8 Assessment of key issues

This chapter provides an assessment of the key environmental issues for the project as identified in the DGRs and as per the relevant requirements of Schedule 2, Part 3 of the (NSW) Environmental Planning and Assessment Regulation 2000.

For each key issue the existing environment is described, the potential impacts (both direct and indirect) of the project during construction and operation are assessed, the influence of relevant planning matters are considered and proposed management and mitigation measures are described. The proposed management and mitigation measures in this chapter are collated in Chapter 12.

The assessment of key issues is supported by detailed investigations, which have been documented in the working papers in Volumes 2, 3 and 4. To the extent of any inconsistency between this main volume of the EIS and the working papers, the former prevails.

8.1 Traffic and transport

This section considers potential traffic and transport impacts of the project. Full details of the assessment undertaken are presented in the *WestConnex M4 Widening Traffic and Transport Working Paper – Working Paper 4* (Jacobs AECOM, 2014) (Volume 2 – Working Paper D) with a summary provided below. The assessment has been prepared to address relevant DGRs as documented in the table below.

Director-General's Requirements	Where addressed in EIS
• Traffic and transport – including but not limited to: • details of how the following meet the traffic and transport objectives of the project, taking into account adjacent sensitive land uses, future growth areas (including but not limited to Urban Activation Precincts at Wentworth Point and Carter Street, Lidcombe), approved and proposed infrastructure projects, and traffic (vehicular, cyclist and pedestrian needs):	Section 8.1.5 Chapter 13
– the preferred alignment and design	
– the proposed widening of the M4 Western Motorway between the Pitt Street underpass and Parramatta and Homebush Bay Drive, Homebush	
– the proposed interchange upgrades and augmentation, and	
– associated road infrastructure facilities	
• an assessment and modelling of operational traffic and transport impacts on the local and regional road network, Parramatta Road, and the Sydney motorway network;	Section 8.1.5
• induced traffic and operational implications for public transport (particularly with respect to strategic bus corridors and bus routes) and consider opportunities to improve public transport patronage;	Section 8.1.5
• impacts on cyclists and pedestrian access and safety and consideration of opportunities to integrate cycleway and pedestrian elements with surrounding networks;	Section 8.1.5

Director-General's Requirements	Where addressed in EIS
• construction traffic and transport impacts of the project (including ancillary facilities) and associated management measures, in particular:	Section 8.1.4 Section 8.1.6
– impacts to the road network (including safety and level of service, pedestrian and cyclist access, and disruption to public transport services and access to properties),	Section 8.1.4
– route identification and scheduling of transport movements,	Section 8.1.4
– the number, frequency and size of construction related vehicles (both passenger, commercial and heavy vehicles),	Section 8.1.4
– the nature of existing traffic on construction access routes (including consideration of peak traffic times), and	Section 8.1.4
– the need to close, divert or otherwise reconfigure elements of the road network associated with construction of the project, having reference to the cumulative construction impacts of other infrastructure preparing for or commencing construction;	Section 8.1.4
– details of how the project meets the objectives of the overall WestConnex scheme.	Chapter 13

8.1.1 Assessment methodology

A detailed specialist assessment of the traffic and transport assessment methodology is provided in the traffic and transport working paper included at Appendix D (Volume 2).

Construction traffic

The assessment of construction traffic impacts involves a review of the types of construction activities proposed, staging of works, working hours and the need for temporary periods of road occupancy to allow for construction. Potential impacts on general traffic, localised traffic and access issues, impacts on bus operations and the potential for diversionary effects during construction have been assessed and mitigation and management measures described to minimise impacts where possible.

Operational traffic and transport

The assessment of operational traffic and transport impacts of the project on road transport were evaluated using traffic demand data from the WestConnex Road Traffic Model (WRTM). This is a project specific model developed to forecast road traffic demands for the WestConnex projects including the M4 Widening project. The WRTM has two elements:

- The base demand model: This model is based on the Sydney Strategic Transport Model (STM) operated by the Bureau of Transport Statistics (BTS) and used for projecting travel patterns in Sydney, Newcastle and Wollongong under different land use, transport and pricing scenarios. The base demand model includes the capability to address changes in land use, trip distribution and mode choice as well as producing vehicle traffic demand during peak and off peak periods.
- The toll choice assignment model: This models the range of anticipated driver behaviour to toll strategies and forecasts traffic choice between toll and non-toll routes during peak and inter-peak periods.

The WRTM model was developed and calibrated to current observed travel behaviour, then validated against 2012 Sydney-wide travel behaviour. It was then adjusted to reflect driver behaviour on toll roads observed in Value of Travel Time Surveys (VTTS). Future demand was forecast by applying the model with future year traffic growth assumptions from the STM.

2021 is used as the project case year for the Base 'do minimum' and M4 Widening scenarios (described below) as it is consistent with the BTS data available. It includes the expected additional traffic that will result from population growth out to 2021 and therefore presents a conservative scenario for predicting traffic impacts at the completion of the M4 Widening in 2017.

