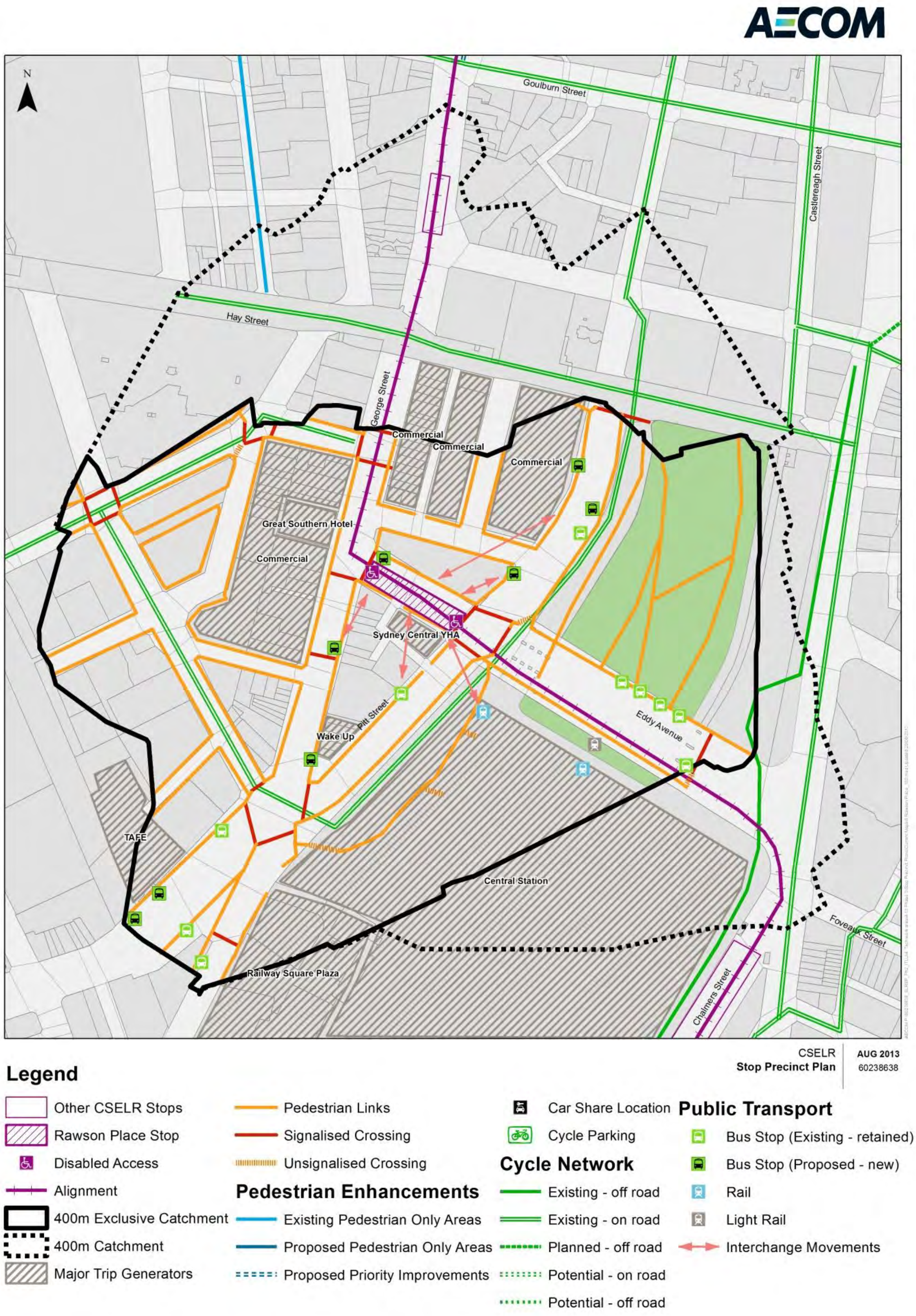


Figure 7-9 Rawson Place Precinct Access Plan



7.3.10. Central Station Precinct Access Plan

Access Improvements

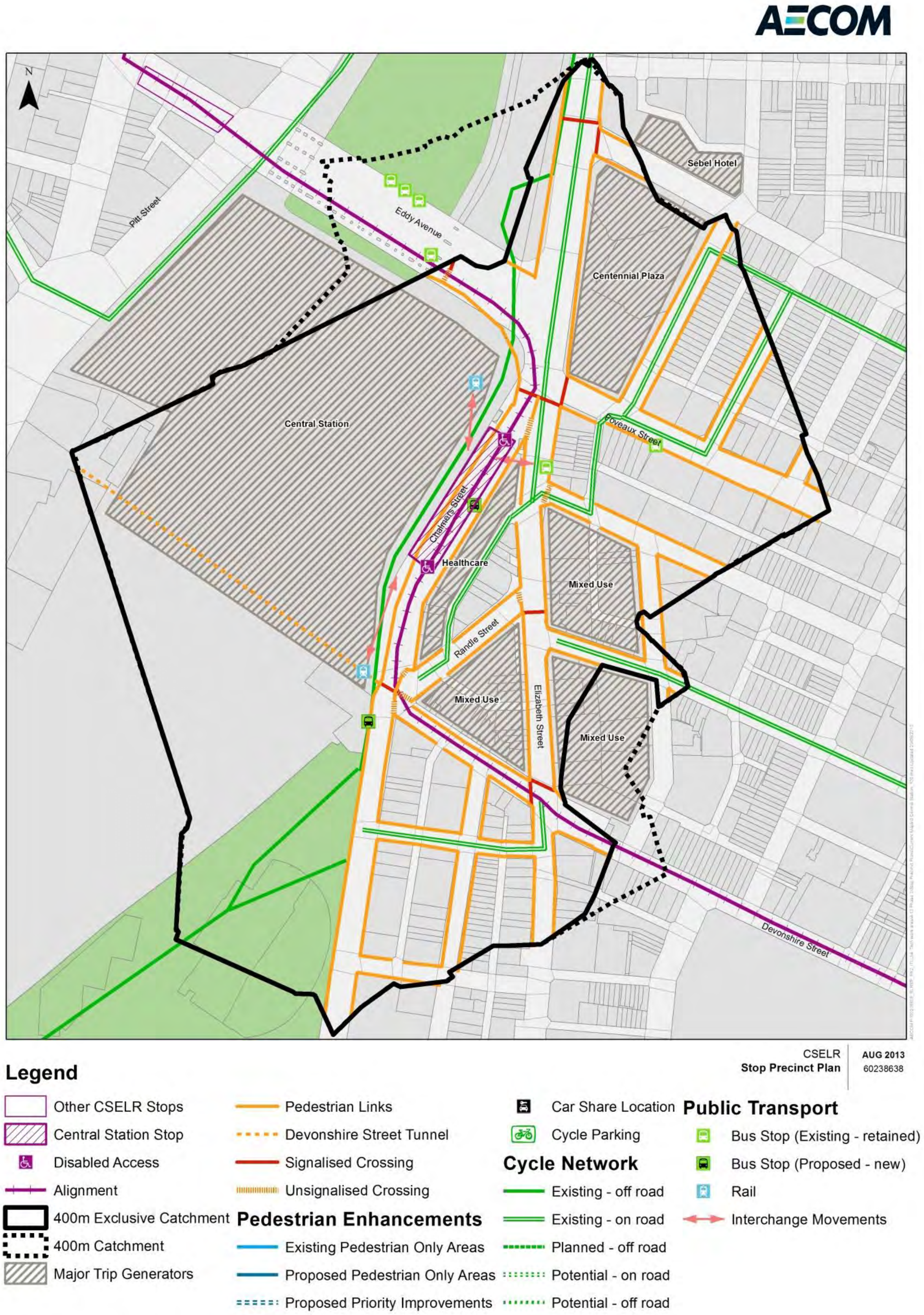
The key actions to resolve the multimodal access issues in the Central Station stop precinct are;

- Balanced interchange to the two entrances to Central Station from Chalmers Street, limiting delays for customers accessing and egressing the precinct. There is potential for a new Central Station concourse running east-west beneath the station in the long term, establishing a direct pedestrian link from all existing heavy rail platforms to the light rail stop on Chalmers Street.
- Integrate platforms with the footpath to enable seamless intermodal transition for passengers.
- Implement pedestrian priority improvements along Chalmers Street to reduce pedestrian wait times at the following key intersections;
  - Chalmers Street, Eddy Avenue, Elizabeth Street and Foveaux Street
  - Chalmers Street and Devonshire Street
- Management of rail replacement bus services.
- Access for coaches and relocation of the current coach terminal.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Coordination of heavy rail, bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.

Table 7-11: Central Station Precinct Access Plan

Stop Name
Central Station
Land Uses
– Residential – Commercial – Tourist accommodation – Transport (Central Station) – Open space (Prince Alfred Park) – Retail / food & beverage (Surry Hills)
Major Trip Generators
– Transport interchange (heavy rail to light rail) – Commercial buildings (such as Centennial Plaza) – Tourist accommodation (The Sebel Surry Hills)
Multi-Modal Stop Access
Patronage
– 2,863 boardings and 2,072 alightings forecast for 2021. – 3,830 boardings and 2,835 alightings forecast for 2036.
Heavy Rail
– Estimated AM peak hour interchange patronage from heavy to light rail is 2,387 (83%) in 2021. – Directly adjacent to east of Central Station.
Light Rail
– 350m north-west of Central Station stop on Inner West line. – 500m south-east of proposed Rawson Place interchange on CSELR line. – 700m north-west of proposed Surry Hills stop on CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 409 (14%) in 2021. – 100m south of existing bus stop on Chalmers Street. – 150m south-west of existing bus stop on Elizabeth Street. – 250m south-west of existing bus stop on Foveaux Street.
Pedestrian
– Estimated AM peak hour walk up patronage of 68 (2%) in 2021.
Bicycle
– Off-road cycle path: ▪ Prince Alfred Park and Chalmers Street (north-south). – On-road routes: ▪ Two way; Elizabeth Street (north of Foveaux Street, north-south), Mary Street and Commonwealth Street (north-south), Albion Way (east-west), Rutland Street (east-west). ▪ One way; Pitt Street (southbound), Elizabeth Street, Randle Street and Randle Lane (southbound), Terry Street (southbound).

Figure 7-10: Central Station Precinct Access Plan



7.3.11. Surry Hills Precinct Access Plan

Access Improvements

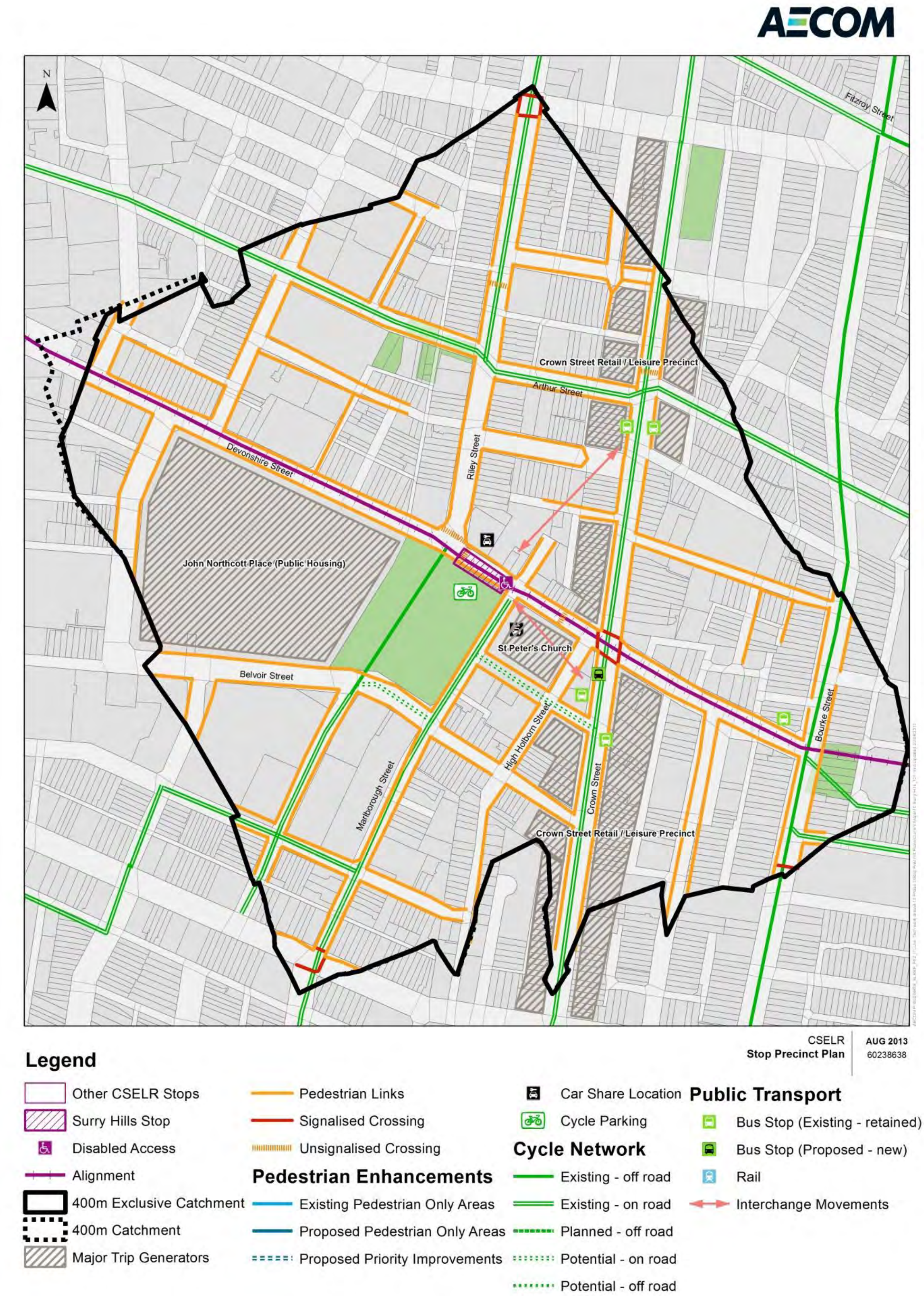
The key actions to resolve the multimodal access issues in the Surry Hills stop precinct are;

- Implement pedestrian priority improvements to reduce pedestrian wait times at key signalised intersections such as;
  - Devonshire Street and Crown Street
- Reduce capacity of Devonshire Street for vehicular traffic and give priority to east-west movements of light rail and pedestrians. The cycle route along Devonshire Street will be relocated to Cooper/Arthur Street, with cyclists not encouraged to continue using Devonshire Street once the construction of light rail begins. Investigate the need for a surface treatment to discourage cyclists.
- Signalise Devonshire Street and Marlborough Street to provide customers with safe, direct access to light rail platforms.
- It is proposed that the provision of additional car share in this location, to strengthen the existing car share offer, would provide onward connectivity options for passengers.
- A dedicated u-rail cycle parking facility with approximately five spaces at or adjacent to the light rail stop.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Consider potential improvements to lighting near Ward Park in detailed stop design.
- Coordination of bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.

Table 7-12: Surry Hills Precinct Access Plan

Stop Name
Surry Hills
Land Uses
– Residential – Retail / food & beverage – Open space (Ward Park) – Church (St Peters)
Major Trip Generators
– Crown Street – bars, cafes, restaurants, retail and residential. – Bourke Street – bars, cafes, restaurants, retail and residential. – Residential apartments within walking distance of stop. – St Peters Church.
Multi-Modal Stop Access
Patronage
– 889 boardings and 852 alightings forecast for 2021. – 1,292 boardings and 1,035 alightings forecast for 2036.
Heavy Rail
– Surry Hills is not forecast to be a major interchange for passengers from heavy to light rail. – ~700m east of Central Station.
Light Rail
– 700m south-east of proposed Central Station stop on CSELR line. – 1.4km north-west of proposed Moore Park stop on CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 505 (57%) in 2021. – 200m north-west of Crown Street stop (south of Devonshire Street). – 300m south-west of Crown Street stop (north of Devonshire Street). – 350m north of Cleveland Street stop (near Marlborough Street).
Pedestrian
– Estimated AM peak hour walk up patronage of 384 (43%) in 2021.
Bicycle
– Off-road cycle path: ▪ Bourke Street (north-south), South Dowling Street (north-south) and Ward Park (north-south). – On-road routes: ▪ Two way; Elizabeth Street (north of Foveaux Street, north-south), Mary Street and Commonwealth Street (north-south), Albion Way (east-west), Rutland Street (east-west). Crown Street (north-south), Marlborough Street (north-south between Devonshire Street and Landsdowne Street), Riley Street (north-south north of Arthur Street), Arthur Street (east-west). ▪ One way; Parkham Lane (westbound), Parkham Street (eastbound), Goodlet Street (eastbound). – Potential to reinstate Cooper Street as an on-road route. – Proposed u-rail cycle parking facility with approximately five spaces at or adjacent to the light rail stop.

Figure 7-11: Surry Hills Precinct Access Plan



7.3.12. Moore Park Precinct Access Plan

Access Improvements

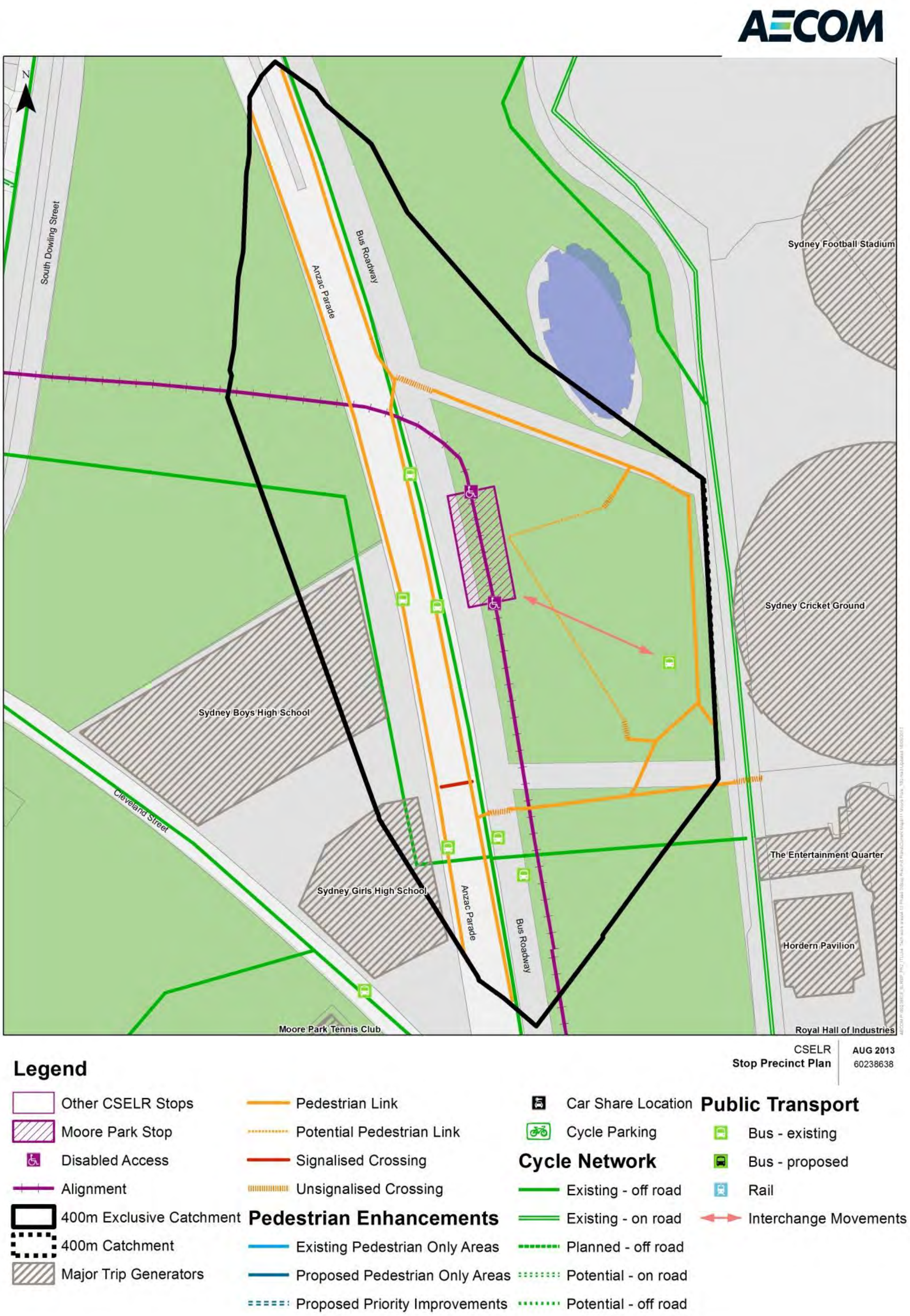
The key actions to resolve the multimodal access issues in the Moore Park stop precinct are;

- Implement pedestrian access improvements locally to the Moore Park Precinct, especially to service sports / entertainment events, and strategic connections to Surry Hills to west (through collaboration with other agencies and stakeholders)
- The Moore Park stop is proposed in an offline location, located outside the existing roadway, which will minimise interaction between cars and pedestrians on the eastern side of Anzac Parade.
- Position bus stops to enable safe and quick transfers to light rail.
- Consider potential improvements to lighting in detailed stop design.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Potential for a shared pedestrian and cycle bridge over Anzac Parade (between Fitzroy Street in the north and Cleveland Street in the south). A bridge is currently under investigation as part of RMS' Central Railway Station to Moore Park Pedestrian Access Study

Table 7-13: Moore Park Precinct Access Plan

Stop Name
Moore Park
Land Uses
– Open and recreational space – Sport – Entertainment – Educational – Residential
Major Trip Generators
– Open and recreational space (Moore Park, Centennial Park) – Sport (SCG, Allianz Stadium) – Entertainment (Hordern Pavilion, Royal Hall of Industries, Cinema Paris, Hoyts, Fox Studios) – Educational (Sydney Boys High School) – Residential (south-east of stop)
Multi-Modal Stop Access
Patronage
– 115 boardings and 477 alightings forecast for 2021. – 134 boardings and 571 alightings forecast for 2036.
Light Rail
– 1.4 km south-east of proposed Surry Hills stop on CSELR line. – 1.6 km north of proposed Carlton Street stop on Kingsford branch of CSELR line. – 1.9 km north-west of proposed Royal Randwick Racecourse stop on Randwick branch of CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 31 (27%) in 2021. – 50m south of existing Anzac Parade stop. – 250m north and south of existing Anzac Parade stops (on both sides of Cleveland Street). – 250m north of existing Cleveland Street stops (on both sides of Anzac Parade).
Pedestrian
– Estimated AM peak hour walk up patronage of 85 (73%) in 2021.
Bicycle
– Off-road cycle path: ▪ South Dowling Street (north-south), Anzac Parade (north-south), Cleveland Street (east-west) and Moore Park (east-west). – On-road routes: • Two way; Driver Avenue (north-south), Robertson Road (north-south). – Proposed u-rail cycle parking facility with approximately five spaces at or adjacent to the light rail stop.

Figure 7-12: Moore Park Precinct Access Plan



7.3.13. Carlton Street Precinct Access Plan

Access Improvements

The key actions to resolve the multimodal access issues in the Carlton Street stop precinct are;

- Implement pedestrian priority improvements to facilitate pedestrian access to the Carlton Street stop at the key intersection of Anzac Parade and Carlton Street. Anzac Parade signals provide customers with safe, direct access to light rail platforms.
- Position bus stops to enable safe and quick transfers to light rail.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Consider potential improvements to lighting in detailed stop design.
- Coordination of bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.

Table 7-14: Carlton Street Precinct Access Plan

Stop Name
Carlton Street
Land Uses
– Residential – Retail – Recreational / Sport
Major Trip Generators
– Residential (medium density dwellings on Anzac Parade, low density detached dwellings to east and west of Anzac Parade). – Retail / F&B (along Anzac Parade). – Recreational / Sport (Centennial Park, Moore Park Golf Course, ES Marks Athletics Field).
Multi-Modal Stop Access
Patronage
– 213 boardings and 9 alightings forecast for 2021. – 241 boardings and 10 alightings forecast for 2036.
Light Rail
– ~450m north of proposed Todman Avenue stop on Kingsford branch of CSELR line. – ~1.6 km south of proposed Moore Park stop on Kingsford branch of CSELR line.
Bus
– Carlton Street is not forecast to be a major interchange for passengers from bus to light rail.
Pedestrian
– Estimated AM peak hour walk up patronage of 213 (100%) in 2021.
Bicycle
– On-road routes: ▪ Two way; Doncaster Avenue (north-south), Boronia Street (north-south), Duke Street (east-west), Todman Avenue (east-west), Addison Street (east-west). – Planned off-road cycle path: ▪ Two way; Anzac Parade (north-south). – Proposed u-rail cycle parking facility with approximately five spaces at or adjacent to the light rail stop.

Figure 7-13: Carlton Street Precinct Access Plan

7.3.14. Todman Avenue Precinct Access Plan

Access Improvements

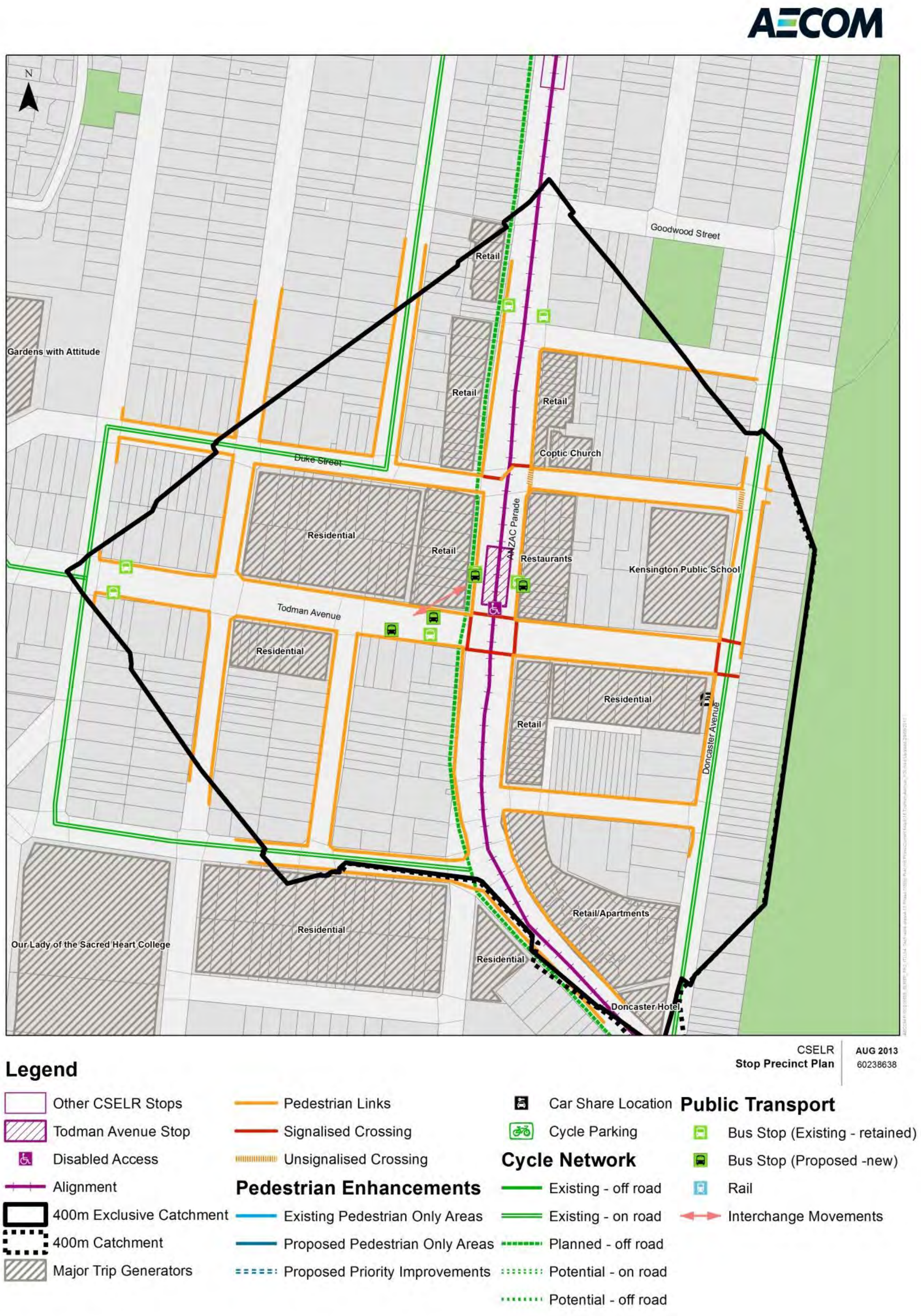
The key actions to resolve the multimodal access issues in the Todman Avenue stop precinct are;

- Implement pedestrian priority improvements to facilitate pedestrian access to the Todman Avenue stop at the key intersection of Anzac Parade and Todman Avenue. Anzac Parade signals provide customers with safe, direct access to light rail platforms.
- Position bus stops to enable safe and quick transfers to light rail.
- Enhance existing car share with additional spaces to provide for onward journey (for example to Green Square).
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Consider potential improvements to lighting in detailed stop design.
- Coordination of bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.

Table 7-15: Todman Avenue Precinct Access Plan

Stop Name
Todman Avenue
Land Uses
– Residential – Student accommodation – Retail / F&B – Educational – Civic
Major Trip Generators
– Residential (medium density dwellings on Anzac Parade, low density detached dwellings to east and west of Anzac Parade. – Student accommodation. – Retail / F&B (along Anzac Parade). – Educational (Kensington Public School). – Civic (Coptic Orthodox Church of St George, Kensington RSL).
Multi-Modal Stop Access
Patronage
– 531 boardings and 296 alightings forecast for 2021. – 637 boardings and 421 alightings forecast for 2036.
Light Rail
– 450m south of proposed Carlton Street stop on Kingsford branch of CSELR line. – 800m north of proposed UNSW Anzac Parade stop on Kingsford branch of CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 83 (18%) in 2021. – 100m north-east of existing Todman Avenue stop. – 200m north and south of existing Anzac Parade stops (on both sides of Todman Avenue).
Pedestrian
– Estimated AM peak hour walk up patronage of 389 (82%) in 2021.
Bicycle
– On-road routes: ▪ Two way; Doncaster Avenue (north-south), Boronia Street (north-south), Duke Street (east-west), Todman Avenue (east-west), Addison Street (east-west). – Planned off-road cycle path: ▪ Two way; Anzac Parade (north-south). – Proposed u-rail cycle parking facility with approximately five spaces at or adjacent to the light rail stop.

Figure 7-14: Todman Avenue Precinct Access Plan



7.3.15. UNSW Anzac Parade Precinct Access Plan

Access Improvements

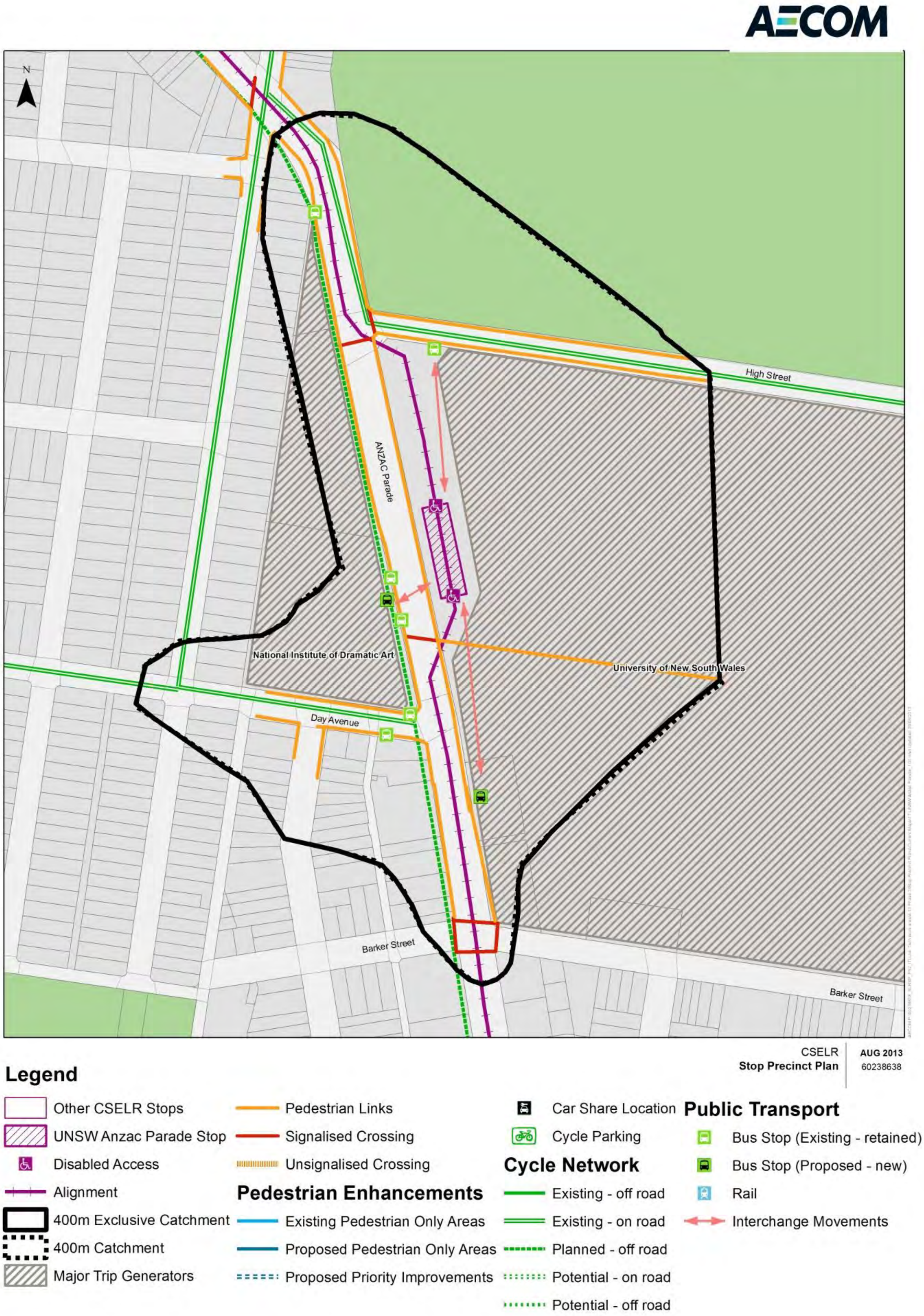
The key actions to resolve the multimodal access issues in the UNSW Anzac Parade stop precinct are;

- The UNSW Anzac Parade stop is proposed in an offline location which will minimise interaction between cars and pedestrians on the eastern side of Anzac Parade. This enables customers alighting at the stop to directly access the University Mall without having to cross Anzac Parade.
- Implement pedestrian priority improvements to reduce pedestrian wait times at the key signalised crossing on Anzac Parade. This will ensure a safe pedestrian connection between the light rail stop and the western side of Anzac Parade.
- Also provide priority for north-south pedestrian movements at the following intersections;
  - Anzac Parade and High Street
  - Anzac Parade and Day Avenue
- Introduce integrated customer information (including for UNSW) and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Consider potential improvements to lighting in detailed stop design.

Table 7-16: UNSW Anzac Parade Precinct Access Plan

Stop Name
UNSW Anzac Parade
Land Uses
– Educational – Residential – Student accommodation – Retail / F&B
Major Trip Generators
– Educational (University of New South Wales, National Institute of Dramatic Art). – Residential (medium density dwellings on Anzac Parade, low density detached dwellings to east and west of Anzac Parade. – Student accommodation. – Retail / F&B (along Anzac Parade).
Multi-Modal Stop Access
Patronage
– 626 boardings and 1,291 alightings forecast for 2021. – 708 boardings and 1,673 alightings forecast for 2036.
Light Rail
– 400m north of proposed Strachan Street stop on Kingsford branch of CSELR line. – ~800m south of proposed Todman Avenue stop on Kingsford branch of CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 146 (35%) in 2021. – Adjacent to existing Anzac Parade northbound stop. – 150m south-west of existing High Street northbound stop. – 200m north of existing Anzac Parade stop (both directions).
Pedestrian
– Estimated AM peak hour walk up patronage of 281 in 2021.
Bicycle
– On-road routes: ▪ Two way; Doncaster Avenue (north-south), Houston Road (north-south), Day Avenue / UNSW (east-west), High Street (east-west). – Planned off-road cycle path: ▪ Two way; Anzac Parade (north-south). – Proposed u-rail cycle parking facility with approximately five spaces at or adjacent to the light rail stop.

Figure 7-15: UNSW Anzac Parade Precinct Access Plan



7.3.16. Strachan Street Precinct Access Plan

Access Improvements

The key actions to resolve the multimodal access issues in the Strachan Street stop precinct are;

- Implement pedestrian priority improvements to reduce pedestrian wait times at the key signalised intersections of Anzac Parade, Strachan Street and Middle Street. Anzac Parade signals provide customers with safe, direct access to light rail platforms.
- Consider potential improvements to lighting in detailed stop design.

Table 7-17: Strachan Street Precinct Access Plan

Stop Name
Strachan Street
Land Uses
– Residential – Retail / F&B – Sport
Major Trip Generators
– Residential (medium density dwellings on Anzac Parade, low density detached dwellings to east and west of Anzac Parade). – Retail / F&B (along Anzac Parade). – Sport (Kensington Park, Kensington Bowls Club, Eastcourts Tennis).
Multi-Modal Stop Access
Patronage
– 802 boardings and 84 alightings forecast for 2021. – 1,024 boardings and 99 alightings forecast for 2036.
Light Rail
– 400m south of proposed UNSW Anzac Parade stop on Kingsford branch of CSELR line. – 450m north of proposed Kingsford stop on Kingsford branch of CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 6 (2%) in 2021. – 60m north of Anzac Parade stop. – 160m south of Anzac Parade stop. – 250m north of Meeks Avenue stop. – 400m north-east of Houston Road stop.
Pedestrian
– Estimated AM peak hour walk up patronage of 316 (98%) in 2021.
Bicycle
– On-road routes: ▪ Two way; Houston Road (north-south), Day Avenue / UNSW (east-west). – Planned off-road cycle path: ▪ Two way; Anzac Parade (north-south). – Proposed u-rail cycle parking facility with approximately five spaces at or adjacent to the light rail stop.

Figure 7-16: Strachan Street Precinct Access Plan

7.3.17. Kingsford Precinct Access Plan

Access Improvements

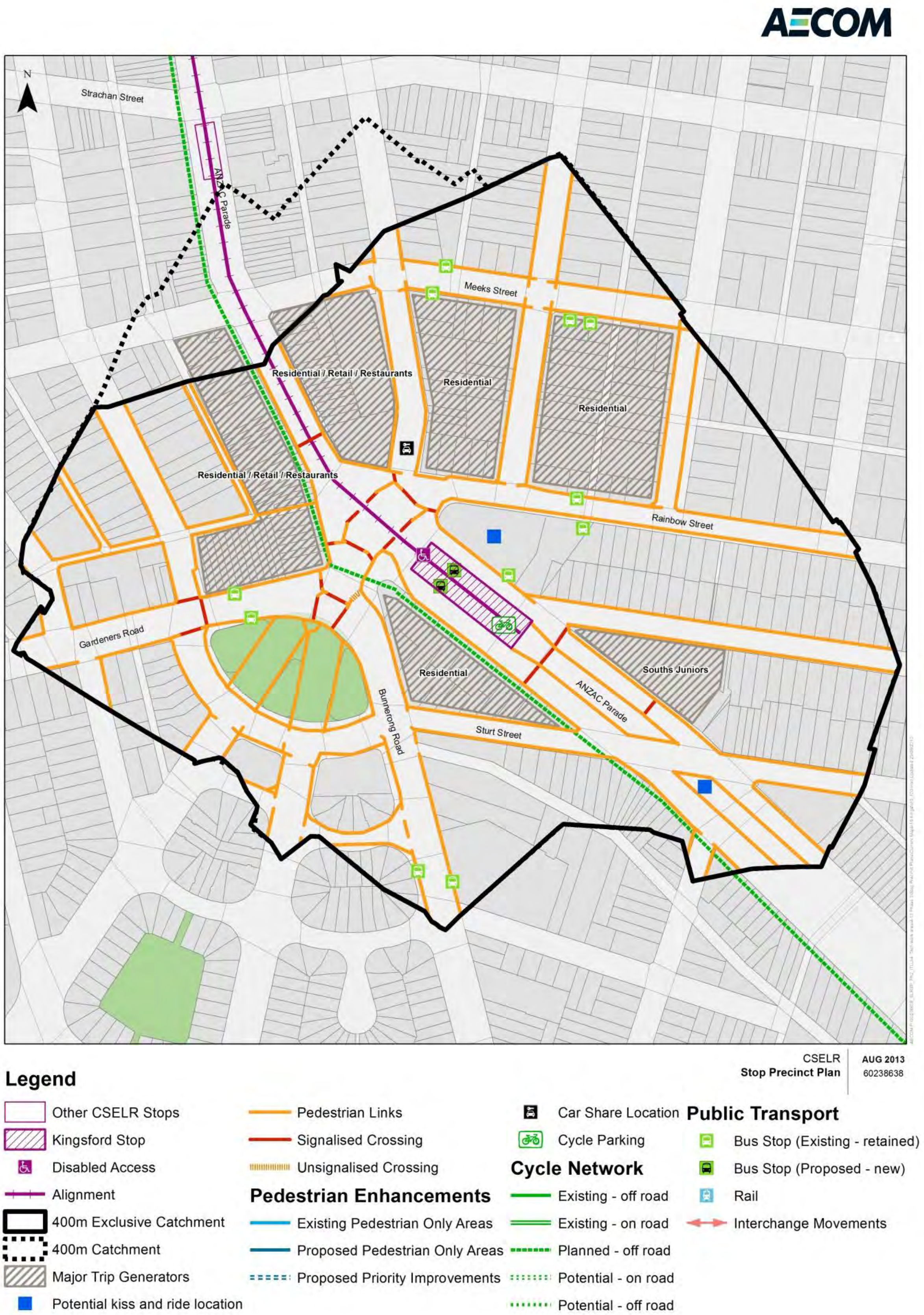
The key actions to resolve the multimodal access issues in the Kingsford stop precinct are;

- Position bus stops to enable safe and quick transfers to light rail. For buses intended to act as interchange services, this includes establishing a cross-platform transfer to / from light rail.
- Coordination of bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.
- Potential kiss and ride locations identified, which will be subject to further consultation with stakeholders.
- Implement upgrade of Nineways intersection to provide improved pedestrian crossing to / from the Kingsford Centre and light rail
- Position new signalised crossings adjacent to the light rail stop for direct pedestrian access to either side of Anzac Parade (south of Nineways).
- Preliminary analysis suggests additional car share located close to the Kingsford stop would be attractive to current and potential car share members. A car share location would help offset the loss of parking once CSELR is implemented in the Anzac Parade corridor.
- Consider potential improvements to lighting in detailed stop design.

Table 7-18: Kingsford Precinct Access Plan

Stop Name
Kingsford
Land Uses
– Residential – Retail / F&B
Major Trip Generators
– Residential (medium density dwellings on Anzac Parade, low density detached dwellings to east and west of Anzac Parade. – Retail / F&B (along Anzac Parade).
Multi-Modal Stop Access
Patronage
– 1,454 boardings and 515 alightings forecast for 2021. – 1,851 boardings and 615 alightings forecast for 2036.
Light Rail
– 450m south of proposed Strachan Street stop on Kingsford branch of CSELR line.
Bus
– This stop is proposed as the terminus of the Kingsford branch of the CSELR line. As such, Kingsford is envisaged as a major bus / light rail interchange for passengers travelling between the city and south-eastern suburbs such as Maroubra, Malabar and Little Bay. To aid transfers between bus and light rail, a cross platform interchange is proposed. – Estimated AM peak hour interchange patronage from bus to light rail is 2,021 (92%) in 2021. – During off peak periods users will be forced to transfer from bus to light rail at Kingsford – efficient and effective transfer arrangements will be required to mitigate any negative impacts. – 150m south of existing Anzac Parade stop. – 150m west of existing Rainbow Street stop. – 250m east of existing Gardeners Road stop.
Pedestrian
– In order for Kingsford to operate as a successful interchange, pedestrian priority improvements are required. – Estimated AM peak hour walk up passengers of 177 (8%) in 2021.
Bicycle
– On-road routes: ▪ Two way; Houston Road (north-south), Sturt Street (east-west). – Planned off-road cycle path: ▪ Two way; Anzac Parade (north-south). – Proposed cycle parking facility with approximately five bicycle locker spaces, supplemented with approximately 10 u-rail spaces at or adjacent to the light rail stop.

Figure 7-17: Kingsford Precinct Access Plan



7.3.18. Royal Randwick Racecourse Precinct Access Plan

Access Improvements

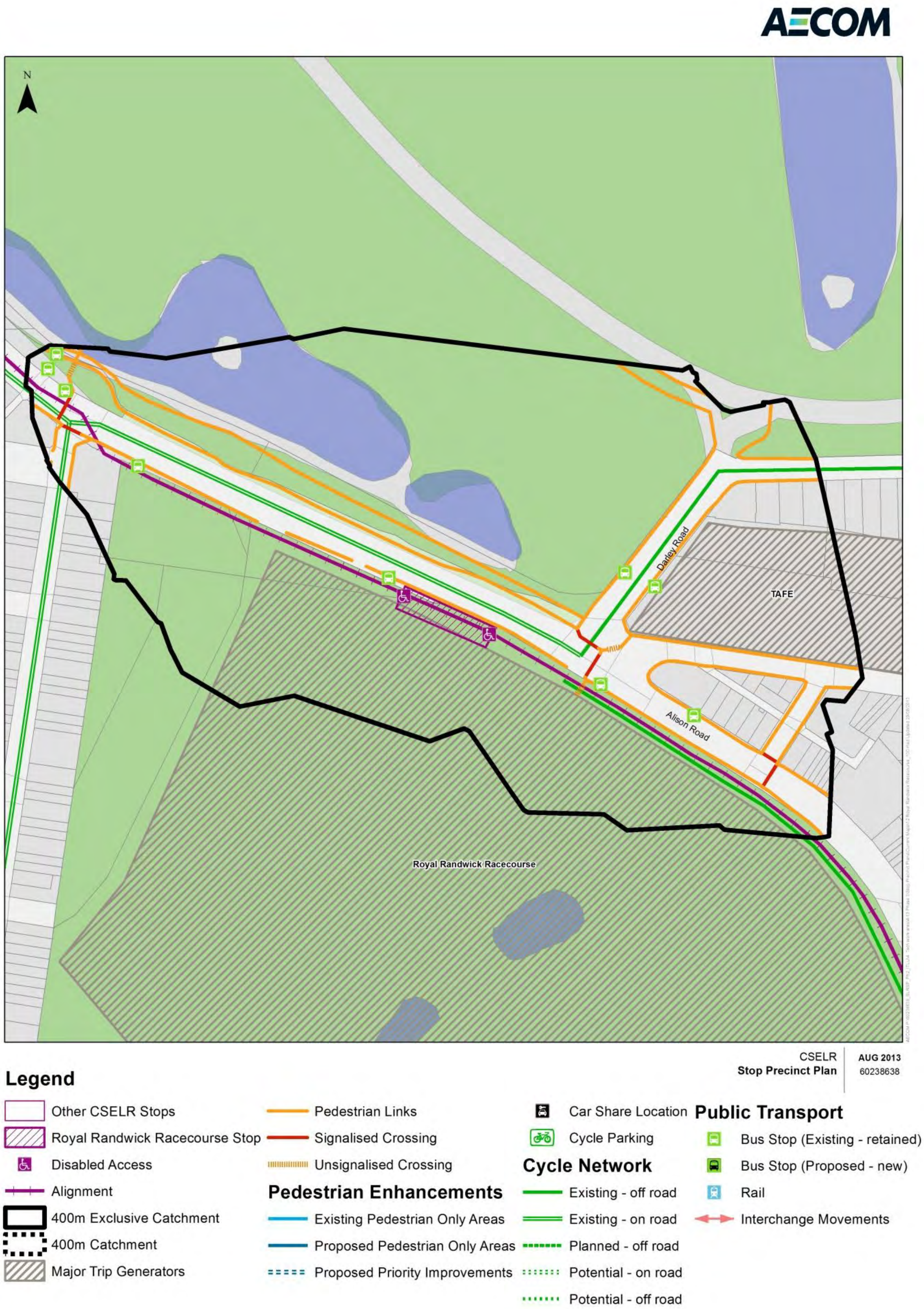
The key actions to resolve the multimodal access issues in the Royal Randwick Racecourse stop precinct are;

- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Implement pedestrian priority improvements to reduce wait times at existing signalised intersections such as;
  - Alison Road and Darley Road, to service the TAFE
  - Alison Road and Doncaster Avenue
- Locate the Royal Randwick Racecourse stop offline to reduce interaction between cars and pedestrians and enable direct connections for high pedestrian flows to / from Royal Randwick Racecourse.
- The Royal Randwick Racecourse stop is proposed in an offline location which will minimise interaction between cars and pedestrians on the southern side of Alison Road.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Consider potential improvements to lighting in detailed stop design.
- The off-road cycle path and footpath on the west side of Wansey Road and south side of Alison Road will be retained, but relocated within the same corridor.

Table 7-19: Royal Randwick Racecourse Precinct Access Plan

Stop Name
– Royal Randwick Racecourse
Land Uses
– Sport – Residential – Recreational – Educational
Major Trip Generators
– Sport (Royal Randwick Racecourse). – Residential (medium density dwellings on Alison Road, low density detached dwellings to east and west of Alison Road. – Recreational (Centennial Park). – Educational (TAFE NSW, UNSW Institute of Languages).
Multi-Modal Stop Access
Patronage
– 691 boardings and 187 alightings forecast for 2021. – 802 boardings and 213 alightings forecast for 2036.
Light Rail
– 1.9km south-east of proposed Moore Park stop on CSELR line. – 900m north-west of proposed Wansey Road stop on Randwick branch of CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 455 (96%) in 2021. – 200m west of existing Darley Road stop. – 200m west of existing Alison Road stop (west of Darley Road). – 300m east of existing Alison Road stops (on busway and Alison Road).
Pedestrian
– Estimated AM peak hour walk up patronage of 18 (4%) in 2021.
Bicycle
– Off-road cycle path: ▪ Two way; Alison Road (west of Darley Road, east-west), Darley Road (east-west). – On-road routes: ▪ Two way; Doncaster Avenue (north-south), Alison Road (east-west). – Proposed u-rail cycle parking facility with approximately five spaces at or adjacent to the light rail stop.

Figure 7-18: Royal Randwick Racecourse Precinct Access Plan



7.3.19. Wansey Road Precinct Access Plan

Access Improvements

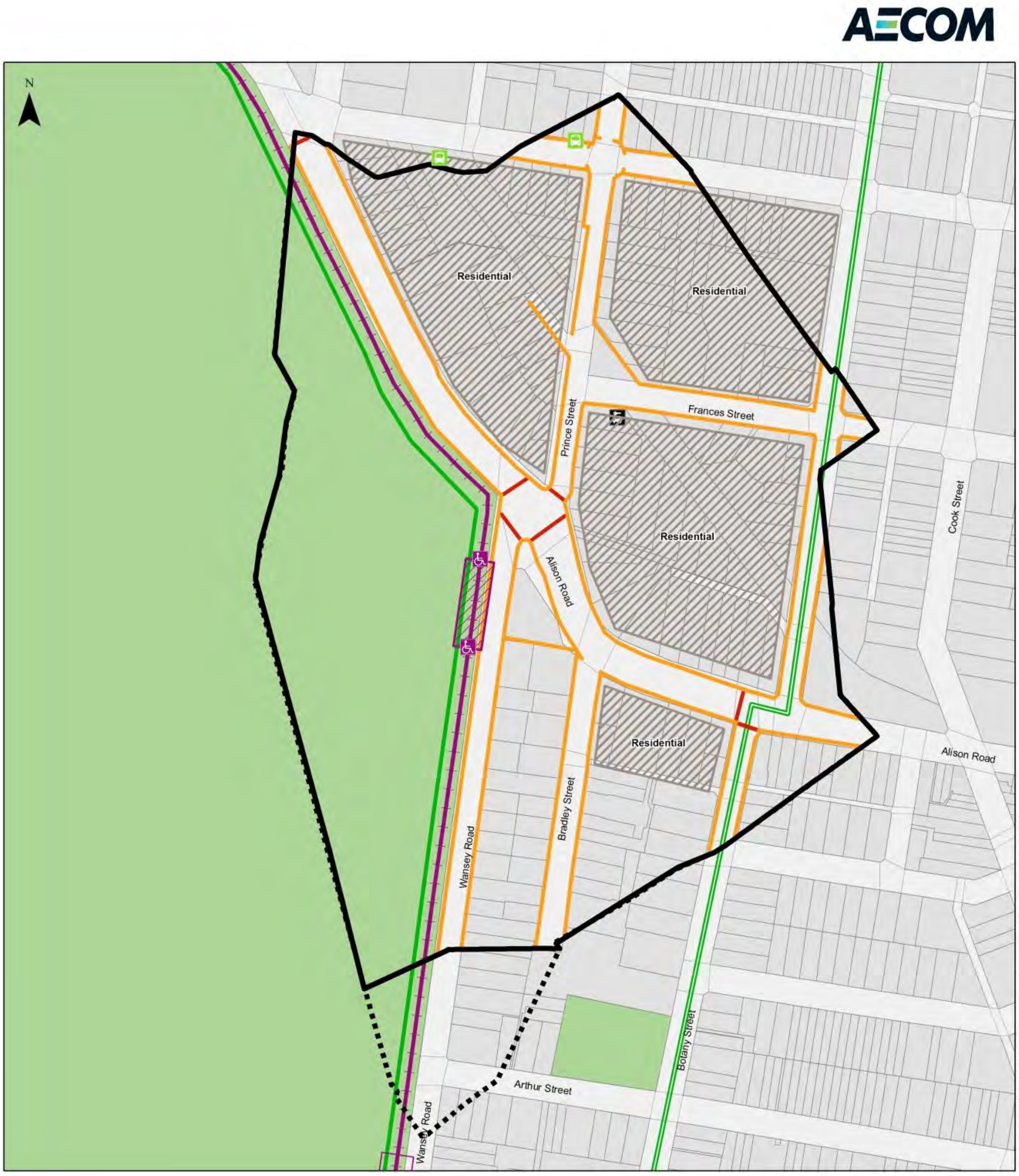
The key actions to resolve the multimodal access issues in the Wansey Road stop precinct are;

- Signalise the intersection of Alison Road and Wansey Road to improve pedestrian access to the light rail stop, to serve the majority of the pedestrian catchment of 700 people per AM peak hour to the north, east and across Alison Road.
- Preliminary analysis suggests a car share location in close proximity to the Wansey Road stop would be attractive to current and potential car share members. A car share location would help offset loss of parking following the implementation of the Alison and Wansey Road corridors. This would provide for onward journeys to the east in Randwick and Waverley.
- Locate the Wansey Road stop offline to reduce interaction between cars and pedestrians trying to access the light rail platforms.
- Consider potential improvements to lighting in detailed stop design.
- The off-road cycle path and footpath on the west side of Wansey Road and south side of Alison Road will be retained, but relocated within the same corridor.

Table 7-20: Wansey Road Precinct Access Plan

Stop Name
Wansey Road
Land Uses
– Residential
Major Trip Generators
– Residential (medium density dwellings on Alison Road, low density detached dwellings to east and west of Alison Road
Multi-Modal Stop Access
Patronage
– 921 boardings and 316 alightings forecast for 2021. – 1,029 boardings and 358 alightings forecast for 2036.
Light Rail
– 900m south-east of proposed Royal Randwick Racecourse stop on Randwick branch of CSELR line. – 450m north of proposed UNSW High Street stop on Randwick branch of CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 30 (6%) in 2021. – 400m south of existing Cowper Road stop. – 500m south-west of Cook Street stop.
Pedestrian
– Estimated AM peak hour walk up passengers of 475 (94%) in 2021.
Bicycle
– Off-road cycle path: ▪ Two way; Wansey Road (north-south), Alison Road (east-west). – On-road route: ▪ Two way; Botany Street / Church Street (north-south). – Proposed u-rail cycle parking facility with approximately five spaces at or adjacent to the light rail stop.

Figure 7-19: Wansey Road Precinct Access Plan



Legend

Other CSELR Stops
Wansey Road Stop
Disabled Access
Alignment
400m Exclusive Catchment
400m Catchment
Major Trip Generators

Pedestrian Links
Signalised Crossing
Unsignalised Crossing

Pedestrian Enhancements

Existing Pedestrian Only Areas
Proposed Pedestrian Only Areas
Proposed Priority Improvements

Car Share Location
Cycle Parking

Cycle Network

Existing - off road
Existing - on road
Planned - off road
Potential - on road
Potential - off road

Public Transport

Bus Stop (Existing - retained)
Bus Stop (Proposed - new)
Rail
Interchange Movements

7.3.20. UNSW High Street Precinct Access Plan

Access Improvements

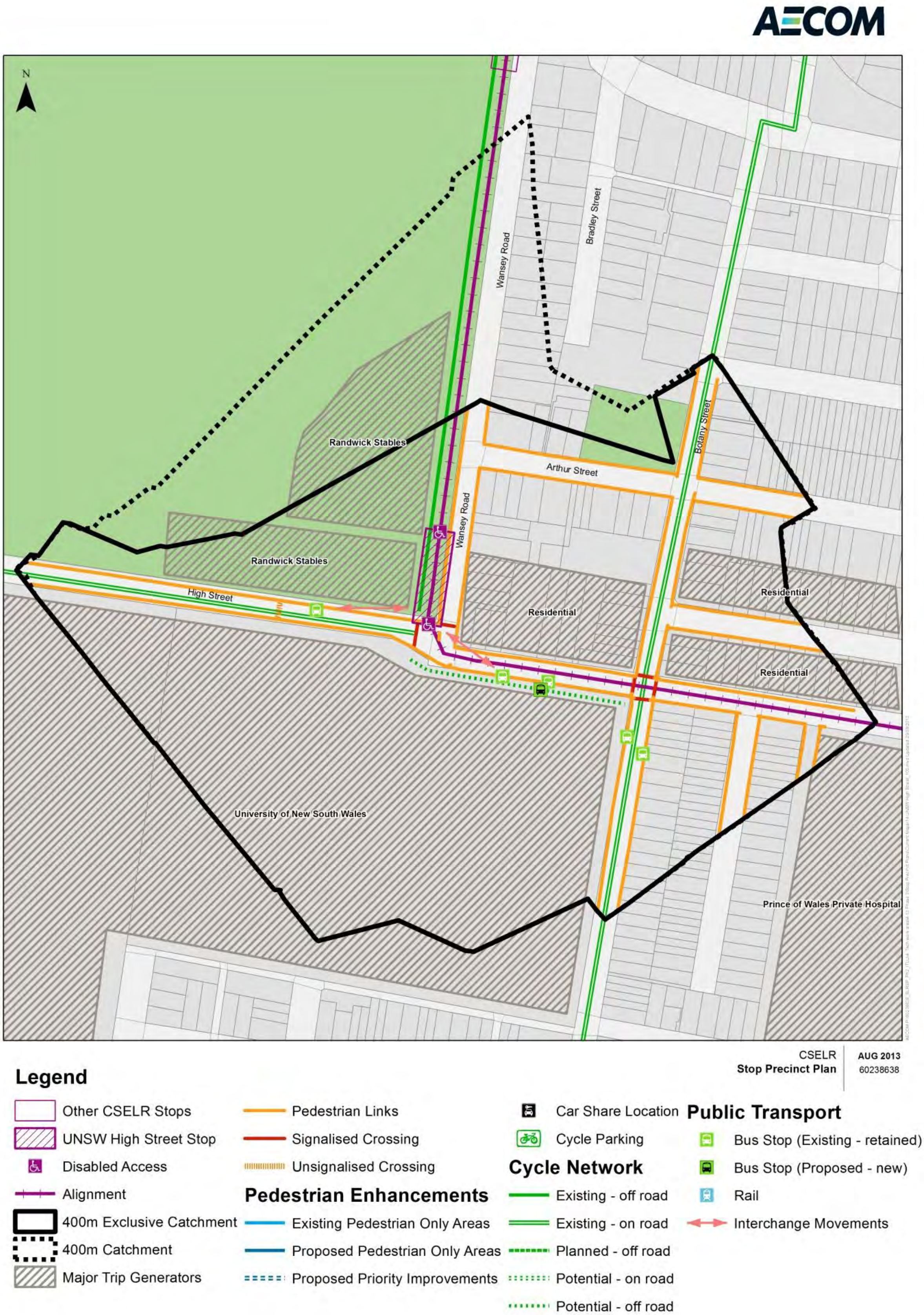
The key actions to resolve the multimodal access issues in the UNSW High Street stop precinct are;

- Replace the existing marked crossing on High Street east of Wansey Road with signalised crossings as part of the signalisation of the intersection of High Street and Wansey Road. This will strengthen pedestrian connections between the light rail stop and UNSW and the remainder of the local catchment.
- Position bus stops to enable safe and efficient transfers to light rail.
- Locate the UNSW High Street stop offline to reduce interaction between cars and pedestrians and enable signalised connections for high pedestrian flows to / from UNSW.
- Introduce integrated customer information and wayfinding for interchange and connections between light rail and all other modes to make the quickest route more legible.
- Consider potential improvements to lighting in detailed stop design.

Table 7-21: UNSW High Street Precinct Access Plan

Stop Name
UNSW High Street
Land Uses
– Educational – Residential – Sport
Major Trip Generators
– Educational (UNSW). – Residential (housing along Wansey Road and High Street). – Sport (stables for Royal Randwick Racecourse).
Multi-Modal Stop Access
Patronage
– 749 boardings and 2,188 alightings forecast for 2021. – 842 boardings and 2,803 alightings forecast for 2036.
Light Rail
– 450m south of proposed Wansey Road stop on Randwick branch of CSELR line. – 650m west of proposed Randwick stop on Randwick branch of CSELR line.
Bus
– Estimated AM peak hour interchange patronage from bus to light rail is 260 (54%) in 2021. – 70-100m east and west of existing High Street stop.
Pedestrian
– Considering the high number of passengers that will alight at UNSW High Street, pedestrian priority improvements are required. – Estimated AM peak hour walk up patronage of 218 (46%) in 2021.
Bicycle
– Off-road cycle path: ▪ Two way; Wansey Road (north-south). – On-road routes: ▪ Two way; High Street (west of Wansey Road, east-west), UNSW (east-west), Botany Road (north-south). – Proposed u-rail cycle parking facility with approximately five spaces at or adjacent to the light rail stop.

Figure 7-20: UNSW High Street Precinct Access Plan



7.3.21. Randwick Precinct Access Plan

Access Improvements

The key actions to resolve the multimodal access issues in the Randwick stop precinct are;

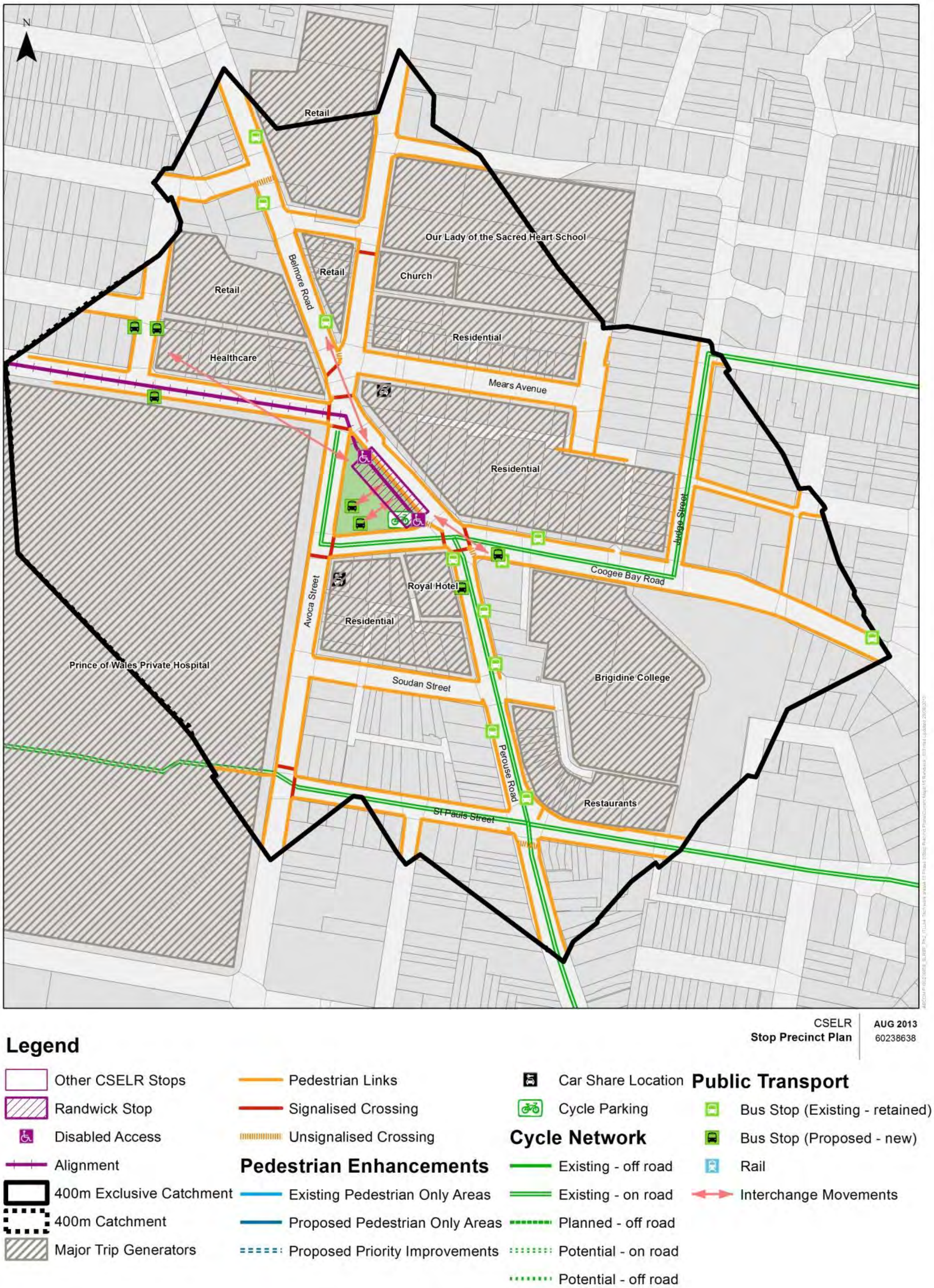
- Maximise opportunities for cross platform and 'round the corner' transfers for passengers interchanging between bus and light rail. This will minimise interaction between cars and pedestrians to enable safe, efficient transfers between modes.
- Coordination of bus and light rail timetables to be investigated, particularly during off peak periods when the frequency of light rail services will be reduced.
- Implement pedestrian priority improvements to reduce wait times at key intersections such as;
  - Belmore Road, Coogee Bay Road, Cuthill Street and Perouse Road
  - Avoca Street and Cuthill Street
  - Avoca Street, Belmore Road and High Street
- Preliminary analysis suggests additional car share located close to the Randwick stop would be attractive to current and potential car share members. A car share location would help offset the loss of parking once CSELR is implemented in the Randwick corridor.
- Proposed dedicated cycle parking facility at light rail stop.
- Consider potential improvements to lighting in detailed stop design.

Table 7-22: Randwick Precinct Access Plan

Stop Name
Randwick
Land Uses
– Medical – Commercial – Retail – Residential – Educational
Major Trip Generators
– Medical (Prince of Wales Hospital). – Retail (Royal Randwick Shopping Centre, Avoca Street and Belmore Road). – Commercial (Randwick Town Centre). – Residential (North of High Street, east of Avoca Street). – Educational (Brigidine College, Randwick Girls High School, Randwick Boys High School, Rainbow Street Public School).
Multi-Modal Stop Access
Patronage
– 826 boardings and 361 alightings forecast for 2021. – 1,008 boardings and 401 alightings forecast for 2036.
Light Rail
– 650m west of proposed Randwick stop on Randwick branch of CSELR line.
Bus
– This stop is proposed as the terminus of the Randwick branch of the CSELR line. As such, Randwick is envisaged as a major bus / light rail interchange for passengers travelling between the city and eastern suburbs such as Coogee and South Coogee. To aid transfers between bus and light rail, the Randwick terminus will operate with "cross platform" and "round the corner" transfers. – During off peak periods users will be forced to transfer from bus to light rail at Randwick – efficient and effective transfer arrangements will be required to mitigate any negative impacts – Estimated AM peak hour interchange patronage from bus to light rail is 1,607 (93%) in 2021.
Pedestrians
– Estimated AM peak hour walk up patronage of 124 (7%) in 2021.
Bicycle
– On-road routes: ▪ Two way; Coogee Bay Road / Judge Street / Dolphin Street (east-west), Prince of Wales Hospital / St Pauls Street (east-west), Perouse Road (north-south). – Proposed cycle parking facility with approximately five bicycle locker spaces, supplemented by approximately 10 u-rail spaces at or adjacent to the light rail stop.

Figure 7-21: Randwick Precinct Access Plan

AECOM



8. Conclusion

8.1. Purpose of the Report

This report identifies the considerable transport capacity, sustainability and reliability benefits that will be derived from the CSELR project, and proposes suitable responses to recognised project effects on the surface traffic and transport network.

The CSELR project contains two of the policy responses outlined in the CCAS - a key guiding document developed under the NSW Long Term Transport Master Plan. The CSELR will transform Sydney's transport network by providing additional capacity and service reliability to address current challenges and adequately cater for future growth in demand for services. Light rail offers an opportunity to redesign the current 'direct' approach to transport service provision to a 'connected' approach, maximising the effectiveness of public transport by introducing a high-capacity, high-frequency transport option integrated within a multi-modal network.

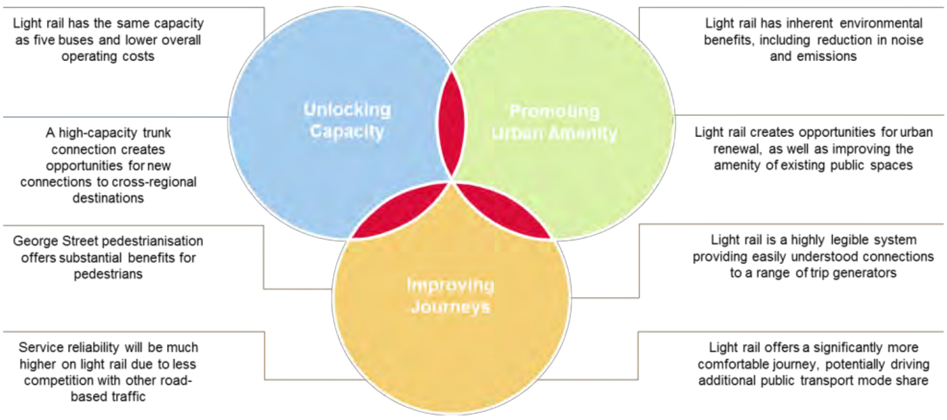
The light rail project comprises of following key characteristics:

- The light rail route will extend from Circular Quay to Kingsford and Randwick with 20 stops in total through the CBD, Surry Hills and South East;
- Integration with other transport modes at interchanges including Circular Quay, Wynyard, Town Hall, and Central Station as well as bus interchanges at Rawson Place, Randwick and Kingsford;
- Each light rail vehicle has the capacity to move 300 commuters, equivalent of five standard buses;
- Integrated customer information and wayfinding between multi-modal connections, at all stops;
- 'Turn up and go' services run every three minutes during peak periods; and
- Complemented by a pedestrianised zone on George Street between Hunter and Bathurst Streets.

8.2. Benefits of the Project

Introducing light rail to the CBD and South Eastern suburbs will provide substantial benefits to address current transport challenges as summarised in Figure 8-1.

Figure 8-1: Potential Benefits from the Introduction of the CSELR[129]



[129] Booz & Company analysis

Promoting Urban Amenity

Sydney has the highest level of congestion in Australia currently costing the economy $5.1 billion annually, expected to increase to $7.8 billion by 2020[130]. This puts great strain on the national economy, and stifles productivity growth in the city.

The CSELR project will introduce high-capacity and high-frequency transport improving urban amenity at a relative low operating and maintenance cost, by:

- Introducing a pedestrianised zone in one of the retail hearts of the Sydney CBD;
- Providing a high-capacity transport mode that meets existing and future travel demand;
- Providing a financially sustainable and environmentally friendly transport option;
- Maintaining low emission and pollution levels; and
- Offering further environmental benefits by seeking to increase public transport mode share.

Unlocking Capacity

Buses currently cater for significant transport demand, and the need for capacity has caused significant growth in the number of buses accessing the CBD cordon which deteriorates the reliability of bus services and negatively impacts the amenity of the CBD. George Street in particular carries up to 290 buses in the peak direction during the AM peak (7am – 9am) and this is expected to increase to over 310 by 2015. The congested bus network combined with the demands of other road users' impacts on customer service and delays essential business functions. The bus network cannot continue to grow to meet demand for capacity without increasing congestion levels.

Light rail offers a high-capacity transport option that:

- Carries up to 300 commuters, the equivalent of around five regular buses on the road space of only three buses resulting in total capacity on the line for 9,000 passengers per hour;
- Reduces the number of bus routes required to access the City Centre while providing an improved level of service;
- Accommodates future growth by providing additional capacity that is able to scale to meet future challenges; and
- Provides opportunities to connect to cross-regional destinations at major interchanges, growing the capacity of the broader transport system.

Improving Journeys

Customers currently receive transport services that don't meet community expectations, with only 50 per cent of commuters satisfied with service timeliness[131]. Transport for NSW analysis suggests only 19-24 per cent of buses arrive within two minutes of scheduled time during the AM peak due to the substantial congestion they experience when accessing CBD gateways.

Light rail offers a comfortable, reliable transport option that meets customer expectations by:

- Delivering service reliability of 97% resulting in an improved experience for commuters;
- Partial pedestrianisation of George Street which improves pedestrian journeys and amenity;

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[130] Bureau of Infrastructure Transport and Regional Economics, *Estimating urban traffic and congestion cost trends for Australian cities Working Paper No. 71,* 2007

[131] Bureau of Transport Statistics, *Transport Customer Survey,* 2012

- Integrated customer information and wayfinding between multi-modal connections, at all stops; and
- Offering multi-modal access at interchanges along the route.

