Epping Road widening between Essex Street and Blaxland Road, Epping

Appendix C
Traffic and transport impact assessment
Part A

November 2015

Roads & Maritime Services

Epping Road Widening between Essex Street and Blaxland Road at Epping

Traffic and Transport Impact Assessment

November 2015

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The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.4. of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

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Glossary and abbreviations

Term	Description
CAMP	Construction traffic management plan
LoS	Level of Service
EP& A Act	Environment Planning and Assessment Act 1979
CEMP	Construction Environmental Management Plan
LGA	Local government area
Mitigation	Reduction in severity
REF	Review of environmental factors
RMS	Roads and Maritime Services
RTA	Roads and Traffic Authority
TfNSW	Transport for NSW
vph	Vehicles per hour
vpd	Vehicles per day
vtph	Vehicle trips per hour
vtpd	Vehicle trips per day

1. Introduction

1.1 Background

Roads and Maritime Services (Roads and Maritime) is proposing to upgrade about 500 metres of Epping Road, between Essex Street and Blaxland Road in Epping (referred to as 'the proposal' for the purposes of this report). The proposal is located about 15 kilometres north-west of the Sydney central business district. The proposal also includes upgrading the Essex Street/Epping Road intersection.

The continued growth and development of the Epping town centre, as proposed by the *Epping Town Centre Study*, and the planning for the Epping Town Centre Urban Activation Precinct, will result in an increase in traffic demand on major regional road links to the town centre. The proposal is needed to improve traffic flows and access to the centre. It is needed to fulfil the commitments of the NSW Government, as confirmed by the 2012/13 budget, to improving the road network within and in the vicinity of the town centre.

A traffic study is required to inform the Review of the Environmental Factors (REF), to assess the potential impacts of the construction and operation of the proposal, in accordance with the requirements of Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The REF will address the requirements of the EP&A Act, and the Environmental Planning and Assessment Regulation *2000* (the Regulation). In particular, it will address the matters for consideration provided by clause 228 of the Regulation.

1.2 Purpose of this report

This traffic impact assessment has been prepared as an input to the REF.

This study has been prepared in accordance with the *Guide to Traffic Generating Developments* document (Roads and Maritime Services, October 2002) where applicable and is structured as follows:

- Section 2 ***Existing conditions***: provides a review of existing road features, adjacent developments, traffic volumes, sight distances and crash data.
- Section 3 ***Proposed road network improvements***: provides details of the proposal and a review of additional traffic generated as a result of construction.
- Section 4 ***Construction traffic impact assessment***: considers the construction impacts associated with the construction of the road upgrade.
- Section 5 ***Operational traffic impact assessment***: provides the results of the Paramics microsimulation and SIDRA intersection traffic modelling assessment of the proposal and assesses the impacts on local roads and access.
- Section 6 ***Recommended mitigation measures***: provides a summary of the key mitigation measures to be undertaken during and before construction.
- Section 7 ***Summary and conclusions***: provides a summary of the key findings and recommendations from the study.

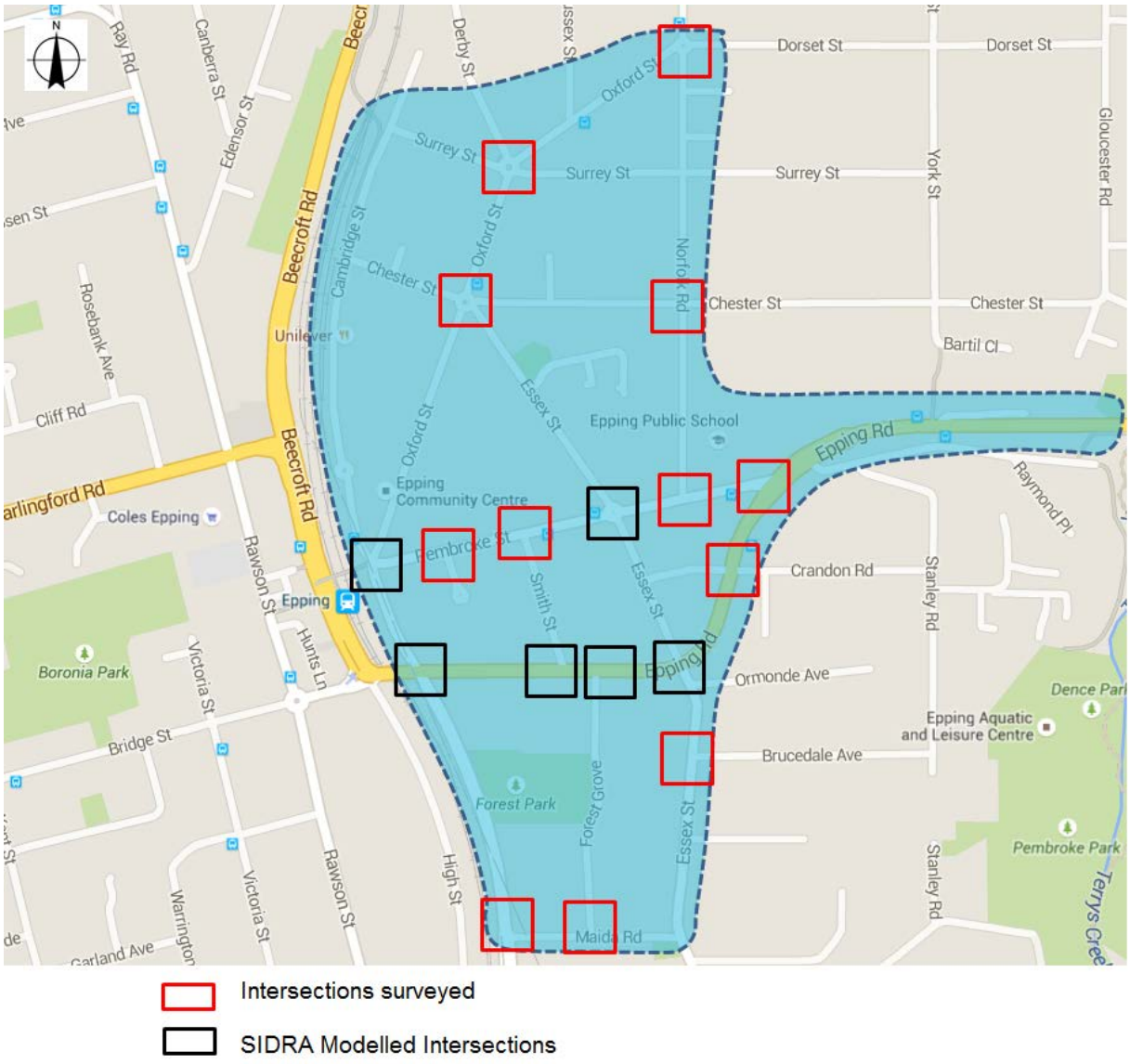
1.3 Study area

Epping Road is approximately nine kilometres long and is a State road linking the north-western suburbs and the Hills district to the lower North Shore and Sydney's central business district. Epping Road runs between Beecroft Road at Epping, and Longueville Road at Lane Cove. For the most part, Epping Road consists of six traffic lanes. The section between Blaxland Road

and Essex Street has four traffic lanes, and is congested in peak periods. Epping Road is one of the main access roads to Epping town centre.

The study area associated with the Epping Road project is outlined in Figure 1. The study area is located east of the Epping Station and provides access to the town centre.

The study area is surrounded mostly by residential properties to the north and south. The study area is shown in Figure 1, which also shows the location of surveyed intersections and key intersections modelled using SIDRA for this assessment. All of the intersections within the study area were included in the Paramics network traffic model, with additional intersections along Beecroft Road and Carlingford Road also included.



Source: Google Maps 2014, modified by GHD

Figure 1 Study area

1.4 Study assumptions and limitations

The following assumptions have been used in conducting this study:

- Future year strategic modelling undertaken by Roads and Maritime;
- Intersection modelling undertaken using the SIDRA 6.1 intersection modelling software and Paramics, with two future horizon years estimated at 2016 and 2026;

- Traffic volumes used for the SIDRA intersection modelling based on traffic demands from the Paramics model. This includes SIDRA modelling for the following traffic scenarios:
  - 2014 base traffic conditions
  - 2016 ‘do nothing’ and “with proposal” traffic conditions
  - 2016 ‘do nothing’ and “with proposal” traffic conditions
- Forecast traffic for the 2016 and 2026 future horizon years derived based on the following assumptions:
  - Background traffic growth provided by Roads and Maritime from the Strategic Traffic Model
  - Traffic associated with planned future development within the Epping Urban Activation Precinct (future horizon year 2026 only), provided from the Epping Town Centre Transport Study Outcomes Report (Halcrow 2011)
- Traffic diversion resulting from the proposed banned turns are based on forecast volumes from the Paramics model;
- Calculations of additional travel times are based on the Paramics model; and

The proposal to construct a new road as the extension of Victoria Street to Carlingford Road has been assessed as part of a separate development assessment and has not been considered as part of this report.

2. Existing conditions

2.1 Overview

This section outlines the existing traffic and transport conditions in the vicinity of the study area. This includes the existing transport and accessibility conditions and the existing road network performance.

2.2 Existing road network characteristics

2.2.1 Functional road hierarchy

Roads are classified according to the functions that they perform. The main purpose of defining a road's functional class is to provide a basis for establishing the policies, which guide the management of the road according to their intended service or qualities. Functional road classification involves the relative balance of the mobility and access functions.

Roads and Maritime define four levels in a typical functional road hierarchy, ranking from high mobility and low accessibility, to high accessibility and low mobility. These road classes are:

- **Arterial roads** – generally controlled by Roads and Maritime, typically no limit in flow and designed to carry vehicles long distance between regional centres;
- **Sub-arterial roads** – can be managed by either council or Roads and Maritime under a joint agreement. Typically their operating capacity ranges between 10,000 and 20,000 vehicles per day, and their aim is to carry through traffic between specific areas in a sub region, or provide connectivity from arterial road routes (regional links);
- **Collector roads** – provide connectivity between local sites and the arterial road network, and typically carry between 2,000 and 10,000 vehicles per day; and
- **Local roads** – provide direct access to properties and the collector road system and typically carry between 500 and 4,000 vehicles per day.

2.2.2 Epping Road

Epping Road is about nine kilometres long, and is a State road linking the north-western suburbs and the Hills district to the lower North Shore and Sydney's central business district. Epping Road runs between Beecroft Road at Epping, and Longueville Road at Lane Cove. For the most part, Epping Road consists of six traffic lanes. The section between Blaxland Road and Essex Street has four traffic lanes, and is congested in peak periods. Epping Road is one of the main access roads to the Epping town centre.

Epping Road carries around 42,000 vehicles per day in the study area and functions as an arterial road providing access to Epping and surrounding residential and employment areas.

In the vicinity of the study area, Epping Road has the following road characteristics:

- Two-way sealed carriageway, about 12 metres wide;
- Sign posted clearways on both sides between 6-10 am and 3–7 pm on weekdays;
- Signalised intersections are located at Essex Street with a signalised pedestrian crossing across Epping Road on the west approach;
- Signalised intersections are located at Langston Place, with signalised pedestrian crossings across Langston Place, Epping Road and Blaxland Road;
- Unmarked, parallel parking is permitted during non-clearway periods;

- Driveway access to properties are accessed directly via Epping Road;
- Two traffic lanes in each direction, each about three metres wide;
- Road marked double white centreline;
- Gutters, footpaths and verges with no road shoulders, provided along either side of the road;
- Sign posted speed limit of 60 km/h; and
- One bus stop located along either side of the road.

During a site visit in July 2014 it was noted that queueing along Epping Road from the Langston Place intersection would queue back towards Crandon Road, during the weekday PM peak.

Photo 1 and Photo 2 show the characteristics of Epping Road in the study area.

Photo 1 Epping Road, west of Essex Street, looking west

Photo 2 Epping Road, west of Langston Place, looking east from Langston Place

2.2.3 Langston Place

Langston Place functions as a collector road and forms a signal controlled intersection with Epping Road at its southern end and a signal controlled intersection with Pembroke Street at its northern end. Langston Place has the following road characteristics:

- Two-way sealed carriageway, around 12 metres wide;
- Signalised pedestrian and zebra crossing facilities provided across Langston Place at the intersection with Epping Road;
- Generally one traffic lane in each direction;
- Road marked single white centreline;
- Footpaths provided along both sides of the road;
- Half hour parking permitted on the western side of the road shoulder during peak periods;
- A taxi zone servicing the Epping Station located on the western side of the road shoulder;
- On-street parallel parking provided on the eastern side of the road during peak periods;
- Sign posted speed limit of 50 km/h;
- Epping Station and retail land are located at the northern end of Langston Place; and
- Bicycle lockers and parking stands located near the train station entrance.

Photo 3 shows the characteristics of Langston Place in the study area.

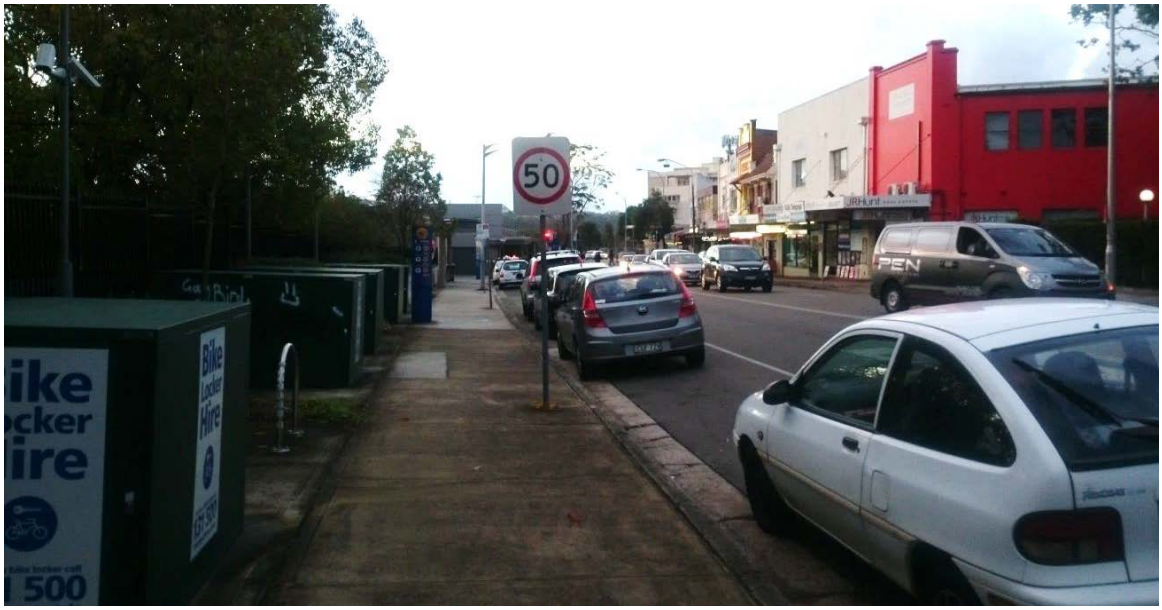


Photo 3 Langston Place, looking north from Epping Road

2.2.4 Blaxland Road

Blaxland Road, within the study area, functions as a sub-arterial road, which forms a signal controlled intersection with Epping Road and Langston Place at its northern end. It provides access to residential areas to the south. The T1 north shore, northern and western train line is located along the western side of Blaxland Road.

Blaxland Road has the following road characteristics:

- A two-way sealed carriageway, which is approximately 18 metres wide;
- Signalised pedestrian crossing facilities provided across Blaxland Road at the intersection with Epping Road;
- It has two traffic lanes in each direction;
- It has a double barrier line on approach to Epping Road, with overtaking allowed towards Eastwood;
- There are footpaths provided along both sides of the road;
- Clearway conditions exist between 6-10 am on the eastern side and no stopping on the western side; and
- It has a sign posted speed limit of 60 km/h.

Photo 4 shows the characteristics of Blaxland Road in the study area.

Photo 4 Blaxland Road, looking south from the Blaxland Road and Epping Road intersection

2.2.5 Smith Street

Smith Street functions as a local road and forms the minor approach of a priority intersection with Epping Road. It provides access to residential land use. Smith Street has the following road characteristics:

- A two-way sealed carriageway, around 10 metres wide;
- There is no marked centreline;
- Footpaths are provided along the western side and a portion of the eastern side of the road;
- Unrestricted on-street parallel parking provided along both sides of the road; and
- It has a sign posted speed limit of 50 km/h.

Photo 5 shows the characteristics of Smith Street in the study area.

Photo 5 Smith Street, looking south towards Epping Road

2.2.6 Forest Grove

Forest Grove functions as a local road and forms the minor approach of a priority intersection with Epping Road at its northern end. It provides access to residential development and a recreational park. Forest Grove has the following road characteristics:

- A two-way sealed carriageway, around 11 metres wide;
- No marked centreline;
- A footpath along the eastern side of the road;
- Unrestricted on-street parallel parking provided along both sides of the road; and
- A sign posted speed limit of 50 km/h.

Photo 6 shows the characteristics of Forest Grove in the study area.

Photo 6 Forest Grove, looking south from Epping Road

2.2.7 Essex Street

Essex Street functions as a collector road, providing access to residential land use and other local roads. It forms the northern and southern approaches of a signal controlled intersection with Epping Road.

Essex Street has the following road characteristics:

- A two-way sealed carriageway, around 10 metres wide;
- No signal controlled pedestrian crossing facilities provided across Essex Street at the intersection with Epping Road;
- Two traffic lanes in each direction;
- Road marked double white centrelines near the intersection;
- Footpaths provided along both sides of the road;
- Unrestricted on-street parallel parking provided along both sides of the road; and
- A sign posted speed limit of 50 km/h

During the weekday AM peak hour twelve pedestrians were surveyed crossing the Essex Street (south) approach of Epping Road/Essex Street intersection, where there is currently no signal controlled pedestrian crossing provided.

Photo 7 shows the characteristics of Essex Street in the study area.

Photo 7 Essex Street, looking south from Epping Road

2.2.1 Oxford Street

Oxford Street functions as a collector road connecting residential development, including North Epping, to Epping Station and to Epping Road, via Langston Place. Oxford Street also provides access to retail development at its southern end. It forms a signal controlled intersection with Langston Place and Pembroke Street at its southern end and a roundabout with Norfolk Road at its northern end.

Oxford Street has the following road characteristics:

- A two-way sealed carriageway, around seven metres wide at the south approach to Langston Place Intersection and around 12 metres wide along other sections;
- Footpaths along both sides of the road;
- A signalised mid-block pedestrian crossing just south of Arden Anglican School, between Chester Street roundabout and Langston Place intersection;
- Restricted on-street parallel parking provided along both sides of the road between Langston Place and the mid-block pedestrian crossing near Arden Anglican School;
- Two hour restricted 45 degree angle parking along the eastern side of the street, with one hour restricted on-street parallel parking along western side of the street, between Arden Anglican School and Chester Street;
- Unrestricted on-street parallel parking, between Chester Street and Norfolk Road; and
- A sign posted speed limit of 50 km/h, with 40 km/h school zone.

Photo 8 shows the characteristics of Oxford Street in the study area.

Photo 8 - Oxford Street, looking south towards Langston Place

2.2.2 Norfolk Road

Norfolk Road functions as a collector road, providing access to residential land use and other local roads. It forms a priority intersection with Pembroke Street at its southern end.

Norfolk Road has the following road characteristics:

- Two-way sealed carriageway, around 11 metres wide;
- Zebra crossing facilities near Epping Public School;
- One traffic lane in each direction;
- Road marked double white centreline;
- Footpaths provided along both sides of the road;
- Half hour parking restriction on the western side of the road shoulder during peak periods south the zebra crossing;

- Unrestricted on-street parallel parking provided on both sides of the road, north of Epping Public School;
- Sign posted speed limit of 40 km/h school zone;
- 50 km/h and 40 km/h pavement marks; and
- Roundabout signs posted at the Chester Street and Oxford Street roundabouts.

Photo 9 shows the characteristics of Norfolk Road in the study area.

Photo 9 - Norfolk Road, looking south towards Pembroke Street

2.2.3 Pembroke Street

Pembroke Street functions as a collector road, connecting residential areas and other local roads to Epping Station and local shops. Epping Public School is also located to the north of Pembroke Street at the intersection with Norfolk Road.

Pembroke Street forms a signalised intersection, no right turn allowed, with Langston Place and Oxford Street at its western end and a signalised intersection, left turn only, with Epping Road east of study area.

Pembroke Street has the following road characteristics:

- A two-way sealed carriageway, around 12 metres wide;
- Generally one traffic lane in each direction;
- Road marked one white centreline;
- Zebra crossing facilities at the eastern approach of Essex Street roundabout;
- Two bus stops along each side of the street between Smith Street and Epping Road;
- Footpaths provided along both sides of the road;
- Bicycle pavement marks on both sides of the street shoulder Essex Street roundabout;
- Half hour parking permit on both sides of the street shoulder during peak periods between Langston Place and Chambers Court;

- One hour parking restrictions during peak periods between Chambers Court and Smith Street;
- Unrestricted on-street parallel parking provided along both sides of the road, between Essex Street and Epping Road; and
- Sign posted speed limit of 50 km/h.

