

Lend Lease (Millers Point) Pty Ltd

**Barangaroo Hickson Road
Remediation**

Traffic Impact Assessment

001

Rev B | 18 August 2015

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 226463-03

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1 Introduction

Arup has been engaged by Lend Lease Millers Point (Lend Lease) to prepare a traffic impact assessment to accompany a Development Application for Remediation of part of Hickson Road at Millers Point (SSD 6617), to be submitted to the Minister for Planning and Environment pursuant to the Part 4 of the Environmental Planning and Assessment Act, 1979. The area of Hickson Rd to be remediated is the subject of NSW EPA Remediation Site declaration 21122

1.1 Site Description

Barangaroo is located on the north western edge of the Sydney Central Business District, bounded by Sydney Harbour to the west and north, the historic precinct of Millers Point (for the northern half), The Rocks and the Sydney Harbour Bridge approach to the east; and bounded to the south by a range of new development dominated by large CBD commercial tenants.

The 22 ha Barangaroo site is roughly rectangular in shape and has frontage to the harbour foreshore of 1.4km. Hickson Road delineates the eastern boundary.

The Barangaroo Delivery Authority is the state government authority that manages and delivers the development of Barangaroo.

1.2 EPA Declaration Area (#21122)

In May 2009, the NSW Environment Protection Authority (EPA) determined that a portion of land at Millers Point (part of the Barangaroo Site and an adjacent portion of Hickson Road), was contaminated in such a way as to present a significant risk of harm (SROH) to human health and the environment. As a consequence the EPA declared the area to be a remediation site (Declaration Number 21122; Area Number 3221) under the Contaminated Land Management Act 1997.

The Remediation Site Declaration 21122 indicates that the area of the declaration coincides with the known footprint of the former Millers Point gasworks facilities. This area is located on part of Barangaroo and part of Hickson Road adjacent to Barangaroo.

The Declaration Area comprises:

- Part Lot 200 DP 1204948 and Lot 101 DP 1204946 (formerly Part Lot 5 and Part Lot 4 DP876514), Hickson Road, Millers Point.
- Part of Hickson Road adjacent to:
 - 30-34 Hickson Road (Lot 11, DP1065410)
 - 36 Hickson Road (Lot 5, DP873158)
 - 38 Hickson Road (SP72797) Millers Point

The Barangaroo Delivery Authority has entered into a Voluntary Management Proposal (VMP) with the EPA associated with EPA Declaration Area (Approval No. 20101719). Phase 1 of this VMP involves investigative works and undertaking remedial design to determine and obtain agreement on a proposed remediation methodology. Phase 2 of the VMP will involve the implementation of the agreed remediation works.

An independent, EPA-accredited Site Auditor has been appointed to undertake review of proposed remediation works, and prepare statutory audit statements prior to and following completion of remediation.

For the purposes of planning and staging works, the EPA Declaration Area is divided into 3 areas as follows:

- Block 4 Remediation Area - the part of the Declaration Area on Barangaroo South
- Hickson Road remediation Area - the part of the Declaration Area on Barangaroo Central (including remediation of some land adjacent to the Declaration Area on the west)
- Hickson Road Remediation Area - the part of the Declaration Area located on Hickson Road

This DA is for the Hickson Road Remediation Area only. Remediation for the Block 4 and Hickson Road remediation Areas have been the subject of separate development applications.

1.3 Summary Site History and Key Contaminants

The Millers Point gasworks operated on the Declaration Area between 1840 and 1921. The Site has subsequently been used for various activities, but predominantly a commercial port facility and public road.

When EPA declared parts of Barangaroo and Hickson Road a “Remediation Site”, it described the nature of contamination as gasworks waste, with the following particular substances: polycyclic aromatic hydrocarbons (PAHs); benzene, toluene, ethylbenzene and total xylenes (BTEX); total petroleum hydrocarbons (TPH); ammonia and cyanide.

A Remedial Action Plan (RAP) prepared by AECOM (AECOM 2013) provides more specific details regarding the type, magnitude and location of ground contamination as identified in previous site investigations.

1.4 Definition of Site for Hickson Road Remediation DA

For the purposes of the Hickson Road Remediation Development Application, the **Site** includes the area of Hickson Road to be remediated (**Site Remediation Area**), plus any adjacent land used for the staging and undertaking of the proposed remediation.

The **Site Remediation Area** comprises the part of Hickson Rd within the Declaration Area that requires remediation, per the RAP.

1.5 Role of Lend Lease

Lend Lease has been contracted by the Barangaroo Delivery Authority to undertake remediation of the Declaration Area, which includes the Hickson Rd Remediation Area.

Lend Lease has also been appointed by the Barangaroo Delivery Authority as the Proponent to undertake the development for Barangaroo South.

1.6 Remedial Action Plan and Methodology

The proposed remediation of the Declaration Area is detailed in the AECOM Remedial Action Plan (AECOM 2013).

The RAP included two potential methodology options for Hickson Road:

- Preferred - In-situ remediation (chemical oxidation); or
- Alternate - Ex-situ remediation (excavate, off-site disposal and backfill).

The Development Application for Hickson Road Remediation includes for undertaking either the preferred or the alternative method above, with final method to be selected following agreement with the NSW EPA.

1.7 Summary of Proposed Works

The following summarises the works proposed as part of the Hickson Rd Remediation DA, in undertaking the preferred or alternate method as applicable (with final method selected following agreement with the NSW EPA). For both methods, Hickson Rd to remain open to traffic, with required temporary road closures/diversion in place during remediation works.

Preferred Method – In-situ Remediation

Undertaking remediation of required Hickson Road areas (including footpath), using **in-situ chemical oxidation / product extraction**. The in-situ remediation method will be SISCO/SEPR (Surfactant enhanced In-Situ Chemical Oxidation and Surfactant Enhanced Product Recovery) or similar in-situ oxidation process.

The in-situ remediation process involves the installation of subsurface wells and piping in Hickson Road, and a temporary staging compound in the road reserve, which facilitate controlled injection of chemical mixtures into the ground, to treat required areas of gasworks contamination in-situ.

Summary of works:

- Localised pruning of street trees where required to facilitate works
- Undertake temporary lane / traffic diversion as required during works.
- Undertake local service diversion or protection as required
- Maintain access to 30 and 38 The Bond driveways
- Install remediation infrastructure (wells and piping) in Hickson Rd.
- Install temporary remediation compound/staging area in Hickson Rd reserve.
- Install boundary groundwater control walls where required.

- Undertake in-situ chemical oxidation remediation through controlled injection and extraction.
- Management of extracted fluids, through either: limited storage/treatment within Hickson Rd compound, transfer to temporary water treatment plant on Barangaroo site or tankering off-site.
- If required, undertake localised excavations and off-site disposal (with appropriate odour controls).
- Undertake detailed environmental monitoring (air, noise, water) for duration of works.
- Validate remediation per RAP, including groundwater monitoring where required
- Decommission (cap and leave in-situ) sub-surface well/piping infrastructure
- Re-surface required areas of road/pavement.

If the above preferred method is not undertaken, the works for the alternative method below are proposed to be implemented, as part of this DA:

Alternative Method - Ex-situ Remediation

Undertaking remediation through selective excavation of required Hickson Road areas (including footpath), followed by off-site disposal (and treatment where required) of material at licensed facilities, backfilling and re-instatement of road/footpath.

Summary of works:

- Removal of street trees where required to facilitate excavation works
- Undertake temporary lane / traffic diversion as required during works.
- Undertake local service diversion or protection as required
- Maintain access to 30 and 38 The Bond driveways
- Undertake remediation in 2 main stages (east and west):
- Temporarily close one half and undertake remediation, while traffic is diverted to other half.
- Following 1st stage, re-instate remediated half, and re-divert traffic to complete remaining stage.
- Install boundary groundwater control walls, and walls to facilitate staged excavation, where required.
- Install odour control structures over excavation area (in stages as required).
- Excavate gasworks contamination in stages where required, from beneath road/footpath.
- Excavate rock, if required, to facilitate access to deep contamination within annulus trench.
- Transfer excavation water to temporary Barangaroo water treatment plant, for treatment
- Transfer excavated material directly off-site to licensed facility for treatment/disposal.

- Undertake detailed environmental monitoring (eg. air, noise) for duration of works
- Validate remediation per RAP
- Backfill excavations with suitable fill or suitable excavated material.
- Decommission odour tents.
- Re-surface road / pavement.
- Plant new street trees to replace those removed.
- Remove temporary traffic diversions.

1.8 Glossary of Key Terms

- **Block 4 Remediation Area** - *Portion of the Declaration Area situated within Barangaroo South.*
- **Hickson Road remediation Area** - *Portion of the Declaration Area located within Barangaroo Central (including remediation of some land adjacent to the Declaration Area on the west)*
- **EPA** – *Environment Protection Authority,*
- **EPA Declaration Area** - *Remediation Site Declaration 21122*
- **Hickson Road Remediation Area** - *Portion of the Declaration Area situated within the Hickson Road reserve,*
- **Ex-situ Remediation Methodology** - *Excavation of contamination and off-site disposal (with off-site pre-treatment, where required)*
- **LLMP** – *Lend Lease (Millers Point)*
- **RAP** – *Remedial Action Plan*
- **Site** - *area required for the purpose of the Hickson Road remediation Development Application identified as:*
 - *Hickson Road remediation Area*
 - *Any other areas of Barangaroo or Hickson Road required for staging and undertaking the remediation and stormwater diversion works.*
- **Site Remediation Area** - *The Hickson Road remediation Area (including remediation of some land adjacent to the Declaration Area on the west).*
- **VMP** – *Voluntary Management Proposal*

2 Study Background

2.1 Scope of the Report

This report assesses the forecast construction traffic generated during all stages of the development of the site and its likely impact to the road network, as well as pedestrian safety and amenity issues during the construction of the subject development. It assesses the cumulative traffic impacts associated with the Hickson Road remediation works and the following surrounding construction works:

Works directly related to Barangaroo South

- Stage 1A Basement Construction
- T2 Commercial Building
- T1 Commercial Building
- T3 Commercial Building
- R8/R9 Residential Buildings
- Concrete Batch Plant Operation
- Block 4 Remediation
- Block 5 Remediation
- Hickson Road remediation
- C8 Building
- City Walk Bridge
- R1 Building
- R7 Building
- Crown Sydney
- Stage 1B basement and towers

Works external to Barangaroo South

- Wynyard Walk
- Headland Park and Northern Cove
- Barangaroo Central – Waterfront Promenade and Interim Public Domain Works
- Barangaroo Ferry Wharf

With respect to construction work external to Barangaroo South, assumptions have been made regarding expected vehicular activity based on documents submitted as part of the planning applications for each of these works.