8.3. Managing the Effects of the Project

Whilst recognising the benefits of the CSELR Project, a key aim of this report has been to highlight any effects of the Project on traffic and transport operations. An infrastructure change of this magnitude in a highly congested city such as Sydney introduces a variety of challenges. The significant impacts that CSELR will have on the current operations of the city's traffic and transport network have been recognised, and proposed mitigation strategies have been developed to manage these impacts as best possible. The impacts examined in detail within the report are summarised in Table 8-1, and in the section below. These effects have been mitigated through treatment under the Traffic and Transport Impact Management Framework.

Table 8-1: CSELR Traffic and Transport Constraints

Category	Operational Constraints
Network operations	▪ General traffic lanes occupied by light rail ▪ Potential for increased competition for road space between private vehicles and public transport in some locations ▪ Capacity of alternate streets to absorb displaced traffic ▪ Continued operation of bus priority with changes to bus lanes ▪ Light rail might impact east-west traffic flow
Access	▪ Road operations changed which may limit access to some destinations ▪ Potential for bus diversions that limit convenient and direct access to CBD rail stations for interchanging customers ▪ Ability of local residents to access bus stops and local facilities ▪ Footpath width and layout may constrain access to light rail stops
Amenity	▪ Noise generated by light rail operations and passengers accessing light rail ▪ Noise generated through diversion of traffic onto secondary streets
Customer Experience	▪ Slower journey times for some customers ▪ General traffic lanes occupied by light rail ▪ Some customers might have to change a current one seat journey to a two seat journey due to changes in bus services
Kerbside Uses	▪ Loss of parking in some areas ▪ Limitations on kerbside uses (taxi ranks, service deliveries etc.)
Supporting Infrastructure	▪ Footpath capacity in some locations ▪ Ability to provide cycling infrastructure

Network Operations

The Project will significantly alter current traffic network operations once regular operations of light rail commence. In particular, substantial volumes of vehicular traffic will be displaced from a once-significant north-south corridor in the City, George Street, onto alternative routes. To manage these impacts:

- A revised road hierarchy for the CBD has been developed as part of the CCAS to reclassify George Street for primarily pedestrian and light rail use and to identify complementary priority routes for traffic, buses and bicycles on alternative corridors;
- Retention of general traffic lanes outside the pedestrianised zone northbound and southbound where corridor widths permit to facilitate traffic circulation;
- Retention of east-west connections through the CBD (including the pedestrianised zone) to ensure cross-regional vehicular traffic is not unnecessarily impinged;
- Optimisation of light rail integration with existing intersections to ensure levels of service are not degraded where possible; and
- Retention of as many general traffic lanes and bus priority measures as can be accommodated on the strategic road corridors of Anzac Parade and Alison Road.

A key finding of road network modelling undertaken to support the Project has been that by the year 2021 traffic volumes in the CBD and South East are forecast to grow by 7% without the implementation of light rail. As a result of this growth, average vehicle speeds are likely to reduce by approximately 10% from current levels. Implementation of light rail is expected to ameliorate this level of traffic growth as a result of the positive effect the Project has on public transport mode share. Indeed, this analysis has shown that the benefits of light rail for public transport users and pedestrians can be achieved without unacceptable detriment to road traffic.

Broadly speaking the traffic analysis demonstrates that the CSELR project can be introduced into the road network without significant detrimental impact to general traffic and buses. A number of key intersections have been identified where further design and optimisation work is underway, to provide increased capacity.

To address the effects of the identified future traffic patterns, TfNSW and RMS are working together to develop an appropriate Network Management Plan (NMP). This includes intersection modifications, traffic signal changes and traffic management measures that integrate to deliver the overall strategy for network operations with CSELR in place. This work is ongoing and the modelling assessment undertaken to date represents the first stage in the development of this wider NMP. As this plan is refined further improvement to the operation of the network is likely to be achieved.

This report outlines a number of demand management and network improvement strategies available to the Project team and road authority to maintain acceptable levels of network performance following introduction of the Project. These management strategies, documented in Chapter 5, would be developed and deployed at various stages of the Project from planning through to construction and operation.

Access

The changes to current road operations also impact on access through and to some destinations. Ensuring multi-modal access to light rail stops, CBD rail stations and network-critical bus and ferry interchanges was a key area of investigation during the development of this report. In particular;

- Multi-modal access strategies were developed for each light rail stop to maximise the opportunities for the community to access light rail services;

- Stop positioning and interchange passenger flows were examined for key interchange stops such as Town Hall, Circular Quay, as well as Kingsford and Randwick termini; and
- Local access to light rail, residences and commercial precincts were considered and managed – particularly adjacent to Devonshire Street in Surry Hills.

Amenity

Longer-term amenity impacts were considered in the CBD and Surry Hills precincts, where noise and accessibility issues were most pronounced. To ensure amenity was maintained or improved for the community wherever possible, the Project includes:

- A pedestrianised zone between Bathurst and Hunter Streets in the CBD;
- If feasible, inclusion of wire-free operations capability to preserve heritage and environmental icons; and
- Detailed investigation of suitable designs along Devonshire Street in Surry Hills to minimise light rail conflicts with pedestrian and local vehicle traffic.

User Experience

Light rail will facilitate significant improvements to the quality of service many customers experience when using the public transport system. Additional capacity, improved reliability and greater comfort are some of the features inherent in the delivery of many light rail systems, but the CSELR also includes:

- Specific design consideration for major events at Moore Park and Royal Randwick Racecourse to improve the quality of transport service provided to these events;
- A high-capacity, high-frequency contra-peak service along Anzac Parade to provide additional capacity for students and staff seeking to access the University of NSW and nearby commercial, education and health precincts;
- Proposed retention of express bus services to the northern CBD to provide transport options for customers travelling to this precinct, subject to ongoing study;
- Design of bus services to deliver passengers to within walking distance of their destination or in cases where duplication with light rail is not justified ensure quality interchange between bus and the CSELR; and
- Placement of the light rail line in the median or in a segregated zone where possible to both improve the reliability and operating speed of light rail, but also to minimise the need to reduce the number of traffic lanes available to the general public.

Kerbside Uses

Due to the nature of light rail, current kerbside uses will be affected by the requirement to re-allocate road space for the benefit of the majority of users. Kerbside uses including taxi zones, parking, loading zones, car-share and property access along the alignment were examined and appropriate management strategies developed to ensure the needs of kerbside and road transport system users were balanced. This included:

- Retaining all existing parking and loading provisions where feasible on the alignment;
- Considering options to replace impacted parking and loading on the alignment or in adjacent streets within the same precinct;
- Considering consolidation of parking and loading to ensure efficiency of road space allocation; and
- Developing a hierarchy of kerbside access to determine retention of the most critical uses.

Supporting Infrastructure

With the introduction of light rail to the CBD and South East and the pedestrianisation of George Street additional pedestrian flows around the stops will be generated. To ensure the supporting infrastructure, such as footpath and platform widths and road corridors was suitable, investigations were undertaken to determine the effect CSELR would have on existing pedestrian and cycling infrastructure. It was determined that:

- The pedestrianisation of Alfred and George Street between Hunter and Bathurst Streets will provide safe pedestrian access;
- Priority improvements, by way of signalised pedestrian crossing facilities, will be provided on all arms of existing signalised intersections to provide controlled crossing points of the light rail alignment; and
- Realignment of the strategic cycle network in the City Centre to support the redeveloped road hierarchy.

8.4. Ready to proceed

Significant investigations have been undertaken to determine how the CBD & South East Light Rail could be delivered into a complex, congested and critical part of Sydney's transport network. These investigations have been undertaken to support the development of an Environmental Impact Statement and inform the Department of Planning & Infrastructure of the opportunities and challenges presented by the Project. This report confirms the understanding that, while the Project will substantially change the surface transport system in Inner Sydney, there are no traffic and transport impacts to prevent the Project from proceeding through planning approval.

It has been determined that the identified effects of the Project can be appropriately managed through the application of design and/or best practice environmental management measures. Refinement of these measures, in parallel with ongoing design work will further enhance the Project and manage the identified impacts. If, through further project development work additional impacts to the surface transport system are discovered these will be quantified and assessed through the Traffic and Transport Management Framework used herein.

This report also outlines the substantial opportunity presented by the Project. The CSELR will transform the transport network in Sydney, through introducing a high-capacity, sustainable transport mode, resulting in significant long-term benefits for the community. Though recognising that a project of this magnitude will impact the wider traffic and transport network significantly, several management strategies have been proposed to mitigate these impacts as best possible. The management strategies will continue to be refined as the Project is developed, in consultation with stakeholders and the community to ensure the net positive impact of the Project is achieved.

9. Glossary

AFL	Australian Football League
ATC	Australian Transport Council
ATC	Australian Turf Club
BDA	Barangaroo Delivery Authority
BTS	Bureau of Transport Statistics
CBD	Central Business District
CCAS	City Centre Access Strategy
CSE Corridor	CBD and South East Corridor
CSELR	CBD and South East Light Rail
DoS	Degree of Saturation
DSAPT	Disability Standards for Accessible Public Transport
EIS	Environmental Impact Statement
GDP	Gross Domestic Product
GCT	Generalised Cost of Travel
ICC Sydney	International Convention Centre Sydney
IDM Data	Integrated Diagnostic Monitor Data
LGA	Local Government Area
LoS	Level of Service
LRVs	Light Rail Vehicles
MBSC	Metropolitan Bus System Contract
MS&EB	Materials Science and Engineering Building
NRL	National Rugby League
PTPM	Public Transport Project Model
SCATS	Sydney Co-ordinated Adaptive Traffic System
SCCBP	Sydney City Centre Bus Plan
SCG	Sydney Cricket Ground
SFS	Sydney Football Stadium
SICEEP	Sydney International Convention Exhibition and Entertainment Precinct
SIDRA	Signalised Intersection Design and Research Aid
SLRSP	Sydney Light Rail Strategic Plan
STM	Strategic Travel Model
TAFE	Technical and Further Education
TfNSW	Transport for New South Wales
UNSW	University of New South Wales
BITRE	The Bureau of Infrastructure, Transport and Regional Economics

CBD AND SOUTH EAST LIGHT RAIL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2

Technical papers

TECHNICAL PAPER 2: CONSTRUCTION TRAFFIC MANAGEMENT PLAN

Construction Traffic and Transport Management Strategy

FINAL REPORT

TRANSPORT FOR NSW

07 NOVEMBER 2013

SYDNEY

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Table of Contents

List of Figures

List of Tables

Executive Summary

Purpose of the Report

This report outlines potential traffic and transport impacts during construction of the CBD and South East Light Rail (CSELR) project and identifies proposed transport management measures that would be adopted to mitigate these impacts. This assessment has been undertaken at two levels:

- Network level construction impacts and mitigation measures – which aim to minimise any reduction in network performance and journey times for all road users. This includes travel demand management measures, to ensure demand is better matched to the temporarily reduced network capacity.
- Precinct level construction impacts and mitigation measures – which addresses the day-to-day activities undertaken on and around the corridor. This includes local traffic, pedestrian, cycle and emergency vehicle access.

This report is one of a number of technical documents prepared to support the planning approvals process for Transport for New South Wale (TfNSW) State Significant Infrastructure Application for the CSELR proposal under Part 5.1 of the NSW Environmental Planning & Assessment Act 1979 (EP&A Act). It should be read alongside the Transport Operations Report (prepared by the Integrated Transport and Land Use Technical Advisers), which identifies potential impacts and proposed transport management measures for the end-state operation.

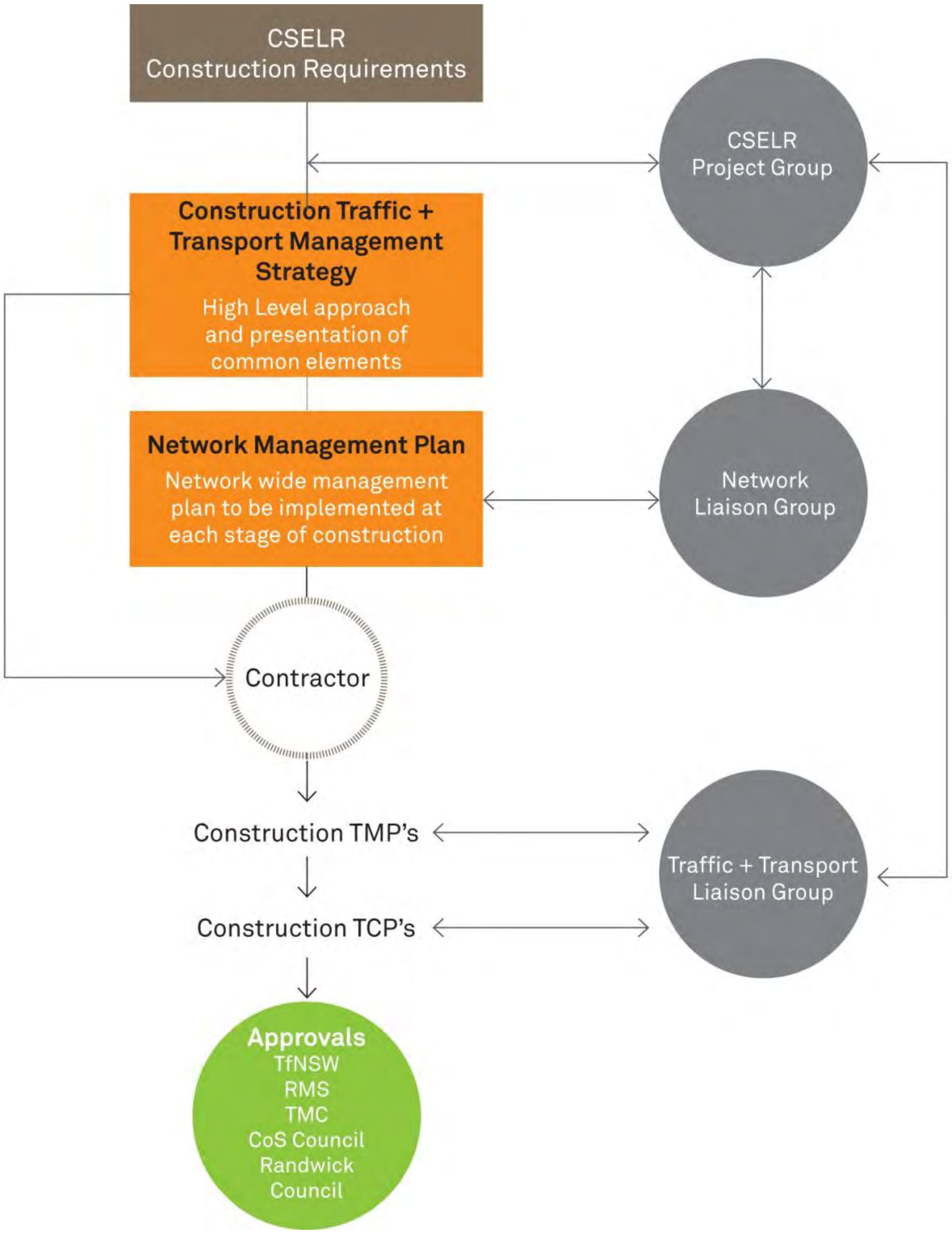
This report aims to inform the planning approvals process by assessing the potential transport and traffic impacts of constructing the CSELR project. This CTTMS identifies one likely approach to construction and set out the framework by which adverse impacts of construction on the operation of the transport network could be managed. The CTTMS represents the first in a series of progressively more detailed management plans that would be developed for the construction of the Sydney CBD and South-East Light Rail (CSELR).

In total, there would be four levels of documentation to help manage and mitigate traffic and transport network impacts during construction of the CSELR:

- Construction Traffic and Transport Management Strategy (TfNSW and ITLU) (this document);
- Network Management Plan (TfNSW, Enabling Works and Civil Works Contractors);
- Site Specific Construction Traffic Management Plans (Enabling Works and Civil Works Contractors); and
- Site Specific Construction Traffic Control Plans (Enabling Works and Civil Works Contractors).

The process to be followed and hierarchy of these plans is shown below in Figure 0-1.

Figure 0-1: Hierarchy of Traffic & Transport Management Plans



Construction Staging

Construction of the CSELR will consist of three key stages – Early Works, Main Civil Works and Commissioning. Estimated time periods for each of these main stages of construction are shown in Table 0-1. Allowing for some overlap between stages the total construction program is expected to occur over a period of 6 years.

Table 0-1 Construction Program Overview

Construction Phase	Estimated Length
Early Works Construction	1-2 years
Main Civil Works Construction	3-4 years
Testing & Commissioning	1 year
Total Construction Program	Up to 6 years

Construction Scenario

The Construction Traffic and Transport Management Strategy (CTTMS) assumes maximum worksite footprints would be required during the civil works and that early works utility adjustments can be undertaken within the same footprint as developed by the construction advisor. This assumption has been made to assess the worst case traffic and transport impacts - with the full length of the corridor as an active worksite and all proposed road closures in place concurrently and managed accordingly. However, as a general principle to improve legibility for users, it has also been the objective of this CTTMS to minimise the number of required changes to the road network. As such, wherever appropriate, the CTTMS proposals align with the end-state network configurations. More specific construction scenario implications are summarised below.

- Within the CBD and Surry Hills:
  - Alfred Street between George Street and Loftus Street would be closed to general traffic with only local and emergency access permitted;
  - George Street would be closed to general traffic with only local and emergency access permitted. The majority of intersections along George Street would remain open, however full intersection closures would occur on weekends but in accordance with Transport Management Centre approvals;
  - Chalmers and Devonshire Streets would be closed to general traffic with only local and emergency access permitted; and
  - The coach station and bus lane along Eddy Avenue would be relocated.
- Anzac Parade would be unaffected north of Dacey Street, but would operate with two of the six lanes closed south of Dacey Street. There would also be a change in operating arrangements and weekend closures of some intersections.
- Alison Road would remain open, but would operate with two of the six lanes closed with weekend closure of some intersections. This would reduce the number of right turn lanes on Darley Road and the intersection with Alison Road.
- Wansey Road would be closed to general traffic with only local and emergency access permitted.
- High Street would remain open, with weekend closures of some intersections.
- The closures of intersections would be in accordance with TMC approvals.

Network Level Construction Impacts and Mitigation

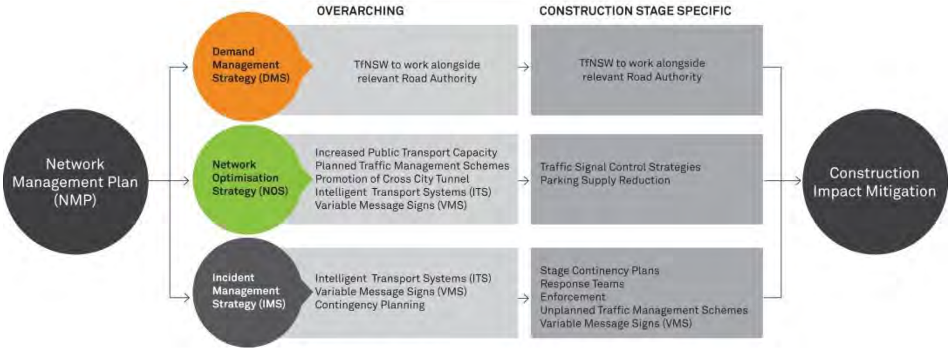
Management and Mitigation Principles

The following overarching principles have been applied to determine management or mitigation measures for network wide construction impacts:

- Manage transport efficiency against an extended construction program to identify a balanced outcome;
- Implement demand management measures to reduce the demand for travel to levels that can be serviced by the capacity available during construction;
- Minimise impact to active transport modes;
- Minimise impact to property and emergency vehicle access along the corridor; and
- Manage impacts safely.

Based on these principles, the CSELR Network Management Plan (NMP) identifies the key measures that would be implemented during construction to ensure journey times and congestion levels are kept at acceptable levels. The structure of the plan is set out below in Figure 0-2.

Figure 0-2: CSELR Construction Network Management Plan



The NMP seeks to align the peak period travel demand with the traffic capacity available during construction. To maximise their effectiveness across the network, it is essential that these strategic measures are planned and coordinated as one.. Successful implementation of the NMP would ensure that network impacts during construction of CSELR can be adequately managed and negative impacts minimised.

A summary of the potential network level impacts and the proposed management and mitigation approach is outlined below.

Bus Management

The Sydney City Centre Bus Plan (SCCBP) removes all buses from George Street as part of a redesigned bus network. The majority of the SCCBP will be implemented prior to CSELR construction commencement. Changes to the south east bus network included within the SCCBP are however dependent on light rail, thus they will not be implemented until the CSELR is operational. As such construction management needs to maintain access for all bus services in the south east.

The SCCBP interfaces with the construction of light rail at four key locations:

1. Chalmers Street
2. Eddy Avenue
3. Rawson Place
4. Park Street/Druitt Street/George Street intersection

Local bus diversions have been developed to manage the impact on bus operations at these four locations during construction.

Traffic Management

As part of the NMP, targeted traffic management measures would address the reduction in traffic capacity that results during construction. Upgrade measures would include but not be limited to:

- Reversal in operation of one and two way streets to maximize operational efficiency and access. This includes:
  - Pitt Street two-way (between Alfred Street and Bridge Street)
  - Two-way operation of Hunter Street with Margaret Street
  - Reversal of O'Connell Street
- Removal of kerb blisters and extension of parking restrictions to increase the number of operational traffic lanes;
- Upgrade of intersection geometries and signal phasing to optimise the priority traffic corridors as set out in Section 4;
- Banning of traffic movements to increase intersection capacities and optimize priority routes; and
- Rephasing traffic signals.

Parking Management

All on-street parking and loading along the light rail corridor would be affected during construction. A parking utilisation study undertaken for the CSELR project concluded that, whilst parking demand based on current levels would reach or exceed the reduced capacity in some localised areas, these effects could be managed through:

- Extension of parking permit schemes, particularly in predominately residential precincts surrounding the project corridor. These would be designed to afford priority to local residents to park in the vicinity of their home with an allowance for short term parking for visitors and for vehicle access to commercial land uses and other short stay trip generators; and
- Providing priority on streets immediately adjacent to the project corridor where commercial land uses are present for loading and short term parking. For example, allocation of kerbside capacity on side streets directly off the corridor for locations where commercial land uses are present for loading and short term parking

Implementation of the above proposed measures would require consultation with Randwick City Council and City of Sydney Council.

Pedestrian Management

Site specific pedestrian management would be adopted to manage the existing longitudinal (along footpath) and transverse (across roads) pedestrian movements. For the majority of the construction works, the existing longitudinal pedestrian movements would be maintained along the footpaths. Appropriate management measures for transverse pedestrian movement would need to be adopted by the selected construction contractor.

During installation of overhead wiring poles and service relocations during the early works stage, additional localised footpath restrictions would be required. During such cases, the footpaths would be narrowed past the worksite or pedestrians would be diverted to adjacent footpaths via safe crossing facilities with appropriate barriers and signs.

Where worksites have an impact on footpaths, consideration would be given to the requirements of all pedestrians and especially vulnerable users. Disability Discrimination Act requirements would be adopted with drop kerbs and other necessary measures provided at crossings. Footpath widths would allow two-way pedestrian traffic facilitating access for pushchairs and wheelchairs.

Cycle Management

Existing cycle routes have been maintained along the corridor where the footprint of the worksite permits. Where the worksite occupies existing cycle facilities or makes their retention unsafe, alternative routes have been identified. For example:

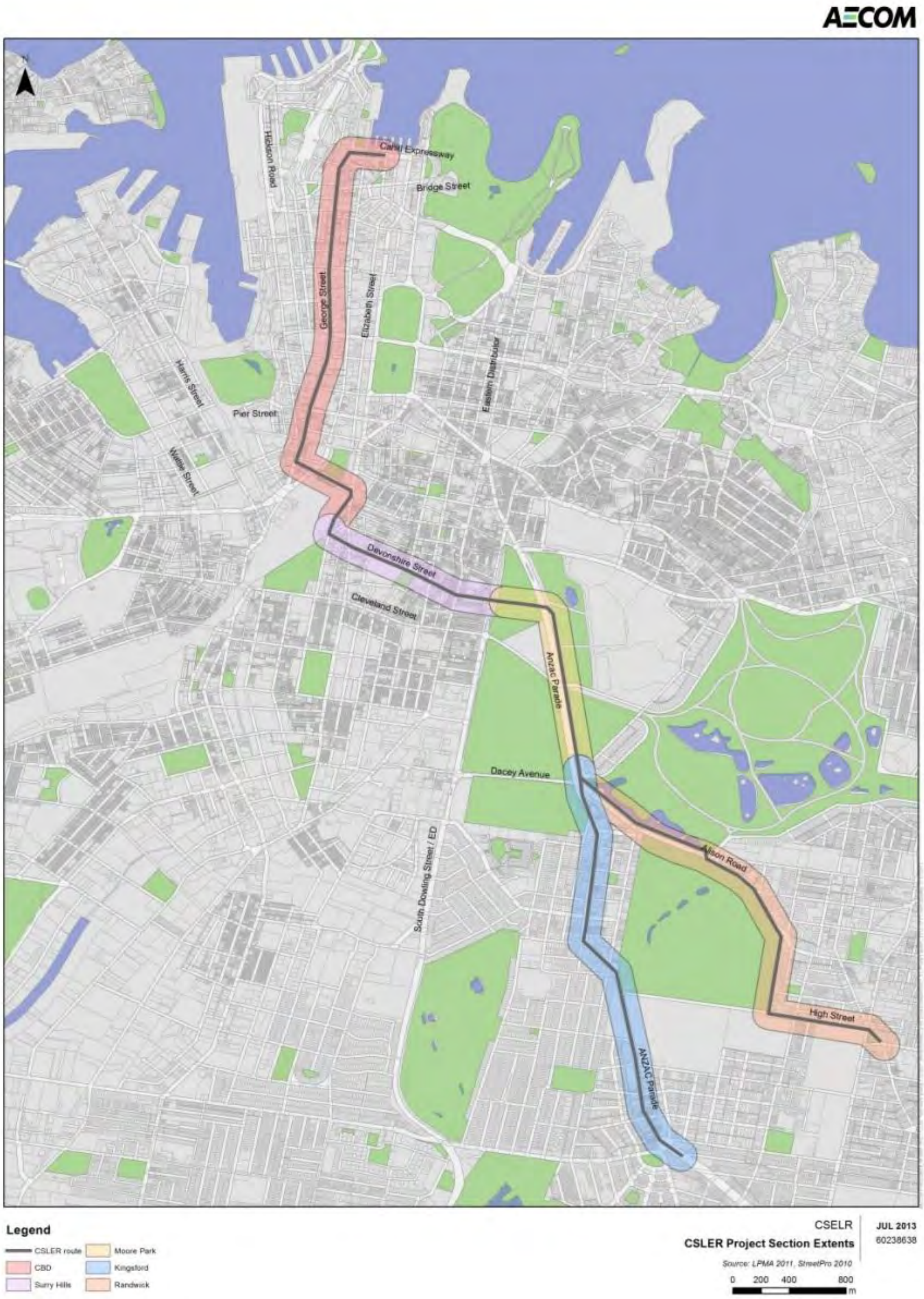
- To avoid Devonshire Street an alternative route along Cooper Street/Arthur Street is proposed; and
- To avoid Wansey Road and Alison Road an alternative route along Botany Street, Church Street and Kings Street is proposed.

Precinct level construction impacts and mitigation

The CSELR corridor has been segregated into five precincts as shown in Figure 0-2. At the precinct level CSELR construction has the potential to limit local, property and emergency vehicle access due to the extended worksite coverage along the corridor. In response to these risks this CTTMS outlines the key issues identified in each precinct and resulting mitigation measures.

Access for emergency vehicles would be maintained within all precincts and emergency services would be advised of all planned changes to traffic arrangements prior to applying the changes. During periods when major construction and loading/unloading activities are underway it may not be possible to allow emergency vehicles to traverse the full block length. However at these times access to an emergency within the block would still be maintained at an identified access point and diversion routes would be agreed with the emergency services prior to the activities commencing. The contractor would also consult with NSW Fire and Rescue regarding any specific requirements for any of the buildings adjacent to the rail alignment in preparing the site specific Traffic Management Plans. Details of property access diversions are included in Section 4.

Figure 0-2: CSELR corridor precincts[1]



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1 AECOM, 2013

CBD Precinct - construction impacts and mitigation

In the CBD precinct the key issues relate to property, local and pedestrian access. All properties that have active driveways directly accessed off the corridor would retain this access during construction through the provision of access only lanes in sections of George Street. Additional controls are needed at a limited number of locations that would require agreement with the property owners. These include:

- Scheduling of deliveries for early morning/late night for short periods when the active work zone is directly outside the property.
- Restriction of access to smaller trucks (this may depend on access to remote warehousing or centralised dispatch centre where large loads can be broken down).
- Use of road bridges / plates over the worksite to provide crossings.
- East-west cross streets in the CBD to remain open to traffic except for planned closures at weekends.

Prior consultation and agreement from property owners and any additional controls on access would be undertaken. The duration of any access restrictions would likely be limited to short periods when the active work zones are directly outside the property. However, contingency arrangements would need to be identified, such as limiting the extent of duration of any impacts and alternate parking arrangements or loading facilities.

Access to The Rocks precinct would be affected by the closure of Alfred and George Streets to through traffic; however access is maintained via alternative routes as shown in the precinct access map (Appendix A.1). Whilst access is maintained there would be some increase in the distance vehicles have to travel.

Pedestrian access would also be maintained to George Street at all times. The contractor would ensure traffic lanes and control devices provided adjacent to construction worksite are provided in accordance with RMS Traffic Control at Worksite Manual Version 4.0 and AS 1742, Part 3.0: Manual of Uniform Traffic Control Devices. Where existing controlled pedestrian crossing facilities exist, pedestrian access through the worksite would be provided.

For special events which typically utilise George Street and Circular Quay, consultation with City of Sydney Council would be required in order to develop management measures and possible re-routing of events in the CBD. Weekend closures would not be undertaken on weekends when major events are scheduled, e.g. City to Surf, Anzac Day Marches and Sydney Running Festival.

Surry Hills Precinct - construction impacts and mitigation

Due to the constrained cross section of Devonshire Street a continuous traffic lane is not possible through the corridor. Traffic would be diverted to alternative east west corridors such as Cleveland, Foveaux and Albion Streets. All properties with direct driveway access to Devonshire Street would be maintained throughout construction, through the worksite under traffic control.

Local access to the Surry Hills precinct would be affected by the closure of Rawson Place and George Street to through traffic; however access is maintained via alternative routes as shown in the precinct access maps (Appendix A.2).

Moore Park Precinct - construction impacts and mitigation

Construction activities would infringe on the existing busway reducing the available width for bus operations. To manage these impacts the busway is proposed to operate in the peak direction only with buses in the counter peak direction being relocated onto Anzac Parade. To maintain bus services along Anzac Parade, especially for the major trip generator of UNSW, priority bus lanes in the counter peak direction should be examined further.

Special events at the Moore Park entertainment precinct generate increased pedestrian, car and bus demand in the area. In general, the proposed worksite areas do not infringe upon special event bus operations or parking, however it is recommended that local construction activities are paused during special events to improve safety for spectators accessing the venues.

Kingsford Precinct - construction impacts and mitigation

The Anzac Parade corridor is a key arterial route for the south-eastern suburbs. It has a number of key intersections along its length through which light rail would operate, and therefore requiring works that would temporarily reduce traffic carrying capacity. To minimise the effects of these intersection works, they are proposed to be staged during a combination of weekends and nights.

During construction, Anzac Parade would be reduced from a total of six lanes to four lanes. To prevent this reduced cross section from impacting upon existing bus services two options are to be further investigated in consultation with TfNSW, RMS and bus operators:

- Tidal flow operation on Anzac Parade to provide a peak direction bus lane along the kerbside lane and two peak direction traffic lanes. This would result in the non-peak traffic movement being constrained to a single lane.
- Local diversions on parallel roads. Noting the significant impact on a local, residential street such diversions would only be considered as a last resort and significant further investigations are required to determine the feasibility of this option.
- Investigate staged construction works along the Anzac Parade and Alison Road corridors. Assessments to date and resulting increase in forecast travel times on Alison Road and Anzac Parade assume concurrent works on both corridors. Staggering these works would provide additional capacity during construction and reduce travel time increases.

Randwick Precinct - construction impacts and mitigation

During construction access to Randwick Racecourse from Alison Road and Wansey Road would be restricted. Access would be provided via existing alternative entrances on Ascot Street and High Street and through internal circulating roads. During events, the current bus set down area on the Alison Road frontage would be unavailable and alternative drop off and pick up locations would be provided on Darley Road. This requires provision of a pedestrian crossing facility for Alison Road located to the west of Darley Road and the use of marshals to ensure pedestrian safety and legibility.

The UNSW and Prince of Wales hospitals are both accessible via High Street. Besides these developments there are high density residential apartments, medical practices and retail stores with off-street parking provisions. With an existing road width of 12.5 metres, the kerb and guttering would require realigning, to satisfy the minimum lane widths when light rail is operational. To minimise the impact to properties, and in particular the hospital emergency access points, the light rail construction works are proposed to be undertaken in segments and stages, which maintains access at all times.

Localised changes are also required to existing bus operations, in all instances alternative stops and pedestrian access points have been defined, although some increase in walking distances would be experienced.

1. Introduction

1.1. Purpose of the report

This Construction Traffic and Transport Management Strategy (CTTMS) for the Sydney CBD and South East Light Rail project (CSELR or 'the Project') has been developed as part of the Environmental Impact Statement (EIS). It has been prepared by the Integrated Transport and Land Use (ITLU) Technical Advisor (Booz & Company and AECOM Pty Ltd) on behalf of Transport for NSW (TfNSW). As part of the report, detailed investigations were undertaken to determine how the Project could be delivered into a complex, congested and critical part of Sydney's transport network.

This Construction Traffic and Transport Management Strategy (CTTMS) outlines potential traffic and transport impacts during construction of the CSELR and transport management measures to mitigate these. The CTTMS establishes the key criteria to be considered and the overarching traffic management processes to be followed to facilitate construction.

The Project requires construction works to be undertaken on George Street in the CBD and within or adjacent to major arterial/sub-arterial and local roads between the CBD, Kingsford, Randwick and Surry Hills. This document sets out a coherent and organised approach to managing the direct and cumulative impacts of construction on the road and pedestrian networks.

This report should be read in conjunction with the CSELR Transport Operations Report which details the integration and operation of light rail within the wider transport network post construction and details the benefits of implementing the Project. It sets out the end-state operational characteristics of the light rail corridor which results in the required worksite and construction approach assumed in this CTTMS. As a general principle to improve legibility for users, it has also been the objective of this CTTMS to minimise the number of required changes to the road network. As such, wherever appropriate, the CTTMS proposals align with the end-state network configurations.

The CTTMS provides a framework of procedures and techniques for mitigating or managing impacts, including measures to:

- Protect pedestrians, cyclists, and maintain surface public transport services past the worksites;
- Manage traffic flows through, and around, the construction zone and haulage routes;
- Minimise impacts on the remainder of the road network;
- Minimise the impact on existing bus services travelling along or around the worksites;
- Minimise the impact of construction on local residents and businesses; and
- Address local and regional traffic impacts during construction.

The CTTMS considers the effects of construction and identifies mitigation measures at two levels:

- Network Level: construction impacts and mitigation measures to minimise any reduction in network performance and journey times for all road users. This includes travel demand management measures, to ensure demand is better matched to the temporarily reduced network capacity. Network modelling of the corridor and surrounding road network has been undertaken by others to identify network upgrade measures to increase capacity on alternative road links to offset the loss of capacity on the construction corridor.The network performance and management measures are discussed in detail in Section 4.
- Precinct Level construction impacts and mitigation measures: day-to-day activities undertaken on and around the corridor need to function satisfactorily. This includes local traffic, pedestrian, cycle, bus services and emergency vehicle access. Specific management measures would be detailed in the site specific Construction Traffic Management Plans and Traffic Control Plans to be developed at later stages of the Project for each individual worksite. Section 5 of this report identifies management principles for each of the CSELR precincts.

The Project is currently at the Planning Approval phase, and this CTTMS presents one potential construction management approach. Other approaches may be defined in future by a contractor. In either case, the construction contractor will be responsible in acquiring approvals for traffic and transport management approaches during construction.

Traffic and transport management would be required for up to 3 years, with the main civil works running from late 2015 to 2018. Construction impacts would occur in sections of the route as they are consecutively built. The concept traffic staging and phasing descriptions and drawings in this CTTMS detail the sequence and extent of potential temporary traffic diversions for the construction of the works.

1.2. Scope of the Report

This report has been prepared to inform the planning approvals process by assessing the potential transport and traffic impacts of constructing the CSELR project. The assessment has been based on the Definition Design (May 2013), and uses preliminary traffic assessment of wider network impacts (TfNSW, 2013). The assessment of these impacts is discussed in Section 3 (Network Impacts) and Section 4 (Precinct Impacts). This report is also to be read in conjunction with the ERSUD Definition Design Report – Volume 5 – Constructability Report.

The CTTMS is one of a series of management plans that would be developed for the construction of the Sydney CBD and South-East Light Rail (CSELR).

In total, there would be four levels of documentation to help manage and mitigate traffic and transport network impacts during construction of the CSELR:

- Construction Traffic and Transport Management Strategy (TfNSW and ITLU) (this document);
- Network Management Plan (TfNSW, Enabling Works and Civil Works Contractors);
- Site Specific Construction Traffic Management Plans (Enabling Works and Civil Works Contractors); and
- Site Specific Construction Traffic Control Plans (Enabling Works and Civil Works Contractors).

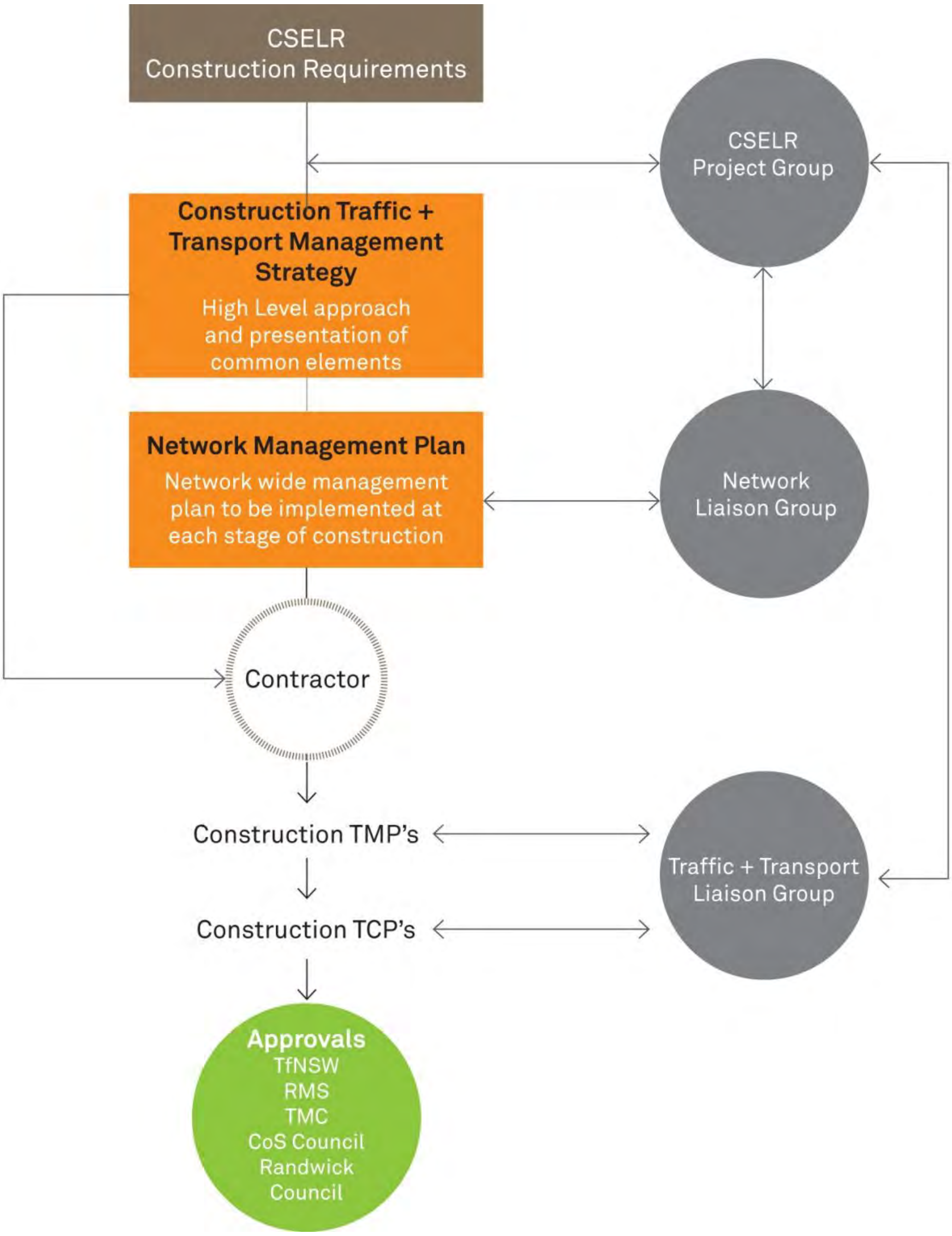
The purpose of each document is highlighted in Table 1-1.

Table 1-1: Purpose of Traffic Management Plans Hierarchy and Documentation

Document	Purpose	Produced by
Construction Traffic and Transport Management Strategy	Provides a framework for procedures and techniques to ensure effective traffic management to enable project delivery. Summarises the proposed traffic management and traffic safety requirements for the construction phases of the project. With general principles and key assumptions.	TfNSW and ITLU
Network Management Plan	Based on the framework presented in this document a network management plan would detail the specific measures implemented at each stage of construction to mitigate transport impacts	TfNSW, and Stakeholders, in consultation with Contractors
Site Specific Construction Traffic Management Plans (CTMP)	Individual site Construction Traffic Management Plans (CTMP's) to develop the specific staging areas of construction work or activities. CTMP describe in detail the area of work or activity, the extent of the expected traffic impact, and the management and responsibility measures to be implemented.	Contractor
Site Specific Traffic Control Plans (TCP)	Traffic Control Plans (TCP's) to be included as part of CTMP's and will identify specific traffic control measures to be implemented for each CTMP. CTMP's and TCP's will describe items such as temporary signage requirements, traffic barrier requirements and placement, traffic control crew requirements, delineation devices, ROL applications, temporary speed zones etc. which must be in place for the duration of the activity or work area impact. All Traffic Control Plans to be used during the construction activity will be developed in accordance with Australian Standard 1742.3 and the RMS's "Guide to Traffic Control at Worksites" by a suitably qualified person.	Contractor
Roads Agreement	Form of agreement between TfNSW and the relevant Roads Authority (RMS) documenting the responsibilities for undertaking design, construction and maintenance work in the Road Reserve.	TfNSW / RMS

The process to be followed and hierarchy of these plans is shown below in Figure 1-1.

Figure 1-1: Hierarchy of Traffic & Transport Management Plans



1.3. Structure of the Report

The remainder of the report is structured as follows:

- This chapter (Chapter 1) outlines the proposed project and the construction process, including:
  - A project overview;
  - The construction staging; and
  - Interfaces with related projects.

- Chapter Two outlines the assessment approach and principles followed to mitigate the impacts, including:
  - High level requirements for construction worksites;
  - Heavy vehicle forecasts and haulage routes;
  - Approach to intersection works and traffic control;
  - Midblock worksite requirements; and
  - The requirements for interagency liaison and approvals processes.

- Chapter Three outlines the overall network performance and mitigation measures to be implemented during construction, including:
  - High level management measures for all modes during construction;
  - Network management through a Network Management Plan (NMP);
  - Property and emergency vehicle access strategy;
  - Parking impacts; and
  - An assessment of the network impacts.

- Chapter Four outlines the local level impacts and mitigation measures, including:
  - Individual property access;
  - Local precinct access; and
  - Specific management requirements for all modes.

1.4. CSELR Project Overview

In December 2012, the NSW Government announced that it would extend light rail from Circular Quay to Kingsford and Randwick, through the heart of the Sydney CBD via George Street. The proposed light rail corridor is shown in Figure 1-2. The project comprises twenty stops, and would integrate with both the bus network and heavy rail stations at Circular Quay, Wynyard, Town Hall and Central.

Figure 1-2: Route of the CSLER project[2]

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2 AECOM, 2013

Services would be provided by 45 metre low floor light rail vehicles, providing capacity for up to 300 commuters (the equivalent of five standard length buses). The line would operate in a dedicated light rail lane, minimising competition with other modes of transport such as cars and buses. In summary the CSELR proposal comprises construction and operation of a light rail service from Circular Quay to Kingsford and Randwick via Surry Hills. The key features of the proposal include:

- approximately 12 kilometres of new light rail track from Circular Quay to Central and Kingsford and Randwick via Surry Hills and Moore Park (including track at the depot facilities);
- a pedestrianised zone on George Street between Hunter and Bathurst Streets, with light rail vehicles (LRVs) operating wire-free in this zone;
- 20 light rail stops along the alignment with platforms at all stops to accommodate 45-metre long light rail vehicles, except at Chalmers Street and Moore Park, where platforms would be provided to accommodate both 45 metre and 90 metre long light rail vehicles (double-length vehicles) running during special event services between Central Station and Moore Park;
- depot facilities adjacent to Royal Randwick Racecourse and at Rozelle for light rail vehicle stabling and/or general maintenance (including washdown);
- interchange with heavy rail, bus and ferry services at Circular Quay, Wynyard, Town Hall and Central stations;
- 45 metre vehicles, featuring air conditioning and accessible low-floor design capacity for approximately 100 seated and 200 standing passengers;
- a fleet of 30 vehicles providing a 3 minute peak service in the opening year increasing to 40 vehicles providing a 2.5 minutes peak service by 2036;
- integration with the existing light rail system;
- bus interchange at the Kingsford and Randwick stops;
- special event services between Moore Park and Central Station;
- George Street public domain improvements including concepts for paving, street trees, lighting and furniture;
- a new bridge structure overpassing the eastern distributor and an underground alignment in the form of a cut and cover tunnel through Moore Park and a canopy tube tunnelling methodology used under Anzac Parade;
- special events sidings at Circular Quay, Eddy Avenue, Chalmers Street, Moore Park and Royal Randwick Racecourse: and
- turn-back facilities at the Circular Quay, Wynyard, Kingsford and Randwick.

1.5. Construction Staging

The delivery phase of the entire project includes the following stages:

1. Preparation of surveys, geotechnical investigations, identification of location and depth of existing public utilities and underground structures, tree and arborist reports, specific heritage issues, other specific studies.
2. Communication and consultation with property owners and other affected stakeholders along the route
3. Planning of overall and localised traffic management plans in consultation with the local councils and roads authorities.
4. Establishment of the inspection and monitoring program.
5. Establishment of site compounds and erection of safety barriers around the sites of work. In most cases the site compounds may need to be established at the start of the Critical Early Works to support these works.
6. Establishment of site compounds and erection of safety barriers around the sites of work for the Critical Early Works and Main Works.
7. Implement site specific construction traffic management plan and site specific traffic control plan to enable construction works in the road reserve.
8. Construction of the Critical Early Works by the Managing Contractor for works that are classified in the following categories:
    a. Major works or service relocations / protection along the CSELR alignment that may have a long lead time;
    b. Major service relocations with a high risk cost profile for the Main Work Contract;
    c. Facilitation of bus and traffic re-routing to minimise future traffic disruptions;
    d. Third Party Works – Program and Existing Activities;
    e. Works that that have limited access dates;
    f. Vacant property access along alignment, including the relocation of existing facilities;
    g. Critical pre-works outside alignment; and
    h. RMS traffic signal works.
9. Construction of the remaining Early Works by the Main Works Contractor that are not covered in the Critical Early Works.
10. Track construction would begin once a clear corridor along a substantial part of the alignment has been established, with utility services diverted where necessary prior to works beginning.
11. Stop construction would be undertaken as separate work sites as the work front moves progressively along, so as to not interfere with the corridor works. These need to be undertaken after the work front has progressed through or the work corridor will be restricted and productivities impacted.
12. Intersection construction would involve partial or full closure of intersections with appropriate traffic diversions and would be primarily undertaken at the weekends and the intersections returned to normal operation prior to 5.00am on Monday morning. Intersection construction would be scheduled to suit the available workforce and current construction priorities.

13. Restoration of the road to allow for pedestrian and road traffic.
14. Installation of the overhead wiring will be able to start after a sufficient number of adjacent sections of the route that make up the length of a wire tensioning section are completed.
15. Finally, commissioning and trial running of the route can be carried out once all systems infrastructure are complete, including electrical connections to the overhead wiring and signals. Commissioning will require the complete route corridor available for a period of time, and will include integration of the new signalling system with the existing road signalling system.

Estimated time periods for each of these main stages of construction are shown in Table 1-2. Allowing for some overlap between stages the total construction program is expected to occur over a period of 6 years

Table 1-2 Construction Program Overview

Construction Phase	Estimated Length
Early Works Construction	1-2 years
Main Works Construction	3-4 years
Testing & Commissioning	1 year
Total Construction Program	Up to 6 years

This CTTMS assumes maximum worksite footprints would be required during the civil works and that Early Works utility adjustments can be undertaken within the same footprint. This assumption has been made to assess the worst case traffic and transport impacts. Early and main civil works activities would consider the requirements for Traffic Management Centre (TMC)'s approvals.

1.6. Related Projects

The CSELR forms part of a broader public transport solution aimed at improving access to and within the CBD. Other key projects related to the CSELR include the Sydney City Centre Access Strategy (CCAS) and the associated CBD and South East bus network changes. Each of these projects is explored in more detail below.

1.6.1. Sydney City Centre Access Strategy

The CSELR is a key project identified in the Sydney City Centre Access Strategy (CCAS), which has been developed within the context of the NSW Long Term Transport Master Plan and a number of modal delivery plans, to improve the way the CBD transport system operates. CCAS outlines a number of actions for all transport modes in the CBD being delivered in an integrated manner.

The other components of the CCAS are anticipated to be implemented over a number of years. One component of the CCAS of particular relevance to the CSELR is the city centre bus network redesign. These bus changes are being prepared in parallel with development of the CSELR proposal and would be consistent with the CSELR proposal. The proposed changes would undergo a separate planning approval process. These would not, therefore, form part of the EIS for the CSELR proposal, with the exception of cumulative impact considerations. An outline of the proposed city centre bus changes is provided below.

1.6.2. Sydney City Centre Bus Plan

The Sydney City Centre Bus Plan (SCCBP) also forms part of the CCAS to develop the bus network within the Sydney CBD to improve bus reliability and customer experience and modifications to the street network associated with the CSELR project.

The SCCBP is a key element for the delivery of the CSELR project, in particular the relocation of existing bus services from George Street and will therefore be delivered (subject to appropriate planning approvals) in advance of major construction works commencing for the CSELR project.. In addition to the SCCBP the south east bus networks have also been re-designed to facilitate the operation of light rail. The SCCBP was developed in parallel to the re-design of the south east bus network with a focus on aligning the networks.

A summary of the key objectives and proposed network for the SCCBP is provided in this section. A summary of proposed south east bus network changes is available in the Transport Operations Report prepared by Booz & Company and AECOM.

The CBD bus network would be redesigned to establish an easy to understand, all-day network of reliable, high frequency bus routes. The redesign would help to address congestion and capacity constraints in the short term but also responds to the future role of light rail and the integration of bus and light rail services.

Some of the key changes that would benefit customers include:

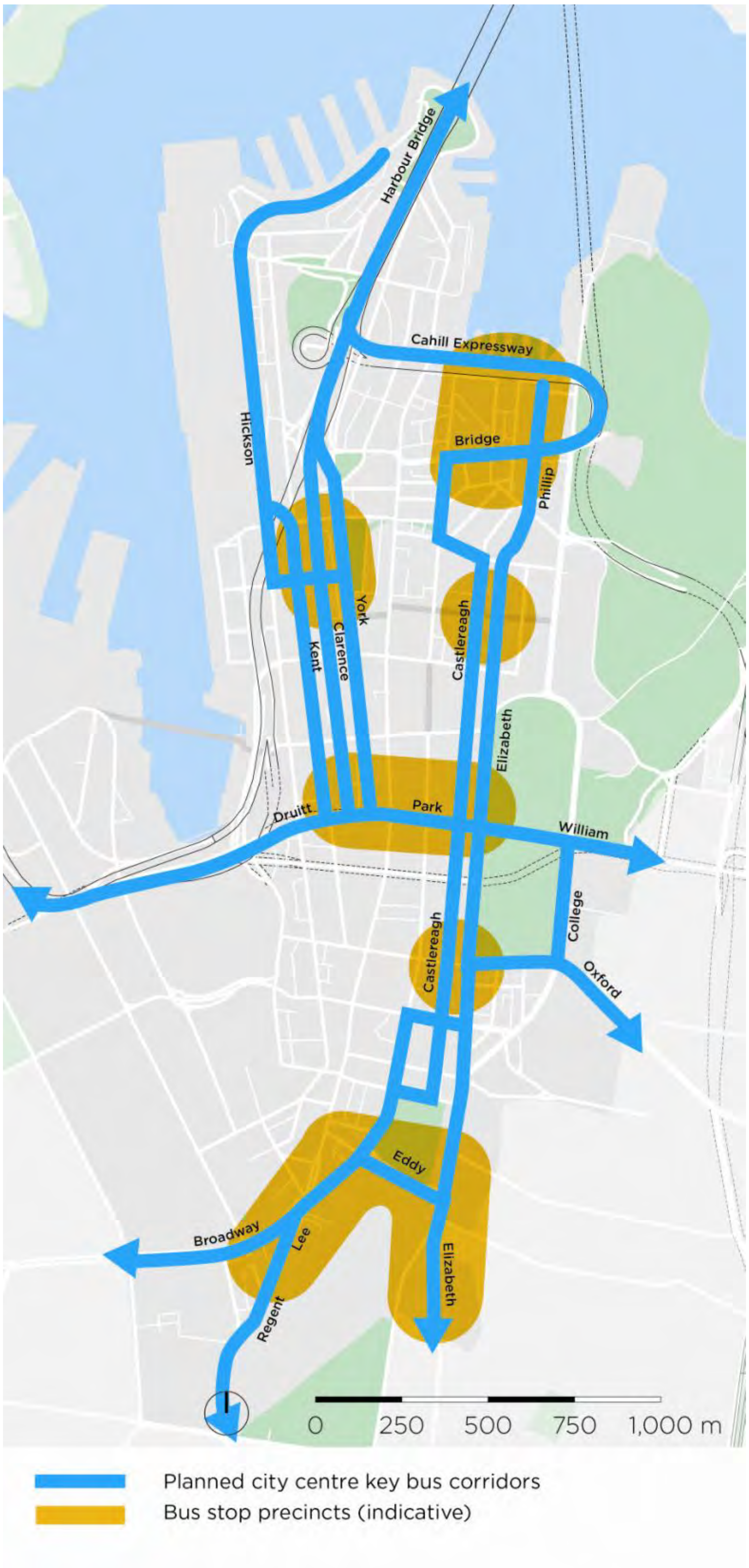
- Bus turning movements would be reduced at the Elizabeth Street and Park Street intersection. This would help simplify bus movements through the city centre.
- Existing Metrobus routes would be configured to operate more efficiently through the city centre and better serve customer demand. Sydney Harbour Bridge services to Railway Square would operate via the Cahill Expressway, Bridge Street, Castlereagh Street southbound and Elizabeth Street northbound.
- The remaining bus routes that enter the city centre via the Sydney Harbour Bridge would use York and Clarence Streets and either terminate at Wynyard or QVB (Town Hall).
- Buses from the Eastern Suburbs via William Street would run to Barangaroo and Walsh Bay or to Pyrmont.
- Approximately half of the Inner West bus routes entering the city centre via Broadway would only operate to Central in order to reduce the number of buses unnecessarily entering the city centre; while the remaining routes would continue to the northern end of the city centre via Elizabeth Street northbound and Castlereagh Street southbound.
- Several routes would be connected to operate as through-routed services to reduce the overlap of bus services on city centre streets and the need for bus lay-over in the city centre.
- Victoria Road bus routes that currently use George Street and terminate at Circular Quay would either continue through the city centre via Druitt Street and Park Street to lay-over outside the city centre or terminate at Wynyard

The key benefits of the redesigned bus network include:

- Turns at critical intersections are minimised within the city centre, improving intersection performance for all users. This change would bring specific improvements for articulated (or "bendy") buses which currently cause delays at certain intersections due to their length and lack of manoeuvrability.
- Trials of double deck buses are currently underway to assess potential benefits across the transport network.
- Concentrating more buses on fewer streets, reducing impacts on other road users and making the bus system easier to understand.
- Major bus stops located within key interchange precincts at Town Hall, Wynyard, Central and Circular Quay, and also at Martin Place and Museum. These interchange precincts would connect different transport modes such as rail, light rail, ferry and bus.
- Key interchange precincts providing increased comfort, for all customers through improvements such as de-cluttering walkways, providing new shelters, better signage and the provision of real time information.
- Other bus stops outside the interchange precincts rationalised to improve bus travel speeds and improve customer understanding of the network.
- Priority bus spines developed with enhanced bus lanes and dedicated stopping bays. They would improve travel time and reliability along Elizabeth Street/ Castlereagh Street, Park Street / Druitt Street and Clarence Street / York Street.

The SCCBP would be implemented prior to commencement of the main construction works for CSELR. It will be the subject of a separate planning approval and therefore is not assessed as part of the CSELR Project EIS with the exception of cumulative impact considerations.

Figure 1-3: Key Bus Route Paths in the Sydney City Centre[3]



A summary of proposed south east bus network changes is available in the Transport Operations Report prepared by Booz & Company and AECOM.

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3 Transport for NSW unpublished data, 2013

2. Assessment Approach and Construction Impact Management Principles

2.1. Assessment Approach

This section identifies construction management principles that could apply in future stages of design or in the preparation of construction management processes by others.

2.2. Construction Worksites

Site specific Traffic Management Plans would identify worksite boundaries, footpath controls and road controls. Activities within the worksite are excluded from the Traffic Management Plans except in relation to ensuring adequate geometry for construction traffic on entry and exit from the worksite.

In providing any hoarding and gantry structure, consideration would be given to ensuring sight lines for side roads, vehicle accesses, signposting, and traffic signals are maintained. Hoarding should comply with any TfNSW specific requirements.

For the remainder of work areas, approved barriers, anti-gawk screens and pedestrian fencing would be provided, as required, to prevent unauthorised access into work areas, protect workers and contain pedestrian movement on footpaths and diversion routes.

2.2.1. Hoardings

The design of hoardings for worksite compounds and depots would have an important impact on the success of worksites in public areas subject to higher levels of pedestrian movement, such as at First Fleet Park and Belmore Park. Construction hoardings should:

- Comply with relevant codes and standards;
- Have bright surfaces;
- Have smooth surfaces particularly for areas adjacent to footpaths to allow pedestrians to brush past without snagging (this reduces shying from the edge);
- Free of trip hazards at the base of the hoardings;
- Be clean and have a regular inspection of the surfaces;
- Have graffiti and advertisements removed regularly; and
- Have adequate lighting.

Worksite hoardings would discourage entry without approval and minimise vandalism. All access points to fenced compounds and depots would have lockable gates. Appropriate information signs should be provided at worksites to identify the project, safety and communication protocols and contact persons.

2.2.2. Site security, site access and signage

Access to individual work areas would consider:

- Safety of travelling public;
- Safety of construction workers and equipment;
- Impact on local communities in terms of safety, noise and road damage;
- Ease of access for emergency vehicles; and
- Site security, particularly outside work hours.

2.3. Heavy Vehicle Forecast

Minor volumes of materials are expected to be excavated for utility relocation or protection, or for the track slab. Larger volumes of heavy vehicles would be likely during the main works construction phase when heavy vehicles are required to transport spoil, concrete, equipment, tracks, overhead wiring etc.

Heavy vehicle movements would be in compliance with the NSW Road Rules 2008, Regulation 300-3 - Driving lengthy vehicles in the Sydney CBD. The size of truck used for haulage would be consistent with these access route constraints, safety and any worksite constraints. We have assumed the standard vehicle would be either a tip truck or truck and dog, with a capacity of up to 25 tonnes as shown in Figure 2-1.

Some construction activities (such as the delivery of track) may require truck and trailer combinations or semi-trailer. Access arrangements for these vehicles would be defined in the worksite Traffic Management Plans produced by the contractor.

Figure 2-1: Sample Construction Vehicle Types

The number of truck movements has been estimated based on the average number of truck movements per day and the individual peak number of movements for any activity throughout the works.

Generally, the peak level of truck movements in the CBD is associated with concrete pours and is of short duration extending over one to four shifts, nominally over one to four days, depending on whether day / night work is proposed.

For the south-east section, the peak number of truck movements is forecast to be associated with concrete pours, excavation of diaphragm wall, excavation and pavement construction. The major works in this section, such as the cut and cover tunnel, mean the peak movements extend over a longer timeframe, e.g. the excavation for the diaphragm wall extends over some 8 shifts.

The forecast average daily truck generation and peak daily movements for each of the precincts within the corridor is summarised in Table 2-1 and Table 2-2.

Table 2-1: Average & Peak Daily Heavy Vehicle Generation CBD Sector [4]

CBD Route							
Route	Street Start	Street End	Total Duration *	Average Daily Heavy Vehicle Trips * (Day)	Peak Daily Heavy Vehicle Trips* (Day)	Total Number of Peak Activity Shifts	Peak Activity
Chalmers Street	Eddy Avenue		8 months	3	87	3	Concrete delivery
Eddy Avenue	Chalmers Street	Pitt Street	9 months	3	84	4	Concrete delivery
Rawson Place	Pitt Street	George Street	11 months	1	87	1	Concrete delivery
George Street	Rawson Place	Hay Street	7 months	2	86	1	Concrete delivery
George Street	Hay Street	Goulburn Street	7 months	3	87	2	Concrete delivery
George Street	Goulburn Street	Liverpool Street	4 months	4	87	2	Concrete delivery
George Street	Liverpool Street	Bathurst Street	8 months	3	93	2	Concrete delivery & CSR backfill
George Street	Bathurst Street	Druitt Street	4 months	4	87	2	Concrete delivery
George Street	Druitt Street	Market Street	8 months	3	88	3	Concrete delivery

[4] CBD and South East Light Rail - Summary Schedule. - AI2MO2 - 6June 2013', ERSD, 2012

CBD Route							
Route	Street Start	Street End	Total Duration *	Average Daily Heavy Vehicle Trips * (Day)	Peak Daily Heavy Vehicle Trips* (Day)	Total Number of Peak Activity Shifts	Peak Activity
George Street	Market Street	King Street	5 months	4	87	3	Concrete delivery
George Street	King Street	Margaret Street	9 months	4	95	1	Concrete delivery & CSR backfill
George Street	Margaret Street	Grosvenor Street	9 months	2	96	1	Concrete delivery & CSR backfill
George Street / Alfred Street	Grosvenor Street	Loftus Street	9 months	6	86	4	Concrete delivery & CSR backfill

** Average / Peak Daily Heavy Vehicle Trips represent the total inbound and outbound truck movements of the worksite (construction works only; therefore excludes all early works, and systems construction component of civil works, rolling stock & rail systems contract component).*

** In the Total Duration, the number of days for overlapping sections of work would not be added separately, only the first and last date of that whole section of overlapping works is allowed for when calculating average truck movement.*

** Average / Peak Daily Heavy Vehicle Trips does not include the cumulative truck movements; shows only single site movements*

Table 2-2: Average and Peak Daily Heavy Vehicle Generation – South East Sector[5]

South East Route							
Route	Street Start	Street End	Total Duration*	Average Daily Heavy Vehicle Trips* (Day)	Peak Daily Heavy Vehicle Trips* (Day)	Total Number of Peak Activity Shifts	Peak Activity
Devonshire Street	Chalmers Street	Elizabeth Street	8 months	3	89	3	Concrete delivery
Devonshire Street	Elizabeth Street	Crown Street	10 months	5	87	5	Concrete delivery
Devonshire Street	Crown Street	Bourke Street	5 months	4	88	3	Concrete delivery

[5] 'CBD and South East Light Rail - Summary Schedule. - AI2MO2 - 6June 2013', ERSUD, 2012

South East Route							
Route	Street Start	Street End	Total Duration*	Average Daily Heavy Vehicle Trips* (Day)	Peak Daily Heavy Vehicle Trips* (Day)	Total Number of Peak Activity Shifts	Peak Activity
Devonshire Street	Bourke Street	South Dowling Street	5 months	3	84	2	Concrete delivery
South Dowling Street	South Dowling Street	Anzac Pde tunnel	15 months	18	80	8	Excavate to top of diaphragm wall for cut & cover tunnel
Anzac Parade	Anzac Pde tunnel	Lang Road	11 months	7	113	NA	Excavate and place pavement through offline areas
Anzac Parade	Lang Road	Alison Road	8 months	13	118	NA	Excavate and place pavement through offline areas
Anzac Parade	Alison Road	Todman Avenue	9 months	11	103	14	Concrete delivery
Anzac Parade	Todman Avenue	Doncaster Avenue	4 months	10	104	5	Concrete delivery
Anzac Parade	Doncaster Avenue	High Street	3 months	13	119	NA	Excavate and place pavement through offline areas
Anzac Parade	High Street	Barker Street	5 months	9	104	6	Concrete delivery
Anzac Parade	Barker Street	Nine Ways	5 months	11	103	7	Concrete delivery
Anzac Parade	Nine Ways	Terminus	8 months	14	111	NA	Excavate and place pavement through offline areas
Alison Road	Anzac Pde	Darley Road	11 months	16	126	NA	Excavate and place pavement through offline areas

South East Route							
Route	Street Start	Street End	Total Duration*	Average Daily Heavy Vehicle Trips* (Day)	Peak Daily Heavy Vehicle Trips* (Day)	Total Number of Peak Activity Shifts	Peak Activity
Alison Road	Darley Road	Wansey Road	10 months	13	126	NA	Excavate and place pavement through offline areas
Wansey Road	Alison Road	High Street	10 months	10	118	NA	Excavate and place pavement through offline areas
High Street	Wansey Road	Avoca Street / Belmore Road	19 months	5	112	8	Concrete delivery
Belmore Road	Avoca Street / Belmore Road	Cuthill Street	3 months	22	105	NA	Excavate and place pavement through offline areas
Randwick Stabling Alison Road	Doncaster Avenue	Randwick Racecourse Stabling Yard	9 months	2	116	NA	Excavate and place pavement through offline areas

** Average / Peak Daily Heavy Vehicle Trips represent the total inbound and outbound truck movements of the worksite (construction works only; therefore excludes all early works, and systems construction component of civil works, rolling stock & rail systems contract component).*

** In the Total Duration, the number of days for overlapping sections of work would not be added separately, only the first and last date of that whole section of overlapping works is allowed for when calculating average truck movement.*

** Average / Peak Daily Heavy Vehicle Trips does not include the cumulative truck movements; shows only single site movements*

The peak truck numbers by individual worksites will not necessarily coincide at any one time and therefore a total for all trucks movements has not been provided in the preceding tables.

2.4. Heavy Vehicle Haulage Route

Designated access routes for construction and spoil vehicles would be via the shortest viable route to the arterial road network. Where possible, the construction corridor would be utilised as much as possible for haulage to minimise negative impacts to other road users.

Details of all routes used for access and haulage during construction would be refined in consultation with relevant stakeholders and be detailed in the appropriate section of the site specific Traffic Management Plans.

Spoil haulage routes would be developed in a format such that a suite of individual instructions and maps are provided to contract operators for all points of origin to respective destinations and return. In addition, layover areas would be nominated for vehicles to 'store' prior to arriving at the spoil removal sites, if required. Approximate travel times during various periods of the day would be developed for each route as a guide to operators and also assist in more consistent and uniform arrival rates at each site.

While the volume of delivery materials and spoil removal are not high, a holding area would permit consolidated delivery and removal, potentially by larger trucks. It is the responsibility of the contractor to determine the requirements of truck storage and dispatching. However, no heavy vehicle storage would be provided in the CBD and would operate as a call in process. The contractor would determine any options in detailed worksite planning and TMPs.

Any additional heavy haulage or oversize vehicle routes that are required by the contractor are to be approved by TfNSW and the relevant Roads Authority.

2.5. Intersection Works

Disruption to current intersection movements should be kept to a minimum to maintain network operations. The following principles are recommended:

- Partial or full closures of major intersections are not undertaken during peak traffic periods i.e. are undertaken at weekends or nights;
- Intersection closures are staged in consultation with the relevant Roads Authority to minimise network impacts;
- Co-ordination of major closures at times in the year with reduced traffic demand e.g. school holidays;
- Days and times for intersection works need to be qualified and assessed/approved by the TMC; and
- The public are informed in advance of upcoming closures and alternative routes are developed and advertised.

To understand how these principles might manifest in management of specific intersections, briefing sessions were held on the 28 March, 4 April and 22 July 2013. The briefing sessions included the following stakeholders:

- TfNSW Planning & Programs Division;
- TfNSW Transport Services Division;
- TfNSW Transport Projects Division;
- RMS;
- TMC;
- City of Sydney Council;
- Engineering, Rail Systems and Urban Design (ERSUD); and
- Integrated Transport and Land Use (ITLU).

These sessions set out the high level principles around which the intersection and side road closures could be considered along the corridor. Based on these sessions a hierarchy of major and minor intersections was established, with appropriate closure treatments and interdependencies. Intersection works were grouped in two categories which define when works can be undertaken:

- Night Works (10.00 PM and 5.00 AM) – Staged and full intersection closures; and
- Weekend Works (11.00 PM Friday to 5:00 AM Monday) - Staged and full intersection closures.

During these closures pedestrian crossing movements would be managed by directing pedestrians around the intersection, to alternate footpaths or where permitted by the work, providing a path through the worksite.

2.6. Traffic Signal Modification

Any temporary or permanent works requiring reconstruction or adjustment to traffic signals requires prior RMS approval of traffic signal design plans and Transport Management Centre approval for the times for intersection works. Lead times for approvals can be more extensive than for other temporary works approvals, i.e. an indicative timeframe of 10 weeks or more dependent upon the scale of changes. Additional time may be required to facilitate the modification of traffic signals electronic hardware, in addition to undertaking any physical changes onsite to intersection layouts.

Additional traffic signal modifications are likely to be required to facilitate network management measures as identified in Section 3. These changes are likely to include:

- Phase adjustments;
- Temporary vehicle detection;
- Removal of kerb buildouts; and
- Geometry upgrades.

The Contractors would be responsible for the preparation of traffic signal designs and obtaining prior approvals in a timely manner. Designs would comply with the RMS manual, *Traffic Signal Design* and Specification SI/TCS/8 *Installation and Reconstruction of Traffic Light Signals*. Any works would be carried out by an RMS accredited traffic signal contractor.

2.7. Midblock Works

Midblock cross sections along the construction corridors dictate the number of traffic lanes that can be kept open during the construction program. The Engineering, Rail Systems and Urban Design (ERSUD) constructability advisors (Aquenta) have identified and provided the required midblock worksite areas and cross sections as input to this CTTMS.

Access should be maintained to local land uses, including residential, employment and retail. Traffic lanes provided adjacent to construction worksite are to be in accordance with RMS Traffic Control at Worksite Manual Version 4.0 and RMS D&C G10 Traffic Management.

All aspects of the Traffic Control Plan (TCP) including safety barriers adjacent to traffic lanes would be in accordance with Australian Standard 1742 *Manual of Uniform Traffic Control Devices* and the RMS *Traffic Control at Work Sites Manual Version 4.0* as well as Supplements to Australian Standards and other RMS complementary materials.

Further details on each of the midblock work components are detailed in the Definition Design Report, Volume 5 – Constructability Report.

2.8. Interagency and Community Liaison

Implementing a project of this scale involves effective and ongoing interaction between various organisations and the general public. It is recommended that the following groups would be established:

- Network Co-ordination Liaison Group and
- Traffic and Transport Liaison Group.

2.8.1. Network Co-ordination Liaison Group

The Network Co-ordination Liaison Group (NCLG) would provide a strategic and tactical forum for ensuring the various project works are coordinated with other development and public works; and to mitigate impacts on local business, residents and visitors. This would include works proposed by RMS and Councils. Chaired by TfNSW, this coordination group would include representation from:

- Roads authorities affected (i.e. RMS, Randwick City Council and City of Sydney Council);
- Transport Management Centre;
- NSW Police;
- Utility Service authorities;
- State Emergency Services;
- Contractor; and
- State Transit Authority.

2.8.2. Traffic and Transport Liaison Group

A Traffic and Transport Liaison Group (TTLG) would be formed to ensure the stakeholders most affected are aware of the proposed construction activities, upcoming works and related transport implications. It is anticipated that the TTLG would review early stage development of TMP's, TCP's, ROL's, network management and the TCS designs.

Given the range of approvals and consents that may be required to facilitate the construction of the light rail, the site specific TMPs would provide the main basis for any required approvals. These documents would be considered for approval by the relevant road authority and consulted on through the TTLG. Membership of the TTLG would include representatives of the main approval bodies. The TTLG, given its composition, could give in-principle approval by signing off the TMPs and TCMPs. This would streamline the delivery process.

The TTLG would be chaired by TfNSW and would have a range of functions. Possible terms of reference include:

- To improve and maintain communication between the Sydney Light Rail Program project and all other stakeholders;
- To plan and review the traffic management arrangements for the light rail works and approvals;
- To mitigate the overall impacts of the light rail works on the area;
- To allow co-ordination of works / schemes in the area;
- To obtain approval in principle for the traffic management arrangements;
- To develop measures that offers the best value for traffic and the project; and
- To ensure that plans are agreed in a timely manner in accordance with the overall project programme.

The participants may vary depending on the worksite and potential issues and areas affected, however the core group may consist of:

Approval authorities

- Transport for NSW;
- Transport Management Centre; and
- Relevant Road Authority.

Other Stakeholders

- NSW Police;
- RMS;
- State Emergency Services;
- Local Councils;
- State Transit Authority;
- Sydney Harbour Foreshore Authority;
- Sydney Business Chamber;
- Bus Operators;
- Centennial Parklands;
- Royal Randwick Racecourse;
- UNSW;
- Sydney Children's Hospital;
- Prince of Wales Hospital; and
- Contractors.