Photo 10 shows the characteristics of Pembroke Street in the study area.

Photo 10 - Pembroke Street, looking east towards Norfolk Road

2.3 Site observations

GHD conducted site visits to gain an understanding of current traffic and transport conditions within the study area. The site visits were carried out during the following periods:

- Thursday 28th August 2014, 5 pm to 6:30 pm (PM Peak);
- Friday 29th August 2014, 7:30 am to 8:30 am (AM Peak);
- Tuesday 17th February 2015 3.30 pm to 6:30 pm (PM Peak); and
- Various AM and PM peak site inspections in February 2015 for the Paramics base model development.

The focus of the site visits was to identify any major causes of queuing or congestion along Epping Road. Signal phasing, queues and the interactions between vehicles and pedestrians were observed at all intersections within the study area.

2.3.1 AM peak

In general, heavy eastbound traffic at Epping Road was observed during the weekday AM peak. No significant congestion was observed at any of the intersections within the study area.

Table 2-1 below outlines the site observations during the AM peak period.

Table 2-1 AM peak observations

Intersection	Description	Photo Index (Refer to Appendix A)
Epping Road/Langston Place /Blaxland Road	• Heavy eastbound traffic observed at Epping Road • The vertical grade at the bridge reduces the speed of heavy vehicles along Epping Road in a westbound direction, especially when they are stopped at the red light. • Eastbound queues extended back to the pedestrian bridge at Beecroft Road. About 10 to 15 cars were observed per lane. Lane 1(kerbside) and lane 2 were utilised more than the third lane. • Queues at Langston Place just reached the upstream intersection however they cleared every cycle time. • Epping Road westbound queues never extended past Smith Street. The westbound queue reached Smith Street only once and quickly dissipated. • Only signal queues were observed at Blaxland Road. They were observed to clear at each cycle time. • Although heavy traffic was observed, the traffic was moving and delays were only signal related and due to the tight horizontal curve just before the railway bridge. No significant congestion was observed. It was observed that traffic at Epping Road is close to the capacity and any incidents could lead to heavy delays.	Site Photo 1 Site Photo 2 Site Photo 3
Epping Road/Smith Street	• Very minor traffic was observed at Smith Street, with around 70 two-way traffic movements an hour at the intersection with Epping Road. • Major delays were not observed at the Smith Street intersection as vehicles were able to enter and exit Smith Street by the gaps created by upstream and downstream signals.	Site Photo 4
Epping Road/Forest Grove	• Very minor traffic was observed at Forest Grove, with around 60 two-way traffic movements an hour on Forest Grove at the intersection with Epping Road. • Major delays were not observed at Forest Grove intersection as vehicles were able to enter and exit Forest Grove by the gaps created on Epping Road by upstream and downstream signals at Blaxland Road and at Essex Street.	
Epping Road/Essex Street	• The through traffic is co-ordinated at Epping Road between Blaxland Road and Essex Street. • Only signal queues are observed at Epping Road. • Queues at Essex Street (north approach) occasionally extend back to Pembroke Street. Majority of the green time is provided to Epping Road traffic, leading to higher delays at the minor Essex Street.	Site Photo 5

2.3.2 PM peak

In general, heavy westbound traffic at Epping Road was observed during the PM peak. Table 2-2 outlines the site observations during the PM peak period.

Table 2-2 PM peak observations

Intersection	Description	Photo Index (Refer to Appendix A)
Epping Road/Langston Place/Blaxland Road	• Heavy westbound traffic was observed at Epping Road. • The vertical grade at the bridge reduces the speed of heavy vehicles along Epping Road, especially when they are stopped at the red light. • Westbound queues extended back to the Epping Road/Pembroke Street intersection. It continues further up to Beecroft Road, near the pedestrian bridge. • Northbound traffic along Blaxland Road experience queue lengths to Maida Road intersection. A large proportion of the traffic was found turning left onto Epping Road. • Queueing tends to occur across the bridge along Epping Road. • Southbound traffic forms queues along Langston Place, which extend back to the intersection with Pembroke Street and Oxford Street. Most of the demand comes from lane 2, with vehicles turning right from Langston Place onto Epping Road. • Although heavy traffic was observed the traffic was moving and delays were only signal related and due to the tight horizontal curve just before the Railway Bridge. No significant congestion was observed. It was observed that traffic at Epping Road is close to capacity and any incidents could lead to heavy delays.	Site Photo 6 Site Photo 7 Site Photo 8 Site Photo 9 Site Photo 10
Epping Road/Smith Street	• Very minor traffic was observed at Smith Street, with around 40 two-way traffic movements an hour on Smith Street at the intersection with Epping Road. • Major delays were not observed at the Smith Street intersection as vehicles were able to enter and exit Smith Street by the gaps created by upstream and downstream signals.	
Epping Road/forest Grove	• Low traffic was observed at Forest Grove at the intersection with Epping Road. • Major delays were not observed at the Forest Grove intersection as vehicles were able to enter and exit Forest Grove by the gaps created on Epping Road by upstream and downstream signals at Blaxland Road and at Essex Street.	Site Photo 11
Epping Road/Essex Street	• The through traffic is co-ordinated at Epping Road between the Blaxland Road and Essex Street intersections. • Crossing this intersection for pedestrians was found to be difficult with the lack of pedestrian crossing facilities. • Westbound traffic along Epping Road was found to extend back to	

Intersection	Description	Photo Index (Refer to Appendix A)
	the Pembroke Street intersection, occasionally. • Kerb ramps were not aligned along pedestrian footpaths across the southern leg of the intersection (Essex Street). • Northbound traffic along the southern leg of the intersection experienced queue lengths of about 28 vehicles.	Site Photo 12 Site Photo 13 Site Photo 14

2.3.3 Summary of site observations

Overall, traffic along Epping Road is very congested, with significant eastbound queue lengths observed during the AM peak and conversely significant westbound queue lengths during the PM peak periods.

2.4 Existing daily and peak hour traffic volumes

2.4.1 Average daily midblock traffic counts

Roads and Maritime commissioned Skyhigh Pty. Ltd. To undertake midblock traffic counts at key roads within the study area. These 'tube' traffic counts were undertaken over a seven day period between 3rd and 15th March 2015.

A summary of the average daily traffic volumes, by direction, is provided in Table 2-3. The traffic data indicates that Beecroft Road experiences the highest daily combined traffic flows, with around 55,100 vehicles per day on a weekday.

Table 2-3 Average daily traffic flows in the study area

Road	Direction	Weekdays (Vehicles per day)	Weekends (Vehicles per day)
Epping Road, east of Langston Place	Eastbound	17,415	15,618
Epping Road, east of Langston Place	Westbound	18,190	16,163
Beecroft Road, north of Epping Road	Northbound	27,836	26,297
Beecroft Road, north of Epping Road	Southbound	27,259	25,929
Essex Street, north of Epping Road	Northbound	1,929	1,453
Essex Street, north of Epping Road	Southbound	2,792	2,338
Langston Place, north of Epping Road	Northbound	8,134	9,429
Langston Place, north of Epping Road	Southbound	4,230	5,093
Blaxland Road, south of Epping	Northbound	8,192	9,635
Blaxland Road, south of Epping	Southbound	6,994	7,310
Pembroke Street, east of Langston Place	Eastbound	2,336	1,895

Road	Direction	Weekdays (Vehicles per day)	Weekends (Vehicles per day)
Pembroke Street, east of Langston Place	Westbound	2,034	1,819
Pembroke Street, west of Epping Road	Eastbound	3,535	3,429
Pembroke Street, west of Epping Road	Westbound	3,568	3,497
Maida Road, east of Blaxland Road	Eastbound	1,217	390
Maida Road, east of Blaxland Road	Westbound	988	958
Crandon Road, west of Epping Road	Eastbound	67	67
Crandon Road, west of Epping Road	Westbound	60	48
Essex Street, south of Epping Road	Northbound	19	33
Essex Street, south of Epping Road	Southbound	18	40
Norfolk Road, north of Pembroke Street	Northbound	3,760	3,600
Norfolk Road, north of Pembroke Street	Southbound	3,833	4,022

Epping Road

A chart showing the average daily two-way traffic profile on an average weekday, Saturday and Sunday along Epping Road to the east of Blaxland Road is shown at Figure 2. The traffic data shows the weekday average to have the highest peak hourly two-way traffic flow, with around 2,570 vehicles per hour, which occurred between 7 - 8 am.

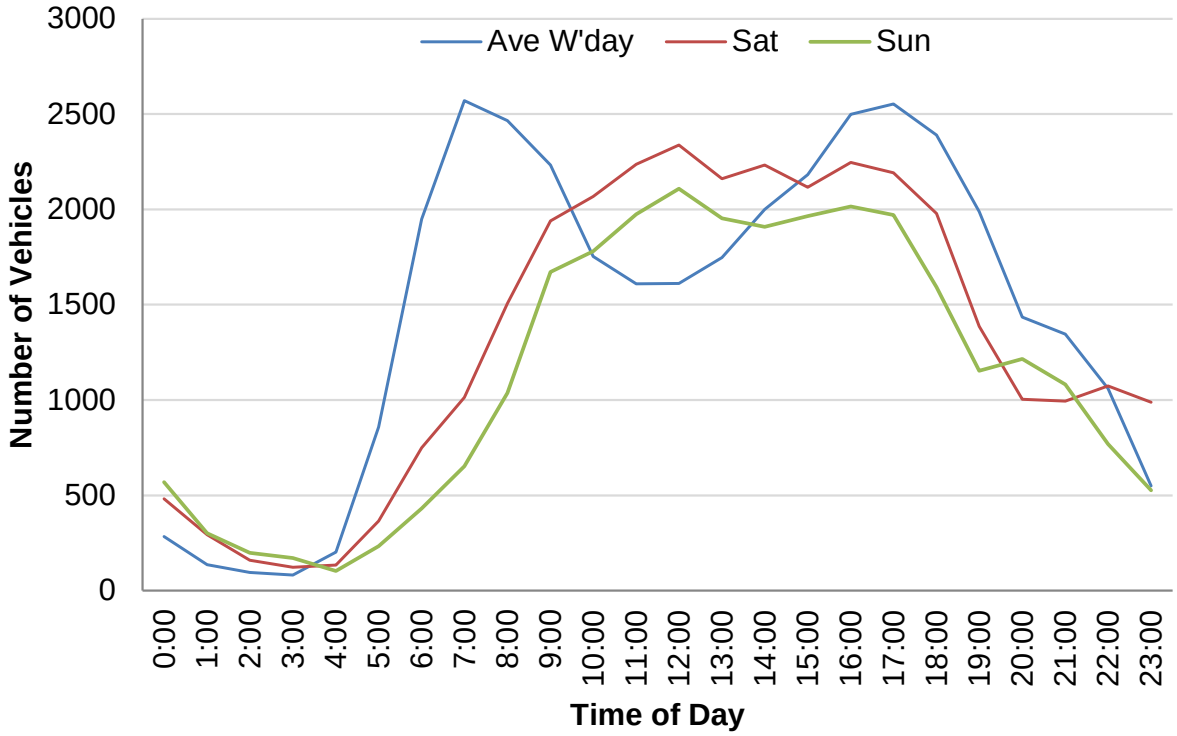


Figure 2 Average hourly two-way traffic movements along Epping Road

2.4.2 Intersection traffic counts

Intersection traffic counts were undertaken on Wednesday 13th August 2014 between 6:30-9:30 am and 4-7 pm and on Saturday 16th August 2014 between 11 am and 2 pm at the following intersections:

- Carlingford Road/Rawson Street/Ray Road
- Carlingford Road/Beecroft Road
- Beecroft Road/Bridge Street/Epping Road/High Street
- Epping Road/Langston Place/Blaxland Road
- Epping Road/Smith Street
- Epping Road/Forest Grove
- Epping Road/Essex Street

Intersection traffic counts were undertaken on Wednesday 4th March 2015 between 6-9 am and 3-6 pm and on Saturday 7th March 2015 between 11 am and 2 pm at the following intersections:

- Maida Road/Forest Grove
- Essex Street/Brucedale Avenue
- Essex Street/Pembroke Street
- Norfolk Road/Pedestrian Survey
- Oxford Street/Chester Street/Essex Street
- Oxford Street/Surrey Street/Derby Street
- Norfolk Road/Chester Street
- Epping Road/Crandon Road

- Epping Road/Pembroke Street
- Pembroke Street/Norfolk Road
- Pembroke Street/Smith Street
- Pembroke Street/Chambers Court
- Blaxland Road/Maida Road
- Essex Street/Maida Road

2.4.3 Network peak hour

The traffic assessment undertaken for this study focuses on the impacts during the weekday AM, weekday PM and Saturday peak periods, when demand for traffic capacity in the surrounding network is perceived to be at its highest. These peak periods were calculated by adding consecutive 15 minute period vehicular flow rates from all approaches in the network and finding the maximum value for the hourly intervals. Analysis of the traffic survey data found the peak hours of the road network occur during the following:

- Weekday AM peak hour between 7:30 – 8:30 am
- Weekday PM peak hour between 5:30 – 6:30 pm
- Saturday peak hour between 12:30 – 1:30 pm.

It should be noted that the peak periods are for all intersections within the study area and are different to the peak hours along Epping Road shown in Figure 2.

The traffic survey reports are provided in full in Appendix B.

Peak hour two-way traffic volumes and the proportion of heavy vehicles on each road in the study area are summarised in Table 2-4. Some of the intersections shown in Table 2-4 were collected at a later date, and as such the weekday PM peak hour was reported between 5:00-6:00 pm. These intersections are identified with an asterisk.

Table 2-4 Network peak hour traffic volumes (2015)

Road section	AM peak (7.30-8.30 am) Total vehicles	AM peak (7.30-8.30 am) % Heavy vehicles	PM peak (5.30–6.30 pm) Total vehicles	PM peak (5.30–6.30 pm) % Heavy vehicles	Saturday peak (12.30–1.30 pm) Total vehicles	Saturday peak (12.30–1.30 pm) % Heavy vehicles
Epping Road, east of Beecroft Road	4,427	2%	4,193	1%	4,003	1%
Epping Road, east of Langston Place	2,968	2%	2,944	1%	2,466	1%
Epping Road, east of Smith Street	2,906	2%	2,921	1%	2,432	1%
Epping Road, east of Forest Grove	2,878	2%	2,477	1%	2,351	1%
Epping Road, east of Essex Road	2,728	2%	2,221	1%	2,207	1%
Epping Road, north of Crandon Road*	2,719	2%	1,975	1.5%	2,281	1%
Cambridge Street, west of Oxford Street	123	26%	99	26%	41	15%

Road section	AM peak (7.30-8.30 am) Total vehicles	AM peak (7.30-8.30 am) % Heavy vehicles	PM peak (5.30–6.30 pm) Total vehicles	PM peak (5.30–6.30 pm) % Heavy vehicles	Saturday peak (12.30–1.30 pm) Total vehicles	Saturday peak (12.30–1.30 pm) % Heavy vehicles
Pembroke Street, east of Smith Street	428	8%	360	7%	185	3%
Pembroke Street, east of Essex Street	642	7%	609	5%	407	2%
Pembroke Street, east of Norfolk Road*	570	7%	479	6%	450	3%
Norfolk Road, north of Pembroke Street*	626	3%	662	1%	564	1%
Norfolk Road, north of Chester Street*	499	1%	535	1%	492	0%
Blaxland Road, south of Epping Road	1,114	3%	826	1%	1,179	1%
Langston Place, south of Cambridge Street	732	1%	644	0%	804	0%
Oxford Street, north of Cambridge Street	654	1%	577	0%	684	0%
Oxford Street, north of Chester Street*	534	3%	501	1%	423	0%
Oxford Street, north of Surrey Street*	548	3%	484	1%	380	0%
Chester Street, east of Oxford Street	75	0%	55	2%	36	0%
Smith Street, north of Epping Road	67	1%	42	0%	43	0%
Forest Grove, south of Epping Road	58	5%	463	0%	141	0%
Essex Street, south of Epping Road	406	0%	506	1%	321	0%
Essex Street, south of Pembroke Street	516	1%	586	0%	338	0%
Essex Street, north of Pembroke Street	336	0%	325	0%	179	0%
Essex Street, south of Brucedale Ave	410	2%	565	0%	303	0%
Maida Road, east of Blaxland Road	88	9%	516	1%	162	1%

2.5 Existing intersection performance

2.5.1 Intersection assessment criteria

The Level of Service (LoS) is the standard measure used to understand the operational performance of the network and intersections. This is defined as the qualitative assessment of the quantitative effect of factors such as speed, traffic volume, geometric features, delays and

freedom of movement. The level of service concept is applied to intersections through measures of effectiveness, as summarised in Table 2-5.

Table 2-5 Measures of effectiveness for Level of Service definition for intersections

Intersection control	Measure of effectiveness
Priority controlled	Degree of Saturation Delay to critical movements (sec/vehicle) Queue length for critical movements
Traffic Signals	Average Delay (sec/vehicle) Delay to critical movements Degree of Saturation Cycle Length Queue length for critical movements
Roundabout	Average Delay (sec/vehicle) Delay to critical movements Degree of Saturation Queue length for critical movements

The assessment of intersection operation is based on criteria outlined in Table 2-6**,** as defined by Roads and Maritime Services' *Guide to Traffic Generating Developments* (Roads and Maritime 2002).

Table 2-6 Intersection LoS assessment criteria

LoS	Average delay/ vehicle (secs)	Traffic signals and roundabouts	Give-way and stop signs
A	Less than 15	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	28 to 42	Satisfactory	Satisfactory, but accident study required
D	42 to 56	Operating near capacity	Near capacity, accident study required
E	56 to 70	At capacity, excessive delays; roundabout requires other control mode	At capacity; requires other control mode
F	exceeding 70	Unsatisfactory; requires additional capacity	Unsatisfactory, requires other control mode.

Source: Guide to Traffic Generating Developments (Roads and Maritime 2002)
Note:

- *The average delay assessed for signalised intersections is over all movements*
- *For roundabouts and priority control intersections (with Stop and Give Way signs or operating under the T-junction rule), the critical criterion for assessment is the movement with the highest delay per vehicle*
- *Average delay is expressed in seconds per vehicle.*

The operational performance of intersections has been assessed using SIDRA 6.1 intersection analysis software tool. The LoS criteria set by Roads and Maritime is outlined in Table 2-6 and it is noted that LoS 'D' is generally an accepted operating condition along urban roads, but E or F may be considered acceptable in certain situations in urban centres.

2.5.2 Network assessment criteria

The SIDRA 6.1 intersection modelling software allows the modelling of paired intersections (closely-spaced intersection systems) such as staggered T intersections, freeway signalised diamond interchange and complex intersection arrangements. SIDRA 6.1 also allows models to be signal coordinated.

As outlined in the SIDRA 6.1 intersection user guide, network LoS is based on a speed efficiency parameter. Speed efficiency is the ratio of the average travel speed to average desired speed. The speed efficiency ranges and the corresponding LoS are provided in Table 2-7.

Table 2-7 SIDRA Speed efficiency method for network LoS

Network LoS	Speed efficiency	Travel time index
A	0.90 < Re ≤ 1.00	8.9 < TTI ≤ 10
B	0.80 < Re ≤ 0.90	7.8 < TTI ≤ 8.9
C	0.70 < Re ≤ 0.80	6.7 < TTI ≤ 7.8
D	0.50 < Re ≤ 0.70	4.4 < TTI ≤ 6.7
E	0.30 < Re ≤ 0.50	2.2 < TTI ≤ 4.4
F	0.00 < Re ≤ 0.30	0.0 < TTI ≤ 2.2

Source: SIDRA 6.1 Intersection Guide, 7 Aug 2014

2.5.3 2014 Intersection capacity assessments

The capacity and LoS analysis was carried out for the intersections during the weekday AM, weekday PM and weekend peak periods using the SIDRA 6.1 intersection modelling software. SIDRA model calculates capacities, queue lengths and delays for traffic signals, roundabouts and priority controlled intersections. The following intersections have been analysed using SIDRA for the weekday AM, PM and weekend peak hours based on the 2014 and 2015 traffic counts discussed in Section 2.4:

- Langston Place/Epping Road signal controlled intersection
- Smith Street/Epping Road priority controlled intersection
- Forest Grove/Epping Road priority controlled intersection
- Essex Street/Epping Road signal controlled intersection
- Oxford Street/Pembroke Street signal controlled intersection
- Pembroke Street/Essex Street priority controlled intersection

SIDRA 6.1 network models provide the functionality of studying the impacts from upstream lane blockages on the adjacent intersections. It does so by adjusting the capacity, the arrival flow rate and the utilisation ratios for each lane based on the performance of the upstream intersections. For the purposes of this study a network model was more appropriate. This is because the performance of the Epping Road/Blaxland Road/Langston Place signalised intersection highly influences the performance of other intersection in the study area along the Epping Road corridor.