As the anticipated construction period (and level of vehicle activity) for the Barangaroo Central precinct is currently unclear, these works have been excluded from the analysis.

2.2 Study Objectives

Specific issues addressed in the report respond to the Secretary's Environmental Assessment Requirements (SEARs) in relation to traffic and transport for SSD 6617, those being:

Preparation of a traffic impact assessment (TIA) that evaluates:

- *Traffic movements likely to be generated by the project;*
- *Cumulative impacts associated with other construction activities on the Barangaroo site;*
- *Details of access arrangements for workers, service vehicles and emergency vehicles;*
- *Details or arrangements for interim cycling and pedestrian access during construction;*
- *Details of any proposed transportation of materials via the Harbour and proposed locations for handling materials.*

3 Existing Traffic Conditions

3.1 Road Network

Sussex Street / Hickson Road form a wide road that runs along the western side of Sydney CBD, and bounds the east of the Barangaroo Stage 1A site. The Sussex Street section continues south from Napoleon Street to Hay Street. It is two-way north of King Street and one way southbound, south of King Street. Hickson Road forms the northern extension of Sussex Street and continues north from Napoleon Street to George Street at Dawes Point.

Napoleon Street provides a connection between Hickson Road and Kent Street / Margaret Street. It is a relatively wide road and has moderate downward slope from Kent Street to Hickson Road. Traffic signals were recently installed at the Hickson Road / Napoleon Street intersection, which provides for controlled vehicle movements out of the Barangaroo Stage 1A basement.

Shelley Street provides a connection between Sussex Street (to the north) and Erskine Street (to the south). Shelley Street also forms a northbound connection from Harbour Street into the Barangaroo Stage 1A site.

Lime Street is located south of the Barangaroo construction site in a north-south direction and currently provides limited local access from priority controlled Erskine Street.

3.2 Pedestrian Conditions

There are a number of existing dedicated pedestrian facilities adjacent to the Barangaroo South site, including:

- Signal controlled pedestrian crossings across all approaches of the Sussex Street / Shelley Street intersection
- Signal controlled pedestrian crossings across all approaches of Hickson Road / Napoleon Street intersection
- Adequate footpaths on both sides of Hickson Road

3.3 Traffic Volumes

Traffic counts were undertaken in the Barangaroo precinct in July 2013 and are presented in Table 1. The traffic volumes on Hickson Road and Sussex Street progressively increase towards the south as vehicles join this southbound route on the western side of the city. This is particularly evident in the PM peak, when Sussex Street is utilised as a major departure route from the city to the Western Distributor-Anzac Bridge and routes further south and east.

Table 1: Hickson Road / Sussex Traffic Volumes

Traffic Count Date	Road	Location	AM Peak (8am – 9am)			PM Peak (5pm – 6pm)		
			NB	SB	Total	NB	SB	Total
Nov 2011	Hickson Road	North of Napoleon Street	647	250	897	469	659	1,128
Jul 2013			601	254	855	380	606	986
% Change from 2011 to 2013			-7%	+2%	-5%	-19%	-8%	-13%
Nov 2011	Sussex Street	North of Shelley Street	1,101	705	1,806	747	805	1,552
Jul 2013			926	556	1,482	569	714	1,283
% Change from 2011 to 2013			-16%	-21%	-18%	-24%	-11%	-17%
Nov 2011	Sussex Street	North of Erskine Street	628	619	1,247	479	808	1,287
Jul 2013			650	518	1168	409	845	1,254
% Change from 2011 to 2013			+4%	-16%	-6%	-15%	+5%	-3%
Nov 2011	Sussex Street	North of King Street	597	1,005	1,602	294	1,223	1,517
Jul 2013			578	907	1,485	316	1,364	1,680
% Change from 2011 to 2013			-3%	-10%	-7%	+7%	+12%	+11%

Source: Arup traffic surveys 25 July 2013, AECOM traffic surveys 8th November 2011

It should be noted that both surveys were conducted on a typical Thursday outside of school holiday periods, and are therefore representative of traffic volumes in the precinct. Key points to emerge from the recent traffic surveys include:

- North of Napoleon Street traffic volumes have decreased on average by 10% since the November 2011 counts over both the AM and PM peak hours
- On Sussex Street between Napoleon Street and Shelley Street, there has been a significant reduction in traffic during both the AM and PM peak hours since the November 2011 counts. This may possibly be the result drivers avoiding the road works on Shelley Street and Sussex Street being carried out during the July 2013 count.

The existing morning and afternoon peak hour intersection traffic volumes from the July 2013 traffic surveys are illustrated in Figure 1 and Figure 2.

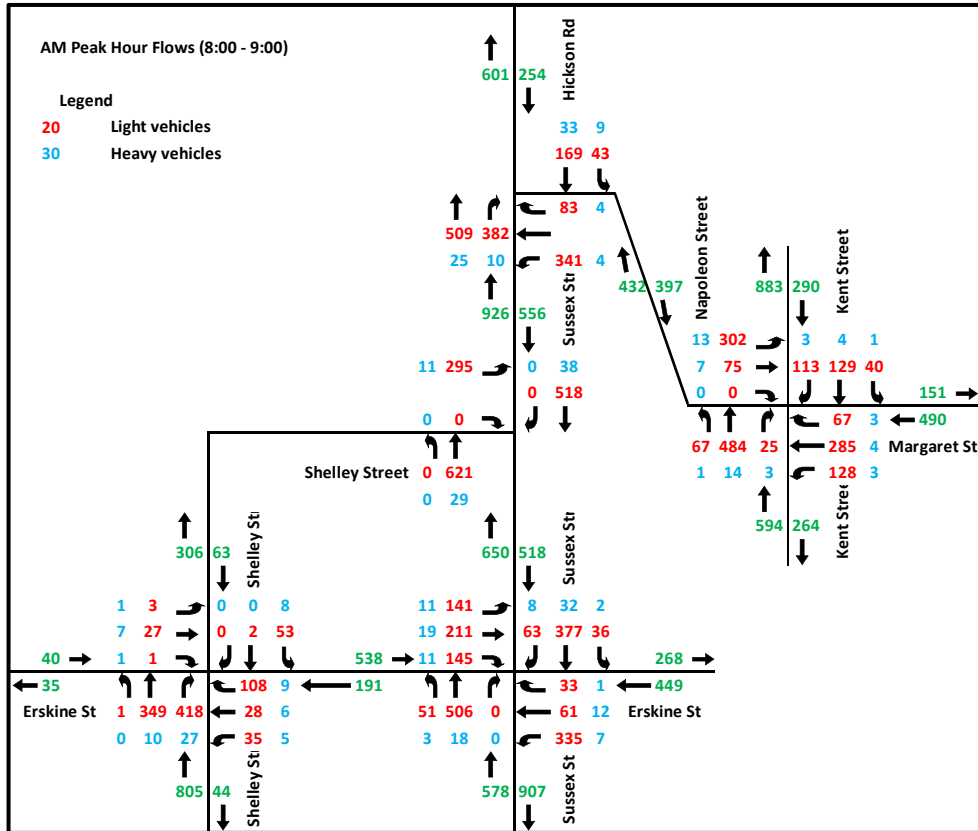


Figure 1: AM Peak Hour Traffic Flows, July 2013

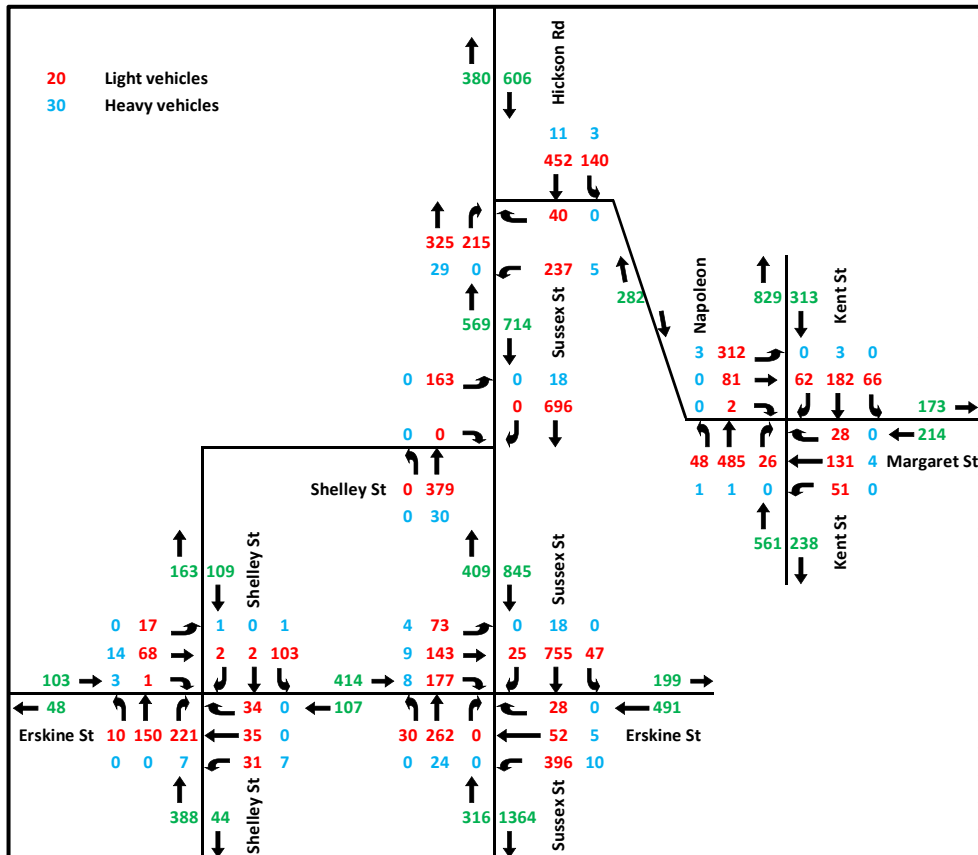


Figure 2: PM Peak Hour Traffic Flows, July 2013

3.4 Existing Construction Activity

Construction works on the Barangaroo South site commenced in late 2011, with the C4 building and Stage 1A public domain opening in July 2015. Construction works for the C3 and C5 buildings are currently ongoing.

The number of construction vehicles generated by the site, over the course of a typical weekday in July 2013, is shown in Figure 3 below.