The TTLG would co-ordinate with other existing groups to ensure an integrated planning approach before, during and after the construction.

2.9. Role of Safety Audits

2.9.1. Purpose and Benefits

A Road Safety Audit Process is a formal procedure for checking the design, implementation and operation of road works from a safety perspective. The establishment of quality systems provides the philosophy underpinning the Road Safety Audit Process. The overriding objective of the process is to ensure that all existing road schemes and future routes operate at an acceptable level of safety, with safety being an integral part of the road network development process.

The benefits of road safety audits are that:

- The likelihood of accidents on the road and the adjacent network can be reduced;
- The severity of accidents can be reduced;
- Road safety is given greater prominence in the minds of road designers;
- The need for costly remedial work is reduced; and
- The total cost of a project to the community, including accidents, disruption and trauma, is reduced.

This process would need to ensure that rail safety regulations are also considered and followed where necessary. It also allows for testing of the Light Rail prior to the commissioning of the system. Specifically in relation to construction it should be noted that a construction site becomes a rail site from the point in time when traction power systems are being installed, or it is intended that rolling stock would operate, including rail vehicles or any other rail mounted vehicle.

2.9.2. Stages when road safety audits are undertaken

Road safety audits would be undertaken at the following stages:

Detailed design stage	At this stage, the geometric design, traffic signing scheme, line marking plans, lighting plans and landscaping plans are available and would be looked at in relation to the operation of the road.
Pre-openings	Prior to opening a site, an inspection would be made for all relevant conditions at night and during the day for all likely road users to ensure that the construction has addressed earlier audit concerns and to check for any hazardous conditions that were not apparent at the feasibility or design stages.
Road safety audits of temporary work	The Contractor would undertake regular safety audits of work zones to ensure all worksite safety arrangements are in place. These audits would be additional to the daily inspections by site staff. Particular attention would be given to OH&S guidelines, work areas adjacent to the road, movement of construction traffic, vehicle speeds, and all warning devices / systems.
Road safety audit procedure	All road safety audits would be undertaken in accordance with the RMS Publication "Guidelines for Road Safety Audit Practices, July 2011", but also with reference to Austroads Guide to Road Safety Part 6 January 2009.

2.10. Approvals

2.10.1. Traffic Management Plan Approvals Process

The site specific Traffic Management Plans (TMP) would provide details of individual Traffic Control Plans and Road Occupancy Licence TCP and ROL requirements. This should be prepared in accordance with RMS construction specifications and RMS *Traffic Control at Work Sites Manual Version 4.0*. Approval of these documents should be by the relevant Roads Authority and be submitted through TfNSW.

2.10.2. Road Occupancy Licence Approval Process

The contractor would comply with relevant Road Authority's procedures in applying for Road Occupancy Licences as summarised in this document. ROLs and supporting TCPs would include applications to the relevant Road Authorities for any required 'Speed Zone Authorisations' (SZA). The applications should be submitted to TfNSW, who would coordinate all submissions.

For the project initiation works, lead times for submission of TMPs and associated ROLs are likely to be extended due to the complex cumulative impacts during construction. The cumulative impacts of the construction works need to be assessed in detail by the construction contractor during the later stages of the project. To streamline this process, TfNSW is required to oversee ROL applications for CSELR construction corridors in order to satisfy the approval requirements and to reduce approval delays in the case of managing cumulative construction impacts. Once the worksites are established, relevant roads authority lead time for ROL applications may be applicable. The application period will be depending on the extent of proposed road network changes.

After the granting of the ROL, it would be the responsibility of the Construction Team to ensure that the works are carried out safely and in accordance with applicable legislation, regulations, Australian Standards and RMS specifications and procedures.

Implementation of the TCP submitted with the ROL would be the responsibility of the Construction Manager or delegate. Prior to the commencement of any changes to the existing traffic arrangements, a toolbox or daily pre-start meeting of all involved would be held, with the nature of the changed arrangements and procedures for their implementation being discussed.

2.10.3. Coordination of ROL Activities & Cumulative Considerations

TfNSW would oversee ROL applications in and around the CSELR construction corridor to manage cumulative impacts.

The cumulative impact on travel time resulting from multiple ROLs and operating concurrently would be assessed by the Road Authority. Proposed road occupancies will also be consulted with the TTLG and informed of the traffic management measures.

Where necessary concurrent works are expected to have unreasonable impacts on travel time or create unreasonable levels of disruption, communication strategies would be provided to advise motorists of extended journey times in accordance with the project Community Consultation protocols.

2.10.4. Speed Zone Authorisation (SZA)

An application to the relevant Road Authority should be made through TfNSW for any proposed adjustment to speed limits whether they are temporary, such as those required for short term road occupancies; longer term, such as for the duration of a construction stage; or permanent.

Temporary speed zones need to be implemented to control traffic through roadwork sites. The selection of speed zones would be dependent on the degree of vehicular conflicts, the type and extent of the work in progress, the characteristics of the road and the proximity of workers to passing traffic and it should be in accordance with the RMS's *Traffic Control at Work Sites Manual Version 4.0*. A Speed Zone Authorisation application usually accompanies a ROL application where a change in speed limit is proposed as part of the road occupancy.

The SZA process involves submission of a form available online from the RMS website, which is to be submitted to the Transport Management Centre's Planned Incident Unit through TfNSW. Depending on the extent of works and project familiarity, the application would be supported by project TMP and TCPs. Speed Zone approvals comprise part of the process for approval of the TCP. No adjustments to speed limits would be undertaken without an approved Speed Zone Authorisation.

2.10.5. Special Events

The RMS special event management guidelines process identifies four classes of special event:

- Class 1: is an event that impacts major traffic & transport systems and there is significant disruption to the non-event community. For example: an event that affects a principal transport route in Sydney, or one that reduces the capacity of the main highway through a country town.
- Class 2: is an event that impacts local traffic and transport systems and there is low scale disruption to the non-event community. For example: an event that blocks off a main street town or shopping centre but does not impact a principal transport route or a highway.
- Class 3: is an event with minimal impact on local roads and negligible impact on the non-event community. For example: an on-street neighbourhood Christmas party.
- Class 4: is an event that is conducted entirely under Police control (but is not a protest or demonstration). For example: a small march conducted with a Police escort vehicle.

Wherever possible, agreement would be sought with event organisers to ensure that Class 1 and 2 events do not occur concurrently if they are identified as having a cumulative impact on travel demand around the CSELR construction corridors. To this effect a calendar of all events would be kept during the construction period and coordination of these events and approval to proceed provided through the NCLG. All special events would be assessed and approved by RMS and the TMC in consultation with the Department of Premier and Cabinet.

The traffic management requirements of Special Events may require adjustment to times of operation and routes used by haulage or delivery operations as well as varying approved road occupancy licence (ROL) conditions for the construction. The ROL approval would identify time and day restrictions, where potential conflicts are known at the time of submission.

The Contractor would be responsible for incorporating known special events into the construction program and detailed responses and contingencies in the CTMP subject to further inputs from other stakeholders such as City of Sydney, Randwick Council, State Emergency Services and RMS.

3. Network Performance and Construction Management

3.1. Principles

This section of the CTTMS assesses the network wide traffic impacts of constructing the Project, and suggests management and/or mitigation measures. These impacts are typically caused by reduced capacity on the corridor diverting traffic onto other surrounding routes.

Details of specific construction impacts are assessed on a precinct by precinct basis in Section 4.

The overarching principles used to determine management or mitigation measures for network wide impacts are:

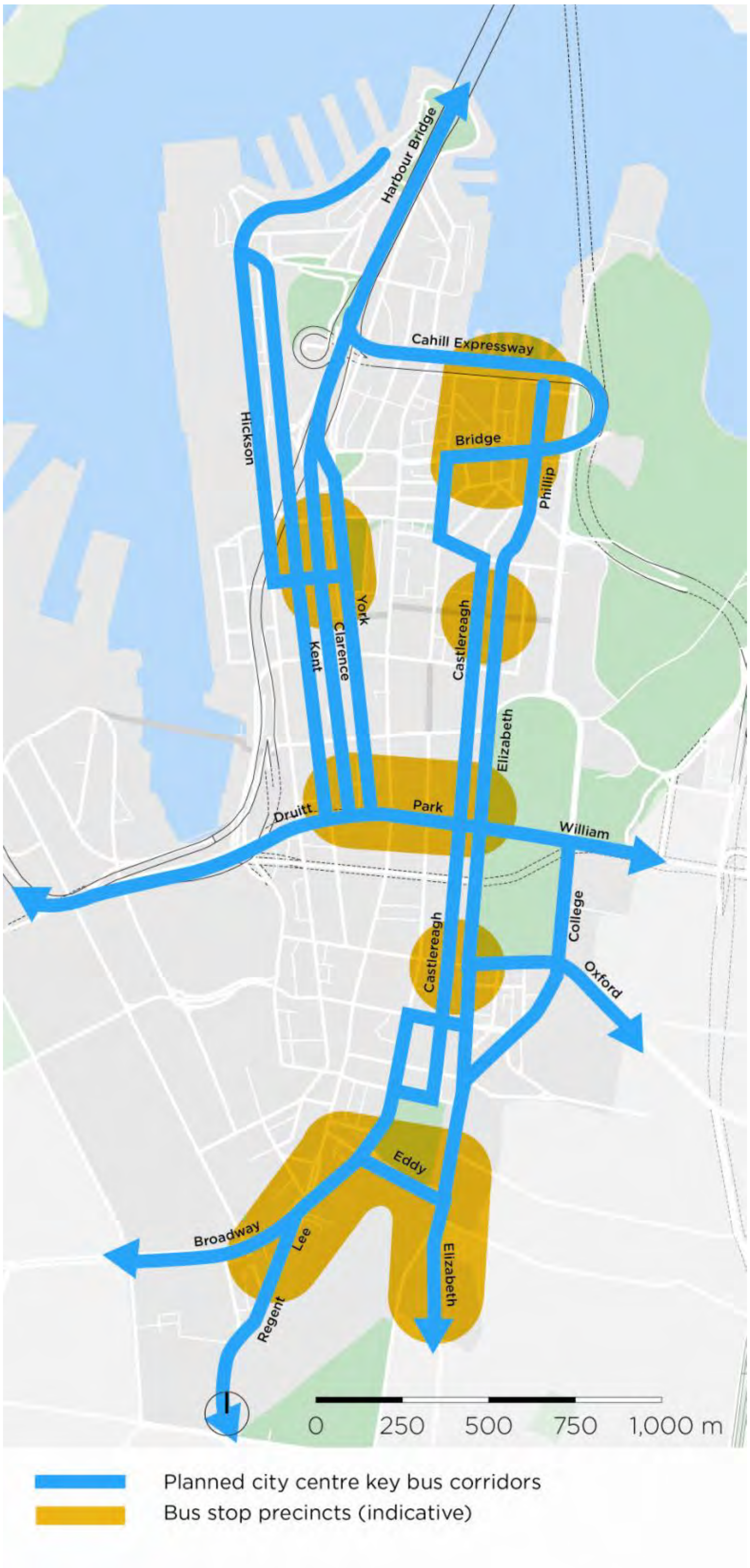
- Balancing transport efficiency against an extended construction program to identify a balanced outcome;
- Implement demand management measures to reduce the demand for travel to levels that can be serviced by the capacity available during construction;
- Minimise impact to active transport modes;
- Minimise impact to property and emergency vehicle access along the corridor;
- Implementation of traffic management measures to offset impact on of the road network; and
- Managing impacts safely.

3.2. Bus and Traffic Management

3.2.1. Bus Management

The Sydney City Centre Bus Plan (SCCBP), South East Bus Plan and the CCAS are to be implemented as separate projects to CSELR and do not form part of this EIS. They will however, be completed prior to commencement of the major construction works for the CSELR. Refer to Figure 3-1 below for the key arterial roads used by buses under the SCCBP.

Figure 3-1 Sydney City Centre Bus Plan Key Corridors



City Centre and South East Bus Operations

During construction, the SCCBP will have been implemented with services from the South East continuing to operate in advance of the introduction of light rail. Further detail on the development of both the South East Bus Plan and SCCBP is available in the Transport Operations Report; however the key features of both are summarized below.

The key features of the SCCBP are:

- Bus turning movements would be reduced at the Elizabeth Street and Park Street intersection. This would help simplify bus movements through the city centre. Existing Metrobus routes would be configured to operate more efficiently through the city centre and better serve customer demand. Sydney Harbour Bridge services to Railway Square would operate via the Cahill Expressway, Bridge Street, Castlereagh Street southbound and Elizabeth Street northbound.
- The remaining bus routes that enter the city centre via the Sydney Harbour Bridge would use York and Clarence Streets and either terminate at Wynyard or QVB (Town Hall).
- Buses from the Eastern Suburbs via William Street would run to Barangaroo and Walsh Bay or to Pyrmont.
- Approximately half of the Inner West bus routes entering the city centre via Broadway would only operate to Central in order to reduce the number of buses unnecessarily entering the city centre; while the remaining routes would continue to the northern end of the city centre via Elizabeth Street northbound and Castlereagh Street southbound.
- Several routes would be connected to operate as through-routed services to reduce the overlap of bus services on city centre streets and the need for bus lay-over in the city centre.
- Victoria Road bus routes that currently use George Street and terminate at Circular Quay would either continue through the city centre via Druitt Street and Park Street to lay-over outside the city centre or terminate at Wynyard

The SCCBP is supplemented by a South East light rail corridor bus strategy which features the termination of most existing all-stops CBD services at light rail interchanges and introduction of additional cross-regional bus routes. The South East light rail corridor bus strategy would only be implemented once CSELR is operational.

The SCCBP would be implemented in advance of construction of the CSELR with some adjustments to compensate for the absence of the mass-transit functionality that would be carried out by light rail in the end-state. Most significantly, eastern suburbs originating CBD all-stops services would continue to operate to the City Centre during construction.

Local Impacts

In addition to the continued operation of South East bus services, the SCCBP interfaces with the construction of light rail at four key locations:

1. Chalmers Street
2. Eddy Avenue
3. Rawson Place
4. Park Street/Druitt Street/George Street intersection

Local bus arrangements have been developed to manage the impact on bus operations at these four locations during construction.

Chalmers Street

With the closure of Chalmers Street, between Randle Street and Elizabeth Street, buses on Chalmers Street would proceed northbound via Randle Street and Elizabeth Street. The kerb realignment at the intersection of Randle Street and Elizabeth Street is proposed as part of the project and would be designed to accommodate the turning maneuver of buses at this intersection.

Bus stops on Chalmers Street would be maintained, with the bus stops relocated south of Devonshire Street to provide sufficient capacity for buses to divert to Randle Street. Exact locations of these bus stops are subject to further investigation and consultation with the operators and City of Sydney.

Eddy Avenue

At Eddy Avenue, all bus services will be retained and sufficient general traffic lanes are maintained to facilitate the continued operation of buses through this precinct during construction. The staging of works at the pedestrian crossing outside Central Station will need to cater for the demand for UNSW bus services and provide safe access to these bus stops.

Rawson Place

At Rawson Place, Route 555 is the only currently operating service directly impacted. As part of the SCCBP, significant volumes of Broadway/Inner West buses are proposed to operate via Rawson Place and George Street southbound. This would not be possible during the construction period, so buses anticipated to make this movement would travel north and southbound via Pitt Street to Railway Square.

Park/Druitt/George Street Intersection

The eastbound and westbound movement of buses through this intersection would be maintained during weekdays. Bus diversions may be required for eastbound bus routes during staging of intersection works at weekends. These diversions may be via Bathurst Street or King Street. Utility relocation and civil works required within the intersection would be managed under the intersection closure detour arrangements shown in Appendix D.

South East CSELR Corridor

As previously indicated, the south east bus network would remain in full operation during construction of the CSELR (i.e. bus network changes cannot be implemented until the substitute light rail product is in operation). Impacts to the operation of the network would be managed through a mixture of local route diversions and construction staging to ensure continuity of access. Key areas where this approach would be adopted to manage construction impacts include:

- Anzac Parade, particularly at Kingsford and Kensington;
- High Street;
- Alison Road;
- Anzac Parade/Alison Road intersection; and
- The Moore Park Bus roadway.

Operational Impacts

The rerouting of bus services would require modification of traffic facilities at adjacent intersections to facilitate bus maneuverability. Some precincts would require prior construction and installation of traffic facilities before the commencement of the early works to accommodate bus diversions.

Such a significant infrastructure transformation would result in impacts on bus management, and key issues are drawn out from the SCCBP below.

Occupancy

The forecast bus occupancy across all corridors during construction, as outlined in the SCCPB, is estimated to be 60%. The only gateway nearing full bus capacity during construction is the Eastern Distributor, while other gateways have the bus capacity to absorb diverted commuters from either terminating routes or alternative routes to the city centre.

Bus stop capacity

In order to accommodate for the bus volumes in the city centre during construction, sufficient kerb space and length is required. The bus stop capacity assessment in the SCCBP shows that all analysed bus stops have adequate capacity for the required activity within the city centre during construction, with some bus stops closer to exceeding capacity than others. Any modifications to the existing bus stops outside the CBD during the construction period must provide sufficient capacity for the number of bus services operating.

Layover facilities

The 21 potential layover facilities in the city centre were assessed for capacity to accommodate for terminating buses in the city centre. The SCCBP identifies some locations that may exceed layover capacity at certain periods. The provisions made in the SCCBP would be implemented, with the modification of excluding Rawson Place during construction for outbound buses. These services would instead be diverted to Pitt Street, and would continue across Lee Street and stop at Railway Square. Bus stops would need to be provided on Pitt Street to cater for bus layovers as required.

3.2.2. Traffic Management

Construction activities would disrupt existing traffic patterns in the surrounding areas. Minimising disruption through effective traffic management techniques across the network, in accordance with the project objectives, is fundamental to the overall success of the Project. Given the scale of the Project and the wide geographical area covered by the proposed corridor, traffic management would be key to providing network operations at a satisfactory level of service.

The principle of providing dedicated light rail services into the Sydney CBD is to reduce the demand on oversaturated bus and private vehicle road networks. In doing so the Project results in a fundamental change in the functionality and operation of the CBD road network. These wider network changes are integrated with two major initiatives that do not form part of the CSELR EIS submission:

- Surface transport changes outlined in the Sydney City Centre Access Strategy (CCAS)
- Sydney City Centre Bus Plan (SCCBP)

Traffic management measures associated with the wider CBD network form part of the CCAS, which has developed the priority traffic routes as identified in Figure 3-2 to complement the end-state for operations in the CBD.

The implementation of the SCCBP, SE Bus Plan and the CCAS will not be implemented by the CSLER project, however they are to be completed prior to the commencement of the CSLER project.

Figure 3-2: Priority Traffic Routes in the CBD[6]

6 *Transport for NSW, unpublished data, 2013*

Additional measures required during construction of CSELR are in development based on model outputs that highlight key congestion hotspots during the construction phase; and in consultation with RMS and TMC. Results of this analysis to date and identified interventions to mitigate these effects are provided in Section 3.9.

3.2.2.1. Road functionality

Broadly speaking the road functionality required during construction would be consistent with the longer term functionality of the road network with light rail in operation. As such the network traffic management measures to be implemented during construction would optimise for the road functionality shown in Table 3-1 and Table 3-2.

Table 3-1: CBD north-south road functionality

Key North / South Street	Function
Sussex Street	Available for general traffic and to service Barangaroo and The Rocks
Kent Street	Available for general traffic with existing segregated cycleway
Clarence Street	Primarily for northbound buses, service vehicles and taxis. Limited availability for private cars
York Street	Southbound only Primarily buses with some limited capacity for service vehicles and taxis. Private car capacity severely diminished from existing due to displaced traffic from George Street and additional buses required
George Street	Local access, servicing and emergency vehicles only in pedestrianized zone Limited traffic capacity outside pedestrianized area
Pitt Street	Priority north-south connection between Railway Square and Liverpool Street Service vehicles taxis and limited private traffic
Castlereagh Street	Southbound only Primarily buses with service vehicles and taxis. Limited capacity for private vehicles. Planned cycleway
Elizabeth Street	Primarily buses, limited capacity for taxis and service vehicles. Private car capacity severely diminished
Macquarie Street / College Street	Available for general traffic

Table 3-2: CBD east-west road functionality

Key East / West Street	Function
Grosvenor Street / Bridge Street	Key east west street to distribute traffic to and from the Harbour Bridge
Hunter / Margaret Street	Only direct link between Barangaroo and Macquarie Street.
King Street	The only street to exit from the Western Distributor to City North Existing and planned cycleway
Market Street	The major street to provide access from City North to the Western Distributor
Druitt / Park Street	Key function is for bus services to access and depart the City. Secondary function is to provide access to the Western Distributor for City South
Bathurst Street	Connection for all traffic from the Western Distributor to City South and also to City east.
Liverpool Street	Key connection for all traffic to egress from City South and City East to Sydney Harbour Bridge.
Goulburn Street	Priority route, providing connectivity for all traffic to and from Darling Harbour / Pyrmont
Hay Street	Lower order connection from Pyrmont to City South
Eddy Avenue	Key function is for east west movements for public transport including light rail. Connection for traffic from Broadway to Wentworth Avenue and to north eastern CBD. Closure at Rawson Place limits westbound traffic use.

The road network functions outlined above would be achieved through measures that would include but not be limited to:

- Reversal in operation of one and two way streets to maximize operational efficiency and access. This includes:
  - Pitt Street two-way north of Bridge;
  - Two-way operation of Hunter Street with Margaret Street; and
  - Reversal of O'Connell Street.
- Removal of kerb blisters (subject to pedestrian safety audit and Council consultation) and extension of parking restrictions to increase the number of operational traffic lanes;
- Upgrade of intersection geometries and signal phasing to optimise the priority traffic corridors;
- Banning of traffic movements to increase intersection capacities and optimise priority routes; and
- Rephasing traffic signals.

The process for development and delivery of these traffic management measures is set out below:

- Develop an integrated roads strategy as part of the CCAS and SSCBP;
- Develop a co-ordinated network approach using traffic modelling tools that include AIMSUN network modelling and localised models e.g. LinSIg, SIDRA, Commuter;
- Implement identified infrastructure changes;
- Develop SCATS operational strategies prior to construction commencing; and
- Implement and refine SCATS strategies during construction

3.3. Pedestrian and Cycle Access Management

Much of the CSELR corridor is located in areas of high pedestrian activity, particularly the CBD precinct. Many CBD footpaths experience high levels of congestion at peak times which includes weekday lunchtimes. For these reasons the construction methodology has minimised the impact to footpath widths and crossing facilities to ensure sufficient pedestrian capacity is provided in a safe environment

All worksites would take consideration of issues of pedestrian safety and security issues as indicated below:

- Any hoardings, or other fixed site boundaries would have lighting as required by current standards.
- Consideration would also be given in design to the layout of any hoarding / fence lines to maximise sight lines for pedestrians, and design out hiding places and blind spots to improve pedestrian personal security. Any gantry arrangements or tunnels would have internal lighting.
- Consideration would be given to relocating or supplementing existing CCTV cameras if the worksite creates unacceptable blind spots.
- It is proposed that footway lighting is provided and that any barriers and pedestrian screens adjacent to pedestrian footway, permit observation from the worksite and opposite footway. For this reason, it is not proposed to use hoardings at the footway/ kerbline, which would block sightlines and tunnel pedestrians into long restricted passages.
- Pedestrian capacity on footpaths will be enhanced by the removal of bus stops and increased crossing opportunities at intersections, because of the reduction or elimination of George Street traffic movements.
- During the days when worksites are in operation, there will be overviewing of the footway from businesses and traffic controllers at intersections will be able to monitor the pedestrian movements and respond to incidents on footpaths and at crossings.
- At night, pedestrian numbers will be lower, but personal security will be more important. Depending on the extent of the work zone and whether frontage premises have extended operating hours, it may be necessary to maintain traffic controllers and/ or security staff. Prior to the start of work, the coverage provided by existing monitoring and the need for and type of any support at particular locations, should be agreed with NSW Police and local councils.
- Emergency evacuation requirements would need to be agreed with emergency service providers (Fire Brigade). Depending on the stage of work this may require
  - Temporary road plates to permit crossing of the work zone.
  - Assistance of traffic controllers in restricting public access to the street block and facilitating access for emergency service vehicles.
  - Protocols for managing emergency response will need to be agreed with service providers prior to the start of work.
  - Protocols to manage the evacuation of occupants adjacent to the worksite will need to be agreed with the building owners and service providers prior to the start of work.

3.3.1. Provision for vulnerable users (school children, elderly and mobility impaired)

Where worksites have an impact on footpaths, consideration would be given to the requirements of all pedestrians and especially vulnerable users. The Disability Discrimination Act requirements would be adopted with drop kerbs, etc. provided at crossings. Footpath widths are required to allow two-way pedestrian movements of pushchairs and wheelchairs.

Where high numbers of vulnerable users use a footpath, special provision and design consideration may be required to mitigate impacts.

3.3.2. Pedestrian Provisions

For the majority of the main civil works, the existing longitudinal (along the footpath) pedestrian movements would be maintained along the footpaths. Transverse (crossing of roads) pedestrian movement would be maintained at pedestrian crossings at intersections or controlled by traffic controllers, where works are carried out.

Installation of overhead wiring poles and service relocations during the early works stage would require the closure of the footpaths. During such cases, the footpaths would be narrowed past the worksite or pedestrians would be diverted to adjacent footpaths via safe crossing facilities with appropriate barriers and signs or temporary structures would need to be installed to facilitate the pedestrians over the worksites.

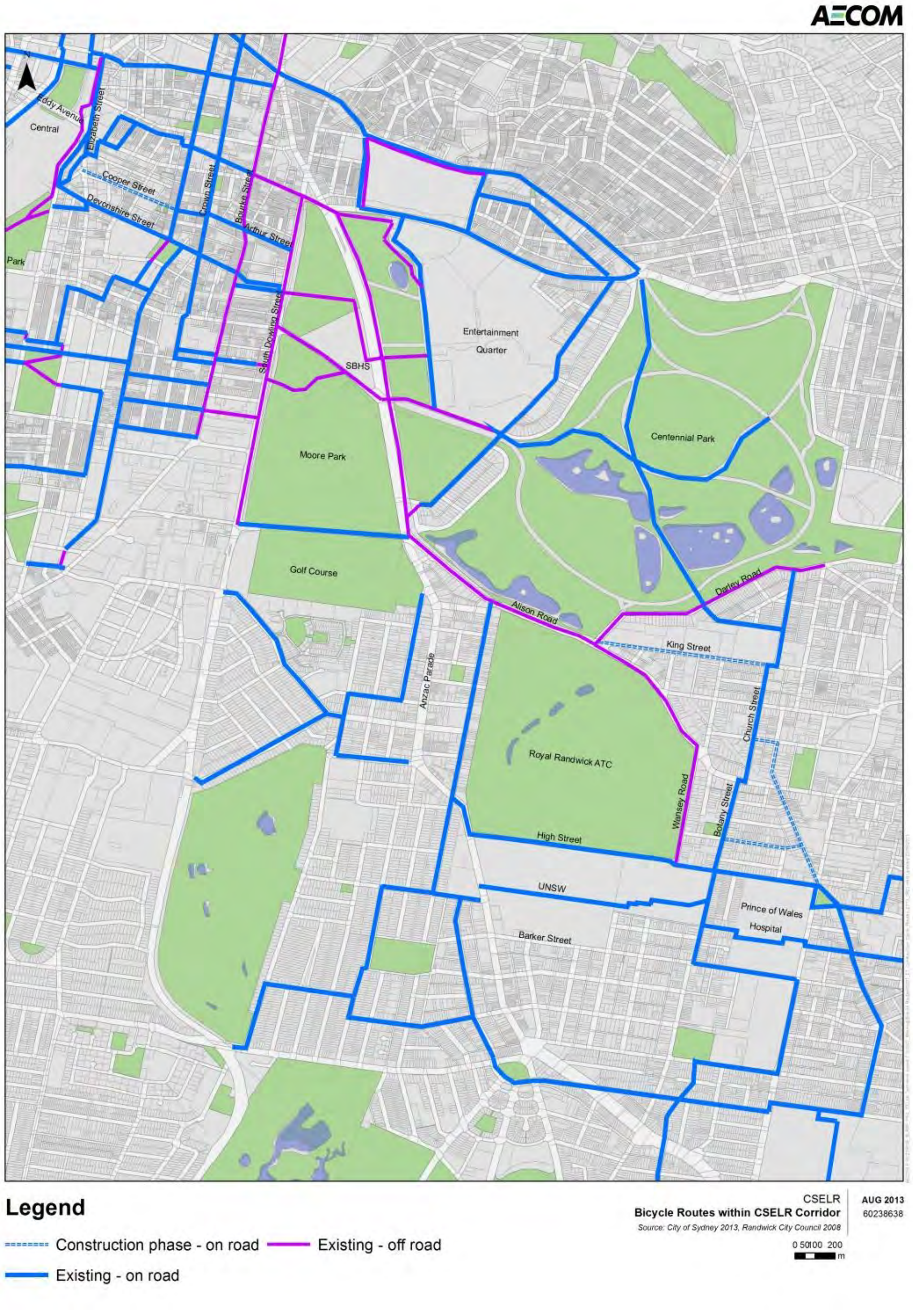
Footpaths adjacent to worksites, with high volumes of construction vehicle movements, would require traffic controllers to manage the conflict between construction vehicles and pedestrians.

3.3.3. Cyclist Provisions

Where existing cycle routes or facilities are occupied by the construction worksites, alternate routes have been identified as shown in Figure 3-3. In developing these temporary diversions, consideration has been given to their suitability based on the road environment and current function. Existing cycle paths located within the construction corridor but not occupied by the required worksite, would be maintained during the construction phase.

Alternate cycle routes would be reviewed by the relevant Road Authority with input from local Bicycle User Groups. Further details of the management measure to be implemented for each of these routes are contained in Section 4.

Figure 3-3: Required changes to cycle route during construction[7]



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[7] AECOM, 2013

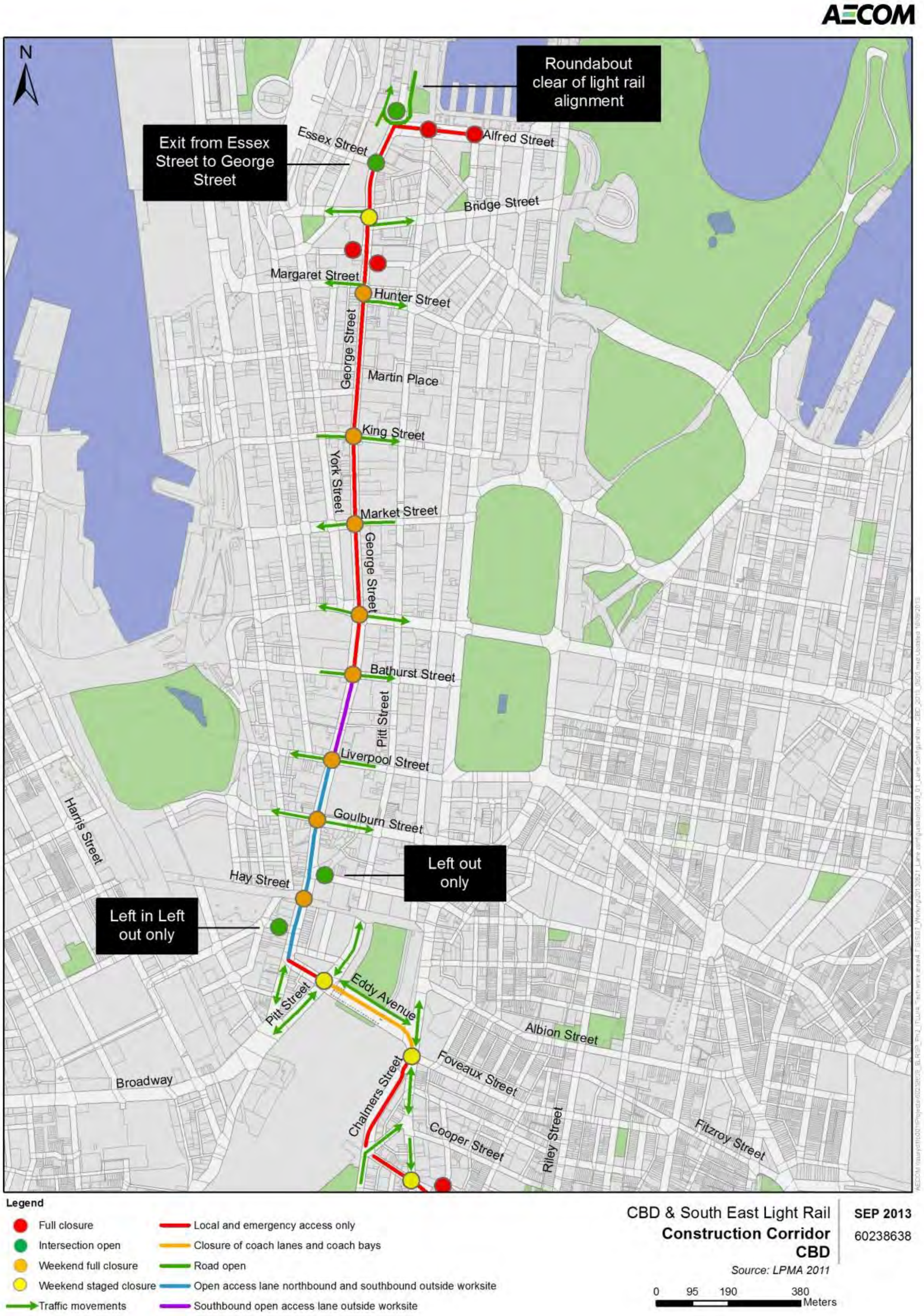
3.4. Network Management

Prior to construction of CSELR commencing, a coordinated approach to proactive management of the transport network would be required. This network management approach would be required to run through the entire construction program to ensure that the impacts of the rolling multiple worksites and resulting fluctuations in network capacity are offset by appropriate measures.

To ensure the most effective management approach is adopted, all assessment undertaken in this CTTMS is based upon a worst case scenario assessment. Under this scenario it is assumed that the full length of the corridor is an active worksite and as such all proposed road closures are in place concurrently. Once a contractor is appointed and detailed construction staging established, it is likely roads would be progressively reopened resulting in improved levels of network performance.

The network scenario assumed for assessment is shown Figure 3-4 to Figure 3-6.

Figure 3-4: CBD and Surry Hills (north) Construction Scenario[8]



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8 AECOM, 2013

Figure 3-5: Surry Hills, Moore Park and Kingsford (north) construction scenario[9]

9 AECOM, 2013

Figure 3-6: Kingsford (south) and Randwick construction scenario[10]

Whilst an increase in localised delays and congestion is highly likely during construction, as a result of temporarily reduced network capacity, the key objective is to ensure congestion and network journey times remain at acceptable levels. Travellers on the

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10 AECOM, 2013

road network would often be accepting of increased journey times for short periods, provided their journey is reliable.

The approach to Network Management during construction of CSELR to deliver satisfactory network performance throughout construction is set out below.

3.4.1. Network Management Plan

The identification of appropriate management measures and coordination of their implementation would be delivered through development of a Network Management Plan (NMP). The NMP would have the high level objective of maintaining network journey times and congestion levels at acceptable levels as identified by the Network Coordination Liaison Group (NCLG). TfNSW would be responsible for developing and maintaining the NMP in coordination with the NCLG.

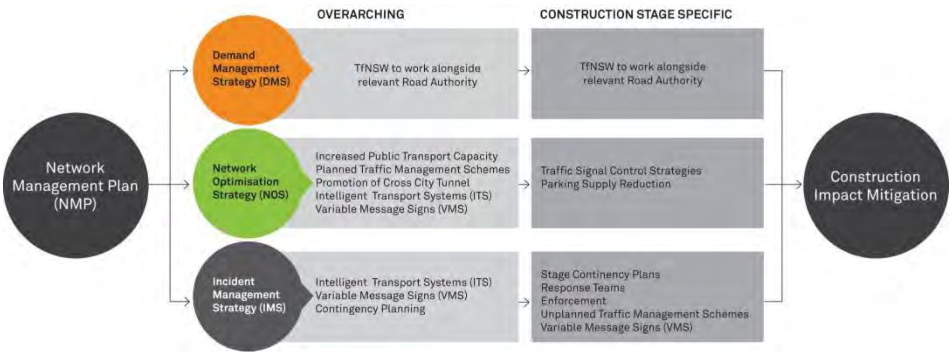
Through consultation with agencies and assessment of forecast impacts to the transport network, the NMP would result in a holistic approach to mitigate the effects of construction and result in the maximum effectiveness of these measures. The plan would consist of three main elements:

- Demand Management Strategy;
- Network Optimisation Strategy; and
- Incident Management Strategy.

When coordinated through the NMP, the above strategies would be able to match peak travel demand to the latent network capacity at each stage of construction.

The structure of the NMP is shown in Figure 3-7 with each of the strategies and available measures detailed in the following sections.

Figure 3-7: Construction Network Management Plan



3.4.1.1. Demand Management Strategy

A reduction in travel demand is necessary as the city cordon is currently operating at capacity, hence the reduction in road network capacity associated with construction of CSELR would lead to further congestion if appropriate measures are not taken. Managing traffic generation by congestion is considered an inappropriate way to reduce demand as it leads to increased travel times, air quality degradation and crashes. Further congestion also adversely impacts on public transport trips thus decreasing the efficiency of the whole transport system.

It is important to note that during construction there would be increased travel demands to be managed arising from the presence of construction vehicles and increased circulating traffic becoming accustomed to the new traffic conditions (with George Street being a key two-way street in the city and most other being one-way, internal CBD trip lengths would be increased thus increasing the volume of traffic on each street).

To successfully mitigate these factors, measures would be required in two discrete categories:

- Overarching Strategies – Strategies that are promoted and implemented prior to construction commencing and run throughout the construction program to reduce peak period demands on the network. In broad terms the CBD traffic capacity is reduced by the volume of traffic using George Street and the network needs to be managed to achieve a similar level of demand reduction at peak times. To achieve this TfNSW will work alongside the relevant road authorities to develop appropriate demand management initiatives.
- Construction Stage Strategies – Generally more localised strategies that are applied during specific stages of construction to focused groups.

The majority of these overarching strategies would require implementation prior to construction commencing. Maximum levels of effectiveness are achieved when these demand management strategies are integrated with the network optimisation measures below.

3.4.1.2. Network Optimisation Strategies

To offset the loss of capacity on the corridor during construction, wider changes to the road network can deliver operational efficiencies and ensure more effective utilisation of available network capacity. These measures would be required in two discrete categories:

- Overarching Strategies – Strategies that are promoted and implemented prior to construction commencing and represent network optimisation objectives closely associated with the end-state:
  - Planned traffic management measures, as identified in Section 3.9.4. These measures would complement the CCAS and SCCBP. This would include modification to SCATS operation in the CBD to ensure traffic signals actively manage traffic onto the priority routes.
  - Implementation of VMS, ITS devices, priority routes enhancements, parking strategies and clearways.
  - Promotion of CBD bypass route and the Cross City Tunnel to increase usage and to reduce demand on the congested surface streets.
- Construction Stage Strategies – Generally more localised strategies that are applied during specific stages of construction to focused parts of the network:
  - Implementation of traffic signal control strategies that minimise delay based on the corridor and road network capacities associated with the current construction stage would be implemented by RMS.
  - Temporary removal or restriction of localised parking to provide additional traffic lanes.

The specific measures would be identified through focused traffic modelling to determine network pinch points and to ensure maximum network capacity is achieved.

3.4.1.3. Incident Management Strategies

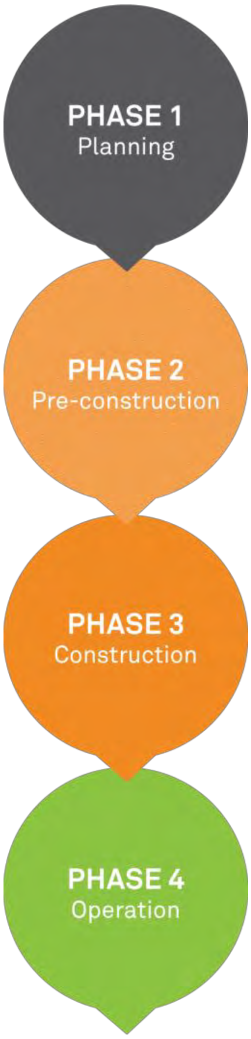
The demand and optimisation strategies identified earlier ensure that network demand and capacity during construction are matched under usual operation. However unplanned incidents such as broken down vehicles are a common occurrence. During the construction period such events have the potential to severely impact operations and it is essential effective strategies are in place to provide resilient operation of the network. These measures would be required in two discrete categories:

- Overarching Strategies – Strategies that seek to pre-empt possible unplanned events based on general network operations during construction. These strategies are likely to represent enhancements to current incident management tools that would remain in place following construction to assist light rail network operations:
    - Ensuring ITS capabilities are enhanced on the CSELR corridor and key alternative routes would facilitate quicker detection of events and provide additional management tools to respond to these events. For example ensuring full CCTV coverage of the corridor is provided would enable the TMC to identify incidents, whilst improved vehicle detection and SCATS enhancements would enable appropriate traffic control responses to be implemented remotely.
    - Provision of temporary and permanent VMS signage, in line with RMS technical direction TDT 2005/02b, to advise drivers of likely delays, upcoming works and diversion routes would influence driver behaviour and reduce demand on problematic corridors.
    - Development of contingency plans to deal with possible events would be required. This would include the review of current contingency plans that may not be suitable in light of construction activity and network changes.
- Construction Stage Strategies – More localised strategies that are applied during specific stages of construction to focused parts of the network and would be removed following completion of the construction program:
    - Incident response teams would be located at strategic points on the network and controlled by the TMC to provide a rapid response to any incidents. These response teams would have the objective of clearing the incident from the network in the safest and quickest time possible to minimise the impact. This is likely to require the provision of light and heavy vehicle tow capabilities.
    - Unplanned traffic management measures would be developed in response to specific hot spots that occur for longer periods and can be resolved through relatively low cost measures such as extension of parking restrictions and minor intersection modifications.
    - Mobile VMS units would be deployed in line with RMS technical direction TDT 2005/02b during each significant construction stage to advise drivers of upcoming works and suitable alternative routes.
    - Enhanced enforcement of traffic regulations would reduce the occurrence of negative network impacts that can occur through non-compliance, as well as improving operations; this would also provide a safety benefit.
    - Construction stage contingency plans developed and tested in advance of each major construction stage.

3.4.1.4. Network Management Plan Implementation

Successful implementation of the NMP would ensure that network impacts during construction of CSELR can be adequately managed and negative impacts minimised throughout the construction program. The NMP would operate in four phases as highlighted below in Figure 3-8.

Figure 3-8: Phases of NMP Operation



The NMP would represent a live document and constantly evolving plan that develops as the Contractor builds up a greater understanding of the construction staging during the planning phase and as new responses are identified in response to unforseen events during construction and light rail operations.

Demand management and network optimisation strategies work most effectively when planned and coordinated as one. The CSELR NMP would ensure this holistic approach is adopted to mitigate the negative impacts of construction.

3.5. Property Access

During construction, property access would be maintained, where possible, along the corridor to minimise the impact to local residents and businesses. However, due to the closure of some approach routes diversions to properties on or adjacent to the corridor would result in an increase to travel distance. The precincts most affected due to the closure of key corridors are:

- The Rocks (George / Alfred Street closures)
- Surry Hills (Devonshire Street closure)

For these precincts, access maps have been produced to detail the effect of these alternate routes. These precinct maps are located in Appendix A.

3.6. On-Street Parking

All on-street parking and loading along the light rail corridor would be affected during construction in order to provide sufficient worksite width and to maximise the number of traffic lanes available. Table 3-3 below quantifies the number of available spaces affected.

Table 3-3: Existing Parking Supply affected on the Corridor

Parking restriction	Parking Supply Impacts by Time Period		
	Pre-AM Peak	Inter Peak	Post-PM Peak
Car Share, Hospital, Mail Zone	5	5	5
Disability Parking	10	10	10
Loading Zone	25	63	24
Short Stay Parking (≤1P)	180	277	213
Long Stay Parking (Restricted)	114	149	153
Taxi Zone	31	31	64
Long Stay Parking (Unrestricted)	459	468	552
Total	**821**	**1000**	**1018**

When light rail is operational only 2% of these spaces would be reinstated during the post-PM peak. As such, the detailed study of parking supply and utilisation undertaken as part of the Transport Operations Report (see Section 6 of the Transport Operations Report) is appropriate during construction. The study concluded that whilst parking demand based on current levels would reach or exceed the reduced capacity in some localised areas; these effects could be managed through:

- Extension of parking permit schemes, particularly in predominately residential precincts surrounding the project corridor. These would be designed to afford priority to local residents to park in the vicinity of their home with an allowance for short term parking for visitors and for vehicle access to commercial land uses and other short stay trip generators. Extension of parking permit schemes would be implemented by the relevant parking authority.

- Providing priority on streets immediately adjacent to the project corridor where commercial land uses are present for loading and short term parking. For example, allocation of kerbside capacity on side streets directly off the corridor for locations where commercial land uses are present for loading and short term parking. All such measures would be developed on a case-by-case basis.

It is therefore concluded that through implementation of the end-state parking strategy prior to construction commencing, the parking impacts can be successfully mitigated. However, additional temporary loading zones may be required at adjoining side streets during construction if access to the off-street parking or loading bays cannot be maintained during construction. Those properties affected and the potential loading zone locations are identified in Section 4.

3.7. Emergency Vehicle Access

Access for emergency vehicles are to be in accordance with emergency vehicle requirements and would be maintained at all construction sites, including access to hospitals. The emergency services would be advised of all planned changes to traffic arrangements prior to applying the changes. Advice would include information about upcoming traffic switches, anticipated delays to traffic, extended times of work, locations of road possession or any likely major disruptions. The construction contractor is to liaise with Emergency Services to minimise the impacts of response times.

Measures to facilitate the movement of emergency vehicles through a worksite would be made available at all worksites and would be defined in the worksite specific TMPs, these measures may include clearways adjacent to worksites and/or road plates.

During short periods when major construction and loading/unloading activities are underway it may not be possible to allow emergency vehicles to traverse the full block length. Access to an emergency within the block would still be maintained at an identified access point and diversion routes would be agreed with the emergency services prior to the activities commencing. The contractor shall also consult with NSW Fire and Rescue regarding any specific requirements for any of the buildings adjacent to the rail alignment in preparing the site specific Traffic Management Plans to minimise the impact to emergency vehicle response times.

An Emergency Management Plan would coordinate these measures and provide a framework for input to the individual worksite TMPs.

3.8. Emergency Management and Planned Event Management

An emergency can be defined as:

An unforeseen event which requires urgent action to protect life or property, or an occasion when emergency services (Police, Fire Brigade, Ambulance or State Emergency Services) take control of a portion of the road network.

Examples of emergencies could include:

- Traffic accidents;
- Hazardous spillages;
- Power Failures;
- Terrorist attacks;
- Flood;
- Fire; and
- Structural damage to a rail line, building, road tunnel or bridge.

The RMS's Incident Response Plan Manual guides the appropriate procedure and responses required in the event of an emergency.

All details of emergencies that occur within ROL areas are to be recorded and forwarded to RMS's Traffic Operations Manager within 7 days of the incident occurring, with details of where the incident occurred, any contributing factors related to the ROL and any actions that have been taken with respect to the ROL conditions.

Incident Management Plans for light rail worksites would be developed in the site specific CTMPs.

The ROL database would maintain records of traffic accidents and incidents reported at work sites. Any complaints received regarding delays at work sites would be via the TfNSW project communications team and referred to the Contractor for investigation, the drafting of replies, and reporting. The person in charge of the work site would continue to be responsible for dealing with complaints regarding safety issues. Where action is considered necessary to address the matters of the complaint, an appropriate recommendation would be forwarded to the contractor.

3.9. Network Impacts

The network impacts during construction have been assessed through a mesoscopic modelling assessment undertaken by TfNSW.

3.9.1. Methodology

The modelling platform adopted includes the development of an area wide mesoscopic model with a large part modelled using a hybrid model concept. The extents of this model are shown in Figure 3-9. The hybrid simulator concept allows for dynamic simulation of an area large enough to account for regional route diversion, as well as micro-simulation modelling of smaller pockets that require representation of individual vehicle dynamics in the detailed road network.

3.9.1.1. 2016 construction scenario

A traffic forecast year of 2016 was adopted to represent traffic demand on the road network at the time construction would be underway. These traffic demands were derived by interpolating between TfNSW's 2011 and 2021 PTPM model forecasts.

Modelling has been produced for the AM peak (6am-10am) and PM peak (3pm-7pm) time periods. Consistent with the approach adopted throughout this CTTMS, the modelled scenario represents a worst case assessment in terms of network traffic demand and capacity reductions. Under this scenario it is assumed that the full length of the corridor is an active worksite and as such all proposed road closures are in place concurrently. This enables the identification of likely critical access and congestion points on the network. Additional detailed planning needs to take place to develop construction staging and access during construction.

Once a contractor is appointed and detailed construction staging established it is likely improved levels of network performance would be achieved.

Figure 3-9: Mesoscopic model area[11]

[11] Mesoscopic traffic modelling undertaken by TfNSW, 2013

3.9.1.2. Network Performance Measures

Global Performance

The high level network statistics provide a good indication of how the network performs and these can be defined in terms of average speed, vehicle hours travelled (VHT) and vehicle kilometres travelled (VKT) for all vehicles in the network in the defined study area. Such statistics enable a relative comparison to be made between the existing network performance and the 2016 Construction scenario. Increases in VKT indicate that vehicles are travelling longer distances to avoid congestion and thus minimise delay. Increases in VHT indicate increased delays and build-up of congestion in the network.

In addition, the "*Vehicles in Network*" parameter provides an indication of the ability for the modelled road network to cater for future demands. A greater number of vehicles within the network at the end of the modelled period indicate that congestion within the model has prevented these vehicles from completing their trip.

Network Traffic Volumes

The introduction of CSELR results in a reduction in traffic capacity on several key roads within the CBD and south-east suburbs, including George Street, Eddy Avenue, Chalmers Street, Elizabeth Street, Devonshire Street, Anzac Parade and Alison Road. Traffic volume changes on roads are an indicator of traffic redistribution resulting from traffic 'hot spots'.

Network Speeds

Complementary to traffic volumes changes, variations to the travel speeds by road segment throughout the network were also assessed. This is a measure of congestion on various roads as indicated by low operating speeds.

Intersection Delays

The intersection average delay is the primary criteria for assessing the Level of Service (LoS) for signalised intersections. The intersection average delay is calculated in the model by determining the average delay for each approach to the node.

3.9.2. Network Performance

This section outlines the wider network effects that occur as a result of the reduced traffic carrying capacity of the light rail corridor during construction. It accounts for the reassignment of traffic onto alternative routes and provides an indication of where the congestion hotspots may occur requiring the implementation of traffic management measures as part of the Network Optimisation Strategy (described in Section 3.4.1.2).

The resulting network wide performance measures and a comparison to existing conditions in the CBD and wider model area are shown in Figure 3-10 and Figure 3-11.

Figure 3-10: 2016 network performance statistics – AM peak[12]

Table 5.16: 2016 Construction Scenario Network Performance Statistics – AM Period

Statistic	2012 Base	2016 Construction Scenario	% Change
Full Model Area			
VHT (8-9am)	11,045hrs	12,582hrs	14%
Normalised VHT (6-10am)	36,338hrs	41,691hrs	15%
VKT (8-9am)	364,316km	377,465km	4%
Normalised VKT (6-10am)	1,259,408km	1,354,122km	8%
Average Speed All (8-9am)	34.0km/h	31.8km/h	-6%
Normalised Average Speed All (6-10am)	34.6km/h	32.5km/h	-6%
Average Speed Bus (8-9am)	18.6km/h	21.1km/h	13%
Average Speed Bus (6-10am)	19.4km/h	22.3km/h	15%
Average Delay (8-9am)	64sec/km	73 sec/km	14%
Average Delay (6-10am)	56sec/km	65 sec/km	16%
Vehicles in Network (at 10am)	8,705	11,038	27%
CBD Cordon			
VHT (8-9am)	2,651hrs	2,970hrs	12%
VHT(6-10am)	8,216hrs	9,103hrs	11%
VKT (8-9am)	72,287km	72,138km	0%
VKT (6-10am)	243,603km	251,289km	3%
Average Speed All (8-9am)	27.2 km/h	24.3 km/h	-11%
Average Speed All (6-10am)	29.6 km/h	27.6 km/h	-7%
Average Speed Bus (8-9am)	10.5 km/h	13.5 km/h	29%
Average Speed Bus (6-10am)	10.9 km/h	14.4 km/h	32%
Vehicles in Cordon (at 10am)	2,112	2,419	15%

The AM peak model results indicate the following potential outcomes could occur when compared to the 2012 base case:

Full Model Area:

- 15% increase in total time travelled by all vehicles
- 8% increase in total distance travelled by all vehicles
- 6% decrease in average speed for all vehicles to approximately 33km/h
- 15% increase in average speed for buses from to approximately 22km/h
- 16% increase in average delay for all vehicles to 65sec/km
- An increase of 2,300 vehicles retained in the network at the end of the peak period. This can be attributed to the additional demand in 2016 and the reduced vehicle speeds that result in fewer vehicles completing their trip by the end of the peak period.

CBD Cordon:

- 11% increase in total time travelled by all vehicles
- 3% increase in total distance travelled by all vehicles
- 7% decrease in average speed for all vehicles decreases to approximately 28km/h
- 32% increase in average speed for buses to approximately 14km/h.

12 Mesoscopic traffic modeling undertaken by TfNSW, 2013

Figure 3-11: 2016 network performance statistics – PM peak[13]

Table 5.17: 2016 Construction Scenario Network Performance Statistics – PM Period

Statistic	2012 Base	2016 Construction Scenario	% Change
Full Model Area			
VHT (5-6pm)	11,816hrs	13,572hrs	15%
Normalised VHT (3-7pm)	46,278hrsc	53,148hrs	15%
VKT (5-6pm)	370,895km	375,996km	1%
Normalised VKT (3-7pm)	1,429,419km	1,543,499km	8%
Average Speed All (5-6pm)	32.8km/h	30.9km/h	-6%
Normalised Average Speed All (3-7pm)	30.9km/h	29.0km/h	-6%
Average Speed Bus (5-6pm)	16.8km/h	16.7km/h	-1%
Average Speed Bus (3-7pm)	17.2km/h	17.4km/h	1%
Average Delay (5-6pm)	70sec/km	88sec/km	26%
Average Delay (3-7pm)	69sec/km	82sec/km	19%
Vehicles in Network (at 7pm)	12,057	15,377	28%
CBD Cordon			
VHT (5-6pm)	2,894hrs	3,321hrs	15%
VHT(3-7pm)	10,829hrs	12,180hrs	12%
VKT (5-6pm)	71,778km	71,427km	0%
VKT (3-7pm)	278,874km	279,816km	0%
Average Speed All (5-6pm)	24.8km/h	21.5 km/h	-13%
Average Speed All (3-7pm)	25.7km/h	23.0 km/h	-11%
Average Speed Bus (5-6pm)	9.6km/h	8.2 km/h	-15%
Average Speed Bus (3-7pm)	9.9km/h	8.5 km/h	-14%
Vehicles in Cordon (at 7pm)	2,296	3,020	32%

The PM peak model results indicate the following potential outcomes could occur when compared to the 2012 base case:

Full Model Area:

- 15% increase in total time travelled by all vehicles
- 8% increase in total distance travelled by all vehicles
- 6% decrease in average speed for all vehicles to 29km/h
- Average speed for buses remaining relatively unchanged at approximately 17km/h
- 19% increase in average delay for all vehicles to 82sec/km
- An increase of 3,300 vehicles retained in the network at the end of the peak period. This can be attributed to additional demand in 2016 and the reduced vehicle speeds that result in fewer vehicles completing their trip by the end of the peak period.

13 Mesoscopic traffic modeling undertaken by TfNSW, 2013

CBD Cordon:

- 12% increase in total time travelled; with a negligible change in total distance travelled by all vehicles
- 11% decrease in average speed for all vehicles to 23km/h
- 14% decrease in average speed for buses to approximately 9km/h.

Overall the road network is expected to function satisfactorily during the AM peak period, however the PM period conditions may present problems in the CBD, particularly noting the decline in bus travel times. Measures to address these impacts are identified in Section 3.9.4.

3.9.3. Travel times and intersection performance

Further to the above network statistics, travel times and intersection delays for key corridors have been extracted for the CBD and south east sections of the model.

3.9.3.1. Travel times

The travel time statistics are provided below in Figure 3-12 and Figure 3-13.

Figure 3-12: 2016 Construction scenario AM peak travel times[14]

Route	Direction	From	To	2012 Base		2016 Weekday Construction Scenario	
				Travel Time (sec)	Average Speed (km/h)	Travel Time (sec)	Average Speed (km/h)
Bathurst Street	EB	Day Street	Elizabeth Street	89	24	92	23
Liverpool Street	WB	College Street	Harbour Street	145	20	179	16
King Street	EB	Sussex Street	Elizabeth Street	113	25	117	25
Market Street	WB	Elizabeth Street	Sussex Street	106	20	122	18
Alison Road	EB	Anzac Parade	Belmore Road	264	29	242	31
	WB	Belmore Road	Anzac Parade	211	36	486	16
Anzac Parade	NB	Oxford Street	Sturt Street	628	31	894	22
	SB	Sturt Street	Oxford Street	711	27	742	26
High Street	EB	Anzac Parade	Belmore Road	271	20	225	24
	WB	Belmore Road	Anzac Parade	237	23	314	17

The travel time forecasts indicate the 2016 construction scenario would have the following impacts when compared to the 2012 base case, within the CBD and south-east in the AM peak:

- The Anzac Parade corridor would experience an increase in travel times in both directions.
- Traffic travelling on High Street would be subject to unchanged travel times in the eastbound direction and an increase in the order of 70 seconds in the westbound direction.
- An increased travel time of approximately 180 seconds along the Alison Road westbound corridor.

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[14] Mesoscopic traffic modelling undertaken by TfNSW, 2013

Figure 3-13: 2016 Construction scenario PM peak travel times[15]

Route	Direction	From	To	2012 Base		2016 Weekday Construction Scenario	
				Travel Time (sec)	Average Speed (km/h)	Travel Time (sec)	Average Speed (km/h)
Bathurst Street	EB	Day Street	Elizabeth Street	146	15	160	14
Liverpool Street	WB	College Street	Harbour Street	232	12	230	13
King Street	EB	Sussex Street	Elizabeth Street	109	26	192	15
Market Street	WB	Elizabeth Street	Sussex Street	124	17	131	16
Alison Road	EB	Anzac Parade	Belmore Road	262	29	241	31
	WB	Belmore Road	Anzac Parade	214	35	398	19
Anzac Parade	NB	Oxford Street	Sturt Street	560	35	888	22
	SB	Sturt Street	Oxford Street	865	22	918	21
High Street	EB	Anzac Parade	Belmore Road	275	20	277	19
	WB	Belmore Road	Anzac Parade	232	23	302	18

The travel time forecasts indicate the construction scenario would have the following impacts within the CBD and south-east in the PM peak:

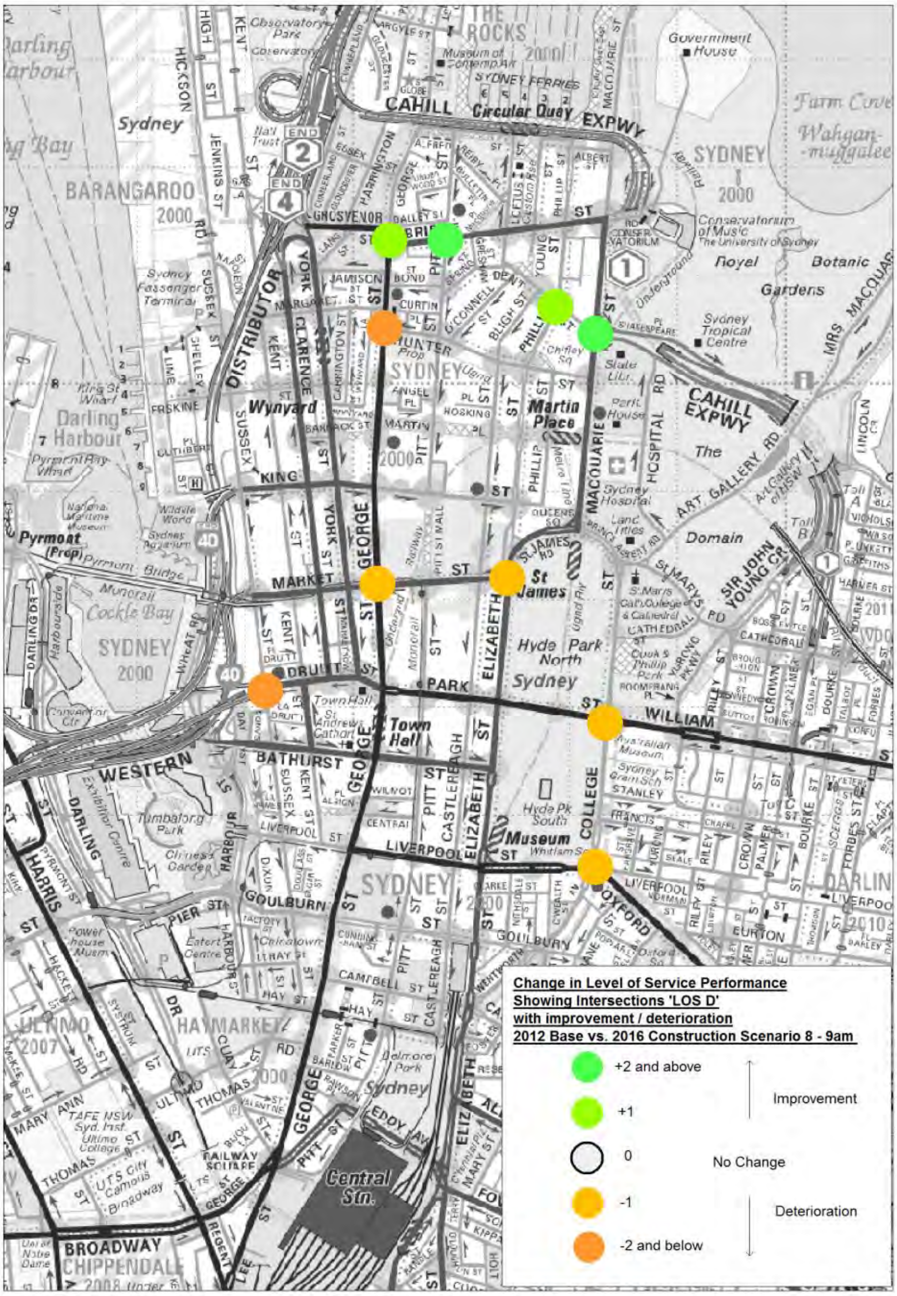
- Improvements to travel times on Liverpool Street.
- The King Street corridor would see increased travel times of approximately 80 seconds.
- Travel time increase for the routes within the south-east with the exception of the Alison Road eastbound which would experience travel time reduction of approximately 20 seconds.

3.9.3.2. Intersection delays

Within the CBD, an assessment of the change in level of service is provided in Figure 3-14 and Figure 3-15. The figures compare the forecast intersection performance of the 2012 Base and the 2016 construction scenario. The colour coding illustrates the performance of key intersections that operate at LoS D or worse in either scenario. The green denotes improved level of service during construction, whilst the amber identifies deterioration in level of service.

15 Mesoscopic traffic modelling undertaken by TfNSW, 2013

Figure 3-14: 2016 construction scenario vs. 2012 base change in level of service - AM peak[16]



The AM results illustrate that the construction scenario would impact on the performance of the intersections in the mid-city, especially along Park Street, Market Street, College Street and Hunter Street. The introduction of the CBD bus plan shows improvements to the intersections along Bridge Street as well as Bent Street.

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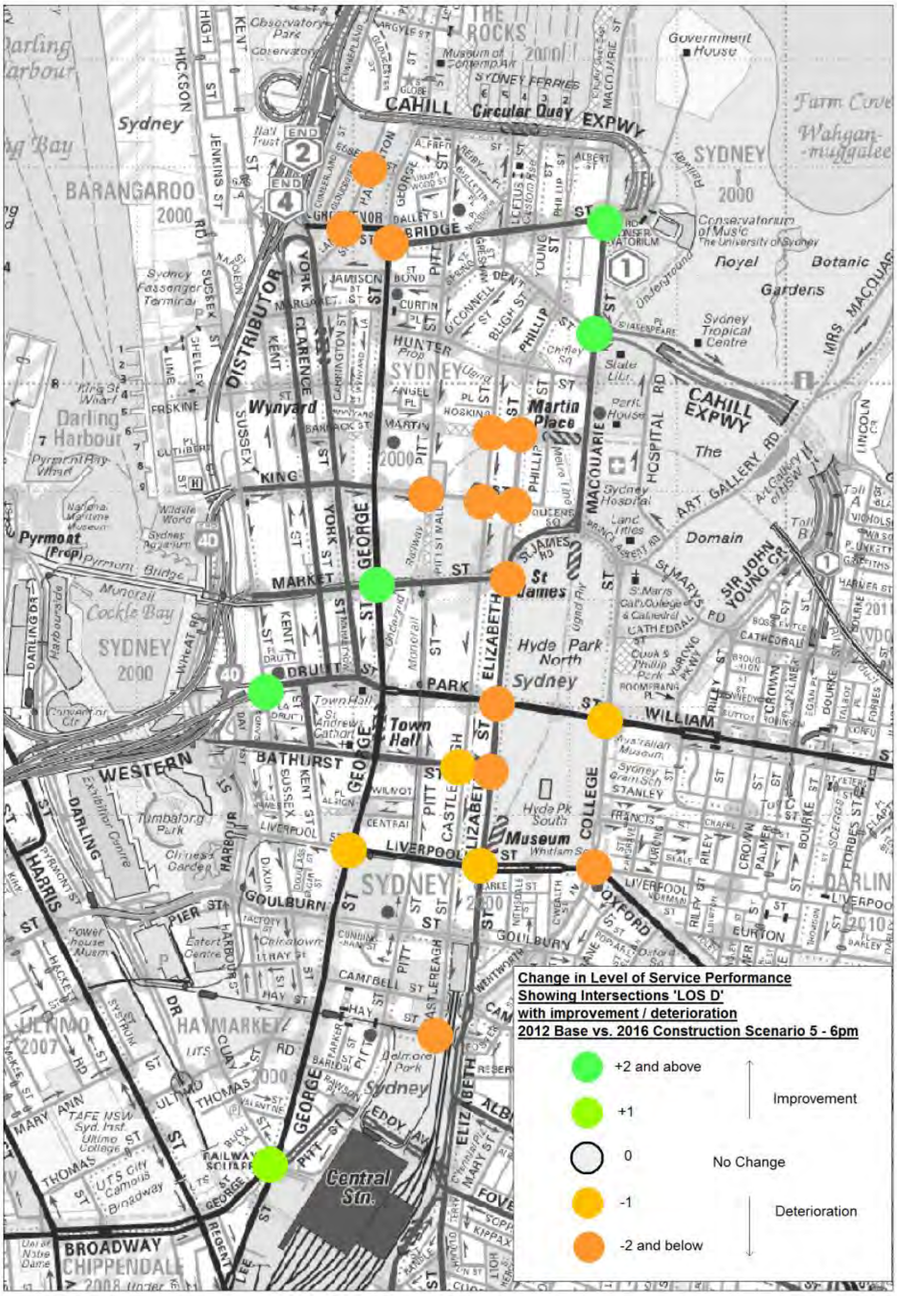
16 Mesoscopic traffic modelling undertaken by TfNSW, 2013

Figure 3-15: 2016 construction scenario vs. 2012 base change in level of service - PM peak[17]



The PM peak period results for the construction scenario show a contrasting pattern to the AM peak with the increase in intersections delays concentrated around Bridge Street and King Street in the northern CBD and around Elizabeth Street and Liverpool Street in the southern CBD. The increased delays along Elizabeth Street and Castlereagh Street corridors are due to increased bus activity associated with the SCCBP.

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[17] Mesoscopic traffic modelling undertaken by TfNSW, 2013

3.9.4. Indicative planned traffic management measures

Both the operational and construction phases of light rail would result in a reduction in traffic capacity along the corridor that may require additional mitigation measures at the network level. The potential wider network intervention measures identified for the operational end-state would also provide a benefit during construction and as such these measures could be implemented prior to construction commencing. Potential measures identified by modelling undertaken by TfNSW are shown in Figure 3-16 and Figure 3-17. Further assessment is required to confirm the specific package of mitigation measures that could consist of ITS, CCTV, VMS and changes in traffic management.

Within the CBD, a key objective of these measures is to address a reduction in vehicle speeds on Elizabeth Street by promoting College and Macquarie Streets as the priority traffic routes.

Figure 3-16: Possible Area management intervention measures[18]

Area Management	**Recast SCATS Management Strategy** To include but not limited to the following points: 1. Bent Street / Macquarie Street – Promote a shift of traffic exiting northern CBD from Castlereagh and Elizabeth Street to Macquarie Street by increasing right turn phase duration from Bent Street into Macquarie Street southbound. 2. Goulburn Street / Harbour Street– Facilitate capacity for demand increase during PM for the westbound Goulburn St CBD egress to Harbour St northbound by increasing right turn phase duration. 3. Bridge Street and Bent Street at Macquarie Street– Promote a shift of traffic exiting northern CBD from Castlereagh and Elizabeth Street to Macquarie Street by increasing right turn phase duration from Bridge Street into Macquarie Street southbound. During PM facilitate demand increase for Bridge St CBD entry by increasing eastern approach from Cahill Expressway phase duration. 4. Oxford Street / College Street– Facilitate capacity for demand increase during PM for the westbound Oxford Street right turn into College Street northbound by increasing right turn phase duration. 5. Wentworth Street / Goulburn Street– Facilitate capacity for demand increase during PM for the eastbound Goulburn Street CBD egress through Wentworth Street by increasing eastbound phase duration. 6. Hunter Street / Macquarie Street– Promote a shift of traffic exiting northern CBD from Castlereagh and Elizabeth Street to Macquarie Street by increasing Hunter Street eastbound approach phase duration. 7. Goulburn Street / George Street– Facilitate capacity for east-west demand increase during PM along Goulburn Street by increasing east-west phase duration from proposed light rail signal timing arrangements for the junction. 8. Kent Street – Facilitate with improved co-ordination north bound flow to Harbour Bridge 9. Wattle Street / Harris Street – facilitate traffic movements to and from Western Distributor to encourage alternate route to Broadway / George Street
	Strategic Supplementary Corridor Directional Sign Posting To position traffic in corridors that best serve the network during the peak periods with light rail, the following corridors are recommended to be sign posted as key CBD entry and exit corridors: 1. Eastern CBD Periphery – Macquarie Street / College Street / Wentworth Street – "To Northern CBD and Cahill Expressway" 2. Western CBD Periphery – Kent Street / Clarence Street – "To Barangaroo, Northern CBD and Harbour Bridge" 3. South-Western CBD Periphery – Wattle Street/ Fig Street / Harris Street – "To Harbour Bridge and Northern CBD" 4. Southern CBD Periphery – Cleveland Street

18 Mesoscopic traffic modelling undertaken by TfNSW, 2013

As part of the on-going process of developing a network management plan, RMS has initially identified further measures for optimisation of the CBD:

AM Peak Measures

Promote the following as alternative priority routes:

- Wattle Street and Harris Street

PM Peak Measures

Promote the following as alternative priority routes:

- City North to Sydney Harbour Bridge:
  - Hunter Street and Macquarie Street
  - Bent Street and Macquarie Street
  - Bridge Street
- City to Anzac – Goulburn Street and Harbour Street
- City to East Suburbs - Oxford Street and College Street
- Convention Centre to Sydney Harbour Bridge - Kent Street
- City to Anzac – Wentworth Street and Goulburn Street

Figure 3-17: Physical intervention measures[19]

Intervention Level	Details
	<u>Kent Street Corridor</u> Due to increased reliance of Kent Street for northbound CBD departing traffic to the Sydney Harbour Bridge with the implementation of light rail on George Street, increased capacity is required on Kent Street to manage queue lengths such that they do not significantly impede on traffic operations in the northern CBD precinct. It is recommended that a three lane corridor and a two lane right turn facility for the northbound movement onto the SHB is implemented with light rail.
	<u>Cleveland Street</u> Comprehensive arterial management incorporating turn conflicts reduction, kerbside parking, etc
Physical Changes	<u>Removal of CBD On-Street Parking Facilities</u> To facilitate enhance CBD network capacity during the PM period with light rail in critical areas, the following on-street parking facilities are recommended to be removed: 1. <u>Hunter Street</u> – 2 eastbound lanes between Elizabeth Street and Phillip Street with removal of westbound on-street parking provision 2. <u>Bridge Street</u> – 3 eastbound lanes between Young Street and Phillip Street with removal of westbound on-street motorcycle parking provision 3. <u>Kent Street</u>– provision of a three lane corridor from Liverpool Street to Druitt Street with removal of eastern on-street parking provision 4. <u>Goulburn Street</u> – 3 eastbound lanes between Elizabeth Street and Foy Lane with removal of westbound on-street parking provision
	<u>Intersection Lane Changes</u> It is recommended that the following intersections introduce dual right turn lanes in order to cater for the shift in traffic patterns with light rail: 1. <u>Liverpool Street / Kent Street</u> – two right turn lanes from Liverpool Street westbound to Kent Street (one lane shared with through movement) 2. <u>William Street / College Street</u> – two exclusive right turn lanes from William Street westbound to College Street 3. <u>Macquarie Street / Bent Street</u> – two right turn lanes from Macquarie Street northbound to Eastern Distributor eastbound on-ramp (one lane shared with through movement) 4. <u>Kent Street / SHB On-Ramp</u> – two right turn lanes from Kent Street northbound to the SHB on-ramp (one lane shared with through movement) 5. <u>King Street / Elizabeth Street</u> – improve left turn capacity from King Street to Elizabeth Street northbound including reduction of pedestrian conflict.