Accordingly, impacts have been considered both for the M4 Widening as a standalone project and in the broader context of the fully completed WestConnex projects as appropriate. Opportunities for improvement to the network have been described.

The modelled scenarios are:

- **Existing case (2012)**: Current road network with no new projects or upgrades.
- **Base 'do minimum' (2021)**: The Base 'do minimum' case assumes that the M4 Widening and the remainder of the WestConnex projects are not built. It is called 'do minimum' rather than 'do nothing' as it assumes that on-going improvements will be made to the broader transport network including some new infrastructure and intersection improvements to improve capacity and cater for traffic growth but does not include the M4 Widening or other WestConnex projects.
- **M4 Widening (2021)**: A widened M4 Motorway but without any other WestConnex projects.
- **Future 'do minimum' (2031)**: A future network including some upgrades to the broader transport network over time to improve capacity and cater for traffic growth but does not include the M4 Widening or other WestConnex projects. The Future 'do minimum' case is at a time ten years later than the Base 'do minimum' case.
- **Full WestConnex (2031)**: With all WestConnex projects completed (Note: The NSW Government has committed to achieving completion of all WestConnex projects by 2023).

8.1.2 Existing environment

Land use

There is a wide variety of land uses in the vicinity of the M4 Widening corridor. Parramatta CBD lies to the north of the M4 Motorway at the western end of the project. Parramatta is designated as a Regional City (NSW Government, 2013a) and is often recognised as the second CBD of Sydney. It has large areas of commercial and retail land uses and includes the Parramatta Transport Interchange, a major rail and bus hub providing public transport access to large areas of Sydney.

Other town centres include Merrylands, Granville, Auburn and Lidcombe (all located to the south of the M4 Motorway). These town centres are located on railway lines and are dominated by retail land uses with some commercial and medium-density housing. A retail precinct along Parramatta Road in Auburn is dominated by low-density retail uses such as car yards, bulky goods and large-lot retailing.

Industrial areas are located at Camellia, Rosehill, Clyde, Silverwater and Lidcombe. There are three business parks at Silverwater, Lidcombe and Newington. Other industrial and commercial facilities include a waste transfer station; rail marshalling yards in Clyde; and Sydney Markets at Flemington.

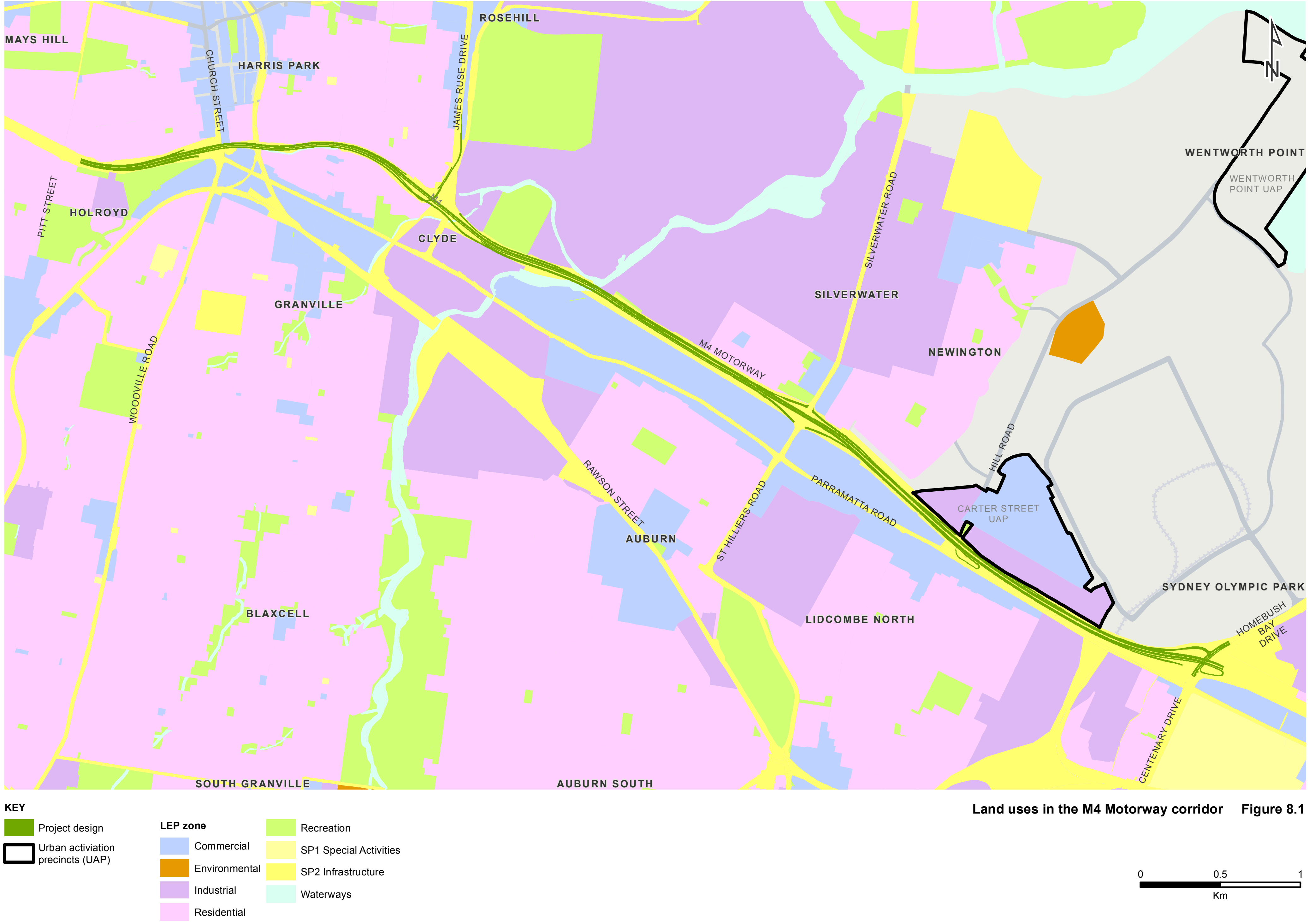
The Chullora and Enfield Intermodal Terminals, which are a significant generator of freight traffic on the M4 Motorway, are located five kilometres south of the M4 Motorway.