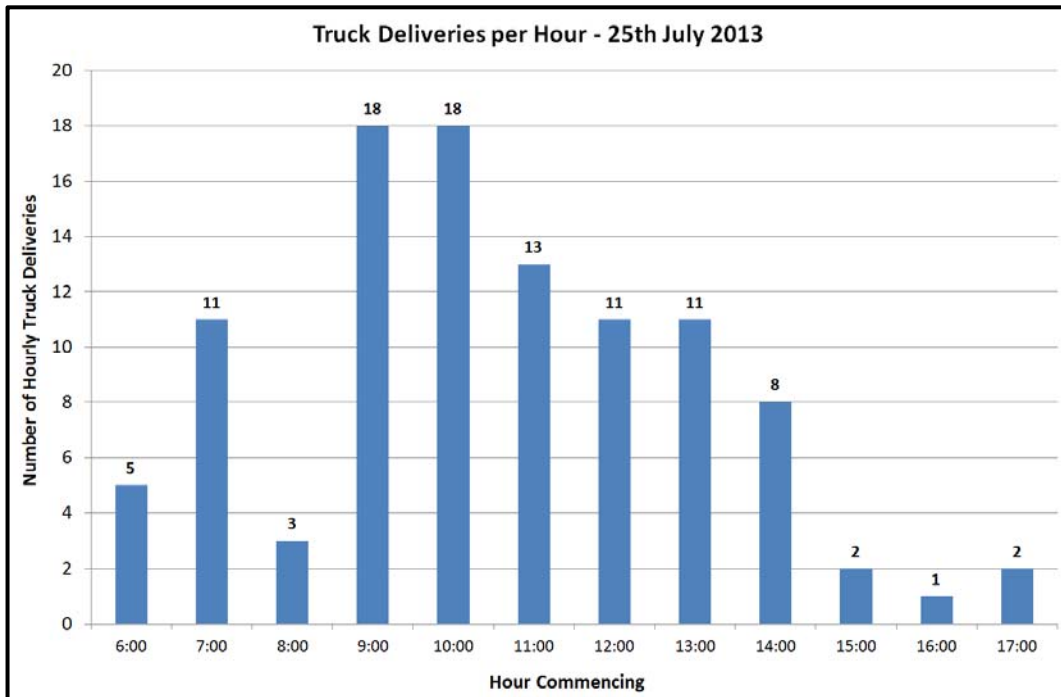


Figure 3: Existing Construction Activity for Barangaroo South (July 2013)

This existing profile demonstrates the majority of vehicle activity takes place outside the commuter peak hours of 8am-9am and 5pm-6pm. Most notably, construction activity dissipates significantly after 3pm, with only 5% of the day's total trucks arriving after this time. 2 truck deliveries were recorded during the PM peak hour of 5pm – 6pm, equating to 2% of the daily vehicle activity.

This shows that the construction activity generated by Barangaroo South has a relatively minor impact on the operation of nearby intersections during the critical PM peak period (4pm-7pm).

4 Construction Program

4.1 Barangaroo South Works

Table 2 below outlines the concurrent developments within the Barangaroo South site, noting the start and finish dates by annual quarters.

Table 2: Construction Details of Barangaroo South Works

Project	Project Duration*		Overlaps with Hickson Road remediation works?
	Start	Finish	
Stage 1a Basement Construction	Oct 2011	Sept 2015	✗
C3 Commercial Building	Mar 2014	Sept 2016	✗
C4 Commercial Building	May 2013	Oct 2015	✗
C5 Commercial Building	Oct 2013	Apr 2016	✗
C2 Building	Jul 2015	Sep 2016	✗
C1 Buildings	Nov 2016	Feb 2018	✓
R8/R9 Residential Buildings	Jun 2014	Nov 2015	✗
Batch Plant Operation	Sept 2013	Sept 2015	✗
Block 4 Remediation Works	Aug 2015	Nov 2017	✓
Block 5 Remediation Works	Nov 2015	Oct 2017	✓
Stage 1a Public Domain Works	Jul 2014	Mar 2016	✗
City Walk Link Bridge	Oct 2014	Jun 2015	✗
Building R1	Sep 2015	Jun 2016	✗
Building R7	Jul 2015	Apr 2016	✗
Stage 1C Remediation and Earthworks	Dec 2015	Mar 2018	✓
Crown Sydney	June 2016	Nov 2019	✓
Hickson Road Remediation	Nov 2016	Oct 2018	✓
Stage 1B basement	Jun 2017	Mar 2021	✓
Stage 1B residential towers	Dec 2019	Jul 2023	✗

* The above dates are indicative only and allow for future tenant fit out works within the individual buildings

4.2 Works External to Barangaroo South

The construction staging for works external to the Barangaroo South site are outlined in Table 3 below.

Table 3: Construction Details of Works Adjacent to Barangaroo South

Project	Project Duration		Overlaps with Hickson Road remediation works?
	Start	Finish	
Wynyard Walk Bridge	Apr 2013	Sep 2015	✗
Headland Park Main Works	Apr 2013	Jul 2015	✗
Barangaroo Ferry Wharf	Aug 2015	Aug 2016	✗
Barangaroo Central – Waterfront Promenade	Mar 2014	Jul 2015	✗

5 Construction Traffic Movements

5.1 Overall Principles

The overall construction traffic management principles will be to ensure:

- Construction access driveways are designed to allow trucks to enter and leave the site in a forward direction;
- Construction access driveways are managed and controlled by site personnel;
- Safety for works and the public in the vicinity of the worksite is maintained;
- Designated truck routes for all access points are developed which minimises the impacts on the local road network;
- A safe, convenient and appropriate environment is established for pedestrians and cyclists at all times; and
- Appropriate capacity for pedestrians along the Hickson Road footpath is maintained

5.2 Traffic Routes

The predominant traffic routes that construction vehicles utilise to Barangaroo are presented in Figure 4 through Figure 6 on the following pages, and summarised below.

From the north and north-west:

- Harbour Bridge – Western Distributor – Bathurst Street – Liverpool Street – Harbour Street – Shelley Street – Erskine Street – Sussex Street (inbound); and
- Hickson Road – Napoleon Street – Kent Street – Western Distributor – Harbour Bridge (outbound)

This southbound truck activity would occur during peak hours as there is no access for general traffic from the Harbour Bridge to York Street between 6.30am – 9.30am (Monday – Friday).

From the west and south-west:

- Anzac Bridge – Western Distributor – Sussex Street – Hickson Road (inbound); and
- Hickson Road – Sussex Street – Western Distributor – Anzac Bridge (outbound)

From the south and east:

- Eastern Distributor – Cross City Tunnel – Western Distributor – Wattle Street – Western Distributor – Sussex Street – Hickson Road (inbound); and
- Sussex Street – Harbour Street – Cross City Tunnel (outbound)