[19] Mesoscopic traffic modelling undertaken by TfNSW, 2013

In addition to the above changes it is also proposed that the following measures be investigated further for possible implementation during construction of CSELR:

- **Investigation of staged construction works of the Anzac Parade and Alison Road corridors**. The modelling undertaken to date and resulting forecast travel time increases on Alison Road and Anzac Parade assume concurrent works on both corridors. Staggering these works would provide additional capacity during construction and reduce these increases to travel time. Opportunities to adopt this approach are currently being investigated by TfNSW.
- **Signposting and promotion of alternative corridors** in the south east. Promotion of these wider diversion routes would result in lower traffic volumes along the construction corridor and as a result improved travel speeds to those identified by the traffic modelling. The alternative corridors identified include:
  - Wentworth Avenue, Gardeners Road and Botany Road for traffic travelling to/from south eastern suburbs such as La Perouse, Little Bay, Malabar and Maroubra.
  - Avoca Street, Carrington Road, Arden Street, York Road, Syd Einfeld Drive and Oxford Street from eastern suburbs such as Coogee, Clovelly, Bronte and Bondi.
- **Promotion of routes bypassing the CBD** such as the Eastern Distributor, Cross City Tunnel and Cleveland Street as alternative.
- **Review of current and proposed bicycle corridors** in the CBD to ensure they are integrated with the newly defined traffic priority routes.
- **Subject to further investigation, tidal flow operation on Anzac Parade** during construction, to provide a bus priority lane in the peak direction and protect bus journey time reliability along the corridor.
- **Retention of a single lane in the peak direction along the entire length of the existing Anzac Parade busway** and complementary bus priority kerbside lane on Anzac Parade in the non-peak direction as well as bus priority measures on Alison Road. This would facilitate bus priority through these congested sections of the network, but may have an impact upon the construction program for this section.

3.9.5. Conclusions

The assessment of the Construction Scenario indicates some traffic management challenges to be resolved prior to construction of CSELR. In particular, the PM peak forecasts indicate that implementation of management measures will be critical to ensure priority bus corridors are protected against increased levels of congestion. In the south east corridor the importance of maintaining acceptable operations on Anzac Parade and Alison Road during construction is clearly demonstrated.

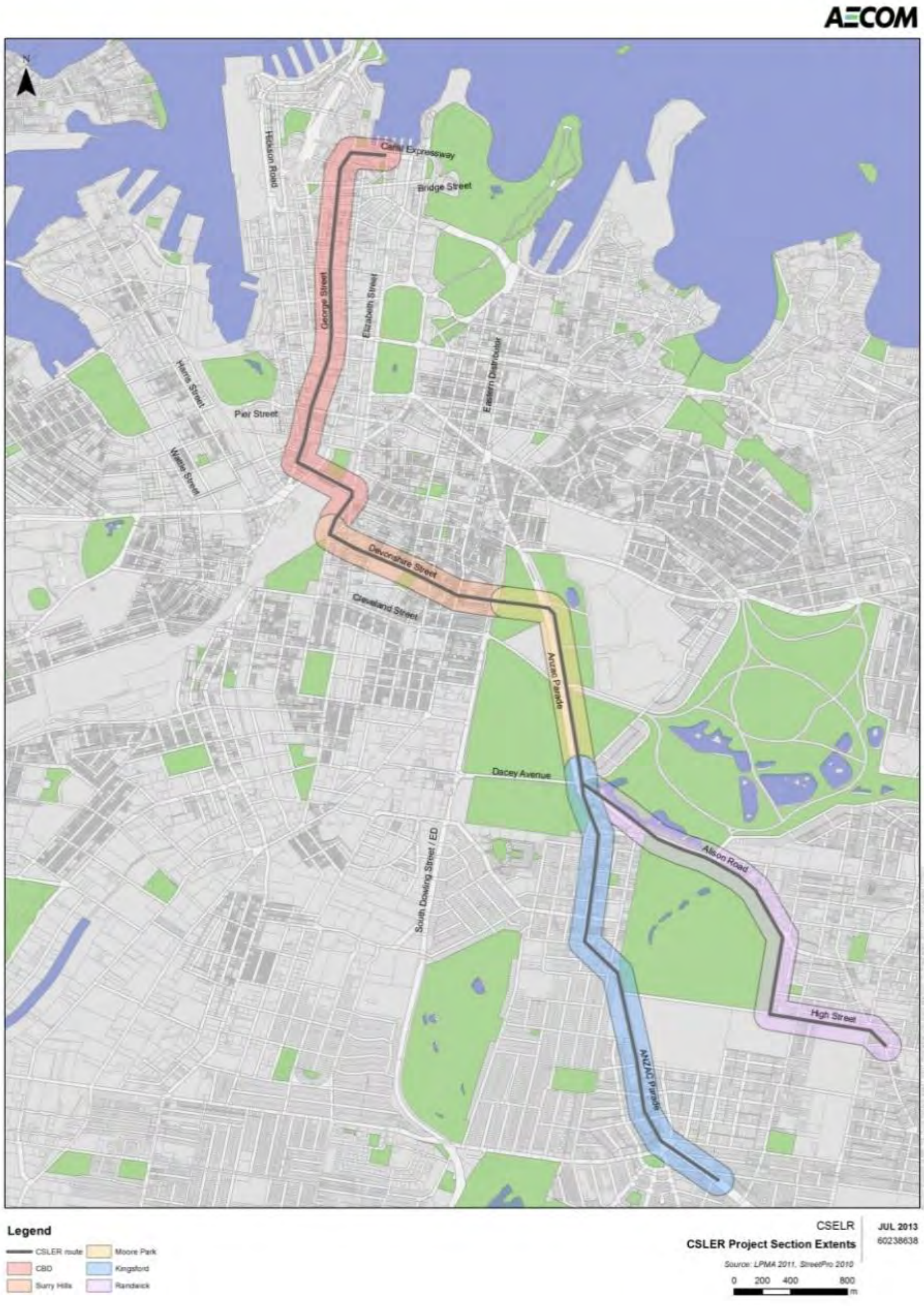
In conjunction with the Network Management Plan, the measures outlined in section 3.9.4 would serve to improve network and corridor performance over and above that described in the modelling analysis undertaken. Further refinement of these measures to target specific road network issues is being undertaken by TfNSW and RMS in consultation with other stakeholders.

4. Precinct Access and Construction Management

This section assesses the specific CSELR construction impacts and identifies construction management initiatives on a precinct by precinct basis. The assessment has been broken down into the following five precincts as shown in Figure 4-1:

- CBD – between Circular Quay and Central Station.
- Surry Hills – between Central Station and South Dowling Street.
- Moore Park – between South Dowling Street and Robertson Road.
- Kingsford – between Robertson Road and Nine Ways.
- Randwick – between Anzac Road / Alison Road intersection and High Cross Park.

Figure 4-1: CSELR precinct areas[20]



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20 AECOM, 2013

4.1. Key Objectives

A number of key objectives were established prior to development of the precinct access and construction management plans. These objectives are outlined below in Table 4-1 and discussed in detail in the following sections.

Table 4-1: Key Objectives for Construction Traffic and Transport Management

Key result area	Construction objective
Worksite operation	▪ Minimise local precinct impacts ▪ No worker injury accidents during construction ▪ No injury accidents to members of the public because of construction
Property access	▪ Minimise disruption to businesses, residents and uses local to construction sites ▪ Provide advance notice of upcoming works and traffic arrangements ▪ Maintain vehicle access to hospitals and emergency providers at all times ▪ Maintain pedestrian access to properties fronting George Street ▪ Develop alternate strategy for servicing, in consultation with property owners and businesses ▪ Consult public and private owners to agree options to maintain proposed operations during the works
Pedestrians and cyclists	▪ Minimise disruption to pedestrians and cyclists on footpaths and crossing at intersections ▪ Review existing traffic signal operation for pedestrian conflicts with traffic on access lanes ▪ Maintain pedestrian access to businesses during the works ▪ Maintain adequate conditions for security of footpaths at night / daytime, including lighting, surface free of trip hazards, overviewing (visibility to and from adjacent sites) of paths.
Traffic operations	▪ Provide advance notice of upcoming works and traffic arrangements ▪ Provide directional / detour signage to direct drivers around/ away from work areas ▪ Minimise the number of traffic changes to assist legibility for drivers ▪ Minimise conflict between bus routes and traffic detour routes ▪ Promote alternate travel times, modes and routes for drivers with CBD destinations or travelling across CBD
Communications	▪ Implement communications plan to notify changes to transport operations ▪ Provide advance notice of upcoming works and traffic arrangements ▪ Promote new bus routes and stops, preferred traffic routes and detours

4.1.1. Worksite operations

As detailed in Section 2.4, heavy vehicles generated during the construction phase would be consigned to key arterial roads. With concurrent activities at multiple construction sites, management of the heavy vehicle movements would be required to ensure that the construction vehicles do not congest the already constrained network, especially during peak hours. To reduce the impact, haulage vehicles would utilise the construction corridor, where feasible, and the worksites would all have common haulage origins and destinations to the west, north and south so as to manage the truck movements and ensure they do not coincide at the same time.

Worksites are only to be accessed by defined access points to manage safety and road impacts.

Staff parking is not generally supported, and staff parking is not provided at worksites,with the exception of Moore Park and Randwick Racecourse. The following options are recommended to reduce the need for staff parking within, or around, worksites:

- Early utilisation of stabling yards as staff parking areas with transfers between the stabling yards and worksites;
- Long term lease of adjacent commercial parking spaces within the CBD; and
- Parking within Moore Park and Randwick Racecourse work sites with transfers to adjacent work sites.

4.1.2. Management of Property Access

Access to existing driveways and service points would be managed during the construction stage to ensure acceptable accessibility levels are maintained consistent with current works. The alignment of the light rail in some sections of the narrow road widths may hinder accessibility to adjacent properties. At such instances, the traffic management plan would consider:

- Managing access through worksite by traffic controllers where vehicle manoeuvring requirement dictates, i.e. truck turns into and out of property are restricted by barriers or the available traffic lane is on opposite side of the worksite.
- Short term restrictions to access, with prior notification of businesses.
- Provision of additional loading zones prior to commencement of construction on adjacent side streets in line with the CSELR Transport Operations Report.

Additional short term strategies would also be required when the active worksite is at the property frontage and when concrete pours etc. prevent service vehicles driving across the worksite. Short term strategies include:

- Agreeing with property owners / operators for scheduling of deliveries for early morning / late night or varying the size of vehicle. Other options include:
  - Identifying potential central consolidation / breakdown / warehousing centre for loading to reduce overall truck numbers through the construction sites and thus reduce impacts of delays for both the construction program and courier companies.
  - Providing temporary loading zones on side roads with the use of trolley / forklift transfer. However, this is not an option where ramped access and containerised garbage operations currently exist.
- Where no alternative locations are feasible and access is essential at all times, the construction methodology may require a bridge/ plate over the rail alignment to provide crossings.
- Prior consultation and agreement from property owners for any additional controls on access is required. Protocols will be developed for managing representations and in relation to any temporary controls.

4.1.3. Traffic signal operation

Changes to traffic signal operations may be required where construction activities have a significant impact on traffic movements. All operational changes for traffic signals would be provided by the contractor as part of ROL applications and subject to approval by TMC and relevant road authorities.

4.1.4. Communications and public liaison

A key element in successfully implementing the required changes to precinct operations is to manage the public's expectations and limit disruption. This can be achieved through provision of information to all road users affected by the construction activity. It is important that all parties are aware of restrictions and provisions during the whole construction period.

Information packs would be prepared that covers the proposals for the following activities:

- Pedestrian access to premises;
- Waste collection;
- Deliveries;
- Emergency vehicle access;
- Emergency pedestrian evacuation routes;
- Disability access;
- Event management; and
- Noise management.

The elements of access that would be covered in these information packs would include:

- Pedestrian routes and restrictions;
- Cycle diversions;
- Vehicular routes;
- Times restrictions of access if applicable;
- Vehicle size restrictions; and
- Speed restrictions.

All affected residents, surrounding businesses and road users will be notified in advance of the above issues and any disruptions to traffic. The methods of notification will be by various means such as:

- Driver warning signs;
- Variable message signs;
- Project information web-site;
- Newspaper leaflets; and
- Public notices in local publications.

The project newsletter will notify the local community of updates on the project and the current stage of the construction to inform on what changes, if any, are expected within the transport network. In addition, extensive liaison with UNSW, Randwick hospitals, Randwick Racecourse and Centennial Parklands Moore Park Trust would be undertaken given the significant trips generated by these developments.

4.2. CBD Precinct

Key construction traffic issues in the CBD precinct are:

- Managing the impacts of construction on George Street, Chalmers Street and Alfred Street, which are busy CBD roads carrying high volumes of cars and pedestrians. There is also a need to manage buses at;
  - The intersection of Pitt Street, Eddy Avenue and Rawson Place
  - East-west routes that cross George Street primarily on Druitt Street
  - Chalmers Street
- Maintaining property access to CBD retail, residential and office buildings.
- Maintaining safety for all road users in and around the corridor.
- Providing emergency vehicle access in constrained locations in the George Street corridor.

TfNSW has identified the following construction phases in the CBD precinct:

- Enabling works, associated with relocation or protection of utilities and site preparation.
- Civil works comprising site establishment, excavation for the track slab and laying of slabs and track.
- Installation of overhead wiring or alternate power supply in key sections; and
- Platforms, systems and fit-out.

This CTTMS has sought to minimise the number of traffic and transport changes during construction to improve the customer experience and reduce uncertainty.

4.2.1. Construction Worksites and Access

Two construction worksites are proposed within the CBD:

- Within First Fleet Park, adjacent to Circular Quay; and
- Within Belmore Park, adjacent to Central Station.

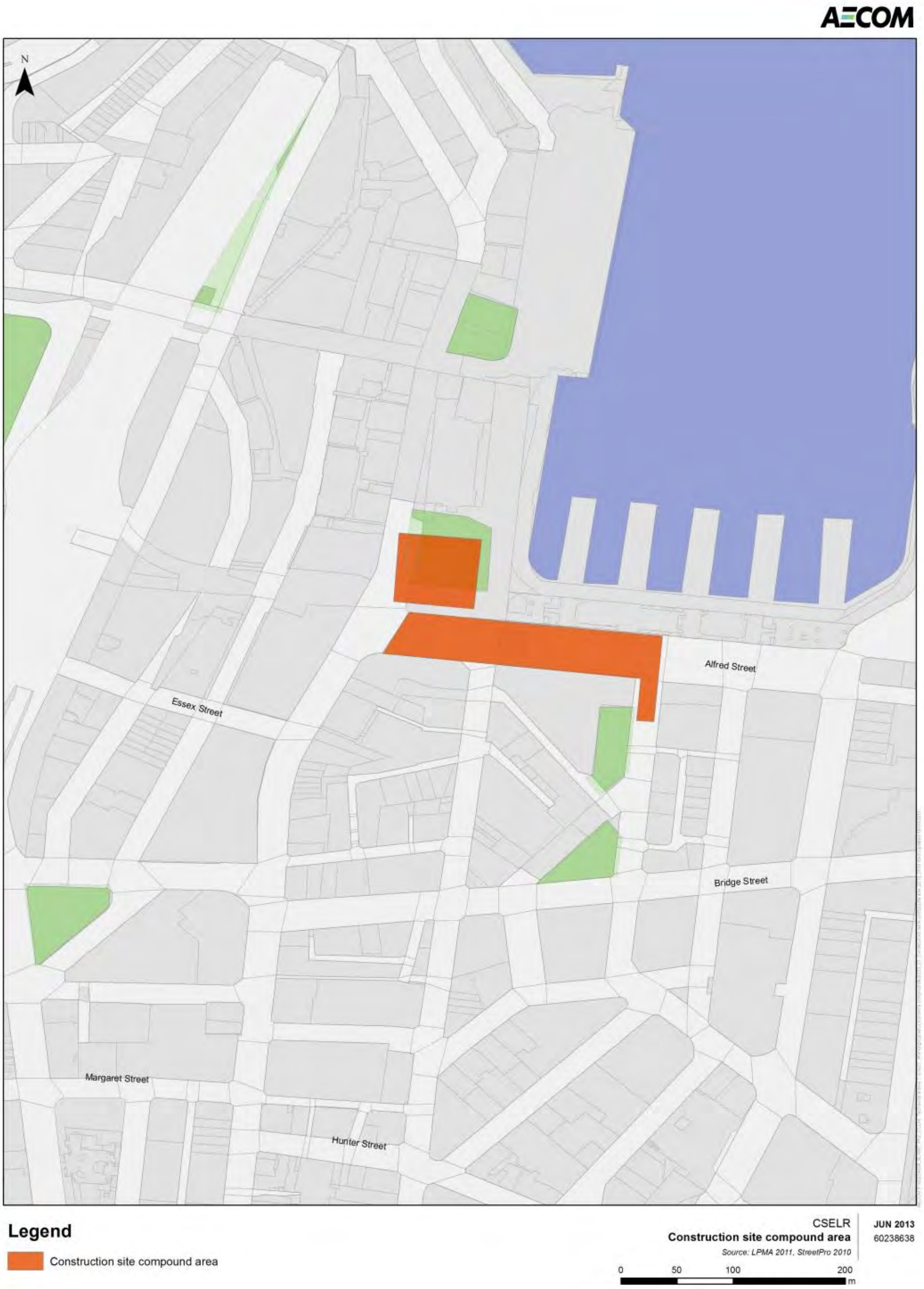
First Fleet Park Worksite

A northern worksite, of approximately 2,400 square metres, is proposed in First Fleet Park. An indicative location is shown in Figure 4-2. Vehicle access to the worksite would be:

- Harbour Bridge – via the Cahill Expressway, Bridge Street and Loftus/Pitt Streets.
- Anzac Bridge – The Rocks via Hickson Road
  - Construction vehicle parking is suggested along Alfred Street frontage continuing onto Loftus Street. This area would allow parking of construction vehicles for both the northern and southern CBD worksites.

No on-site parking is proposed for the construction workforce, who would be expected to utilise existing public transport. A potential option would be to provide remote parking on the stabling yard and shuttle transfer workers to site, which would depend on demand for this facility and the shift hours. Another option would be for the Contractor to establish long term leases, during the construction phase, of commercial parking spaces within the CBD.

Figure 4-2: Indicative Northern CBD Worksite – First Fleet Park

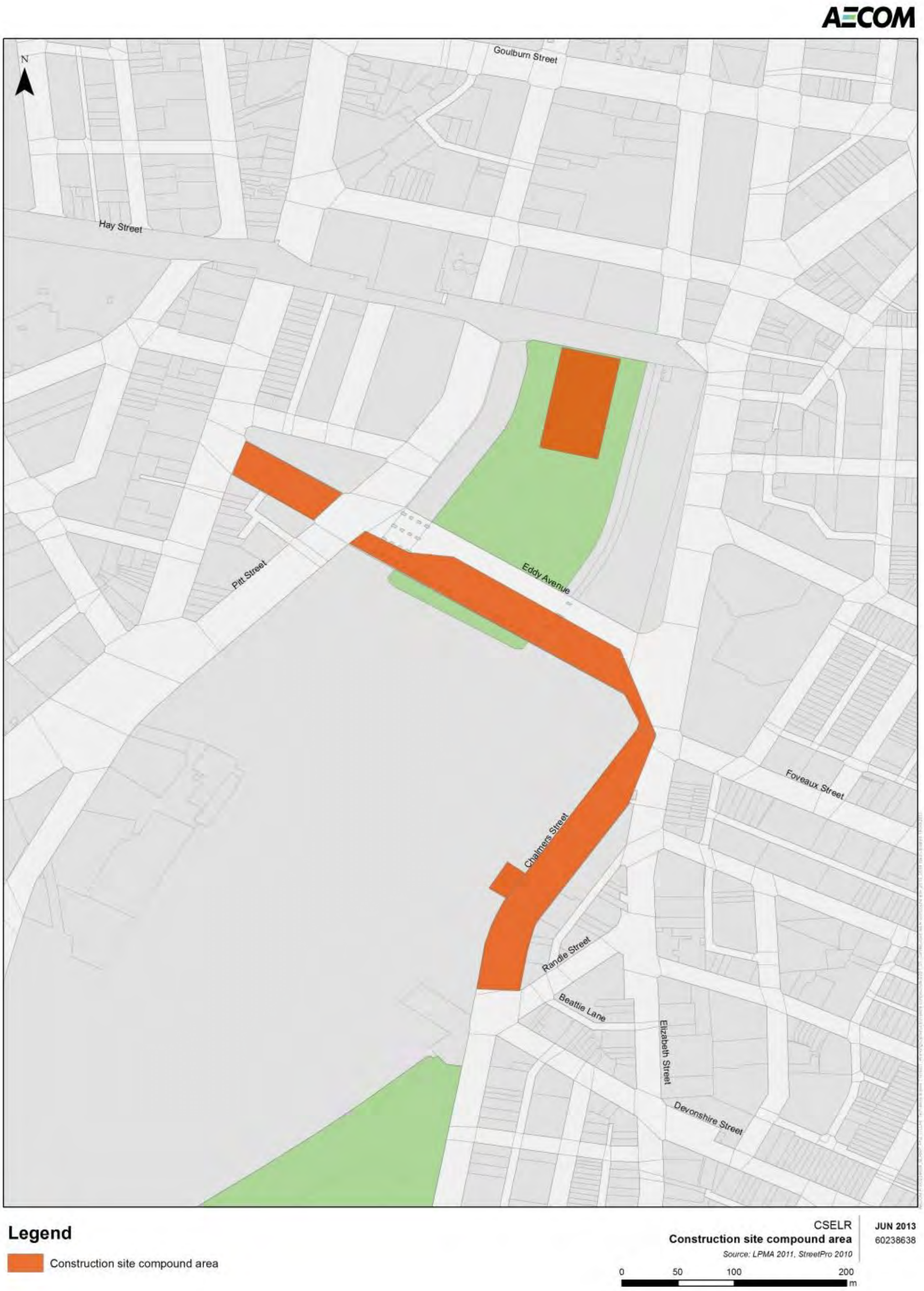


Belmore Park Worksite

A southern worksite, of approximately 3,200 square metres, is proposed in Belmore Park. An indicative location is shown in Figure 4-3.

The proposed worksite and access arrangements will be coordinated with the City of Sydney. Council's current proposals for upgrading the park may be impacted by the worksite and remediation of the worksite required on completion of the CSELR works.

Figure 4-3: Indicative Southern CBD Worksite – Belmore Park



Modifications would be made at the intersection of Pitt Street and Hay Street to allow heavy vehicles to access the worksite.

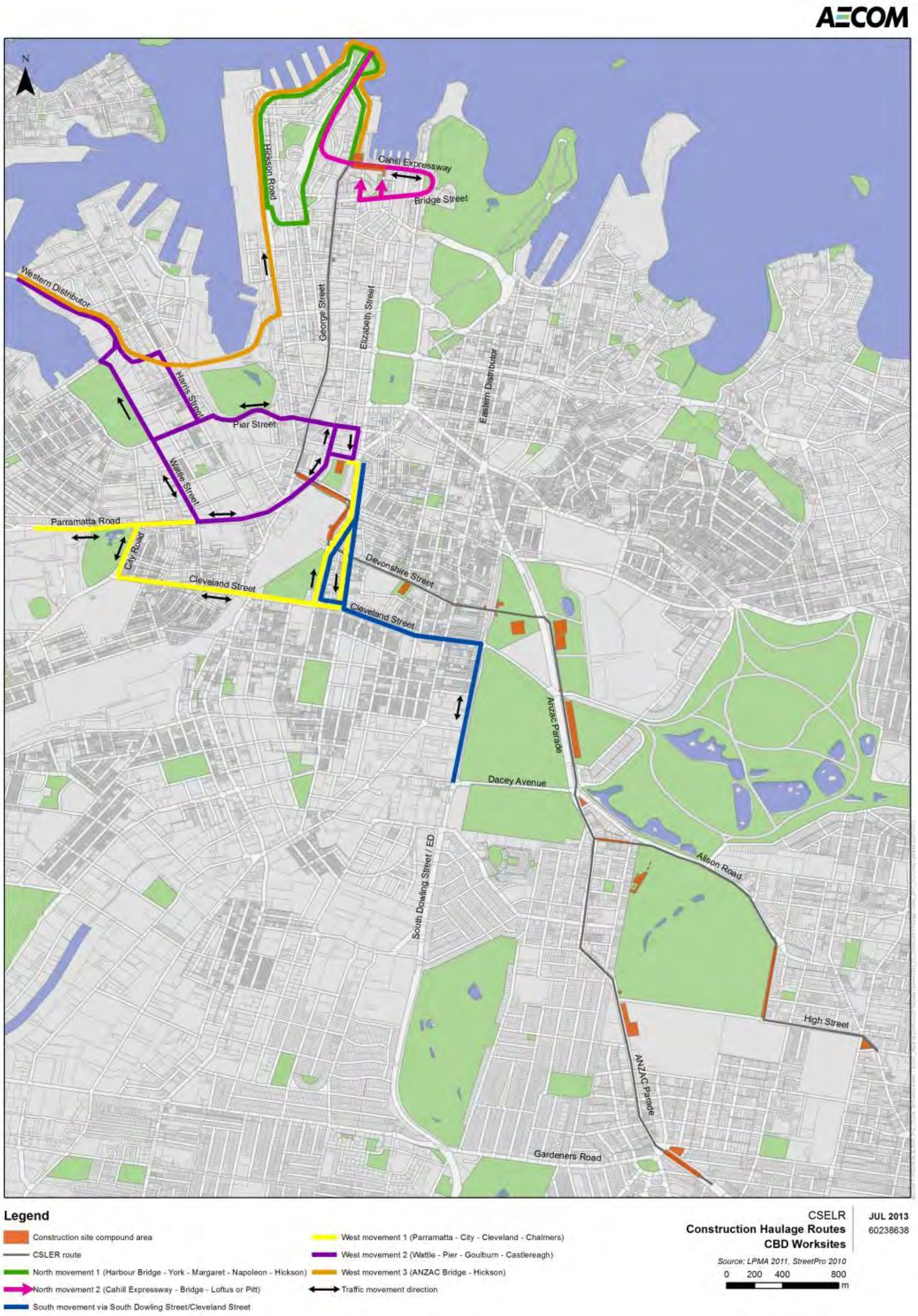
Vehicle access to the worksite would be:

- Harbour Bridge – no access is provided to this worksite from the north
- Anzac Bridge – via Pier and Harris Street or Broadway and Wattle Street
- Parramatta Road – via Elizabeth Street and Cleveland Street or Pitt Street and Broadway,

No on-site parking is proposed for the construction workforce, who would be expected to utilise existing public transport. An alternative arrangement would be to provide remote parking at the stabling yard and shuttle transfer workers to site, which would depend on demand for this facility and the shift hours.

The proposed haulage routes for the CBD worksites are shown in Figure 4-4. Where the current worksite activity permits, trucks from First Fleet Park or Belmore Park would travel through the George Street workzones.

Figure 4-4: CBD Construction Haulage Routes



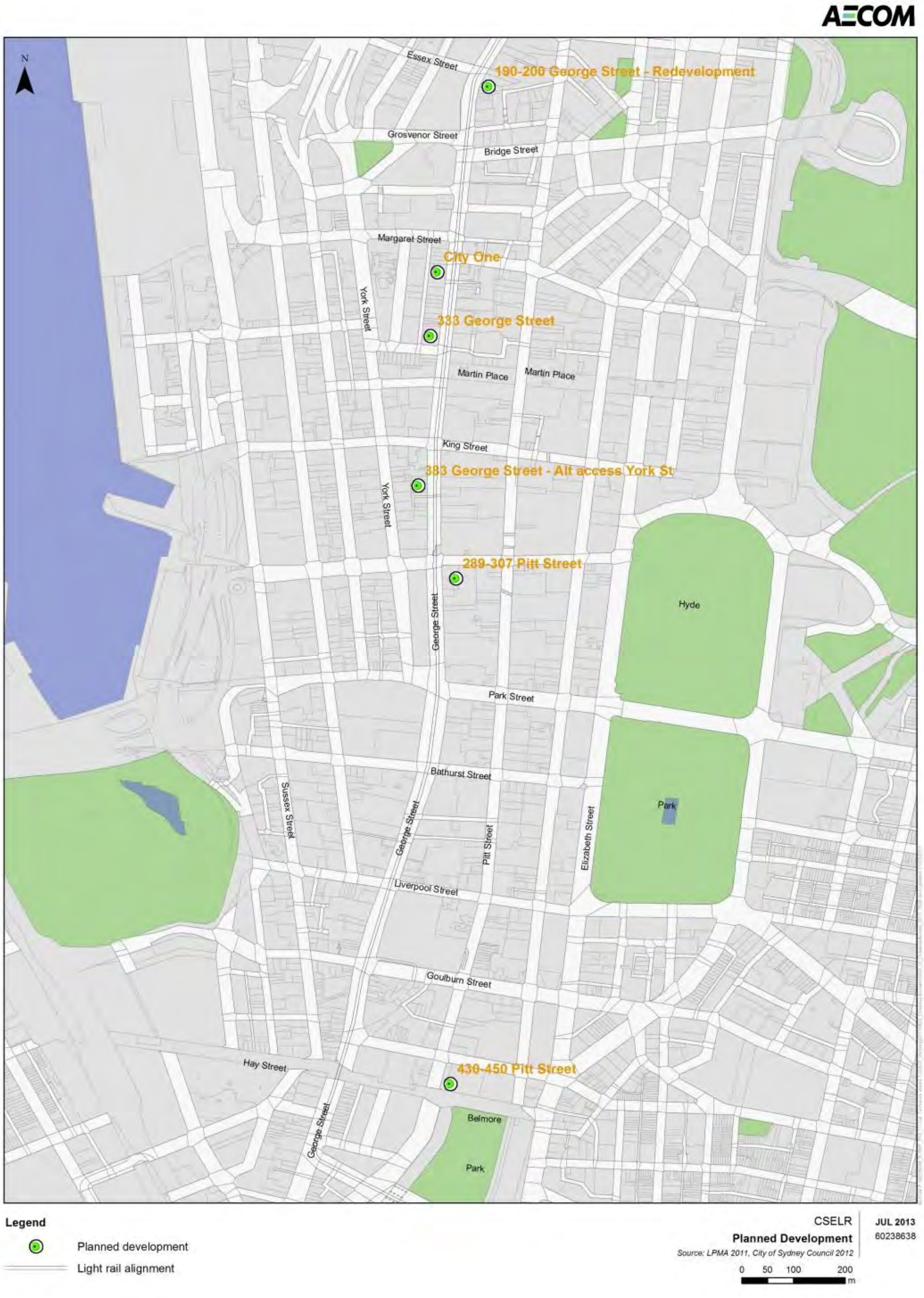
These haulage routes have been chosen due to their suitability for carrying heavy vehicles and direct access routes out of the CBD. Once trucks are dispersed onto on these major roads, the effects would be low (less than 250 trucks per day); less than 0.4% of existing daily traffic volumes on Parramatta Road and Anzac Bridge.

4.2.1.1. Other potential construction sites within the CBD

Six potential building construction projects have been identified adjacent to, or near, the CSELR project as shown in Figure 4-5. The Network Coordination Liaison Group would be consulted prior to approving any construction activities within the CBD. The traffic management plan for any construction within the CBD would include a cumulative assessment of traffic changes.

Other known projects include the upgrade of Wynyard, Town Hall and Central Stations, surface transport projects associated with the CCAS and the redevelopment of Barangaroo. The construction impacts of these projects would be considered by TfNSW in the planning processes for those projects.

Figure 4-5: Location of Current and Planned Redevelopment Sites



4.2.2. Rozelle Maintenance Facility

All vehicles associated with the CSELR and Inner West Light Rail (IWLR) will be maintained at the new integrated maintenance facility located at Rozelle Goods Yard in Lilyfield.

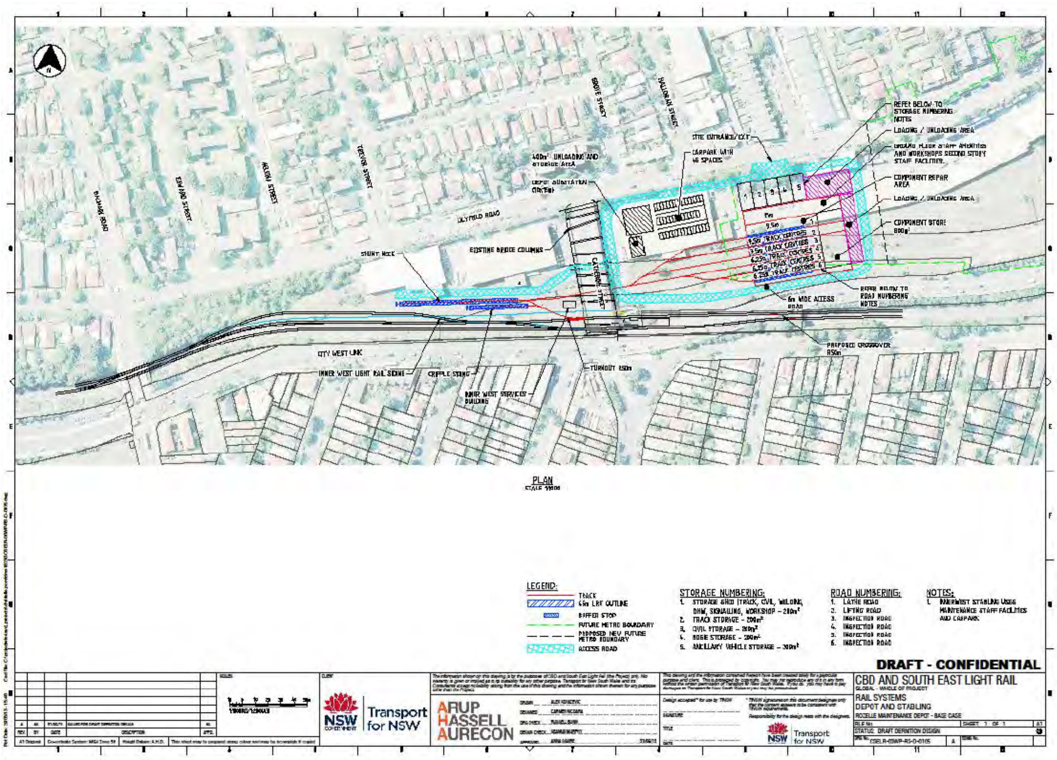
The existing IWRL maintenance and stabling facility at Pyrmont will be retained with IWLR vehicles stabled at both the existing Pyrmont facility and Rozelle. The CSELR vehicles will be stabled at a site adjacent to Royal Randwick Racecourse which will also be where the integrated Operations Control Centre (OCC) will be located. The CSELR vehicles will infrequently transfer to Rozelle via the IWLR system.

The construction worksite associated with the Rozelle Maintenance Facility will be limited to internal activities within the former goods yard at Rozelle. In developing the Rozelle Maintenance Facility, the following potential construction activities will be required:

- Vehicle crossing between the site and Lilyfield Road;
- Demolition of existing buildings;
- Paving and track work;
- Equipment installation; and
- Fit outs.

The Rozelle Maintenance Facility is illustrated in Figure 4-6

Figure 4-6: Maintenance Facility at Rozelle (Preferred Option) [21]



The site is located within the Rozelle Goods Yard with access proposed on the southern side of Lilyfield Road, to the east of Catherine Street. Access to the Rozelle Maintenance Facility would be via the existing vehicle access point on Lilyfield Road, which is designed to accommodate heavy vehicles turning to and from Lilyfield Road.

The existing maintenance workshops and facilities on the site would need to be demolished to accommodate the new depot / stabling yard. However, as the yard is located in an existing rail corridor, potential land contamination may require the site to be

[21] CBD and South East Light Rail, Operations Advisor, Final Fleet, Stabling Requirements and Operating Protocols (Draft, 31 July 2013) Figure 10.2.4

capped in preference to disturbing material and transporting from site. Therefore, consequences of raising levels on drainage would need to be assessed.

The construction activities associated with the maintenance facility include:

- **Site remediation**/Clearing and grubbing typically undertaken through the utilisation of standard earthmoving equipment.
  Any material hauled offsite to a suitable disposal location may need to be treated as contaminated waste.
- **Building demolition**: An area is set aside on the site in order to test, sort and stockpile material to minimise offsite disposal costs.
- **Detailed excavation** and other preparatory activities.
- **Form, reinforce, concrete pour works**: formworking and steel fixing crews.
- **Mechanical and electrical activities**: these will be undertaken through the utilisation of small crews.
- **Specialised packages** e.g. Locowash.

4.2.2.1. Rozelle Maintenance Facility Truck Movements

Traffic movements during construction are anticipated to be low due to the minor works required to adapt the existing site. While a detailed breakdown of truck movements by activity has not been undertaken at this stage, it is anticipated that at peak times, truck movements would not exceed 100 truck trips (two way movements) per day.

Existing industrial premises and the existing site uses generate truck movements on Lilyfield Road, suggesting that the proposed site would be compatible with current uses. Once established, traffic movements would be limited to the movement of staff vehicles, deliveries and staff undertaking inspections of the rail alignment. Movement of the light rail vehicles would occur infrequently via the existing IWLR tracks.

The existing driveway access to Lilyfield Road is designed for and historically accessed by heavy vehicle movements and capable of accommodating the future traffic demands proposed by the Rozelle Maintenance Facility. Therefore, the existing traffic facilities on Lilyfield Road, such as bicycle lanes and footpaths are unlikely to be affected during both construction and operation of the proposed maintenance facility.

4.2.2.2. Rozelle Maintenance Facility Haulage Routes

Lilyfield Road provides direct access to City West Link via Catherine Street and Balmain Road. Therefore the majority of heavy vehicles generated by construction of the maintenance facility would utilise City West Link. Staff may have more dispersed origins / destinations and travel on local roads, via Balmain Road / Catherine Street / Darling Street / Victoria Road to access local suburbs, such as Leichhardt and Balmain. The proposed haulage route for the Rozelle Maintenance Facility worksite is shown in Figure 4-7.

Figure 4-7: Haulage Routes for Rozelle

4.2.3. Traffic Management

The variability of cross section and access requirements on George Street, and the completion of intersection works on weekends, requires varying traffic management by street block and intersection. As such the principles of the CBD traffic management and construction strategy are:

- Implement end state transport arrangements, where appropriate, and compatible with construction requirements, e.g.
  - Diversion of bus services, moving towards the end state bus arrangements identified in SCCBP with the exception of services from the south east which would continue to operate.
  - Closure of minor side road junctions and laneways proposed for closure at end state.
  - Enhancements to east-west capacity of cross streets, where possible and required to mitigate long term changes to traffic patterns.
- Minimise traffic disruption by undertaking intersection works at weekends.
- Provide clearly defined pedestrian paths and fencing to separate the pedestrian path from the worksite and prevent random crossings.
- Review traffic signal operation for turning movement conflicts with pedestrians crossing at intersections and vehicles on access lanes and accessing worksites.
- Minimise the number of traffic changes to maximise the legibility of the network for the public, businesses and emergency services to simplify network operations.

  Maintain access past the worksites on George Street for local access and emergency services. These access corridors may be via open access lanes outside the worksite boundary or via controlled access lanes through the worksite.

  - The open access lanes may be used by construction vehicles, where the current activity prevents vehicles driving through the worksite. Pull–off areas, between gaps in barriers would be provided to allow construction vehicles to stand clear of the open access lanes. In sections of the corridor where this is not feasible and delivery requirements dictate vehicles to stand for an extended time, e.g. while unloading track sections, these deliveries would be made outside business hours. Generally open access lanes are only achievable in the southern CBD due to the wider road cross section.
  - The controlled access lanes through the worksite would be managed by traffic controllers. The location of the lanes would be shifted within the roadway to suit the current work zone. Generally controlled access lanes are proposed in the northern CBD between Alfred Street and Bathurst Street.
  - Through traffic in the CBD would be discouraged by public education, signs, traffic controllers and enforcement.

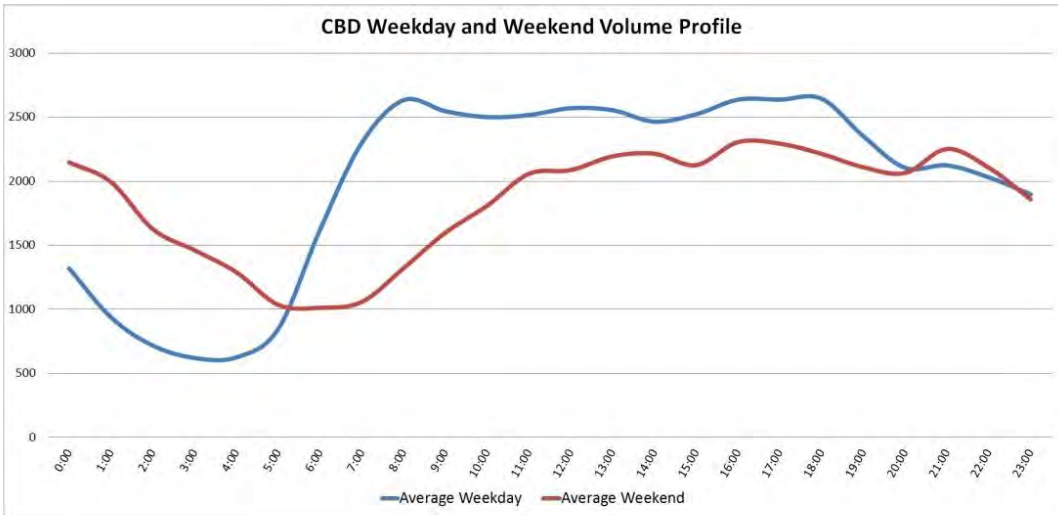
- Maintain property access based on a hierarchy of frequency of use and subject to agreement with property owners and business operators:
  - Infrequent access would be managed by traffic controllers on an ad hoc basis and/or scheduled deliveries outside work hours.
  - An access lane would be maintained for properties with frequent deliveries, such as the Westfield loading dock and car park access requirements such as 420 George Street.
  - Where feasible an open access lane would be retained for 24 hour property access. Where this is not feasible, traffic controllers would manage property access via controlled access lanes, 24 hours per day, or as otherwise required to meet the needs of frontage properties.
- Major intersections would be staged to maintain key traffic movements, e.g. Grosvenor Street / Bridge Street and Pitt Street / Eddy Avenue.
  - Other intersections would be closed at weekends and traffic diverted to alternate routes. The closure of these intersections would be conditional on the alternate route remaining open, e.g. Hunter Street westbound is open when Bridge Street westbound closed.
- Schedule disruptive major works to target times of lower traffic movement, e.g. Christmas New Year/ January; consistent with managing pedestrian movements, which may be higher at holidays times, e.g. in The Rocks/ Circular Quay, Chinatown areas.

4.2.3.1. Intersection works

All intersection works within the CBD would be undertaken during the weekend to minimise impacts on traffic movements. It is acknowledged that events often occur in the CBD during the weekend and as such any weekend work would require careful planning and close liaison with the City of Sydney. However, during major scheduled events such as City to Surf, Anzac Day and Sydney Running Festival, weekend works would not be permitted. Furthermore, there may be opportunities to undertake minor construction activities during weeknights.

An assessment of traffic volumes in the CBD has shown that peak weekend traffic volumes are approximately 88% of peak weekday traffic movements, this information is shown in Figure 4-8. Weekends provide the best opportunity for extended work shifts to complete the intersection works in an efficient manner.

Figure 4-8: CBD weekday & weekend traffic profiles (veh/hr)



Note: This data shows average George Street intersection traffic volumes at King Street; Market Street; Druitt Street; Liverpool Street; and Goulburn Street.

Source: NSW Roads and Maritime Services, 2013

Major intersection works would be staged to maintain key traffic movements at:

- Grosvenor Street at Bridge Street - Grosvenor Street eastbound movement would be maintained at all times (see Appendix B.1).
- Pitt Street at Eddy Avenue / Rawson Place would maintain through movements on Pitt Street. Completion of these intersection works is a prerequisite to enable diversion of bus routes from George Street to Pitt Street (see Appendix B.2).

Other intersections would be closed during weekends, during time periods specified in Section 2.5, and traffic diverted to alternate routes. Table 4-2 summarises the individual intersections and any conditions or works associated with the closure.

Table 4-2: Summary of Proposed Conditions for Intersection Closures

Intersection of George Street at	Condition of closure	Required works/issues to be resolved
Chalmers Street at Randle Street	Randle Street Open	▪ Reconstruct Chalmers Street/ Randle Street intersection for through movement to Randle Street, reversing existing southbound movement. ▪ Introduce contra flow (northbound) lanes on Elizabeth Street between Randle and Eddy Avenue. ▪ Modify geometry and traffic signal operation for northbound movement on Elizabeth Street at Eddy Avenue intersection. ▪ Review the geometry of the Randle Street to Elizabeth Street intersection to accommodate large vehicles turning left from Randle Street to Elizabeth Street northbound. ▪ Consultation with Council regarding access to Beattie Lane.
Pitt Street at Eddy Avenue	Pitt Street intersection works complete prior to bus diversion off George Street to Pitt Street.	▪ Introduce traffic and pedestrian management of bus routes/ stops and signal modification to permit George Street bus services to be transferred to Pitt Street, as per the SCCBP.
Rawson Place	Maintain eastbound and westbound through traffic on Eddy Avenue	▪ Maintain access to Sydney Central YHA & servicing on Rawson Lane. This would require some reversing of trucks, however initial discussions indicate this would be acceptable. ▪ Buses during construction would use stops located on Pitt Street, north and south of Eddy Avenue. ▪ Existing bus stops on Eddy Avenue remain operational.
Ultimo Road		▪ Maintain pedestrian crossing of George Street and stage crossing location, where necessary to suit current work zone. ▪ Maintain pedestrian access to existing signal pushbuttons or provide traffic controllers for short term works.

Intersection of George Street at	Condition of closure	Required works/issues to be resolved
Hay Street	Maintain light rail on weekdays. Temporary closure of LRT on weekends	▪ Maintain pedestrian crossings during the intersection works. ▪ Provide signage, traffic controllers and shuttle bus transfers for IWLR passengers ,where installation of turnouts, and commissioning of signalling at the junction, requires weekend closure of the existing IWLR and access to Central Station. ▪ Short running of the LRT during weekend closures would require shuttle bus transfers to connect to Central Station. Buses may be permitted to use Hay Street between Pitt Street and George Street and turn left onto George Street during this time, to permit LRT passenger transfer.
Goulburn Street	Liverpool Street open Bathurst Street open	▪ Provide advance warning and directional signage to redirect Goulburn Street traffic, e.g. Harris Street/Pier Street to Harbour Street to Bathurst Street (eastbound) or westbound on Liverpool Street or Park Street traffic to exit south (or north) on Harris Street. ▪ Maintain car park access to Goulburn Street frontage and two way traffic east of George Street. ▪ Monitor and where necessary control pedestrian movement at George Street intersection. ▪ Maintain bus access (EB) to Park Street.
Liverpool Street	Park Street-Druitt Street open	▪ Maintain Goulburn Street and Park Street open WB depending on required traffic capacity and split between CBD. ▪ Sign posting and advance warning
Central Street & Wilmot Street	Remain open-Access via Pitt Street	▪ Provide southbound service lane on George Street, between Wilmot and Central Street
Bathurst Street	King Street open	▪ Provide advance warning and directional signage of detour

Intersection of George Street at	Condition of closure	Required works/issues to be resolved
Park Street/ Druitt Street	Bathurst Street open. Market Street open	▪ Alternate CBD crossing could be achieved by promoting the CCT tollway. ▪ Divert CBD bus services eastbound to Bathurst Street. Consider staged intersection works to permit buses to turn right from George Street to maintain access to Park Street bus stops. Alternatively provide temporary bus stop on Bathurst Street, east of George Street. ▪ Divert general westbound traffic to Market Street. Maintain Liverpool Street as a secondary route, if additional capacity required. ▪ Stage intersection works to maintain single lane westbound bus only movement through intersection
Market Street	Druitt Street open Liverpool Street open	▪ Divert CBD bus services eastbound to King Street, southbound on York Street and QVB terminus. ▪ Manage pedestrian crossings near Town Hall Station. Entertainment precinct to the south would contribute to extended hours of pedestrian activity for weekend works. ▪ Maintain Goulburn Street as a secondary route to Liverpool Street, subject to required capacity.
King Street	Bathurst Street open	▪ Maintain Bathurst Street eastbound ▪ Promote Grosvenor Street eastbound (in lieu of King Street) for Sydney Harbour Bridge traffic. ▪ Provide advance warning and directional signage to redirect diverted traffic
Hunter Street	Bridge Street open	▪ Maintain Bridge Street westbound. Provide advance warning and directional signage to redirect diverted traffic.
Margaret Street	Bridge Street WB open Jamison Street open, with single NB lane on George Street maintained	▪ Maintain Bridge Street to the north or Market Street as secondary route, if additional capacity required. ▪ Implement staged intersection works (four stages) as required for Hunter Street to Margaret Street section of George Street. ▪ Maintain access to Jamison Street during Margaret Street closure, where sequence of intersection works permits.

Intersection of George Street at	Condition of closure	Required works/issues to be resolved
Bond Street	Closed- two way access to Pitt Street	▪ Directional and intersection signage.
Jamison Street	Entry from controlled access lane	▪ Directional and intersection signage. ▪ Two way movement on Jamison Street and traffic signal modifications at York Street
Bridge Street	Hunter Street WB is open, if Bridge Street WB closed Margaret Street open	▪ Maintain Hunter Street to Margaret Street westbound connection as alternate route with George Street open between Hunter and Margaret Street
Dalley Street	Closed. Two way access to Pitt Street	▪ Provide two way movements on Pitt Street.
Grosvenor Street	Grosvenor Street EB open	▪ Stage intersection works to maintain two lanes on Grosvenor Street eastbound at all times.
Essex Street	Access via Harrington Street at Grosvenor Street maintained	▪ Modify kerb extension at Essex Street / George Street corner to facilitate left turn from Essex Street to open access lane.
Blue Anchor Lane	Access via Essex Street and northbound open access lane	▪ Access to and from the northbound open access lane on the western side of George Street. ▪ Managed access across worksite required.

Intersection of George Street at	Condition of closure	Required works/issues to be resolved
Alfred Street / Circular Quay Station	Pedestrian access maintained	▪ Direct pedestrians on Alfred Street to the southern edge. ▪ Contain southbound pedestrians from The Rocks George Street North to the western footpath of George Street or via the foreshore to Circular Quay. ▪ Convert Pitt Street north of Bridge Street to two way traffic. ▪ Provide approach from Bridge Street at Loftus Street and right turn northbound, to Reiby Place as through site link to Pitt Street. ▪ Provide U-turn facility on Pitt Street, south of Alfred Street ▪ Maintain pedestrian access around foreshore between Circular Quay and Overseas Passenger Terminal and The Rocks beyond.
George Street North	Northbound lane on George Street, north of Essex Street U-turn facilities	▪ Provide roundabout at George Street/Alfred Street for U-turn for trucks up to 8.8m length. ▪ Provide work site driveway on George Street North. Accommodate 3-point turn for larger trucks (>8.8m) at site driveway on George Street. ▪ Maintain access to Four Seasons Hotel port cochere from northbound open access lane on George Street ▪ All exit via Alfred Street roundabout to George Street north/ Hickson Road. ▪ Alternate rear access on Harrington Street to hotel is feasible, but less attractive.

4.2.3.2. Detour Routes during intersection closures

The proposed detour routes for intersection closures are shown in Appendix D.

4.2.4. Property Access

Existing properties with access to car parking or loading docks adjacent to the light rail corridor are shown in Figure 4-9.

Figure 4-9: Location of Existing Driveways on George Street

Loading dock and servicing access for existing premises would be maintained. Consultation with property owners would be undertaken to fully understand servicing requirements, but measures would need to include:

- Provision of an access lane and sufficient manoeuvring space for required vehicle turning movements into driveways. This would be dictated by the alignment of travel lane through worksite, current worksite activity and vehicle types requiring service access.
- Scheduling deliveries outside work hours, when active worksite is across driveway would be considered, where feasible; and
- Managing access through worksite by traffic controllers.

To maintain this access, open access lanes or controlled access lanes have been provided on George Street. When determining required lane widths, consideration would need to be given to the potentially constrained environment due to barriers or pedestrian fencing on both sides and the geometry required for vehicles to access each driveway. As a minimum these lanes are to be in accordance with RMS Traffic Control at *Work Sites Manual Version 4.0.*

4.2.5. CBD Construction Zone 1: Alfred Street

The construction strategy proposes to close Alfred Street to traffic between Loftus Street and George Street to allow the First Fleet Park worksite to be connected to the CSELR alignment. This is consistent with the end-state design.

4.2.5.1. Driveway Access

There are no properties with driveways on Alfred Street.

Goldfields House with frontage to the southern side of Alfred Street has a construction access driveway on George Street, the driveway will not be required once refurbishment of the building is completed, which is anticipated prior to the start of CSELR works.

Businesses on the northern side of Alfred Street would be serviced from either Pitt Street or Alfred Street to the east of Loftus Street.

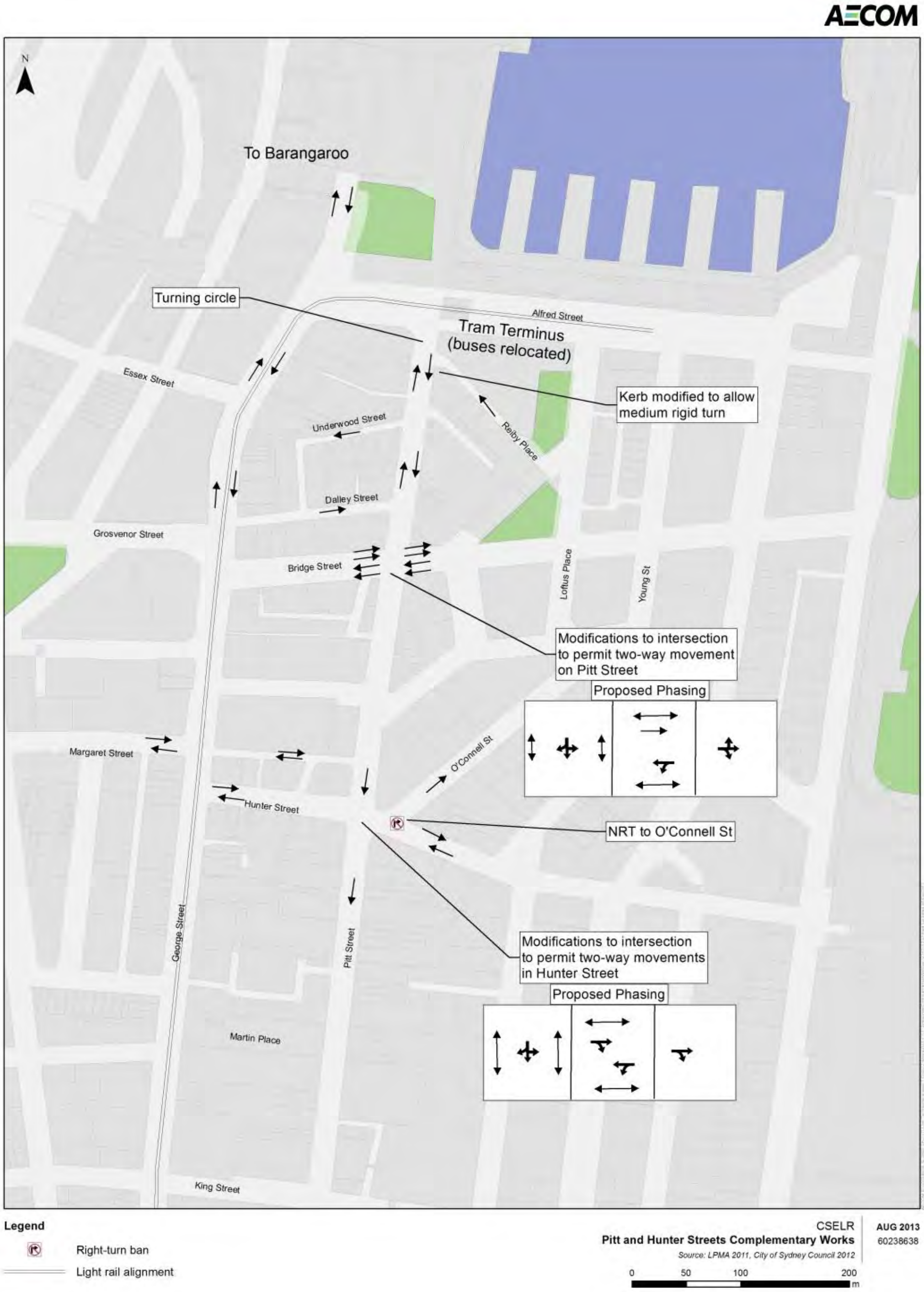
4.2.5.2. Local road network changes

The proposed changes are shown in Appendix C (sheet 1).

Pitt Street would be converted to two way traffic north of Bridge Street to allow for local property access. Access from the east would be via Loftus Street and Reiby Place. The proposed changes to traffic conditions on Pitt Street are shown in Figure 4-10.

Northbound vehicles on Pitt Street would be able to turn around prior to the worksite and exit southbound. The proposed turning head has a diameter of 40m, as shown in Appendix C, which will accommodate up to medium size trucks. For larger vehicles a three point turn would be required. The turning head is located within Herald Square, which will impact the pedestrian footpath, but will not require property acquisition.

Figure 4-10: Proposed Traffic Management for Pitt Street



George Street provides a connection for CBD traffic into The Rocks. During construction, alternate routes would include:

i. Sussex Street - Hickson Road (in both directions).This route would also service the Overseas Passenger Terminal via the upper level concourse or access controlled road opposite Argyle Street;

ii. Kent Street to Argyle Street or Lower Fort Street (inbound) to Cumberland Street or Harrington Street; and

iii. Cumberland Street or Harrington Street (outbound) to Grosvenor Street / Bridge Street or Jamison Street.

A precinct access map for The Rocks is provided in Appendix A.1.

George Street will be closed to southbound traffic at Albert Street. A temporary roundabout is proposed at the George Street / Alfred Street intersection to allow U-turn movements for these these vehicles. The geometry of the roundabout would limit vehicle size to a small / medium truck up to 8.8m long. Larger trucks would need to make a three point turn using the driveway access to the First Fleet Park worksite under traffic control.

With these measures in place, access to The Rocks would be retained at all times. Hickson Road, as the main access route, would experience an increase in congestion, which would likely occur at the traffic signals under the harbour bridge which control a section of one-way traffic movement. A review of current peak hour traffic, exiting The Rocks southbound, at Alfred Street shows about 400 peak hour vehicles. If it is assumed all of this traffic travels north along Hickson Road to exit The Rocks, a total of approximately 600 vehicles per hour can be expected on Hickson Road. Based on the available green time at the signals sufficient capacity can be maintained. In addition, the travel demand management measures put in place during construction would further reduce demand from existing levels. Initial network modelling has shown that traffic speeds along Hickson Road, during construction, would remain at similar levels to existing conditions, thus suggesting that sufficient capacity would be maintained along Hickson Road.

4.2.6. CBD Construction Zone 2: George Street between Alfred Street and Jamison Street

4.2.6.1. Driveway Access

The majority of properties in this section are serviced via laneways.

The Four Seasons Hotel has a port cochere on the western side of George Street. The hotel also has a back of house arrivals area on Harrington Street for tourist coaches.

Two options exist for providing access to the hotel:

- Providing a northbound lane within George Street;
- Temporarily relocating port cochere activities to Harrington Street.

This CTTMS has assumed providing a northbound lane in George Street would have least impact on the hotel operations and has therefore been assumed as the preferred option. All vehicles exiting the hotel would be required to travel north via George Street through The Rocks.

The northbound lane would be established between Essex Street and Alfred Street by removing kerb indents and an existing taxi bay. Access into the open access lane would be via Essex Street. Depending on the stage of work, it will be feasible to retain some taxi parking adjacent to the access lane. When work on the track slab is occurring at the site frontage, an alternate taxi parking area could be made available on Harington Street

Two sites are being redeveloped in this section of George Street. Goldfields House at the southern corner with Alfred Street and the Mirvac redevelopment at 190 George Street.

Goldfields House

Goldfields House is located at the corner of Alfred Street / Herald Square and George Street. This building is being refurbished and has temporary access to George Street, as shown in Figure 4-11. The site has access to Pitt Street for car parking and loading, and no proposed access to George Street in the approved development application.

Figure 4-11: Temporary George Street Driveway at Goldfields House

190 George Street

190 George Street (opposite Essex Street) is being redeveloped with hoardings erected on the George Street frontage. There is currently no driveway to George Street, although a potential construction access is available via Crane Place, a small narrow laneway adjacent to the site, but with no driveway crossover to George Street. A construction zone on George Street has been approved until 2015; requirements for worksite access would be confirmed in discussions with building owners.

Access to and from Essex Street would be feasible, given the site location opposite Essex Street, with a crossing through the worksite maintained.

4.2.6.2. Local road network changes

Blue Anchor Lane

Blue Anchor Lane (located at CH 2740) is on the eastern side of George Street and permits servicing of properties fronting George Street and is shown in Figure 4-12.

Access would be maintained with entry and exit to the northbound travel lane on the western side of George Street. This would require access across the construction zone; depending on the work stage, a road plate may be required to provide continuous access.

Figure 4-12: Blue Anchor Lane

Dalley Street

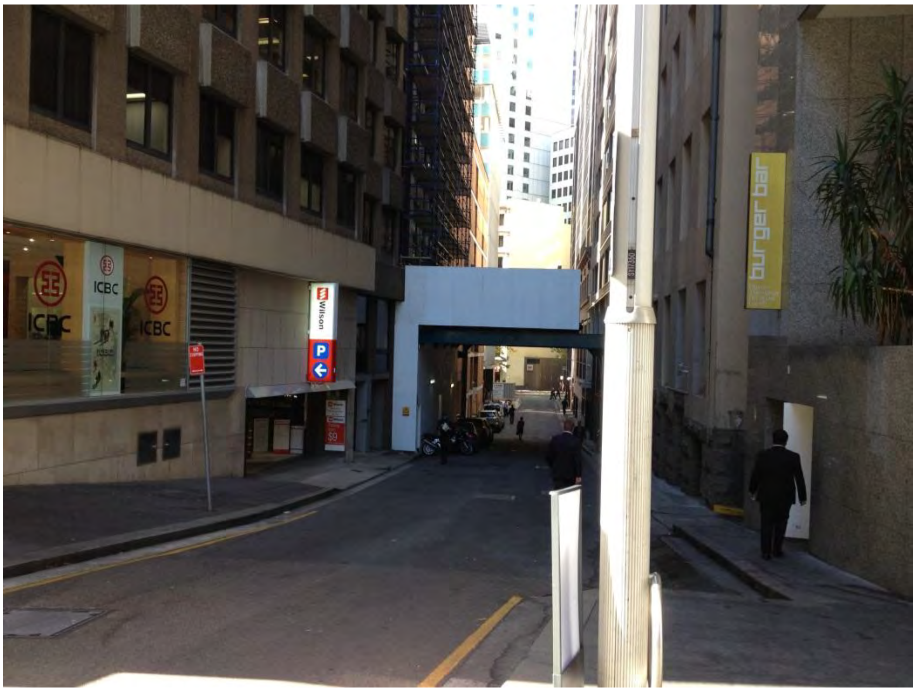
Dalley Street is a one-way eastbound street immediately to the east of George Street, although drivers were observed accessing the car parking station, shown in Figure 4-13, westbound on Dalley Street. Dalley Street would be closed at George Street with entry/exit movements provided via Pitt Street.

Dalley Street intersects with a one way east-south bound loop road, Underwood Street from Pitt Street. It is proposed to retain this one way loop with the section of Dalley Street between Underwood Street and George Street becoming two-way. Drivers needing to access the section of Dalley Street between George Street and Underwood Street would be limited to the parking station and informal loading, where drivers would be able to utilise the existing premise or driveways to turn around. However 'No stopping" signposting of the western end of Dalley Street would provide a temporary turn-around facility for cars.

A controlled southbound access lane on George Street is proposed with entry from Essex Street. Alternate access arrangements, under traffic control, may be considered to maintain left turn entry to Dalley Street.

The width of the street is adequate for two-way movements, although removal of kerbside parking could be considered to provide additional capacity, should this prove desirable.

Figure 4-13: Dalley Street



Jamison Street

Jamison Street is located to the west of George Street. It is currently one-way westbound with access from George Street.

The George Street entrance to Jamison Street would be closed during construction and access and egress would be provided via York Street. A turn-around facility would be provided for vehicles on Jamison Street.

Temporary changes would be required to the signalised intersection of York Street / Jamison Street to facilitate access and egress to Jamison Street.

The proposed changes are shown in Appendix C (sheet 2).

4.2.7. CBD Construction Zone 3: George Street between Jamison Street and Barrack Street

4.2.7.1. Driveway Access

No direct property access is provided onto George Street. Access to properties in this section is via adjacent streets and laneways, as described in the following section.

4.2.7.2. Local road network changes

Bond Street

Bond Street, shown in Figure 4-14, is proposed to be closed at George Street, with "No Stopping" restriction proposed prior to George Street, to permit cars and vans to turnaround for entry and exit to Pitt Street.

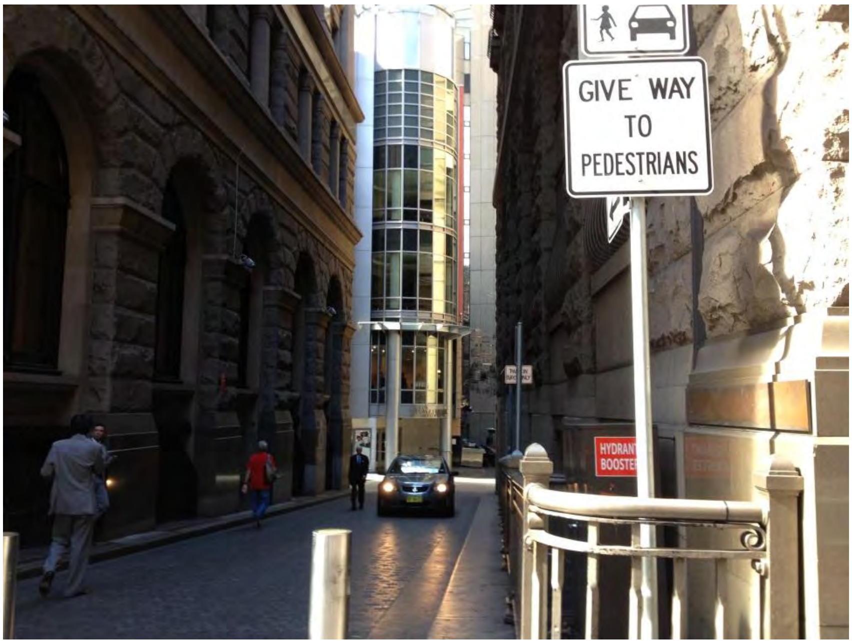
The proposed changes are shown in Appendix C (sheet 3).

Figure 4-14: Bond Street, looking east at George Street

Angel Place

Access to Angel Place (located at CH2200), shown in Figure 4-15, would be from the controlled access lane on George Street, with exit to Pitt Street, as permitted under existing conditions. An alternative would be to close the George Street access with entry from and exit to Pitt Street as there are no property access on the western section of Angel Place, which would permit 'No Entry' signage to be installed at the Ash Street junction. The narrow width of the lane would make U-turns difficult unless the side road junction at Ash Street or driveways could be utilised. The preferred arrangement will be subject to negotiation with adjacent property owners and businesses.

Figure 4-15: Angel Place looking east at George Street



Barrack Street

Barrack Street, shown in Figure 4-16, is located to the west of George Street. It is currently a shared zone, with access via York Street and one-way eastbound movement to George Street.

The exit to George Street is proposed to be closed during construction, requiring Barrack Street to be two-way with access and egress to York Street. Cars and small delivery vehicles would be able to turn around in Barrack Street. Consideration may be given to scheduling early morning deliveries to business premises in this section. Any contingency arrangements would be subject to negotiation with business owners.

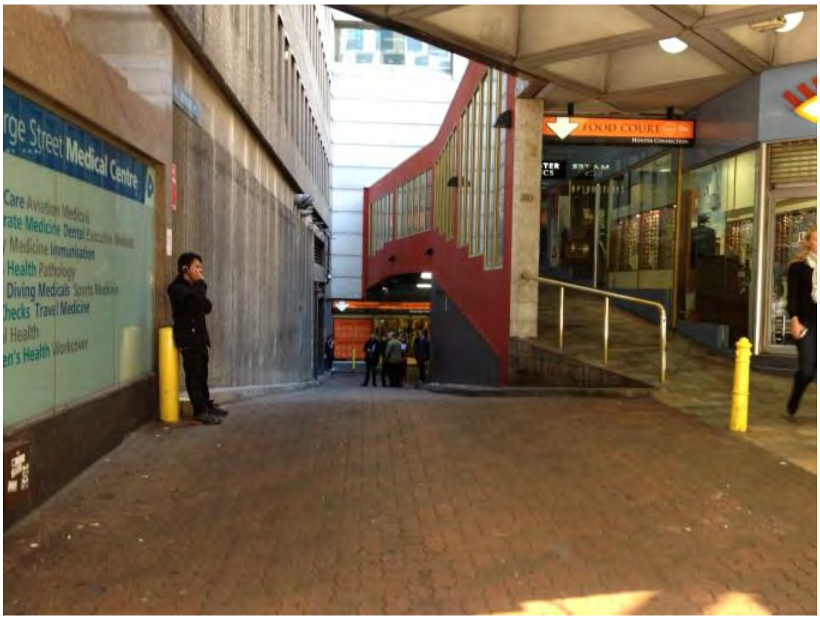
Figure 4-16: Barrack Street looking west at George Street

De Mestre Place

De Mestre Place, (located at CH2290), is proposed to operate as left-turn entry and exit to George Street with a southbound controlled access lane provided between Hunter Street and King Street. Demestre Place currently services the Hunter Connection loading docks as shown in Figure 4-17.

Based on the likely driveway geometry and available lane width it may be necessary to limit the size of truck to a maximum of 8.8m length. This would be adequate for typical small to medium trucks, which currently service the lane and would be confirmed in discussions with business owners.

Figure 4-17: Demestre Place access to Hunter Connection loading dock



4.2.8. CBD Construction Zone 4: George Street between Barrack Street and Market Street

4.2.8.1. Driveway Access

This section of the CBD construction zone has the highest demand for access to properties. Surveys in the section between King Street and Market Street have indicated approximately 300 vehicles arrive and 290 vehicles depart this zone between 7.00am-7.00pm (City of Sydney, 2010). A breakdown of the vehicle movements by driveway is shown in Table 4-3.

Table 4-3: King Street to Market Street driveway movements[22]

Access	Vehicles In (7am-7pm)	Vehicles Out (7am-7pm)	Vehicle types
Westfield	201	186	▪ cars / utes / vans (76%) ▪ small to large rigid trucks (23%) ▪ articulated trucks (a few per day)
420 George Street / Mid City	77	104	▪ cars / utes / vans (67%) ▪ small to large rigid trucks (33%)
Dymocks	22	0	

A southbound controlled access lane is proposed on the eastern side of George Street, between King Street and Market Street, to provide access to these properties. The location of the access lane would be varied to suit the current work location.

Depending on the current work zone and proximity of the access lane to the eastern kerbline, access to 420 George Street, Dymocks and GPO / Westin Hotel may be restricted to 8.8m long vehicles at times, due to geometric constraints and available lane width.

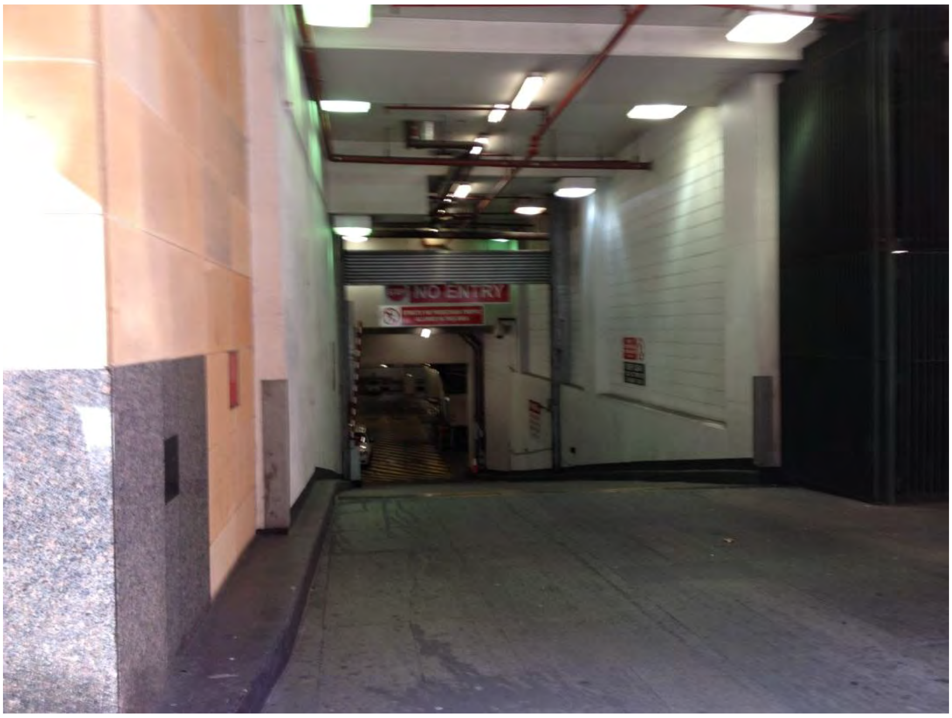
Figure 4-18 shows the GPO / Westin hotel loading dock driveway.

The 8.8m vehicle restrictions would be adequate for typical mail vans and medium sized trucks. The site also has other driveway(s) accessed from Pitt Street, which offer a viable alternative, where exit movements can be accommodated.

Further south, on approach to the Market Street intersection, the road cross section widens for the right turn lane from George Street to Market Street. The driveway to Westfield loading docks, Tower Apartments and Swisshotel is located in this section. The wider access lane enables larger vehicles to service the Westfield loading dock; however, depending on the work area, these may be limited to 12.5m rigid trucks.