The area also contains a range of tourist and recreational facilities including Sydney Olympic Park, Blaxland Riverside Park, Sydney Speedway in Granville and Rosehill Racecourse. Local parks in the area include Wallawa Reserve at Granville, Holroyd Sports Ground at Holroyd, Deakin Park at Silverwater and Hume Park at Silverwater.

Community facilities including places of worship, community halls and scout/guide halls are located within the Merrylands, Parramatta, Granville, Auburn and Lidcombe town centres. There are major health facilities nearby, namely the Westmead health precinct and Concord Hospital. The Westmead health precinct is accessed from the M4 Motorway via the Coleman Street ramps and Hawkesbury Road, and Concord Hospital is accessed via Concord Road.

Suburbs along the M4 Motorway corridor within the study area that are dominated by residential land uses include Merrylands, Harris Park, Granville, Auburn, Newington, Lidcombe, Homebush and North Strathfield.

As discussed in section 3.2.6, there are two UAPs in the vicinity of the M4 Motorway corridor being Wentworth Point and Carter Street, Lidcombe. UAPs were announced by the NSW Government in 2013 as an important component of a package of wider housing delivery and employment initiatives. The UAPs aim to deliver more homes in places with access to infrastructure, transport, services and jobs.



Land uses in the M4 Motorway corridor Figure 8.1

Corridor road network

The M4 Motorway is a 40 kilometre urban motorway class road currently connecting the Blue Mountains in the west with Parramatta Road near Concord Road in the east. From Concord Road at North Strathfield, motorists can access the Sydney CBD and Sydney's inner western and eastern suburbs via Parramatta Road.

The existing M4 Motorway can be divided into three sections:

- Glenbrook to M7 Motorway – approximately 21.5 kilometres in length with seven interchanges. In the eastbound direction two lanes are provided between Glenbrook and Mulgoa Road and three lanes are provided between Mulgoa Road and the M7 Motorway. The westbound lane configuration is the same as eastbound, with the exception of an additional lane between Russell Street and Glenbrook (to provide for slow-moving vehicles ascending the steep grade).
- M7 Motorway to Cumberland Highway – approximately 10.5 kilometre road in length with three lanes in each direction and including three interchanges.
- Cumberland Highway to Parramatta Road – approximately 14 kilometres in length with seven interchanges. In the eastbound direction, four lanes are provided between Cumberland Highway and Church Street/Woodville Road, three lanes are provided between Church Street/Woodville Road and Homebush Bay Drive/Centenary Drive, and two lanes are provided between Homebush Bay Drive/Centenary Drive to Parramatta Road. The westbound lane configuration is the same as eastbound, with the exception of the segment between Coleman Street and Cumberland Highway, where there are three lanes instead of four. At the James Ruse Drive interchange, the mainline in both directions narrows to two lanes on approach to the merge with the entry ramps that restore the third lane. This narrowing is one of the major constraints to travel along this corridor.

Principal arterial road routes parallel to the M4 Motorway include:

- Great Western Highway (A44).
- Parramatta Road (A44, A4 and A22).
- Victoria Road (A40).

Major north-south routes include:

- Woodville Road.
- James Ruse Drive.
- Silverwater Road (A6).
- Hill Road.
- Homebush Bay Drive/Centenary Drive (A3).