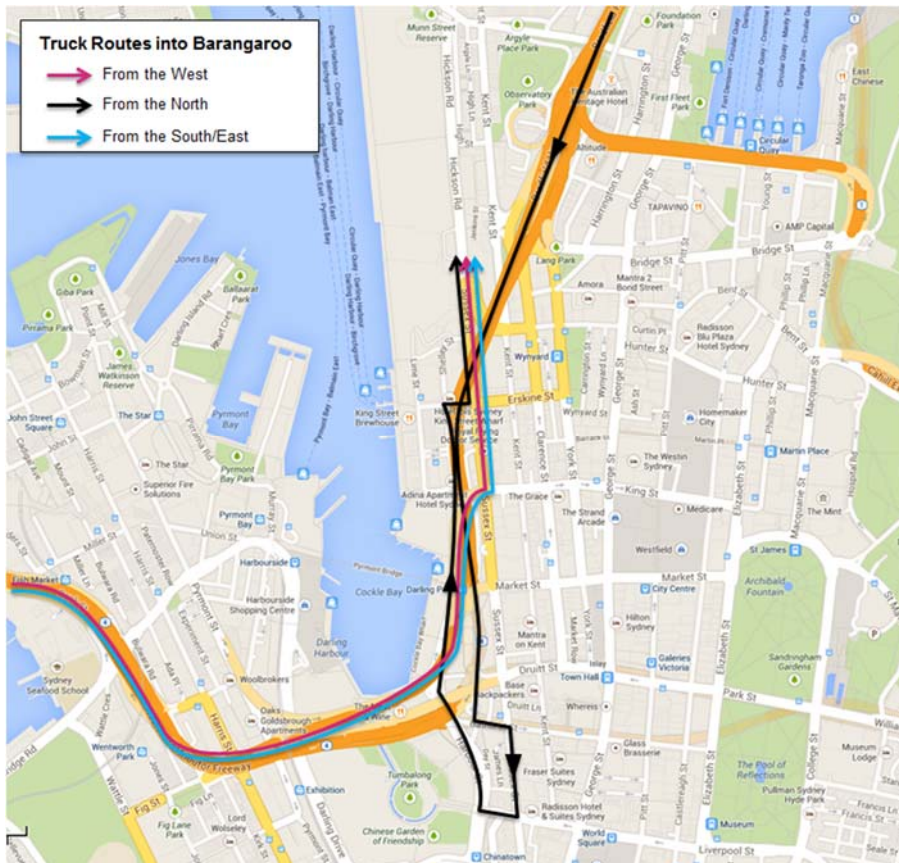


Figure 4: Inbound Traffic Routes to Barangaroo

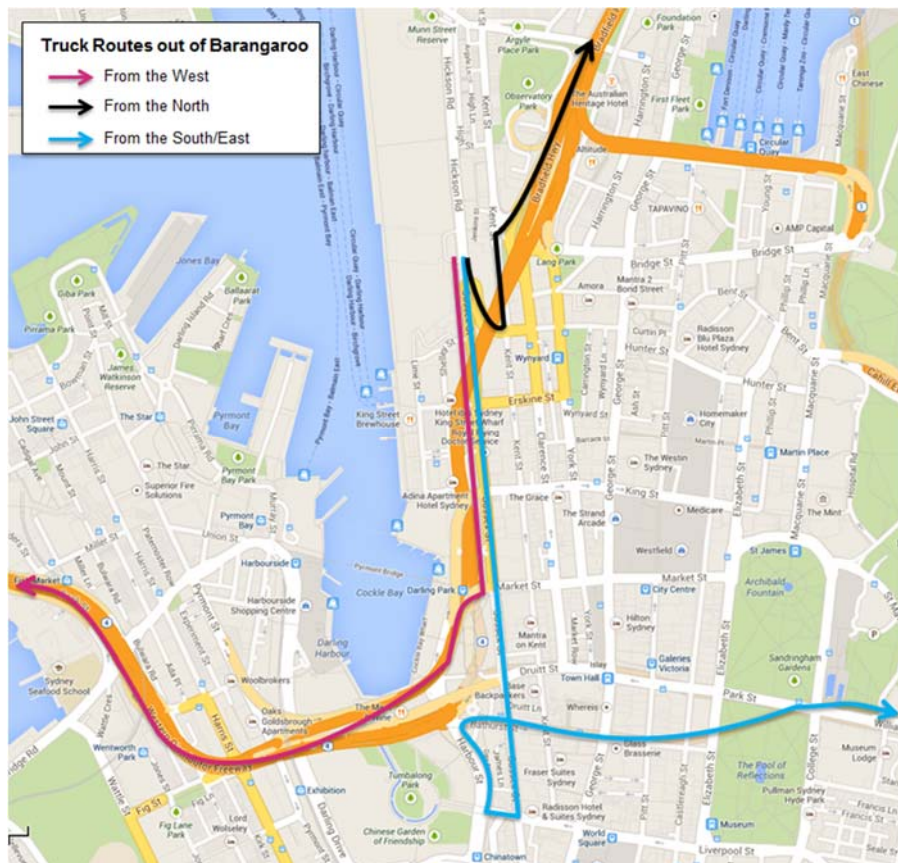


Figure 5: Outbound Traffic Routes from Barangaroo

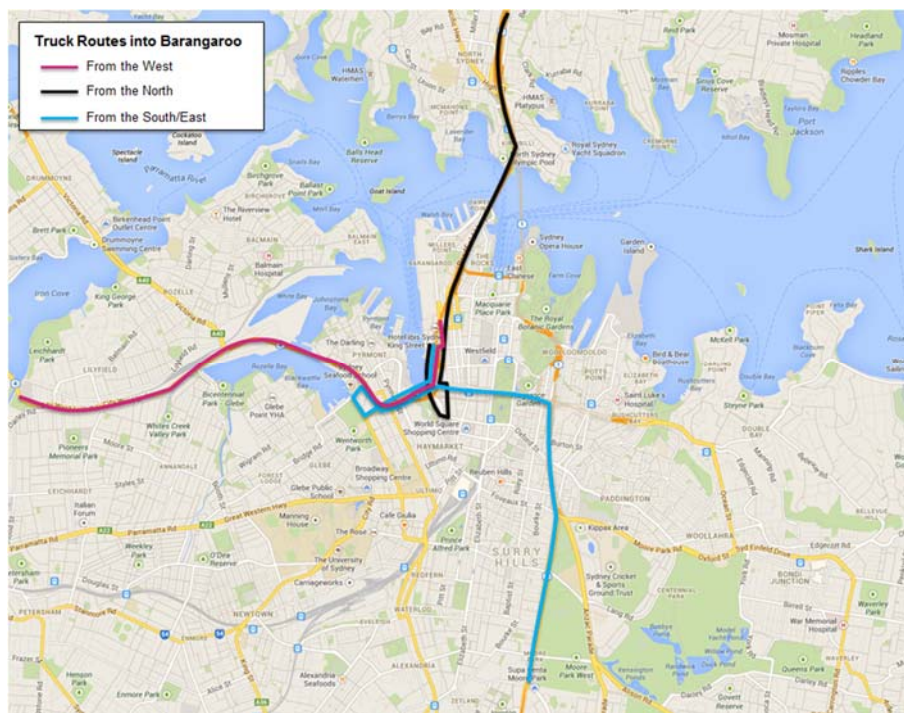


Figure 6: Construction Traffic Routes through the Sydney CBD

5.3 Forecast Traffic Movements

An assessment has been made of the cumulative impacts of construction activities in the precinct, based on the works described in Section 4 of this report.

The proposed construction timeframe for Hickson Road remediation will extend into the period of the occupation of the Barangaroo South Stage 1A development. As such, an assessment of the road network impact of these works during this time has also been undertaken.

5.3.1 Hickson Road Remediation Works

The works associated with the remediation of Hickson Road are expected to occur between June 2016 and July 2018, depending on the final method selected. Works for each method option are to be divided into stages as summarised in Table 4 below.

Table 4: Summary of Hickson Remediation Works – In Situ Method

Stage of Works	Indicative Duration*	Summary of Works	Daily Construction Vehicle Movements
Stage 1	Nov 16 – Dec 16	Installation – west half Temporary removal of street parking for works Install wells and infrastructure. Temporary traffic diversions	10
Stage 2	Jan 17 – Feb 17	Installation – east half Install wells and infrastructure. Install groundwater control walls. Set-up compound in road reserve. Temporary traffic diversions	20
Stage 3	Mar 17 – Aug 17	Remediation – east half Undertake ISCO remediation	4
Stage 4	Sep 17 – Feb 18	Remediation – west half Undertake ISCO remediation	4
Stage 5	Mar 18 – Aug 18	Validate remediation Decommission wells / Restore road (staged) Re-instate street parking	8

Table 5: Summary of Hickson Remediation Works – Ex Situ Method

Stage of Works	Indicative Duration*	Summary of Works	Daily Construction Vehicle Movements
Stage 1	Nov 16 – Feb 17	East half – Establish/commissioning Temporary removal of street parking for works Removal of street trees Divert traffic to west half Service diversion where required Install retention systems Install & commission odour structures. Install Dewatering infrastructure	20
Stage 2	Mar 17 – Sep 17	East half - remediation Excavate and dispose fill off-site. Dewatering.	50
Stage 3	Oct 17 – Dec 17	East half - remediation Validate excavations Backfill excavations. Road/footpath restoration Decommission odour structures	25
Stage 4	Jan 18 – Apr 18	West half - Establish/commissioning Divert traffic to east half Removal of street trees Service diversion where required Adjust existing retention systems Install & commission odour structures. Install Dewatering infrastructure	20
Stage 5	May 18 –Jul 18	West half – remediation Excavate and dispose fill off-site. Dewatering.	50
Stage 6	Aug 18 – Oct 18	West half – remediation Validate excavations Backfill excavations. Road/footpath restoration Decommission odour structures Re-instate street parking and trees	25

* The above dates are indicative only

For the road network analysis undertaken as part of this assessment, the construction traffic volumes arising from the Ex Situ method have been utilised. This is a worst case scenario, with the construction timeframe and number of daily vehicles potentially reduced should the preferred In-Situ method be adopted.

5.3.2 Construction Vehicle Movements

The number of construction vehicles generated by works within the Barangaroo South site is based on recent advice from Lend Lease Buildings. The number of vehicle movements expected during the peak hours has been determined based on the existing activity profile for the Barangaroo South site. Construction vehicle activity generated by works external to Barangaroo South have been forecast based on the supporting planning documents to each of the project application, as follows:

- **Headland Park:** *Barangaroo Headland Park Early Works – Construction Traffic Management Plan and Impact Assessment, Halcrow (October 2010)*
- **Wynyard Walk:** *Wynyard Walk Review of Environmental Factors (BPL-R-EN-059[A]), April 2012*
Bridge Works - Traffic Management Plan (BPL-R-GN-053), May 2012
- **Barangaroo Central – Waterfront Promenade:** *Barangaroo Central Waterfront Promenade and Interim Public Domain – Traffic Impact Assessment, Aurecon (Rev 4, 30 Oct 12)*

Current advice from Transport for NSW with respect to the Barangaroo Ferry Hub is that minimal construction activity is expected to travel to the site via road. Indicative forecasts suggest approximately 10 vehicles per day servicing the site.

It is noted that the construction program for the Barangaroo Central Waterfront Promenade has been shortened compared to that outlined in the original planning application. However, it is considered that the original estimate of 40 truck movements in the peak hour (as outlined in the planning report) is overly conservative. Therefore, notwithstanding the shorter construction period, the cumulative analysis has retained the figure of 40 peak hour truck movements.

5.3.3 Development Traffic

The proposed construction timeline for the proposal coincides with the occupation of commercial and residential buildings within the Barangaroo development. These include:

- C3 commercial building
- C4 commercial building
- C5 commercial building
- R8/R9 residential buildings
- C2 commercial building
- R1 & R7 buildings
- Headland Park

210 cars and 50 service vehicles are anticipated to be generated from these developments during peak hours following their occupation (including associated on-street parking).

5.3.4 Cumulative Traffic Movements

Table 6 on the following page provides a detailed summary of anticipated construction and development traffic movements associated with each project in the Barangaroo precinct. This demonstrates the peak traffic, during the Hickson Road remediation works between November 2016 and October 2018, is anticipated to occur in June 2017 with 335 traffic movements forecast during the AM peak hour. Of these, only a small proportion (3%) are attributable to the Hickson Road remediation works.

As previously illustrated in Figure 3, the majority of construction truck movements occur prior to the afternoon peak commuter period (5pm – 6pm). Therefore the analysis has considered the morning peak hour (8am – 9am) to determine the impacts arising from the Hickson Road remediation works.

Forecast Vehicle Activity - Vehicle Movements per Hour

* Anticipated construction vehicle activity generated by Barangaroo South worksites are based on recent information provided to Arup by Lend Lease Buildings

5.4 Road Network Operations

5.4.1 Traffic Distribution

Construction Traffic Movements

Consistent with the forecasts adopted in previous construction traffic management plans for Barangaroo South works, 70% of construction vehicles are forecast to approach the worksite from the southern and western parts of Sydney. The remainder would approach from the northern direction (i.e. via the Harbour Bridge, Western Distributor and Harbour Street). For trucks returning to the north, they would utilise Napoleon Street and then turn left onto Kent Street to approach the Harbour Bridge. Margaret Street would not be used as a construction route during peak hours.

Operational Traffic Movements

Traffic associated with the new development has been distributed across the road network based on Journey to Work Census data, consistent with the assumptions outlined in the MWT Modified Concept Plan – Transport Report, July 2008.

Table 7 Development Traffic Distribution

Direction	Route	Distribution
North	Harbour Bridge	40.7%
East	Eastern Distributor	22.9%
	William Street	1.5%
	Oxford Street	4.1%
South	Harbour Street	8.6%
West	Western Distributor	21.8%
Sydney Inner	-	0.4%
Total		100%

5.4.2 Road Network Layout

The traffic modelling has considered the current road network layout in the Barangaroo precinct. This includes:

- The closure of the northern section of Shelley Street to vehicular traffic.
- The installation of traffic signals at the Hickson Road / Napoleon Street intersection, including the provision of a fourth leg at the intersection which provides egress from the Stage 1A basement car park.

Prior to the completion of the Barangaroo Stage 1B development, the Hickson Road / Watermans Quay intersection will be priority controlled.