[22] *Sydney CBD George Street Driveway Surveys, ROAR Data Pty Ltd for City of Sydney Council, 4 August 2010*

Figure 4-18: GPO/Westin Hotel loading dock driveway south of Martin Place



4.2.8.2. Access changes to minor side roads

Temperance Lane would be closed to traffic and no access provided, which is consistent with the City of Sydney's laneways program.

The proposed changes are shown in Appendix C (sheet 4).

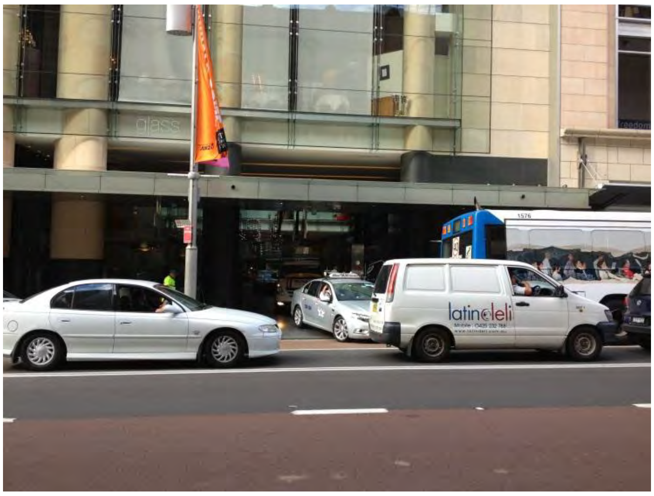
4.2.9. CBD Construction Zone 5: George Street between Market Street and Bathurst Street

4.2.9.1. Driveway Access

Hilton Hotel (exit only)

The Hilton Hotel driveway on George Street caters for exiting vehicles only, as shown in Figure 4-19.

Figure 4-19: Hilton Hotel Exit driveway from port cochere



An alternate option of providing an on street facility at the Pitt Street frontage for pick-up set-down of patrons was considered. However the driveway access can be maintained to George Street, with a southbound controlled access lane provided between Market Street and Park Street.

Taxis and hire cars exiting the hotel would be permitted to turn left into the Park Street bus lanes, whilst general traffic would proceed southbound to Bathurst Street.

Energy Australia loading dock access

An existing loading dock access to the Energy Australia building is located on George Street, south of Park Street. This building is currently vacant and the dock gated at the time of inspection. The building has a separate car park access off the Bathurst Street frontage. However, the loading dock access to George Street would be maintained during construction. The wider cross section in this section of George Street permits a southbound controlled access lane to be maintained.

St Andrews/ Town Hall forecourt driveway

A driveway is located on the western side of George Street which provides access to the St Andrews / Town Hall House forecourt areas. Lockable bollards generally prevent access during the day. This access would not be maintained during construction. Alternate access is provided via a gated driveway located on Bathurst Street, west of George Street. It is proposed that the Bathurst Street access would be used, subject to prior agreement with St Andrew's Cathedral staff.

478 George Street (former Mick Simmons building),

A development application for this site proposes a new 16 storey office building with retail on the lower level and upgrades to the existing State Theatre Annex Building.

Access is via a work zone in a temporary, indented parking bay in the George Street footpath, which permits vehicles to stand and unload material without obstructing the George Street Bus Lane.

The works zone will not be available on major event days (including New Year Eve and Day, Australia Day, etc) and no construction activity will occur during December.
The controlled access lane will be available for access to the indented work zone, however the building owners and contractor will be consulted to coordinate work and access requirements, particularly for the time when CSELR works are in this section of George Street.

4.2.9.2. Local road network changes

There are no changes proposed to side roads in this section.

The proposed changes are shown in Appendix C (sheet 5).

4.2.10. CBD Construction Zone 6: George Street between Bathurst Street and Goulburn Street

The cross section in this section of George Street widens to 15.3m, which will generally permit an open access lane to be maintained for both the northbound and southbound travel directions.

4.2.10.1. Driveway Access

No driveways have direct access to George Street in this section.

4.2.10.2. Local road network changes

The proposed changes to side road operations in this section are outlined below.

Wilmot Street and Central Street

The existing one way movement on Wilmot Street and Central Street would be reversed with Wilmot Street becoming one-way westbound and Central Street one way eastbound. This requires a southbound lane to be maintained on George Street for circulation between Wilmot Street and Central Street.

In this section of George Street a southbound controlled access lane will maintained between Bathurst Street and Liverpool Street. This access would need to be managed for the duration of work on utility adjustments and track slab and track laying. Once this work is completed an open access lane would be available. The width of the lane and turning geometry onto George Street may limit the truck size to 8.8m at times; this limitation would need to be agreed with businesses using the lane, including NSW Police.

Ultimo Road

Ultimo Road is proposed to be limited to left in left-out traffic movements via the northbound open access lane on George Street.

Hay Street

The operation of the inner west light rail would be maintained during weekday hours, with the intersection constructed over five weekends, when there would be disruptions to services. Pedestrian movements at the intersection would be managed by traffic controllers, particularly at weekends when Daring Harbour and Paddy's Markets generate increased activity.

The proposed changes are shown in Appendix C (sheet 6).

4.2.11. CBD Construction Zone 7: George Street between Goulburn Street and Barlow Street

The cross section in this section of George Street widens to 17.6m, which permits an open access lane to be maintained for both the northbound and southbound travel directions, outside the work area.

4.2.11.1. Driveway Access

A small off-street car park is currently accessed via a driveway adjacent to the Central Baptist Church on the western side of George Street. Access to the northbound lane would be available with left-in left-out access.

4.2.11.2. Local road network changes

Campbell Street

Current one way westbound movement on Campbell Street will be maintained with left-out to the southbound open access lane on George Street. Peak hour right-turn movements out of this intersection are currently limited to 70-100 vehicles per hour, and an alternate northbound route is available via Pitt Street.

The proposed changes are shown in Appendix C (sheet 7).

4.2.12. CBD Construction Zone 8: Rawson Place and Eddy Avenue

Managing pedestrian crossing opportunities for the substantial volume of pedestrians crossing Eddy Avenue to access bus stops or continue through Belmore Park would be an important issue during construction. Staged works would be necessary to maintain the crossing locations. In association, this requires relocation of temporary traffic signal control.

4.2.12.1. Driveway Access

Access to a small number of car parking spaces and loading facilities at the Eddy Avenue frontage to Central Station is proposed to be maintained by progressively shifting driveway crossovers as construction work proceeds. Access to these driveways are proposed to be facilitated from the kerbside lane of Eddy Avenue.

4.2.12.2. Local road network changes

Rawson Place

Rawson Place would be closed to all traffic.

Rawson Lane

Rawson Lane current extends between Pitt Street and Rawson Place. It is proposed to close the lane at Rawson Place, which is consistent with end state proposals. Consultation with City of Sydney Council indicated concurrence with this approach. Service vehicles have been observed to turn within Rawson Place, although larger vehicles may need to reverse in and out.

Eddy Avenue

Eddy Avenue, shown in Figure 4-20, (and Chalmers Street) are closely linked to Central Station and associated interchange between rail, bus, coach, taxis and light rail. The proposed Eddy Avenue works would remove existing coach parking, along the southern kerbline at the railway frontage.

The Eddie Avenue coach facilities are proposed to be relocated to the Western Forecourt on Lee Street and Chalmers Street.

The existing bus operations along Eddie Avenue would continue during construction, in particular the university express services would be maintained on Eddie Avenue during construction works along Eddie Avenue.

Figure 4-20: Eddy Avenue looking west toward Pitt Street (coach bays on aisle to the left)

The proposed changes are shown in Appendix C (sheet 8).

4.2.13. CBD Construction Zone 9: Chalmers Street between Eddy Avenue and Devonshire Street

4.2.13.1. Driveway Access

Access to the existing driveway for the Sydney Trains car park adjacent to the Devonshire Street portal would be retained with entry via Chalmers Street (south) and exit via Randle Street.

4.2.13.2. Access changes to minor side roads

Access to Beattie Lane via Randle Street would be maintained; although reversal of Randle Street (see Section 4.2.6.3) would affect approach routes.

4.2.13.3. Local road network changes

It is proposed to reverse the operation of Randle Street and provide two northbound lanes in Elizabeth Street (as shown in the proposed concept sketch in Figure 4-21 to facilitate northbound traffic movements during the closure of Chalmers Street.

This requires works to be undertaken at the following intersections prior to commencement of the main works in Chalmers Street:

- Elizabeth Street / Eddy Avenue / Foveaux Street;
- Devonshire Street / Randle Street / Chalmers Street; and
- Randle Street / Elizabeth Street.

Figure 4-21: Elizabeth and Randle Street Modifications

As shown in Figure 4-21, the intersection of Randle Street and Elizabeth Street would require adjustment of the layout to accommodate dual left turn movements onto Elizabeth Street, especially for buses travelling from Chalmers Street to Elizabeth Street.

The proposed changes are shown in Appendix C (sheet 9).

4.2.14. Parking and Loading Zones

As a primary north-south bus route, on-street parking on George Street has been removed together with the majority of driveway access, where properties have viable alternate frontages. No provision for on-street parking or loading along the light rail corridor during construction is proposed. Loading zones would be provided on adjacent side streets where possible with potential locations for mitigation measures provided in Table 4-4.

Table 4-4: Loading Zone mitigation

CBD Loading zone Mitigation
Network changes to intersections along the George Street corridor provide an opportunity to mitigate the impacts by relocating loading zones and off-peak parking to the additional kerb space provided at the cross streets for example, e.g. obsolete turning bays for movements onto George Street can potentially be converted into parking. The current design allows for the impacted loading and taxi zones to be relocated to the following locations: ▪ George Street North – potential to relocate the taxi zone at the Four Seasons Hotel, to the north of Alfred Street. ▪ Essex Street – reclassify short stay parking on the southern kerb. ▪ Bridge Street – The dedicated left turn lanes into George Street become obsolete due to the removal of access to George Street. This presents an opportunity to enhance the footpath and provide a taxi/loading zone on Bridge Street. ▪ Margaret Street –Opportunity to convert kerbside left turn lane into parking / loading due to George Street closure. ▪ Hunter Street – existing 4 lanes which would reduce in future, providing an opportunity for additional parking / loading on both sides of Hunter Street. ▪ Market Street – removal of monorail and left turn into George presents an opportunity for additional loading capacity on one side of Market Street to the east of George Street. ▪ Bathurst Street – left turn lane onto George Street would become obsolete creating opportunities for additional parking / loading spaces. ▪ Ultimo Road – dual turning lanes onto George Street become obsolete as George Street would have only one northbound lane therefore there is an opportunity to create new parking / loading spaces along the northern kerb.

All workers would be expected to park off-site with shuttle bus transfers of the construction workforce at shift change over to prevent an increase in demand for on-street parking.

4.2.15. Public Transport Access

Prior to construction commencing all bus services would be relocated from George Street as part of the City Centre Bus Plan. As a result, bus passengers would need to access the CBD via new corridors to the east and west of George Street on York, Clarence, Elizabeth, Castlereagh Streets and Park/Druitt Streets.

Access to the key heavy rail interchange hubs of Wynyard, Town Hall and Central would be retained, with existing controlled crossing points through worksites being maintained.

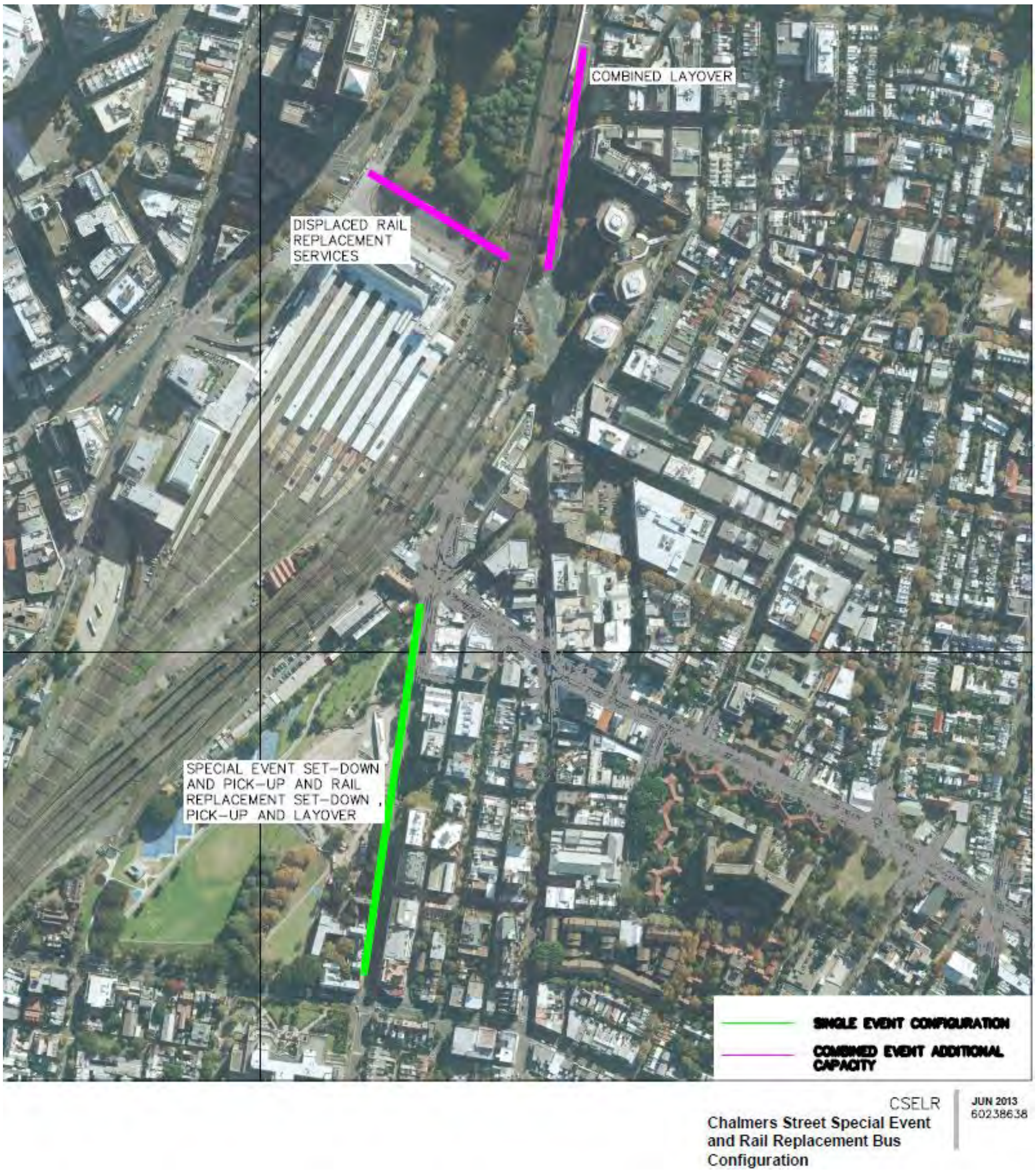
4.2.15.1. Special Event & Rail Replacement Bus Services

Special event buses currently operate between Central Station and Moore Park entertainment precinct and Royal Randwick Racecourse. At present, the buses pick-up and set-down passengers along Chalmers Street, between Devonshire Street and Elizabeth Street. However, with the construction closing off Chalmers Street to traffic, these services would be required to move south of Devonshire Street. This continues to provide a good connection for heavy rail passengers exiting Central Station from the Devonshire Street portal.

In addition to special events buses, rail replacement buses also operate via Chalmers Street, and during the construction phase, would also require relocation south of Devonshire Street. This location would not have sufficient capacity to accommodate these dual uses. Therefore two alternative mitigation measures are proposed:

- Wherever possible schedule rail replacement works during weekends when no special events are proposed;
- Where this is not possible, special events would continue to pick-up and set down passengers at Chalmers Street south of Devonshire Street, while rail replacement buses would need to be relocated to Elizabeth Street, north of Eddy Avenue as shown in Figure 4-22. In addition, changes to Sydney Trains maintenance schedules would be required to minimise the passenger transfer requirement at Central Station, such as maintaining operation of Central – Bondi Junction services under a Configuration 1a possession. Details of rail replacement bus requirements not impacted by construction are available from the Transport Operations Report.

Figure 4-22: Special Events Bus Operation at Chalmers Street with Rail Replacement Buses



4.2.16. Pedestrian and Cycle Access

Pedestrians would be protected in narrow footpath sections by fencing, to physically separate pedestrians from traffic lanes.

Where existing controlled pedestrian crossing facilities exist, these would be maintained and when required by the current work location, pedestrian access through the worksite provided under traffic control. Existing crossing widths at mid-block crossing points such as at Martin Place may be reduced to allow reduced construction periods. This is feasible without reducing pedestrian levels of service due to the greatly reduced traffic volumes (i.e. construction and service vehicles only) on George Street, which will only require traffic controllers to stop pedestrian movements infrequently.

North-south cycle movements on George Street could be moved to one of the existing on-road cycle corridors as defined by the City of Sydney;

- Pitt Street (on-road, two way)
- York Street (on-road, southbound only)
- Clarence Street (on-road, northbound only); and
- Kent Street segregated cycleway (two-way).

East-west cycle movements may be more restricted during the construction phase:

- While cyclists may dismount and use the Circular Quay foreshore or Herald Square to George Street/The Rocks; a temporary cycle route on Bridge Street could act as an alternative on-road cycleway to Alfred Street to support east-west movements.

  Bridge Street will provide two westbound traffic lanes during construction, which may permit an on-road cycle lane within the existing roadway. During intersection staging works, the lane would not continue through the intersection to Grosvenor Street due to the need to divert the two traffic lanes with restricted alignment around staged worksites. During these closures, Hunter Street is to remain open for westbound movement, which would also require temporary diversion of cyclists to this route.

  The potential use of Bridge Street is compatible with longer term operational plans which identify Bridge Street as a future cycle route (on-road, two ways east of Pitt Street)
- King Street (on road, eastbound only) provides the next west to east crossing opportunity

4.2.17. Emergency vehicles

Access for emergency vehicles would be maintained at all construction sites and emergency services would be advised of all planned changes to traffic arrangement prior to applying the changes. Advice would include information about upcoming traffic switches, anticipated delays to traffic, extended times of work, locations of road possession or any likely major disruptions.

As shown in the George Street corridor plans contained in Appendix C, there are a number of locations where no access lane external to the worksite is being provided. In these locations access to the block would be facilitated by traffic controllers to the location of the emergency. However during certain loading/unloading and construction activities a clear path through the length of the block to permit through travel cannot be provided. At these times emergency services would be advised in advance of the required alternate routes.

4.2.18. Taxis

All taxi ranks would be displaced from George Street during construction, many of which are off-peak or late night ranks only. This is consistent with the end-state and the corresponding end-state mitigation measures would be implemented prior to construction. Potential replacement loading zones as identified in Table 4-4 could also provide off-peak taxi rank facilities to mitigate these impacts.

4.3. Surry Hills

4.3.1. Construction Worksites and Access

The construction worksites within the Surry Hills to Moore Park precinct consist of the following:

- Rail tracks along Devonshire Street;
- Surry Hills platforms at Ward Park; and
- Bridge over the Eastern Distributor.

Construction along this route would involve closing Devonshire Street between Chalmers Street and Crown Street. East of Crown Street, an eastbound lane is proposed to be retained during the construction phase.

A number of adjoining streets along Devonshire Street would close as part of the proposals for CSELR. These streets are:

- Buckingham Street;
- Holt Street;
- Clisdell Street;
- Waterloo Street; and
- High Holborn Street

In addition to these road closures, the following network changes are proposed within Surry Hills:

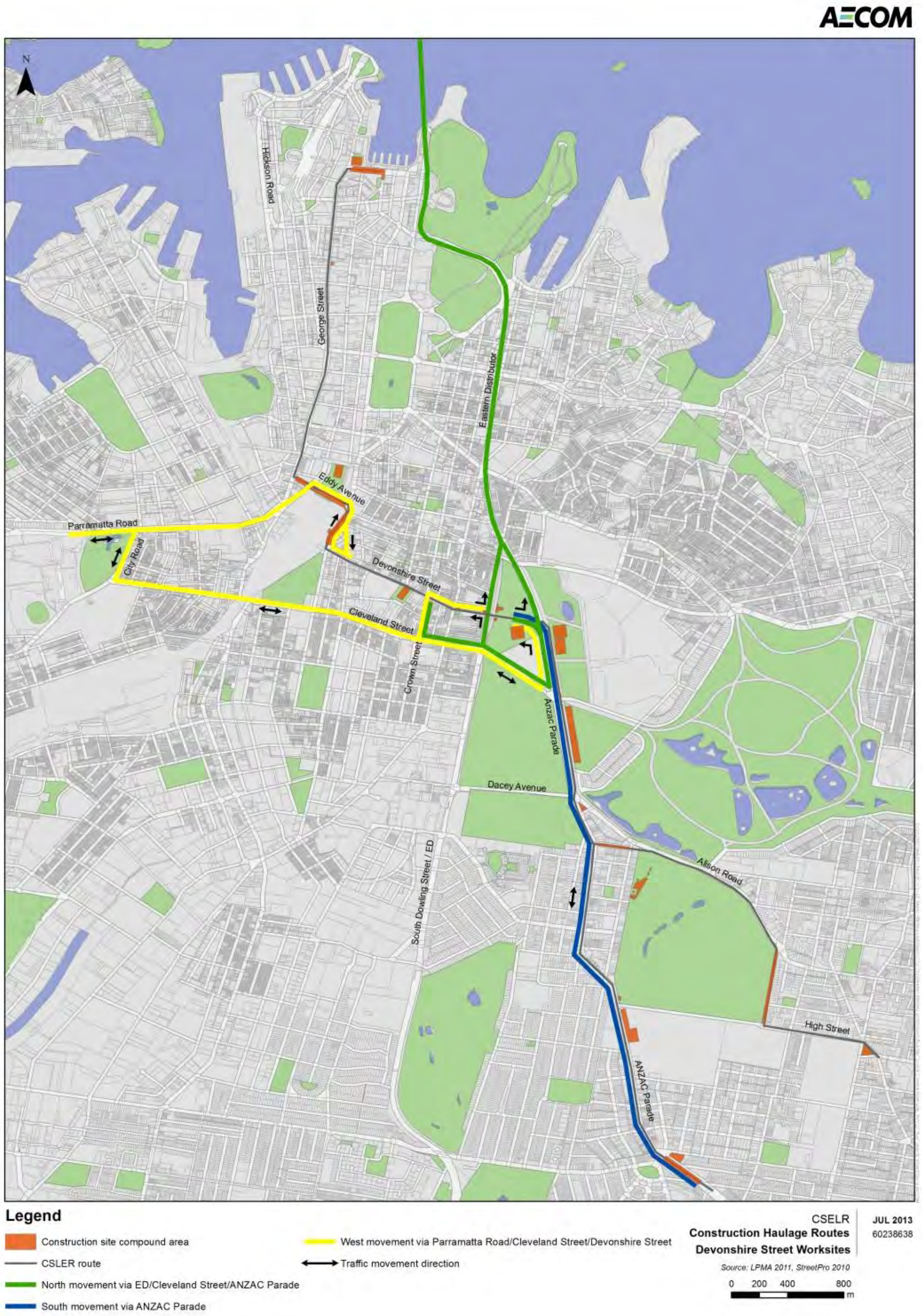
- Extension of Cooper Street onto Riley Street;
- Conversion of Steel Street to one-way southbound;

To facilitate local access and minimise the number of changes to the road network, all of the end-state measures would be in place prior to the commencement of construction, with the exception of the closure of Waterloo Street (discussed in the following Section 4.3.3).

4.3.1.1. Haulage Route

The haulage route for construction vehicles accessing Devonshire Street is shown in Figure 4-23.

Figure 4-23: Devonshire Street Construction Haulage Route



4.3.2. Traffic Management

The CSELR alignment crosses the following key road links, which would remain operational during construction:

- Elizabeth Street;
- Crown Street; and
- Bourke Street.

Works at these intersections would require staged construction to allow traffic to pass adjacent to the worksites and thus ensure property and network accessibility within the precinct. The staged intersection works are presented in Appendix B.3-B.5.

4.3.2.1. South Dowling Street and Eastern Distributor

Construction, and subsequent road closures, across South Dowling Street and the Eastern Distributor can only be undertaken during over-night shifts. For South Dowling Street, construction is to be undertaken in one directional flow at a time, due to the significance of the road within the greater transport network. During construction works at these sites, traffic would be diverted via alternate corridors via the shortest route possible.

During the closure of the northbound South Dowling Street carriageway, South Dowling Street will be closed at the intersection of Cleveland Street. City bound traffic would be diverted via Dacey Avenue and Anzac Parade to lead motorist to Flinders Street and South Dowling Street. Local traffic accessing Surry Hills will be diverted at the intersection of Cleveland Street.

During the closure of the southbound South Dowling Street carriageway, airport bound traffic will be diverted via Anzac Parade and Dacey Avenue. Surry Hills bound traffic will be diverted via Fitzroy Street.

Similarly, during the closure of the Eastern Distributor, to facilitate the installation of the pre-fabricated bridge over the Eastern Distributor, traffic will be diverted to Dacey Avenue and Anzac Parade. Northbound traffic would be diverted from Southern Cross Drive and directed to South Dowling Street with the entrance to the Eastern Distributor closed on approach to Todman Avenue. Motorists bound for the Eastern Distributor would then be directed to the Anzac Parade on-ramp adjacent to Moore Park Road.

Southbound traffic on the Eastern Distributor will be diverted to the Anzac Parade off-ramp within the tunnel and diverted to Anzac Parade, Dacey Avenue and South Dowling Street prior to joining Southern Cross Drive.

The detour routes are presented Appendix E.

4.3.3. Property Access

As Devonshire Street is proposed to be closed to through traffic, the properties with vehicle access from Devonshire Street would require mitigation measures to manage access during the construction phase. Existing properties with access to car parking or loading docks on Devonshire Street are shown in Figure 4-24 to Figure 4-27.

Figure 4-24: 483 Riley Street – car park to commercial business

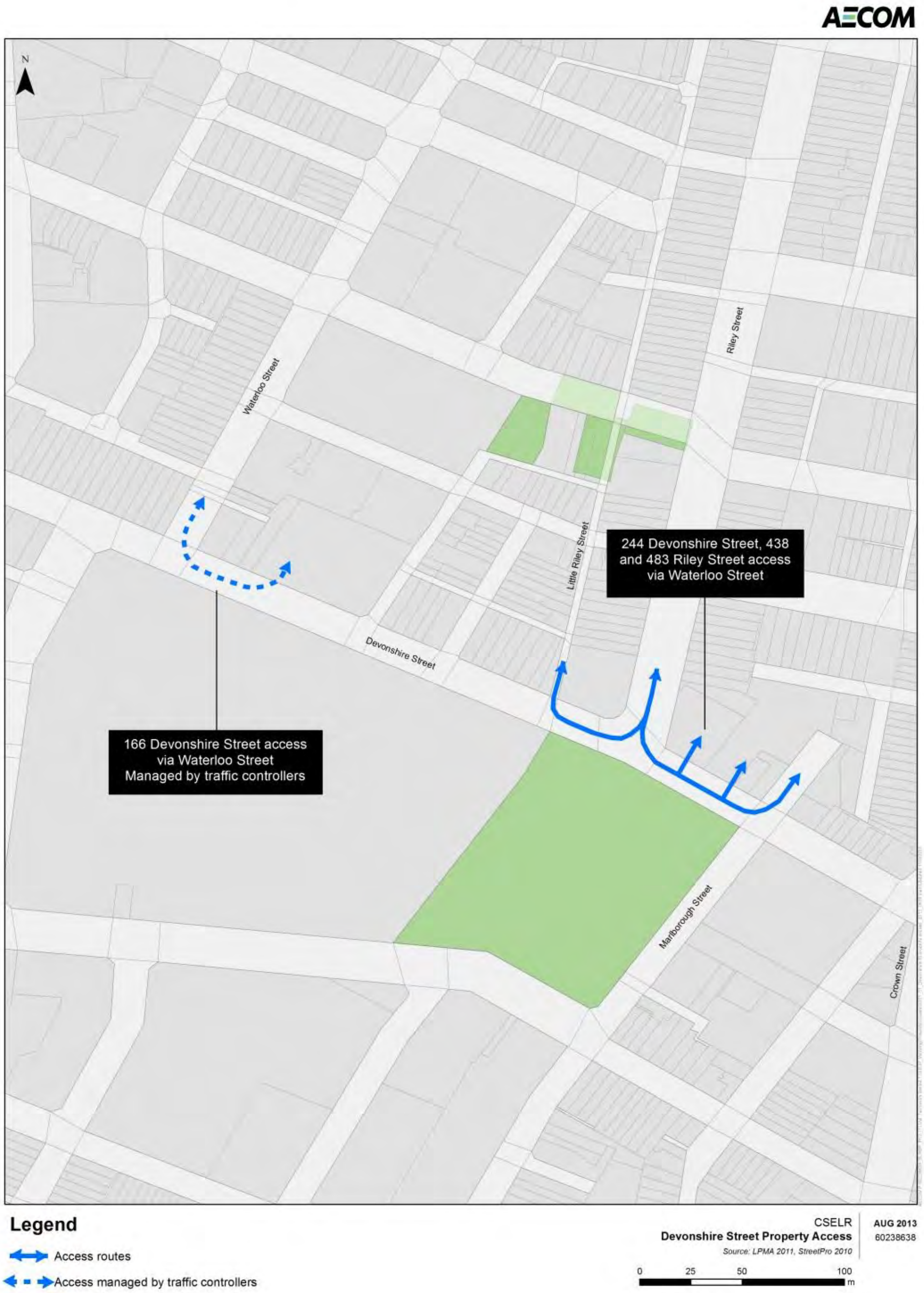
Figure 4-25: 244 Devonshire Street – low density residential

Figure 4-26: 438 Riley Street – driveway to St Patricks Business College

Figure 4-27: 166 Devonshire Street driveway - high density residential development

In addition to these driveways, the properties on Marlborough Street north of Devonshire Street and driveways on Nickson Lane are accessible only via Devonshire Street. To ensure accessibility to these properties during construction, Waterloo Street and Riley Street would remain open as shown in Figure 4-28.

Figure 4-28: Devonshire Street Property Access



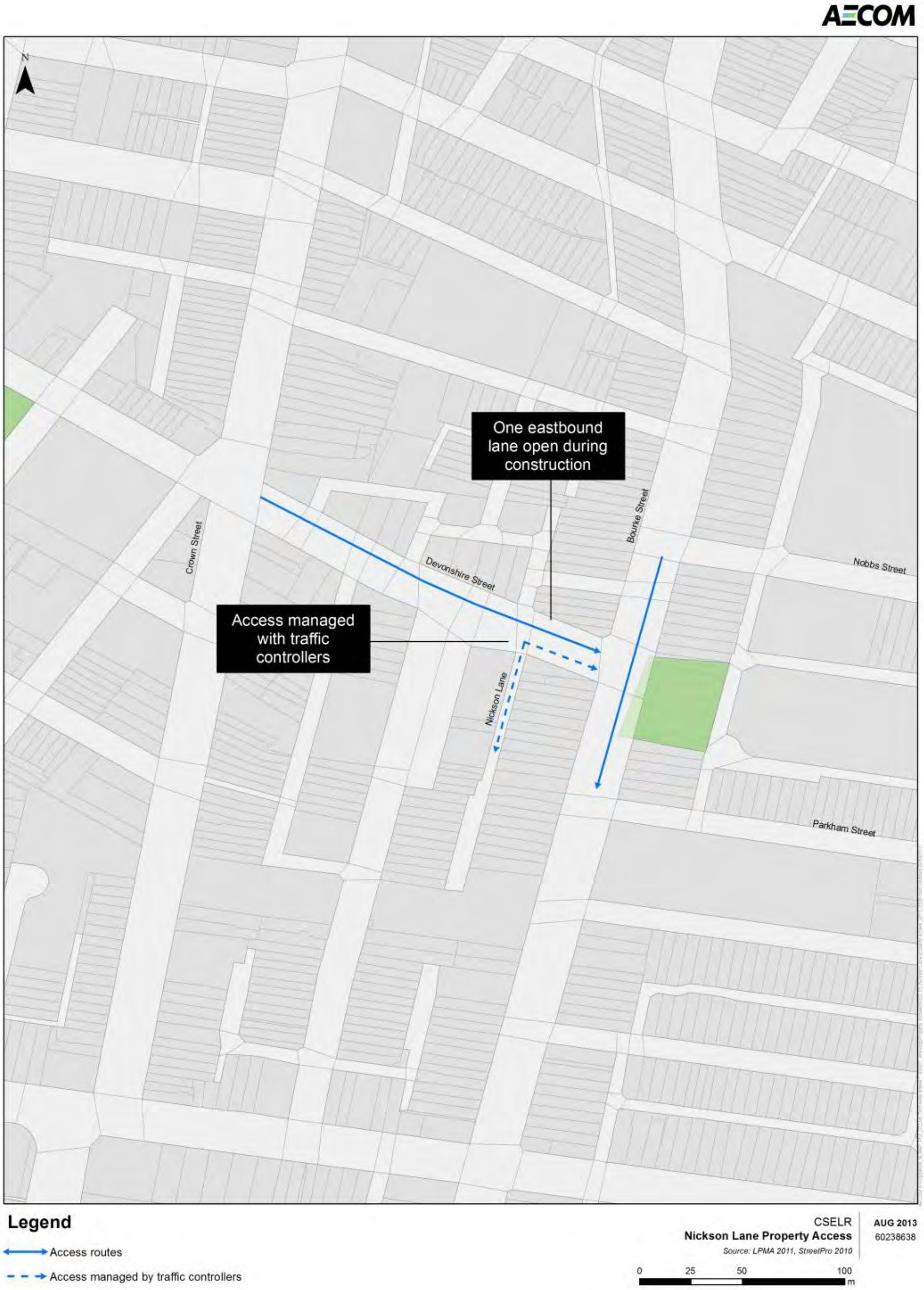
Since the light rail is aligned within Ward Park, sufficient road widths can be maintained adjacent to Riley Street to facilitate safe separation, with concrete barriers, between the worksite and vehicles accessing the properties. However, safe separation cannot be provided adjacent to Waterloo Street for vehicles accessing 166 Devonshire Street. Therefore, traffic controllers would be required to guide the vehicles between the driveway and Waterloo Street when works are undertaken adjacent to Waterloo Street.

Similarly, access to Nickson Lane would be managed by traffic controllers, as shown in Figure 4-29 due to the limited lane width.

With the closure of Devonshire Street the residents within the Surry Hills precinct may experience increased travel distances in their journeys. However, vehicles access to all adjacent properties would still be maintained during the closure of Devonshire Street. The precinct access plans are contained within Appendix A.2.

Consistent with the operational phase of the CSELR , the light rail alignment precludes access to the existing Langton Centre off-street car park at Parkham Place. During construction phase suitable alternative parking for the clinic will be provided within the general vicinity.

Figure 4-29: Nickson Lane Access



4.3.4. Parking

In the CSELR end-state, the restricted road cross section allows no opportunity for parking along Devonshire Street. The CSELR Transport Operations Report established that, with appropriate parking management, there is sufficient capacity within the adjacent road network to absorb the displaced parking demands during peak demand periods. This would also be the case during the construction phase, since the construction activities would not alter the on-street parking demands. Construction vehicles would be contained within the Ward Park worksite and staff would be utilising potential parking facilities within Moore Park and Royal Randwick Racecourse worksites.

To facilitate the retail and commercial businesses on Devonshire Street, time-restricted loading zones could be provided on Holt Street, Waterloo Street, Riley Street. These would effectively replace the displaced loading zones from Devonshire Street and would facilitate the requirement of the businesses located on the northern side of Devonshire Street between Holt Street and Riley Street.

4.3.5. Public Transport Access

Due to the right turn ban at the intersection at Baptist Street and Cleveland Street, the inbound bus route 355 currently utilises Crown Street, Devonshire Street and Bourke Street to enter the eastbound lanes of Cleveland Street. During construction works, although an eastbound lane would be open between Crown Street and Bourke Street, the swept paths requirements of large vehicles, such as buses, cannot be maintained for right-turn movements from Crown Street south to Devonshire Street.

Two alternate route options could be considered for bus route 355 by TfNSW during construction works along Devonshire Street, as shown in Option A (Figure 4-30) and Option B (Figure 4-31).

Figure 4-30: Bus Route 355 Diversion Option A

Figure 4-31: Bus Route 355 Diversion Option B

Option A shown in Figure 4-30 proposes to divert the bus route via Lansdowne Street and Marlborough Street to enter Cleveland Street, west of Crown Street. The roads along this route are generally local streets with residential developments and captures portions of the existing catchment area without deflecting too far the existing route.

Option B shown in Figure 4-31 shows both diversions for inbound and outbound routes. The inbound route is proposed to be diverted via Redfern Street and Chalmers Street whereas the outbound route would travel directly between Cleveland Street and

Elizabeth Street. Option B is major departure from the existing bus route as it would not service the developments adjacent to Phillip Street and Bourke Street.

Both Options A and B are viable temporary options which would need further consultation with Council and State Transit Authority to discuss potential operational and community impacts.

4.3.6. Pedestrian and Cycle Access

Existing pedestrian footpaths along Devonshire Street would be retained at all times and protected from the worksite with barrier protection. The only sections where this is not possible would occur when construction works are undertaken adjacent to Ward Park, at which point pedestrians could be diverted to the northern footpath.

During intersection staging works, pedestrian crossing facilities would be maintained either by providing an alternate crossing opportunity adjacent to the workzone or maintaining the existing pedestrian facilities.

Marked crossings are located adjacent to Steel Street, Riley Street and High Holburn Street along Devonshire Street. Given the proximity of these locations and the low traffic environment during construction, these crossings would be consolidated to a single location. The new pedestrian crossing would be located adjacent to Riley Street, to the west of Ward Park.

Devonshire Street is currently recognised as an on-road cycle route with intermittent signposting of cycles. During construction, as per the private vehicles, cyclists would be prohibited from accessing the road pavements. Cyclists could be directed to the alternative parallel east-west routes of Cooper Street and Arthur Street.

Arthur Street is currently recognised as an on-road cycle route by the City of Sydney, and Cooper Street a former on-road cycle route. The segregated Bourke Street off-road cycleway provides a suitable alternative route for access to the southern CBD via Campbell Street.

To facilitate the cycle route along Arthur Street and Cooper Street, improvements to the connection at Riley Street would need to be implemented as part of the early works to ensure a clear through path. Line marking, kerb ramps and directional signage along the route would need to be installed where required to further reinforce the cycle route.

During construction, the reconfiguration of Randle Street will allow for two-way cycle movements, providing a connection from Cooper Street through to Prince Alfred Park (inner south) and Belmore Park (southern CBD).

4.3.7. Emergency Vehicle Access

It is intended that emergency vehicles would utilise the construction vehicle paths within the worksites when attending to emergencies within Devonshire Street. Access to the block would be facilitated by traffic controllers to the location of the emergency. However during certain loading/unloading and construction activities a clear path through the length of the block to permit through travel cannot be provided. At these times emergency services would be advised in advance of the required alternate routes.

4.3.8. Taxis

As present, Taxi zones exist along Devonshire Street, between Chalmers Street and Elizabeth Street, as well as on Chalmers Street, adjacent to the Foveaux Street and Elizabeth Street intersection. With the closure of Chalmers Street and Devonshire Street, these zones could be consolidated into one location adjacent to Central Station in Chalmers Street, south of Devonshire Street, as per the end state.

4.4. Moore Park (Anzac Parade, North of Alison Road)

4.4.1. Construction Worksites and Access

The construction worksites within the Moore Park precinct consist of the following:

- Anzac Parade tunnel;
- Moore Park stop;
- Moore Park cut and cover; and
- Work compound within Moore Park

The construction of the Moore Park and Anzac Parade tunnels will require a facility with an estimated area of 5,625 square metres for waste water, laydown and storage, plant and equipment and a bentonite plant for the construction tunnels. The facility will be required to be located close to the tunnel construction works and will be initially located on the western side of Anzac Parade and then relocated to the eastern side of Anzac Parade as construction progresses.

A site compound of approximately 1,500 square metres include car parking for 60 cars is also proposed to be located in the Moore Park East precinct or at or at Royal Randwick Racecourse.

A laydown area of approximately 12,000 square metres is also identified within Moore Park, south of the Parklands Sports Centre and on the eastern side of the existing busway.

The proposed worksite areas are shown in Figure 4-32.

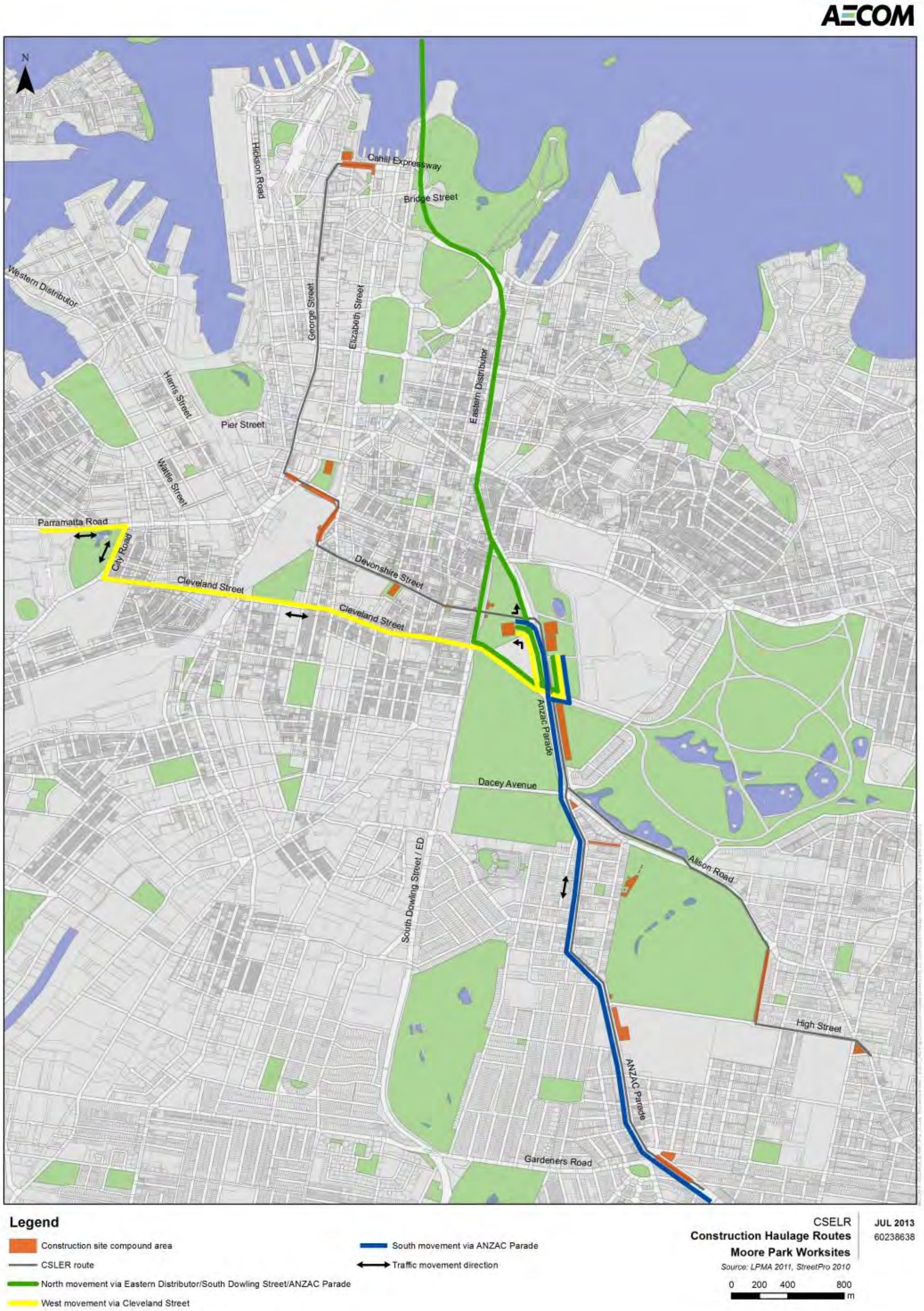
Throughout the construction phase, the existing capacity of Anzac Parade, north of Alison Road, would be maintained to accommodate three lanes in each direction of travel. However, the bus lanes within Moore Park, located to the east of Anzac Parade would be affected during the construction phase, as barriers would need to be positioned within the bus lane to separate the light rail construction and movement of buses on the adjoining lane.

Figure 4-32: Locations of Proposed Work Compounds

4.4.1.1. Haulage Route

The haulage route for construction vehicles accessing Moore Park is shown in Figure 4-33.

Figure 4-33: Moore Park Construction Haulage Route



4.4.2. Traffic Management

Construction works along the Moore Park alignment would be primarily off road, except for the Lang Road crossover, which would be undertaken over two weeks of night time works. These construction activities would avoid periods when major events are scheduled within Moore Park.

Furthermore, to minimise the disruption, construction of the light rail works across Lang Road would be undertaken during complete closure of the Lang Road arm of the Anzac

Parade intersection. As shown in Figure 4-34, this requires traffic diversions to alternate access points of Driver Avenue and Moore Park Road for access to the Moore Park entertainment precinct as well the residential developments within Centennial Park that usually access Lang Road.

Figure 4-34: Lang Road Closure

Westbound traffic along Lang Road will be diverted towards Moore Park Road, where traffic can turn to Anzac Parade for southern destinations or proceed towards South Dowling Street to access Cleveland Street. Eastbound traffic from Cleveland Street will need to access Anzac Parade northbound and turn into Moore Park Road to access Driver Avenue and Lang Road.

During the Lang Road closure, advisory signs will need to be active within the Eastern Distributor to notify motorists to use the Moore Park Road to access Lang Road and the Moore Park entertainment precinct.

These diversions will not affect vehicle access to developments within Moore Park. In particular, if events are scheduled within the Parklands Sports Centre, located to the south of Lang Road, traffic controllers will manage the interaction between visitors and construction vehicles.

4.4.3. Property Access

The major developments along the Moore Park corridor are located in the entertainment precinct consisting of the Sydney Football Stadium, Sydney Cricket Ground and Playbill Venues (Hordern Pavilion and Royal Hall of Industries) located to the east of Anzac Parade and accessed via Driver Avenue at Moore Park Road and Lang Road at Anzac Parade. Along the western side of Anzac Parade lie the Sydney Boys and Girls High schools, with their access points located on Cleveland Street.

During special events, the intersection of Lang Road and Anzac Parade experiences increased traffic activity, as a result of vehicles accessing the car parks within Moore Park, resulting in delays along Anzac Parade and Driver Avenue. Aside from the traffic accessing the entertainment precinct, Lang Road also provides access to the residential developments within Centennial Park located to the east of Moore Park.

As Figure 4-34 shows, access to the entertainment precinct and the residential developments can still be maintained during the closure of the Lang Road intersection. However, as identified earlier, construction works would not occur during sporting and special events at Moore Park as both access points at Driver Avenue and Lang Road are required to manage the park.

4.4.4. Parking

Parking within Moore Park, during normal operations, is provided along the on-street angle parking at the southern section of Driver Avenue, outside the Sydney Football Stadium, and the multi-story car parks within the precinct. These parking provisions would be unaffected during the construction phase.

4.4.4.1. Special Events Parking

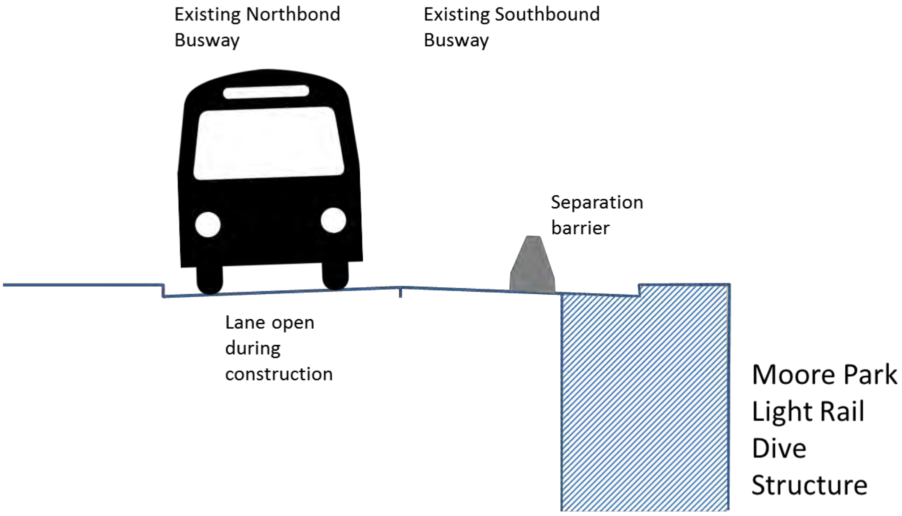
During sporting and major events at the stadiums, pre-booked on-grass parking is accommodated adjacent to Kippax Lake, opposite the Sydney Football Stadium, as well as the Showground Field, opposite the Hordern Pavilion, with access to these parking areas provided along Driver Avenue. Combined, these areas can hold approximately 2,300 vehicles.

The site compound, bentonite plants and lay down facility that is to be located in the Moore Park East precinct will be positioned in an area to minimise the effect on parking provisions during special events. Furthermore, to minimise the impact on the road network and in particular the localised congestion within the Moore Park precinct during major events, construction activities and traffic movements to and from the staff car park would be planned to ensure that there is minimal construction traffic within the local area.

4.4.5. Public Transport Access

Within the Moore Park precinct, light rail is aligned along the eastern side of the off-road busway. Towards Alison Road, the light rail corridor shares the alignment with the buses to join with Alison Road. To ensure safety of the workers on site, separation barriers would be installed along the borders of the worksites where there is high speed traffic on adjacent lanes. As the busway borders the rail alignment, the southbound bus lane cannot be accommodated due to the requirement of separation barriers between the moving bus lane and construction activities. Therefore, only one lane can remain operational during the construction phase. An example of the placement of the barrier adjacent to the Moore Park stop is shown in Figure 4-35.

Figure 4-35: Busway Adjacent to Moore Park



The operational bus lane would be utilised in the peak directional flow i.e. northbound during the AM and southbound during the PM and the opposing bus movements would be directed onto Anzac Parade during the construction phase.

Separation barriers are required whilst works are undertaken along the boundary of the light rail e.g. excavation and track slab installation. Outside of these times, the barriers could be moved further into the workszone to allow dual movement of buses on the busway.

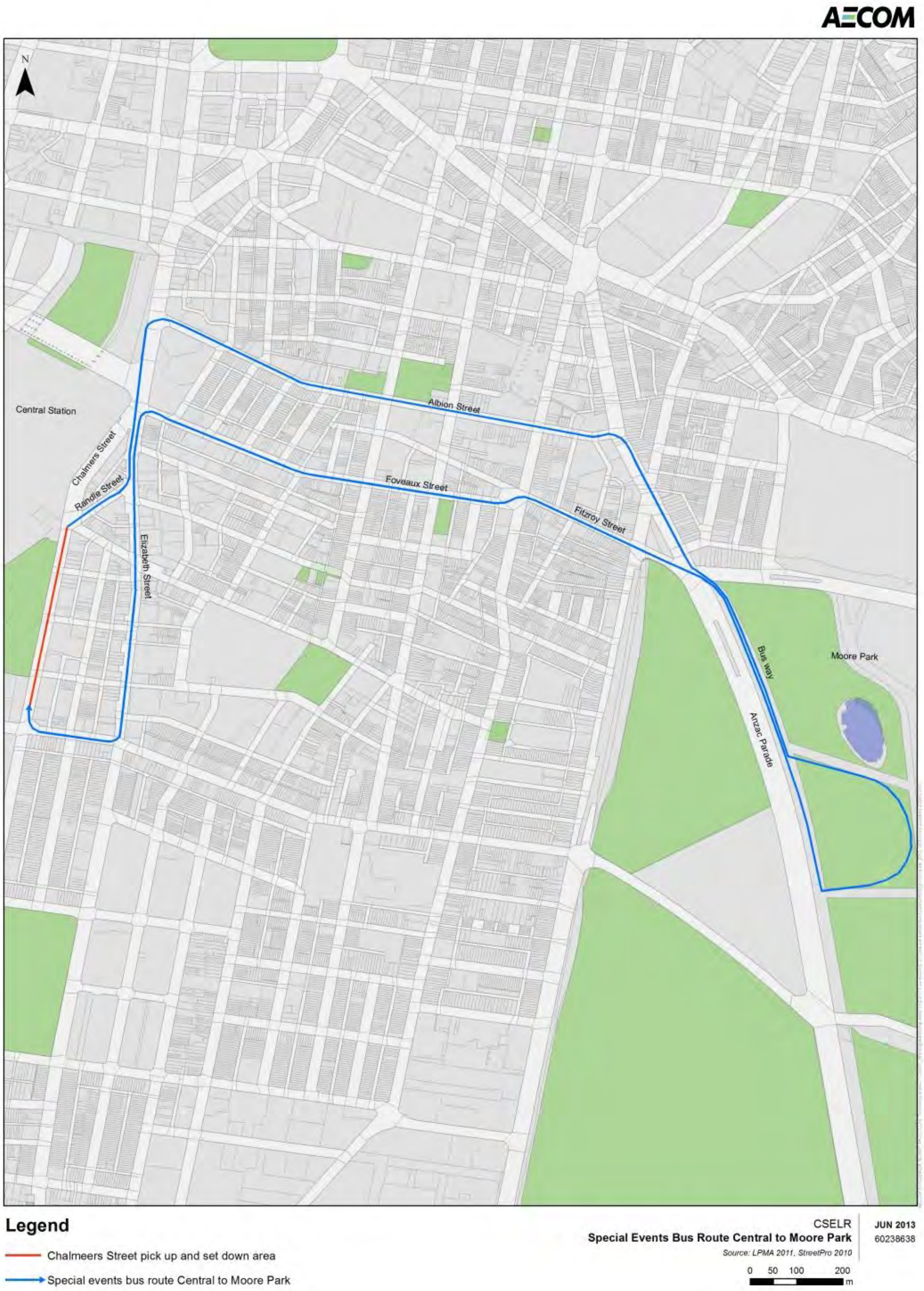
Towards Alison Road, the alignment of the light rail would encompasses both lanes of the busway which would require closure of busway. Alison Road services would enter / exit the Anzac Parade busway via the existing Robertson Road signals. It is noted that the Robertson Road layover facility is proposed to be removed as part of the project and would be decommissioned during construction.

With high trip generators of UNSW and Randwick hospitals located to the south of the CBD, there are significant public transport demands in the counter peak direction during the AM and PM peak periods. Therefore, bus priority measures such as providing peak hour bus priority lanes along Anzac Parade must be explored as part of the Traffic Management Plan of the project following discussions with key stakeholders such as UNSW, Health Infrastructure, STA and RMS.

4.4.5.1. Special Events Transport Access

During major events at Moore Park, special events buses operate between Central Station and Moore Park to transfer visitors between the rail services and the event location. These services operate via Chalmers Street, Foveaux/Albion Street and Anzac Parade busway, utilising the loop around Tramway Oval to set down and pick up passengers as shown in Figure 4-36.

Figure 4-36: Moore Park Special Events Buses



As previously indicated, during the construction of the CSELR, the southbound lane must be closed to ensure safety precautions can be maintained on site. Moore Park special events buses may continue to operate as shown in Figure 4-36, since only the northbound bus movement is required along the busway with buses entering Moore Park via the northern intersection of Gregory Avenue and exiting via the southern intersection. This requires the northbound STA services to operate along the busway during special events at Moore Park with southbound services operating on Anzac Parade.

Construction at the southern Gregory Avenue intersection with busway must be undertaken in a staged manner to facilitate one directional bus movements at this location at all times. To ensure the current level of operation remains unchanged during construction, the site compound and the bentonite plant would remain wholly within the Tramway Oval boundary and the circulating lane would remain serviceable during construction.

4.4.6. Pedestrian and Cycle Access

A shared pedestrian and cycle path is located adjacent to the busway within Moore Park and is situated between the southbound traffic lanes of Anzac Parade and the northbound bus lane. Similar to the busway, this shared path extends from Moore Park Road to Alison Road before continuing onto Centennial Park and UNSW via Alison Road and Wansey Road to follow the path of the light rail alignment.

For the majority of the alignment, the shared path would remain unaffected from the construction activities as it is separated by the busway. However, towards Alison Road, the light rail alignment crosses over the shared path, in which case an alternate path would need to be provided for pedestrians and cyclists. This alternate path would be provided within the same segment of the intersection and would not require crossing of Anzac Parade or Alison Road.

During intersection works at Lang Road, all existing pedestrian and bicycle crossing facilities would be maintained either by providing an alternate crossing opportunity adjacent to the work zone or maintaining the existing pedestrian facilities.

4.4.7. Emergency Vehicle Access

During construction, no special provisions would be provided adjacent to the worksites within Moore Park. It is assumed that emergency services would travel via Anzac Parade and the surrounding roads when responding to emergencies. When responding to emergencies within the worksites, it is intended that the emergency vehicles would utilise the construction vehicle paths along the workzone or the adjacent bus lanes.

4.4.8. Taxis

There are no taxi facilities adjacent to the light rail alignment, however taxi drop offs occur along Driver Avenue during special events and taxi ranks are located behind the Horden Pavilion to pick up passengers These facilities would continue to operate during construction activities within Moore Park and would not be impacted, therefore, no additional provision is proposed for taxis within the Moore Park precinct.

4.5. Kingsford (Anzac Parade between Alison Road and 9-Ways)

4.5.1. Construction Worksites and Access

Construction within the Kingsford Precinct consists of the following:

- Anzac Parade kerb re-alignment;
- Staged construction of Alison Road crossover;
- Carlton Street platforms;
- Staged construction of Todman Avenue crossover;
- Todman Avenue platforms;
- Staged construction of Doncaster Avenue crossover;
- Staged construction of High Street;
- UNSW frontage crossover;
- UNSW platforms;
- Anzac Parade median crossover, at Day Avenue;
- Intersection crossovers at Barker Street, Strachan Street, Borrodale Street (complete closure);
- Strachan Street platforms;
- Staged re-construction of the 9-Ways intersection; and
- 9-Ways interchange.

To enable these works, the following construction compounds and worksites would be required:

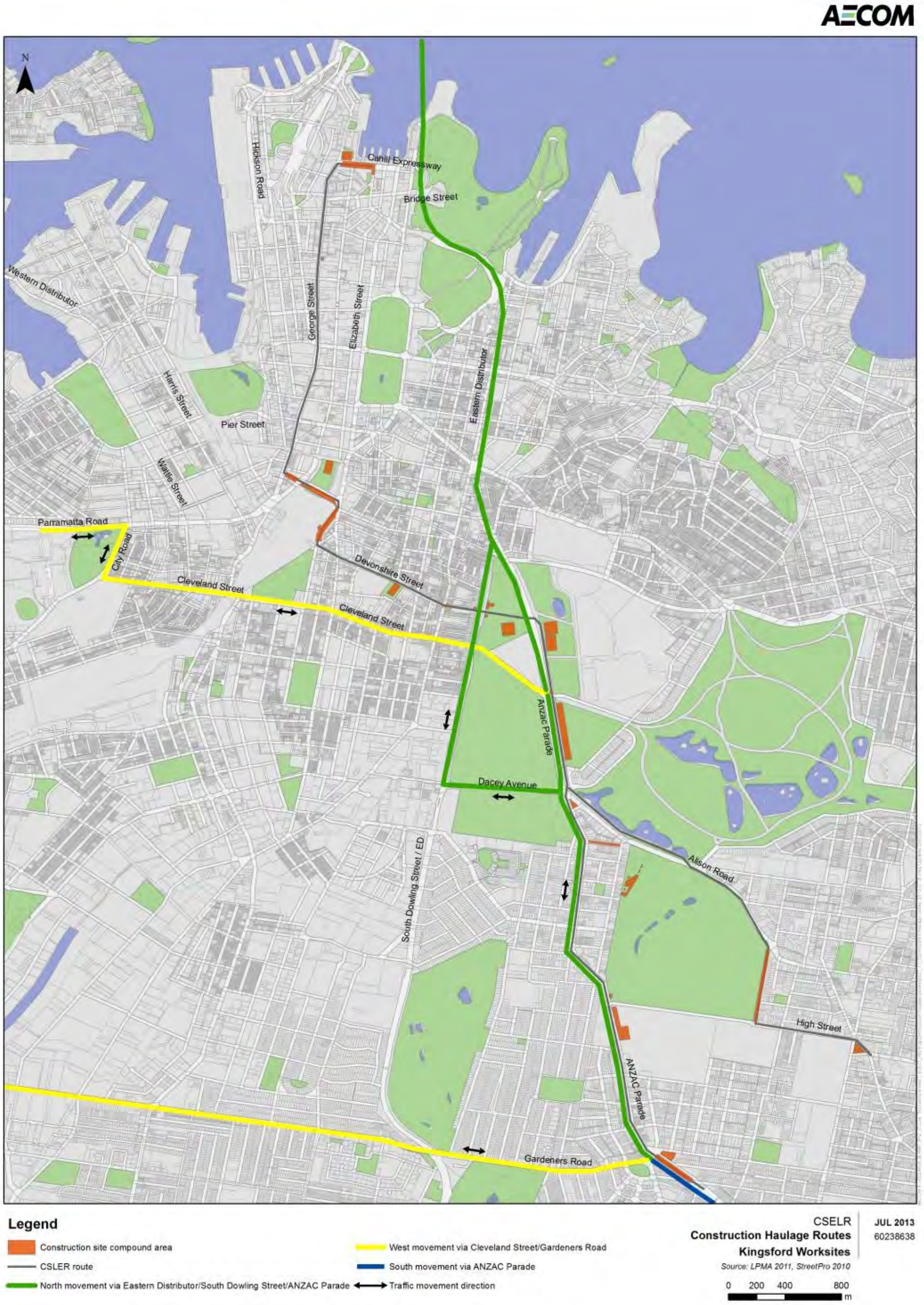
- 1,200 square metre construction site within Tay Reserve;
- 6,000 square metre worksite and 3,200 square metre work compound within UNSW;
- 1,200 square metre worksite at the intersection of Rainbow Street and Anzac Parade, currently owned by Sydney Transit Authority and Randwick City Council; and
- 8,400 square metre worksite within the Anzac Parade median, adjacent to the 9-Ways intersection.

Access points to these worksites would be via Anzac Parade and Alison Road with secure entry and exit points established to ensure the worksites are clearly defined to motorists and are not mistaken for roadways.

4.5.1.1. Haulage Route

The haulage routes for works in the Kingsford precinct have been identified in Figure 4-37.

Figure 4-37: Kingsford Construction Haulage Route



4.5.2. Traffic Management

The light rail construction within the Kingsford precinct would involve staging of works to maximise capacity of Anzac Parade during construction and, where possible, to implement the ultimate end state configurations along the corridor. This would involve maintaining a minimum of two lanes of traffic in both directions during the day time and construction activities at major intersections limited to weekend periods to minimise traffic impact on peak hour traffic and public transport operations.

However, locations with platforms would require staged night works with traffic deflections, kerb barriers and speed reductions down to 40km/hr before reverting back to normal traffic speeds and removal of kerb barriers before the morning peak.

As per the ultimate plan, the closure of the median gaps at Abbotford Street, Carlton Street and Ascot Street would be implemented during the construction phase. This would force the right-turn movements at these intersections to be facilitated at the intersection of Todman Avenue, with the new right turn facility form Anzac Parade south to Todman Avenue east.

During construction, it is probable that there may be multiple activities along various sites on Anzac Parade at any one time. These must be managed so that accesses to adjacent developments are maintained. In particular, concurrent construction activities may occur within UNSW adjacent to Anzac Parade which will require local traffic management measures that considers the UNSW development's traffic management plans.

4.5.2.1. Alison Road

The intersection of Alison Road and Anzac Parade is one of the major intersections along Anzac Parade and accommodates over 7,000 vehicle movements during the peak hour (7:45 - 8:45AM). This intersection is located adjacent to the entertainment precinct and the Royal Randwick Racecourse, which regularly generate large crowds during weekends.

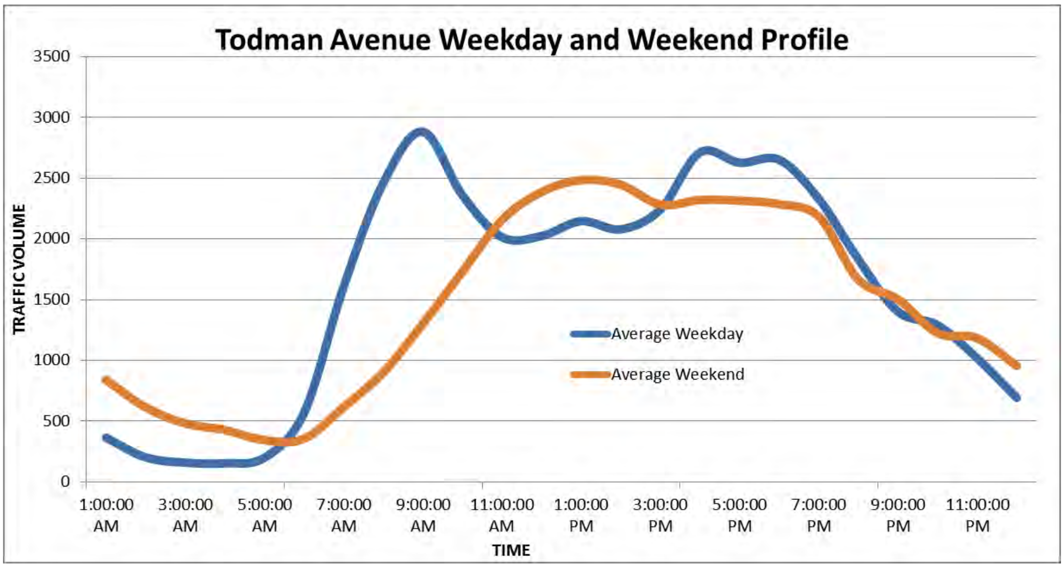
Given the important function of the intersection during peak weekday and weekend periods, the intersection crossover would need to be undertaken during week nights to minimise the impact on adjacent developments and the road network. The construction of the light rail across Alison Road would be undertaken in stages to maintain a minimum of two lanes of travel in each direction during the construction. The proposed staging across the intersection is contained in Appendix B.6.

The limited construction window of working only during weeknights would result in the duration of the intersection crossover exceeding 14 weeks. However, there may be opportunities where no events are scheduled in the Moore Park Precinct / Randwick Racecourse and periods of low traffic generated by UNSW (such as Christmas/new year) when intersection works would be feasible during the weekend period. Further discussions with Centennial Parklands, Randwick Racecourse, UNSW and other stakeholders will be required to explore potential targeted periods.

4.5.2.2. Todman Avenue

Similar to Alison Road, but to a lesser extent, Todman Avenue is a major signalised intersection that links Anzac Parade traffic with Southern Cross Drive. The peak traffic movements at the intersection, during weekdays, occur mainly during the AM and PM peak periods, whereas during the weekend, peak flows occur in the afternoon period equivalent to approximately 90% of the peak weekday traffic, as shown in Figure 4-38.

Figure 4-38: Todman Avenue and Anzac Parade Intersection Traffic Profile



To minimise the impact during journey to work/education trips, as well as minimising impact on the network, construction across the Todman Avenue intersection would be staged during the weekend. The staging would not impact on the north-south capacity of Anzac Parade, however, during some stages, the right turn movement from Todman Avenue east to Anzac Parade north cannot be accommodated. Therefore, the right turn movements onto Anzac Parade northbound must be accommodated at the adjacent Doncaster Avenue intersection during construction activities at Todman Avenue. The intersection staging plans are contained in Appendix B.7.

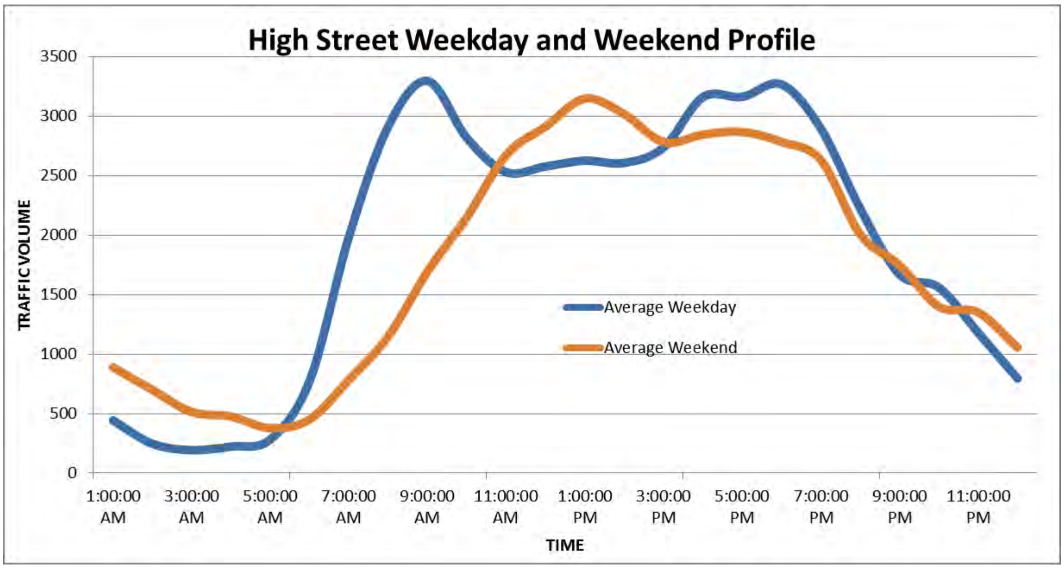
4.5.2.3. High Street

The intersection of High Street and Anzac Parade provides access to three major developments within the precinct – Royal Randwick Racecourse, UNSW and the Randwick hospitals (Sydney Children's Hospital and Prince of Wales Hospital). Although other access points are available for these developments, the High Street and Anzac Parade intersection serves as one of the major points of access for these developments.

UNSW in particular is major daily trip generator with up to 30,000 people each day. A significant portion these trips access the university via the express bus services operating between the university and Central and Circular Quay stations. These services operate via High Street and Anzac Parade during peak hours.

Similar to Todman Avenue, the peak traffic movements during weekdays occur mainly during the AM and PM peak periods, whereas during the weekend, peak flows occur in the afternoon period with total flows representing approximately 90% of the weekday traffic, as shown in Figure 4-39.

Figure 4-39: High Street and Anzac Parade Intersection Traffic Profile



As identified previously, the average weekend flows are lower overall when compared to weekday flows, therefore the construction of the High Street crossover would be staged during the weekend. This will also ensure that university express bus services remain operational during weekday peak hours. Furthermore, construction activities at the intersection should be avoided, wherever possible, during special events at the racecourse or the university during the weekends.

The staging of the High Street intersection would maintain all existing movements at the intersection; however the existing dual right turn from High Street would need to be restricted to a single lane during these weekend closures.

Vehicles exceeding 12.5 metres would be prohibited from turning at this intersection. This would require bus operations between High Street and Anzac Parade to be limited to 12.5m length buses. Furthermore, heavy vehicle deliveries to Randwick Racecourse and the university would need to utilise alternate access points such as Doncaster Avenue, for the recourse, and Barker Street, for the university, during the scheduled weekend periods when construction activities are carried out at the intersection of High Street and Anzac Parade.

The proposed staging plan of High Street intersection is contained in Appendix B.8.

4.5.2.4. Rainbow Street / Gardeners Road (Nine Ways)

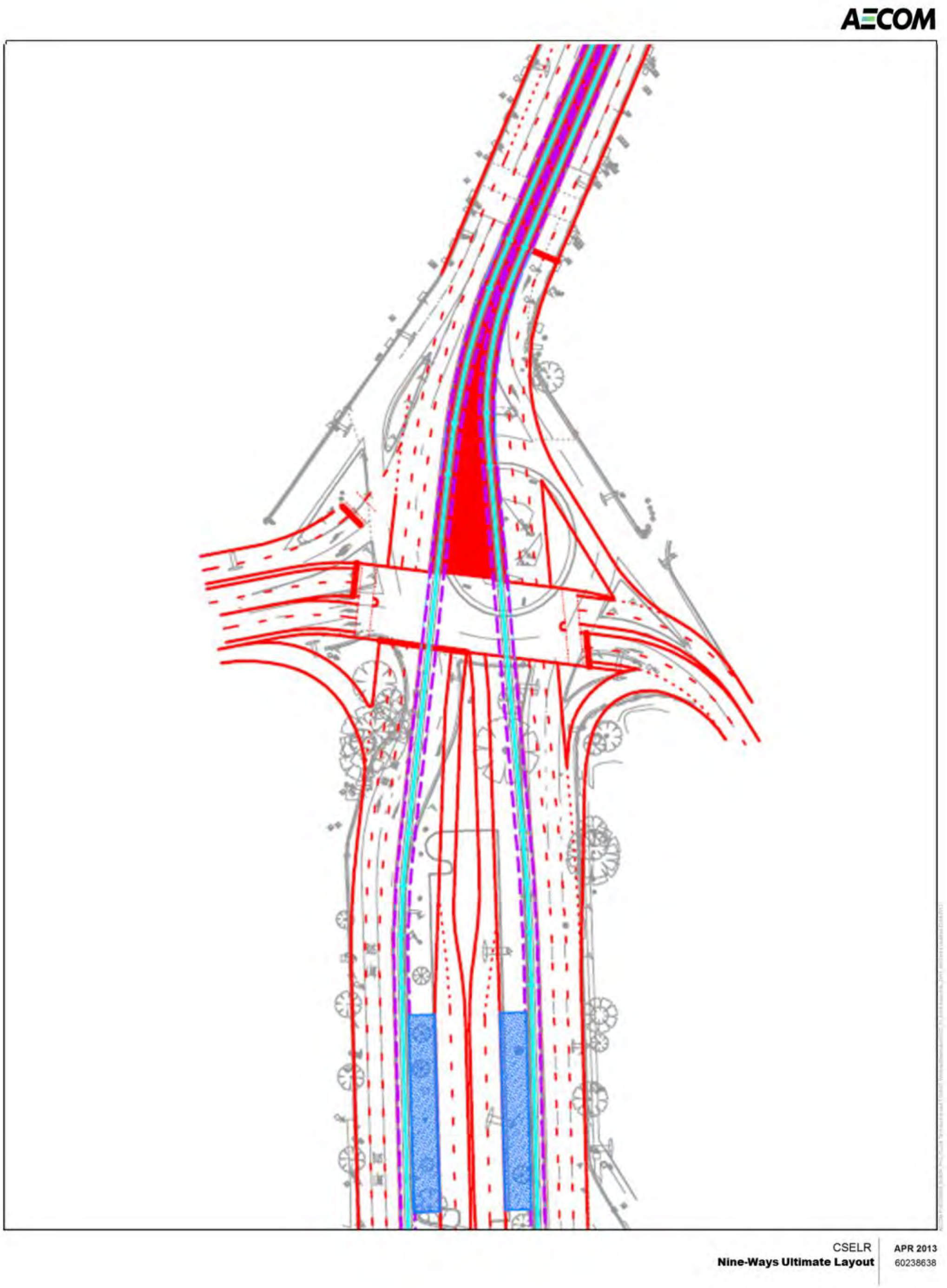
The roundabout intersection of Anzac Parade, Rainbow Street, Gardeners Road or commonly referred to as the Nine Ways intersection accommodates volumes exceeding 4,000 vehicles in the peak hour (4:45-5:45 PM). As the existing intersection is controlled by a roundabout, a multi-staged crossing of the intersection is not possible. Instead, an interim reconfiguration of the intersection, whilst retaining the existing pavement, with minor adjustments, would be implemented to allow construction of the Kingsford Terminus and trackwork. The strategy during construction would be to maintain end-state turning movements at the intersection.