The network LoS criteria shown in Table 2-7 was used to assess the intersection and network performance. The peak hour traffic volumes used for the SIDRA analysis are based on the following:

- Weekday peak hour traffic obtained from the 2014 base Paramics model, as detailed in Section 5.6. This has been done to model peak hour demands, rather than actual turning

counts, which can be lower than the actual demand and therefore underestimate traffic congestion.

- Weekend peak hour volumes from the 2014 intersection traffic surveys

A summary of the results of the SIDRA intersection modelling is shown in Table 2-8, with detailed SIDRA outputs provided in Appendix D.

Table 2-8 SIDRA Results - 2014 base traffic flows

Intersection	AM peak Ave Delay (s)	AM peak LoS	PM peak Ave Delay (s)	PM peak LoS	Weekend peak Ave Delay (s)	Weekend peak LoS
Langston Place/Epping Road	37	C	45	D	37	C
Smith Street/Epping Road	>140	F	>140	F	>140	F
Forest Grove/Epping Road	>140	F	97	F	58	E
Essex Street/Epping Road	21	B	41	C	16	B
Oxford Street/Pembroke Street	11	A	11	A	10	A
Pembroke Street/Essex Street	7	A	7	A	6	A
Network Summary	28	E	31	E	16	D

**Note: when delays are in excess of 140s, delays are increased exponentially in the SIDRA model.*

The SIDRA results indicate that the Smith Street/Epping Road and Forest Grove/Epping Road intersections currently operate at a LoS F, which is caused by vehicles being unable to turn right into Epping Road, due to insufficient gaps between traffic. This however is a unrealistic representation of current traffic conditions, as SIDRA 6.1 is not able to model gaps created by upstream and downstream signals; or drivers allowing traffic to turn in congested locations. No major delays were observed at Smith Street and Forest Grove during the site inspections (as discussed in Section 2.3).

All other intersections currently operate at an acceptable LoS during peak periods. The overall network performance during AM and PM peak periods operates at a LoS E, which is an accurate representation of existing conditions, with high levels of congestions observed along Epping Road.

2.6 Public transport

Eastbound and westbound bus stops (2121214 and 212126) are located on the northern and southern sides of Epping Road in the study area. A summary of the bus services and frequencies operating along Epping Road in the study area is provided in Table 2-9.

Bus routes 288, 290, 295 and 140 provide services to Epping Station via Pembroke Street and do not access Epping Road in the study area. Bus routes 630 and M54 access Epping Road in the study area.

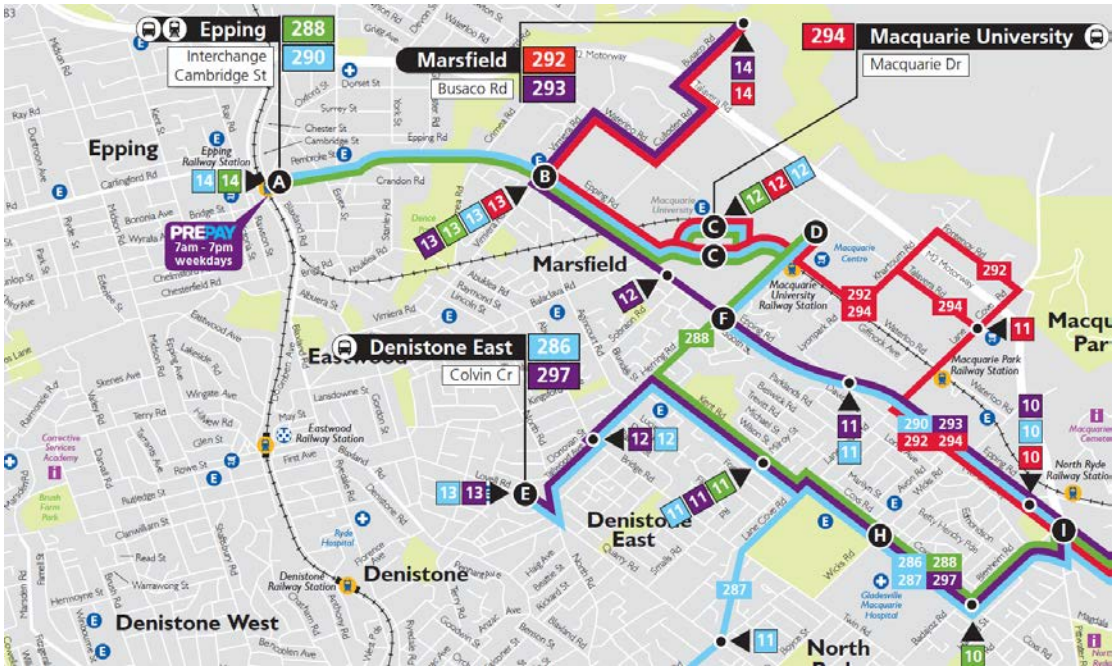
Table 2-9 Bus services in the study area

Route	Service	Via	Service frequency AM peak	Service frequency PM peak	Service frequency Saturday peak
288	Epping to City	Epping, North Ryde, Lane Cove and City via QVB	25 mins	30 mins	15 mins

Route	Service	Via	Service frequency AM peak	Service frequency PM peak	Service frequency Saturday peak
290	Epping to City	Epping, Macquarie Centre, North Ryde, City via North Sydney	30 mins	15 mins	hourly
M54	Parramatta Interchange to Lane Cove Road	Parramatta, Carlingford, Epping, Macquarie University and Macquarie Park	10 mins	10 mins	20 mins
295	North Epping to Macquarie Centre	Epping and Macquarie University	30 mins	15 mins	Hourly
140	Manly to Epping	Manly, Balgowlah, Neutral Bay, Crow's Nest, Lane Cove, Macquarie Centre, Macquarie University and Epping	1 hour 30 mins	Hourly	-
630	Blacktown to Macquarie Park	Seven Hills, M2 Busway and Macquarie Centre	30 mins	30 mins	-

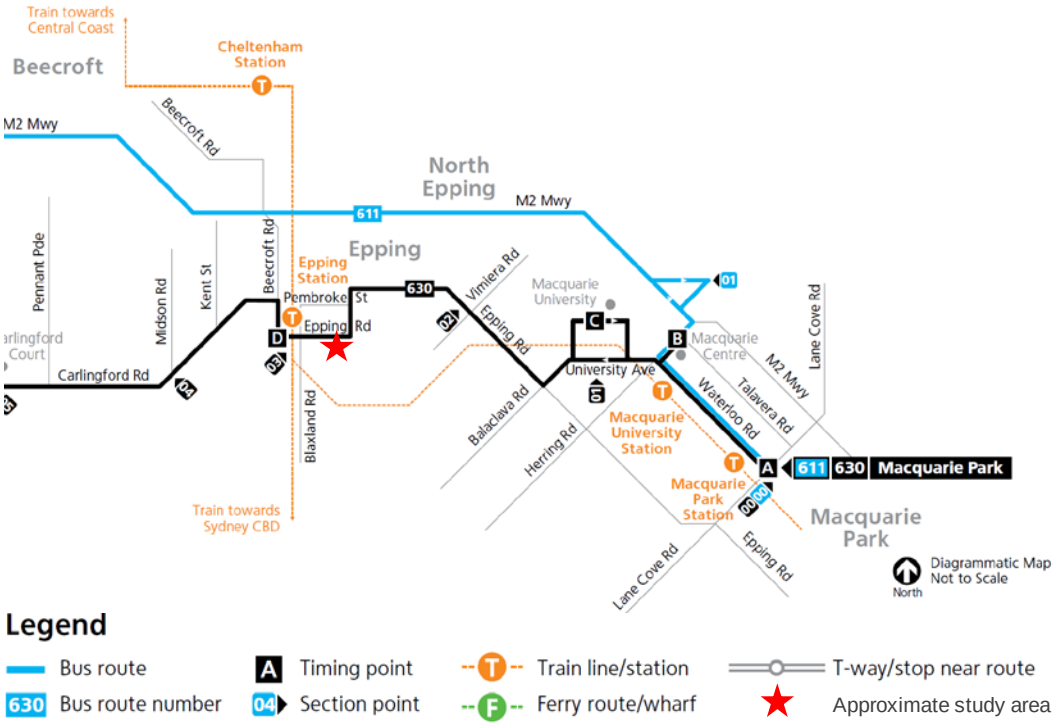
Source: Transport for NSW 630, 288,290, M54, 295, 140 Route Map

Figure 3 shows an extract of the Sydney Buses Route Map illustrating the routes of bus services 288 and 290, which operate along Pembroke Street. Figure 4 shows an extract of Sydney Hillsbus Bus Map, showing bus route 630, which operates along Epping Road. Detailed maps of the each of the bus routes identified in Table 2-9 are provided in Appendix B.



Source: http://www.sydneybuses.info/routes

Figure 3 Sydney Buses route 288 and 290 route map



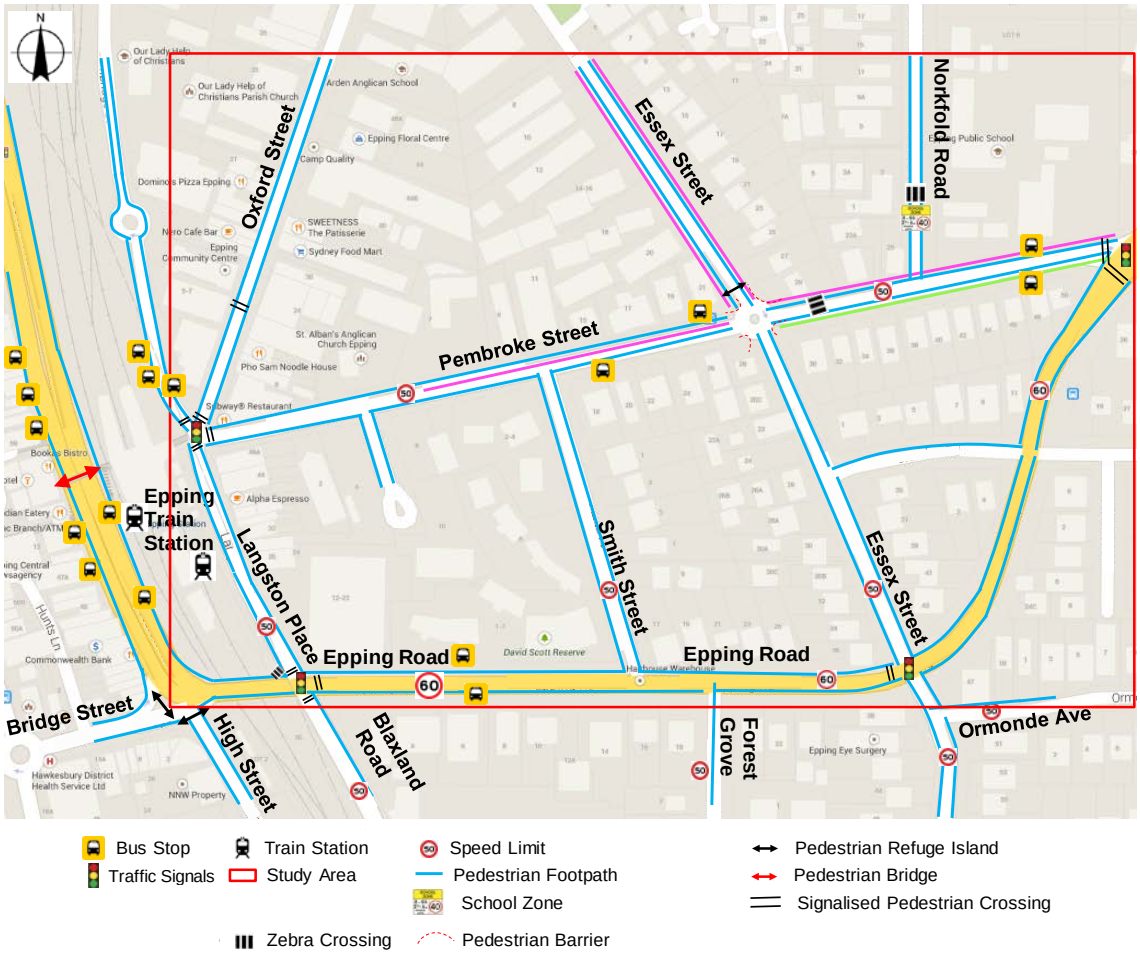
Source: Transport for NSW Sydney Hillsbus Bus Timetables (2 June 2014), modified by GHD

Figure 4 Hills Bus route 630 route map

2.7 Pedestrian and cyclist access

2.7.1 Pedestrian mobility

The existing pedestrian facilities in the study area are shown at Figure 5. Footpaths are located along both sides of Epping Road, providing a continuous link for pedestrians. No pedestrian crossing facilities currently exist across Smith Street, Forest Grove and Essex Street (north and south of Epping Road).



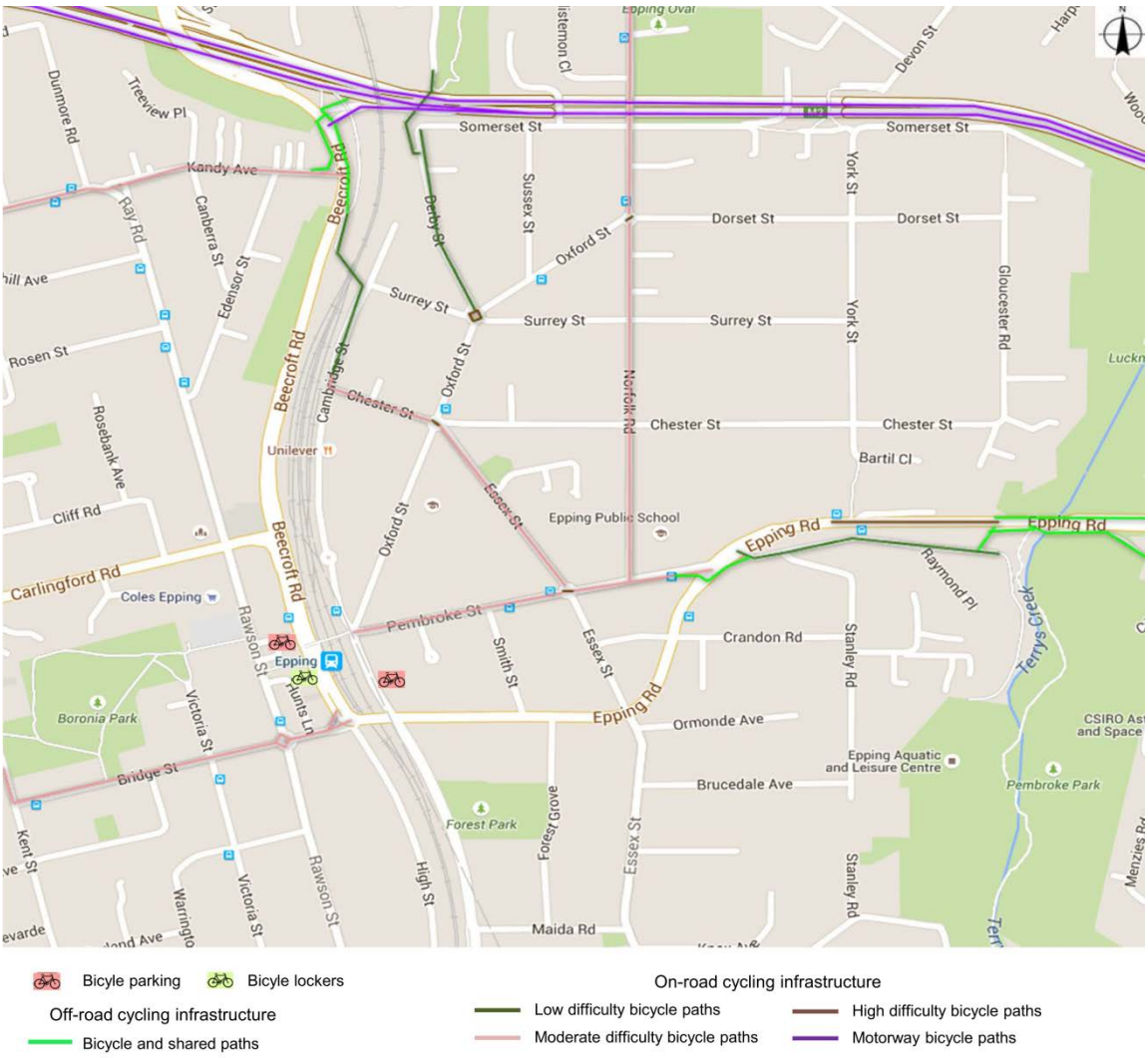
Source: Google Maps 2014, modified by GHD

Figure 5 Existing pedestrian facilities

2.7.2 Cycle facilities

Bicycle routes in the study area are shown at Figure 6. A cycle route is provided between Terrys Creek and the intersection of Pembroke Street and Epping Road. Pembrooke Street, Norfolk Road and Essex Street are designated on-road cycle routes with cycle wayfinding and on-road cycle markings provided. There is also a section of on-road cycle lane in the westbound direction along Pembroke Street, between Epping Road and Essex Street.

Bicycle lockers and parking facilities are provided at Epping Station.



Source: http://www.rms.nsw.gov.au/roads/using-roads/bicycles/cyclewayfinder/index.html

Figure 6 Existing bicycle network

2.8 Parking

Clearways currently exist along both sides of Epping Road. Parking and stopping is restricted during the following periods:

- Monday to Friday 6-10 am; and
- Monday to Friday 3-7 pm.

During non-clearway periods on-street parking is permitted along Epping Road. Figure 7 shows the location and the approximate number of parking spaces available during non-clearway periods. In total there are approximately 31 unmarked parking spaces on the northern side of Epping Road, with approximately 13 spaces along the southern side. The number of spaces has been calculated by measuring the available parking distance along the road, assuming a parking bay length of six metres.

Source: Google Maps 2014, modified by GHD

Figure 7 Parking locations and number of spaces along Epping Road

2.9 Crash statistics

Roads and Maritime supplied crash statistics for roads within the study area used for the Epping Road widening project over a five year period between (July 2009 and June 2014). This crash data was used to determine the main factors contributing to crashes within the study area shown in Figure 1. A detailed report of the data is supplied in Appendix E with a summary by each road provided below.

In summary, the crash data review identified the following:

- A total of 125 crashes were recorded within the study area. These crashes involved 134 light vehicles and five heavy vehicles.
- Five pedestrian crashes were recorded, of these all involved pedestrians crossing the carriageway.

The locations of crashes, including the severity of these crashes, for the five year period between July 2009 and June 2014 are shown at Figure 8. This shows the main crash clusters within the study area at the following locations:

- Epping Road/Langston Place/Blaxland Road intersection
- Epping Road/Smith Street and Epping Road/Forest Grove intersections
- Epping Road/Essex Street intersection
- Epping Road/Pembroke Street intersection

Source: Google Maps 2015, modified by GHD

Figure 8 Crash degree statistics map (2009 – 2014)

2.9.1 Langston Place

In total, there were eight crashes recorded along Langston Place within the study area. Of these:

- Two (25%) incidents resulted in injuries;
- Six (75%) incidents occurred at an intersection;
- Three (38%) incidents involved through and opposite right turn movements; and

- One (13%) pedestrian related incident, which occurred at the intersection Langston Place/Cambridge Street intersection.

2.9.2 Pembroke Street

In total, there were eight crashes recorded along Pembroke Street within the study area. Of these:

- Two (25%) incidents resulted in injuries;
- Five (63%) incidents occurred at intersections, two at Chamber Court T-intersection and three at Norfolk Road T-intersection;
- One (13%) incident occurred at the Essex Street roundabout;
- One (13%) incident involved a pedestrian; and
- One pedestrian related incident occurred along Pembroke Street, 10 metres east of Chambers Court.

2.9.3 Essex Street

In total, there were six crashes recorded along Essex Street within the study area. Of these:

- Three (50%) incidents resulted in injuries;
- Two (33%) incidents occurred at the Pembroke Street roundabout;
- One (17%) incident occurred at the Ormonde Avenue/Essex Street intersection, where a right turning vehicle collided with a vehicle heading north in Essex Street;
- Two (33%) incidents involved cross traffic collisions at the Pembroke Street/Essex Street roundabout; and
- One (17%) incident involved a pedestrian, which occurred 50 metres north of Maida Road.

2.9.4 Forest Grove

In total, there were two crashes recorded along Forest Grove within the study area. Of these:

- Both incidents resulted in injuries;
- One pedestrian related incident occurred near the Forest Grove/Epping Road intersection, which involved a vehicle turning from Epping Road to Forest Grove, colliding with the pedestrian crossing Forest Grove; and
- In addition to the pedestrian incident another incident occurred in Forest Grove, 20 metres south of Epping Road, which involved a vehicle parking manoeuvre.

2.9.5 Blaxland Road

In total, there were 22 crashes recorded on Blaxland Road within the study area. Of these:

- Eight (32%) incidents resulted in injuries;
- 17 (77%) incidents occurred at intersections;
- Five (31%) incidents involved cross traffic collisions;
- Five (31%) incidents involved through and opposite right turn movements;
- Three (19%) incidents involved a rear end collision with vehicles travelling in the same lane direction; and

- One (5%) incident involved a pedestrian, which occurred at the intersection of Epping Road and Blaxland Road.