Parramatta Road runs adjacent to the M4 Motorway for approximately 9.5 kilometres, from its intersection with the M4 Motorway in Strathfield to its intersection with Woodville Road and Church Street in Granville. This section of Parramatta Road serves the local town centres of Homebush, Homebush West (Flemington), Lidcombe, Auburn, Granville, Lidcombe, and Silverwater.

Parramatta Road also serves the Auburn and Granville industrial areas, Sydney Markets, and offers access to Sydney Olympic Park. Parramatta Road continues for 16 kilometres from the east of Strathfield to its intersection with City Road and Broadway in Camperdown. Beyond Camperdown, the road continues to the CBD as Broadway.

Freight network

Sydney's heavy vehicle freight task is highly dependent on the motorway network. More than 37 per cent of all heavy freight vehicle (HFV) kilometres travelled in the Sydney Metropolitan Area are on the motorway and highway network, even though the network represents less than 17 per cent of the arterial road network. A key reason for this is that while strategic centres have largely grown up around the rail network, the location of industrial activity since the second world war has largely been linked to the motorway and highway networks.

Modelling by the Bureau of Freight Statistics estimates that the average number of weekday freight trips in the Sydney Metropolitan Area would increase by almost 40 per cent between 2011 and 2031. This includes:

- An increase in the number of trips made by rigid trucks on an average weekday from 271,000 to 355,000, an increase of around 30 per cent.
- A more rapid increase in articulated truck trips from 95,000 to 157,000, an increase of around 65 per cent.

The M4 Motorway is a key component of the primary freight network within the Sydney road freight hierarchy. It performs a strategic role of serving the freight routes between Port Botany/ Sydney Airport, freight and intermodal terminals and industrial hubs. The M4 Motorway also offers an arterial route, free of traffic signals, to time sensitive vehicles.

Rail freight (primarily bulk commodities such as coal, minerals and grains) are carried on the Main Western Rail Line as well as dedicated freight rail tracks connecting Lidcombe/Homebush West with Port Botany, running via Enfield and Marrickville.

Rail freight to/from the NSW Central West, primarily coal trains between mines in the Lithgow area and Port Kembla, use the same tracks as the Main Western Rail Line passenger trains west of Flemington Junction. These lines are at capacity. Rail-borne freight for Brisbane and northern NSW leaves the dedicated freight network at North Strathfield and joins passenger services on the Main Northern Rail Line.

Commercial

Business and commercial trips are an important part of the transport task, with the majority of these trips being undertaken by private vehicles or taxis.

This market segment includes a wide range of trip purposes and vehicle types, with origins and destinations being network-wide. Light commercial vehicles (LCV) are a broad range of vehicles that are used for direct movements of goods for commercial purposes (light goods vehicles), and to support tools of trade (service vehicles).

Business and commercial trips are relatively more focused on centres of activity than heavy vehicle freight trips, and may include white-collar workers travelling on work business (not commuting) and other mobile workers such as district nurses, tradesmen, sales personnel and others whose workplaces are not static. Both business and commercial trips rely heavily on the east-west distributor function that the M4 Motorway plays, and rely on lower order roads for north-south connections within and to the Global Economic Corridor.

The M4 Motorway corridor carries more than double the proportion of work-related business trips compared to other parts of the rest of the wider Sydney network.

Passenger

The M4 Motorway/Parramatta Road corridor will serve natural growth in Sydney's transport demand that results from a growing population and economy. The number of jobs in Sydney is expected to grow from 2.3 million in 2011 to 2.9 million in 2031 (BTS, 2012a) and any change in the spatial distribution of employment will have a large impact on Sydney's transport task. Much of the forecast employment growth by 2031 will occur in the Global Economic Corridor. However, outside the Global Economic Corridor, pockets of significant jobs growth are expected along the M4 Motorway corridor, around Parramatta CBD, Sydney Olympic Park and Rhodes.

Public transport

The Main Western Rail Line is broadly parallel to the M4 Motorway and Parramatta Road through this corridor. The M4 Motorway crosses over the railway between Harris Park and Granville stations. West of Harris Park the rail line is located north of the M4 Motorway. East of Granville the rail line is south of the M4 Motorway. The Harris Park Y-link western arm is used by Sydney CBD – Liverpool – Campbelltown trains on the Main Southern Rail Line and Cumberland Line trains (Blacktown – Parramatta – Liverpool – Campbelltown).

The Carlingford Rail Line leaves the Main Western Rail Line at Clyde and heads north, passing under the M4 Motorway at Rosehill. Lidcombe is the Main Western Rail Line station furthest away from the M4 Motorway – almost two kilometres to the south. The Sydney Olympic Park Rail Line leaves the Main Western Rail Line at Lidcombe. East of Lidcombe the Main Western Rail Line continues to Sydney CBD. Main Northern Rail Line services branch off the Main Western Rail Line at Strathfield. Between Strathfield and Sydney there are six tracks carrying an intensive level of commuter service.