As per the ultimate plan, the right turn movement from Anzac Parade south to Rainbow Street would be prohibited during construction. These movements would be accommodated at the downstream intersection at Barker Street or earlier upstream at adjoining roads and accessing Avoca Street as shown in Figure 4-48.

The interim layout would require removal of the existing kerb blisters surrounding the roundabout island as well as minor adjustments of the roundabout island to increase capacity.

Upon completion of the trackworks, within the interim intersection worksite, the proposed layout, as shown in Figure 4-40, could be implemented

Figure 4-40: Proposed Configuration of Nine-ways Intersection



The interim layout would allow for the installation of the southern trackwork as well as the removal of the roundabout island and formation of the final intersection layout. With the implementation of the ultimate layout, the worksite required for the northern trackwork can be facilitated.

Minor interruptions to the intersections would be required during overhead wiring as well as during changeovers between the intersection layouts to facilitate installation of signals, linemarking, removal of kerb blisters and paving. These construction works would need to be undertaken during nightshifts to minimise the impact on traffic.

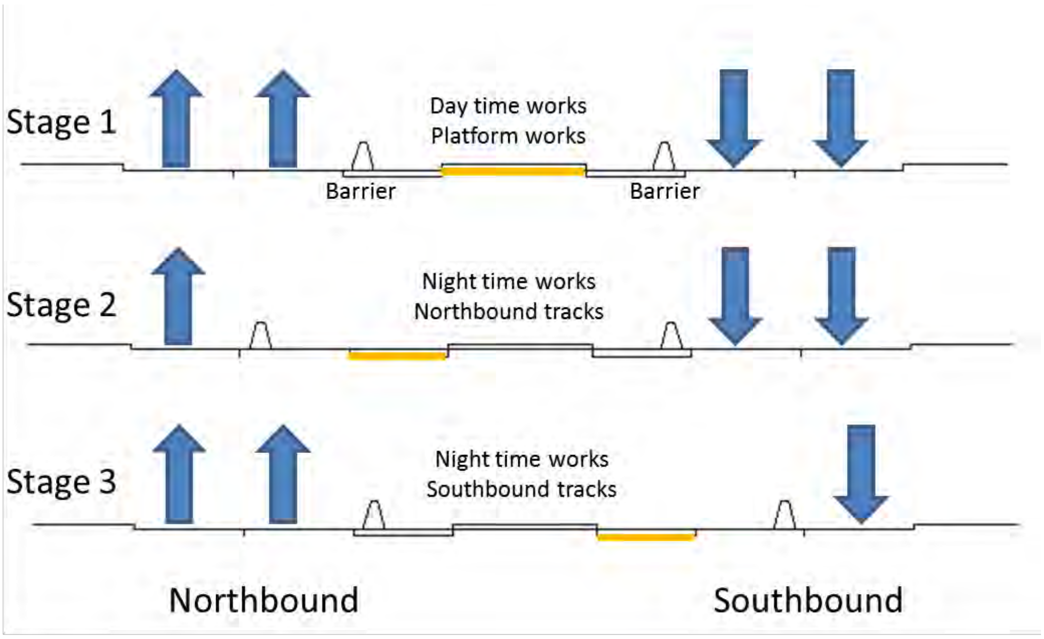
Table 4-5: Summary of Proposed Conditions for Anzac Parade Intersection Closures

Intersection of Anzac Parade	Condition of closure
Alison Road	Weeknight works.
Abbotford Street	Left turn only as per the end configuration
Carlton Street	Left turn only as per the end configuration
Goodwood Street	Left turn only as per the current configuration
Ascot Street	Left turn only as per the end configuration
Bowral Street	Left turn only as per the current configuration
Todman Avenue	Weekends works Doncaster Avenue open
Doncaster Avenue	Weekend works Todman Avenue open
High Street	Weekend works Maintain access for all vehicles under 12.5m
Day Avenue	Left turns only as per the end configuration
Barker Street	Weekend works Middle or Meeks Street open Through and left turn movements allowed on Anzac Parade
Middle / Strachan Street	Barker Street open
Meeks / Borrodale Street	Barker Street open
Nine Ways	End state turn movements

4.5.2.5. Restricted Mid-block Works

During track works adjacent to median light rail platforms, the road width would be insufficient to accommodate traffic and construction activities. Therefore construction within constrained road widths would be undertaken in stages to maintain two lanes in each direction along Anzac Parade, during peak daytime periods, and one lane in one direction during night works as shown in Figure 4-41.

Figure 4-41: Constrained Road Width Construction Staging



As shown in Figure 4-41, the staged construction of track lines adjacent to the platforms would require closures of a single lane. These track works would occur during night shifts with speed restrictions along the corridor. After each night shift, the barriers would be positioned within the rail corridor to allow dual lanes in each direction prior to the start of the AM peak traffic.

4.5.3. Property Access

Within the Kingsford precinct the majority of the light rail alignment is contained within the existing central median of Anzac Parade. As a result, impacts on property access during the construction phase would be minimal.

The strategy during construction would be to maintain the end-state right-turn opportunities along Anzac Parade intersections wherever possible. However during construction works at key intersections, alternative locations would be provided, in conjunction with RMS, to ensure sufficient capacity is maintained. These alternatives include:

- Doncaster Avenue as alternative when Todman Avenue is closed;
- Meeks and Middle Streets as alternatives when Barker Street is closed; and
- Barker Street as alternative when High Street is restricted.

The only periods where access may be hindered is during the intersection works at Todman Avenue and Doncaster Avenue. Since these intersections would be key locations for vehicles accessing properties bounded by Anzac Parade, Doncaster Avenue and Alison Road, during both the construction and operational stages, construction activities at Todman Avenue and Doncaster Avenue would need to be carried out separately.

Similarly, the right turn movements from Anzac Parade at the Day Avenue, Strachan / Middle Streets and Borrodale / Meeks Streets intersections would be banned during both the construction and operational phases. This allows right turn movements to only occur at the intersection of Anzac Parade and Barker Street. Therefore, intersection works at Strachan / Middle Streets and Borrodale / Meeks Streets would not coincide with works at Barker Street. The interdependencies between these intersections are shown in Figure 4-42 and Figure 4-43 and the interdependencies of the intersections are summarised in Table 4-5

Figure 4-42: Barker Street Intersection Dependency on Middle / Strachan Street

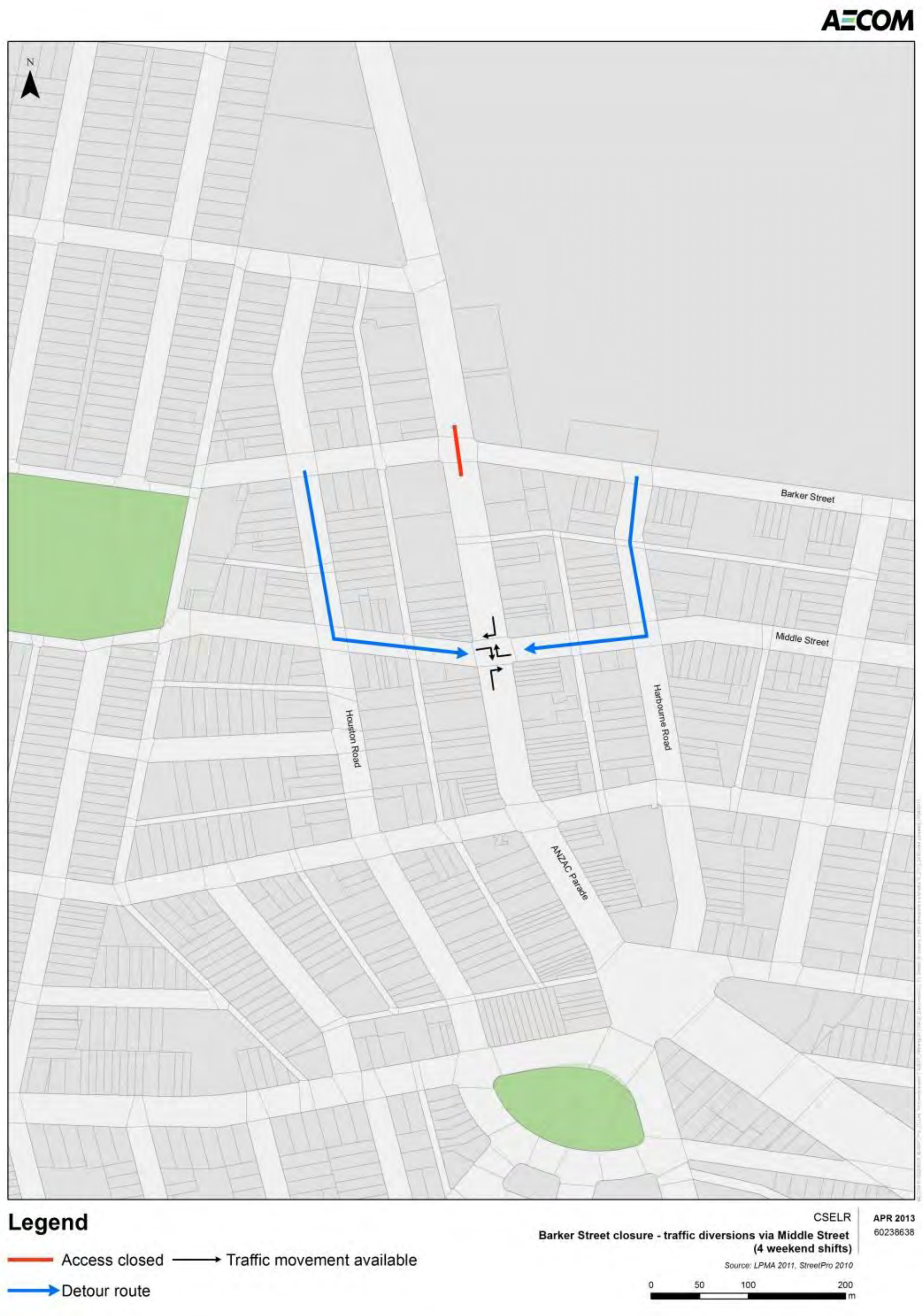


Figure 4-43: Strachan / Middle Street Intersection Dependency on Barker Street

4.5.4. Parking

The impact on parking during construction of CSELR within the Kingsford precinct would necessitate all parking removed along the Anzac Parade light rail corridor. The impacts are comparable to the AM and PM peak parking provision for the light rail end-state configuration as outlined in The Transport Operations Report (Booz/AECOM, 2013).

During the construction of light rail, the parking supply would reduce by 154 spaces, north of Day Avenue, and 267 spaces between Day Avenue and Sturt Street. However as identified within the Transport Operations Report (Booz/AECOM, 2013), the demand may be accommodated within the wider Kingsford precinct.

4.5.5. Public Transport Access

During construction, opportunities to maintain the bus priority lanes between Nine Ways and UNSW would be limited as only two lanes of traffic can be accommodated for each direction, with the loss of an additional lane adjacent to the proposed Strachan Street light rail stop during evening works. As such, the existing level of bus reliability cannot be guaranteed, therefore bus priority measures must be explored during the construction phase.

A possible measure would be to facilitate bus lane operation on Anzac Parade in the peak direction along the kerbside lane and two peak direction traffic lanes. This would result in the non-peak traffic movement being constrained to a single lane and is the subject of further traffic analysis. The bus priority lane would ideally be effective between the UNSW light rail transition and Nine Ways intersection, as these two locations provide ideal switch-over layouts, especially for the UNSW transition and interim 9-Ways intersection. For the ultimate layout, the switchover would need to be facilitated at the intersection of Meeks / Borrodale Street intersection.

North of Barker Street, the UNSW express buses would continue to operate via Anzac Parade and High Street, at bus stops adjacent to existing locations. However, as highlighted at Section 4.5.2.3, vehicle movements between High Street and Anzac Parade will be limited to 12.5m, during weekend construction works. Therefore, existing bus routes that utilise articulated buses will need to be restricted to 12.5m buses, on weekends, during construction works at the intersection of High Street and Anzac Parade.

Considerations could also be given to local diversions such as Houston Road, between Gardeners Road and Day Avenue, however this would result in significant impact on a local residential street and would be considered only as a last resort and would only be feasible following extensive investigations to determine if such an option would be feasible.

4.5.6. Pedestrian and Cycle Access

Pedestrian footpaths are located along both sides of Anzac Parade for the entirety of the road within the Kingsford precinct. The width and quality of the footpaths varies depending on the adjoining developments and the level of pedestrian activity within the region.

For the majority of the alignment, the existing pedestrian footpaths would be maintained, except during kerb realignments and services relocations where the footpaths would be narrowed and localised diversions would be in place to protect the pedestrians from the road activities.

During intersection works, pedestrian crossing opportunities would be maintained either by providing an alternate crossing at an adjacent location or maintaining the existing pedestrian facility. However, at locations where light rail is aligned near the pedestrian facility, pedestrians would need to be diverted to an alternate footpath prior to the works zone being established. For example, the High Street intersection and UNSW platform works would require the closure of the pedestrian footpath between High Street and the UNSW main entrance and diversion of pedestrians to the western side Anzac Parade. Although this would extend the length of the pedestrian trips, access to their destinations would be maintained.

At present, there are no cycle facilities provided along Anzac Parade between Alison Road and the Nine Ways intersection. Cyclists are observed to utilise Anzac Parade both on-road and off-road along the footpaths, where widths permit, but the lack of pavement markings or signs suggest that these are informal cycle movements and that these movements would continue along Anzac Parade, with no special provisions for cyclists.

4.5.7. Emergency Vehicle Access

During construction, no special provisions would be provided adjacent to the worksites within the Kingsford precinct. It is assumed that emergency services would travel via the Anzac Parade traffic lanes, as currently used, and the surrounding roads when responding to emergencies. When responding to emergencies within the worksites, it is intended that the emergency vehicles would utilise the construction vehicle paths, only on approach to the block, and the adjacent traffic lanes would form the key access point.

4.5.8. Taxis

There are no immediate taxi facilities within the Kingsford precinct. There is however, a taxi rank located south of the Nine Ways intersection, adjacent to the South Sydney Junior Leagues Club, along Anzac Parade. As per the end state, this taxi zone would be removed during the construction phase. During the construction phase, it is suggested that these taxi zones be relocated along the Wallace Street frontage of the South Sydney Juniors Club.

4.6. Randwick (Alison Road, Wansey Road and High Street)

4.6.1. Construction Worksites and Access

The construction worksites within the Randwick Precinct consist of the construction activities between west of the Anzac Parade and Alison Road intersection and the intersection of High Street, Avoca Street and Belmore Road and would consist of the following construction activities:

- Kerb realignment along Alison Road, Wansey Road and High Street;
- Randwick Racecourse light rail stabling yard;
- Alison Road crossover at Doncaster Avenue intersection;
- Royal Randwick Racecourse platforms;
- Wansey Road platforms;
- UNSW High Street platforms;
- High Street cross over at Wansey Road;
- Staged segmental construction along High Street;
- Belmore Road cross over; and
- Randwick platforms at High Cross Park.

In addition to the light rail infrastructure, the following network changes would be implemented within the Randwick precinct:

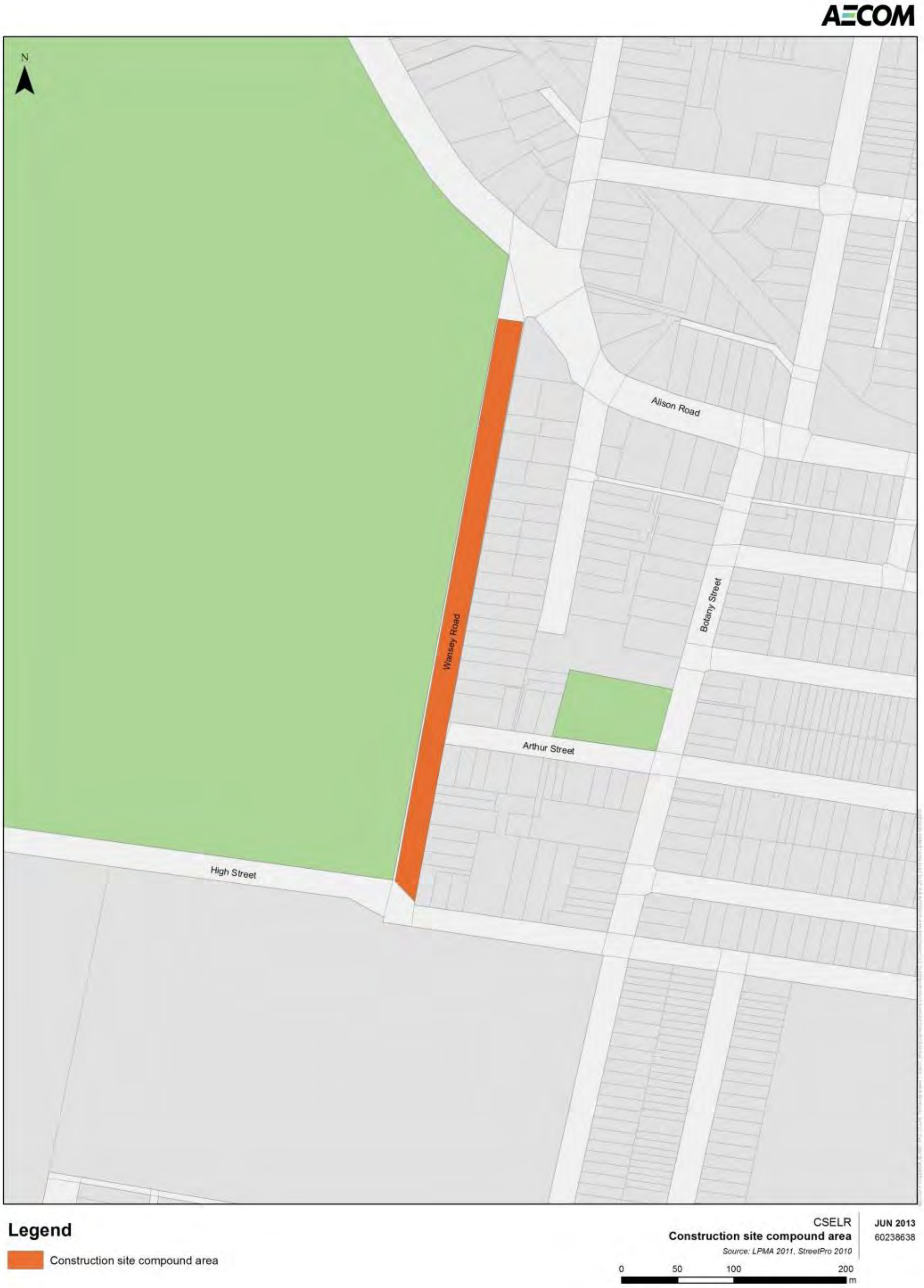
- Reconstruction of the shared path along Wansey Road and Alison Road;
- Signalisation of the Wansey Road and Alison Road intersection;
- Signalisation of the Wansey Road and High Street intersection;
- Signalisation of the Clara Street and High Street intersection; and
- Reconfiguration of the Avoca Street, Belmore Road and Cuthill Street triangle.

A map of the worksites within the Randwick Precinct is shown in Figure 4-44.

Figure 4-44: Royal Randwick Racecourse Work Compound

Access to the Royal Randwick Racecourse worksite would be via Doncaster Avenue. Presently there are multiple existing entry points to the site along Doncaster Street and the construction vehicles would utilise these existing road connections.

Figure 4-45: Wansey Road Worksite



Access to the Wansey Road worksite would be via Alison Road, High Street and Anzac Parade.

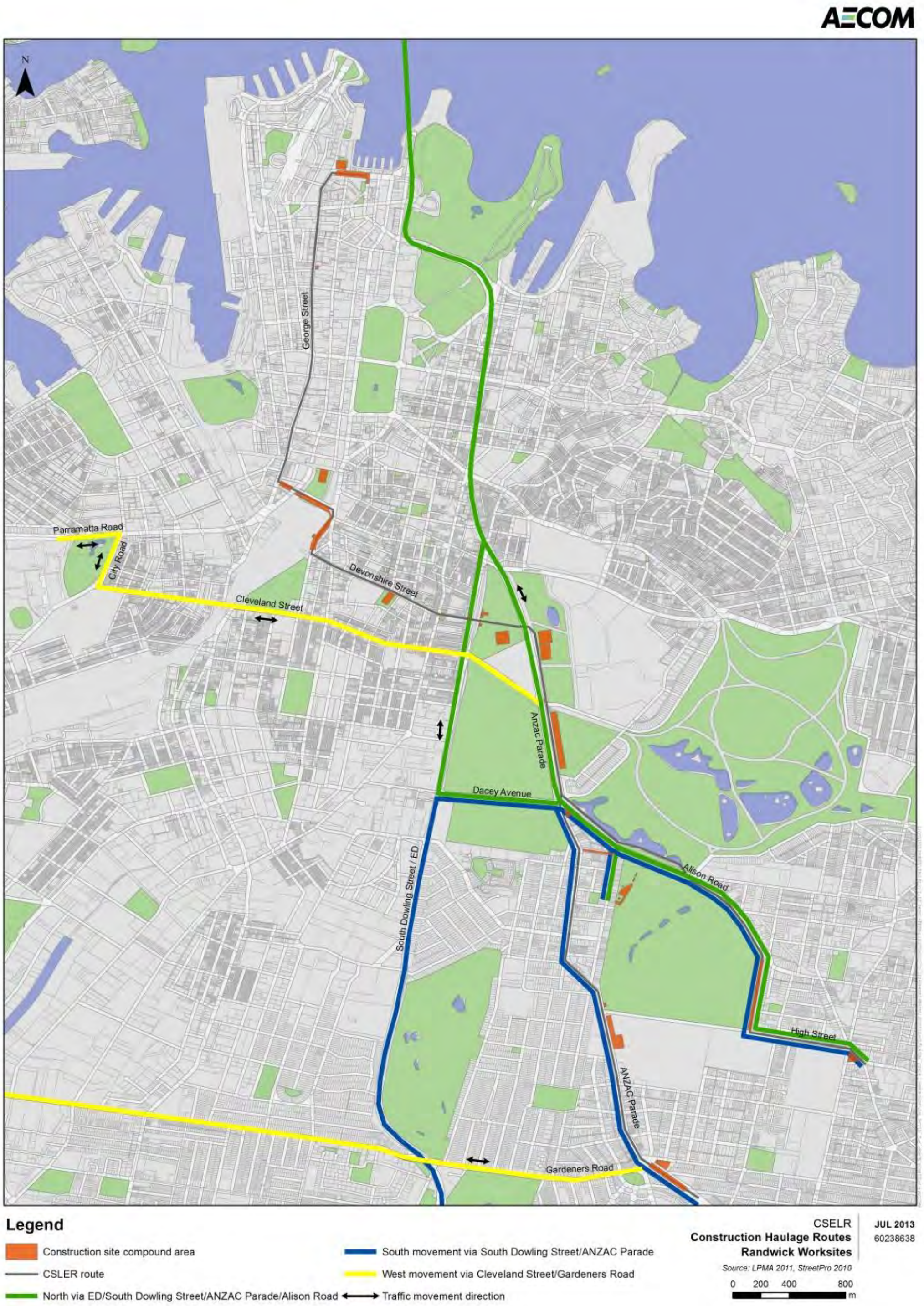
Figure 4-46: High Cross Park Worksite

The High Cross Park worksite would be accessed mainly via High Street and Belmore Road with potential access points available from all three road frontages.

4.6.2. Haulage Routes

The haulage routes for construction vehicles accessing Randwick precinct are shown in Figure 4-47.

Figure 4-47: Alison Road and High Street Construction Haulage Route



4.6.3. Traffic Management

The Randwick precinct alignment crosses three major developments of the Royal Randwick Racecourse, UNSW and the Randwick hospitals. Of these developments, the Sydney Children's Hospital is dependent on the functionality of High Street, at all times, for its emergency vehicles as well as general emergency visitations.

The lane configurations, during the construction phase, would complement the final layouts along Alison Road, Wansey Road and High Street. High Street in particular would maintain a single traffic lane in each direction at all times. Similarly, a single lane would be maintained along Wansey Road and a minimum of two lanes would be maintained along Alison Road, adjacent to the worksites, during construction.

A site south of the Royal Randwick Racecourse stabling yard is identified as one of two potential worksites to be used as the site office for the south east corridor with an area of 600 square metres for a site compound and 3,200 square metres for parking and laydown. With established access from Doncaster Avenue, the site compound could operate independent of the racecourse operations, subject to agreement from the Australian Turf Club.

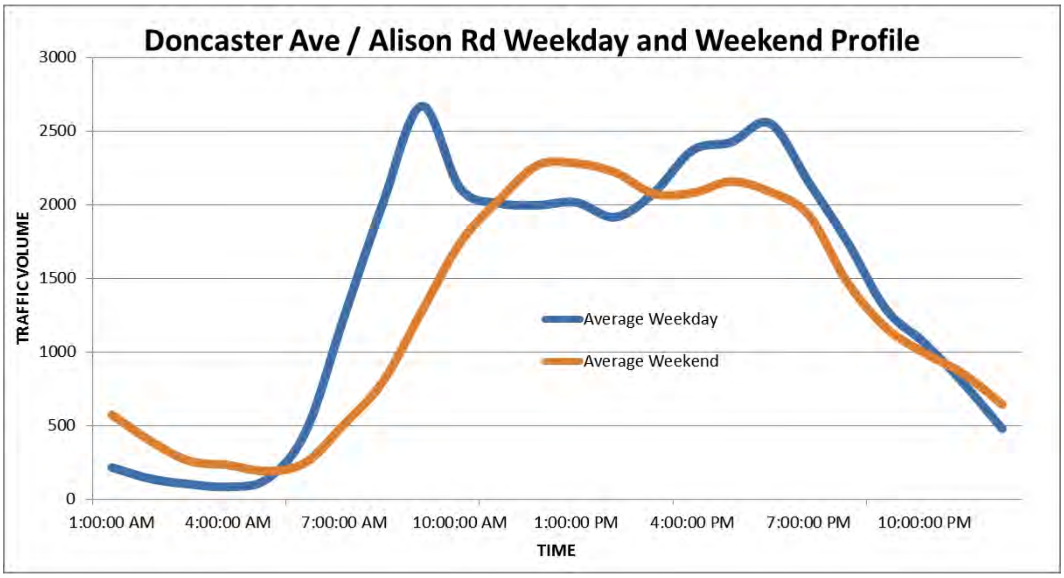
4.6.3.1. Doncaster Avenue

The intersection of Alison Road and Doncaster Avenue caters for traffic entering Alison Road from Doncaster Avenue as well as the bus movements between Alison Road and the busway. This intersection accommodates approximately 4,800 vehicle movements during the average peak hour (7:30 - 8:30AM). In addition to these peak hour commuter flows, this intersection is located adjacent to the Royal Randwick Racecourse, which generates large crowds during special events, usually held during public holidays and weekends.

The peak season for events at the racecourse, based on 2013 scheduled events, occurs between the months of September to December with one or two events scheduled per month for the remainder of the year. Another key time period is the Autumn Racing Carnival when racecourse activity would generate additional traffic on the local network.

The peak traffic movements during weekdays occur mainly during the AM and PM peak periods, whereas during the weekend, peak flows occur in the afternoon period, but with total weekend flows representing approximately 90% of the weekday traffic, as shown in Figure 4-48.

Figure 4-48: Doncaster Avenue and Alison Road Traffic Profile



To reduce the duration of potential disruption to traffic during weekday peak periods, the staged intersection works are to occur during weekends, when no events are scheduled at the racecourse.

The construction of the light rail across Alison Road would be undertaken in stages to maintain a minimum of two lanes of travel in each direction during each works stage. It is estimated that the total disruption to the intersection would be 10 weeks. The proposed staging across the intersection is contained Appendix B.9.

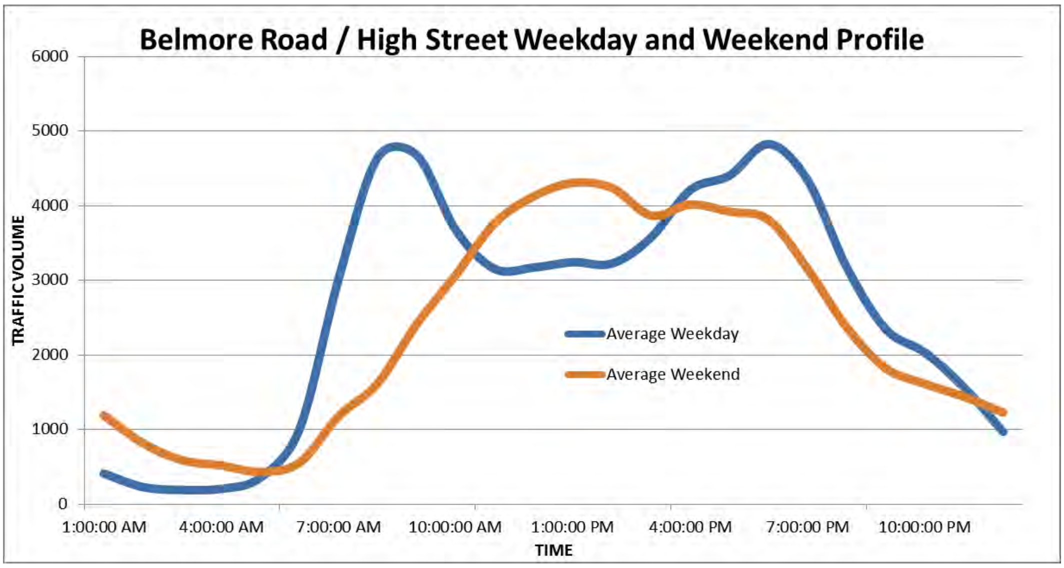
4.6.3.2. High Street

As High Street accommodates multiple developments with numerous off-street parking spaces with varying levels of parking turn-over, construction works along High Street would all be segmental hand-work. This is to minimise the disruption for the property access as well as to maintain vehicles access to the hospitals. Intersection works at Wansey Road and Botany Street would all be undertaken in staged hand-work as the work progresses along High Street, and works would be undertaken during off-peak periods, either during weeknights and/or weekends to facilitate peak hour bus movements between High Street and Botany Street as well as to cater for right turning movements from High Street to Botany Street. Regardless of construction works along High Street, traffic access would be maintained to facilitate traffic movements along High Street for vehicle access to the hospital

4.6.3.3. Belmore Road

The intersection of High Street, Belmore Road and Avoca Street is a five arm intersection that provides access to the main commercial precinct of Randwick as well as the major north-south corridor of Avoca Street and the major developments along High Street. As per the surrounding road network, the peak traffic movements at the intersection occur mainly during the AM and PM peak periods during weekdays, whereas during the weekend peak flows occurs in the afternoon period with approximately 90% of the weekday traffic, as shown in Figure 4-49.

Figure 4-49: Belmore Road / High Street Traffic Profile



To minimise the impact on peak hour movements, the Belmore Road intersection works would be staged during the weekend. During the majority of the works stages, traffic on Avoca Street south of the intersection would be reduced to a single lane in both directions. This is due to the configuration of the intersection and the alignment of the light rail crossing into High Cross Park. The intersection cross over would be undertaken over three stages over 6 weekends. The intersection staging plans are illustrated in Appendix B.10.

4.6.4. Property Access

4.6.4.1. Royal Randwick Racecourse

More than half of the Randwick precinct alignment lies along the boundary of the Royal Randwick Racecourse. At present, there are multiple access points to the racecourse situated along all the boundary streets, with three of their main access points located at Alison Road, Ascot Street and High Street, between Anzac Parade and Wansey Road.

With light rail aligned along the southern side of Alison Road, between Doncaster Avenue and Wansey Road, construction activities would impact on the Alison Road access point and this access may not be maintained. However, it is understood that this access point is used as a secondary access point during scheduled events with the majority of vehicles and taxis utilising the Ascot Street entrance for set downs and pickups. Furthermore, public parking within the in-field area of the racecourse is accessed only via the High Street access point. With an internal road network within the Racecourse providing connections between all the major access points, the closure of the Alison Road entry point during construction would still maintain accessibility to all areas of the racecourse.

Availability of the Alison Road access would only be impacted during works directly outside the entry point and once these works are complete, the access can be opened temporarily during scheduled events. Additionally, to minimise the disruption, construction activities would be on-hold during special events so as not to impact on the roundabout operation at the intersection of Ascot Street and Doncaster Avenue.

Aside from the access points mentioned previously, there are minor access points located further south along Alison Road and Wansey Road that are understood to be utilised by service vehicles throughout the week (with the Wansey Road entrance providing access to the stables). Similar to the main entrance at Alison Road, access to these minor entrances would need to be closed to vehicle traffic during the construction phase and directed to use the alternate access points located along High Street. Although this would increase the travel distance and time, the existing internal roads within the racecourse would maintain accessibility to the buildings currently serviced via Wansey Road and Alison Road.

4.6.4.2. High Street Developments

As mentioned previously, the UNSW and Randwick hospitals are both accessible via High Street. Besides these developments there are high density residential apartments, medical practices and retail stores with off-street parking provisions. With an existing road width of 12.5 metres, the kerb and guttering would require realigning, to satisfy the minimum lane widths when light rail is operational.

To minimise the impact to properties, and in particular the hospital emergency access points, the light rail construction works are proposed to be undertaken in segments and stages using 'hand-work' methods within small workzones. This would allow traffic to pass around the worksites and minimise the occupation of High Street and, in the case of the Hospital, to maintain vehicle access at all times.

4.6.5. Parking

Within the Randwick precinct the impact on parking during construction of light rail would be consistent with those of the end-state configuration. During the construction of light rail, the parking supply would reduce by 304 spaces between Darley Road and High

Cross Park. Based on these numbers, there would be a shortfall in parking capacity within the precinct, however through the proposed tightening of parking controls and restrictions as identified in the parking strategy[23], parking demand can be reduced to meet the practical capacity available.

4.6.6. Public Transport Access

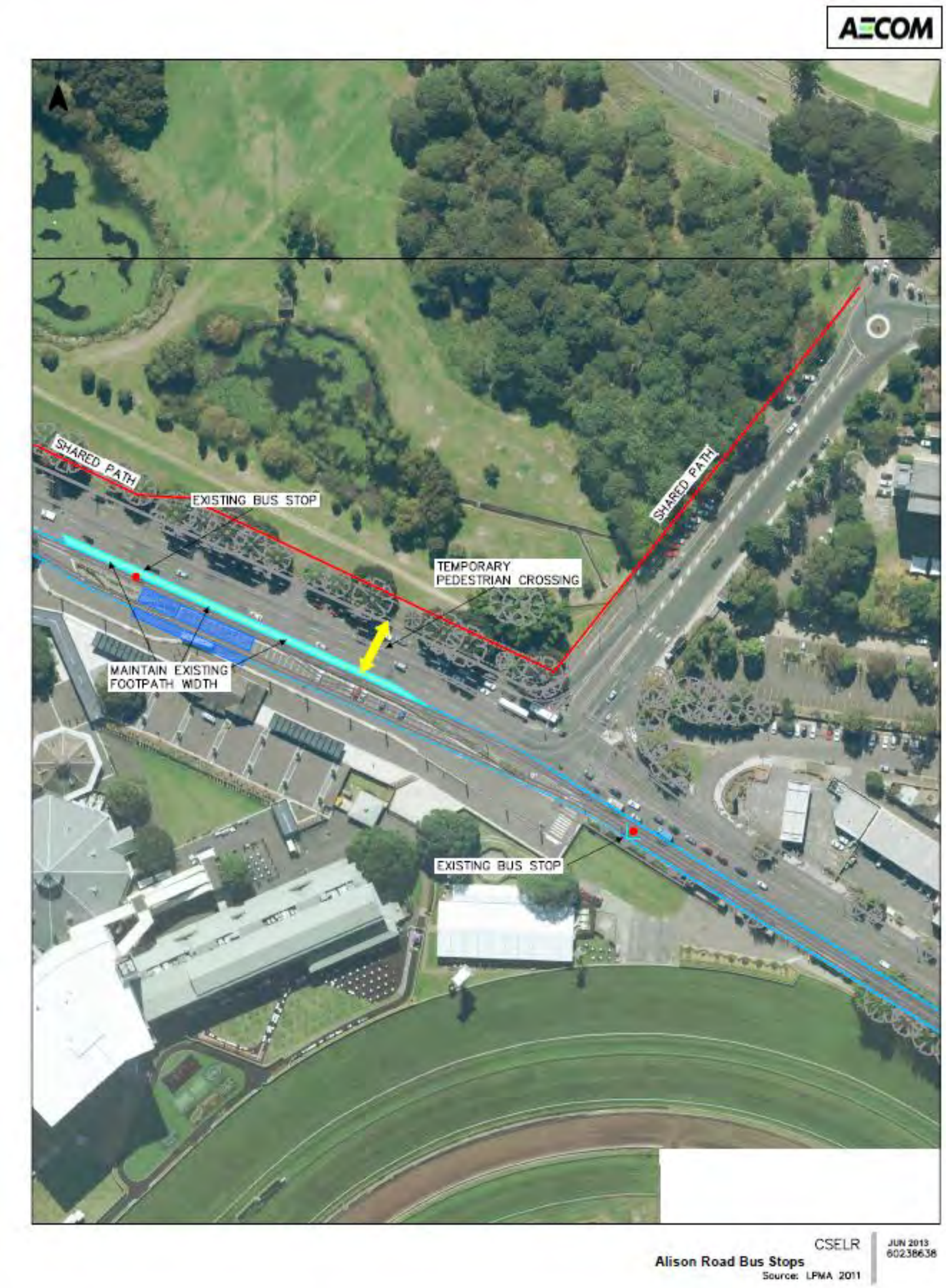
Normal bus operations will remain operational along Alison Road and High Street. The only exception would be the closure of the busway between Anzac Parade and Doncaster Avenue. As identified previously, the light rail is proposed to utilise the existing bus way corridor which will prohibit bus operations during construction. Nevertheless, bus priority measures would need to be explored at the intersection of Anzac Parade and Alison Road with detailed modeling.

4.6.6.1. Alison Road Bus Stop

With construction activities occupying the southern side of Alison Road between Doncaster Avenue and Wansey Road, pedestrian access to this section would be prohibited. At present, there is a bus stop located on the approach to Darley Road and another located adjacent to the main kerbside entrance to the Racecourse. The workzones adjacent to these areas are shown in Figure 4-50.

[23] CSELR Transport Operations Report Chapter 7 (Booz, AECOM, May 2013)

Figure 4-50: Works Zone Adjacent to the Alison Road Bus Stops



As shown in Figure 4-50, the existing bus stop adjacent to the racecourse's main entrance could remain during the construction phase, however the bus stop located to the east of Darley Road cannot be maintained. This eastern bus stop is currently serviced by 372, 373, 374, 376 and 377 which could be serviced by the bus stop outside racecourse. The express buses do not service these stops, as such removal of this eastern bus stop and utilising the western bus stop would not impact on the operation of the express bus routes.

Removal of the eastern bus stop would increase the walking distances of the bus route patrons within the region, the major generator being the TAFE Randwick Campus. To improve the access to this bus stop, a pedestrian path could be provided on Racecourse land, following discussions and agreement with ATC, to maintain continuity of the footpath on the south side of Alison Road to the eastern pedestrian leg at the intersection with Darley Road.

Alternatively, a pedestrian path may be provided within the racecourse grounds to link the bus stop with the existing pedestrian crossing at the intersection of Darley Road and Alison Road. Again this requires discussions and an agreement with ATC.

4.6.6.2. Blenheim Street Bus Diversion

At the intersection of Clara Street and High Street the swept path movements for buses turning between High Street west and Clara Street cannot be accommodated during construction. Therefore, a bus diversion via Blenheim Street would be required for the bus routes 357, 400 and 410 as shown in Figure 4-51.

The diversion shown in Figure 4-51 would require the relocation of the High Street bus stops to Clara Street, north of Blenheim Street. This is consistent with the end-state light rail proposals, whereby the bus stops would be located on Clara Street south of Blenheim Street. As there are no other existing bus stops between the existing bus stop and Botany Street, the impact of the bus diversion would be minimal.

Figure 4-51: Blenheim Street Bus Diversion

4.6.6.3. Alison Road Busway

As identified previously, the light rail corridor would share the busway, located north of Alison Road within Moore Park. As such, buses would not be able to access this portion of the busway during construction and would be required to travel within the Alison Road traffic lanes. This would increase the travel time for buses through the intersection of Alison Road and Anzac Parade and impact on reliability of the services. Potential mitigation measures would be to allow bus priority lanes in the peak direction during peak hours together with bus priority measures at the intersection of Anzac Parade and

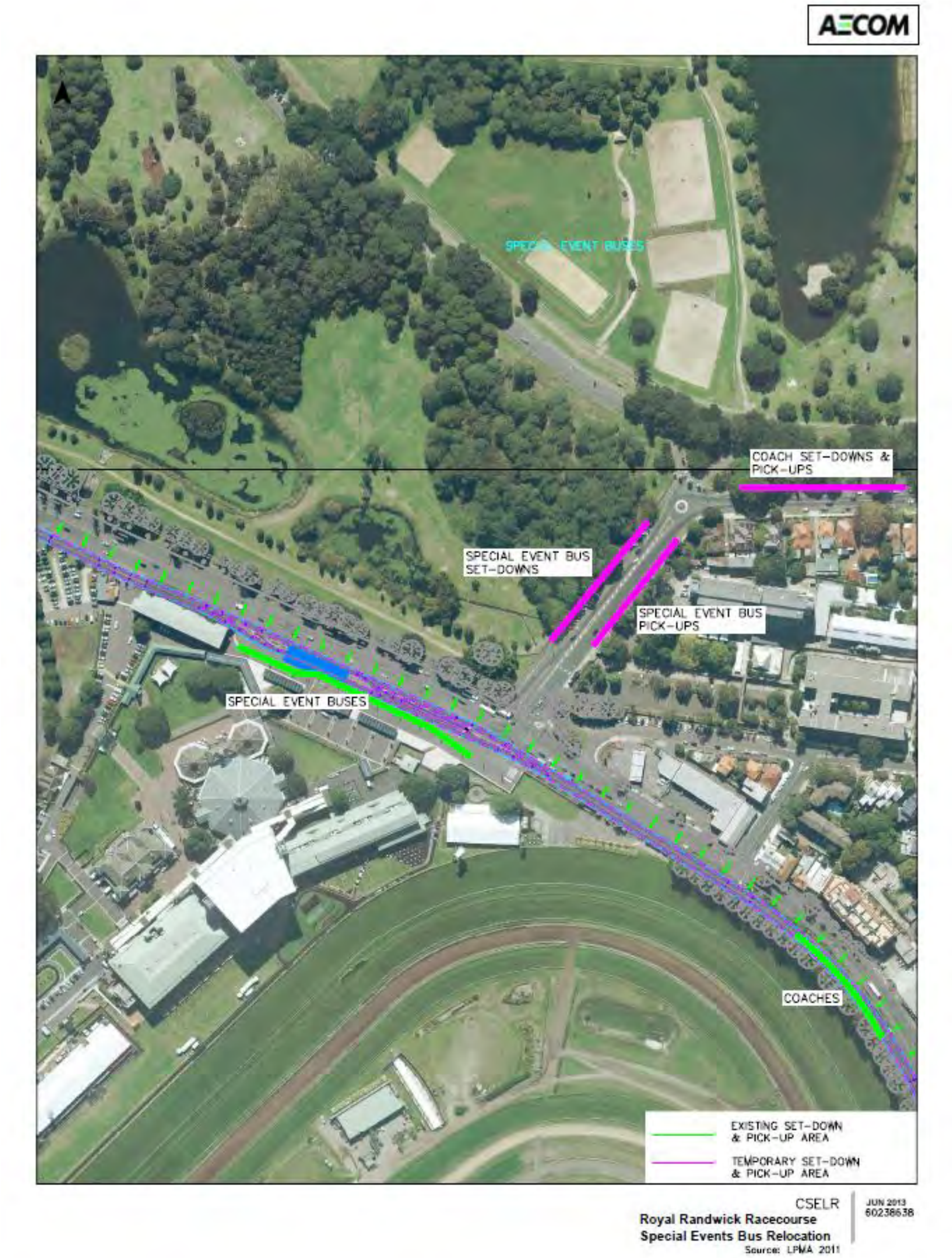
Alison Road. These priority measures will be explored as part of the Traffic Management Plans in consultation with the bus operators and the relevant Road Authority.

4.6.6.4. Special Events Public Transport and Coach Access

During major events at Royal Randwick Racecourse, special event buses operate to transfer visitors between Central Station and the racecourse. These services operate via the passenger drop off zone located within the racecourse grounds along Alison Road. Similarly, private coaches utilise the kerbside amenities to set-down and pick-up passengers along Alison Road between Darley Road and Wansey Road.

With the Alison Road frontage of the racecourse to be designated as a works zone, for the entirety of the construction phase, alternate passenger set-down and pick-up areas are required. The temporary locations for special event buses and coaches during construction would be along Darley Road adjacent to the TAFE Randwick campus as shown in Figure 4-52.

Figure 4-52: Temporary Royal Randwick Racecourse Special Events Bus Set-down and Pick-up Zone



To facilitate the set-down and pick-up zone along Darley Road, the existing on-street angle parking provisions along Darley Road would need to be revised to allow the extension of the existing bus zones. It is noted that these bus zones would only be required during events scheduled at the racecourse and that wardens would be installed within the bus zones to provide directions to visitors and manage the buses.

Given the crowds generated during the events, the temporary relocation of the bus zones would require the retention of the existing pedestrian crossing at the intersection of Alison Road and Darley Road or an alternate facility to safely cross Alison Road, such as police/traffic controllers to manage the large crowds. During events scheduled at the racecourse, construction activities adjacent to the main entrance to the racecourse would be planned to allow safe pedestrian access across the worksites would be provided.

4.6.6.5. University Express Services 890, 891 and 892

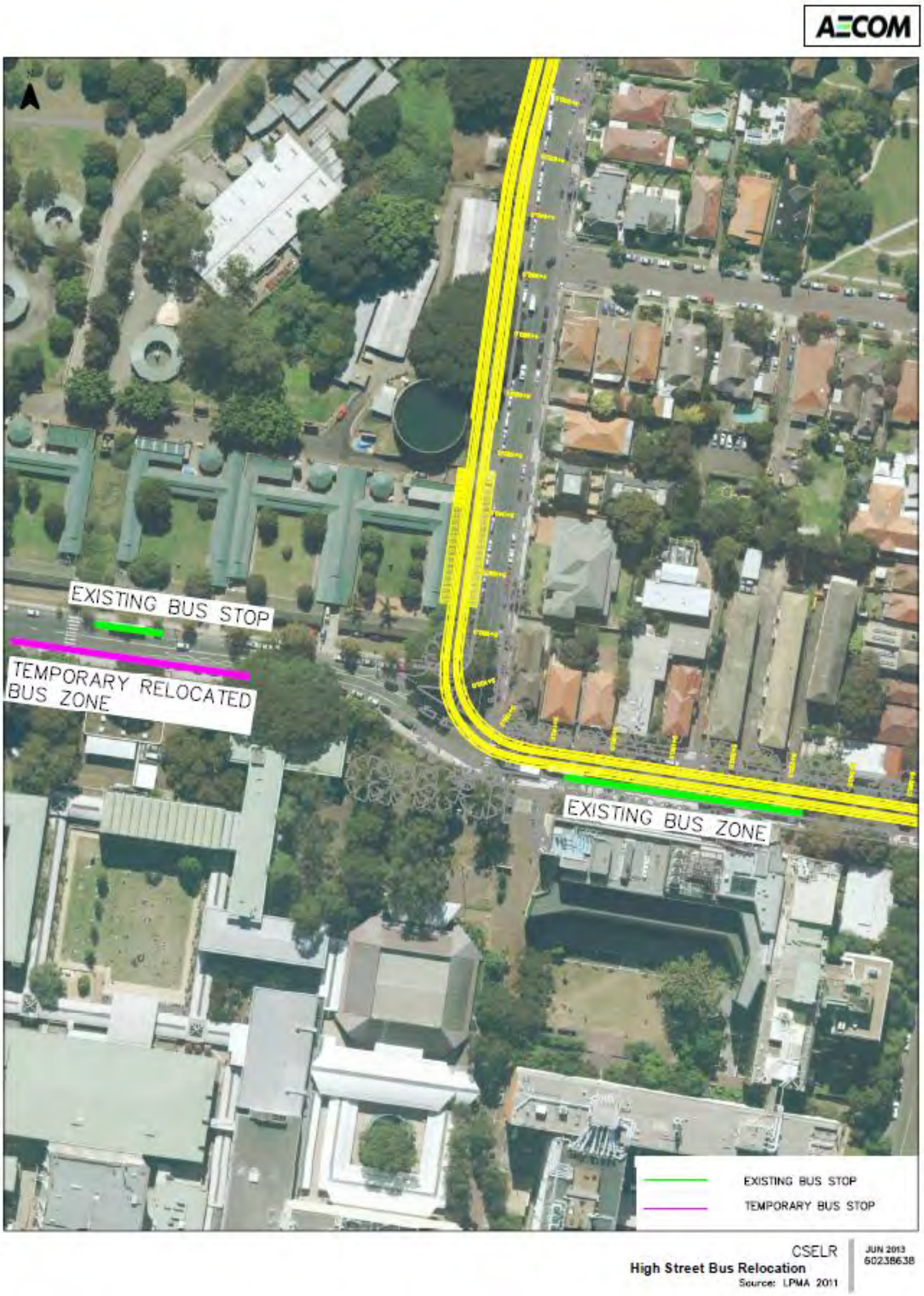
Throughout the construction phase, the university express services 890, 891 and 892 will continue to service the university via Central Station and Circular Quay. The key intersection of High Street and Anzac Parade will accommodate existing bus operations during peak periods. The intersection works at this location will be limited to weekend periods which would limit the manoeuvrability of vehicles, however the university express services only operate during weekday peak periods.

Construction activities along High Street will be contained between Wansey Road and Belmore Road with minimum of one traffic lane in each direction maintained for the majority of the construction as detailed in Sections 4.6.3.2 and 4.6.4.2. Construction activities at the signalised intersection of Botany Road and High Street will occur outside of peak periods to minimise the impact on the university express buses.

At present, the bus stops outside the UNSW, adjacent to Gate 9, is utilised by numerous regular bus services as well as University express services. With the operation of the light rail, an indented bus bay would be provided for the westbound services, adjacent to the existing bus stop, and the eastbound bus stop would be removed. During construction, to reduce any conflict between the bus operations and construction activities, a westbound bus stop is proposed west of Wansey Road, as shown in Figure 4-53.

The existing bus stops located adjacent to the rail stations currently servicing the university express services will remain operational throughout the construction phase.

Figure 4-53: UNSW High Street Bus Relocation



4.6.7. Pedestrian and Cycle Access

The existing shared pedestrian and cycle path along the Royal Randwick Racecourse frontages of Alison Road and Wansey Road would be closed for the duration of construction. During this time, pedestrians would be directed to use the opposite footpaths on Wansey Road and Alison Road. To facilitate the movement of pedestrians in the region, the signalisation of the Wansey Road and Alison Road intersection would need to be implemented as part of the early works so that pedestrians can safely cross Alison Road during the construction phase.

With combined factors of steep road gradient, high traffic volumes during peak hours and reduced lane capacities, Alison Road would not be a desirable on-road cycle route during construction. Alternate on-road cycle routes would be signposted during the construction phase to maintain suitable cycle access to UNSW and the southern Randwick precinct.

A multi-criteria analysis examined suitable cycle route alternatives providing a north south connection between strategic cycle routes and the major attractor of UNSW. Existing Randwick City Council on-road cycle routes would be encouraged through signposting and line marking. Potential cycle routes that service the north-south connection include:

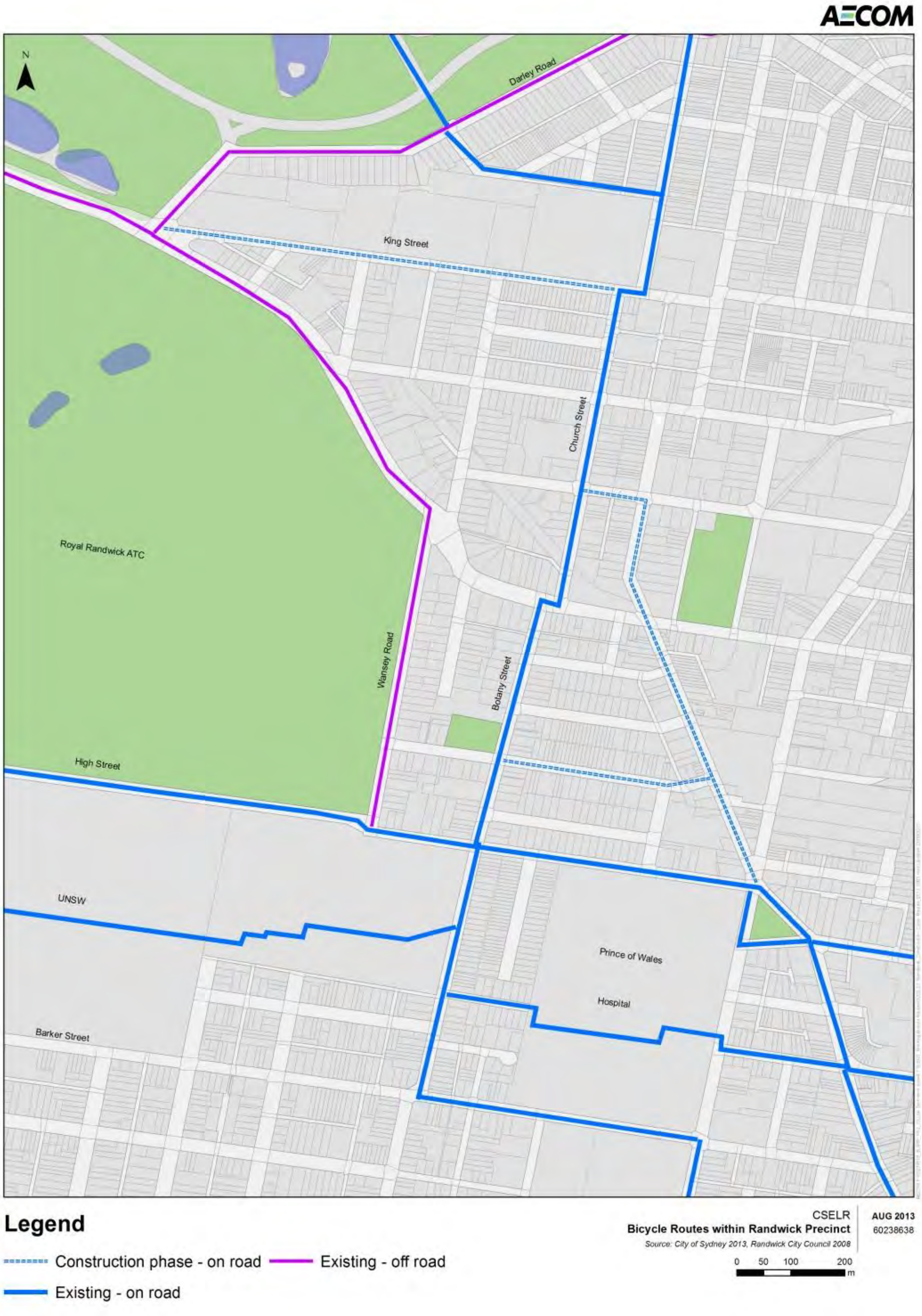
- Botany Street, Church Street and King Street;
- Botany Street, Church Street, and Dangar Street;
- Church Street, Frances Street, Cook Street, and Belmore Road; and
- University Mall, Day Avenue, Doncaster Avenue;

The majority of these streets are currently designated by Randwick City Council as on-road cycle routes.

In addition to the north-south connection, the designated High Street on-road cycle route would be affected for the duration of construction. During this time, cyclists would be directed to alternative east-west routes, including the parallel Arthur Street connection to Belmore Road.

Although these routes may extend the distance of cycle trips, the traffic volumes through these roads are considerably lower than Alison Road during peak hours, contributing to an improved cycling environment. The alternate routes are shown in Figure 4-54.

Figure 4-54: Alternate Randwick Precinct Cycle Route



Line marking and signs would need to be installed along the temporary route to notify drivers of the presence of cyclists on the road. Furthermore, directional signs would need to be installed at key locations to direct cyclists along the cycle route. In total the temporary route would extend cycle trips by approximately 500-600 metres.

For the majority of the alignment, the existing pedestrian footpaths would be maintained, except during kerb realignments and services relocations where the footpaths would be narrowed and localised diversions would be in place to protect the pedestrians from the road activities.

Pedestrian crossing opportunities would be maintained during intersection works at Botany Street and Belmore Road either by maintaining the existing pedestrian facilities or providing alternate crossing opportunities at adjacent locations.

4.6.8. Emergency Vehicle Access

During construction, no special provisions would be provided adjacent to the worksites within the Randwick precinct. It is assumed that emergency services would travel via the open general traffic lanes along Alison Road and High Street, and the surrounding roads when responding to emergencies. When responding to emergencies within the worksites, it is intended that the emergency vehicles would utilise the construction vehicle paths, only on approach to the block, and the adjacent traffic lanes would form the key access point.

4.6.9. Taxis

There is one taxi zone located on High Street, outside the Prince of Wales Hospital. As per the end state, this taxi zone would be removed during the construction phase. The nearest location for a taxi zone is Clara Street, opposite the existing taxi zone. In keeping with the relocation of the bus zones, the taxi zone would be relocated to Clara Street, adjacent to the bus stops.

5. Glossary

Term	Acronym / Abbreviation	Description
Average Annual Daily Traffic	AADT	A transportation engineering measure used to express the total volume of vehicle traffic of a highway or road for a year divided by 365 days.
Bi-directional Signalling		Signalling system which allows trains to move in either direction on a single track with safe separation between trains.
Car		An individual vehicle within a Train Set.
CityRail (Sydney Trains) Station		Existing rail station on the Sydney Trains (formerly CityRail) network.
Consent		Approval to undertake a development received from the consent authority. Also referred to as development consent.
Construction Environmental Management Plan	CEMP	A document setting out the management, control and monitoring measures to be implemented during construction of a development, to avoid or minimise the potential environmental impacts identified during an environmental impact assessment process.
CBD &South East Light Rail	CSELR	The project, Sydney CBD and South-East Light Rail
Construction site (or worksite)		Land required for construction activities associated with the project (including storage, amenities, site offices, etc.), and may be required for the construction and commissioning phases. A construction site may be temporary (e.g. for Enabling Works such as adjustment to a water main) or long term (e.g. a station construction worksite).
Construction Traffic Management Plan	CTMP	Measures put in place during construction projects to manage construction activities, provide safe worksites and minimise disruption to businesses and residents

Term	Acronym / Abbreviation	Description
Construction Traffic and Transport Management Strategy	CTTMS	This Framework is for Sydney CBD and South East Light Rail (CSELR) project. This provides a procedures and techniques for mitigating or managing construction impacts on to general traffic, pedestrians, cyclists, and public transport services past the worksites, manage traffic flows through, and around, the construction zone and haulage routes, minimise the impact of construction on local residents and businesses; and address local and regional traffic impacts during construction.
Controlled Access Lane		Access for construction, local access and emergency vehicles is maintained through work area, under traffic controllers.
Degree of Saturation	DoS	A transportation engineering measure used to express how much demand an intersection or road is experiencing compared to its total capacity.
Director-General's requirements		Requirements for an environmental assessment issued by the Director-General of the Department of Planning in accordance with the *Environmental Planning & Assessment Act 1979*.
Disability Discrimination Act	DDA	The Commonwealth legislation *(Disability Discrimination Act, 1992)* aimed at improving access including on public transport for people with a disability.
End-state		A term used to describe the condition / arrangement of infrastructure in the post-construction phase.
Environmental Assessment	EA	Is an assessment of the possible impact that a proposed project may have on the environment; considering natural, social and economic aspects.
Environmental Impact Statement	EIS	This refers to the report assessing the potential impacts of a proposed Project. EIS would be assessed under Part 4 or 5 of the Environmental Planning and Assessment Act 1979. The assessment will be determined by the Minister for Planning and Infrastructure.
Framework Traffic Management Plan	FTMP	Strategies for proposed traffic management measures that will be established and practiced throughout the construction period of a project.

Term	Acronym / Abbreviation	Description
Handwork		Construction works that rely on manual techniques rather than use of specialised machinery. Generally used at intersections and where confined worksite space restricts use of machines.
Headway		The difference in time or distance between two trains travelling in the same direction.
Heavy rail		The structures and vehicles of railways not falling under the description of trams, light rail, medium capacity system, or rapid transit. In this case, it is Sydney Trains network (formerly CityRail).
Light Rail Construction Contractor	LRTCC	Plan for site access for contractors and public during construction and operation phases.
Light Rail Operations Contractor	LRTO	Light Rail Operations contractor responsible for rollingstock, systems, and station works, fit-out and services including mechanical and electrical.
IMO site access plan		The plans of that name that form part of the project management plans and must be updated by the project company in accordance with the plan and reports schedule.
Inner West Light Rail	IWLR	The existing Pyrmont Light Rail and Inner West extension.
Integrated ticketing		Allows a person to make a journey that involves transfers (within or between different transport modes) with a single ticket that is valid for the complete journey.
Integrated transport		A network of different transport modes providing efficient journeys.
Integrated Transport and Land Use	ITLU	Technical Advisor for the Sydney Light Rail on behalf of Transport for NSW.
Intelligent Transport Systems	ITS	Information and communications technology within transport infrastructure and vehicles to improve transportation safety efficiency.
Interchange point		Location that provides for transfer from one mode to another e.g. to heavy rail, light rail or buses.

Term	Acronym / Abbreviation	Description
Kiss-n-ride		Where a car passenger is dropped off at a public transport station/bus interchange by a private car. This is generally by a family member, hence the 'kiss' goodbye.
Level of Service	LoS	Level-of-service for signalised and unsignalised intersections defines the average vehicle control delay
Light rail		A form of urban rail public transportation that generally has a lower capacity and lower speed than heavy rail and metro systems, but higher capacity and higher speed than street-running tram systems.
Maintenance depot		Land including buildings and facilities for the maintenance of the light rail including rolling stock and the infrastructure.
Mode split		The proportion of passengers between different transport modes.
Network Co-ordination Liaison Group	NCLG	The Network Coordination Liaison Group is a group of key stakeholders who are to be formed to develop and manage traffic and transport issues relating to construction of Light Rail. Issues are considered at a strategic level to ensure consistency and considered within the context of the wider network.
Over-Head Wiring	OHW	The OHW supplying power to the SLR will be fixed to poles, where feasible co-ordinated with existing street lighting poles
Open Access Lane		Access lane provided outside work area for construction, local access and emergency vehicles.
Paid concourse		Area of the station that can only be accessed by ticket holders.
Permanent Route Infrastructure	PRI	Comprises the civil works to be designed and constructed by the construction contractor for handover to the operations contractor for the CBD &South East Light Rail.
Product		The new CBD &South East Light Rail in total including assets, brand, systems, intellectual property, interfaces and metro services.
Product Specification		A Sydney Light Rail document which sets out the owner and technical requirements.

Term	Acronym / Abbreviation	Description
Project		The construction and operation of the proposed Sydney Light Rail as considered by the preliminary environmental assessment.
Proponent		The person proposing to carry out development comprising all or any part of the project, including any person certified by the Minister for Planning to be the proponent (such certification to be obtained prior to commencement of the relevant part of the project).
Rail Clearways program		The Rail Clearways program is an initiative of the NSW Government to improve capacity and reliability on CityRail's Sydney suburban network.
Road header		Machine used to excavate tunnels with a boom-mounted cutting head.
Roads and Maritime Services	RMS	It is a state government authority responsible for building and maintaining infrastructures, providing licence and registration services, managing compliance to rules and regulations, providing safety management services, delivering traffic management services, environmental solutions, managing tolling and regulating users of roads and waterways.
Road Occupancy Licence	ROL	A Road Occupancy Licence is a process whereby an Authority (primarily RTA) gives its approval for an activity which involves removing one or more lane of the road from traffic or parking use to another use – usually temporary construction.
Rolling stock		Standard trains used on the Light Rail.
Scramble crossing		A pedestrian crossing scheme which comprises concurrent all-red phase for vehicles and green pedestrian phase on all arms.
Spoil		Excess material resulting from excavation, generally comprising existing road paving and subgrade, soil and rock material.

Term	Acronym / Abbreviation	Description
Stabling facility		Location where rolling stock (trains) are stored when not in service.
Station		Refers to proposed Light Rail station infrastructure, including platforms, concourse, pedestrian connections, and associated requirements / facilities to service the station.
Station concourse		Areas of the station that can be accessed by any member of the public.
Station Plan		Plans that may be prepared for land on which light rail stations are to be situated, and land in the vicinity of such stations, with respect to development, traffic and parking management arrangements, pedestrian links and access facilities, retail and commercial development associated with Metro railway stations, public domain amenities and improvements, and other matters ancillary to the operation of light rail and any associated transport or other facilities.
South East	SE	This refers to South-East Light Rail project, which covers the south and east of the Sydney central business district. It includes suburbs of Surry Hills, Moore Park, Kensington, Kingswood and Randwick.
Sydney Coordinated Adaptive Traffic System.	SCATS	A computerised traffic light management system.
Sydney Light Rail Strategic Plan	SLRSP	Sydney Light Rail Strategic Plan.
Ticket Vending Machine		Vending machine capable of dispensing, charging and displaying information about ticket media.
Traffic Control Plan	TCP	Plans detailing proposed traffic management for construction staging, including traffic diversions, delineation and signposting.

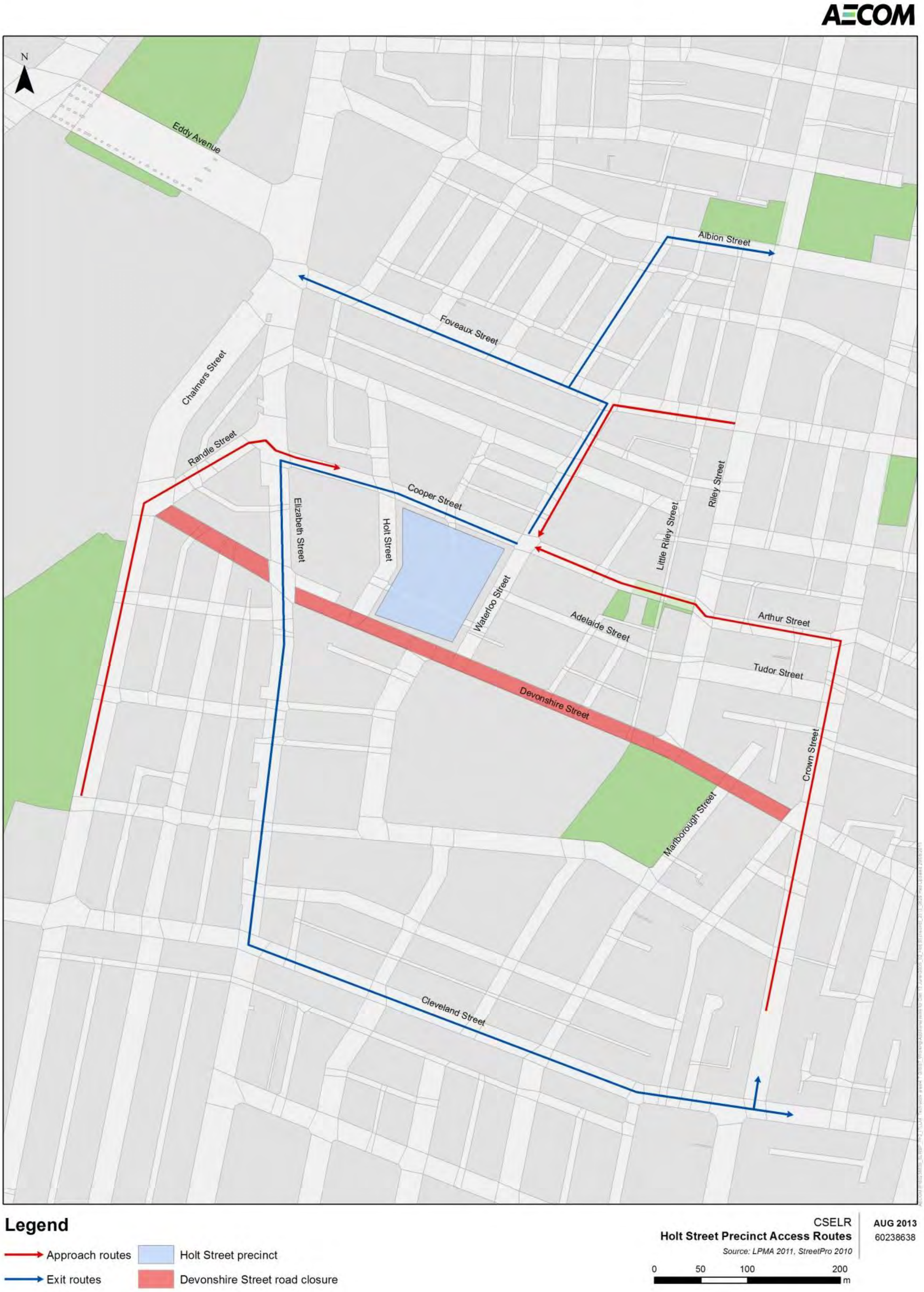
Term	Acronym / Abbreviation	Description
Transport for New South Wales	TfNSW	Transport for NSW is a state government authority responsible for planning, program administration, policy, regulation, procuring transport services, infrastructure and freight. Also providing safe, reliable, clean and efficient transport services to improve the customer experience.
Transport Management Centre	TMC	Transport Management Centre is a part of Transport for NSW responsible for monitoring and managing of the 18,000km NSW State road network 24 hours a day, seven days a week.
Traffic Management Plan	TMP	Measures put in place during construction projects to manage construction activities, minimise traffic disruption and avoid potential safety problems.
Traffic and Transport Liaison Group	TTLG	A group consisting of key stakeholders organised on a local Council basis to discuss and approve in principle to permanent and temporary traffic and surface transport issues relating to stations and worksites.
Transitway	T-way	A Transitway is a bus-only or high-occupancy vehicle road that forms part of a bus rapid transit system. Transitways are usually grade-separated from regular traffic and employ various prioritisation techniques such as exclusive traffic signal phases.
Turnback		Configuration of tracks allowing a train to terminate a service and return to its starting point.
Urban context		The broader area considered for patronage and planning, which is generally a 1km radius of the proposed station.
University of New South Wales	UNSW	The main Kensington Campus located adjacent to Anzac Parade and High Street
Utility Services		Any utility service, including water, electricity (including for the avoidance of doubt, the emergency electrical systems and any diesel or other fuel required for the operation of those systems), steam/condensate, fire services, gas, telephone, drainage, sewerage and all communications services.
Variable Message Sign	VMS	Equipment used in Intelligent Transport Systems to inform and or manage road users.

Term	Acronym / Abbreviation	Description
Wire Free Operation	WFO	Wire free operation to supply power for the CESLR to avoid the need to mount overhead wires on new or existing poles.