2.9.6 Epping Road

In total, there were 55 crashes recorded along Epping Road within the Epping Road widening project study area. Of these:

- 20 (36%) incidents resulted in injuries;
- 35 (64%) incidents occurred at an intersection;
- Eight (15%) incidents occurred at the intersection of Pembroke Street and Epping Road;
- Seven (13%) incidents occurred at the intersection of Blaxland Road and Epping Road;
- Seven (13%) incidents occurred at the intersection of Smith Street and Epping Road;
- Six (11%) incidents occurred at the intersection of Crandon Road and Epping Road;
- Five (9%) incidents occurred at the intersection of Essex Street and Epping Road;
- Two (4%) incidents occurred at the intersection of Forest Grove and Epping Road;
- Twenty Five (45%) incidents involved rear end collisions; and
- No pedestrian incidents were recorded.

2.9.7 Oxford Street

In total, there were ten crashes recorded along Oxford Street within the Epping Road widening project study area, between Pembroke Street and Surrey Street. Of these:

- Three (30%) incidents resulted in injuries;
- Three (30%) incidents occurred at the Pembroke Street and Oxford Street intersection;
- Four (40%) incidents occurred at roundabouts, with two of these located at the Chester Street roundabout and other two located at the Surrey Street roundabout;
- Two (20%) incidents involved rear end collision with vehicles in the same direction;
- Two (20%) incidents involved adjacent cross traffic collisions; and
- No pedestrian incidents were recorded.

2.9.8 Chester Street

In total, there were five crashes recorded along Chester Street within the Epping Road widening project study area, between Cambridge Street and Norfolk Road. Of these:

- Two (40%) incidents resulted in injuries;
- All (100%) incidents occurred at the Norfolk Road and Chester Street intersection;
- Four (80%) incidents involved cross traffic collisions; and
- No pedestrian incidents were recorded.

2.9.9 Norfolk Road

In total, there were two crashes recorded along Norfolk Road within the Epping Road widening project study area. Of these:

- One incident resulted in injuries;
- All (100%) incidents were recorded at the Norfolk Road and Surrey Street intersection;

- All (100%) incidents involved cross traffic collisions; and
- No pedestrian incidents were recorded.

2.9.10 Vehicle crash data review

A high level assessment was undertaken of vehicle crash data for the study area for the years 2009 to 2014, based on the Roads and Maritime crash data. Within the five-year period, 125 crashes were recorded in the study area, which is illustrated in Figure 8. This shows the main crash clusters within the study area at the following locations:

- Epping Road/Langston Place/Blaxland Road intersection;
- Epping Road/Smith Street and Epping Road/Forest Grove intersections;
- Epping Road/Essex Street intersection; and
- Epping Road/Pembroke Street intersection.

The following key points were noted from the assessment of this data:

- 26 crashes (44%) occurred along Epping Road;
- 89 crashes (71%) occurred at 16 Intersections;
- 45 crashes (36%) involved injuries;
- No fatalities were recorded; and
- Five crashes (4%) involved pedestrians, all of which resulted in injuries.

It should be noted that the crash data presented is based on NSW Police reports, which generally under-represent the incidence of pedestrian and cyclist related crashes due to some of these incidents not being reported. This is due to the fact that many minor pedestrian incidents do not result in tow-away crashes where police are called and the incident therefore goes unrecorded.

Crash trends were identified at some locations in the study area, including the Epping Road/Langston Place/Blaxland Road, Epping Road/Smith Street, Epping Road/Forest Grove, Epping Road/Essex Street and Epping Road/Pembroke Street intersections. It was found that 33 percent of the crashes occurred on Blaxland Road between Epping Road and Maida Road. 35 percent of the crashes occurred along Epping Road between Essex Street and Langston Place.

3. Proposed road network improvements

3.1 Proposal overview

Roads and Maritime propose to upgrade about 500 metres of Epping Road, between Blaxland Road and Essex Street, and around 80 metres east of Essex Street, in Epping. The key features of the proposal are summarised below and are illustrated on Figure 9, with an enlarged version in Appendix F:

- Providing an additional westbound lane by widening the southern side of Epping Road by about 3.7 metres between Essex Street and Blaxland Road, this becomes a dedicated left turn lane into Blaxland Road.
- Upgrading the intersection of Epping Road and Essex Street:
  - Widening on the north-eastern side of the intersection to provide an additional right turn lane into Epping Road (westbound). This will provide two marked right turn lanes, and an unmarked left/through lane;
  - Widening on the south-western side of the intersection to provide a left turn lane from Essex Street onto Epping Road (westbound);
  - Removing the right turn movement from Epping Road to Essex Street in both directions;
  - Providing three new traffic light controlled pedestrian crossings.
- Removing the right turn movement from Langston Place into Epping Road in the westbound direction for all traffic.
- To widen 80 metres of the northern side of Epping Road east of Essex Street.
- Construction of a raised median (about 340 metres long) along Epping Road, between Langston Place/Blaxland Road and just west of Essex Street. This would restrict access from Epping Road to Forest Grove and Smith Street, and to residential properties along this section of Epping Road, to left-in and left-out only.
- Constructing a raised median about 20 metres long on Essex Street north of the Epping Road intersection.
- Constructing a 1.2 metre wide pedestrian pathway on Epping Road.

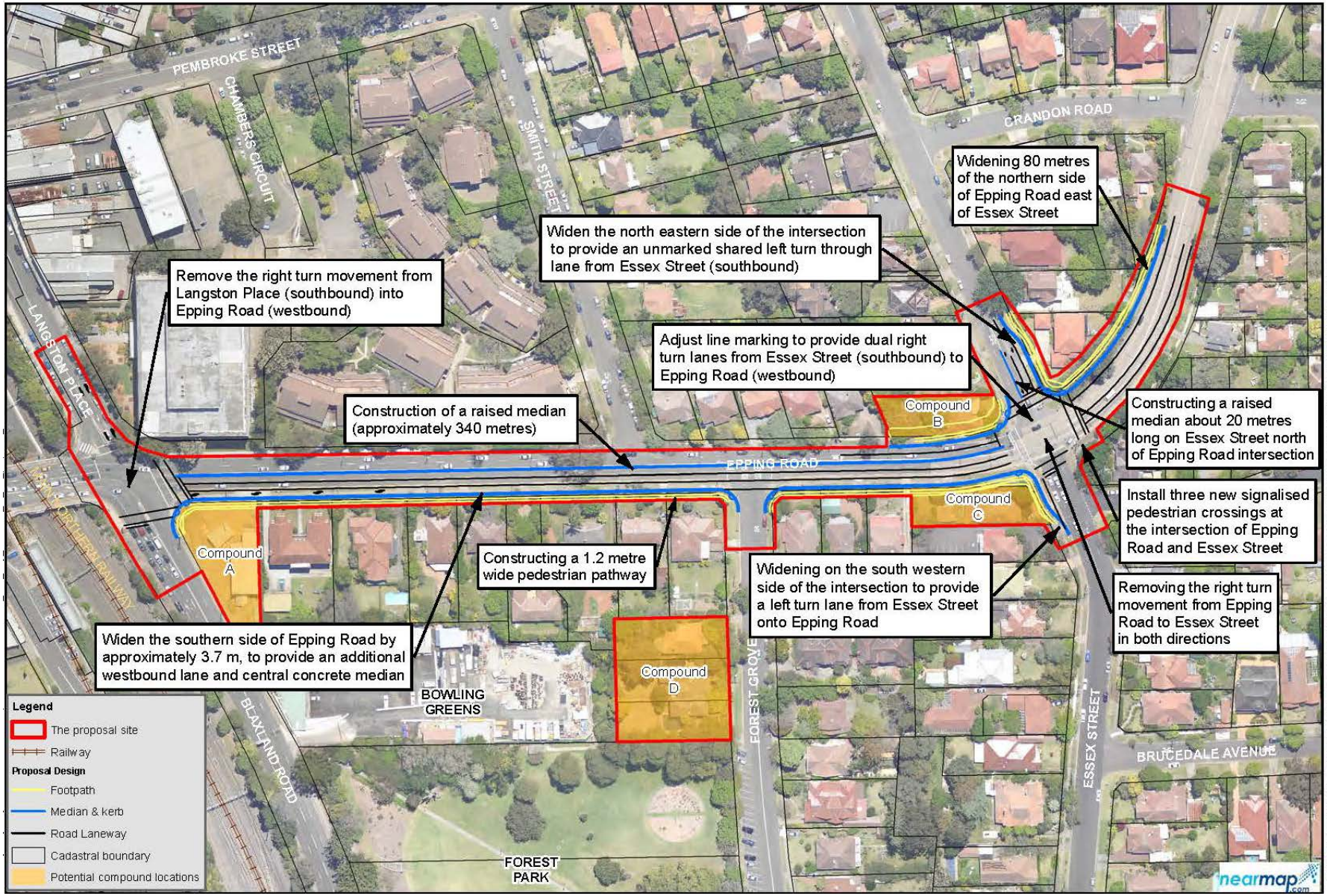


Figure 9 The proposal

3.1.1 Intersection upgrades

Langston Place/Blaxland Road intersection

Part of the proposed upgrades involves banning the right turn from Langston Place (southbound) into Epping Road (westbound). These works would only be carried out along the carriageway, and would not affect adjacent properties.

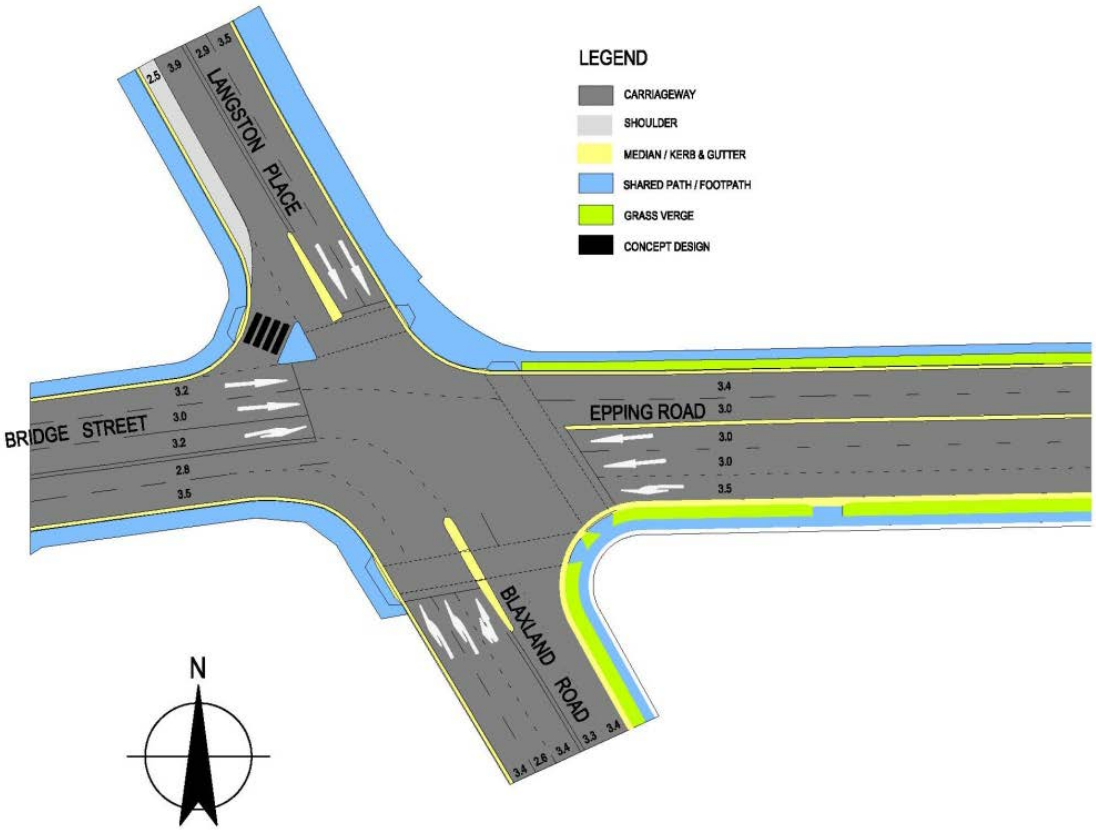


Figure 10 Langston Place/Blaxland Road Intersection

Smith Street and Forest Grove intersections

The existing T-intersections would be restricted to a left-in and left-out only intersection by introducing a 0.5 metre wide concrete median along Epping Road to separate the east and westbound traffic.

The proposed intersection arrangement is illustrated in Figure 11.

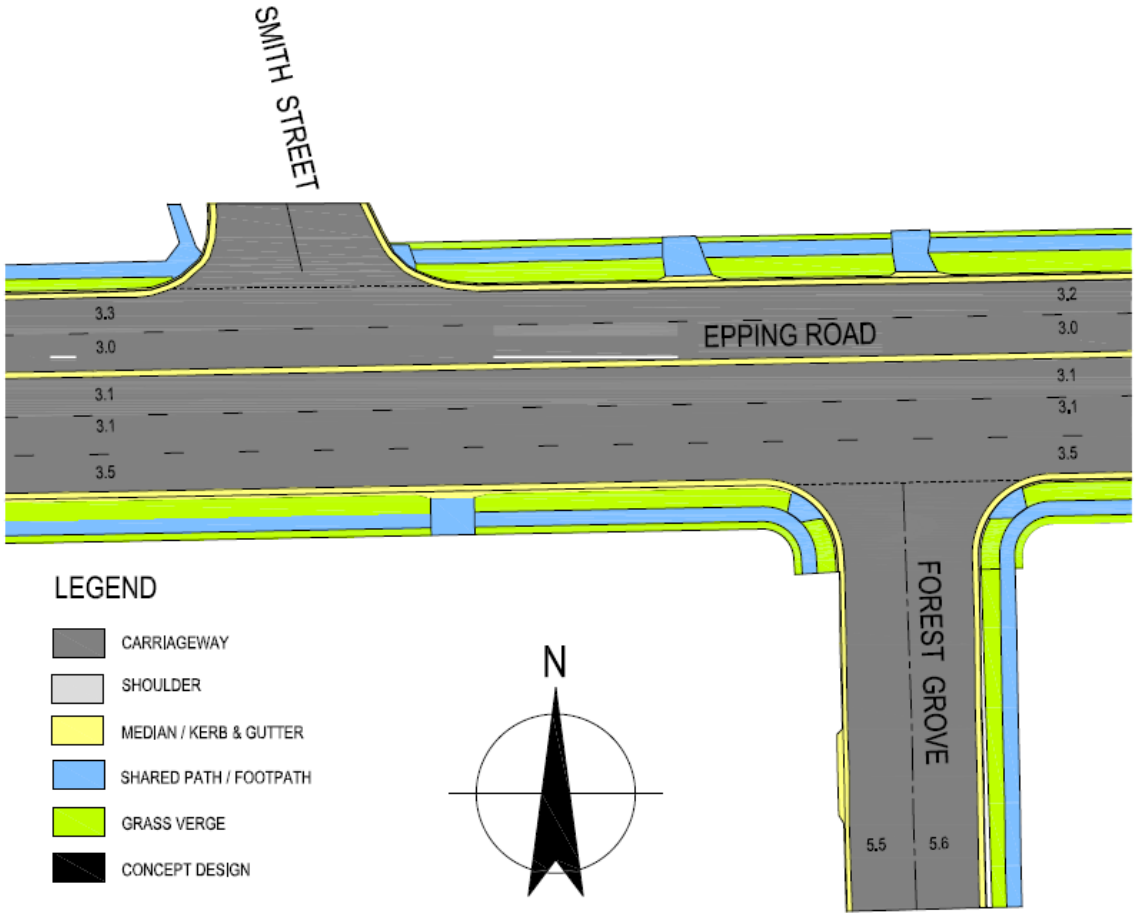


Figure 11 Smith Street and Forest Grove intersections

Essex Street intersection

The existing Epping Road/Essex Street intersection would be modified to include:

- Banning of the right turn movements from the Epping Road eastern and western approaches;
- Dual right turn from Essex Street (north) to Epping Road in the westbound direction;
- Widening on the south-western side of the intersection to provide an additional left turn lane from Essex Street onto Epping Road (westbound).
- Constructing a raised median about 20 metres long on Essex Street north of Epping Road intersection
- New signal controlled pedestrian crossings at both the Essex Street northern and southern approaches;
- Additional Epping Road westbound through lane; and

The proposed intersection arrangement is illustrated in Figure 12.

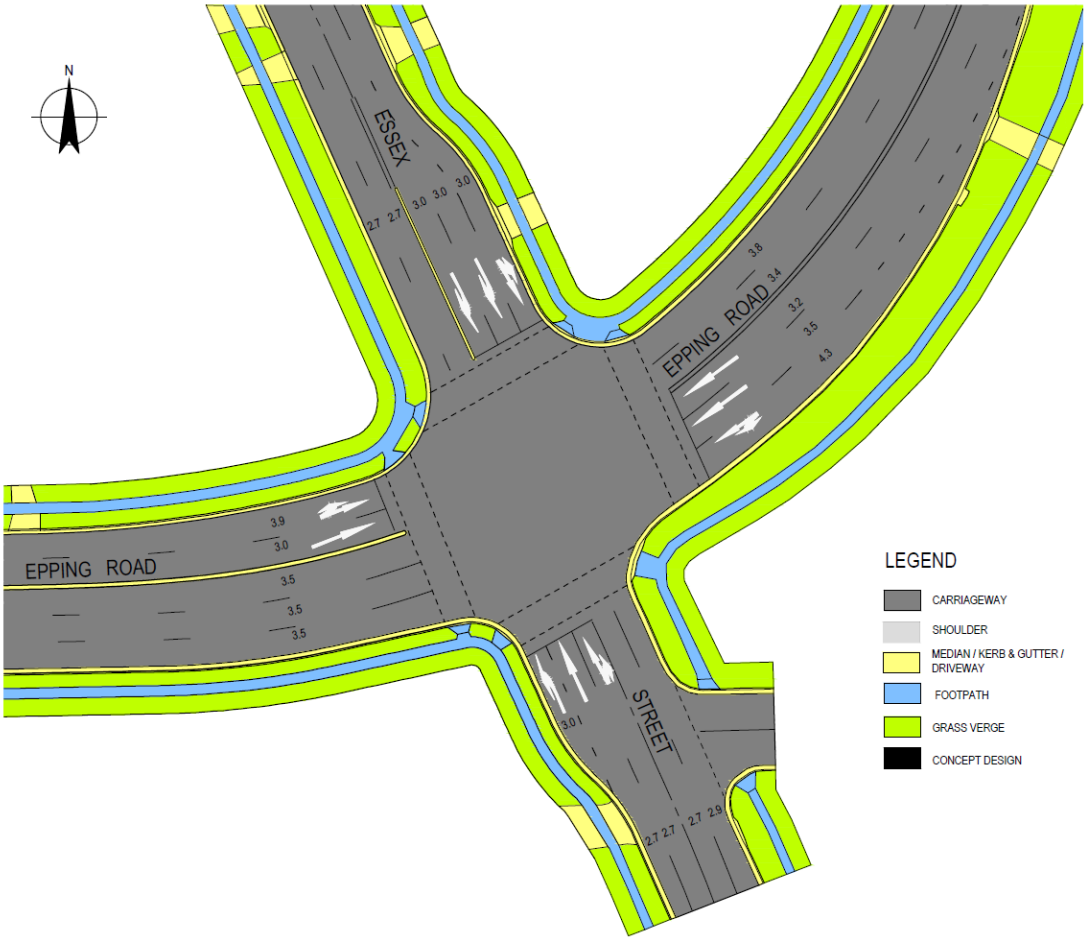


Figure 12 Essex Street intersection

4. Construction traffic impact assessment

4.1 Overview

A construction traffic impact assessment has been undertaken to obtain an understanding of the likely impacts from construction scheduling and sequencing.

4.2 Construction methodology

The proposal would involve the following general work methodology and sequencing:

- Establishment of temporary fencing;
- Installation of erosion and sediment controls;
- Establishment of construction compound sites;
- Utility relocations;
- Vegetation clearing and grubbing;
- Stripping, stockpiling and management of topsoil and unsuitable material;
- Earthworks preparation;
- Bulk earthworks;
- Construction of any retaining walls;
- Drainage work;
- Pavement and median construction;
- Sub-grade preparation and pavement work;
- Landscaping;
- Installation of permanent traffic control signals;
- Finishing work including installation of pavement marking, signposting, and street lights; and
- Removal of construction compound and site tidy up.

4.2.1 Compound locations

- **Compound A** - on part of lot 1 deposited plan (DP) 1192833 (2 Epping Road), which is occupied by an automotive garage (Tuffys Auto Centre) located on the corner of Epping Road and Blaxland Road;
- **Compound B** - at lot 5 DP 1033683 (36 Essex Street), which includes one residential property owned by Roads and Maritime located on the corner of Epping Road and Essex Street;
- **Compound C** - at lot 20 DP 10385 (38 Essex Road), which includes one residential property owned by Roads and Maritime located on the corner of Epping Road and Essex Street; and
- **Compound D** - on lot 10, 11 and 12 DP 10385 (2 and 4 Forest Grove), which includes two residential properties.