There is an extensive network of bus services within the local area. Bus routes in this area provide connections to town centres, retail and employment areas, residential areas and railway stations. The use of Parramatta Road rather than the M4 Motorway supports multi- functional bus routes with stops at regular intervals.

There are over 50 daytime bus routes around the M4 Motorway corridor between Parramatta and Homebush provided by five separate bus operators. These services are delivered as part of five Transport for NSW Sydney Metropolitan Bus Service Contracts (SMBSC).

Cross regional bus routes cross or operate along sections of Parramatta Road. These include:

- Route M91 – Parramatta to Hurstville.
- Route M92 – Parramatta to Sutherland.
- Route 401 – Lidcombe to Sydney Olympic Park.
- Route 525 – Parramatta to Burwood.
- Route 526 – Burwood to Sydney Olympic Park.
- Route 544 – Auburn to Macquarie Centre.

There are also five NightRide bus routes that operate hourly between midnight and 5:00 am along the M4 Motorway corridor:

- N60 – Fairfield to Town Hall.
- N61 – Carlingford to Town Hall.
- N70 – Penrith to Town Hall (uses M4 Motorway).
- N71 – Richmond to Town Hall (uses M4 Motorway).

- N80 – Hornsby to Town Hall.

There are 11 Sydney Olympic Park special event bus routes, which pass through the M4 Motorway/Parramatta Road corridor en route to and from Sydney Olympic Park. These services operate at high frequencies before and after major events held at Sydney Olympic Park.

Apart from the major bus/rail interchanges at Parramatta and Granville, facilities for bus passengers in the M4 Motorway corridor are limited. Where bus routes intersect (for example at the Parramatta Road/Newton Street South/Hampstead Road intersection north of Auburn) there is often very little specific provision for interchanging passengers.

Within the area likely to be impacted by the M4 Widening project, there are several bus priority measures in place. The most notable bus priority measures are:

- Liverpool – Parramatta Transitway, with a 24 hour dedicated bus lane on the Great Western Highway entering Parramatta from the west via Pitt Street and Argyle Street.
- North West Transitway, with a 24 hour dedicated bus lane entering Parramatta from Westmead via Park Road and Argyle Street.
- Holker Street 24 hour bus-only lane between Hill Road and Sydney Olympic Park.
- Peak period bus and transit lanes on Victoria Road, Ermington.

There are also two bus only roads entering Sydney Olympic Park between Silverwater Road and Newington Road in the north-west and a link road off Homebush Bay Drive, passing under Homebush Bay Drive in the south-east. With the exception of a very short length of westbound bus lane approaching the Church Street traffic signals, there are no bus priority lanes or transit lanes on Parramatta Road between Granville and Concord.

Cyclists and pedestrians

The pedestrian network along the M4 Motorway corridor consists mainly of kerbside footpaths along local and arterial roads. There are a number of pedestrian paths through reserves, some of them shared with cyclists. These include:

- A path parallel to the M4 Motorway between Beaconsfield Street, Silverwater and Teal Pond.
- A shared path adjacent to and underneath the M4 Motorway viaduct between Ledger Road and Haslams Creek, which also provides linkages into neighbouring town centres and residential areas.
- A footpath connecting Railway Street, Granville with Church Street through a reserve north of the M4 Motorway.
- A footpath through a reserve connecting the Harris Park and Granville sections of Harris Street.

Grade separated pedestrian access across the M4 Motorway is available at:

- Pitt Street, Merrylands.
- Shared path underpass linking Fox Street, Holroyd to the south of the M4 Motorway and Railway Street, Granville to the north of the M4 Motorway.
- Church Street.
- Good Street, Granville.
- Alfred Street, Granville.
- Harris Street, Granville.

- Arthur Street, Granville (west side only).
- James Ruse Drive (west side only).
- Wentworth Street, Clyde (west side only).
- Deniehy Street, Clyde.
- Junction Street, Auburn.
- Stubbs Street, Auburn.
- Overpass linking Melton Street South, Auburn to the south of the M4 Motorway and Melton Street North, Silverwater to the north of the M4 Motorway.
- Silverwater Road.
- Shared path underpass linking Adderley Street East, Lidcombe to the south of the M4 Motorway and Haslams Creek to the north of the M4 Motorway.
- Hill Road, Lidcombe (west side only).
- Birnie Avenue, Lidcombe.
- Overpass linking Park Road to the south of the M4 Motorway and Wentworth Road South/Pomeroy Street to the north of the M4 Motorway in Homebush.

The majority of signalised intersections on the arterial road network provide pedestrian crossing facilities. While pedestrians are generally well catered for at intersections, there is a lack of mid-block crossing facilities particularly along arterial roads such as Parramatta Road, Silverwater Road, James Ruse Drive and Homebush Bay Drive. Signalised pedestrian crossings, which are provided only at key intersections, are sometimes several hundred meters apart.