5.4.3 Traffic Modelling

This report examines in detail the future stage traffic operations of the five nearest and most relevant intersections to Barangaroo South construction site, namely:

- Hickson Road & Watermans Quay, **Priority Controlled (Future)**
- Napoleon Street & Hickson Road, **Traffic Signals**
- Sussex Street & Shelley Street, **Traffic Signals**
- Sussex Street & Erskine Street, **Traffic Signals**
- Napoleon Street, Margaret Street & Kent Street, **Traffic Signals**

Lane saturation flows within the LinSig model have been lowered at certain locations to consider the impact of queue spillback from upstream and downstream intersections.

The modelling does not consider the redistribution of traffic arising from the changes in transport conditions in the CBD following the introduction of the light rail on George Street. It is understood that Transport for NSW is currently preparing a mesoscopic traffic model which considers the traffic impacts of this proposal. The results of this analysis were not available at the time of writing.

It should be noted that the Sydney City Centre Capacity Improvement Plan (RMS, November 2014) provides some detail with respect to the redistribution of traffic following the closure of George Street to general traffic. This plan illustrates the existing traffic displaced from George Street will be redirected onto adjacent north-south corridors, those being:

- Kent Street
- Clarence Street
- Elizabeth Street
- Macquarie Street

Capacity improvements along both Clarence Street and Kent Street are proposed which are forecast to mitigate the impacts of this redistributed traffic.

Importantly Hickson Road and Sussex Street (at the northern end of the CBD) are not identified as corridors expected to take displaced traffic from George Street. Therefore the traffic flows used for the modelling in the TMAP are considered appropriate to understand the impacts associated with the proposed works.

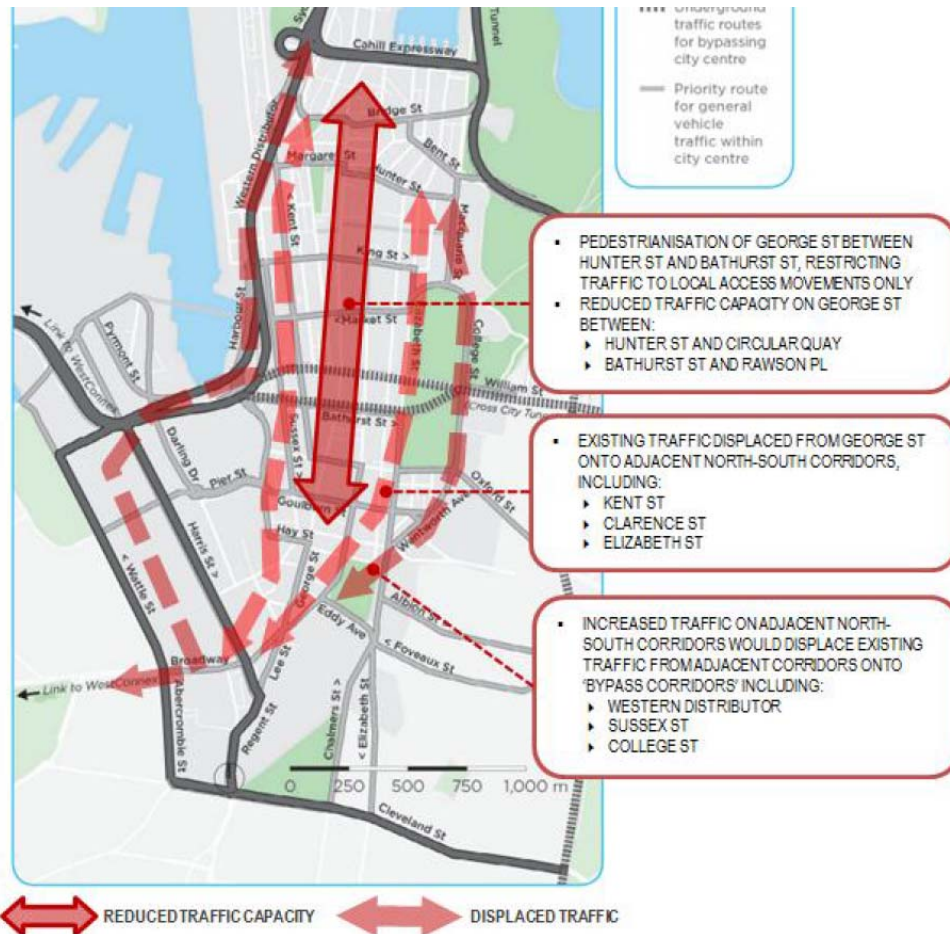


Figure 7 Traffic redistribution following opening of Sydney CBD Light Rail

Source: Sydney City Centre Capacity Improvement Plan (RMS, November 2014)

5.4.4 Intersection Operation

The effect of the estimated additional peak hour traffic during (for the combined construction and operational activities) has been investigated for each of the affected intersections during the AM peak hour. Negligible construction traffic movements are expected during the PM peak hour and therefore this has not been considered in the analysis. These modelling results are summarised in Table 8.

Table 8: Intersection Analysis

Peak	Intersection	Future Traffic Peak, 2017 (Excluding proposed works)			Future Traffic Peak, 2017, (Including proposed works)		
		LOS	DOS	AVD (sec)	LOS	DOS	AVD (sec)
AM	Sussex St / Erskine St	C	0.73	33	C	0.76	33
	Sussex St / Shelley St	A	0.31	3	A	0.31	3
	Hickson Rd / Napoleon St	C	0.89	37	C	0.89	37
	Kent St / Margaret St	B	0.65	24	B	0.65	24
	Hickson Rd / Globe St	A	0.36	2	A	0.35	2

LOS - Intersection Traffic Level of Service, DOS - Degree of Saturation, AVD - Average Delay per vehicle

The results of the LinSig intersection analysis forecast minimal changes in the operation of key intersections as a result of the construction of the Hickson Road remediation works, when compared with the base case scenario. The additional construction vehicles associated with the Hickson Road works has a negligible impact on forecast road network performance.

During the AM peak hour, when construction vehicles attributable to the works are expected to access the site, the road network generally operates satisfactorily. The addition of construction traffic movements associated with Hickson Road remediation works does not impact the overall operation of the local road network, and requires no further works to accommodate the levels of construction traffic anticipated. Therefore the traffic impacts arising from the proposed works is considered to be minimal, particularly in the context of existing and future traffic volumes in the northern CBD area.

6 Construction Impacts

6.1 Construction Vehicle Management

The proposed site hours of operation will be similar to the existing project approvals for Barangaroo South Stage 1A site. These hours, to be confirmed at a later date, will assist the site traffic movements being generated mainly outside the normal commuter peak traffic periods, such that their impacts on the surrounding road network are minimised.

6.1.1 Construction Routes

Trucks will not be able to use York Street or Clarence Street in the AM peak between 6am and 10am due to existing restrictions.

6.1.2 Internal Site Vehicle Access

Access for construction vehicles to the site will be located via Hickson Road at the existing gatehouse, approximately 350m north of the Sussex Street / Napoleon Street intersection. No truck queuing is to occur on Hickson Road. All vehicles will enter the site in a forwards direction. Figure 8 indicates a diagram of the proposed construction site access.

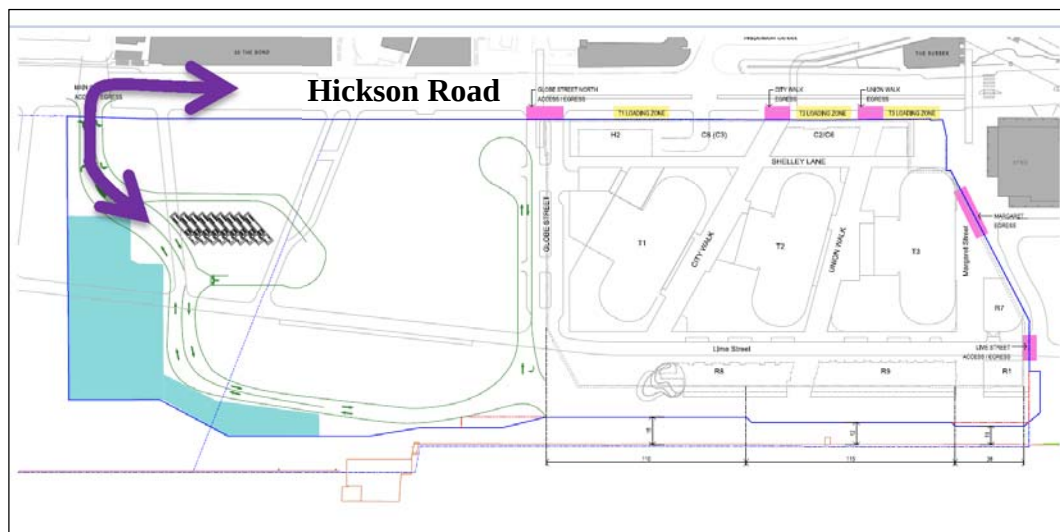


Figure 8: Proposed Construction Site Entry and Exit (indicative only)

6.1.3 Hickson Road Access

During the remediation of Hickson Road, construction vehicles will set down in the area of Hickson Road to be sectioned off to vehicular traffic. As the remediation proceeds north along Hickson Road, trucks will set down further north within the work-zone area adjacent to the excavation.

During the remediation of the western half of Hickson Road, trucks will enter the work-zone from the south via a left turn into the site. To exit, trucks will enter the Barangaroo South construction site via the gatehouse access and turn around within the site. They will then turn right onto Hickson Road and depart the precinct to the south via Sussex Street.