Note: the two properties in Compound D are being demolished. The property in Compound B is also being demolished. The property in Compound C is **not** being demolished.

Figure 13 Possible compound locations

4.2.2 Proposed working hours

Construction is anticipated to commence in late 2015 and would take about eight months to complete, weather permitting. Construction works are likely to be undertaken during the following working hours:

- Monday to Friday: 7 am to 6 pm
- Saturday: 8 am to 1 pm
- Sundays and public holidays: no work

To minimise disruption to daily traffic and disturbance to surrounding land owners and businesses, it would be necessary to carry out some work outside of these hours. Prior notice would be given to the community if any works are planned to be undertaken outside normal construction hours.

4.2.3 Heavy vehicle generation

Heavy vehicle traffic would mainly be generated by activities associated with the following:

- Delivery of construction materials;
- Spoil removal;
- Delivery and removal of construction equipment and machinery; and
- Movement of construction personnel, including contractors, site labour force and specialist supervisory personnel.

About 40 heavy vehicles would be required on-site per day, resulting in about 80 heavy vehicles movements in and out of the compound site per day. These heavy vehicle movements are likely

to be spread through the day, however for this assessment of the traffic impacts it has been assumed that 10 per cent, or four vehicle movements, would occur during the peak hour.

Construction vehicles would access the site via Epping Road wherever possible. However, given that this road already carries high volumes of traffic it is not anticipated that the project would have a high degree of impact above what is currently experienced, as this additional construction traffic would be within the range of daily variation in traffic on these routes.

As a part of the construction management plan it is expected that heavy vehicle traffic would be constrained, as much as possible, to the regional road network and that the impact on local roads would be minimised. Any disruption to access side streets and properties would be minimised and would only be undertaken following consultation with the community and with individual property owners affected by the works.

The movement of materials would be managed through the scheduling of deliveries and availability of fleet, and would aim to minimise the number of haulage and delivery vehicles required during peak periods and weekends.

4.2.4 Light vehicle generation

Light vehicle traffic generation would be associated with staff movements to and from the site. Staff would comprise of project managers, various trades, and general construction staff. Light vehicles used to transport staff to and from the site would be parked at the main site compound facility. For the purpose of this study, 35 light vehicles per day are assumed to be associated with the construction.

For this assessment it is assumed that 35 vehicles would arrive in the AM peak and depart in the PM peak. However, as limited parking is expected to be available at compound sites, some workers are expected to access the site using public transport.

In the instance where workers do drive to the compound site, they should be advised of parking on the eastern side of Forest Park, along Forest Grove, or along the southern section of Forest Grove. This would reduce the demand for parking on the northern section of Forest Grove, due to the possibility of displaced parking from the southern side of Epping Road during construction. A total of 25 angled parking spaces can be found east of Forest Park.

4.2.5 Construction traffic generation

A summary of the total construction traffic movements is provided in Table 4-1.

Table 4-1 Proposed construction traffic movements (one way)

Activity	AM peak (vtph)** - In	AM peak (vtph)** - Out	PM peak (vtph)** - In	PM peak (vtph)** - Out	Daily (vtpd)* - In	Daily (vtpd)* - Out
Light vehicles	35	0	0	35	35	35
Heavy vehicles	4	4	4	4	40	40
Total	4	2	4	39	75	75

Note: vtpd = vehicle trips per day
Vtph = vehicle trips per hour

4.3 Construction traffic impacts

4.3.1 Lane and footpath closures

During certain periods of the construction lifecycle, some sections of the footpath along the southern side of Epping Road are proposed to be closed for safety measures, though provisions for safe access across the construction area would be maintained during construction.

4.3.2 Parking

During the proposal construction, parking would be prohibited along the south of Epping Road during non-clearway periods. This would affect 13 vehicle parking spaces. Alternatively, affected property owners may consider parking on Forest Grove. Parking would also be required for construction site worker vehicles, which would add to the pressure on parking.

4.3.3 Public transport

Two bus routes travel through Epping Road in the vicinity of the proposal, route number 630 and M54. The westbound bus stop (bus stop ID number 212126) would need to be temporarily relocated during construction.

4.4 Construction mitigation measures

The following proposed traffic management principles would be adopted during the construction period:

- A traffic management plan would be developed and incorporated into the Construction Environmental Management Plan (CEMP).
- Property owners would be consulted in advance regarding temporary impacts to property access.
- Construction and delivery vehicles entering or leaving the site compound and/or stockpile sites would use arterial roads wherever possible. Vehicle deliveries would be restricted to nominated times within the approved Construction Traffic Management Plan (CAMP).
- Construction workers should be advised to use public transport as there are limited parking spaces at the compound site.
- Workers are to be advised on suitable alternative parking locations including parking on the eastern side of Forest Park, along Forest Grove, or on the southern section of Forest Grove.
- A detailed CAMP is developed as part of the detailed design stage.
- Provisions for safe pedestrian access across the construction site would be maintained during construction.
- The relocation of bus stops would be done in consultation with local bus service providers.
- Clear signage would be available to notify the public of relocated bus stop locations.

4.5 Summary of construction activities

Compound site A at the corner of Blaxland Road and Epping Road has been identified as the most favourable location for a compound site.

The construction stage is estimated to generate up to 40 truck movements per day during the earth moving phase. The majority of these truck movements would take place outside the peak periods, and based on a worst case scenario, about four trucks per hour would be expected in the peak hours.

It is estimated that 35 light vehicles per day would be associated with the construction. As a worst case assessment it is assumed that 35 vehicles would arrive in the AM peak and depart in the PM peak. The construction traffic is expected to have negligible impacts to the operational efficiency of the surrounding road network.

5. Operational assessment of changes to the traffic network

This section of the report provides a summary of traffic impacts following construction of the proposal.

5.1 Impacts on local roads and access

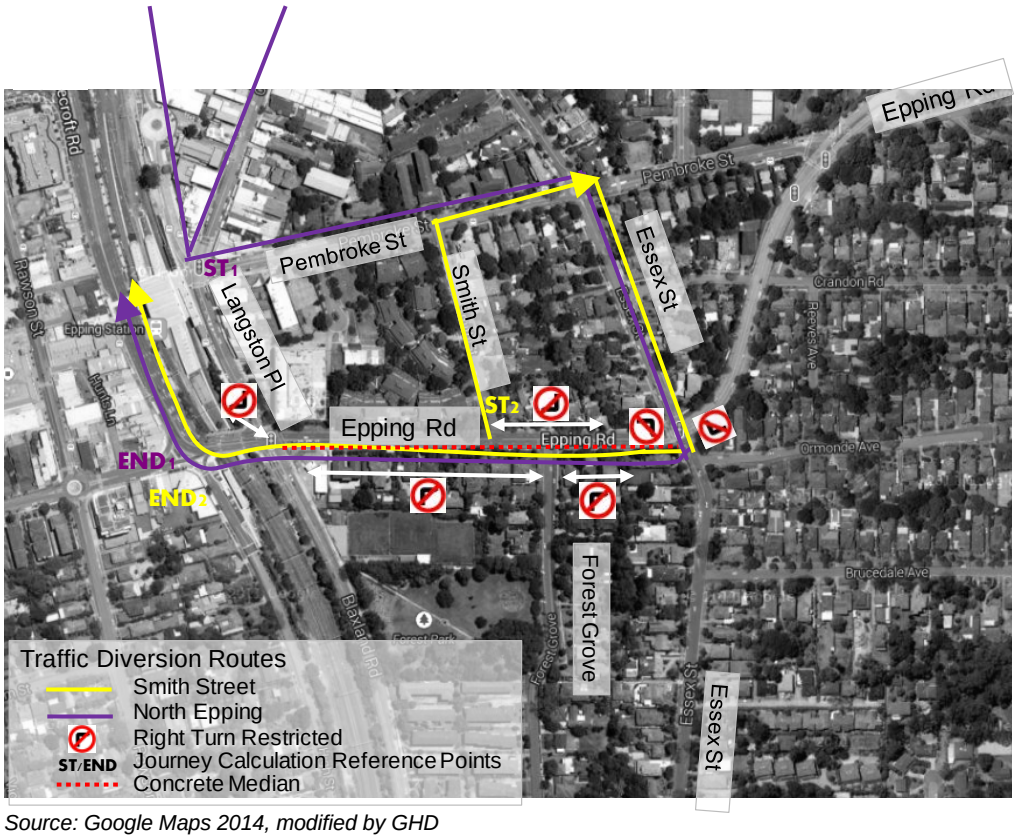
This section discusses the traffic impacts in terms of diverted traffic from the proposed upgrades resulting from the proposed right turn bans and the introduction of the central median along Epping Road between Blaxland Road and Essex Street.

Alternate routes for motorists travelling in the westbound direction from the northern side of Epping Road

With the installation of the proposed concrete median along Epping Road, indicated by the dotted red line Figure 14, it would no longer be possible to make a right turn onto Epping Road from Smith Street, Forest Grove or the properties fronting Epping Road between Langston Place and Essex Street.

Figure 14 shows the alternate route towards Beecroft Road from the properties fronting the northern site of Epping Road, via Smith Street, as indicated by the yellow lines. Properties along the northern site of Epping Road to the east of Smith Street would need to perform a U-turn at Essex Street at the roundabout with Pembroke Street in order to access Beecroft Road and areas to the west.

The purple line at Figure 14 shows the alternative route to Beecroft Road from Oxford Street, via Pembroke Street, Essex Street and Epping Road.



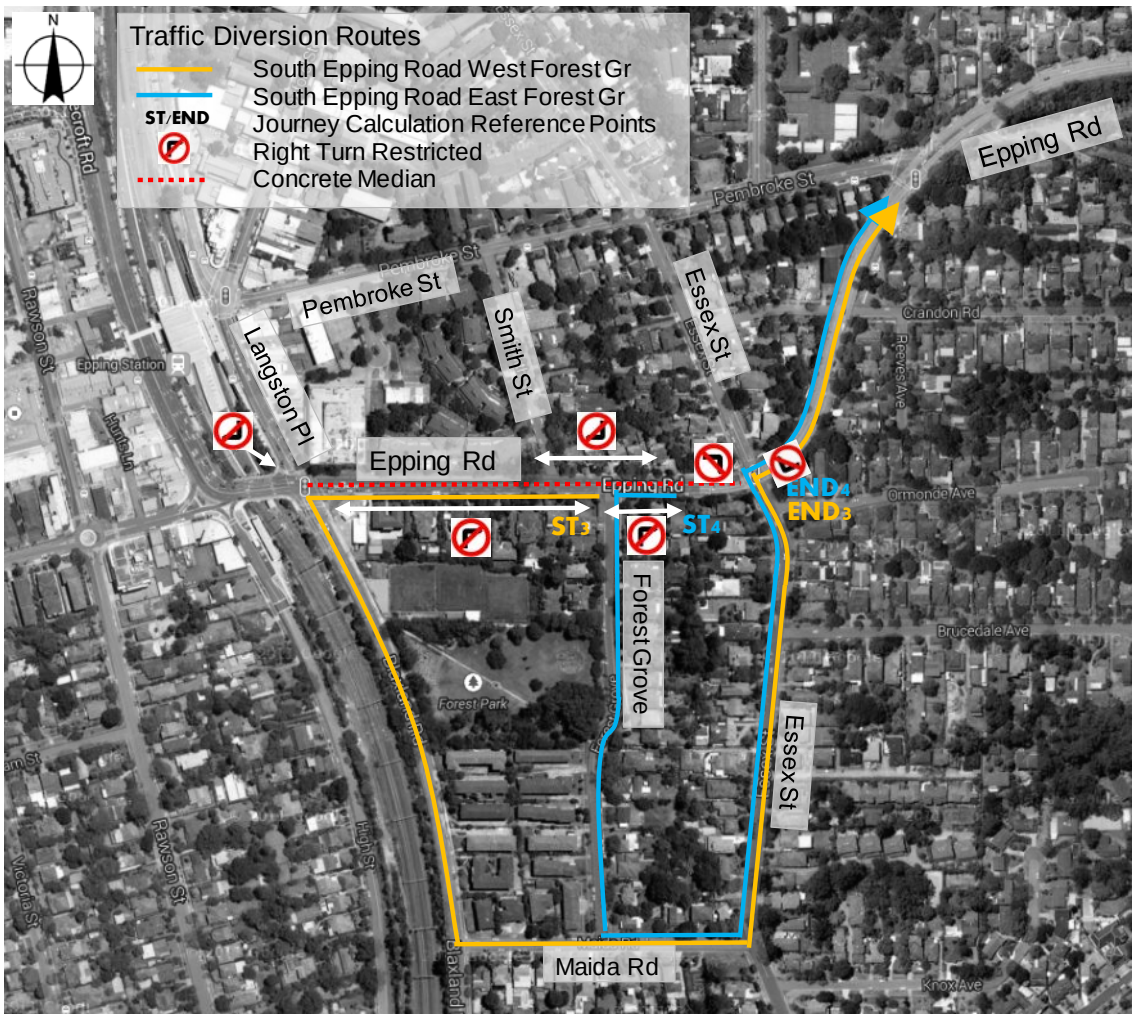
Source: Google Maps 2014, modified by GHD

Figure 14 Alternate routes to west of Epping Road – Purple and Yellow Route

Alternate routes for motorists travelling in the eastbound direction from the southern side of Epping Road

Following the installation of the proposed concrete median, drivers accessing Epping Road (east) from properties along Forest Grove and the southern side of Epping Road, between Essex Street and Forest Grove, are likely to use the route shown in Figure 15, indicated by the blue arrows.

To access Epping Road (east) from properties located along the southern side of Epping Road to the west Forest Grove drivers are likely to use the route indicated by the orange arrows shown in Figure 15.

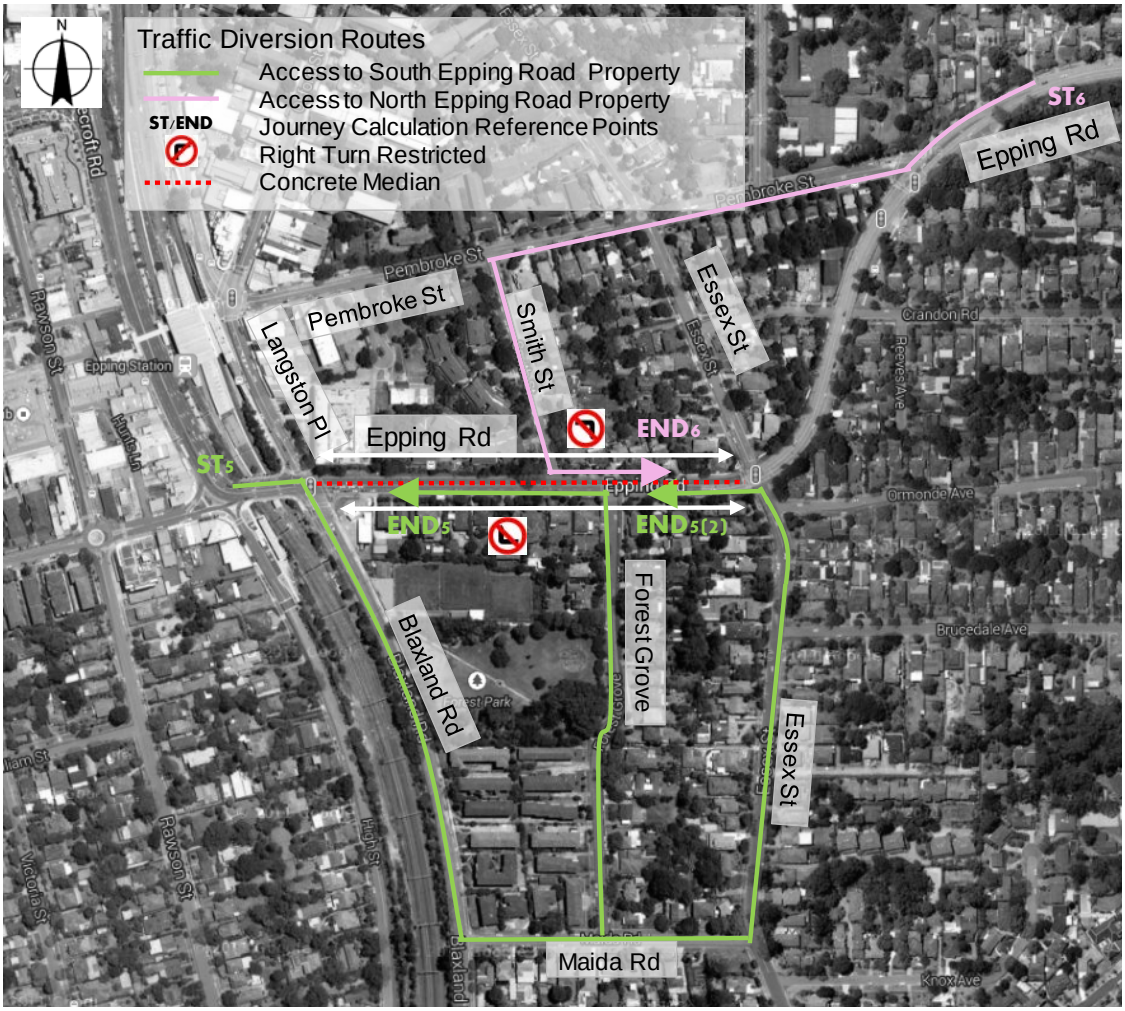


Source: Google Maps 2014, modified by GHD

Figure 15 Alternate routes to east of Epping Road – Orange and Blue Route

Access to Properties fronting Epping Road

Following the proposed introduction of the central median, vehicles would not be able to make a right turn into properties fronting Epping Road. The alternative routes to these properties are shown in Figure 16.

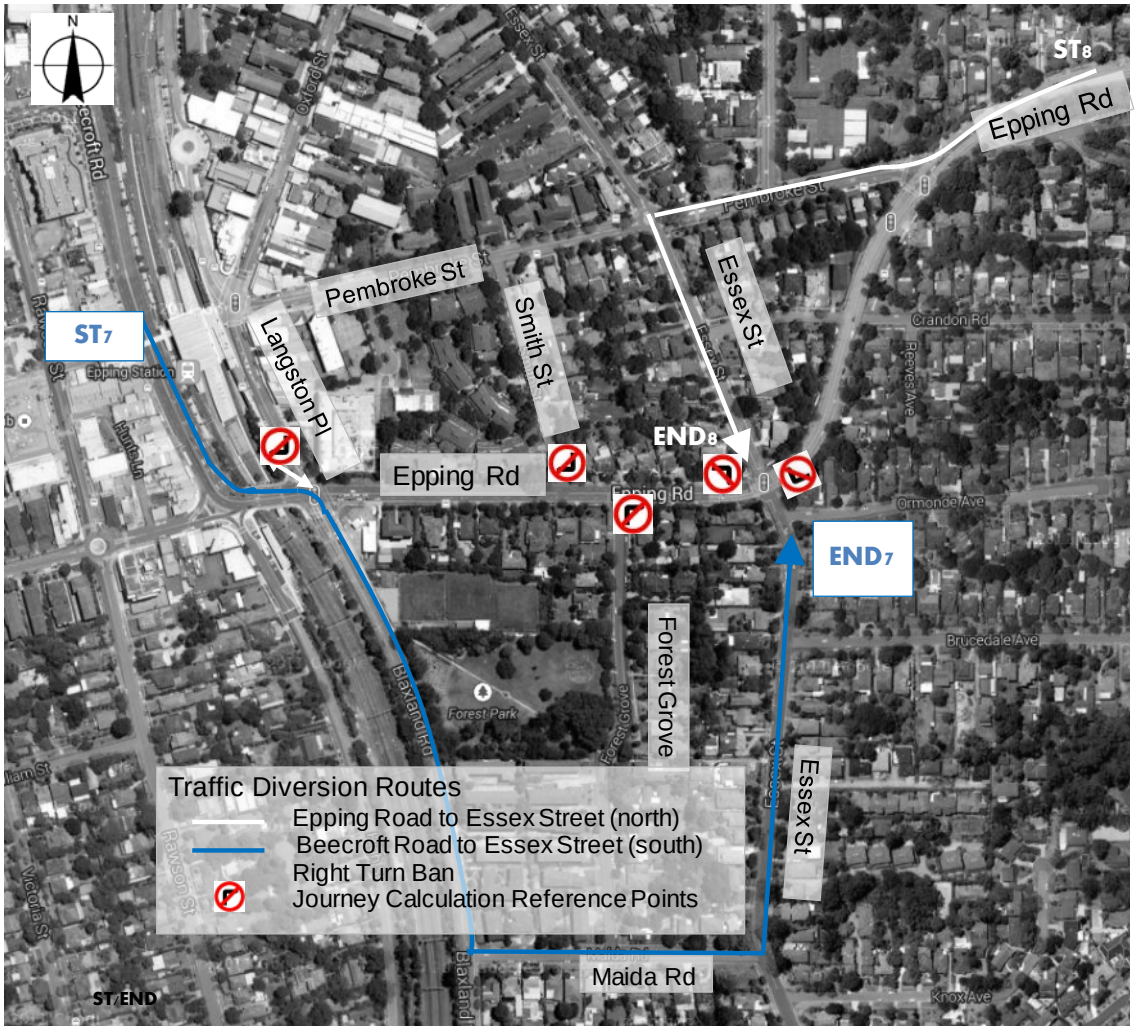


Source: Google Maps 2014, modified by GHD

Figure 16 Alternative routes to properties along Epping Road – Green and Pink Route

Access to Essex Street

The proposed road upgrade includes banning the right turn movements from Epping Road into Essex Street in both the eastern and western directions. The proposed alternative routes to Essex Street, to the north and south of Epping Road, are shown at Figure 17.