Concurrent transport projects

Other transport related projects that are currently proposed or underway include the M4 smart motorway system, M5 West Widening, NorthConnex and North West Rail Link – and the further stages of WestConnex.

The smart motorway system on the M4 Motorway is proposed by Roads and Maritime as a separate project for the section between Lapstone and Mays Hill. The system includes real time traffic and travel information delivered through enhanced variable message signs on the M4 Motorway and approach roads, a coordinated on ramp signals system, dynamic speed and incident management, enhanced network monitoring delivered by traffic sensors in the roadway and CCTV cameras, emergency telephones and stopping bays, and road improvements such as some widened and lengthened on- and off-ramps and nearby intersection improvements. The aim of the system is to improve travel time reliability, improve safety, provide real-time information, reduce vehicle emissions, and reduce journey times.

The M4 Widening project includes the provision of road infrastructure and services to support the future implementation of smart motorway operations within this section of the M4 Motorway.

The M5 West Widening project is currently under construction and expands the M5 South West Motorway from two to three lanes in each direction from King Georges Road in Beverly Hills to Camden Valley Way in Prestons. Construction is expected to be completed before M4 Widening road works commence. That project aims to reduce congestion on the M5 Motorway and improve reliability and travel time, provide relief to congestion on parallel routes, support forecast growth in Sydney's south west and key destinations such as inner Sydney, Port Botany and Sydney Airport, improve communications with a new control centre in Hammondville, provide early warning alerts on the motorway and surrounding arterial networks, and improve incident response times with the installation of a new CCTV system.

The proposed NorthConnex project is a new tolled motorway linking the M1 Pacific Motorway (previously the F3 Freeway) at Wahroonga to the Hills M2 Motorway at West Pennant Hills. The new link features twin motorway tunnels, about eight kilometres in length, with two lanes in each direction and provision for future widening to three lanes and northern and southern interchanges. The project aims to reduce traffic congestion and the number of heavy vehicles, particularly along Pennant Hills Road. NorthConnex provides opportunities for improved public transport, improved freight movements and provides a motorway that integrates with the regional transport network.

The North West Rail Link is a 23 kilometre rail link between Epping and Rouse Hill. Construction commences in 2014 and the line is expected to be operational in 2019. It features a direct underground link to the existing Epping to Chatswood rail tunnels, eight new stations, a train stabling facility at Rouse Hill, 4,000 commuter car parking spaces, twin 15 kilometre tunnels between Epping and Bella Vista, a four kilometre viaduct between Bella Vista and Rouse Hill, and bus, taxi, kiss and ride, pedestrian and cycling facilities at all stations.

8.1.3 Performance of the existing road network

M4 Motorway travel speeds

To gain an understanding of travel speeds on the M4 Motorway, a survey was undertaken on 21 November 2012. The survey involved 100 trips along the M4 Motorway between Church Street and Parramatta Road. Congestion was apparent in the morning peak in the eastbound direction, particularly between Church Street and James Ruse Drive where average speeds were below 30 kilometres per hour. The eastbound segment between Homebush Bay Drive and Parramatta Road also had heavy delays (average speeds below 45 kilometres per hour). Also apparent was congestion during the day and in the evening peak period.

In the westbound direction low travel speeds were recorded in the evening peak between Homebush Bay Drive and James Ruse Drive (average speeds below 30 kilometres per hour). Westbound congestion in the morning peak between Silverwater Road and James Ruse Drive was also noted (averages speeds below 60 kilometres per hour).

M4 Motorway travel times

The travel speed surveys undertaken in November 2012 also provided information about travel times for M4 Motorway journeys. Travel times along the M4 Motorway between Church Street and Homebush Bay Drive were typically 15 minutes eastbound during the morning peak period, however increased up to 25 minutes with disrupted flow. Westbound traffic travel times were typically 23 minutes during the evening peak period and eight minutes during the inter peak period.

Network capacity and level of service

Network congestion occurs when demand exceeds capacity. The M4 Motorway, as well as a number of north-south arterial routes (such as Homebush Bay Drive, Silverwater Road and Hill Road) and their on-ramps and off-ramps, are currently congested. Eastbound travel along the M4 Motorway during the morning peak is dominated by this excessive congestion.

Interchange and intersection performance

Within the M4 Motorway/Parramatta Road corridor, many critical intersections affect local traffic, cross-regional traffic operation, Parramatta Road and accessibility to the M4 Motorway. Table 8.1 shows existing intersection performance in terms of average vehicle delay and level of service

(LoS). There are six levels of service, designated from A to F, with LoS A representing the best operating condition (being an average delay per vehicle of less than 15 seconds) and LoS F the worst (being an average delay per vehicle greater than 70 seconds).