6. Appendices

Appendix A.1 Rocks Precinct Access Plan

Appendix A.2 Surry Hills precinct Access Plan



Legend

Approach routes

Exit routes

Adelaide Street precinct

Devonshire Street road closure

CSELR

Adelaide Street Precinct Access Routes

Source: LPMA 2011, StreetPro 2010

0 50 100 200 m

AUG 2013

60238638

Legend

- Approach routes
- Exit routes
- Traffic direction
- Esther Lane precinct
- Devonshire Street road closure

CSELR
Esther Lane Precinct Access Routes
Source: LPMA 2011, StreetPro 2010

0 50 100 200 m

AUG 2013
60238638

AECOM

Legend

Approach routes — Clisdell Street precinct

Exit routes — Devonshire Street road closure

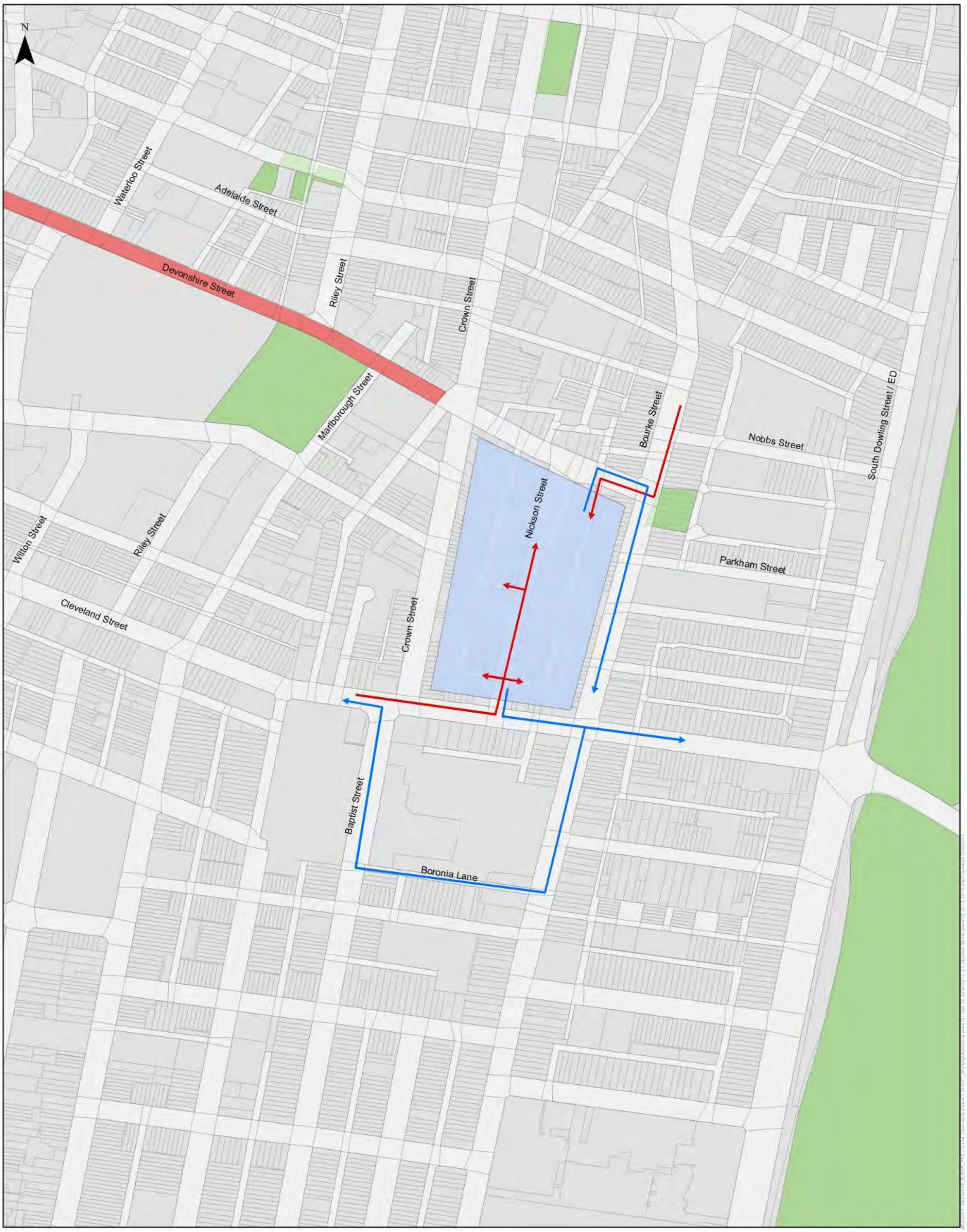
CSELR
Clisdell Street Precinct Access Routes
Source: LPMA 2011, StreetPro 2010

0 50 100 200 m

AUG 2013
60238638

AECOM
N
Chalmers Street
Randle Street
Elizabeth Street
Waterloo Street
Adelaide Street
Devonshire Street
Riley Street
Crown Street
Clisdell Street
John Northcott Place
Belvoir Street
Marlborough Street
Wilton Street
Riley Street
Nickson Street
Cleveland Street
Crown Street
Baptist Street
Boronia Lane
Legend
Approach routes
Exit routes
John Northcott precinct
Devonshire Street road closure
CSELR
John Northcott Precinct Access Routes
Source: LPMA 2011, StreetPro 2010
AUG 2013
60238638
0 50 100 200 m

AECOM
N
Chalmers Street
Randle Street
Elizabeth Street
Waterloo Street
Adelaide Street
Devonshire Street
Riley Street
Crown Street
Clisdell Street
Belvoir Street
Marlborough Street
Nickson Street
Wilton Street
Riley Street
Cleveland Street
Crown Street
Baptist Street
Boronia Lane
Legend
Approach routes
Exit routes
Traffic direction
Marborough Street precinct
Devonshire Street road closure
CSELR
Marlborough Street Precinct Access Routes
Source: LPMA 2011, StreetPro 2010
AUG 2013
60238638
0
50
100
200
m



Legend

- Approach routes
- Exit routes
- Traffic direction
- Nickson Street precinct
- Devonshire Street road closure

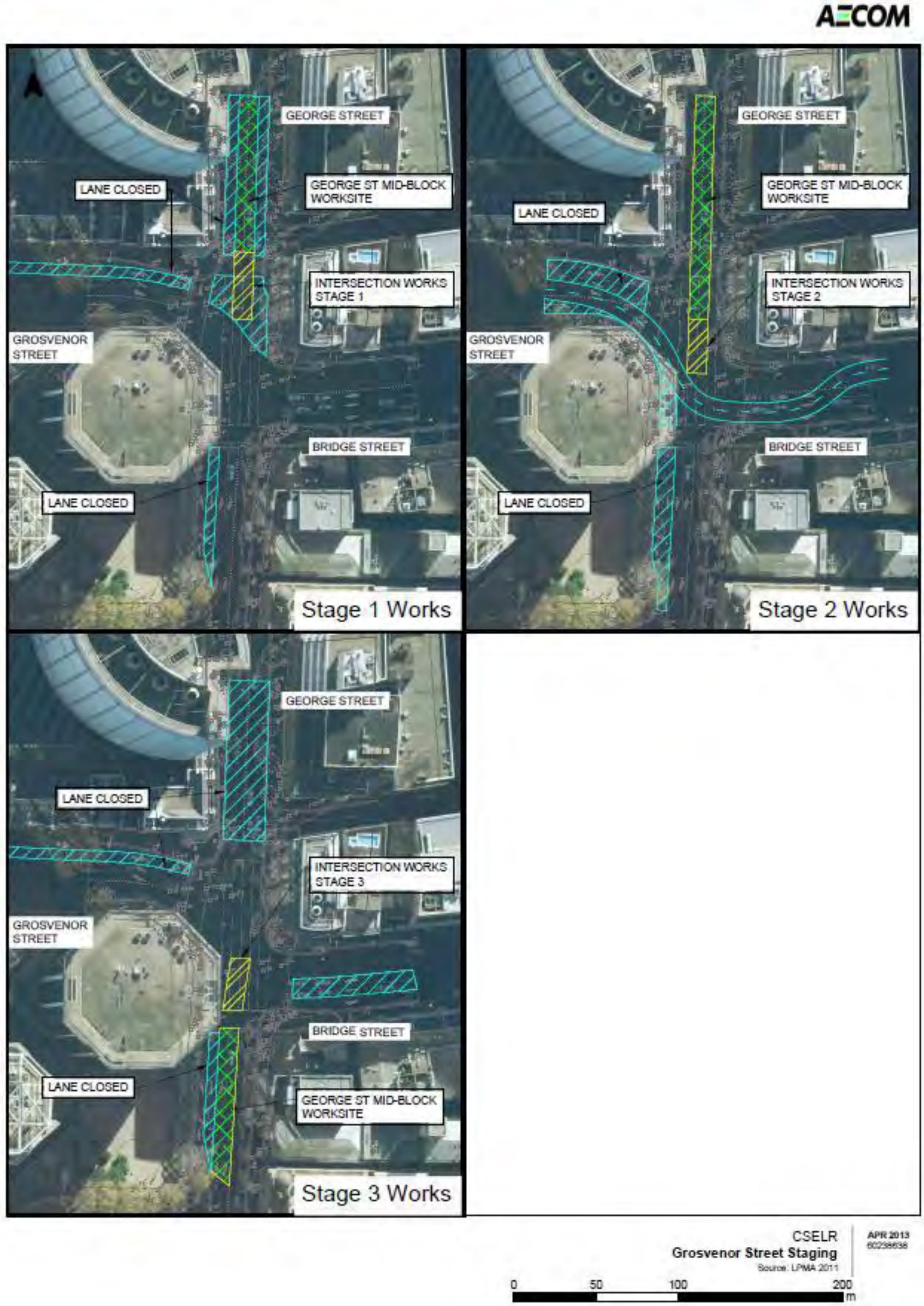
CSELR
Nickson Street Precinct Access Routes
Source: LPMA 2011, StreetPro 2010

0 50 100 200 m

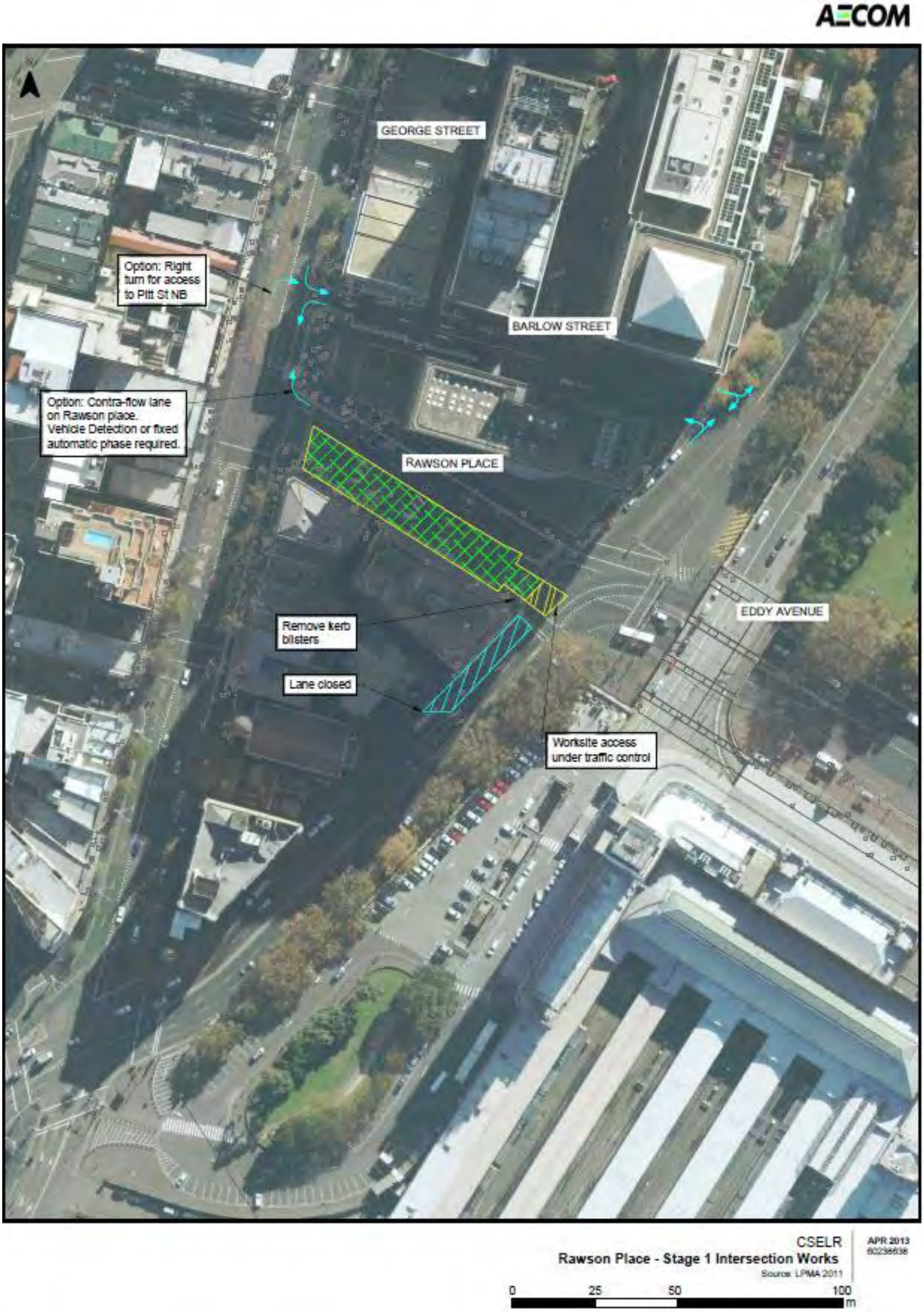
AUG 2013
60238638


AECOM
N
Eddy Avenue
Albion Street
Foveaux Street
Chalmers Street
Randle Street
Cooper Street
Elizabeth Street
Holt Street
Little Riley Street
Riley Street
Waterloo Street
Adelaide Street
Arthur Street
Tudor Street
Devonshire Street
Crown Street
Marlborough Street
Cleveland Street
Legend
Approach routes
Exit routes
Tudor Street precinct
Devonshire Street road closure
CSELR
Tudor Street Precinct Access Routes
Source: LPMA 2011, StreetPro 2010
AUG 2013
60238638
0
50
100
200
m

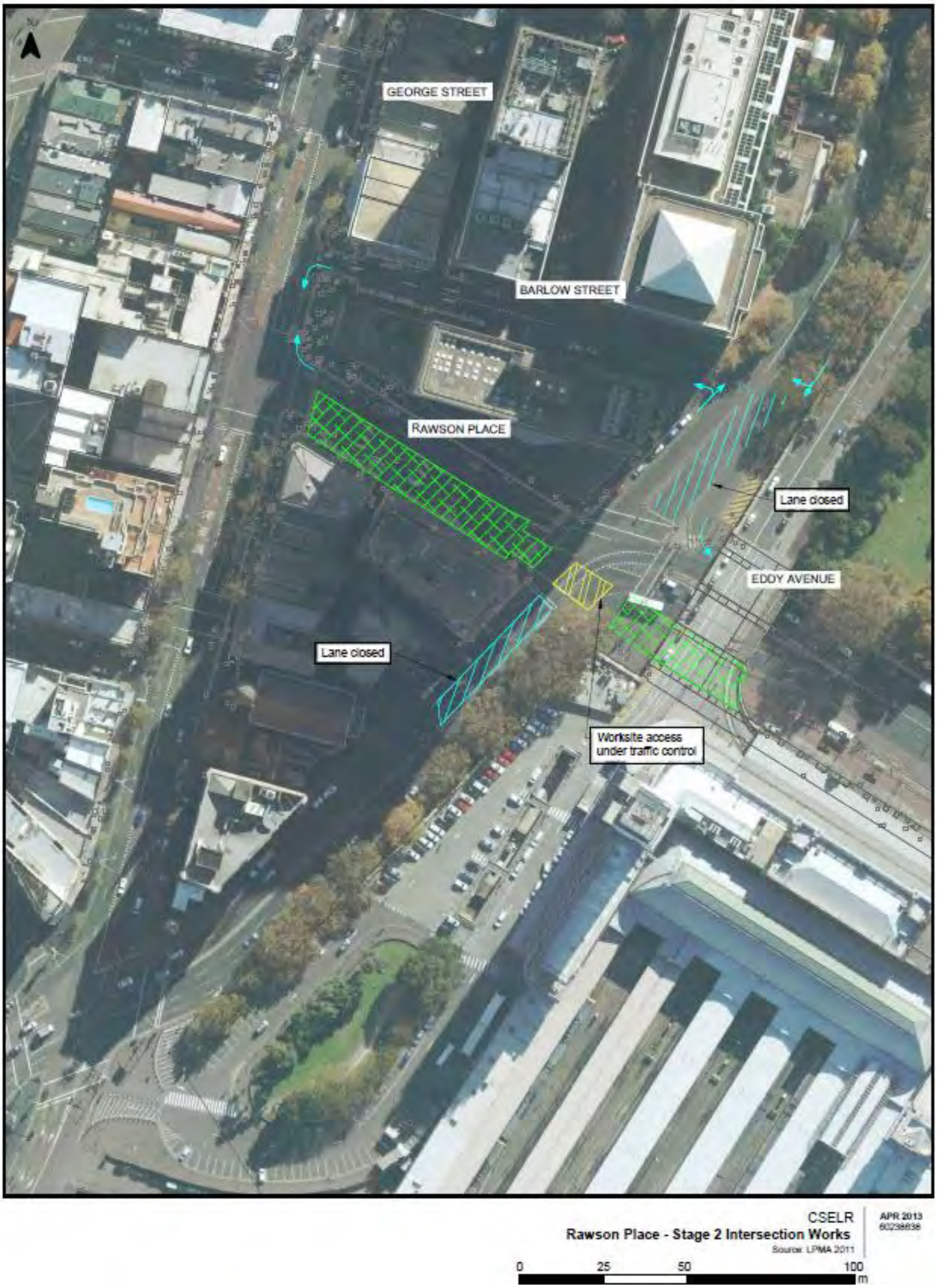
Appendix B.1 Bridge / Grosvenor Street Indicative Staging Diagram



Appendix B.2 Pitt Street / Eddy Avenue Indicative Staging Diagram



AECOM


GEORGE STREET
BARLOW STREET
RAWSON PLACE
Lane closed
EDDY AVENUE
Lane closed
Worksite access under traffic control
CSELR
Rawson Place - Stage 2 Intersection Works
Source: LPMA 2011
APR 2013
60238638
0
25
50
100
m

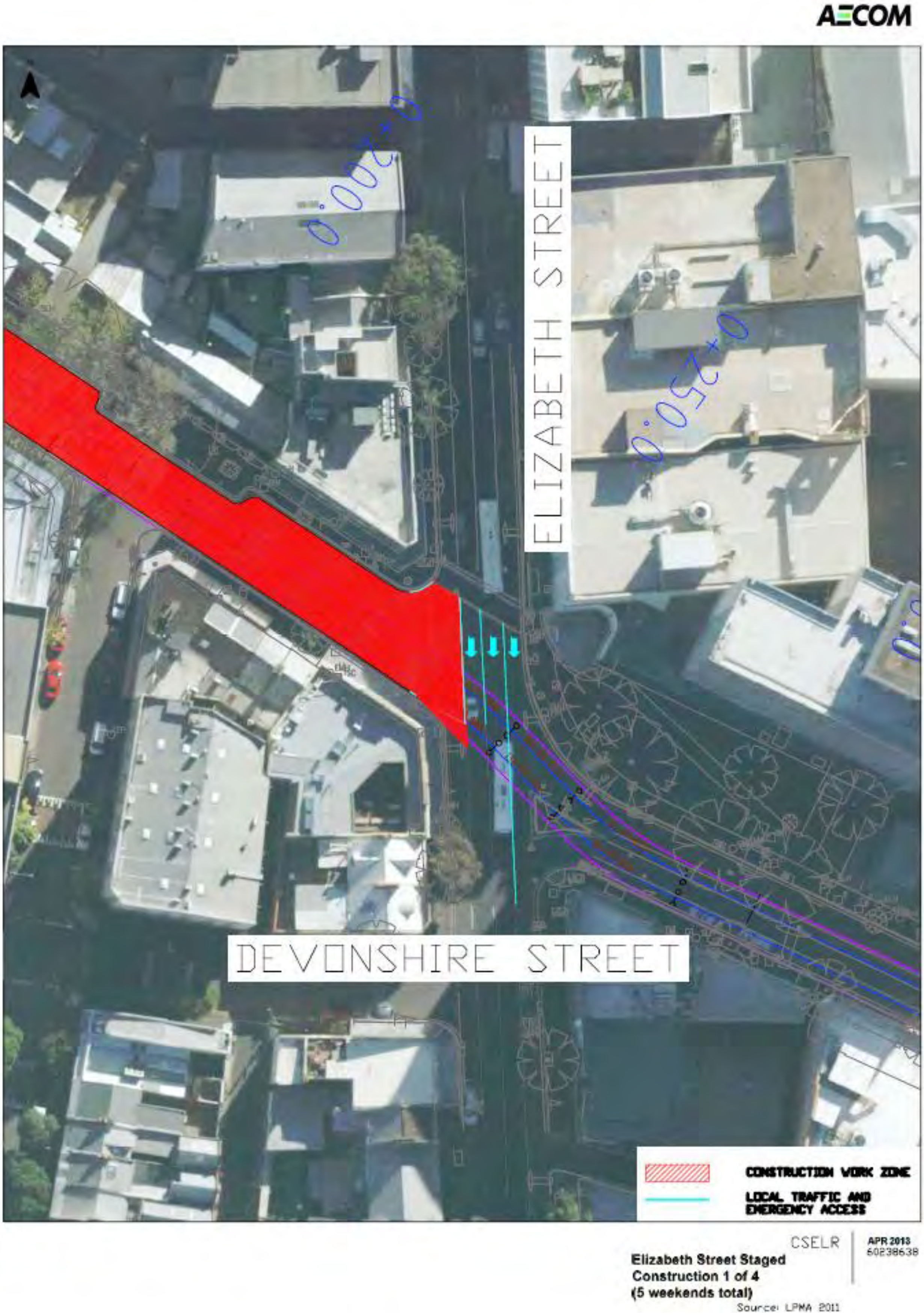
AECOM

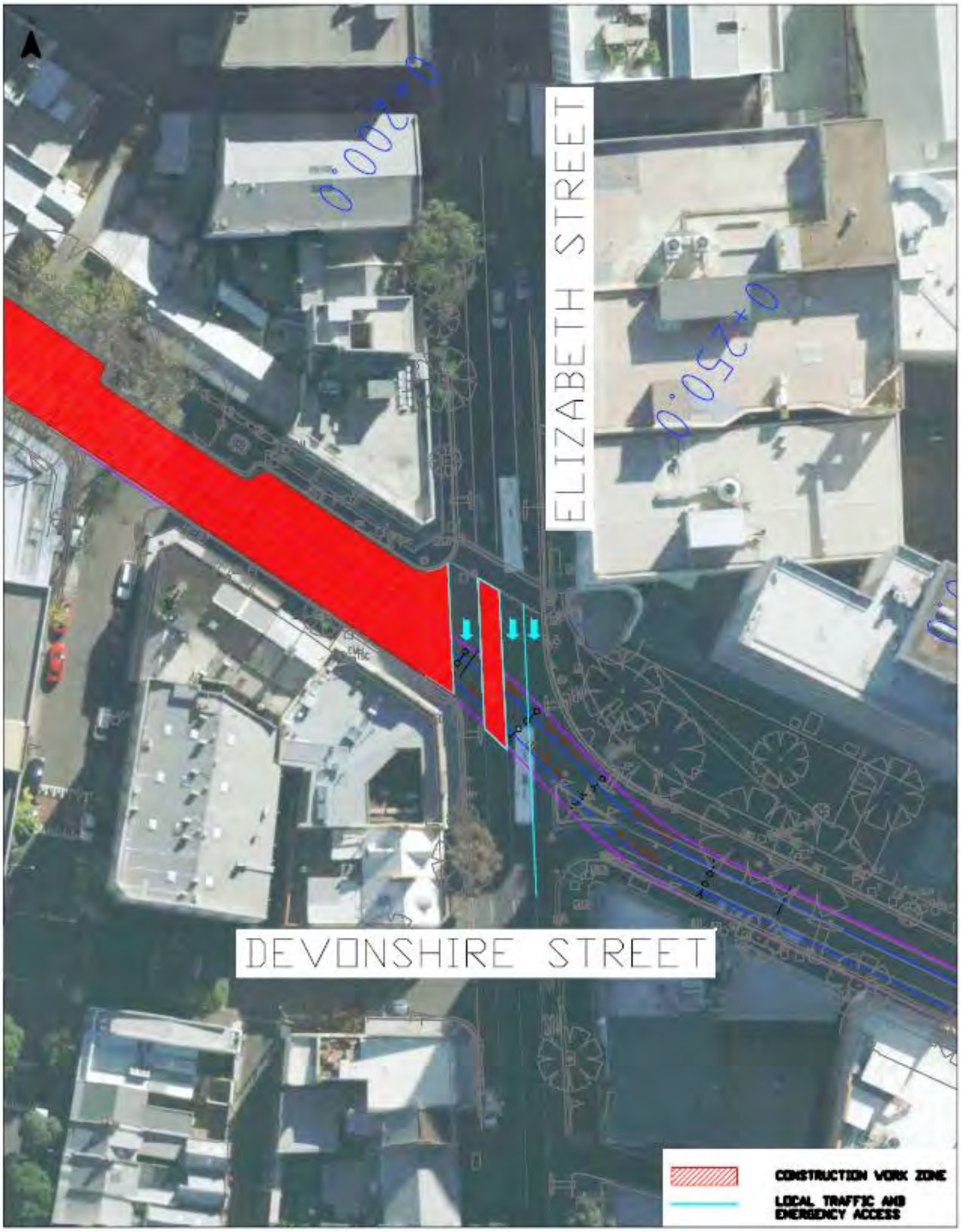
CSELR
Rawson Place - Stage 3 Intersection Works
Source: LPMA 2011

APR 2013
60238638

0 25 50 100 m

Appendix B.3 Elizabeth Street Indicative Staging Diagram





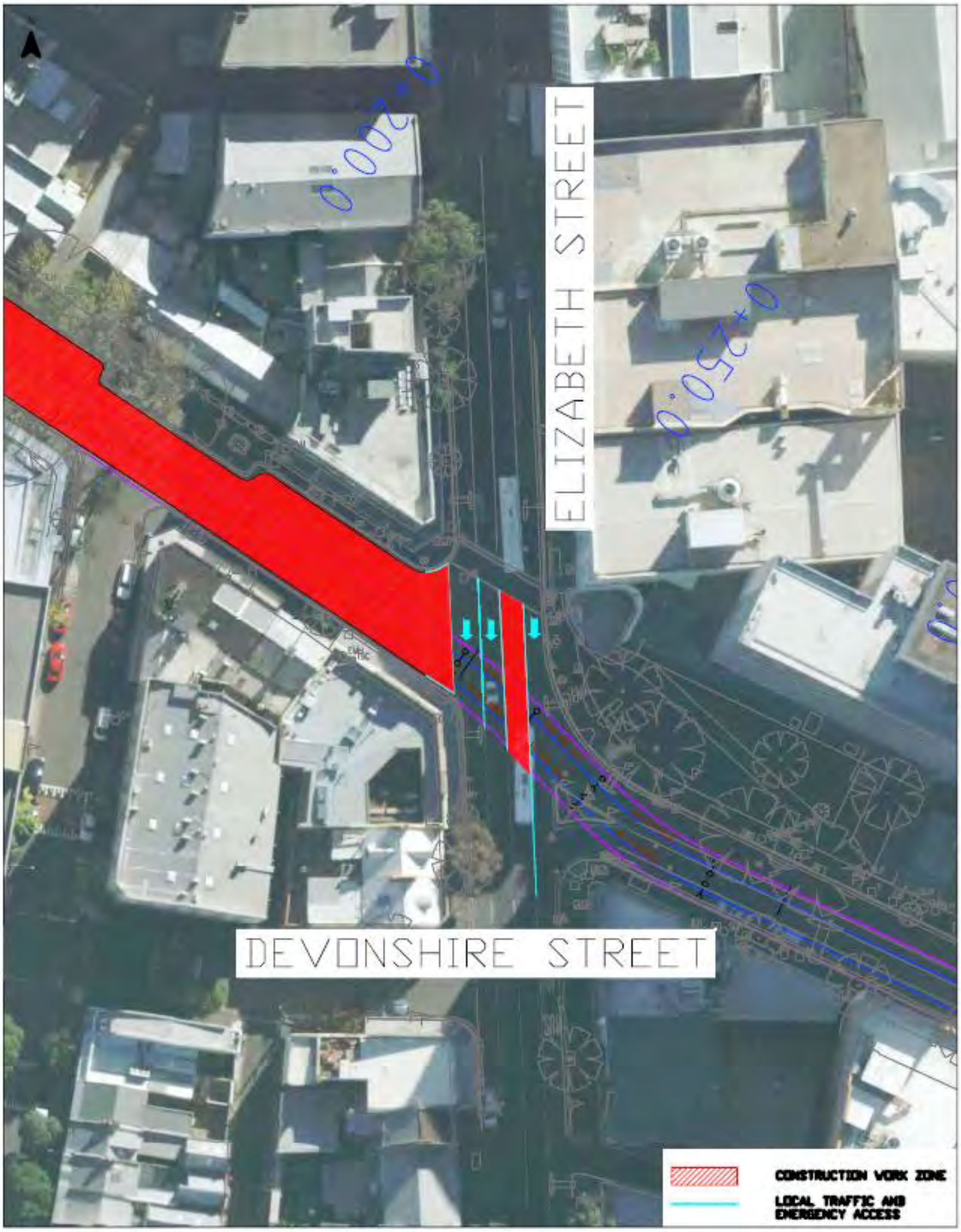
CSELR

APR 2013
60238638

Elizabeth Street Staged Construction 2 of 4 (5 weekends total)

Source: LPMA 2011

AECOM



CSELR
APR 2013
60238638

Elizabeth Street Staged Construction 3 of 4 (5 weekends total)

Source: LPMA 2011

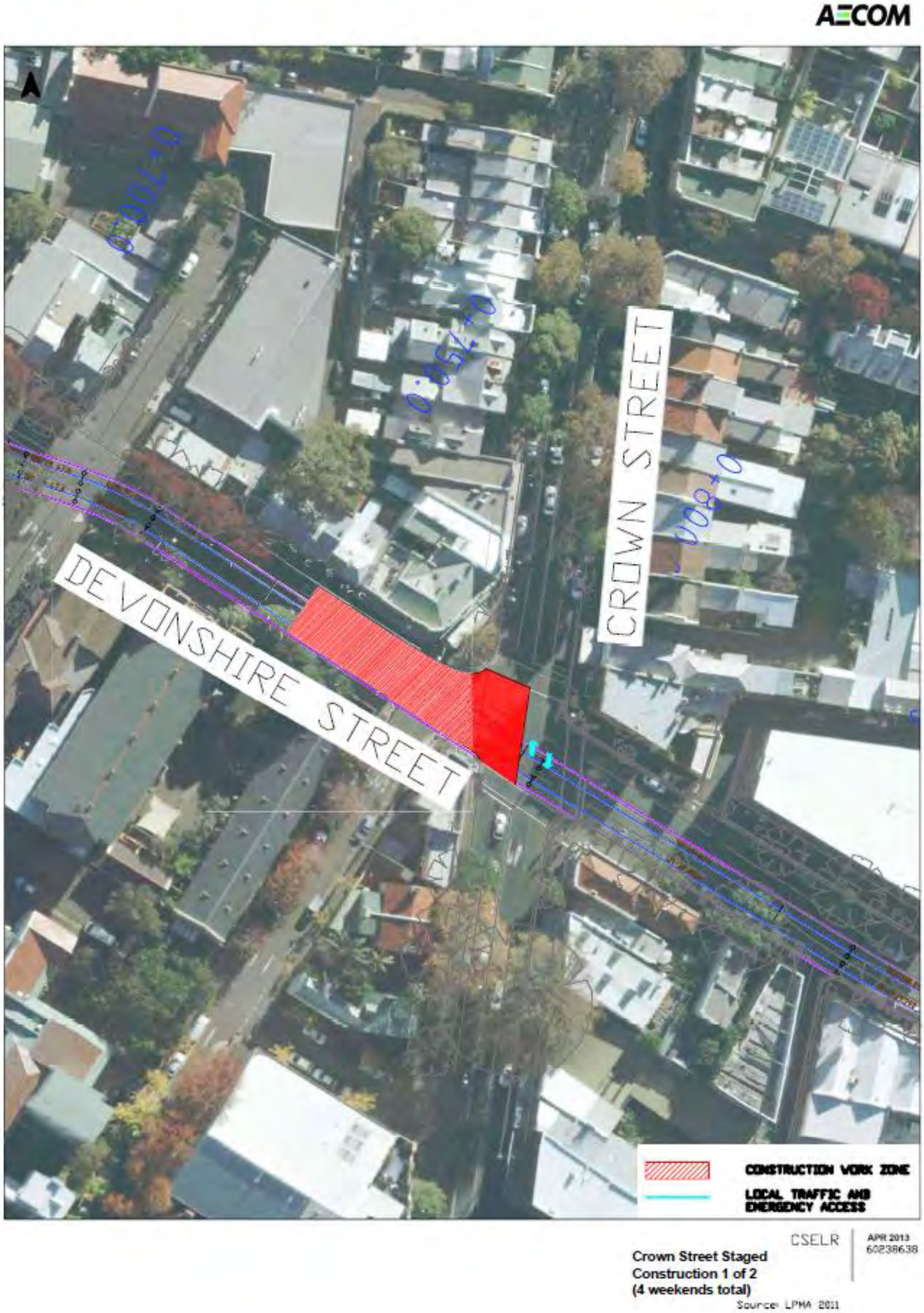
CSELR

APR 2013
60238638

Elizabeth Street Staged Construction 3 of 4 (5 weekends total)

Source: LPMA 2011

Appendix B.4 Crown Street Indicative Staging Plan



AECOM

CSELR

APR 2013
60238638

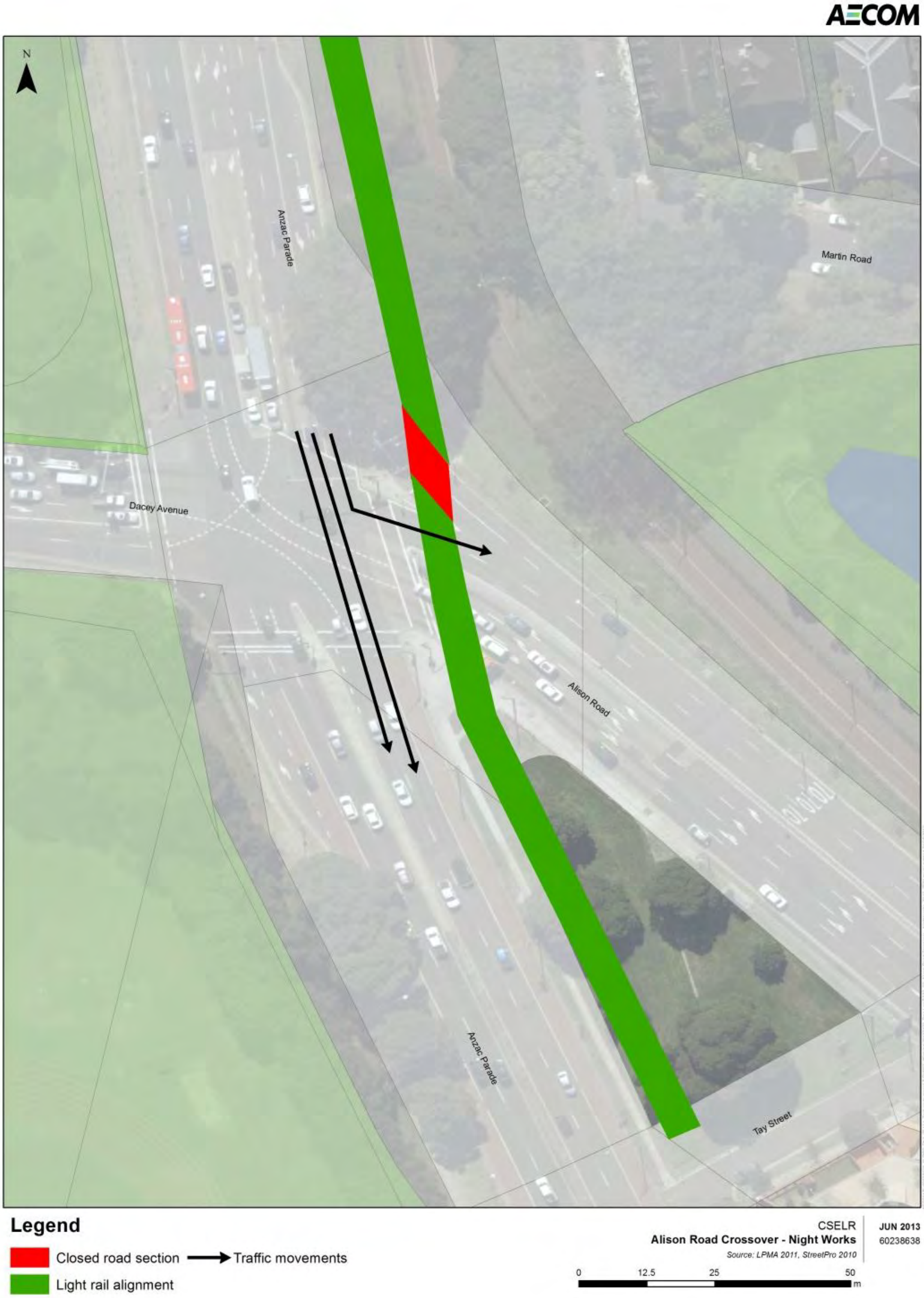
Crown Street Staged Construction 2 of 2 (4 weekends total)

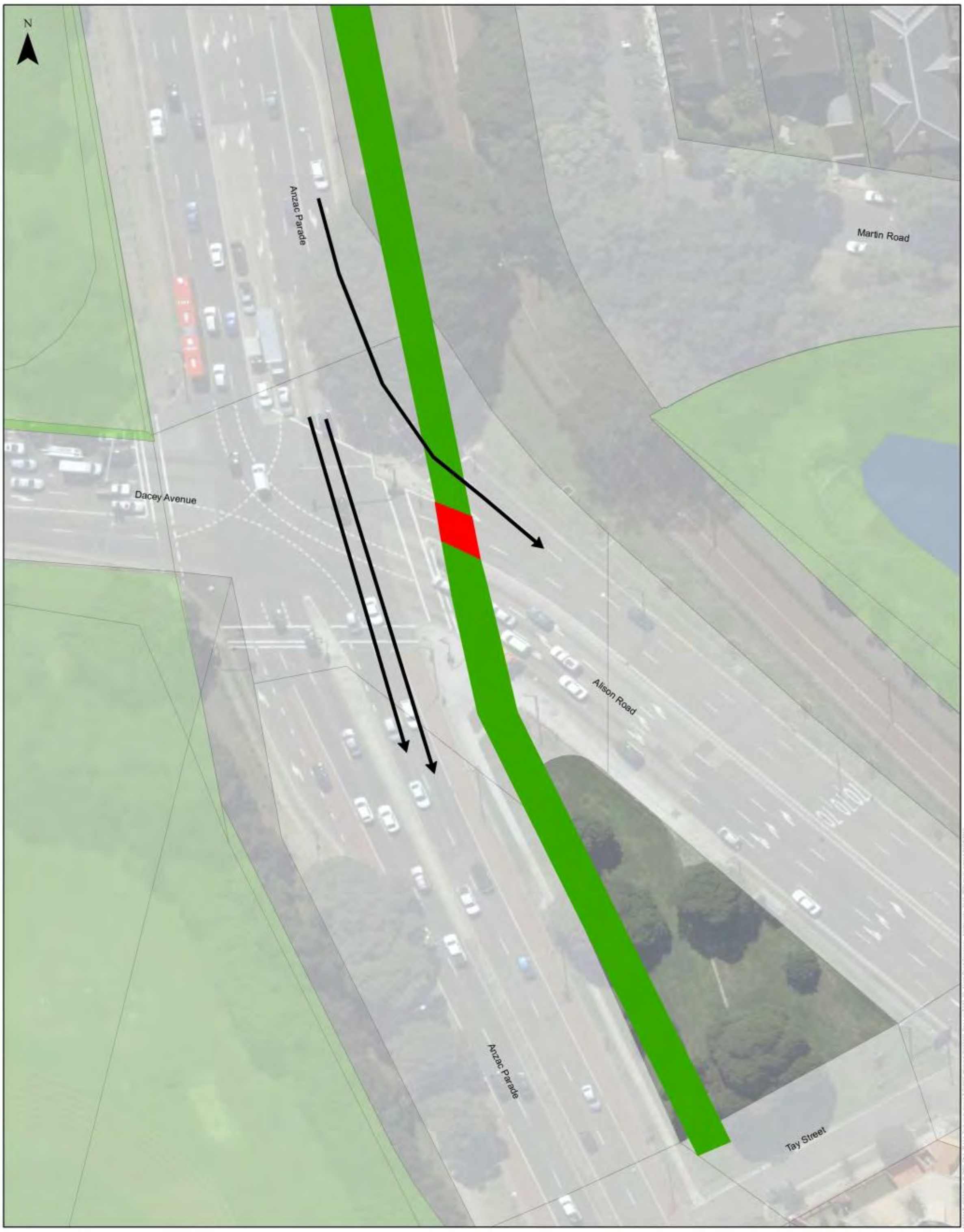
Source: LPMA 2011

Appendix B.5 Bourke Street Indicative Staging Plan

Bourke Street Staged Construction 2 of 2 (5 weekends total)

Appendix B.6 Alison Road Indicative Staging Plan





Legend

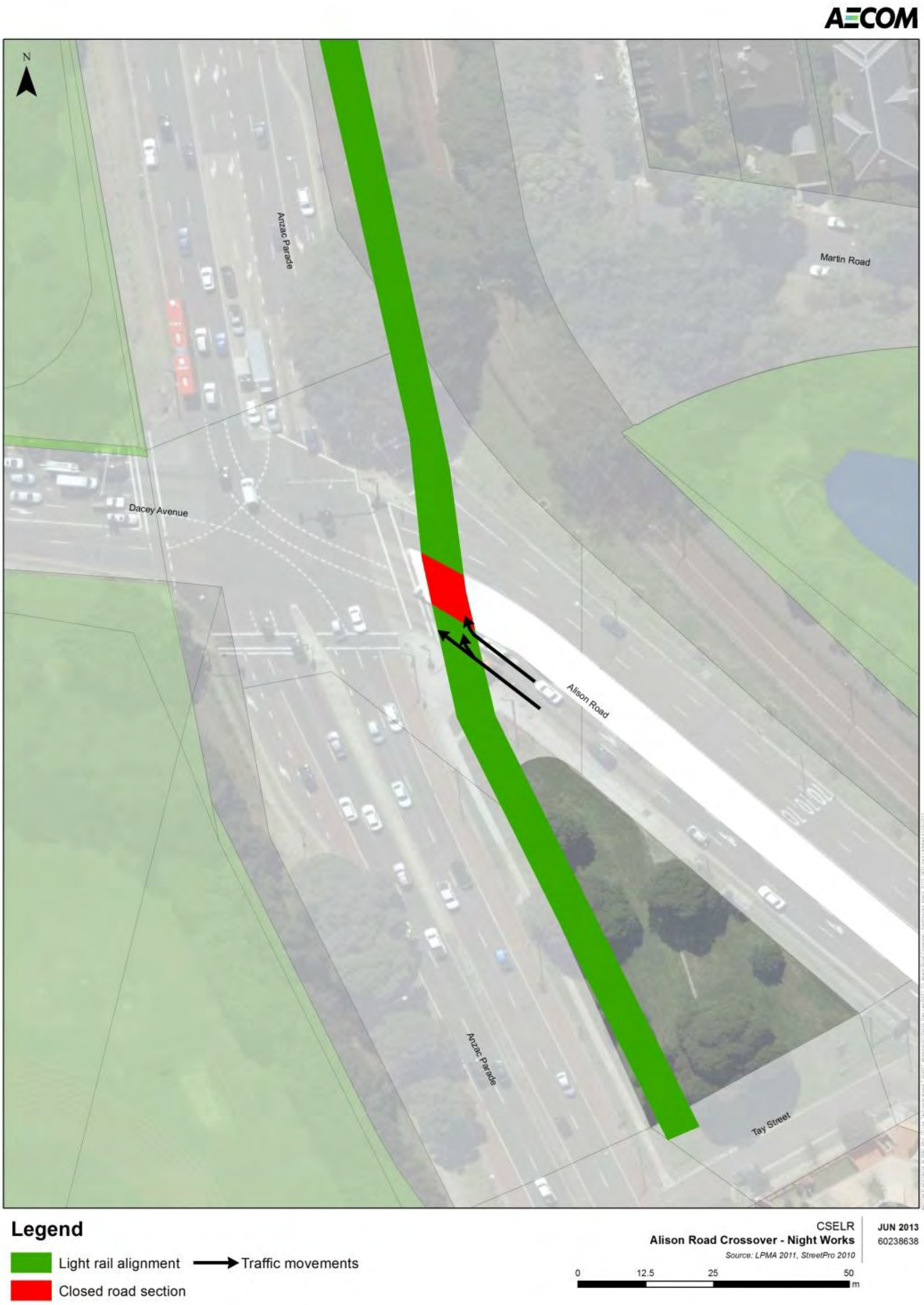
Closed road section → Traffic movements

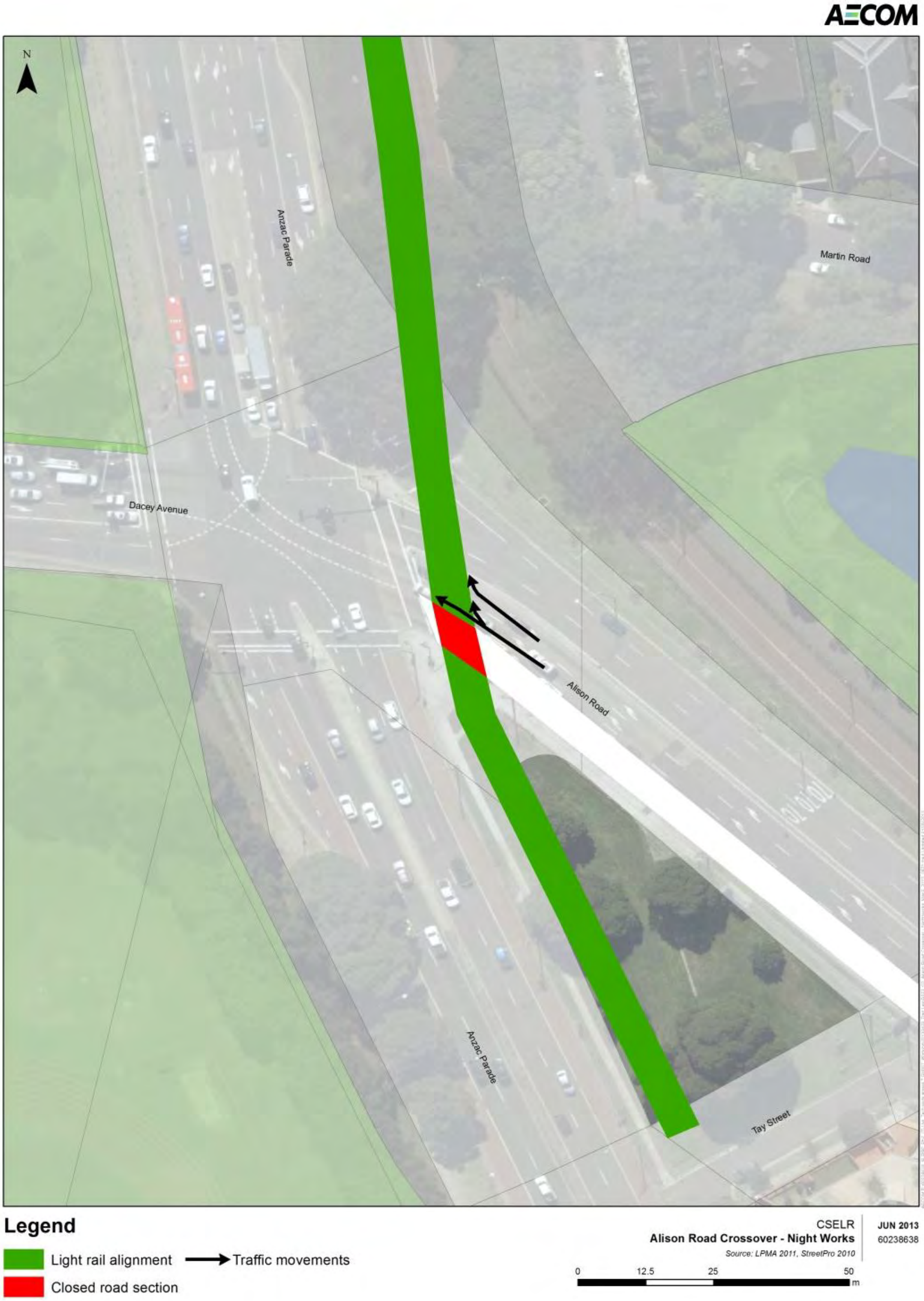
Light rail alignment

CSELR
Alison Road Crossover - Night Works
Source: LPMA 2011, StreetPro 2010

0 12.5 25 50 m

JUN 2013
60238638


AECOM
N
Anzac Parade
Martin Road
Dacey Avenue
Alison Road
Anzac Parade
Tay Street
Legend
Light rail alignment
Traffic movements
Closed road section
CSELR
Alison Road Crossover - Night Works
Source: LPMA 2011, StreetPro 2010
JUN 2013
60238638
0
12.5
25
50
m


AECOM
N
Anzac Parade
Martin Road
Dacey Avenue
Alison Road
Anzac Parade
Tay Street
Legend
Light rail alignment
Traffic movements
Closed road section
CSELR
Alison Road Crossover - Night Works
Source: LPMA 2011, StreetPro 2010
JUN 2013
60238638
0
12.5
25
50
m

Appendix B.7 Todman Avenue Indicative Staging Plan

AECOM

Legend

⟶ Traffic movements

Road section closed

CSELR

Construction Work Zone 2 of 4
Todman Avenue and ANZAC Parade

Source: LPMA 2011, StreetPro 2010

0 10 20 40 m

JUN 2013
60238638

AECOM

Legend

⟶ Traffic movements

Road section closed

CSELR

Construction Work Zone 3 of 4
Todman Avenue and ANZAC Parade

Source: LPMA 2011, StreetPro 2010

0 10 20 40 m

JUN 2013
60238638

Legend

Traffic movements

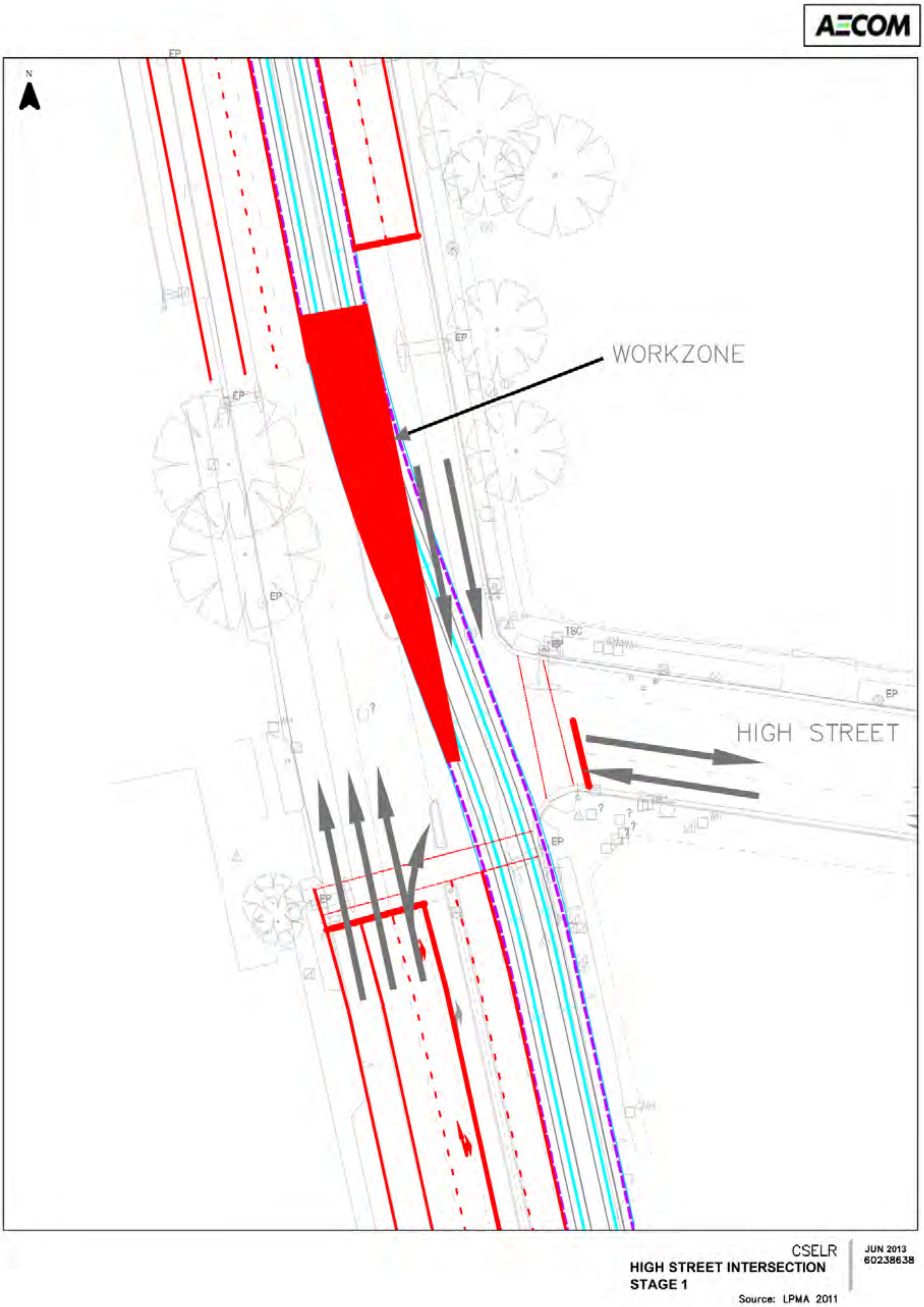
Road section closed

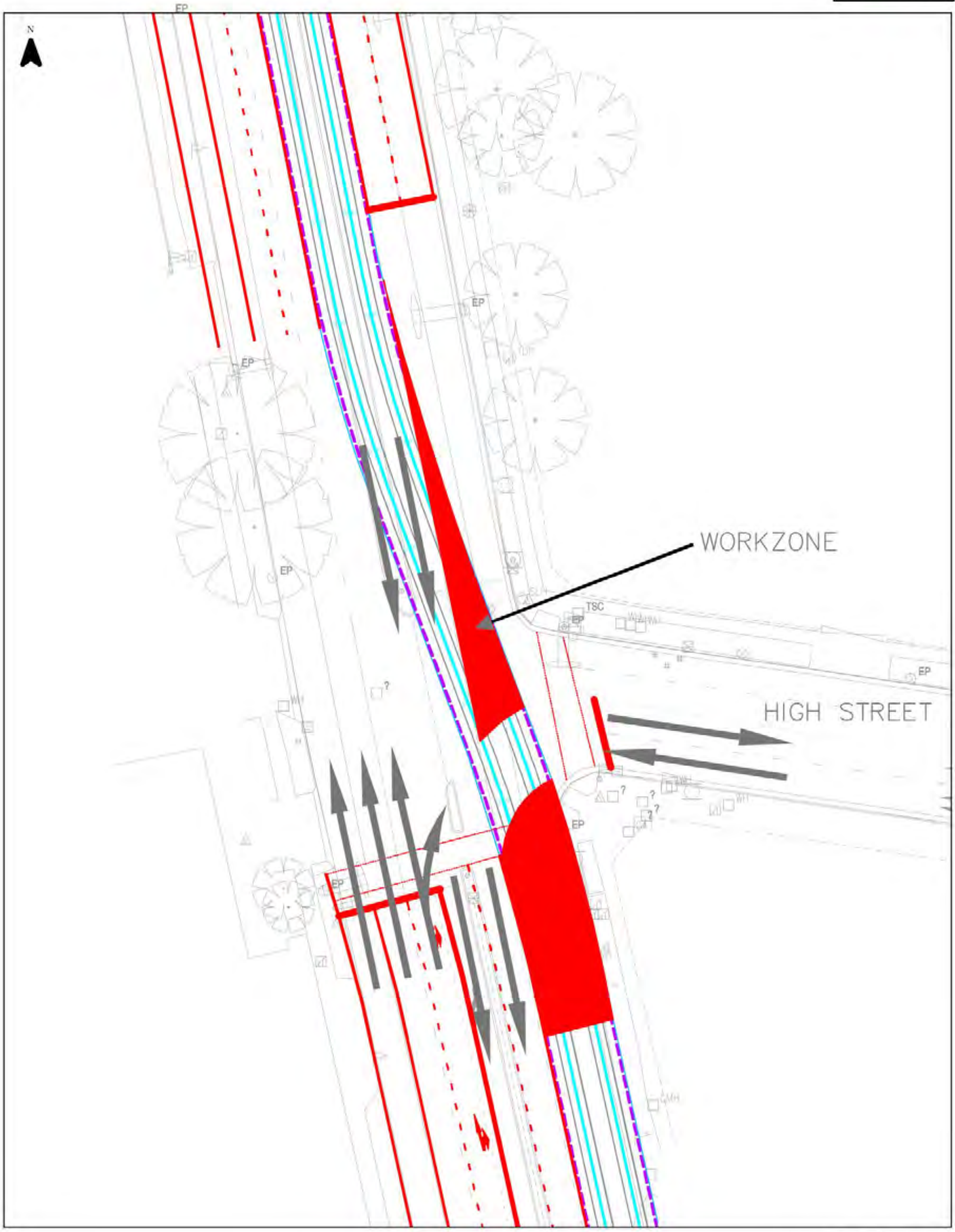
CSELR
Construction Work Zone 4 of 4
Todman Avenue and ANZAC Parade
Source: LPMA 2011, StreetPro 2010

JUN 2013
60238638

0 10 20 40 m

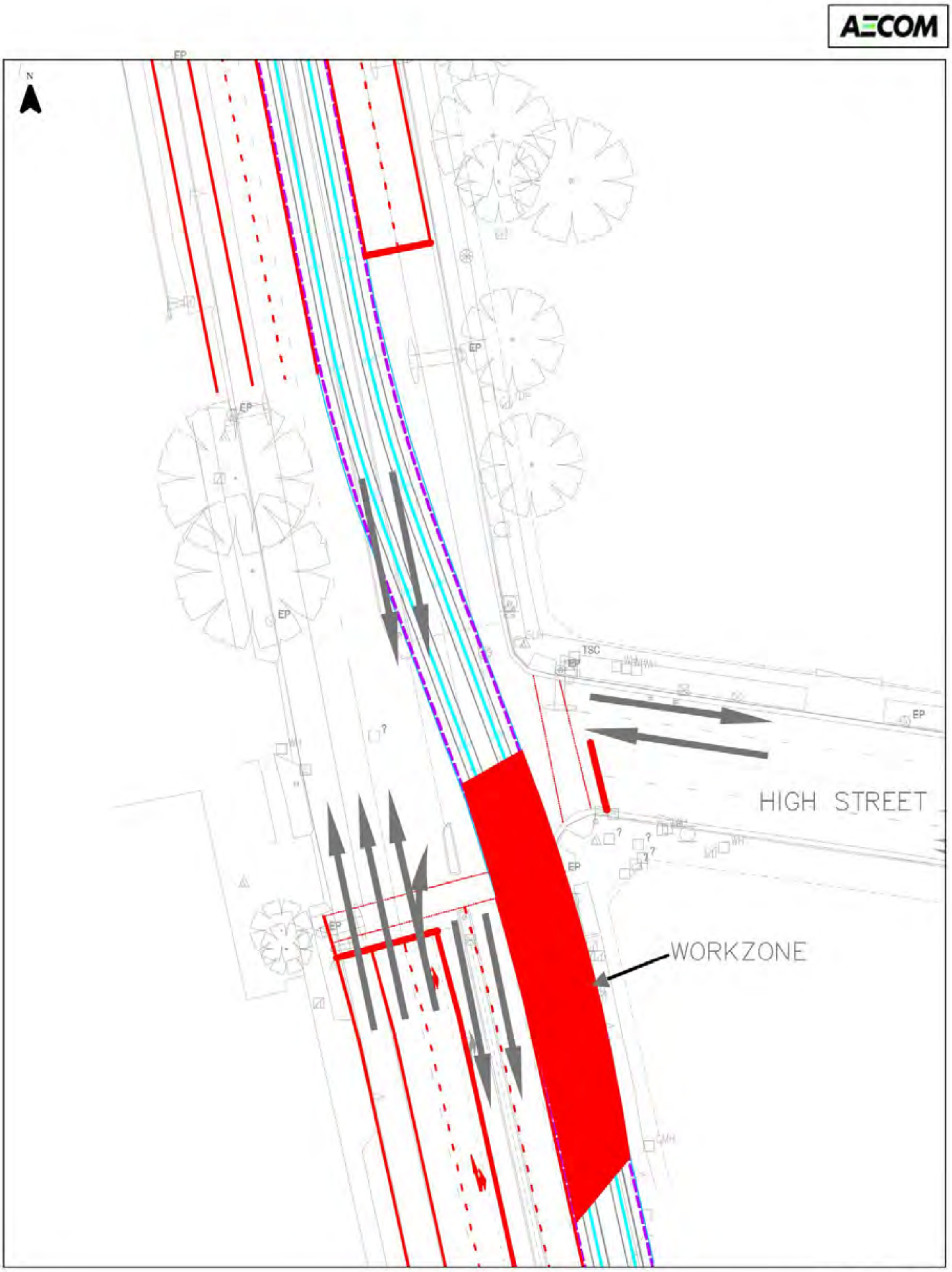
Appendix B.8 High Street Indicative Staging Plan





CSELR
HIGH STREET INTERSECTION
STAGE 2
Source: LPMA 2011

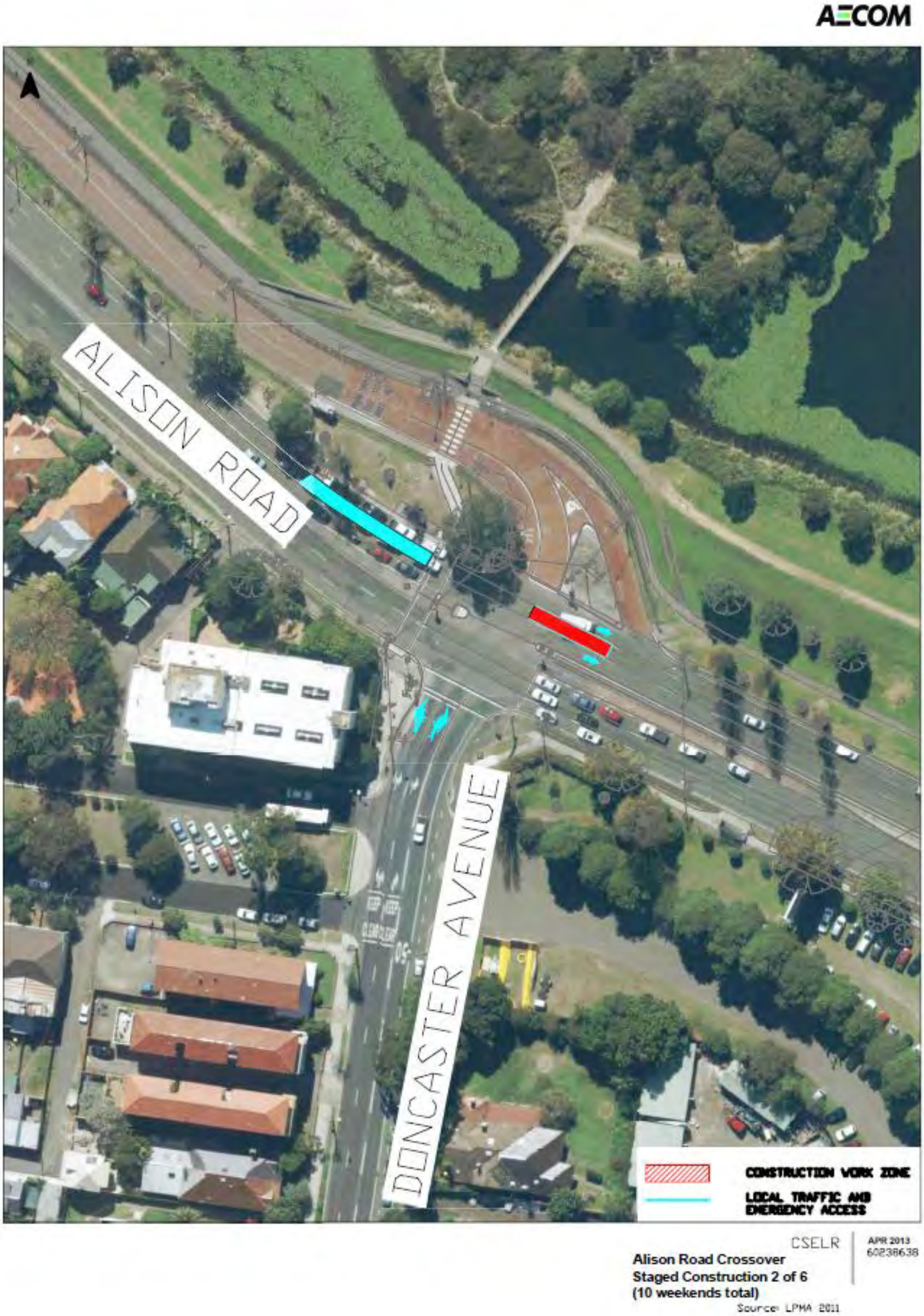
JUN 2013
60238638



CSELR
HIGH STREET INTERSECTION
STAGE 3
Source: LPMA 2011

JUN 2013
60238638

Appendix B.9 Doncaster Avenue Indicative Staging Plan


AECOM
ALISON ROAD
DONCASTER AVENUE
CONSTRUCTION WORK ZONE
LOCAL TRAFFIC AND EMERGENCY ACCESS
CSELR
APR 2013
60238638
Alison Road Crossover
Staged Construction 2 of 6
(10 weekends total)
Source: LPMA 2011

AECOM

CSELR

APR 2013
60238638

Alison Road Crossover
Staged Construction 3 of 6
(10 weekends total)

Source: LPMA 2011

AECOM

CSELR

APR 2013
60238638

Alison Road Crossover
Staged Construction 4 of 6
(10 weekends total)

Source: LPMA 2011

AECOM

CSELR

APR 2013
60238638

Alison Road Crossover
Staged Construction 5 of 6
(10 weekends total)

Source: LPMA 2011

AECOM

CSELR

Alison Road Crossover
Staged Construction 6 of 6
(10 weekends total)

Source: LPMA 2011

APR 2013
60238638

Appendix B.10 Belmore Road / High Street / Avoca Street
Indicative Staging Plan

AECOM

CSELR
APR 2013
60230638

Belmore Street Crossover
Staged Construction 1 of 3
(6 weekends total)
Source: LPMA 2013

AECOM

CSELR
Belmore Street Crossover
Staged Construction 2 of 3
(6 weekends total)
Source: LPMA 2011

APR 2013
60238638

AECOM

CSELR

Belmore Street Crossover
Staged Construction 3 of 3
(6 weekends total)

Source: LPMA 2011

APR 2013
60238638

AECOM

CSELR

APR 2013
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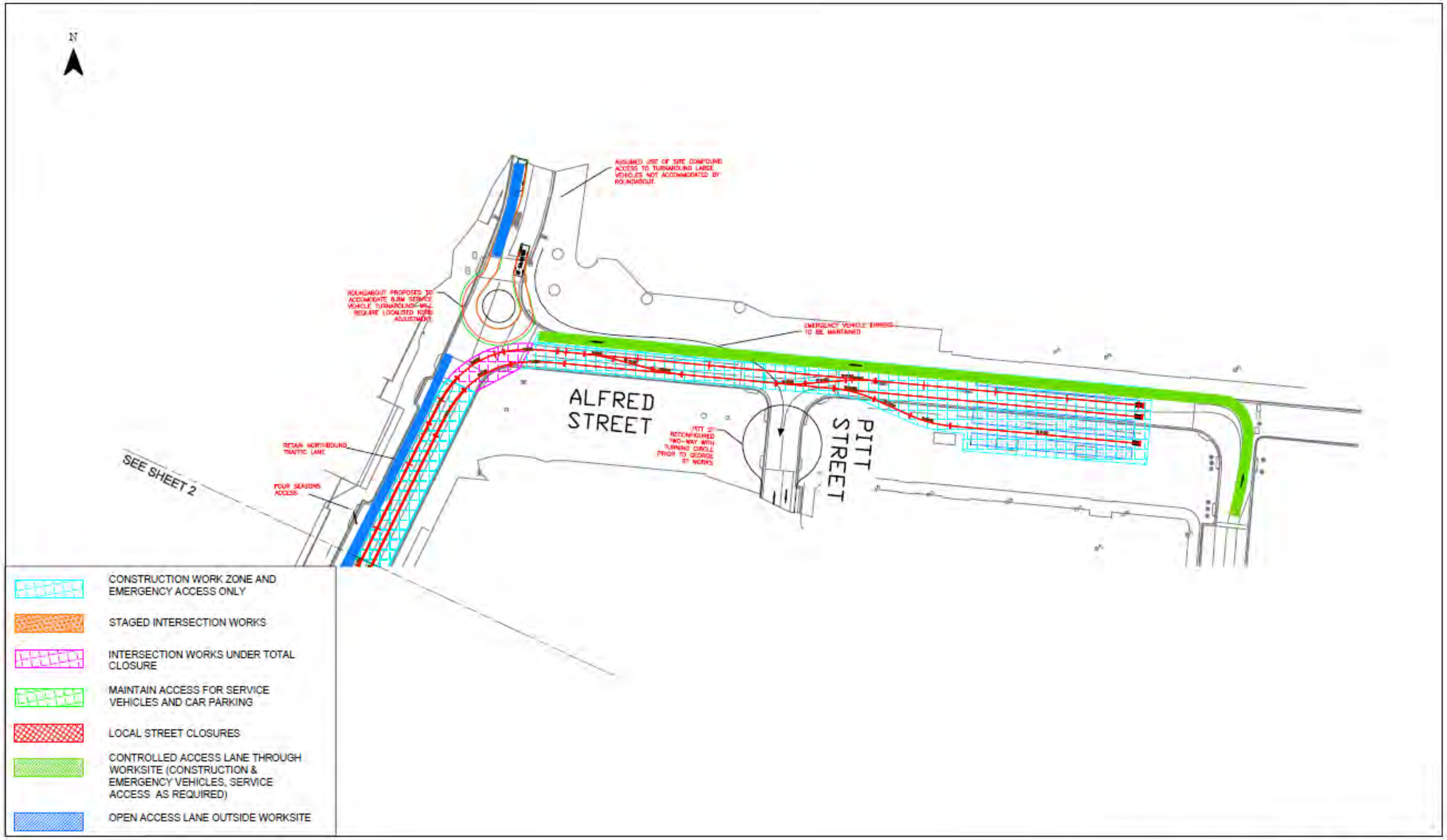
Belmore Street Crossover
Staged Construction 3 of 3
(6 weekends total)