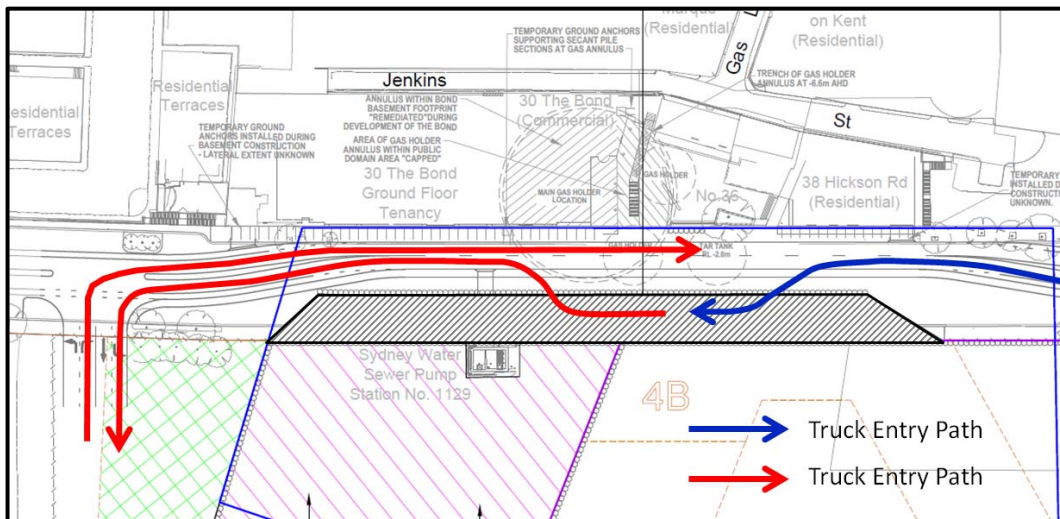


Figure 9 Truck Access Route – Hickson Road Remediation (Western Side)

Note: Indicative Only

To access the eastern half of the Hickson Road work-zone, construction vehicles will typically first enter the Barangaroo construction site and turn around within the site. This is illustrated in Figure 10.

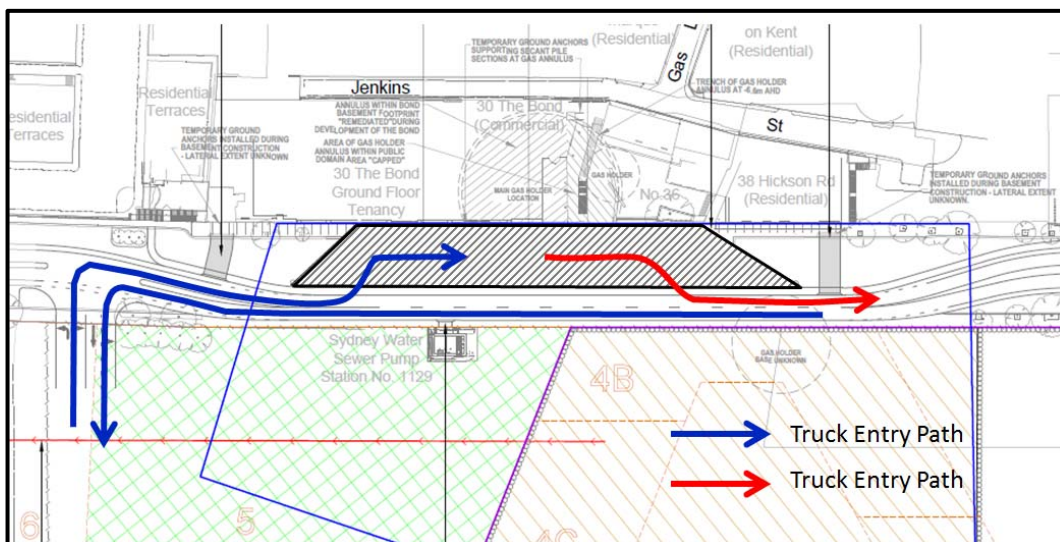


Figure 10 Truck Access Route – Hickson Road Remediation (Eastern Side)

Note: Indicative Only

On occasions when the Barangaroo construction site is not available for vehicles to turn around, entry to the Hickson Road worksite will be via a right turn from Hickson Road - to be managed by an on-site traffic controller. Given the relatively low traffic volumes at this location, the small number of truck movements expected and the presence of a traffic controller, this right turn movement is considered acceptable.

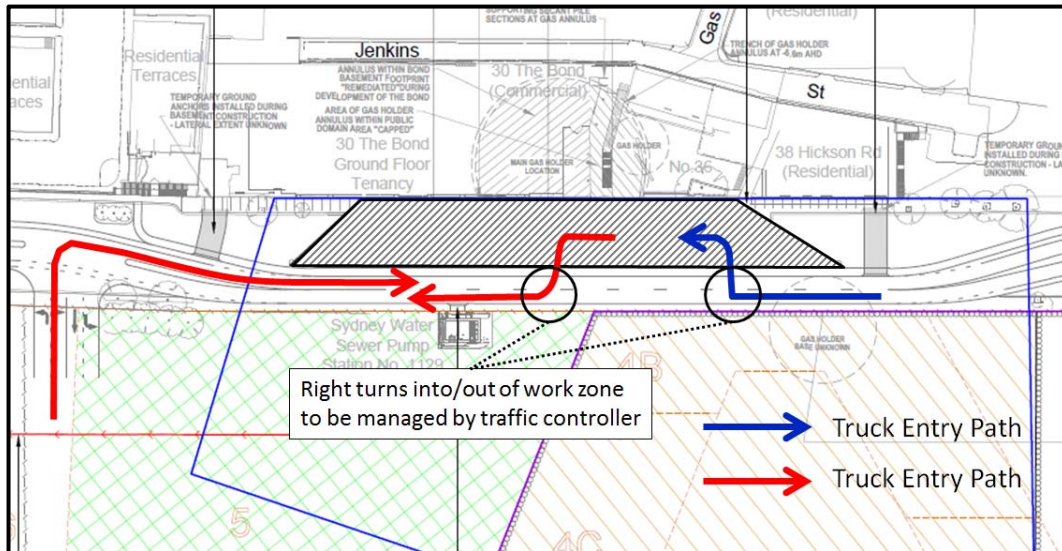


Figure 11 Alternate Truck Access Route – Hickson Road Remediation (Eastern Side)

Note: Indicative Only

It should be noted that the above staging plans are indicative only and not designed to provide detailed traffic management. This would be undertaken using detailed traffic control plans (TCPs) to be prepared prior to the commencement of works on site.

6.1.4 Emergency Vehicle Access

Site entries are to be clearly signposted for the benefit of all approaching site traffic, in particular emergency services vehicles.

6.1.5 Access for Construction Workers

To reduce the impact on the local road network associated with construction work, no on-site parking is to be provided for construction workers. In this manner it is being treated like any other CBD construction project. The constrained parking environment surrounding the site, coupled with the relatively high cost of long term parking, will ensure the majority of construction workers arrive to the site via public transport.

6.1.6 Traffic Control Recommendations

The site traffic control recommendations for each worksite gate entry or exit point (including all appropriate signage) will be determined by means of a Traffic Control Plan to be prepared by an RMS accredited contractor closer to construction commencement.

Truck movements are to be staged and coordinated to prevent trucks circulating CBD streets whilst awaiting access to the site.

Construction vehicles will approach the site from areas outside the CBD using major arterial routes such as the M4, M5 etc.

The size of trucks proposed to access the site will be in accordance with Clause 300-3 of the Road Rules in terms of lengthy vehicle restrictions.

The vehicular traffic movements at each of the site entry or exit gates for traffic to and from Hickson Road will potentially need to be controlled by a flagman to ensure no potential traffic safety conflicts occur between the site truck traffic and pedestrians on the adjacent footpath.

Personnel will not be permitted to use stop/slow signage in Hickson Road or Sussex Street on weekdays between 7am and 9am and 4pm to 7pm. However, personnel using stop/slow signage will be permitted on Hickson Road, north of the intersection of Hickson Road and Napoleon Street, when it is required to ensure safe truck access at designated site access points, provided that vehicles queue lengths generated as a result of the traffic control do not exceed more than six vehicles in either direction.

6.2 Traffic Management

Under both remediation option 1 and 2 a section of Hickson Road will temporarily be restricted to traffic movement. During this time, Hickson Road will be restricted to a single lane in each direction for traffic. On-site traffic controllers will be present to manage the movement of heavy vehicles in this area and ensure through traffic is not significantly impacted.

6.3 Parking Impacts

A number of on-street parking bays along Hickson Road will be temporarily unavailable for use during the construction period. The specific number of spaces impacted will be determined closer to the time of construction when the construction methodology is confirmed. Existing users of these car parking bays will be notified prior to works commencing.

6.4 Bus Routes

In July 2015 the NSW Government announced a series of bus routes will directly service the Barangaroo precinct. These services all run along Hickson Road adjacent to Barangaroo South, terminating at Walsh Bay, and include:

- Route 311
- Route 324
- Route 325

These services are to be operational from 4 October 2015, and are illustrated in Figure 12 below.

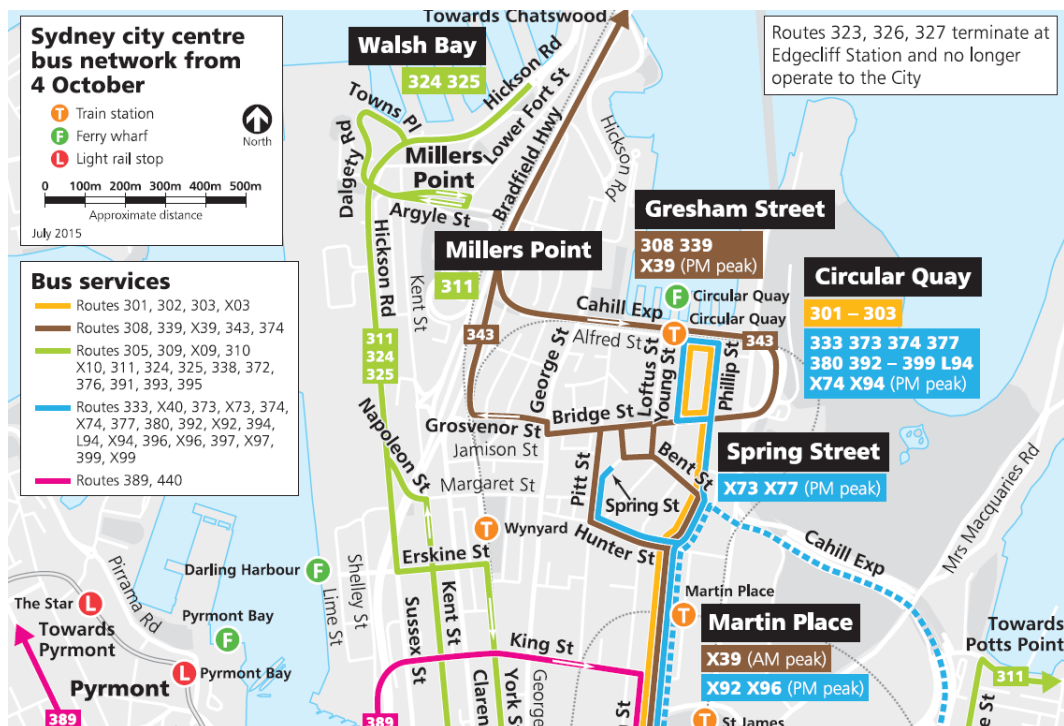


Figure 12 Bus services post 4 October 2015

Locations for new bus stops to serve the future routes along Hickson Road are currently being investigated by Transport for NSW. These bus stops may need to be temporarily relocated during the construction period to accommodate the remediation works. The (potential) requirement for this would be confirmed closer to the time of construction, in consultation with Transport for NSW and the road authority.