Table 8.1 Existing intersection performance

Intersection	Morning peak hour		Evening peak hour	
	Level of service	Average delay per vehicle (secs)	Level of service	Average delay per vehicle (secs)
Granville				
Church Street/M4 Motorway eastbound off-ramp	D	43	D	51
Church Street/Parramatta Road/Woodville Road/M4 Motorway westbound on-ramp	D	43	E	63
Parramatta Road/Bold Street	D	56	C	38
Parramatta Road/Good Street	C	31	C	42
Clyde and Rosehill				
James Ruse Drive/Prospect Street	C	35	D	50
James Ruse Drive/M4 Motorway eastbound on-ramp	B	22	B	24
James Ruse Drive/M4 Motorway westbound off-ramp	C	30	B	22
James Ruse Drive/Parramatta Road/Berry Street	C	36	C	38
Auburn				
Parramatta Road/Rawson Street/Duck Street	D	43	F	82
Silverwater Road/Carnarvon Street	D	46	E	59
Silverwater Road/M4 Motorway eastbound ramps	D	44	D	48
Silverwater Road/M4 Motorway westbound ramps	D	46	D	49
Silverwater Road/Parramatta Road	D	53	D	56
Lidcombe and Sydney Olympic Park				
Parramatta Road/John Street	C	30	C	28
Parramatta Road/Hill Road/Bombay Street	D	54	D	46
Hill Road/M4 Motorway eastbound off-ramp	E	62	A	12
Hill Road/Carter Street	A	13	A	13
Hill Road/John Ian Wing Parade	B	19	B	20
Homebush West and Strathfield				
Homebush Bay Drive/M4 Motorway eastbound on-ramp	A	6	A	11
Homebush Bay Drive/M4 Motorway eastbound off-ramp	E	61	E	60
Centenary Drive/M4 Motorway westbound ramps	E	62	D	54
North Strathfield and Strathfield				
Parramatta Road/Concord Road/Leicester Avenue	F	72	F	75
Parramatta Road/M4 Motorway	E	70	F	74
Parramatta Road/Mosely Street	C	40	C	31
Concord Road/Sydney Street	B	22	B	27

Queuing of traffic exiting the motorway at interchanges is determined by the ability of the interchange to discharge traffic onto the surrounding road network. If the queue becomes longer than the storage capacity of the off-ramp, the back of the queue will affect the left hand through lane of the motorway. This impact would take the form of reduced capacity on the motorway and the potential to increase the number of rear-end type crashes. Observations indicate that queuing occurs at Hill Road eastbound in the morning peak and at Silverwater Road westbound and Church Street eastbound.

Motorway tolling history

As discussed in Section 4.1, the M4 Motorway became Sydney's first tolled motorway in 1992. The M4 Motorway toll was implemented at a single-point, with the toll plaza located immediately west of the Silverwater Road interchange. Users of the M4 Motorway that chose to avoid the toll would exit the motorway and use alternative routes such as Parramatta Road. This diversion of traffic from the motorway resulted in increased traffic volumes on Parramatta Road through areas such as Auburn and Granville.

In 2010, the concession on the M4 Motorway expired and ownership was transferred from Statewide Roads to the NSW Government. The toll on the M4 Motorway was removed at this time. The removal of the toll resulted in higher usage of the M4 Motorway and a reduction of traffic on the parallel section of Parramatta Road.

Further detail on traffic changes due to tolling can be found in section 8.1.5.

Road safety and crash history

Since the removal of the toll on the M4 Motorway, the M4 Motorway/Parramatta Road corridor between Homebush Bay Drive and Parramatta has averaged 372 crashes per year, with 244 crashes on the M4 Motorway and 128 crashes on Parramatta Road. The crash rate on the M4 Motorway (19 crashes with casualties per 100 million vehicle kilometres travelled) is less than that for Parramatta Road (84 crashes with casualties per 100 million vehicle kilometres travelled).

8.1.4 Assessment of potential construction traffic and transport impacts

Chapter 6 explains how the project would be constructed including the construction program, number and location of construction site compounds, access arrangements and working hours. Specific impacts on the road network and different modes of transport are considered below.

Construction vehicle movements

Table 8.2 details proposed construction activities, heavy vehicle movements and number of personnel at each work site for the entire construction period. These movements form the basis of the construction traffic assessment in this section. Potential haulage routes are shown in Figure 6.2 to Figure 6.4.