Source: LPMA 2011

Appendix C Intersection Closures



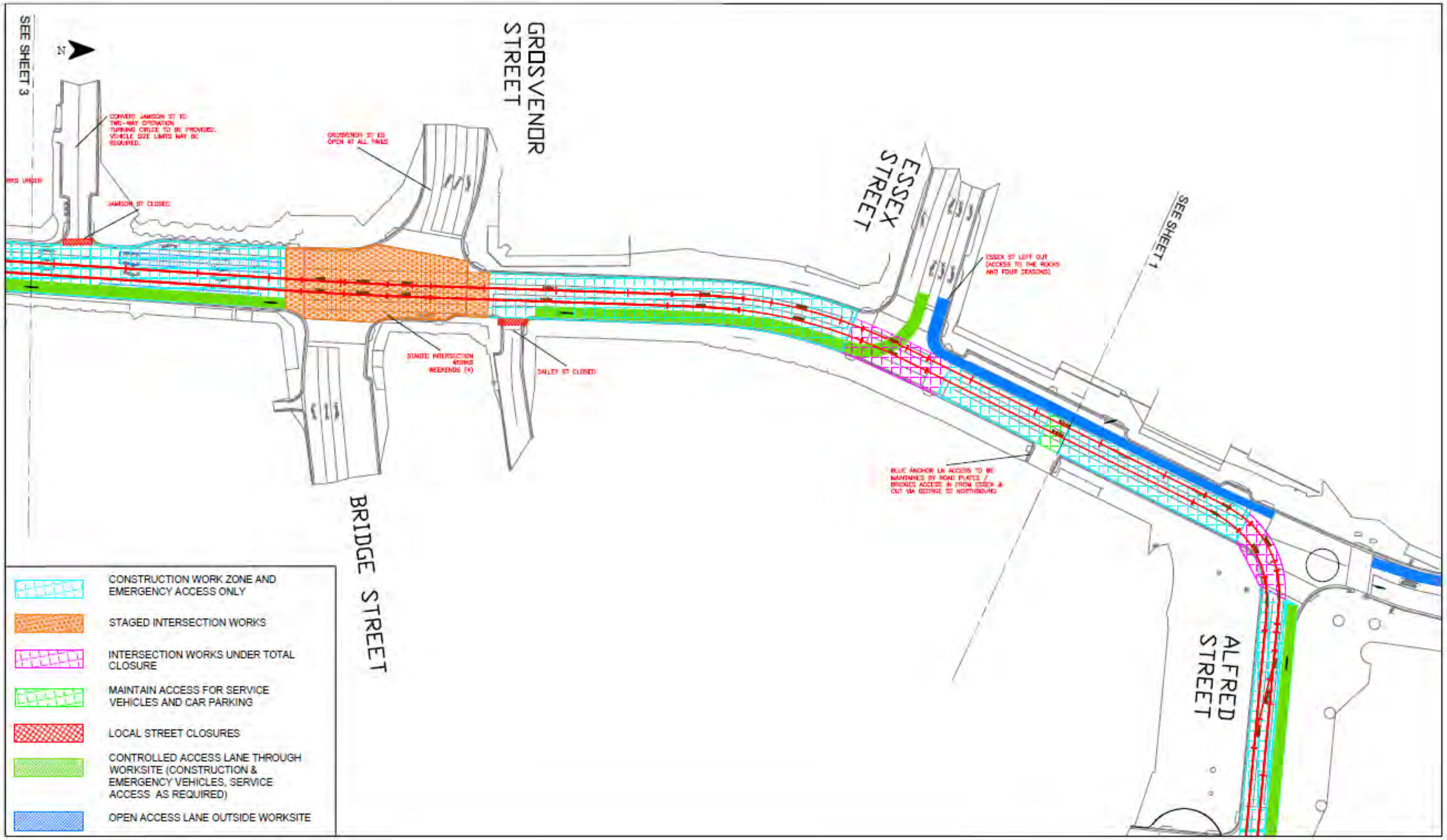
CSELR

Local Access - CBD Construction Zone 1

Source: LPMA 2011

AUG 2013
60238638

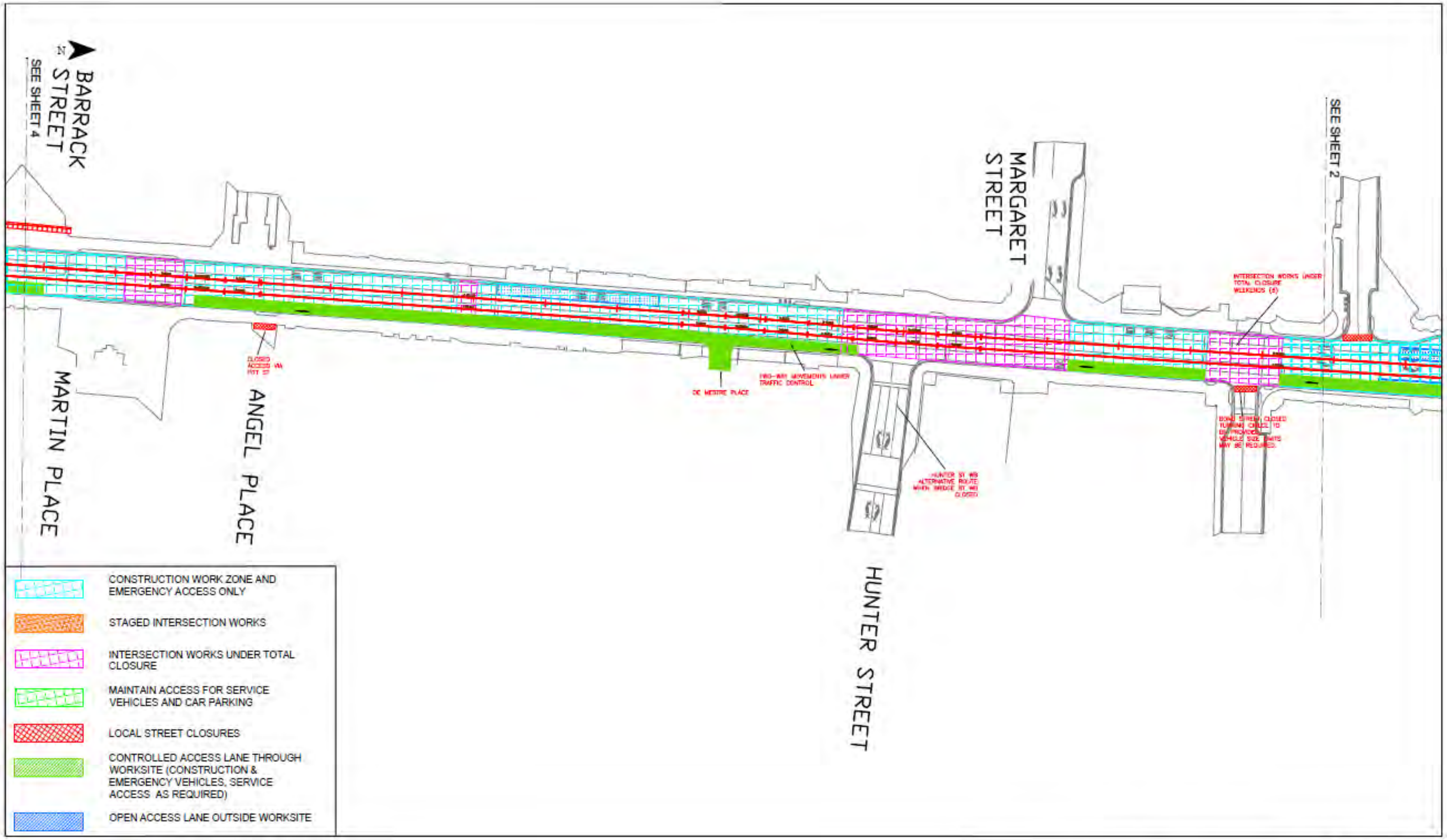
0 50 100 200 m
1:500 @ A1



CSELR
Local Access - CBD Construction Zone 2
Source: LPMA 2011

AUG 2013
60238638

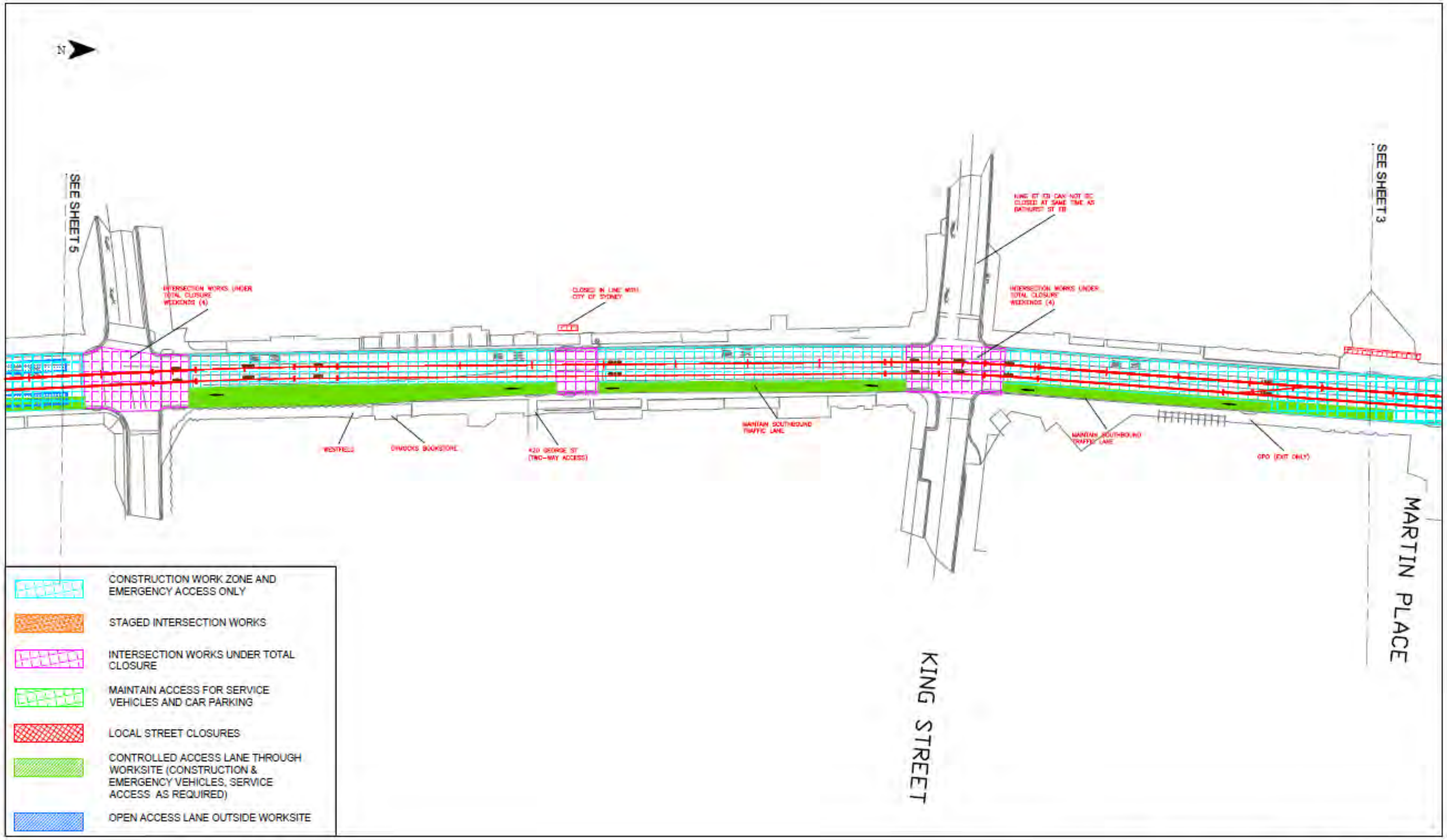
0 50 100 200 m
1:500 @ A1



CSELR
Local Access - CBD Construction Zone 3
Source: LPMA 2011

AUG 2013
60238638

0 50 100 200 m
1:500 @ A1

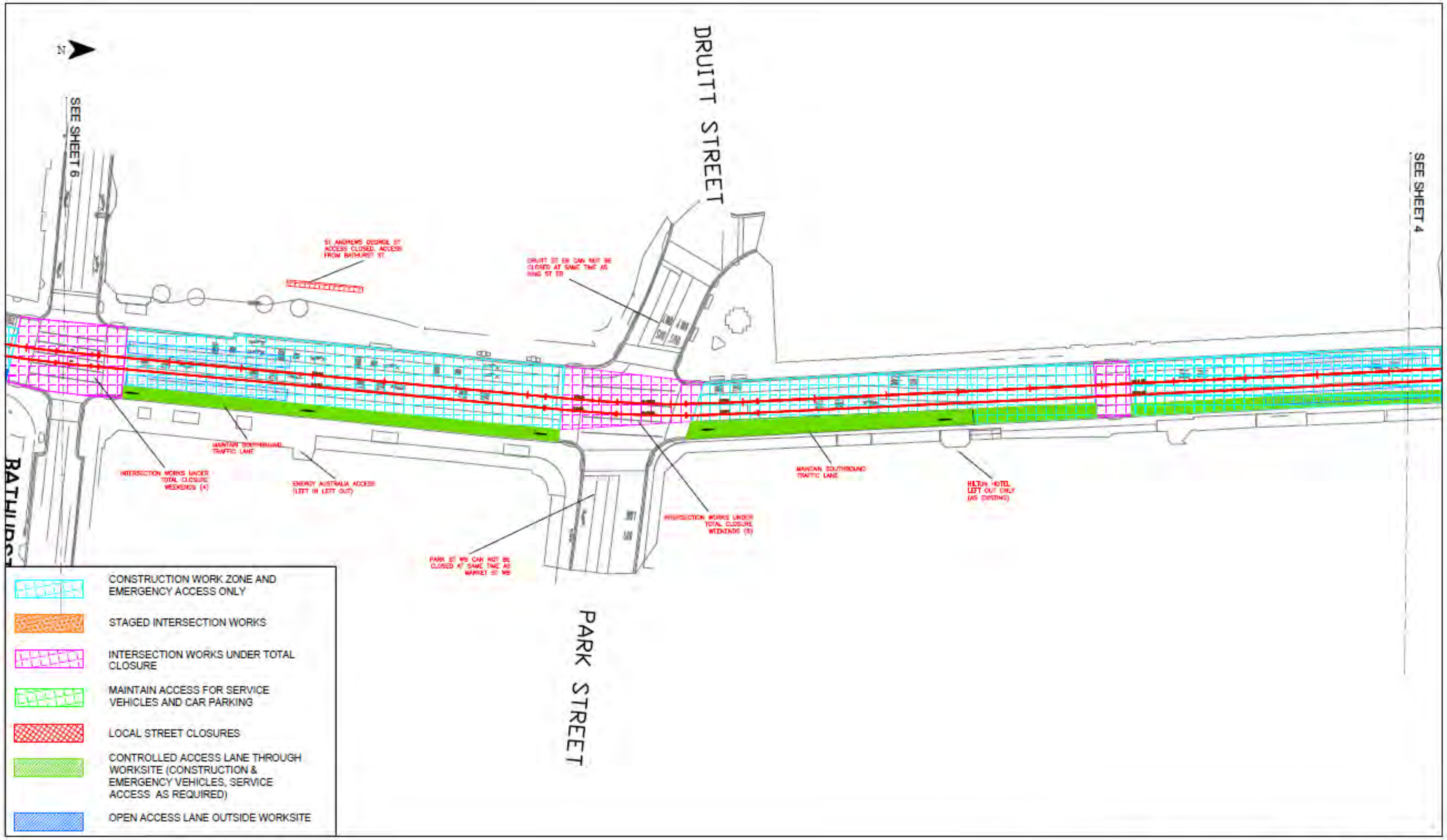


CSELR
Local Access - CBD Construction Zone 4
Source: LPMA 2011

AUG 2013
60238638

0 50 100 200 m
1:500 @ A1

AECOM

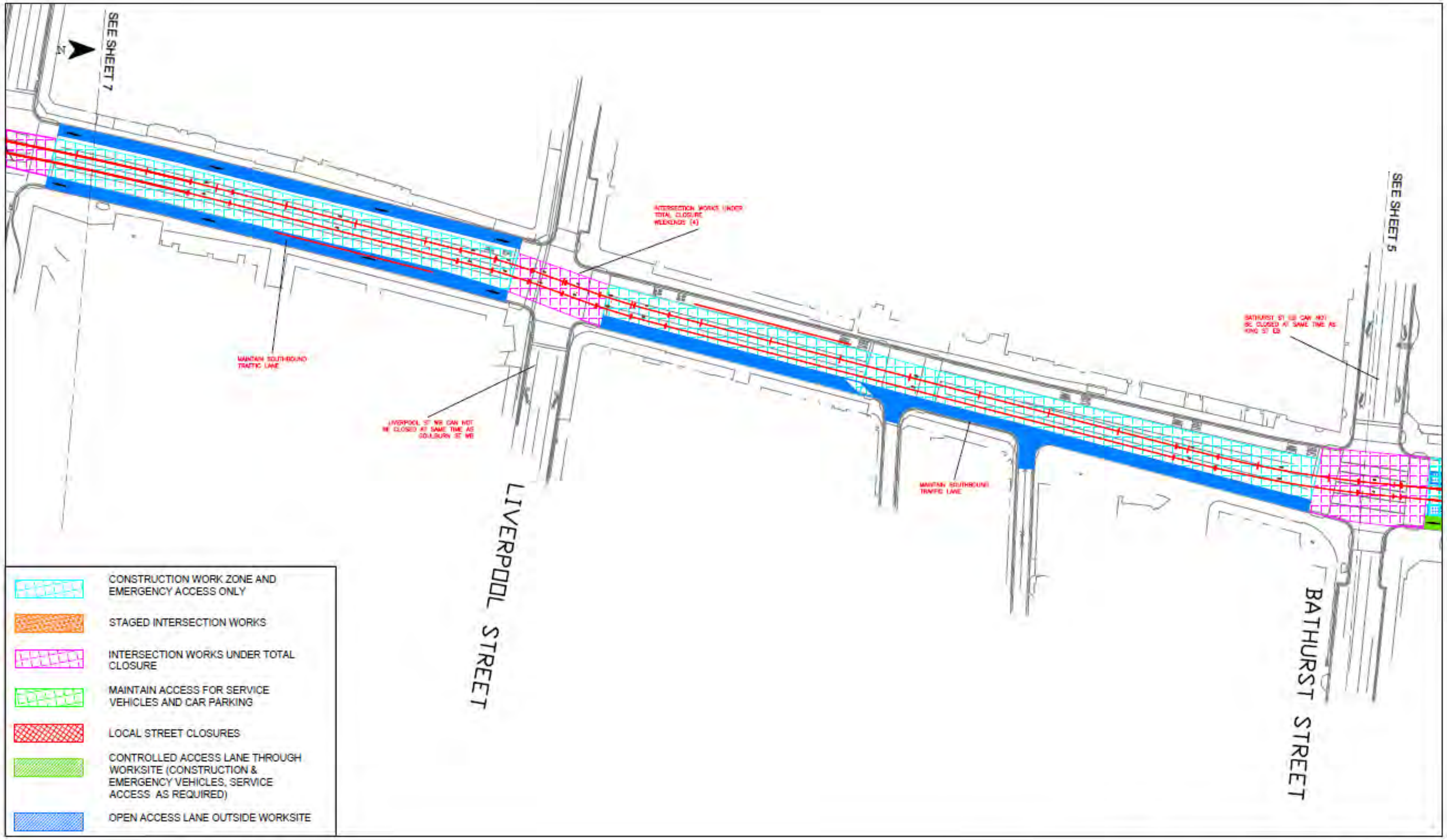


CSELR
Local Access - CBD Construction Zone 5
Source: LPMA 2011

AUG 2013
60238638

0 50 100 200 m
1:500 @ A1

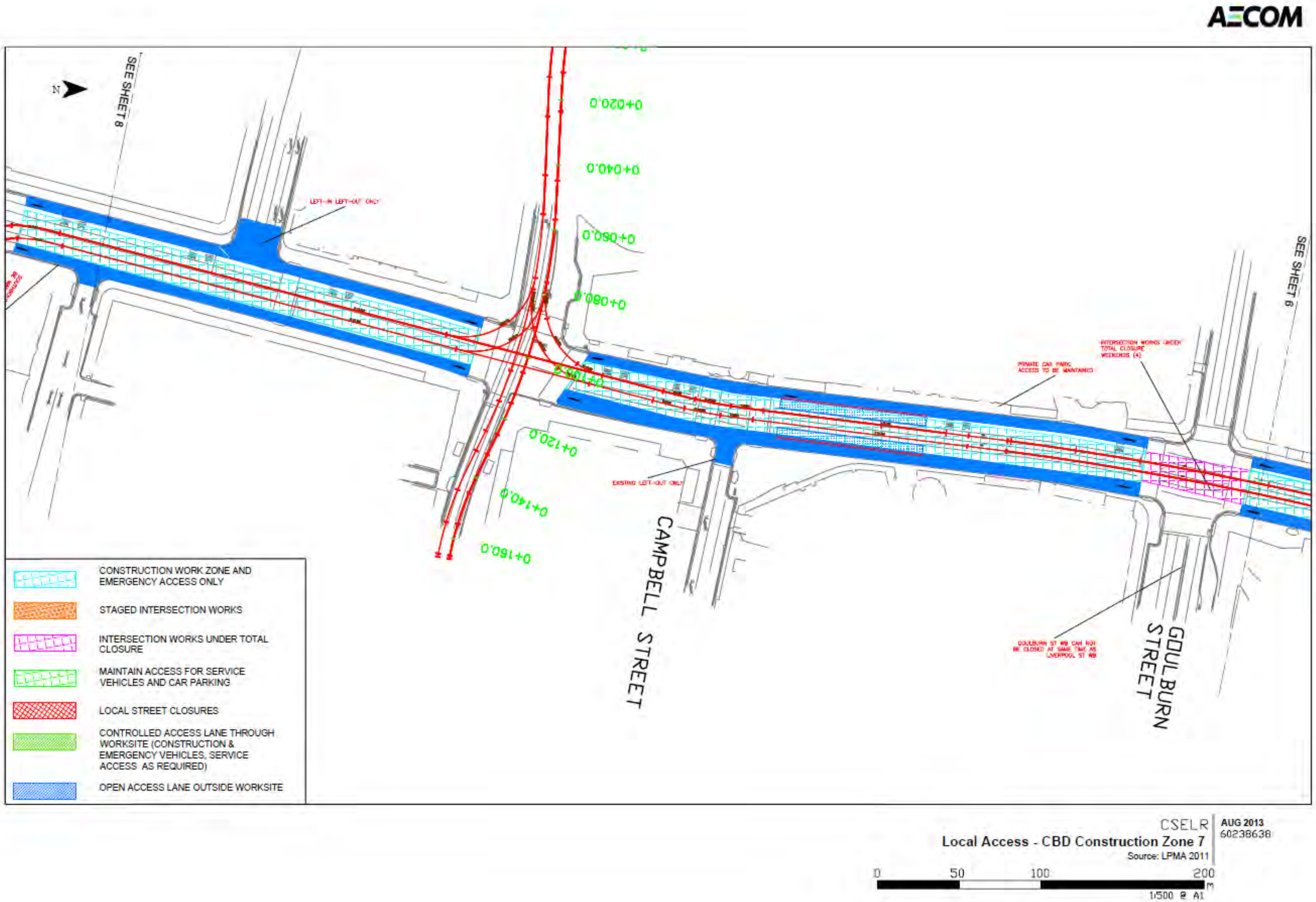
AECOM

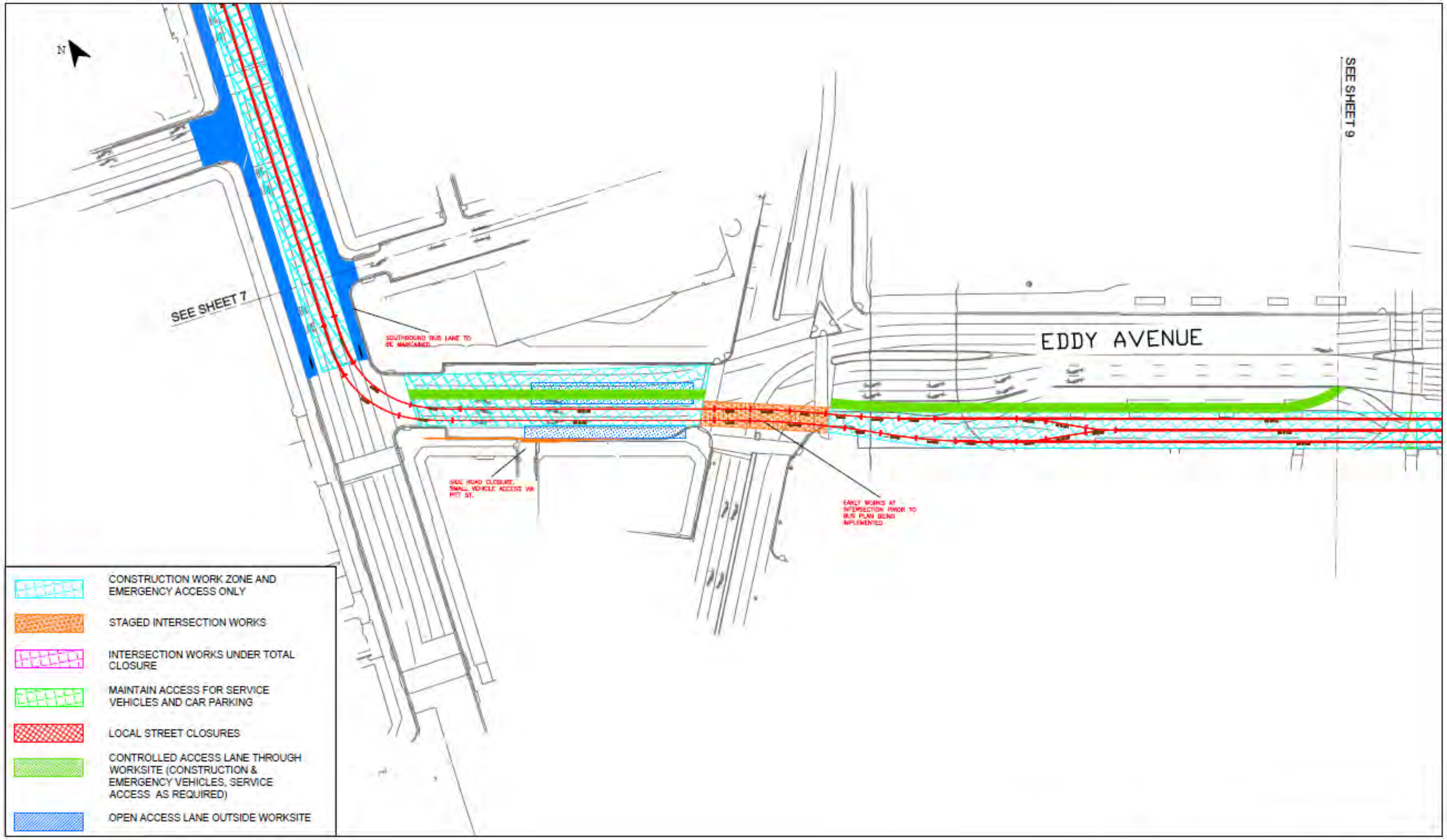


CSELR
Local Access - CBD Construction Zone 6
Source: LPMA 2011

AUG 2013
60238638

0 50 100 200 m
1:500 @ A1

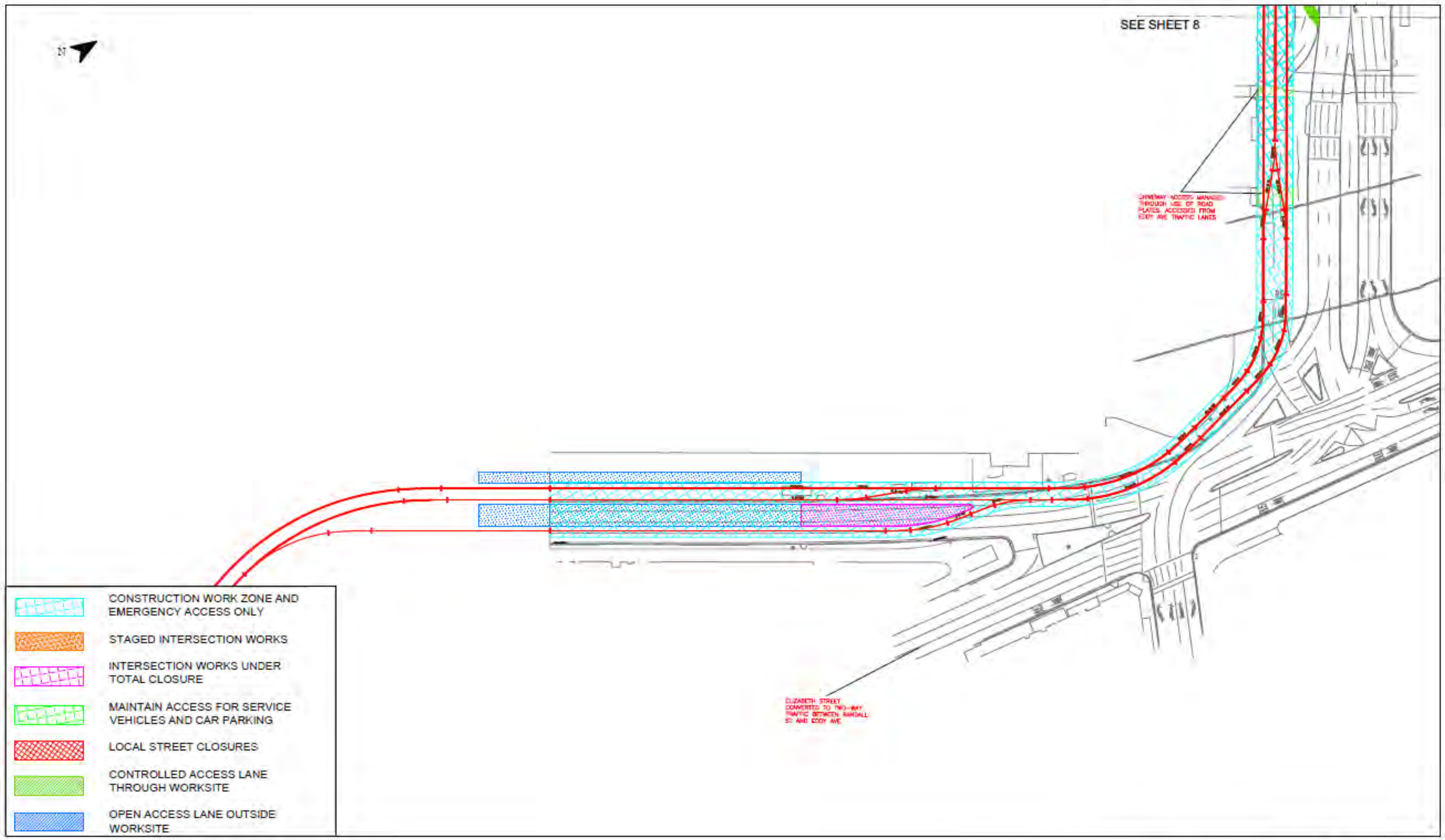

SEE SHEET 8
SEE SHEET 6
N
0+020.0
0+040.0
0+060.0
0+080.0
0+100.0
0+120.0
0+140.0
0+160.0
CAMPBELL STREET
GOULBURN STREET
CONSTRUCTION WORK ZONE AND EMERGENCY ACCESS ONLY
STAGED INTERSECTION WORKS
INTERSECTION WORKS UNDER TOTAL CLOSURE
MAINTAIN ACCESS FOR SERVICE VEHICLES AND CAR PARKING
LOCAL STREET CLOSURES
CONTROLLED ACCESS LANE THROUGH WORKSITE (CONSTRUCTION & EMERGENCY VEHICLES, SERVICE ACCESS AS REQUIRED)
OPEN ACCESS LANE OUTSIDE WORKSITE
CSELR
Local Access - CBD Construction Zone 7
Source: LPMA 2011
AUG 2013
60238638
0
50
100
200
m
1:500 @ A1



CSELR
Local Access - CBD Construction Zone 8
Source: LPMA 2011

AUG 2013
60238638

0 50 100 200 m
1:500 @ A1



CSELR

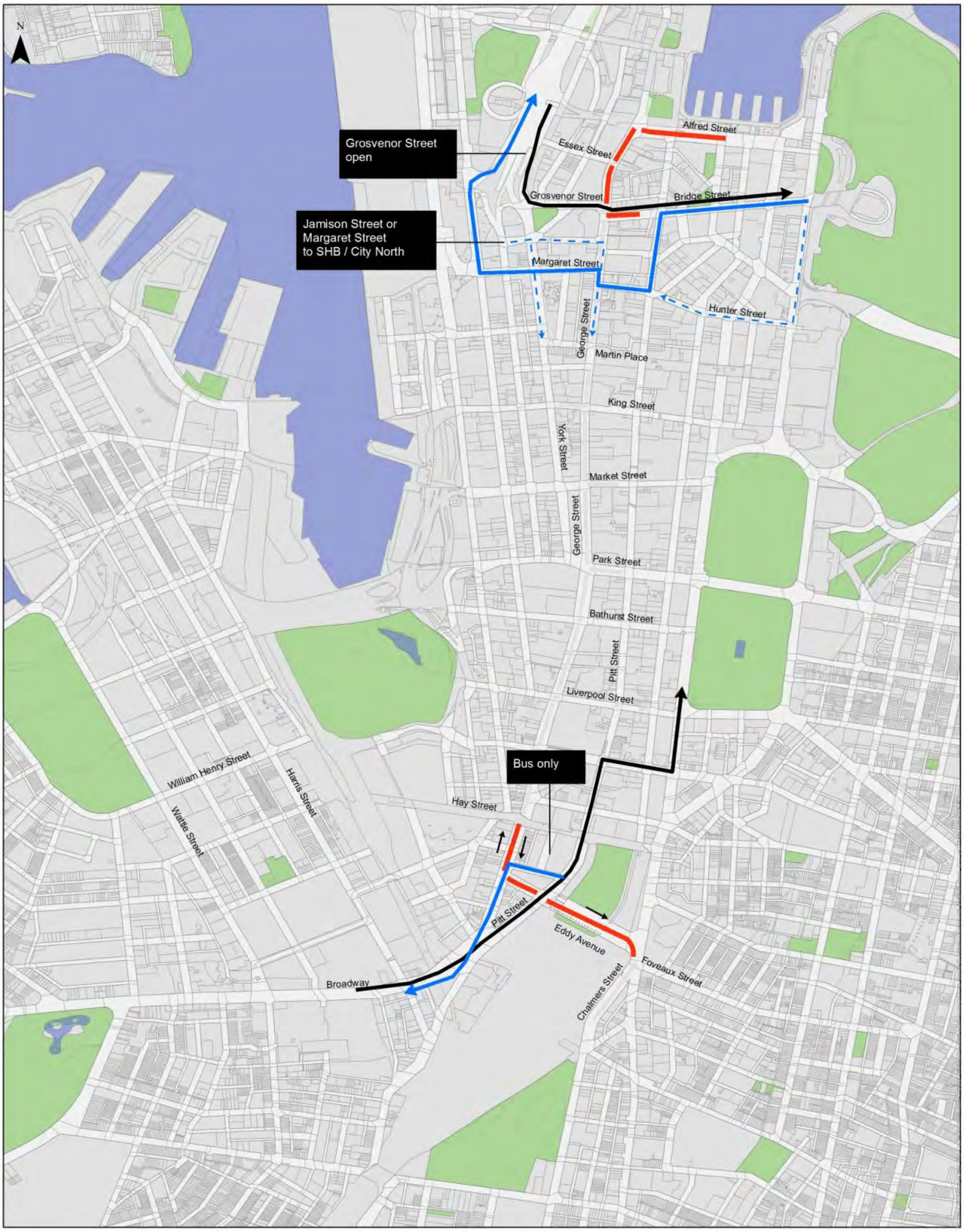
Local Access - CBD Construction Zone 9

Source: LPMA 2011

AUG 2013
60238638

0 50 100 200 m
1:500 @ A1

Appendix D CBD Diversion Routes



Legend

Primary eastbound route(s) — Secondary route(s) — Road section / intersection closed

Primary westbound route(s) — Traffic lanes open

CSELR

Proposed detour routes
George Street closed at Grosvenor Street
Bridge Street closed

APR 2013
60238638
5

Source: LPMA 2011, StreetPro 2010

0 50 100 200 m

Legend

Primary eastbound route(s) — Traffic lanes open

Primary westbound route(s) — Road section / intersection closed

CSELR

Proposed detour routes
George Street closed at Hunter Street

Source: LPMA 2011, StreetPro 2010

0 50 100 200 m

APR 2013
60238638

6

AECOM

Legend

Primary eastbound route(s)

Road section / intersection closed

Secondary route(s)

Traffic lanes open

CSELR

Proposed detour routes
George Street closed at King Street

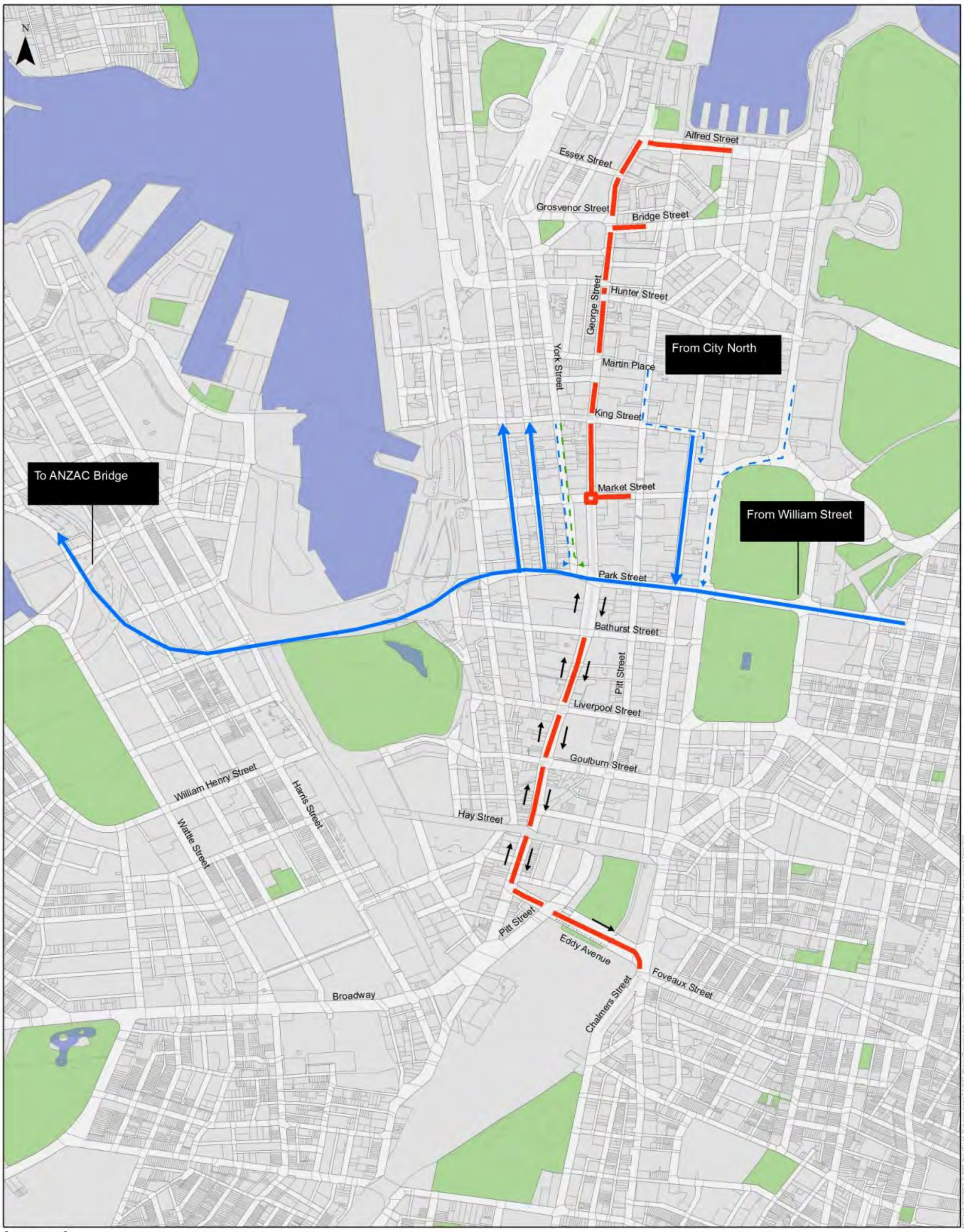
Source: LPMA 2011, StreetPro 2010

0 50 100 200 m

APR 2013
60238638

7

AECOM



Legend

- Primary westbound route(s)
- Secondary route(s)
- Bus route(s)
- Traffic lanes open
- Road section / intersection closed

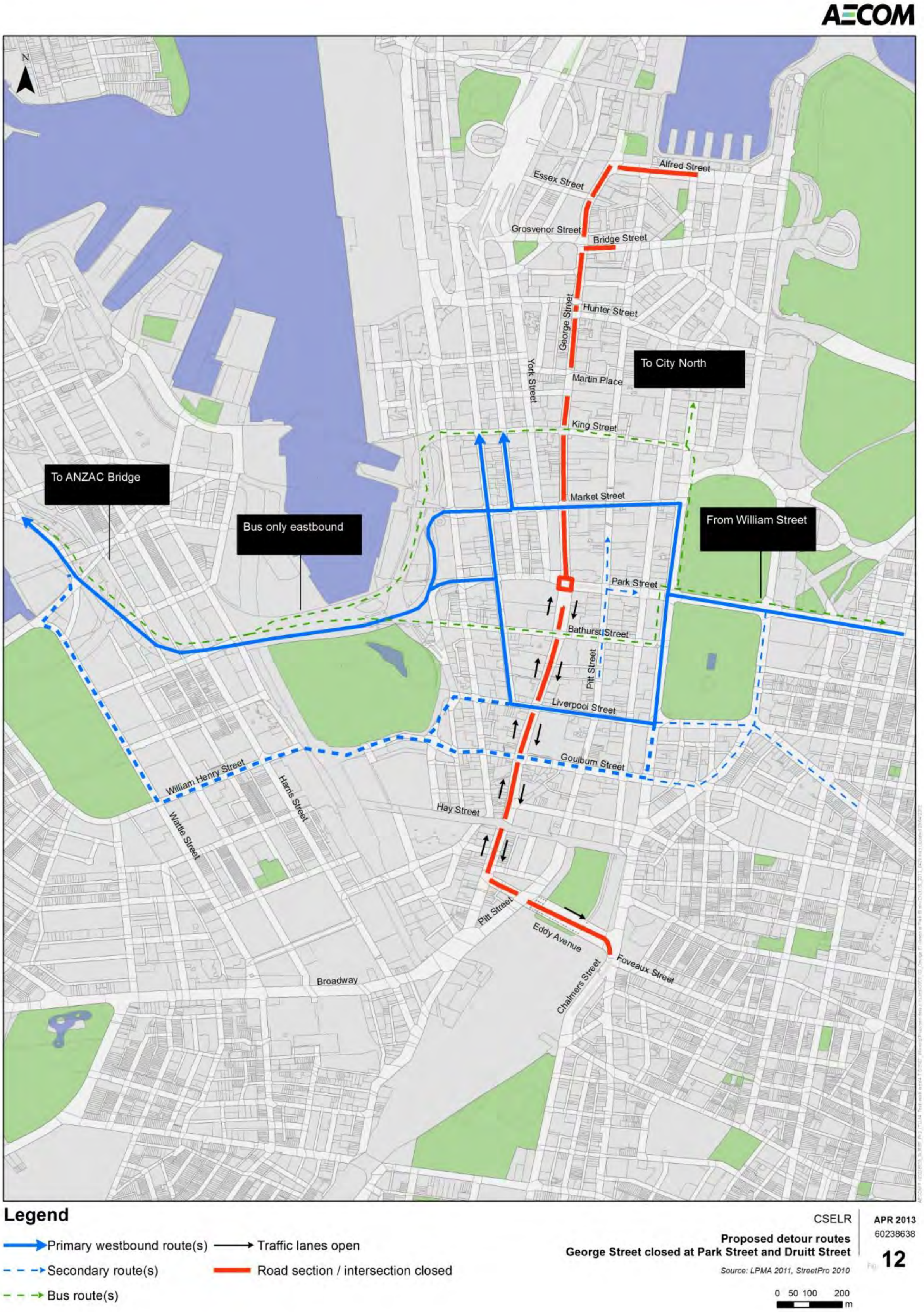
CSELR

Proposed detour routes
George Street closed at Market Street

Source: LPMA 2011, StreetPro 2010

0 50 100 200 m

APR 2013
60238638
8


AECOM
Alfred Street
Essex Street
Grosvenor Street
Bridge Street
Hunter Street
George Street
York Street
Martin Place
To City North
King Street
To ANZAC Bridge
Market Street
From William Street
Bus only eastbound
Park Street
Bathurst Street
Pitt Street
Liverpool Street
Goulburn Street
William Henry Street
Harris Street
Hay Street
Wattle Street
Pitt Street
Eddy Avenue
Foveaux Street
Chalmers Street
Broadway
Legend
Primary westbound route(s)
Traffic lanes open
Secondary route(s)
Road section / intersection closed
Bus route(s)
CSELR
APR 2013
60238638
Proposed detour routes
George Street closed at Park Street and Druitt Street
12
Source: LPMA 2011, StreetPro 2010
0 50 100 200
m

Legend

Primary eastbound route(s) — Traffic lanes open

Secondary route(s) — Road section / intersection closed

CSELR

APR 2013

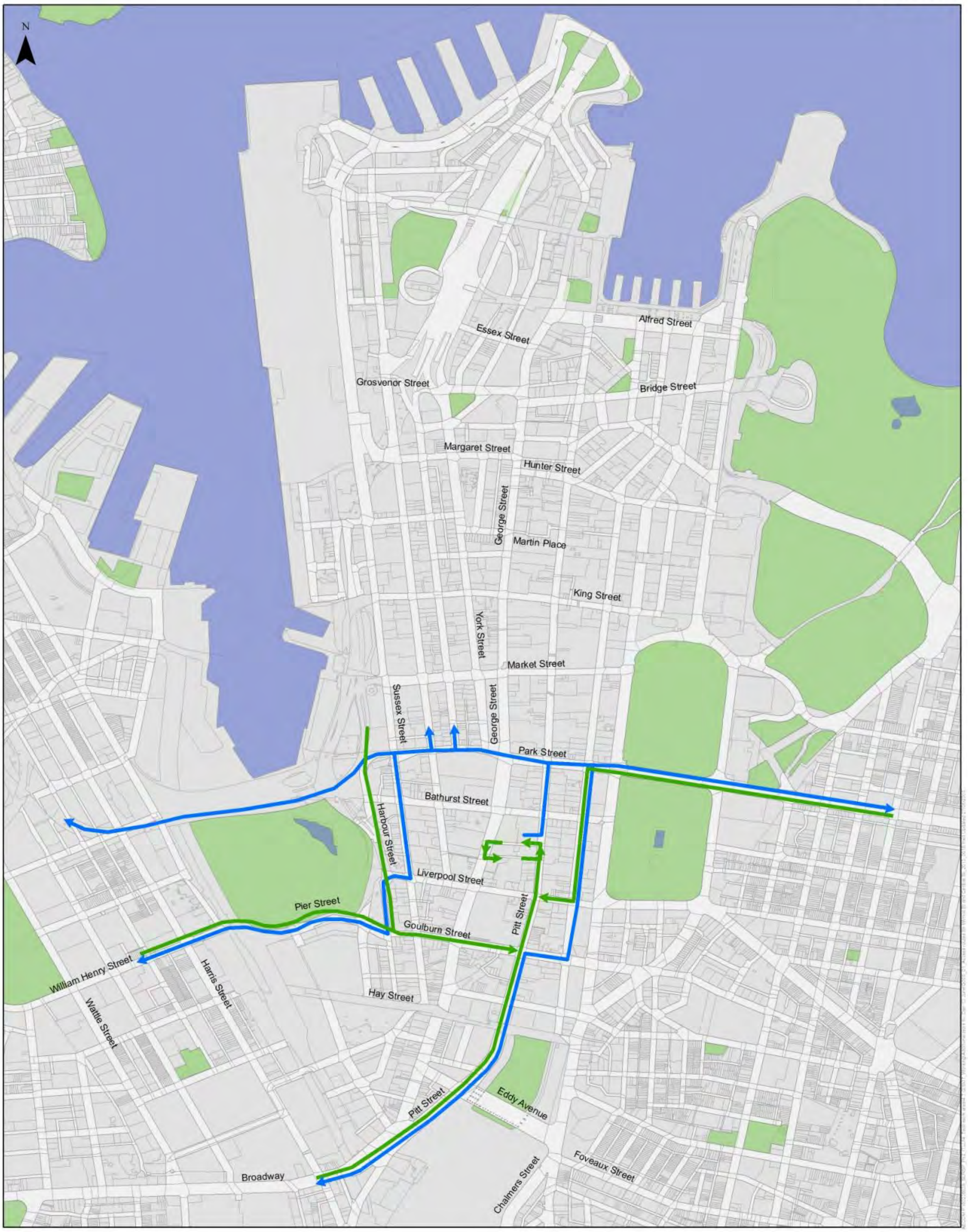
60238638

Proposed detour routes
George Street closed at Bathurst Street

Source: LPMA 2011, StreetPro 2010

0 50 100 200 m

9



Legend

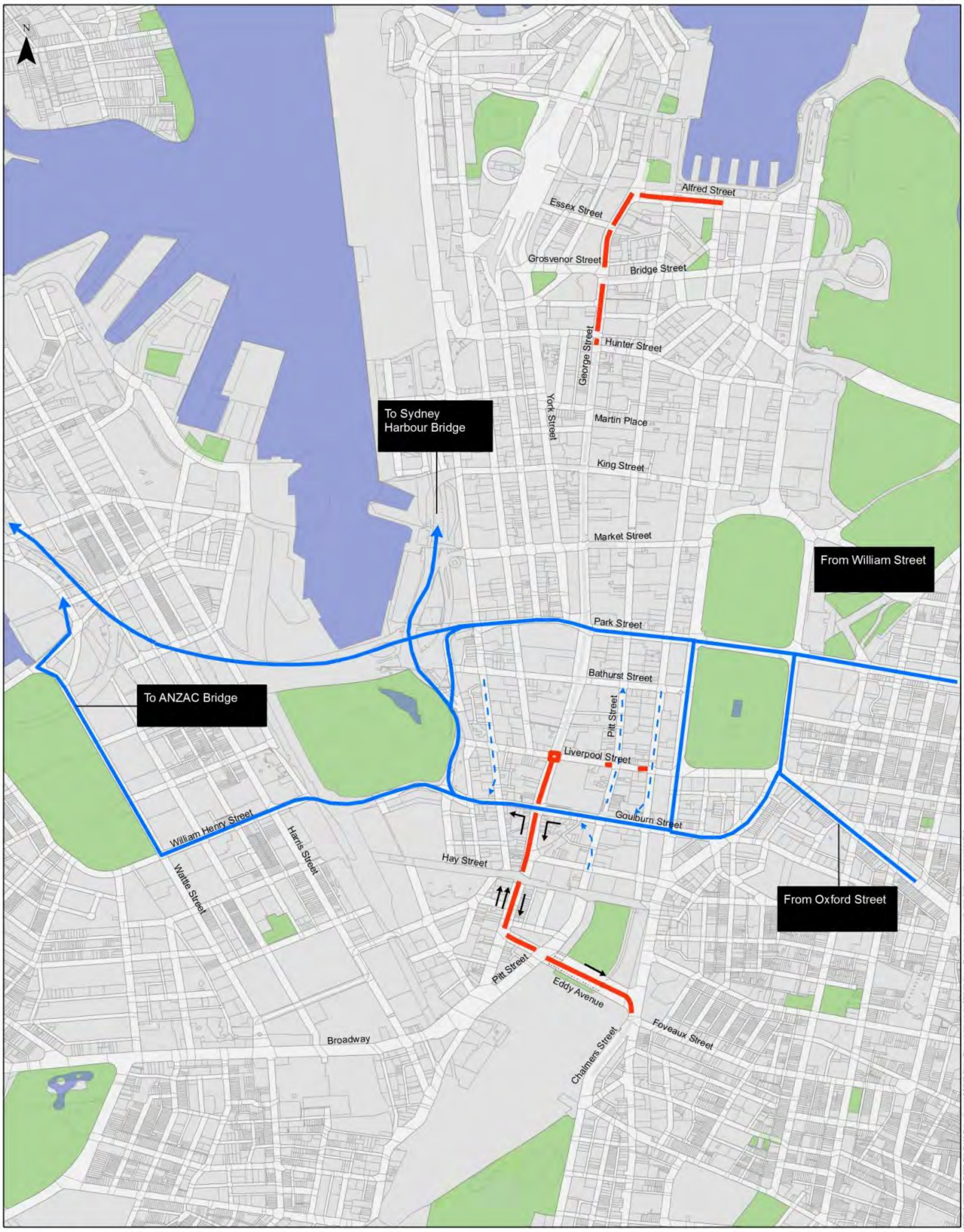
- Approach routes
- Exit routes
- Traffic direction

CSELR
Access routes for Wilmot Street / Central Street
Source: LPMA 2011, StreetPro 2010

0 50 100 200 m

JUN 2013
60238638

AECOM



Legend

Primary westbound route(s) — Road section closed — Traffic lanes open

Secondary route(s) — Road section open

CSELR

Proposed detour routes
George Street closed at Liverpool Street

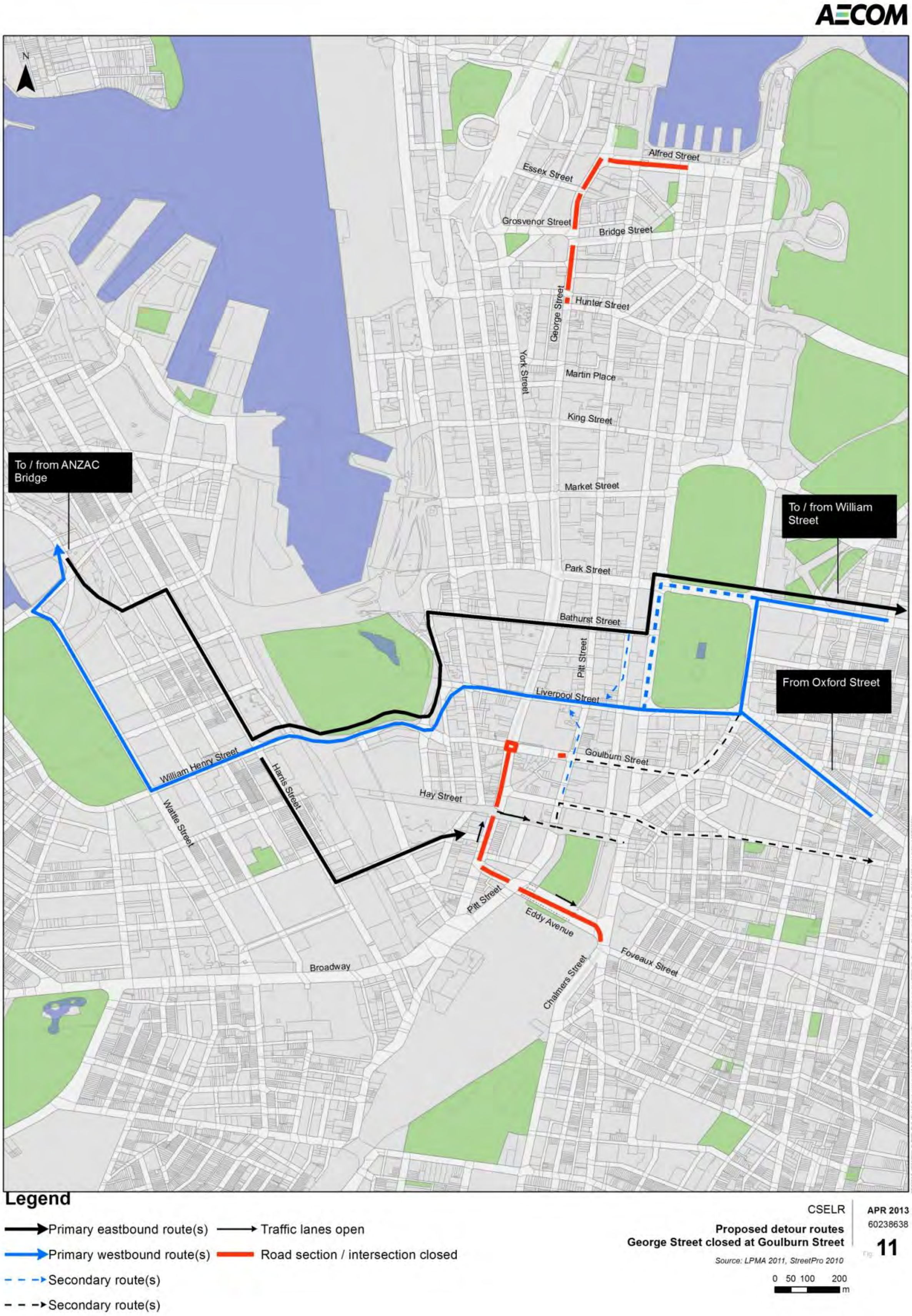
Source: LPMA 2011, StreetPro 2010

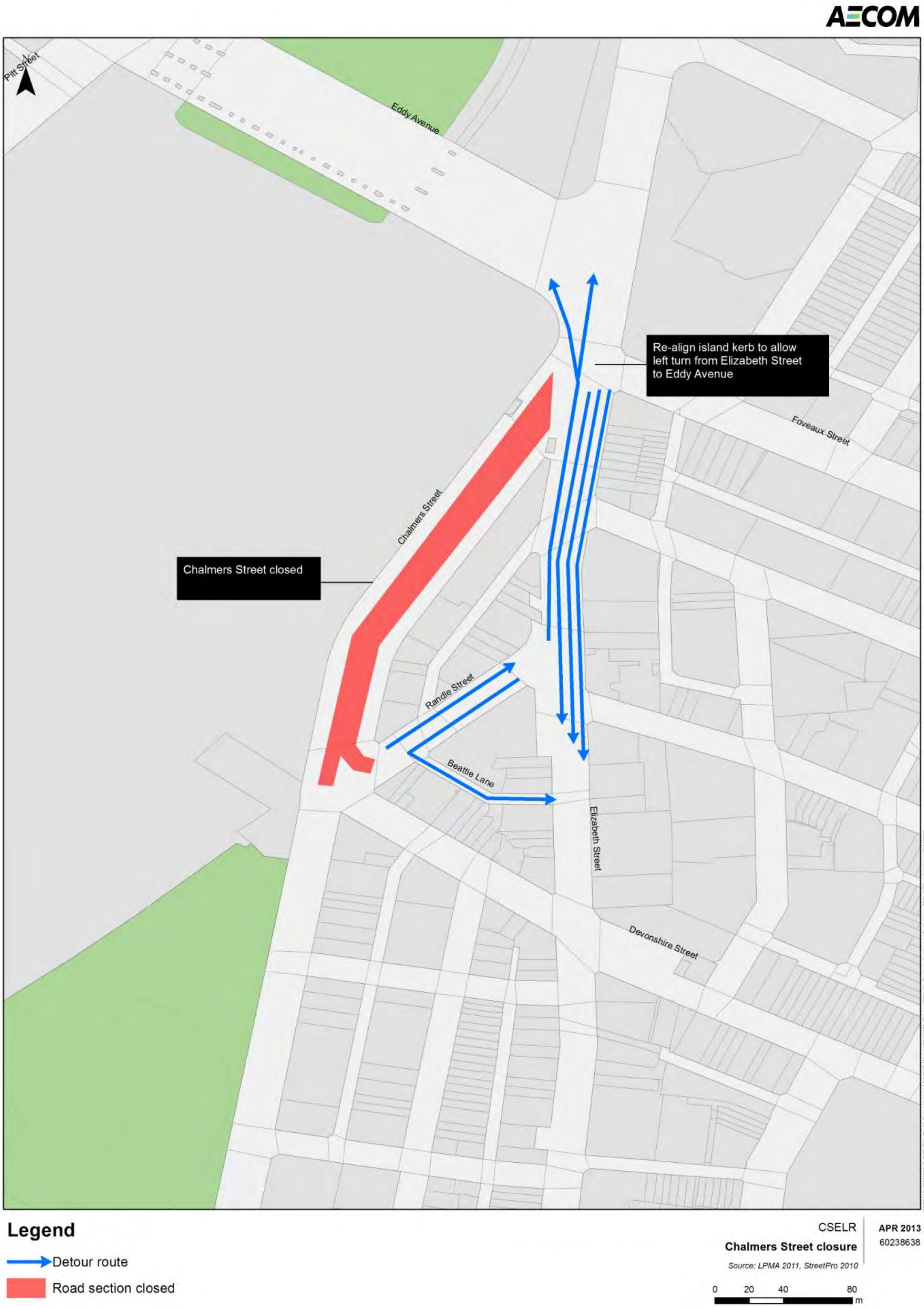
0 50 100 200 m

APR 2013

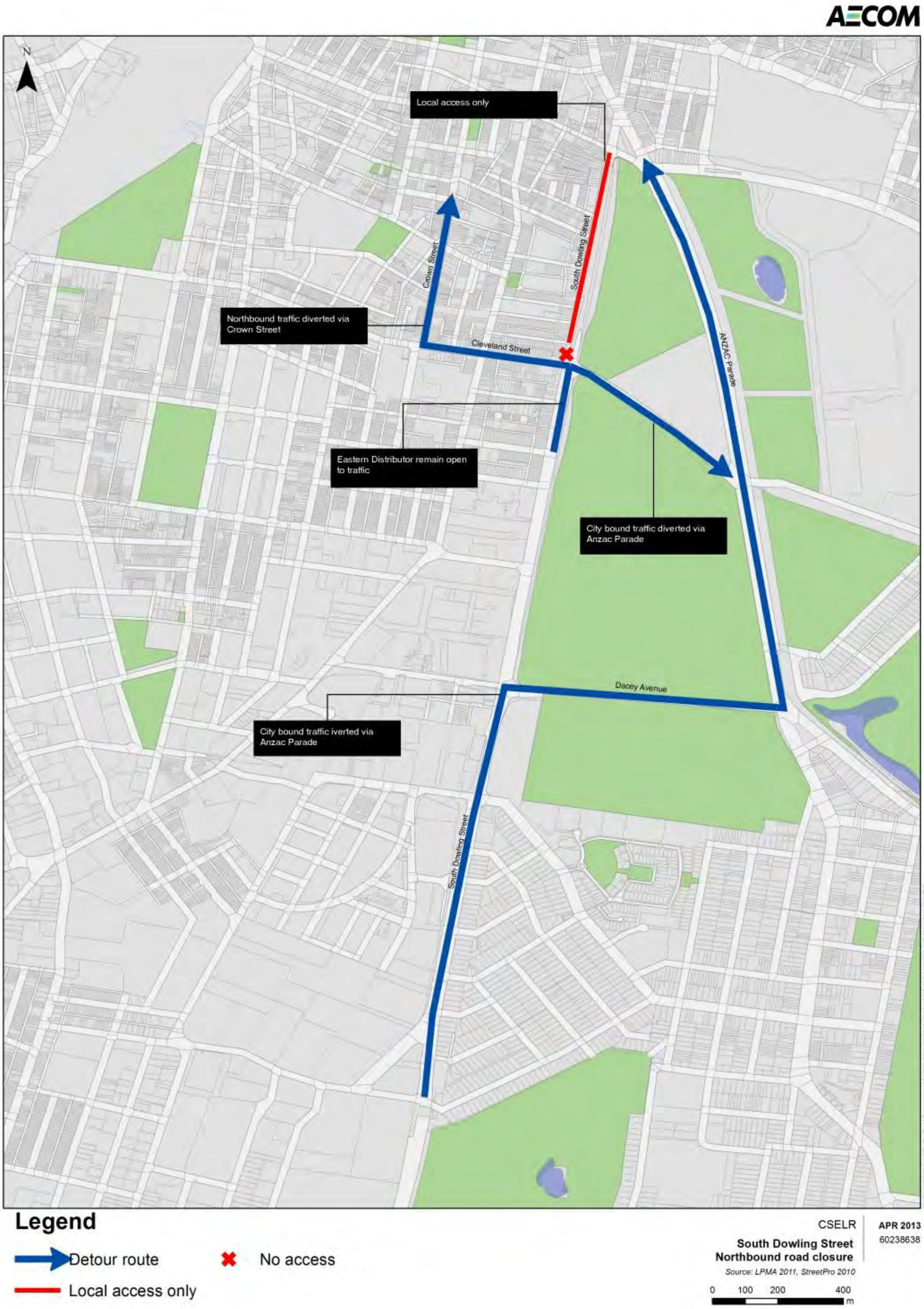
60238638

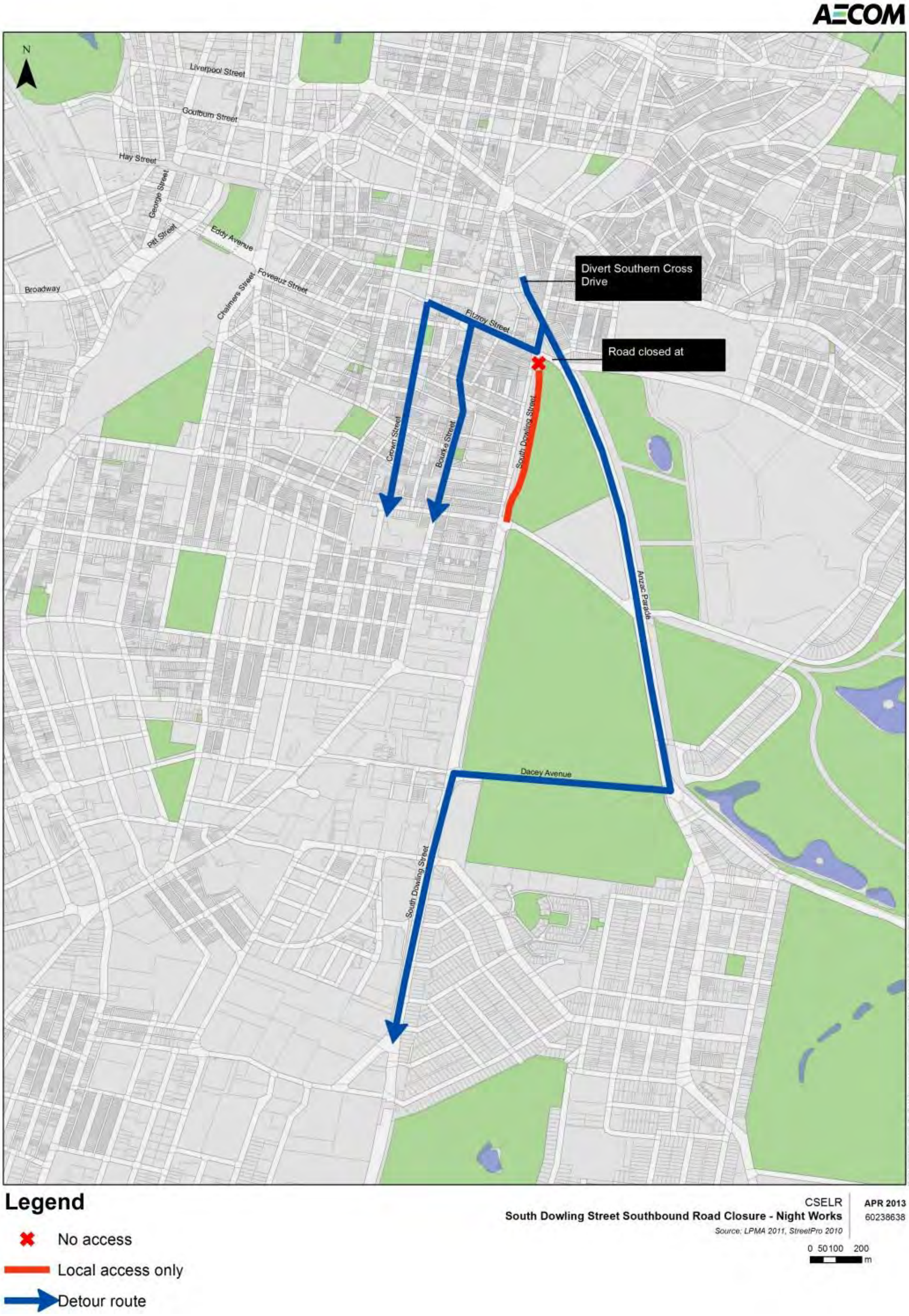
10


AECOM
N
Alfred Street
Essex Street
Grosvenor Street
Bridge Street
Hunter Street
George Street
York Street
Martin Place
King Street
Market Street
To / from ANZAC Bridge
To / from William Street
Park Street
Bathurst Street
Pitt Street
Liverpool Street
From Oxford Street
Goulburn Street
William Henry Street
Harris Street
Hay Street
Wattle Street
Pitt Street
Eddy Avenue
Foveaux Street
Chalmers Street
Broadway
Legend
Primary eastbound route(s)
Traffic lanes open
Primary westbound route(s)
Road section / intersection closed
Secondary route(s)
Secondary route(s)
CSELR
Proposed detour routes
George Street closed at Goulburn Street
Source: LPMA 2011, StreetPro 2010
APR 2013
60238638
11
0 50 100 200
m

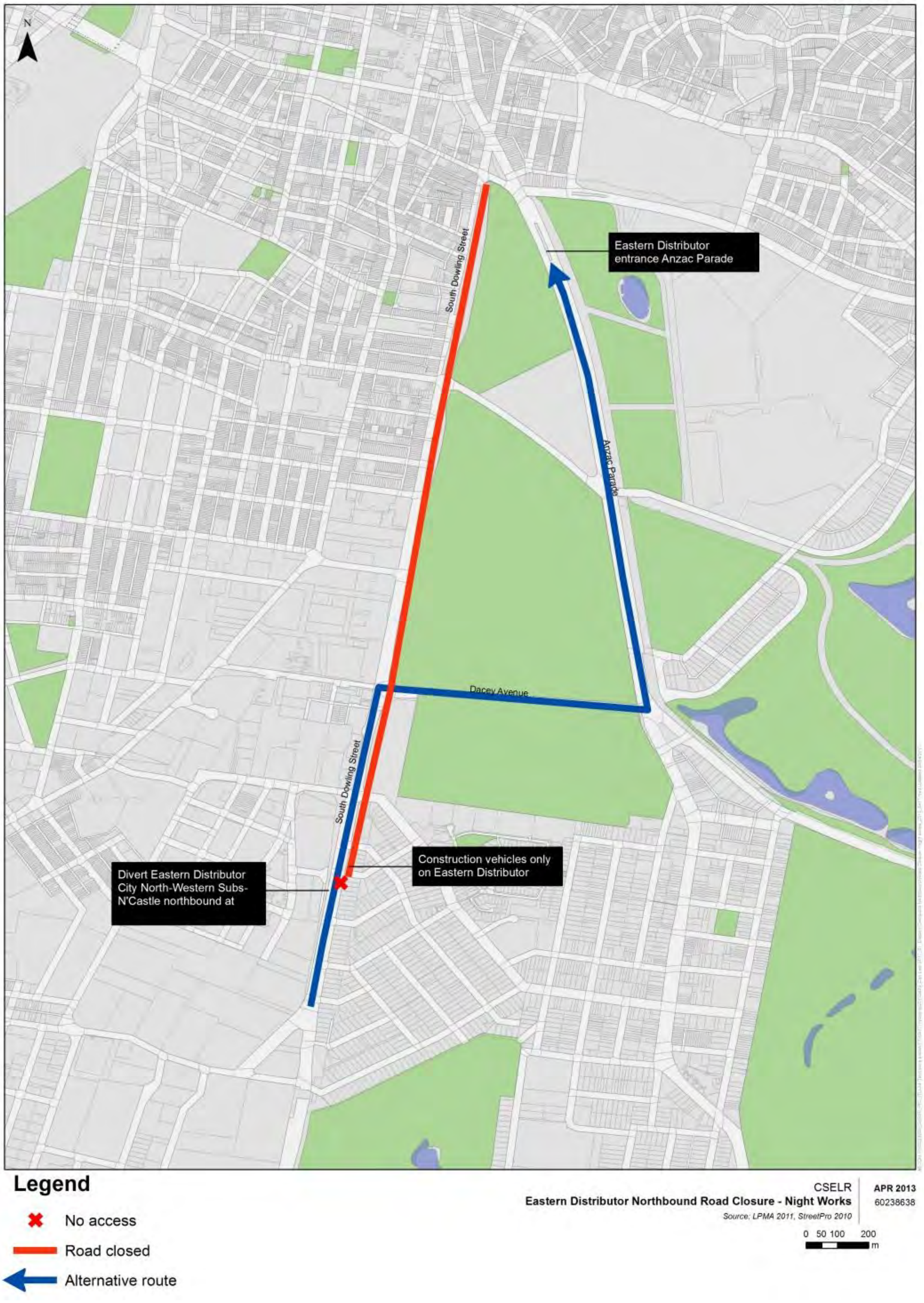

AECOM
Pitt Street
Eddy Avenue
Re-align island kerb to allow left turn from Elizabeth Street to Eddy Avenue
Foveaux Street
Chalmers Street
Chalmers Street closed
Randle Street
Beattie Lane
Elizabeth Street
Devonshire Street
Legend
Detour route
Road section closed
CSELR
Chalmers Street closure
Source: LPMA 2011, StreetPro 2010
APR 2013
60238638
0 20 40 80 m

Appendix E South Dowling Street and Eastern Distributor Detour Plans

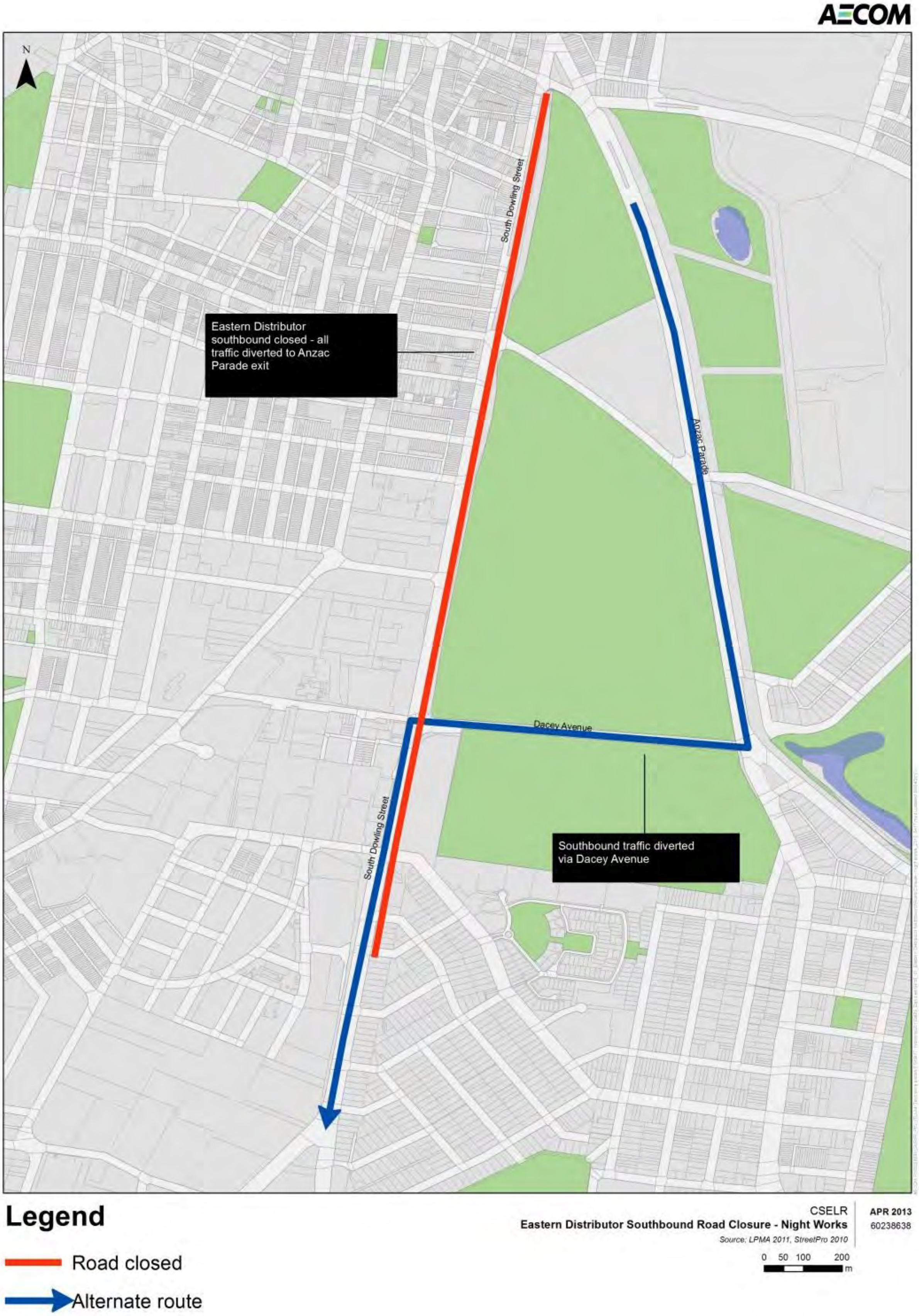



AECOM
Liverpool Street
Goulburn Street
Hay Street
George Street
Pitt Street
Eddy Avenue
Broadway
Chalmers Street
Foveaux Street
Fitzroy Street
Divert Southern Cross Drive
Road closed at
Crown Street
Bourke Street
South Dowling Street
Anzac Parade
Dacey Avenue
South Dowling Street
Legend
No access
Local access only
Detour route
CSELR
South Dowling Street Southbound Road Closure - Night Works
Source: LPMA 2011, StreetPro 2010
APR 2013
60238638
0 50100 200
m

AECOM



South Dowling Street
Eastern Distributor
entrance Anzac Parade
Anzac Parade
Dacey Avenue
South Dowling Street
Construction vehicles only
on Eastern Distributor
Divert Eastern Distributor
City North-Western Subs-
N'Castle northbound at
Legend
No access
Road closed
Alternative route
CSELR
Eastern Distributor Northbound Road Closure - Night Works
Source: LPMA 2011, StreetPro 2010
APR 2013
60238638
0 50 100 200
m


AECOM
N
South Dowling Street
Eastern Distributor southbound closed - all traffic diverted to Anzac Parade exit
Anzac Parade
Dacey Avenue
South Dowling Street
Southbound traffic diverted via Dacey Avenue
Legend
Road closed
Alternate route
CSELR
Eastern Distributor Southbound Road Closure - Night Works
Source: LPMA 2011, StreetPro 2010
APR 2013
60238638
0 50 100 200
m

This document has been prepared by:

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