6.5 Pedestrian and Cycling Management

6.5.1 Pedestrian Routes Approaching the Site

In July 2015 two major improvements to the pedestrian network in the Barangaroo precinct were opened to the public, those being:

- The City Walk Bridge – providing a grade separated pedestrian connection from Napoleon Street, across Sussex Street into the Barangaroo site
- Signalisation of the Hickson Road / Napoleon Street intersection providing controlled pedestrian crossing movements across all four legs of the intersection.

In late 2015 site access for construction workers will be further improved through the completion of the Wynyard Walk development. This will provide safe and efficient access for construction workers walking across Hickson Road and Sussex Street.

If works are required that may temporarily impact access for pedestrians and/or cyclists, appropriate traffic control measures will be implemented (in consultation with the road authority).

6.5.2 Hickson Road Pedestrian Management

During the Hickson Road remediation works, hoardings will be established to maintain pedestrian movement on both sides of the road. Planning for the remediation works has allowed for 2m wide footpaths to be provided on both sides of Hickson Road, except where reduced width is required in areas subject to tree protection measures. This will be coordinated with the project arborist. Pedestrian access to key buildings and paths in the area such as 30 and 38 The Bond and Gas Lane staircase will be maintained throughout the works.

On-site traffic controllers will be present in the precinct to manage the movement of heavy vehicles ensure the safety of pedestrians passing through.

7 Summary and Conclusions

Arup has prepared this construction stage traffic impact assessment for the Remediation of part of Hickson Road, as part of the EPA Declared Remediation Area, for the remediation work which is planned to occur in parallel with construction work at a number of other worksites within Barangaroo South and the future Headland Park area. The purpose of the assessment is to inform and accompany the Hickson Road remediation Development Application.

The cumulative impacts of construction traffic activity associated with all construction works currently planned in the precinct have been assessed. The assessment concludes that the construction related traffic impacts arising from the works proposed under the Development Application can be appropriately managed.

Appendix A

Traffic Modelling Outputs

Basic Results Summary

Basic Results Summary

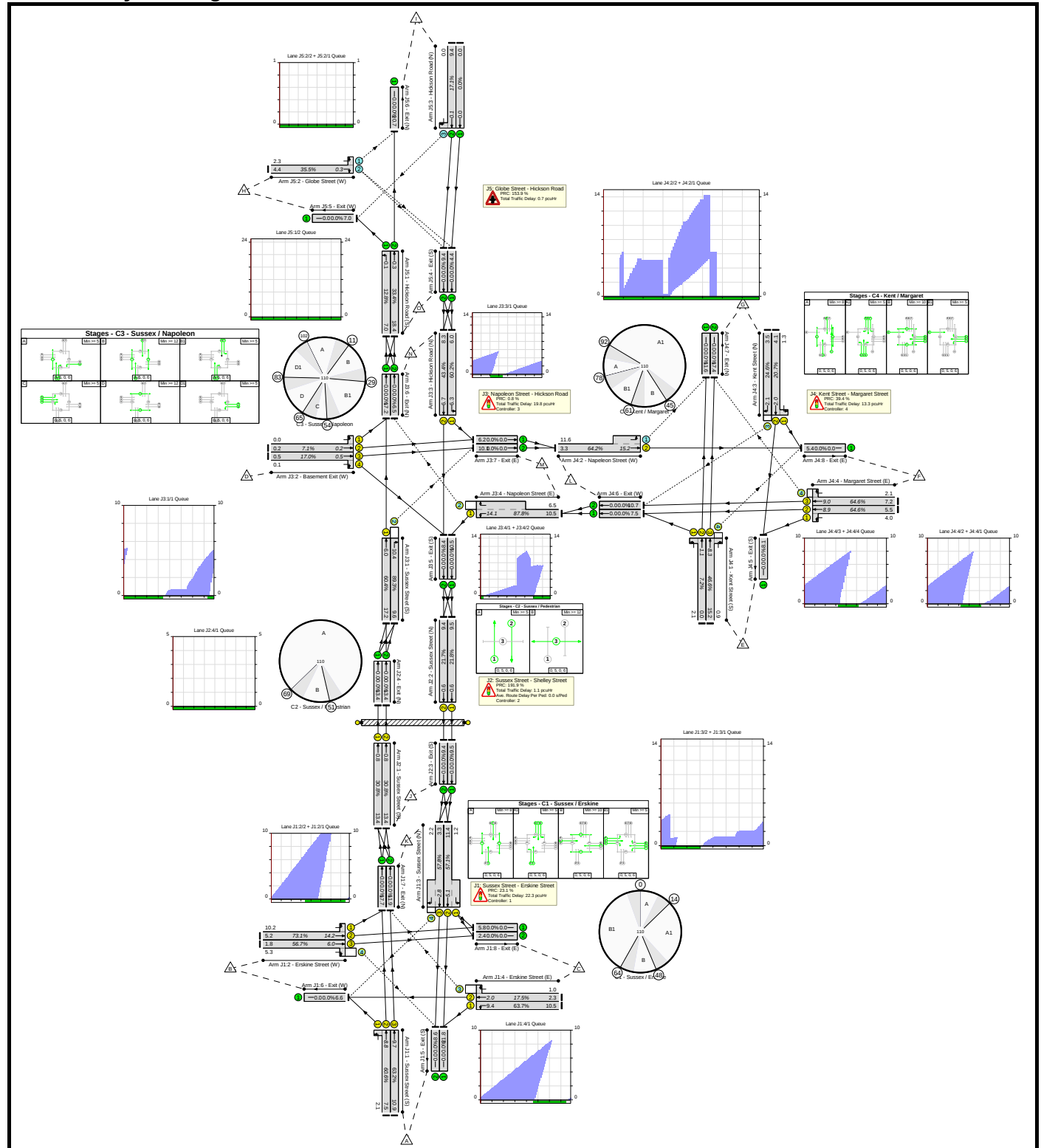
User and Project Details

Project:	Barangaroo Hickson Road Remediation
Title:	Linsig Modelling
Location:	
Company:	Arup Pty Ltd
Address:	Level 10 201 Kent Street Sydney NSW 2000

Basic Results Summary

Scenario 2: 'AM without remediation works' (FG4: 'AM no Block 5', Plan 1: 'Future (with Basement)')

Network Layout Diagram



Basic Results Summary

Network Results

Item	Lane Description	Lane Type	Deg Sat (%)	Av. Delay Per PCU (s/pcu)	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Max. Back of Uniform Queue (pcu)	Mean Max Queue (pcu)
Network: Linsig Modelling	-	-	89.3%	-	-	-	-	-
J1: Sussex Street - Erskine Street	-	-	73.1%	-	-	-	-	-
1/2+1/1	Sussex Street (S) Left Ahead	U	60.6%	39.7	315	1800:1440	8.0	8.8
1/3	Sussex Street (S) Ahead	U	63.2%	35.7	356	1440	8.8	9.7
2/2+2/1	Erskine Street (W) Left Ahead	U	73.1%	38.5	504	1800:1800	12.9	14.2
2/3+2/4	Erskine Street (W) Right Ahead	U+O	56.7%	36.4	232	1800:920	5.4	6.0
3/2+3/1	Sussex Street (N) Ahead Left	U	57.1%	17.4	411	1800:1800	4.4	5.1
3/3+3/4	Sussex Street (N) Ahead Right	U+O	57.8%	27.5	179	1800:1440	2.2	2.8
4/1	Erskine Street (E) Left	U	63.7%	37.5	342	1440	8.6	9.4
4/2+4/3	Erskine Street (E) Ahead Right	U+O	17.5%	20.8	109	1440:1800	1.9	2.0
J2: Sussex Street - Shelley Street	-	-	30.8%	-	-	-	-	-
1/1	Sussex Street (S) Ahead	U	30.8%	2.6	439	1800	0.6	0.8
1/2	Sussex Street (S) Ahead	U	30.8%	2.6	439	1800	0.6	0.8
2/1	Sussex Street (N) Ahead	U	21.8%	2.4	310	1800	0.5	0.6
2/2	Sussex Street (N) Ahead	U	21.7%	2.4	309	1800	0.5	0.6
Ped Link: P1	Shelley	-	0.0%	-	0	-	-	-
J3: Napoleon Street - Hickson Road	-	-	89.3%	-	-	-	-	-
1/1	Sussex Street (S) Ahead	U	60.4%	11.6	563	1800	5.3	6.0
1/2	Sussex Street (S) Right	O	89.3%	55.0	315	1800	6.9	10.4
2/2+2/1	Basement Exit (W) Left Ahead	U	7.1%	69.4	7	1800:1800	0.2	0.2
2/3+2/4	Basement Exit (W) Right Ahead	U	17.0%	69.0	19	1800:1800	0.4	0.5