Source: Google Maps 2014, modified by GHD

Figure 17 Alternative routes to Essex Street – Navy Blue and White Route

Extra distance travelled

Journey calculation reference points indicate the starting "ST" and ending points "END", shown Figure 14 to Figure 17, at in which calculations are made for a comparison of the extra distance motorists have to travel with the traffic diversions. Current shortest routes assume that right turns can be taken in existing conditions.

Table 5-1 Extra distance travelled

Proposed route	Current shortest route (m)	Future route (m)	Extra distance (m)
Purple Route – 1	300	1,300	1,000
Yellow Route – 2	300	980	680
Orange Route – 3	150	1,300	1,150
Blue Route – 4	100	1,000	900
Green Route – 5 (Properties west of Forest Grove)	130	1,100	970

Proposed route	Current shortest route (m)	Future route (m)	Extra distance (m)
Green Route – 5(2) (Properties east of Forest Grove)	350	1,200	850
Pink Route – 6	450	850	400
Navy Blue Route – 7	820	1,200	380
White Route – 8	430	570	140

The Yellow, Orange and Blue routes are alternative routes that some vehicles would have to take following the proposed upgrade to Epping Road. However during peak hours, existing high traffic volumes along Epping Road already make it difficult for vehicles along Epping Road to negotiate a right turn manoeuvre out of properties fronting Epping Road due to an insufficient gap distance between vehicles. It is likely that some vehicles already use the alternative routes, as mentioned above, during peak hours.

Left turning traffic entering and exiting properties along Epping Road would not be impacted by the proposal.

5.2 Public transport impacts

The proposal and the associated traffic diversions do not impact existing bus routes within the study area, which would continue to operate along the same bus routes. The proposed reduction in travel times forecast from the proposal will generally help to improve bus service reliability. The expected reduction in travel times is discussed in Section 5.6.4.

5.3 Parking

Upon completion of the proposal, the 13 affected vehicle parking spaces previously discussed in Section 4.3.2, would be reinstated. No further requirements for parking spaces will be needed for construction site workers.

5.4 Pedestrian Access Study

A Pedestrian Access Study has been undertaken to assess pedestrian accessibility within the study area and forecast the pedestrian impacts from the proposal. The Pedestrian Access Study is provided within Appendix G.

The Pedestrian Access Study report should be read in its entirety, however key findings are summarised as follows:

- A review of crash data was undertaken, which found that there were five reported crashes involving pedestrians over a five year period. The majority of these crashes resulted in at least one injury, with no pedestrian fatalities recorded.
- A review of existing issues and constraints for pedestrians was undertaken in the study area. The audit focused on identifying existing facilities, land uses, any shortcomings in the pedestrian environment and potential safety issues. The key findings include:
  - Poor quality footpath surfaces;
  - Pedestrians crossing busy roads at non-permitted crossing locations;
  - Missing pedestrian links;
  - Lack of pedestrian crossings; and
  - Poor quality pedestrian crossings.

The review resulted in a list of 18 suggested improvements to be considered within the study area. The following improvements are recommended as part of the Epping Road Widening project to provide a safer pedestrian environment as a result of the increased traffic from the proposed road improvements.

Pembroke Street

There are a high number of pedestrians crossing Pembroke Street between Langston Place and Chambers Court. Due to the expected high increase in traffic in this location as part of the Epping Road Widening project, consideration should be given to installing a pedestrian refuge island on Pembroke Street close to Chambers Court.

Pembroke Street and Essex Street roundabout

With the nearby school and increased traffic from the proposal, the Pembroke Street/Essex Street roundabout has been identified as the most important issue for pedestrians that should be addressed as a priority.

The estimated future traffic volumes, with the proposal diversions, are over 500 vehicles per hour and the existing pedestrian movements across Essex Road in this location are 60 per hour in the PM peak. However, this does not meet the PV value Roads and Maritime Services require for a zebra crossing or signal controlled pedestrian crossing. The consideration to install a pedestrian refuge island on the south approach of Pembroke Street and Essex Street roundabout is recommended.

It is also recommended that the existing pedestrian refuge on Essex Street on the northern side of the roundabout be improved to be two metres wide to meet Australian Standard. This crossing location is close to the school and likely to be used by pedestrians with prams. The existing carriageway width appears that it would accommodate a wider refuge island. The proposed upgrade to the Epping Road/Essex Street intersection would also improve pedestrian access at this location, with three new signal controlled pedestrian crossings proposed to be provided at the Epping Road (east), Essex Street (north and south) approaches.

Epping Road proposed concrete median

The proposed installation of the concrete median along Epping Road between Blaxland Road and Essex Street may result in pedestrians being more likely to cross Epping Road without the use of pedestrian facilities. This is perceived from the fact that pedestrians can wait for traffic to pass, while standing on the median.

It is recommended that pedestrian movements on Epping Road be monitored post construction and pedestrian fencing considered in the median in future if the number of pedestrians crossing increases.

In conclusion, there are a significant number of pedestrian improvements within the study area and the proposed treatments identified in this report should be addressed, especially in areas where traffic is proposed to increase as a result of the proposal.

5.5 Cycle access

There is forecast to be an increase in traffic along Pembroke Street, which is a designated on-street cycle route. However, the impacts to cyclists resulting from the proposal are expected to be minimal.

5.6 Network Analysis – Paramics Modelling

5.6.1 Methodology

The operational traffic impact assessment was undertaken using microsimulation modelling utilising the Paramics software package. Paramics models of the AM and PM peak periods were developed. The process for the development of these models is described in the Epping Road Widening and Beecroft Road/Carlingford Road Intersection Upgrade Paramics Model – Calibration Report (GHD, 2015). These base models formed the basis for comparison of the performance of the proposal.

Models incorporating the proposed intersection upgrades were developed by modifying the base models. The results extracted from the models incorporating the proposed intersection upgrades were compared to base conditions to measure the performance of the proposed changes.

The 2014 calibrated and validated base year model was used as the template for developing models for the following network scenarios:

- 2014 base scenario;
- 2016 and 2026 'do nothing' scenario; and
- 2016 and 2026 'upgrade' scenario.

Roads and Maritime have also requested an additional modelling assessment of providing an additional westbound traffic lane at Epping Road to the west of the intersection with Blaxland Road. This additional lane would continue to the north along Beecroft Road to the pedestrian bridge at Epping Station. This proposal was identified in the Epping Town Centre Transport Study Outcomes Report (Halcrow 2011). The assessment was also undertaken using the Paramics microsimulation software, based on the 2026 with proposed upgrade traffic conditions.

5.6.2 Traffic growth

In order to estimate the performance of the network and the proposed intersection upgrades over time growth rates were applied to the existing traffic volumes to calculate 2016 and 2026 volumes. Forecast traffic for the 2016 and 2026 future horizon years were derived based on the following:

- Background traffic growth provided by Roads and Maritime from the Strategic Traffic Model; and
- Traffic associated with planned future development within the Epping Urban Activation Precinct (future horizon year 2026 only), provided from the Epping Town Centre Transport Study Outcomes Report (Halcrow 2011).

Background traffic growth

Background traffic growth rates for road links within the study area were provided by Roads and Maritime from the Strategic Traffic Model. Growth rates for each external entry link from the Paramics model were used to calculate forecast AM and PM peak period background traffic rates for the 2016 and 2026 future horizon years, as shown in Table 5-2.

The Strategic Traffic Model outs are provided at Appendix H.

Table 5-2 Future Year Growth Factors from Strategic Traffic Model

External Road Link	2014 to 2016 Growth Factors (2 years) AM Peak	2014 to 2016 Growth Factors (2 years) PM Peak	2014 to 2026 Growth Factors (12 years) AM Peak	2014 to 2026 Growth Factors (12 years) PM Peak
Bridge Street (west)	7%	5%	42%	27%
High Street (south)	7%	6%	41%	35%
Carlingford Road (west)	2%	3%	14%	18%
Ray Road (north)	14%	9%	86%	54%
Beecroft Road (north)	2%	2%	11%	12%
Norfolk Road (north)	3%	4%	19%	24%
Epping Road (east)	3%	3%	17%	21%
Essex Street (south)	5%	7%	29%	41%
Blaxland Road (south)	3%	4%	20%	25%

Future development traffic

The traffic volumes associated with future planned development within the Epping Urban Activation Precinct were taken from the Epping Town Centre Transport Study Outcomes Report (Halcrow 2011). A summary of the traffic generation for planned development in the Epping Urban Activation Precinct is provided in Table 5-3.

Table 5-3 Proposed development traffic generation

Land Use	Area GFA (m)	Trip Rate AM Peak	Trip Rate PM Peak	Total Trips AM Peak	Total Trips PM Peak
Residential (per unit)	900	0.29	0.29	261	261
Commercial (per 100 m^2)	0	1.1	0.5/1.1	0	0
Retail (per 100 m^2)	3,000	0.3	1.8	9	54

Source: Epping Town Centre Transport Study Outcomes Report (Halcrow 2011), page 54

The future development traffic generation was distributed into the 2026 future year origin-destination matrices in the Paramics model based on the following assumptions:

- Commercial and retail trips have been loaded evenly for model zones within the commercial core of the town centre and apportioned to all of the O/D pairs.
- Residential trips have been distributed across the entire area, excluding external links, and apportioned to all of the O/D pairs.

5.6.3 Qualitative assessment of operational network performance

Microsimulation modelling allows for a qualitative assessment of network performance to be undertaken through observing the model operation.

The Paramics modelling found that the widening of Epping Road and the upgrade of intersections along Epping Road improved traffic throughput on Epping Road, which substantially reduced queuing along Epping Road. However, this resulted in increased vehicle arrival rates on the northbound approach of the Carlingford Road/Beecroft Road intersection, leading to deterioration in performance of this intersection. As this intersection is already operating above capacity the extra traffic is expected to result in very unstable traffic conditions with congestion affecting upstream intersections along Epping Road.

5.6.4 Operational traffic modelling results

To determine the effectiveness of the proposed Epping Road widening, two measures were used:

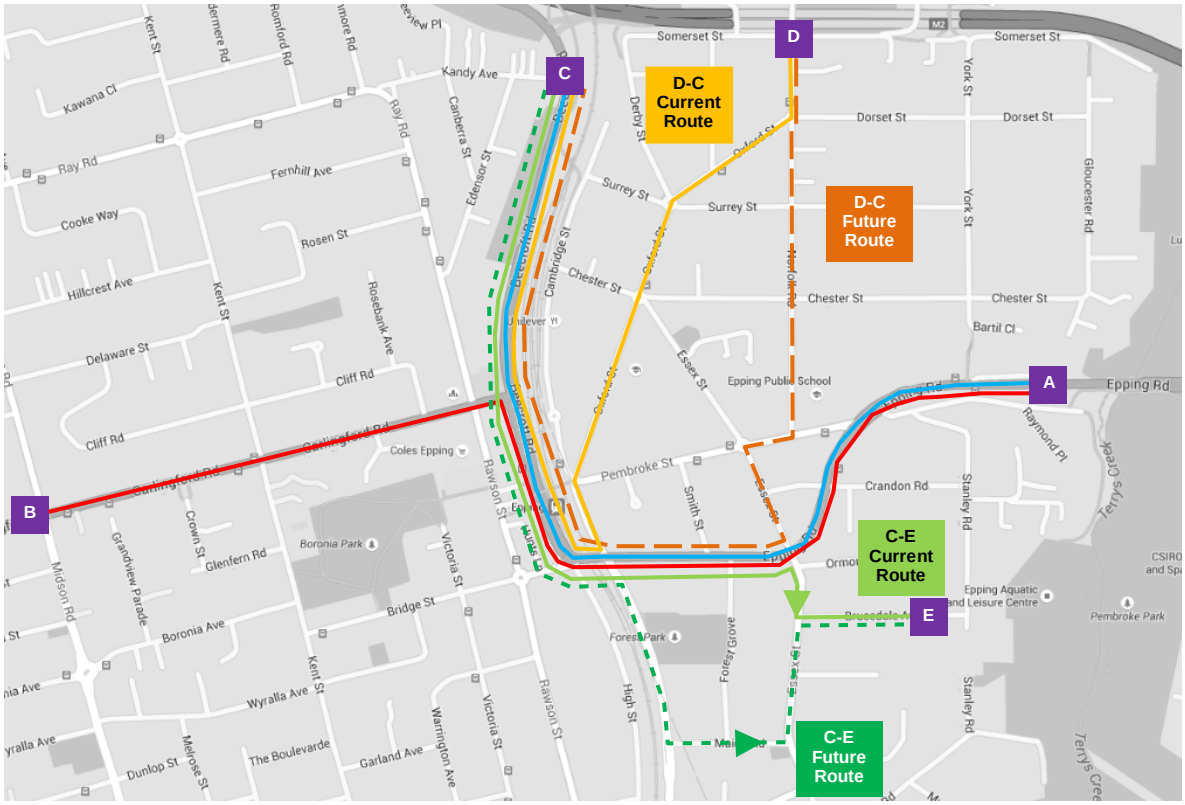
1. Travel Times through key routes; and
2. Network Vehicle Hours Travelled (VHT).

Travel Times

Routes through the study area were assessed to determine the effect of the intersection upgrades. These indicative routes are shown in Figure 18, including

- **Route A-B** Epping Road (east) to Carlingford Road;
- **Route B-A** Carlingford Road Epping Road (east);
- **Route A-C** Epping Road (east) to Beecroft Road;
- **Route C-A** Beecroft Road to Epping Road (east);
- **Route D-C** Norfolk Road to Beecroft Road (existing and future routes following the proposed turn ban from Langston Place to Epping Road);
- **Route C-D** Beecroft Road to Norfolk Road; and
- **Route C-E** Beecroft Road to Brucedale Avenue (existing and future routes following the proposed turn ban from Epping Road to Essex Street).

It should be noted that the Paramics model may choose alternative routes between the zones shown in Figure 18.



Source: Google Maps, modified by GHD

Figure 18 Travel Time Routes

It is noted that comparisons of travel times within a signalised network can be relatively difficult to undertake. This is due to variations in traffic signal timings benefiting different legs of an intersection within different models.

Additionally traffic signal changes may be warranted in the model to reflect future traffic volumes. This can potentially improve one route through the network, at the expense of another, in order to get overall network gains.

Finally, Paramics is a microsimulation modelling package, and as such is stochastic in nature. Therefore the program will automatically vary vehicle volumes across different models by approximately +/- 3% to simulate day to day traffic variations. Therefore if two results differ by only a minor amount they are considered to be an equivalent result for the basis of comparison.

A summary of the travel times for the routes between the zones shown in Figure 18 is provided in Table 5-4 and Table 5-5 for the AM and PM peak hours respectively.

AM peak hour

Table 5-4 indicates that the proposed upgrade will generally result in a reduction in travel times for routes during the AM peak, with the exception of:

- Carlingford Road to Epping Road (east) in 2016 and 2026; and
- Norfolk Road to Beecroft Road in 2016.

The forecast increases in travel times are considered marginal and are due to additional time being allocated to the Beecroft Road northbound and southbound movements at the intersection with Carlingford Road.

The proposal is expected to generally result in a reduction in travel times for other movements within the study area during the AM peak hour; with significant travel time savings for the following movements:

- Beecroft Road to Epping Road (east);
- Beecroft Road to Norfolk Road; and
- Beecroft Road to Brucedale Avenue.

Table 5-4 Forecast travel times – AM Peak

From	To	Route	2016 (h/min/sec) Do Min	2016 (h/min/sec) Upgrade	2026 (h/min/sec) Do Min	2026 (h/min/sec) Upgrade
A	B	Epping Road (east) to Carlingford Road	0:05:01	0:04:19	0:07:19	0:05:50
B	A	Carlingford Road to Epping Road (east)	0:27:45	0:28:34	0:33:08	0:34:19
A	C	Epping Road (east) to Beecroft Road	0:05:09	0:04:32	0:07:40	0:06:09
C	A	Beecroft Road to Epping Road (east)	0:29:26	0:17:37	0:31:28	0:22:03
D	C	Norfolk Road to Beecroft Road	0:05:34	0:05:45	0:08:31	0:07:10
C	D	Beecroft Road to Norfolk Road	0:27:05	0:17:05	0:31:48	0:21:13
C	E	Beecroft Road to Brucedale Avenue	0:26:02	0:18:50	0:34:09	0:22:54

PM peak hour

Table 5-5 indicates that the proposed upgrade will result in increased travel times for the following routes during the PM peak:

- Norfolk Road to Beecroft Road in 2016; and
- Beecroft Road to Brucedale Avenue in 2016.

The forecast increases in travel times are considered marginal and are due to additional time being allocated to the Beecroft Road northbound and southbound movements at the intersection with Carlingford Road and also additional green time allocated to the Essex Street (north) approach to the intersection with Epping Road.

The proposal generally results in a reduction in travel times for other key movements within the study area during the PM peak hour, with significant travel time savings for the following movements:

- Carlingford Road to Epping Road (east) - around seven minutes reduction in travel time in 2026, compared to the 'Do Nothing' results.

Table 5-5 Forecast travel times – PM Peak

From	To	Route	2016 (h/min/sec) Do Min	2016 (h/min/sec) Upgrade	2026 (h/min/sec) Do Min	2026 (h/min/sec) Upgrade
A	B	Epping Road (east) to Carlingford Road	0:15:49	0:12:46	0:26:42	0:24:26
B	A	Carlingford Road to Epping Road (east)	0:12:50	0:10:51	0:29:56	0:22:38
A	C	Epping Road (east) to Beecroft Road	0:14:51	0:12:00	0:25:41	0:24:00
C	A	Beecroft Road to Epping Road (east)	0:05:12	0:04:18	0:06:54	0:04:19
D	C	Norfolk Road to Beecroft Road	0:05:21	0:05:53	0:06:42	0:06:03
C	D	Beecroft Road to Norfolk Road	0:04:14	0:03:53	0:05:43	0:03:54
C	E	Beecroft Road to Brucedale Avenue	0:04:57	0:05:00	0:06:52	0:04:53

5.6.5 Vehicle Hours Travelled

A network wide measure of performance is the change in VHT. A decrease in VHT implies network wide benefits of an upgrade, whereas an increase in VHT implies an overall reduction in network wide performance.

The VHT results shown at Table 5-6 indicate that across the network, the proposed upgrade provides the following:

- In 2016, a 13 percent improvement in VHT during the AM and PM peak.
- In 2026, a nine percent improvement in VHT during the AM peak and 15 percent improvement during the PM peak.

Table 5-6 Vehicle Hours Travelled Comparison (peak 2 hours)

Model Year	AM Peak Do Nothing	AM Peak Upgrade Scenario	AM Peak % Improvement in VHT	PM Peak No Nothing	PM Peak Upgrade Scenario	PM Peak % Improvement in VHT
2016	1,402	1,245	**13%**	819	722	**13%**
2026	1,844	1,691	**9%**	1,537	1,335	**15%**

5.6.6 Additional westbound traffic lane at Epping Bridge

Roads and Maritime have requested that an assessment is undertaken of providing an additional westbound traffic lane at Epping Road to the west of the intersection with Blaxland Road and Langston Place. This additional lane between the rail bridge and the pedestrian bridge at Epping Station was identified in the Epping Town Centre Transport Study Outcomes Report (Halcrow 2011).

This assessment has been undertaken using the Paramics microsimulation software for the 2026 with proposed upgrade scenario. For this assessment, it has been assumed that this additional traffic lane would provide three traffic lanes along Epping Road in a westbound direction and also provide three northbound traffic lanes along Beecroft Road.

Travel times

The forecast travel times in 2026 for the proposed upgrade scenario with additional traffic lanes at Epping Bridge and northbound along Beecroft Road are shown in Table 5-7 for the AM and PM peak periods.

Table 5-7 indicates that the proposed upgrade with the additional westbound traffic lane at Epping bridge will result in increased travel times for the following route when compared to the 'do nothing' scenario:

- Carlingford Road to Epping Road (east) – AM peak in 2016 and 2026; and
- Norfolk Road to Beecroft Road – AM and PM peak in 2016.

This small increase in travel times is due to additional time being allocated to the Beecroft Road northbound and southbound at the intersection with Carlingford Road.

The proposed upgrade, with the additional westbound traffic lane at the Epping Road bridge, is generally expected to result in lower travel times for other routes within the study area, with significant travel time savings for the following movements:

- Beecroft Road to Epping Road (east) during the AM peak; and
- Beecroft Road to Norfolk during the AM peak.

Table 5-7 Travel Times with additional westbound lane at Epping Bridge – AM and PM Peak

From	To	Route	2016 (h/min/sec) AM	2016 (h/min/sec) PM	2026 (h/min/sec) AM	2026 (h/min/sec) PM
A	B	Epping Road (east) to Carlingford Road	0:04:28	0:11:43	0:05:56	0:21:14
B	A	Carlingford Road to Epping Road (east)	0:27:55	0:09:22	0:34:19	0:24:04
A	C	Epping Road (east) to Beecroft Road	0:04:39	0:10:55	0:06:13	0:20:23
C	A	Beecroft Road to Epping Road (east)	0:18:38	0:03:59	0:21:14	0:04:43
D	C	Norfolk Road to Beecroft Road	0:06:02	0:06:06	0:07:45	0:06:23
C	D	Beecroft Road to Norfolk Road	0:18:14	0:03:29	0:20:46	0:04:13
C	E	Beecroft Road to Brucedale Avenue	0:17:50	0:04:44	0:21:28	0:05:51

Vehicle Hours Travelled

The forecast performance in VHT from the Paramics model for the 2026 proposed upgrade scenario, with additional traffic lanes at Epping Bridge and northbound along Beecroft Road is shown in Table 5-8. The VHT results indicate that with the additional lane, the proposed upgrade provides the following:

- In 2016, a 12 percent improvement in VHT during the AM and 15 percent improvement during the PM peak compared to the 'do nothing' scenario.
- In 2026, a nine percent improvement in VHT during the AM and two percent improvement during the PM peak compared to the 'do nothing' scenario.

Table 5-8 Vehicle Hours Travelled with additional westbound lane at Epping Bridge

Model Year	AM Peak Do Nothing	AM Peak Upgrade + Bridge Widening	AM Peak % Improvement in VHT	PM Peak No Nothing	PM Peak Upgrade + Bridge Widening	PM Peak % Improvement in VHT
2016	1,402	1,254	12%	819	712	15%
2026	1,844	1,689	9%	1,537	1,502	2%

5.6.7 Increase in throughput traffic

In congested traffic networks, such as within the Epping study area, the peak hour vehicle demands may not match the number of vehicles that are able to complete their origin to destination journey due to congestion. To understand the effectiveness of the proposed upgrade options, a comparison of the number of vehicles which completed journeys between zones within the Paramics model has been assessed. This comparison of modelled traffic flow is shown in Table 5-9 and Table 5-10 for the AM and PM peak hours respectively. The comparison is based on the additional number of vehicles that were able to complete journeys within the model for the 'upgrade' and 'upgrade with bridge widening' scenarios compared to the 'do nothing scenario'.

AM peak hour

Although the proposal would provide an additional westbound traffic lane, as the dominant traffic direction and during the AM peak is in the eastbound direction (i.e. towards Sydney). As shown in Table 5-9, the Paramics model indicates that the proposal would allow more traffic to travel between Beecroft Road and Epping Road (east) during the AM peak hour.

Table 5-9 Forecast increase in throughput traffic volumes – AM peak

From	To	Route	2016 (vehicles) Do Nothing	2016 (vehicles) Upgrade	2016 (vehicles) Upgrade + Bridge Widening	2026 (vehicles) Do Nothing	2026 (vehicles) Upgrade	2026 (vehicles) + Bridge Widening
A	B	Epping Road (east) to Carlingford Road	210	-5	-3	208	0	+12
B	A	Carlingford Road to Epping Road (east)	503	-30	-5	398	-47	-20
A	C	Epping Road (east) to Beecroft Road	215	+5	+13	223	+4	+8
C	A	Beecroft Road to Epping Road (east)	307	+298	+276	261	+311	+303
D	C	Norfolk Road to Beecroft Road	23	+1	+2	25	-1	-2
C	D	Beecroft Road to Norfolk Road	17	+18	+13	15	+15	+19
C	E	Beecroft Road to Brucedale Avenue	3	+2	+3	2	+4	+5

PM peak hour

As shown in Table 5-10, the Paramics model indicates that the proposal would generally allow more traffic to travel in both the eastbound and westbound direction along Epping Road during the PM peak. The additional westbound traffic lane at the Epping Road bridge would further increase capacity and allow additional traffic to pass through the network, particularly in 2026.

Table 5-10 Forecast increase in throughput traffic volumes – PM peak

From	To	Route	2016 (vehicles) Do Nothing	2016 (vehicles) Upgrade	2016 (vehicles) + Bridge Widening	2026 (vehicles) Do Nothing	2026 (vehicles) Upgrade	2026 (vehicles) + Bridge Widening
A	B	Epping Road (east) to Carlingford Road	417	+41	+55	254	+87	+145
B	A	Carlingford Road to Epping Road (east)	183	+4	+15	106	+41	**+36**
A	C	Epping Road (east) to Beecroft Road	502	+38	+76	330	+74	**+163**
C	A	Beecroft Road to Epping Road (east)	383	-6	-11	387	+16	+15
D	C	Norfolk Road to Beecroft Road	21	+1	+3	24	+4	+4
C	D	Beecroft Road to Norfolk Road	83	+8	+11	96	+1	+3
C	E	Beecroft Road to Brucedale Avenue	11	-3	-4	10	+4	-1

5.7 Intersection Analysis - SIDRA modelling

5.7.1 Methodology

SIDRA 6.1 was used in the analysis of the intersection performances. Since the intersections located in the study area are closely spaced together a network function was used to anticipate for queue lengths caused by downstream traffic on Epping Road.

The network function works by reducing the capacity of the lane, creating more realistic queue lengths to the existing scenario.

Existing signal phase timings were calibrated to match current behaviour of the signals during peak hours.

5.8 Future intersection performance

Epping Road carries about 2,000 vehicles in the eastbound direction during the AM peak hour and about 2,000 vehicles in the westbound direction during the PM peak hour. Long queues, congestion and delays are experienced by motorists.

SIDRA 6.1 analysis was carried out to analyse the impacts of widening Epping Road from two lanes to three lanes in the westbound direction between Essex Street and Blaxland Road.

As a result of this widening, right turns from Langston place, Smith Street, and Forest Grove into Epping Road were assumed to be banned, with both of the right turns from Epping Road into Essex Street also banned. SIDRA network models were developed to understand the full impacts of queues to adjacent intersections associated with the proposed right turn bans and traffic diversions discussed in Section 5.1.

The expected completion of the works is estimated to be finished in the year 2016. To gain an understanding of the future road network performance, a horizon year of 2026 was considered in the analysis.

SIDRA 6.1 analysis was undertaken based on future forecast traffic demands from the Paramics model as discussed in Section 5.6. The SIDRA analysis was undertaken for the weekday AM and PM peak hours only, as no future year traffic growth data was available for the weekend peak. However, it is acknowledged that the weekday AM and PM peak periods generally experience higher traffic demand and longer queue lengths within the study area than during weekend peaks.

A summary of the SIDRA intersection assessment results is provided in the following sections, with detailed SIDRA outputs provided at Appendix D.

5.8.1 2016 Network performance, 'do nothing'

A summary of the 2016 'do nothing' SIDRA intersection assessment results is shown in Table 5-11.

Table 5-11 SIDRA results – 2016 'do nothing'

Intersection	AM Peak Ave Delay (s)	AM Peak LoS	PM Peak Ave Delay (s)	PM Peak LoS
Langston Place/Epping Road	**134**	**F**	50	D
Smith Street/Epping Road	**>140**	**F**	**>140**	**F**
Forest Grove/Epping Road	**>140**	**F**	**>140**	**F**
Essex Street/Epping Road	39	C	23	B
Oxford Street/Pembroke Street	13	A	11	A
Pembroke Street/Essex Street	10	A	11	A
Network Summary	**81**	**F**	24	D
Total Control Delay	358 veh-h/h	358 veh-h/h	100 veh-h/h	100 veh-h/h

**Note: when delays are in excess of 140s, delays are increased exponentially in the SIDRA model. SIDRA is not able to accurately model gaps created by upstream and downstream signals and vehicles drivers allowing traffic to turn in congested locations.*

With the applied traffic growth rates, it is predicted that the Langston Place/Epping Road intersection would function at LoS F during the AM peak in 2016, which is worse compared to the LoS C for this intersection in the 2014 base scenario.

During the PM peak, the LoS for the Langston Place/Epping Road intersection is expected to remain to LoS D in 2016 compared the 2014 scenario.

The overall network performance drops to LoS F during the AM peak, and remains at LoS D during the PM peak. The existing road layout and network is therefore unable to accommodate the increase in traffic in 2016.

The overall network average delay increases by 53 seconds in the AM, decreases by 7 seconds in the PM. This decrease in delays during the PM peak is associated with the change in signal phase timings at the Epping Road/Essex Street intersection.

5.8.2 2016 Network performance, upgrade completion

A summary of the 2016 post completion SIDRA intersection assessment results is shown in Table 5-12.

Table 5-12 SIDRA results – 2016 post completion

Intersection	AM Peak Ave Delay (s)	AM Peak LoS	PM Peak Ave Delay (s)	PM Peak LoS
Langston Place/Epping Road	27	B	**79**	**F**
Smith Street/Epping Road	40	C	7	A
Forest Grove/Epping Road	6	A	10	A
Essex Street/Epping Road	**66**	**E**	26	B
Oxford Street/Pembroke Street	20	B	13	A
Pembroke Street/Essex Street	10	A	11	A
Network Summary	**23**	**E**	**30**	**E**

Intersection	AM Peak Ave Delay (s)	AM Peak LoS	PM Peak Ave Delay (s)	PM Peak LoS
Total Control Delay	112 veh-h/h	112 veh-h/h	128 veh-h/h	128 veh-h/h

The proposed intersection upgrades and the widening of Epping Road is generally expected to improve the network LoS during the AM peak from LoS F in the do 2016 nothing scenario to LoS E in 2016 post completion scenario, with a reduction of average delays of 58 seconds.

During the PM peak, the proposed upgrade is expected to increase the total average delays slightly by 6 seconds. This decrease in delays during the PM peak is associated with the change in signal phase timings at the Epping Road/Essex Street intersection and the redistribution of traffic from the proposed right turn bans.

Langston Place/Epping Road intersection

An improvement in the LoS at the Langston Place/Epping Road intersection is expected during the AM peak following the upgrades with a LoS B, compared to LoS F in the 2016 'do nothing' scenario. This is a result of banning the right turn from Langston Place into Epping Road, allowing additional green time for other approaches.

However, during the PM peak the proposed upgrade is expected to result in increased delays for the Langston Place/Epping Road intersection which is expected to operate at LoS F, compared to LoS D during the 2016 'do nothing' scenario.

Smith Street, Forest Grove/Epping Road intersection

With the construction of the median along Epping Road right turn movements from the Smith Street/Epping Road and Forest Grove/Epping Road intersections will be restricted. With the proposed upgrade, both intersections are expected to operate at satisfactory LoS, which is an improvement compared to the 2016 'do nothing' scenario which operates at an unrealistic LoS F.

Essex Street/Epping Road intersection

The banning of the right turn results in traffic from Langston Place being diverted into Essex Street/Epping Road. This increases the right turning traffic from the north approach of Essex Street onto Epping Road.

As a comparison with the 2026 'do nothing' scenario, the LoS at Essex Street/Epping Road decreases from LoS B to LoS E in the AM peak. However, the proposal is expected to result in the intersection operating at LoS B during the PM peak, with little change in average delay compared to the 'do nothing' scenario.

Oxford Street/Pembroke Street intersection

The intersection is predicted to experience a slight increase in the average delay during the AM and PM peak periods, due to the diverted traffic from Langston Place. However, the intersection is expected to operate satisfactory at LoS A or LoS B.

Pembroke Street/Essex Street intersection

The intersection is predicted to experience a slight increase in the average delay during the AM peak, due to the diverted traffic from Langston Place. However, the intersection is still expected operate at a satisfactory performance, at LoS A during both the AM and PM peaks.

5.8.3 2026 Network performance, 'do nothing'

A summary of the 2026 'do nothing' SIDRA intersection assessment results is shown in Table 5-13.

Table 5-13 SIDRA results – 2026 'do nothing'

Intersection	AM Peak Ave Delay (s)	AM Peak LoS	PM Peak Ave Delay (s)	PM Peak LoS
Langston Place/Epping Road	>140	F	132	F
Smith Street/Epping Road	>140	F	>140	F
Forest Grove/Epping Road	>140	F	>140	F
Essex Street/Epping Road	45	E	36	C
Oxford Street/Pembroke Street	16	B	12	A
Pembroke Street/Essex Street	10	A	11	A
Network Summary	163	F	75	F
Total Control Delay	827 veh-h/h	827 veh-h/h	367 veh-h/h	367 veh-h/h

**Note: when delays are in excess of 140s, delays are increased exponentially in the SIDRA model. SIDRA is not able to accurately model gaps created by upstream and downstream signals and vehicles drivers allowing traffic to turn in congested locations.*

With the applied traffic growth rates, it is predicted that the Langston Place/Epping Road intersection is expected to operate at LoS F during both the AM peak and PM peak periods.

The overall network performance is expected to drop to LoS F both the AM peak and PM peak periods under 2026 'do nothing' traffic conditions. The existing road layout and network is therefore unable to accommodate the increase in traffic in 2026.

5.8.4 2026 Network performance, upgrade completion

A summary of the 2026 post completion SIDRA intersection assessment results is shown in Table 5-14.

Table 5-14 SIDRA results – 2026 post completion

Intersection	AM Peak Ave Delay (s)	AM Peak LoS	PM Peak Ave Delay (s)	PM Peak LoS
Langston Place/Epping Road	142	F	144	F
Smith Street/Epping Road	50	D	7	A
Forest Grove/Epping Road	2	A	12	A
Essex Street/Epping Road	105	F	25	B
Oxford Street/Pembroke Street	11	A	14	A
Pembroke Street/Essex Street	32	C	12	A
Network Summary	67	F	49	E
Total Control Delay	373 veh-h/h	373 veh-h/h	241 veh-h/h	241 veh-h/h

With the proposed upgrades, the overall network performance improves from a LoS F during the PM peak to a LoS E, compared to the 2026 'do nothing' scenario. The network is expected to operate at LoS F during the AM peak with the proposed upgrade in 2026. An overall reduction in average delays of 95 seconds is expected during the AM peak, with a reduction of 26 expected in the PM peak compared to the 2026 'do nothing' scenario.

Langston Place/Epping Road intersection

Langston Place/Epping Road intersection is predicted to operate at LoS F during both the AM and PM peak periods following the proposed upgrade. However, during the AM peak the average delay at the intersection is expected to reduce significantly.

A slight increase in average delay at this intersection is expected during the PM peak, which is associated with the proposed traffic diversions from the proposed turn bans and a change in signal phase timings.

Smith Street, Forest Grove/Epping Road intersection

With the construction of the median along Epping Road right turn movements from the Smith Street/Epping Road and Forest Grove/Epping Road intersections will be restricted. With the proposed upgrade, both intersections are expected to operate at satisfactory LoS, which is an improvement compared to the 2026 'do nothing' scenario which operates at an unrealistic LoS F.

Essex Street/Epping Road intersection

The proposed banning of the right turn from Langston Place results in some traffic being diverted into Essex Street/Epping Road. This increases the right turning traffic from the north approach of Essex Street onto Epping Road.

As a comparison with the 2026 'do nothing' scenario, the LoS at Essex Street/Epping Road decreases from LoS E to LoS F in the AM peak. However, the proposal is expected to result in an improved operation during the PM peak, with the intersection expected to operate at LoS B, compared to LoS C in the 2026 'do nothing' scenario.

Oxford Street/Pembroke Street intersection

The intersection is predicted to experience minimal changes in the average delay, due to the diverted traffic from Langston Place. The intersection is expected to perform at a satisfactory level following the proposed upgrade in 2026.

Pembroke Street/Essex Street intersection

The LoS changes from a LoS A to a LoS C when compared to the 2026 'do nothing' Scenario in the AM peak. The intersection is expected to perform at a satisfactory level with spare capacity during both peak periods in 20 26.

5.8.5 Forecast changes in mid-block traffic volumes

The proposed right turn bans along Epping Road would result in motorists taking alternate routes, as indicated in Section 5.1. This would result in an increase in traffic along at the Essex Street, Norfolk Road and Epping Road. The proposal is also expected to reduce traffic demand along Langston Place as vehicles travelling to Epping Road (west) from North Epping would be required to travel via Norfolk Road and Essex Street before turning right into Epping Road.

A summary of the expected increase in traffic volumes during the weekday AM and PM peak hours is shown in Table 5-15 and Table 5-16 for 2016 and 2026 respectively. A percentage increase in traffic of five percent or more is shown in red text. These flows are based on the predicted future year Paramics peak hour modelled traffic demands (full demands) and are therefore not comparable to the 2014 surveyed traffic volumes shown at Table 2-4.

With reference to Table 5-15, the following links are forecast to experience a percentage increase of five percent or more in two-way traffic movement following the proposed upgrade in 2016:

- Epping Road between Langton Place and Essex Street with an increase of up to 10 percent
- Pembroke Street between Smith Street and Essex Street, with an increase of up to 14 percent.
- Norfolk Road, with an increase of up to 20 percent. This is associated with the vehicles accessing Epping Road (west) from North Epping being diverted via Essex Street following the proposed right turn ban into Epping Road from Langston place. The low traffic volumes on Norfolk Road in the 'do nothing" scenario result in a high percentage increase.
- Blaxland Road, with an increase of up to eight percent in the PM peak.
- Chester Street, with an increase of up to 13 percent in the PM peak. The low traffic volumes on Chester Street in the 'do nothing" scenario result in a high percentage increase.
- Essex Street north of Epping Road, with an increase of up to 78 percent during the AM peak and up to 59 percent in the PM peak. The low traffic volumes on Essex Street in the 'do nothing" scenario result in a high percentage increase.
- Maida Road, with an increase of up to 121 percent. The low traffic volumes on Maida Road in the 'do nothing" scenario result in a high percentage increase.

A number of roads would experience a reduction in two-way traffic volumes in 2016, including:

- Cambridge Street;
- Langston Place;
- Oxford Street;
- Chester Street during the AM peak;
- Smith Street and Forest Grove; and
- Essex Street, south of Epping Road.

Table 5-15 Forecast changes in two-way traffic volumes – 2016

Road Link	Do Nothing Traffic (vph) AM Peak	Do Nothing Traffic (vph) PM Peak	With Development Traffic (vph) AM Peak	With Development Traffic (vph) PM Peak	% Increase AM Peak	% Increase PM Peak
Epping Road, east of Beecroft Road	5064	4308	5032	4402	-1%	2%
Epping Road, east of Langston Place	3356	2986	3682	3138	10%	5%
Epping Road, east of Smith Street	3330	2986	3640	3144	9%	5%
Epping Road, east of Forest Grove	3316	2756	3650	3034	10%	10%
Epping Road, east of Essex Road	3184	2604	3288	2710	3%	4%
Epping Road, north of Crandon Road	3152	2612	3194	2688	1%	3%
Cambridge Street, west of Oxford St	106	106	78	80	-26%	-25%
Pembroke Street,	424	348	336	396	-21%	14%

Road Link	Do Nothing Traffic (vph) AM Peak	Do Nothing Traffic (vph) PM Peak	With Development Traffic (vph) AM Peak	With Development Traffic (vph) PM Peak	% Increase AM Peak	% Increase PM Peak
east of Smith Street						
Pembroke Street, east of Essex Street	720	528	754	592	5%	12%
Pembroke Street, east of Norfolk Road*	490	556	476	552	-3%	-1%
Norfolk Road, north of Pembroke Street	704	584	770	716	9%	23%
Norfolk Road, north of Chester Street*	514	448	606	538	18%	20%
Blaxland Road, south of Epping Road	1284	1008	1308	1092	2%	8%
Langston Place, south of Cambridge St	890	586	554	400	-38%	-32%
Oxford Street, north of Cambridge St	544	434	402	372	-26%	-14%
Oxford Street, north of Chester Street	474	476	424	514	-11%	8%
Oxford Street, north of Surrey Street	454	424	418	434	-8%	2%
Chester Street, east of Oxford Street	20	32	10	36	-50%	13%
Smith Street, north of Epping Road	50	6	20	6	-60%	0%
Forest Grove, south of Epping Road	64	250	6	142	-91%	-43%
Essex Street, south of Epping Road	358	440	356	440	-1%	0%
Essex Street, south of Pembroke Street	370	448	658	712	78%	59%
Essex Street, north of Pembroke Street	196	182	266	276	36%	52%
Essex Street, south of Brucedale Ave	290	440	266	456	-8%	4%
Maida Road, east of Blaxland Road	28	296	62	482	121%	63%

Note: vph – vehicles per hour

With reference to Table 5-16, the following links are forecast to experience a percentage increase of five percent or more in two-way traffic movement following the proposed upgrade in 2026:

- Epping Road between Langton Place and Essex Street, with an increase of up to 14 percent.
- Cambridge Street, with an increase of up to 31 percent. The low traffic volumes on Cambridge Street in the 'do nothing" scenario result in a high percentage increase.
- Pembroke Street, east of Essex Street with an increase of up to 9 percent in the AM peak.