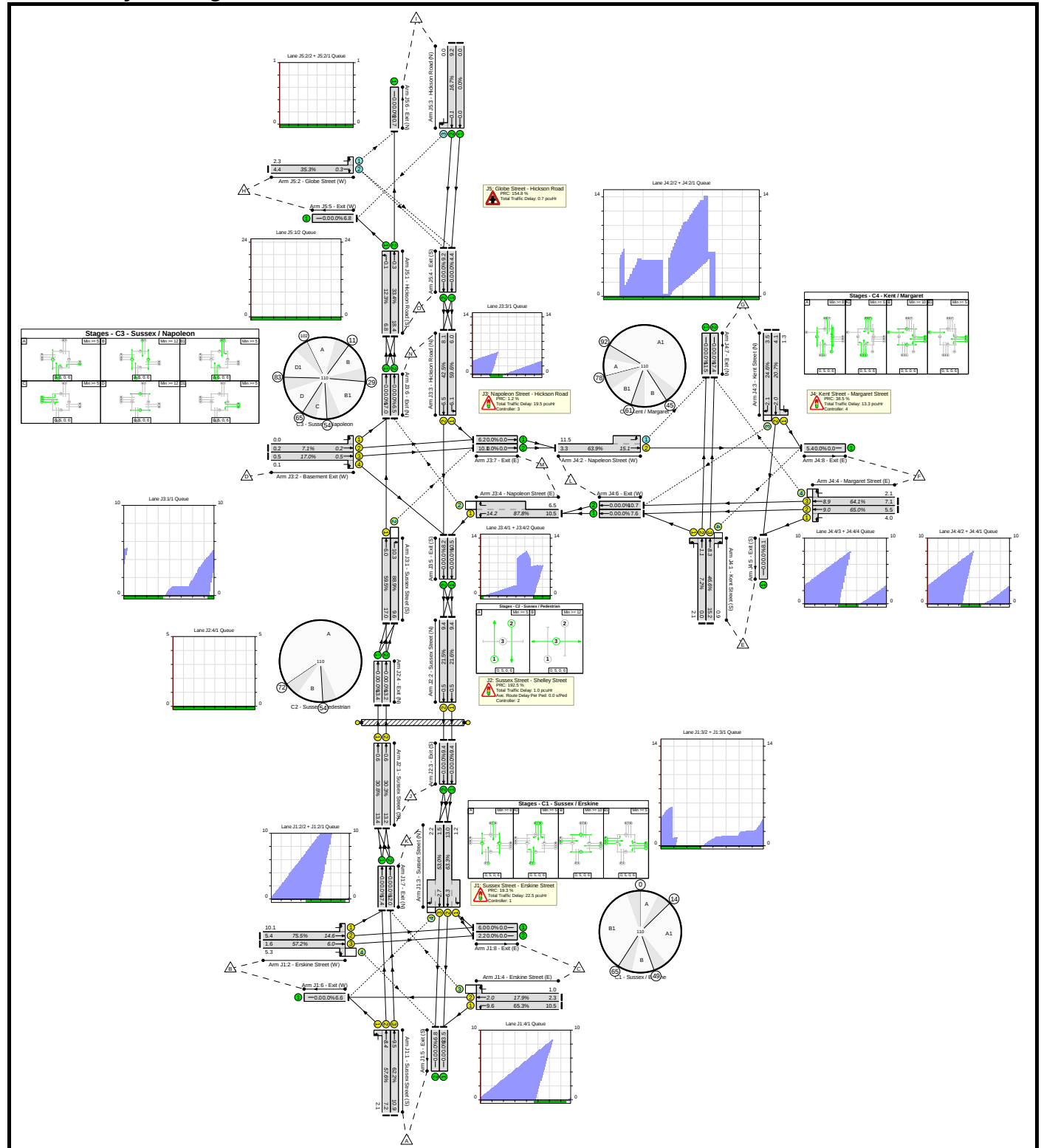
Basic Results Summary

3/1	Hickson Road (N) Left	U	60.2%	55.0	197	1800	5.5	6.3
3/2	Hickson Road (N) Ahead	U	43.4%	32.8	270	1800	6.3	6.7
4/1+4/2	Napoleon Street (E) Left Right	U+O	87.8%	46.5	557	1800:1800	10.8	14.1
J4: Kent Street - Margaret Street	-	-	64.6%	-	-	-	-	-
1/2+1/1	Kent Street (S) Left Ahead	U	7.2%	14.8	68	1440:1800	1.0	1.1
1/3+1/4	Kent Street (S) Ahead Right	U+O	46.6%	12.4	526	1800:920	7.9	8.3
2/2+2/1	Napeleon Street (W) Left Ahead	U+O	64.2%	15.2	487	920:1800	14.3	15.2
3/2+3/1	Kent Street (N) Ahead Left	U	20.7%	11.5	174	1800:920	1.9	2.0
3/3	Kent Street (N) Right	O	24.6%	20.9	116	1800	1.9	2.1
4/2+4/1	Margaret Street (E) Left Ahead	U	64.6%	46.3	310	1800:1800	8.0	8.9
4/3+4/4	Margaret Street (E) Ahead Right	U+O	64.6%	46.8	305	1800:1800	8.1	9.0
J5: Globe Street - Hickson Road	-	-	35.5%	-	-	-	-	-
1/1	Hickson Road (S) Left	U	12.8%	1.1	230	1800	0.0	0.1
1/2	Hickson Road (S) Ahead	U	33.4%	1.5	601	1800	0.0	0.3
2/2+2/1	Globe Street (W) Right Left	O	35.5%	4.5	221	1800:1800	0.0	0.3
3/1	Hickson Road (N) Ahead	U	0.0%	0.0	0	1800	0.0	0.0
3/2+3/3	Hickson Road (N) Ahead Right	U+O	17.1%	1.2	308	1800:1800	0.0	0.1
C1 - Sussex / Erskine C2 - Sussex / Pedestrian C3 - Sussex / Napoleon C4 - Kent / Margaret PRC for Signalled Lanes (%): 23.1 PRC for Signalled Lanes (%): 191.9 PRC for Signalled Lanes (%): 0.8 PRC for Signalled Lanes (%): 39.4 PRC Over All Lanes (%): 0.8 Total Delay for Signalled Lanes (pcuHr): 22.29 Total Delay for Signalled Lanes (pcuHr): 1.06 Total Delay for Signalled Lanes (pcuHr): 19.80 Total Delay for Signalled Lanes (pcuHr): 13.33 Total Delay Over All Lanes(pcuHr): 57.19 Cycle Time (s): 110 Cycle Time (s): 110 Cycle Time (s): 110 Cycle Time (s): 110								

Basic Results Summary

Scenario 3: 'AM with remediation works' (FG5: 'AM with Block 5', Plan 1: 'Future (with Basement)')

Network Layout Diagram



Basic Results Summary

Network Results

Item	Lane Description	Lane Type	Deg Sat (%)	Av. Delay Per PCU (s/pcu)	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Max. Back of Uniform Queue (pcu)	Mean Max Queue (pcu)
Network: Linsig Modelling	-	-	88.9%	-	-	-	-	-
J1: Sussex Street - Erskine Street	-	-	75.5%	-	-	-	-	-
1/2+1/1	Sussex Street (S) Left Ahead	U	57.6%	38.0	307	1800:1440	7.7	8.4
1/3	Sussex Street (S) Ahead	U	62.2%	34.5	358	1440	8.7	9.5
2/2+2/1	Erskine Street (W) Left Ahead	U	75.5%	40.5	508	1800:1800	13.1	14.6
2/3+2/4	Erskine Street (W) Right Ahead	U+O	57.2%	37.7	226	1800:920	5.3	6.0
3/2+3/1	Sussex Street (N) Ahead Left	U	63.3%	17.2	465	1800:1800	5.5	6.3
3/3+3/4	Sussex Street (N) Ahead Right	U+O	53.0%	34.0	119	1800:1440	2.2	2.7
4/1	Erskine Street (E) Left	U	65.3%	39.0	342	1440	8.6	9.6
4/2+4/3	Erskine Street (E) Ahead Right	U+O	17.9%	21.6	109	1440:1800	1.9	2.0
J2: Sussex Street - Shelley Street	-	-	30.8%	-	-	-	-	-
1/1	Sussex Street (S) Ahead	U	30.8%	2.4	438	1800	0.4	0.6
1/2	Sussex Street (S) Ahead	U	30.3%	2.4	432	1800	0.4	0.6
2/1	Sussex Street (N) Ahead	U	21.6%	2.3	307	1800	0.4	0.5
2/2	Sussex Street (N) Ahead	U	21.5%	2.3	306	1800	0.4	0.5
Ped Link: P1	Shelley	-	0.0%	-	0	-	-	-
J3: Napoleon Street - Hickson Road	-	-	88.9%	-	-	-	-	-
1/1	Sussex Street (S) Ahead	U	59.5%	11.8	555	1800	5.3	6.0
1/2	Sussex Street (S) Right	O	88.9%	53.4	315	1800	6.8	10.3
2/2+2/1	Basement Exit (W) Left Ahead	U	7.1%	69.4	7	1800:1800	0.2	0.2
2/3+2/4	Basement Exit (W) Right Ahead	U	17.0%	69.0	19	1800:1800	0.4	0.5

Basic Results Summary

3/1	Hickson Road (N) Left	U	59.6%	54.8	195	1800	5.4	6.1
3/2	Hickson Road (N) Ahead	U	42.5%	32.6	264	1800	6.2	6.5
4/1+4/2	Napoleon Street (E) Left Right	U+O	87.8%	46.5	557	1800:1800	10.8	14.2
J4: Kent Street - Margaret Street	-	-	65.0%	-	-	-	-	-
1/2+1/1	Kent Street (S) Left Ahead	U	7.2%	14.8	68	1440:1800	1.0	1.1
1/3+1/4	Kent Street (S) Ahead Right	U+O	46.6%	12.4	526	1800:920	7.9	8.3
2/2+2/1	Napeleon Street (W) Left Ahead	U+O	63.9%	14.9	485	920:1800	14.2	15.1
3/2+3/1	Kent Street (N) Ahead Left	U	20.7%	11.5	174	1800:920	1.9	2.0
3/3	Kent Street (N) Right	O	24.6%	20.9	116	1800	1.9	2.1
4/2+4/1	Margaret Street (E) Left Ahead	U	65.0%	46.5	312	1800:1800	8.0	9.0
4/3+4/4	Margaret Street (E) Ahead Right	U+O	64.1%	46.6	303	1800:1800	8.0	8.9
J5: Globe Street - Hickson Road	-	-	35.3%	-	-	-	-	-
1/1	Hickson Road (S) Left	U	12.3%	1.1	222	1800	0.0	0.1
1/2	Hickson Road (S) Ahead	U	33.4%	1.5	601	1800	0.0	0.3
2/2+2/1	Globe Street (W) Right Left	O	35.3%	4.4	221	1800:1800	0.0	0.3
3/1	Hickson Road (N) Ahead	U	0.0%	0.0	0	1800	0.0	0.0
3/2+3/3	Hickson Road (N) Ahead Right	U+O	16.7%	1.2	300	1800:1800	0.0	0.1
C1 - Sussex / Erskine C2 - Sussex / Pedestrian C3 - Sussex / Napoleon C4 - Kent / Margaret PRC for Signalled Lanes (%): 19.3 PRC for Signalled Lanes (%): 192.5 PRC for Signalled Lanes (%): 1.2 PRC for Signalled Lanes (%): 38.5 PRC Over All Lanes (%): 1.2 Total Delay for Signalled Lanes (pcuHr): 22.46 Total Delay for Signalled Lanes (pcuHr): 0.98 Total Delay for Signalled Lanes (pcuHr): 19.55 Total Delay for Signalled Lanes (pcuHr): 13.29 Total Delay Over All Lanes(pcuHr): 56.97 Cycle Time (s): 110 Cycle Time (s): 110 Cycle Time (s): 110 Cycle Time (s): 110								