- Norfolk Road, with an increase of up to 11 percent.
- Blaxland Road, with an increase of up to eight percent in the PM peak.
- Essex Street north of Epping Road, with an increase of up to 126 percent during the AM peak and up to 35 percent in the PM peak. The low traffic volumes on Essex Street in the 'do nothing" scenario result in a high percentage increase.
- Maida Road, with an increase of up to 86 percent. The low traffic volumes on Maida Road in the 'do nothing" scenario result in a high percentage increase.

A number of roads would experience a reduction in two-way traffic volumes in 2026, including:

- Pembroke Street, west of Essex Street;
- Langston Place;
- Oxford Street;
- Chester Street;
- Smith Street and Forest Grove; and
- Essex Street, south of Epping Road.

Table 5-16 Forecast changes in two-way traffic volumes – 2026

Road Link	Do Nothing Traffic (vph) AM Peak	Do Nothing Traffic (vph) PM Peak	With Development Traffic (vph) AM Peak	With Development Traffic (vph) PM Peak	% Increase AM Peak	% Increase PM Peak
Epping Road, east of Beecroft Road	5918	5166	6038	5054	2%	-2%
Epping Road, east of Langston Place	3870	3510	4386	3578	13%	2%
Epping Road, east of Smith Street	3826	3514	4326	3592	13%	2%
Epping Road, east of Forest Grove	3804	3248	4344	3484	14%	7%
Epping Road, east of Essex Road	3648	3018	3910	3162	7%	5%
Epping Road, north of Crandon Road	3642	3026	3828	3126	5%	3%
Cambridge Street, west of Oxford St	78	96	102	92	31%	-4%
Pembroke Street, east of Smith Street	512	376	420	380	-18%	1%
Pembroke Street, east of Essex Street	798	644	872	628	9%	-2%
Pembroke Street, east of Norfolk Road*	594	588	592	584	0%	-1%
Norfolk Road, north of Pembroke Street	818	722	906	786	11%	9%
Norfolk Road, north of Chester Street*	652	540	664	600	2%	11%
Blaxland Road, south of Epping Road	1536	1232	1546	1342	1%	9%

Road Link	Do Nothing Traffic (vph) AM Peak	Do Nothing Traffic (vph) PM Peak	With Development Traffic (vph) AM Peak	With Development Traffic (vph) PM Peak	% Increase AM Peak	% Increase PM Peak
Langston Place, south of Cambridge St	1030	716	664	456	-36%	-36%
Oxford Street, north of Cambridge St	658	492	416	404	-37%	-18%
Oxford Street, north of Chester Street	530	592	468	542	-12%	-8%
Oxford Street, north of Surrey Street	502	540	510	492	2%	-9%
Chester Street, east of Oxford Street	28	52	18	52	-36%	0%
Smith Street, north of Epping Road	52	18	32	4	-38%	-78%
Forest Grove, south of Epping Road	78	294	12	156	-85%	-47%
Essex Street, south of Epping Road	432	514	374	468	-13%	-9%
Essex Street, south of Pembroke Street	340	548	770	740	126%	35%
Essex Street, north of Pembroke Street	196	226	348	254	78%	12%
Essex Street, south of Brucedale Ave	340	500	314	484	-8%	-3%
Maida Road, east of Blaxland Road	42	316	78	522	86%	65%

Note: vph – vehicles per hour

5.9 Key findings

The following key findings were identified from the traffic impact assessment:

SIDRA modelling assessment

- The SIDRA intersection analysis indicates that under 2016 'do nothing' conditions, the network would operate at LoS F during the AM peak and LoS D during the PM peak period.
- The SIDRA intersection analysis indicates that under 2026 'do nothing' conditions, the network would operate at LoS F during both the AM and PM peak periods.
- The SIDRA intersection analysis indicates that under 2016 'upgrade' conditions, the network would operate at LoS E during both the AM and PM peak periods.
- The SIDRA intersection analysis indicates that under 2026 'upgrade' conditions, the network would operate at LoS F during the AM peak and LoS E during the PM peak.
- The SIDRA modelling results for the Langston Place/Epping Road intersection for 2026 indicate:
  - Under 2026 'do nothing' conditions, the intersection would operate at LoS F during the AM and PM peak, with an average delay of >200 seconds and 132 seconds respectively.

  - Under 2026 ‘upgrade’ conditions, the intersection would operate at LoS F during the AM and PM peak, with an average delay of 142 seconds and 144 seconds respectively.
- The SIDRA modelling results indicate that the proposal would improve the operation of the Smith Street and Forest Grove intersections with Epping Road, by banning the right turn movements. The operation of these intersections would improve from LoS F under the ‘do nothing’ conditions to LoS D or better with the proposal in 2026.
- The SIDRA modelling results for the Essex Street/Epping Road intersection for 2026 indicate:
  - Under 2026 ‘do nothing’ conditions, the intersection would operate at LoS E during the AM peak and LoS B during the PM peak, with an average delay of 45 seconds and 36 seconds respectively.
  - Under 2026 ‘upgrade’ conditions, the intersection would operate at LoS F during the AM peak and LoS B during the PM peak, with an average delay of 105 seconds and 28 seconds respectively.
- The SIDRA modelling results indicate that the proposal would result in acceptable impacts to the operation of the Oxford Street/Langston Place/Pembroke Street and Pembroke Street/Essex Street intersections. These intersections are expected to continue to operate at a satisfactory LoS C or better during the AM and PM peak periods in 2026 following the proposed upgrade.

Paramics modelling

VHT comparisons between ‘do nothing’ and proposed upgrade scenarios indicate the following:

- In 2016, a 13 percent improvement in VHT during the AM peak and PM peak.
- In 2026, a nine percent improvement in VHT during the AM peak and a 15 percent improvement during the PM peak.

Travel time comparisons between the ‘do nothing’ and proposed upgrade scenarios from the Paramics modelling indicates the following:

- During the AM peak, the proposal will result in a marginal increase in travel times for the following movements:
  - Carlingford Road to Epping Road (east) in 2016 and 2026; and
  - Norfolk Road to Beecroft Road) in 2016.
- During the AM peak, the proposal is expected to generally result in a reduction in travel times for other key movements, with significant travel time savings for the following movements:
  - Beecroft Road to Epping Road (east);
  - Beecroft Road to Norfolk Road; and
  - Beecroft Road to Brucedale Avenue.
- During the PM peak, the proposal will result in a marginal increase in travel times for the following movements:
  - Norfolk Road to Beecroft Road in 2016; and
  - Beecroft Road to Brucedale Avenue in 2016.
- During the PM peak, the proposal is expected to generally result in a reduction in travel times for other key movements, with significant travel time savings for the following movements:

– Carlingford Road to Epping Road (east) - around seven minutes reduction in travel time in 2026.

The Paramics model indicates that the proposal would:

- Allow more traffic to travel between Beecroft Road and Epping Road (east) during the AM peak hour;
- Allow more traffic to travel in both the eastbound and westbound direction along Epping Road; and
- The additional westbound traffic lane at the Epping Road bridge would further increase capacity and allow additional traffic to pass through the network, particularly in 2026 in the PM peak.

Changes in travel distances from the proposed right turn bans

- The proposal will result in additional travel distances of up to 1,150 metres to access properties along Epping Road. This worst case increase in travel distance is associated with vehicles accessing Epping Road (east) from the properties on the southern side of Epping Road immediately to the west of Forest Grove.
- The proposal right turn ban from Langston Place to Epping Road will result in an increase travel distance of around 1,000 metres for vehicles travelling from Langston Place to Beecroft Road.

Change in traffic volumes

The proposed right turn bans along Epping Road would result in motorists taking the alternate routes as indicated in Section 5.1. The following links are forecast to experience a percentage increase of five percent or more following the proposed upgrade in 2026:

- Epping Road between Langton Place and Essex Street, with an increase of up to 14 percent.
- Cambridge Street, with an increase of up to 31 percent. The low traffic volumes on Cambridge Street in the ‘do nothing” scenario result in a high percentage increase.
- Pembroke Street, east of Essex Street with an increase of up to 9 percent in the AM peak.
- Norfolk Road, with an increase of up to 11 percent. The low traffic volumes on Norfolk Road in the ‘do nothing” scenario result in a high percentage increase.
- Blaxland Road, with an increase of up to eight percent in the PM peak.
- Essex Street north of Epping Road, with an increase of up to 126 percent during the AM peak and up to 35 percent in the PM peak. The low traffic volumes on Essex Street in the ‘do nothing” scenario result in a high percentage increase.
- Maida Road, with an increase of up to 86 percent. The low traffic volumes on Maida Road in the ‘do nothing” scenario result in a high percentage increase.

A number of roads would experience a reduction in two-way traffic volumes in 2026, including

- Pembroke Street, west of Essex Street;
- Langston Place;
- Oxford Street;
- Chester Street;
- Smith Street and Forest Grove; and

- Essex Street, south of Epping Road.

Other Impacts

- New signal controlled pedestrian crossing are proposed to be provided at the Epping Road (east) and both Essex Street approaches to the Epping Road/Essex Street intersection, which will improve safety for pedestrians at this location.
- A number of pedestrian improvements within the study area and the have been identified as through the development of the Pedestrian Access Study, undertaken as part of the REF for the Epping Road REF (GHD, 2015). Concerns raised in the Pedestrian Access Study report should be addressed especially in areas where traffic is proposed to increase as a result of the proposal. The recommended measures identified in the Pedestrian Access Study are expected to mitigate the impact to pedestrians associated with the proposal.
- There is forecast to be an increase in traffic along Pembroke Street, which is a designated on-street cycle route. However, the impacts to cyclists resulting from the proposal are expected to be minimal.
- Existing bus routes within the study area would not be impacted by the upgrade, as these bus routes will not require any traffic diversions.
- During non-clearway periods, on-street parking is permitted along Epping Road. In total, there are approximately 31 unmarked parking spaces on the northern side of Epping Road, with approximately 13 spaces along the southern side.

6. Recommended mitigation measures

A summary of the recommended mitigation measures is provided below:

6.1 Construction

The following proposed traffic management principles would be adopted during the construction period:

- A traffic management plan would be developed and incorporated into the Construction Environmental Management Plan (CEMP).
- Property owners would be consulted in advance regarding temporary impacts to property access.
- Construction and delivery vehicles entering or leaving the site compound and/or stockpile sites would use arterial roads wherever possible. Vehicle deliveries would be restricted to nominated times within the approved Construction Traffic Management Plan (CAMP).
- Construction workers should be advised to use public transport since there are limited parking spaces at the compound site.
- Workers are to be advised on suitable alternative parking locations including parking on the eastern side of Forest Park, along Forest Grove, or on the southern section of Forest Grove.
- A detailed CAMP is developed as part of the detailed design stage.
- Provisions for safe pedestrian access across the construction site would be maintained during construction.
- The relocation of bus stops would be done in consultation with local bus service providers.
- Clear signage would be available to notify the public of relocated bus stop locations.

6.2 Operation

Right turn ban signs would be clearly displayed at Langston Place, Smith Street, Forest Grove and at Epping Road on the approaches to the intersection with Essex Street.

7. Summary and conclusions

7.1 Overview

The purpose of this study was to assess the traffic and transport impact from the construction and operation of the proposed Epping Road westbound widening between Essex Street and Langston Place. Epping Road currently operates at capacity during peak periods and it is acknowledged that improvements along the corridor are required to accommodate additional travel demands generated by continued background traffic growth.

7.2 Key findings

The key findings from this study are summarised in the following sections.

7.2.1 Existing conditions

- There are frequent bus services operating along Epping Road and Pembroke Street in the vicinity of the study area.
- Individual intersections were found to perform at satisfactory levels.
- Network performance was found to operate at a LoS E during AM and PM peak periods. The network performs at an acceptable LoS D during weekend peak periods
- Crash trends were identified at some locations in the study area. It was found that 33 per cent of the crashes occurred on Blaxland Road between Epping Road and Maida Road. Thirty five per cent of the crashes occurred along Epping Road between Essex Street and Langston Place
- Twelve pedestrians per hour were recorded crossing the southern approach of Essex Street without the aid of pedestrian crossings during the weekday AM peak.
- During non-clearway periods, on-street parking is permitted along Epping Road. In total, there are approximately 31 unmarked parking spaces on the northern side of Epping Road, with approximately 13 spaces along the southern side.

7.2.2 Future conditions

SIDRA modelling assessment

- The SIDRA intersection analysis indicates that under 2016 ‘do nothing’ conditions, the network would operate at LoS F during the AM peak and LoS D during the PM peak period.
- The SIDRA intersection analysis indicates that under 2026 ‘do nothing’ conditions, the network would operate at LoS F during both the AM and PM peak periods.
- The SIDRA intersection analysis indicates that under 2016 ‘upgrade’ conditions, the network would operate at LoS E during both the AM and PM peak periods.
- The SIDRA intersection analysis indicates that under 2026 ‘upgrade’ conditions, the network would operate at LoS F during the AM peak and LoS E during the PM peak.
- The SIDRA modelling results for the Langston Place/Epping Road intersection for 2026 indicate:
  - Under 2026 ‘do nothing’ conditions, the intersection would operate at LoS F during the AM and PM peak, with an average delay of >200 seconds and 132 seconds respectively.

  - Under 2026 'upgrade' conditions, the intersection would operate at LoS F during the AM and PM peak, with an average delay of 142 seconds and 144 seconds respectively.
- The SIDRA modelling results indicate that the proposal would improve the operation of the Smith Street and Forest Grove intersections with Epping Road, by banning the right turn movements. The operation of these intersections would improve from LoS F under the 'do nothing' conditions to LoS D or better with the proposal in 2026.
- The SIDRA modelling results for the Essex Street/Epping Road intersection for 2026 indicate:
  - Under 2026 'do nothing' conditions, the intersection would operate at LoS E during the AM peak and LoS B during the PM peak, with an average delay of 45 seconds and 36 seconds respectively.
  - Under 2026 'upgrade' conditions, the intersection would operate at LoS F during the AM peak and LoS B during the PM peak, with an average delay of 105 seconds and 28 seconds respectively.
- The SIDRA modelling results indicate that the proposal would result in acceptable impacts to the operation of the Oxford Street/Langston Place/Pembroke Street and Pembroke Street/Essex Street intersections. These intersections are expected to continue to operate at a satisfactory LoS C or better during the AM and PM peak periods in 2026 following the proposed upgrade.

Paramics modelling assessment

The Paramics modelling found that the widening of Epping Road and the upgrade of intersections along the Epping Road improved traffic throughput on Epping Road which substantially reduced queuing along Epping Road. However, this resulted in increased vehicle arrival rates on the northbound approach of the Carlingford Road/Beecroft Road intersection, leading to deterioration in performance of this intersection. As this this intersection is already operating above capacity the extra traffic will result in very unstable traffic conditions with congestion affecting upstream intersections along Epping Road.

Travel time comparisons between the 'do nothing' and proposed upgrade scenarios from the Paramics modelling indicates the following:

- During the AM peak, the proposal will result in a marginal increase in travel times for the following movements:
  - Carlingford Road to Epping Road (east) in 2016 and 2026; and
  - Norfolk Road to Beecroft Road) in 2016.
- During the AM peak, the proposal is expected to generally result in a reduction in travel times for other key movements, with significant travel time savings for the following movements:
  - Beecroft Road to Epping Road (east);
  - Beecroft Road to Norfolk Road; and
  - Beecroft Road to Brucedale Avenue.

- During the PM peak, the proposal will result in a marginal increase in travel times for the following movements:
  - Norfolk Road to Beecroft Road in 2016; and
  - Beecroft Road to Brucedale Avenue in 2016.

- During the PM peak, the proposal is expected to generally result in a reduction in travel times for other key movements, with significant travel time savings for the following movements:
  - Carlingford Road to Epping Road (east) - around seven minutes reduction in travel time in 2026.

The Paramics model indicates that the proposal would:

- Allow more traffic to travel between Beecroft Road and Epping Road (east) during the AM peak hour;
- Allow more traffic to travel in both the eastbound and westbound direction along Epping Road; and
- The additional westbound traffic lane at the Epping Road bridge would further increase capacity and allow additional traffic to pass through the network, particularly in 2026 in the PM peak.

Changes in travel distances from the proposed right turn bans

- The proposal will result in additional travel distances of up to 1,150 metres to access properties along Epping Road. This worst case increase in travel distance is associated with vehicles acceding Epping Road (east) from the properties on the southern side of Epping Road immediately to the west of Forest Grove.
- The proposal right turn ban from Langston Place to Epping Road will result in an increase travel distance of around 1,000 metres for vehicles travelling from Langston Place to Beecroft Road.

Change in traffic volumes

The proposed right turn bans along Epping Road would result in motorists taking the alternate routes. The following links are forecast to experience a percentage increase of five percent or more in two-way traffic movement following the proposed upgrade in 2026:

- Epping Road between Langton Place and Essex Street, with an increase of up to 14 percent.
- Cambridge Street, with an increase of up to 31 percent. The low traffic volumes on Cambridge Street in the ‘do nothing” scenario result in a high percentage increase.
- Pembroke Street, east of Norfolk Road with an increase of up to 9 percent in the AM peak.
- Norfolk Road, with an increase of up to 11 percent. The low traffic volumes on Norfolk Road in the ‘do nothing” scenario result in a high percentage increase.
- Blaxland Road, with an increase of up to eight percent in the PM peak.
- Essex Street north of Epping Road, with an increase of up to 126 percent during the AM peak and up to 35 percent in the PM peak. The low traffic volumes on Essex Street in the ‘do nothing” scenario result in a high percentage increase.
- Maida Road, with an increase of up to 86 percent. The low traffic volumes on Maida Road in the ‘do nothing” scenario result in a high percentage increase.

A number of roads would experience a reduction in two-way traffic volumes in 2026, including:

- Pembroke Street, east of Smith Street
- Langston Place

- Oxford Street
- Chester Street
- Smith Street and Forest Grove
- Essex Street, south of Epping Road

Other Impacts

- New signal controlled pedestrian crossing are proposed to be provided at the Epping Road (east) and both Essex Street approaches to the Epping Road/Essex Street intersection, which will improve safety for pedestrians at this location.
- A number of pedestrian improvements within the study area and the have been identified as through the development of the Pedestrian Access Study, undertaken as part of the REF for the Epping Road REF (GHD, 2015). Concerns raised in the Pedestrian Access Study report should be addressed especially in areas where traffic is proposed to increase as a result of the proposal. The recommended measures identified in the Pedestrian Access Study are expected to mitigate the impact to pedestrians associated with the proposal.
- There is forecast to be an increase in traffic along Pembroke Street, which is a designated on-street cycle route. However, the impacts to cyclists resulting from the proposal are expected to be minimal.
- Existing bus routes within the study area would not be impacted by the upgrade, as these bus routes will not require any traffic diversions.
- During non-clearway periods, on-street parking is permitted along Epping Road. In total, there are approximately 31 unmarked parking spaces on the northern side of Epping Road, with approximately 13 spaces along the southern side.

7.3 Summary

The SIDRA intersection analysis showed that there is a need for network capacity enhancements, as some intersections along Epping Road are expected to operate over capacity in the 2016 and 2026 horizon years.

- The proposal would provide the following benefits:
  - Provides additional westbound road capacity, which would assist in relieving westbound traffic congestion on Epping Road under future traffic conditions;
  - Improves pedestrian safety at the Epping Road/Essex Street intersection; and
- Provision of an additional westbound traffic lane at Epping Road bridge is generally expected to result improved traffic operations compared to the proposed ‘upgrade’ scenario.
- The proposed upgrade would result in longer travel times for some routes and shorter travel times for other routes in the network, with some routes expected to experience a significant reduction in travel times.
- VHT comparisons between ‘do nothing’ and proposed upgrade scenarios indicate the following:
  - In 2016, a 13 percent improvement in VHT during the AM peak and PM peak.
- In 2026, a nine percent improvement in VHT during the AM peak and a 15 percent improvement during the PM peak.

8. References

Transport for NSW, Bus 637, M54, 140, 295, 288 & 290 Route Map.

AUSTROADS, 2009, *Guide to Traffic Management, Part 4 - Network Management*.

Roads and Maritime Services, 2014, Journey Information & Digital, Strategy & Engagement.

R, 2002, Guide to Traffic Generating Developments.

Appendix A – Site Visit Photos

Appendix B – Traffic Survey Reports

Appendix C – Bus Timetables

Appendix D – SIDRA Results

Appendix E – Roads and Maritime Crash Data

Appendix F – Proposed Upgraded Area

Appendix G – Pedestrian Access Study

Appendix H – Roads and Maritime Strategic Growth Factors

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