Table 8.2 Construction vehicle movements

Work site	Approximate number of daily heavy vehicle movements required during construction	Approximate number of daily light vehicle movements required during construction
Works between Pitt Street and Church Street west side	Up to 20	Between 6 and 30
Works east of Church Street	Up to 10	Between 10 and 50
Works between A'Beckett Street and eastern abutment of bridge over Main Western Rail Line	Up to 10	Between 12 and 50
Works at A'Beckett Street and Alfred Street intersection	Up to 10	Between 12 and 40
Works between A'Beckett Street and western abutment of bridge over Carlingford Rail Line	Up to 10	Between 12 and 50
Works at James Ruse Drive west side	Up to 10	Between 12 and 35
Works at James Ruse Drive east side	Up to 10	Between 12 and 45
Works between Wentworth Street and Deniehy Street (south)	Up to 50	Between 12 and 50
Bridge over Deniehy Street	Up to 10	Between 12 and 45
Works between Deniehy Street and western abutment of Duck River	Up to 10	Between 12 and 24
Works between Wentworth Street and Deniehy Street (north)	Up to 10	Between 15 and 45
Extended bridge over Deniehy Street	Up to 10	Between 12 and 60
Bridge over Duck River	Up to 10	Between 15 and 50
Works between Junction Street and Silverwater Road	Up to 50	Between 15 and 60
Works between Silverwater Road and Haslams Creek	Up to 30	Between 15 and 60
Works between Haslams Creek and Birnie Avenue	Up to 50	Between 20 and 60
Works between Birnie Avenue and Homebush Bay Drive	Up to 30	Between 15 and 50

Temporary road closures

Proposed temporary road closures to facilitate construction activities are detailed in Table 8.3. Details of any required detours and measures to reduce the impact of the road closures would be addressed during detailed construction planning and would be identified in the construction traffic management plan (refer to section 8.1.6). Additional temporary road closures may be identified when the construction method is confirmed.

Table 8.3 Temporary road closures

Road	Description of temporary closure
Church Street	• Erection of western approach span for Church Street bridge – closure of northbound lane required on weekend nights. • Erection of bridge span over Church Street – complete closure of Church Street required on weekend nights • Traffic switches for existing viaduct works.
M4 Motorway (main road)	• Erection of western approach span for Church Street bridge – partial closure of shoulder and nearside westbound lane on weekend nights • Church Street to Wentworth Street – two lanes westbound and three lanes eastbound traffic would be switched onto the new viaduct commencing at Wentworth Street, leaving one lane in each direction on the M4 Motorway. • Wentworth Street to Silverwater Road –two westbound lanes and three eastbound lanes would be switched onto the new Duck River bridge, leaving one lane in each direction on the M4 Motorway. Traffic would be switched just west of Silverwater Road. • Silverwater Road to Haslams Creek – median lane closures in both directions could be required to facilitate median works. • Haslams Creek to Birnie Avenue – median lane closures in both directions could be required to facilitate median works. • Birnie Avenue to Homebush Bay Drive – median lane closures in both directions could be required to facilitate median works. • Traffic switches for existing viaduct works and for mill and pavement works.
A'Beckett Street	• Construction of western approach span for Alfred Street bridge – full closure would be required between Alfred Street and Kemp Street on two occasions and a partial closure on other occasions.
A'Beckett Street/Alfred Street	• Construction of bridge span over the intersection would require a full closure of the intersection for periods over a weekend
James Ruse Drive	• Erection of bridge span over James Ruse Drive would require a full closure for periods over a weekend
Martha Street	• Erection of reinforced earth wall panels would require closure of the nearside eastbound lane currently used for parking.
Deniehy Street	• Construction of bridge substructure would require closure of the nearside northbound and southbound lanes. • Erection of beams for bridge deck over Deniehy Street would require a full closure for periods over a weekend

Impacts on M4 Motorway traffic

During the construction period, temporary reductions in speed limits on the M4 Motorway will be required for road and worksite safety. Between Pitt Street, Parramatta and Homebush Bay Drive, Homebush, a reduced speed limit of 80 kilometres per hour will be introduced with some sections requiring further temporary "road work" speed reductions during off-peak periods or night works.

The speed limit reductions will be required due to reduced lane widths, works in the median and other works that would be undertaken in close proximity to travel lanes. The implementation of an 80 kilometres per hour speed limit during the construction period would increase travel times on the motorway by up to one minute in free-flow conditions. However, average travel time in peak periods is not expected to change as existing congestion currently keeps peak period travel speed below 80 kilometres per hour.

During peak periods, the existing number of lanes would be maintained – four lanes from Pitt Street to Church Street and three lanes east of Church Street in both directions of travel.

However, as road shoulders will need to be used to accommodate realigned traffic lanes, there is the potential for extended delays in the event of incidents such as breakdowns or accidents. Where road shoulders are used to accommodate realigned traffic lanes, monitoring of the motorway and work sites would be undertaken using CCTV and mobile patrols used to assist management of incidents, including access for emergency services.

Impacts on local road traffic

During construction, some road users may choose to take an alternative route (diversion). This is expected to mainly occur in the off-peak periods when construction lane closures with lower "road works" speed limits occur. During these periods, alternative routes would have sufficient spare capacity to accommodate additional traffic that has diverted from the motorway.

Impacts due to construction vehicle movements are a further consideration. Based on existing local road traffic and predicted construction traffic volumes (refer to Table 8.2), it is expected that only the residential streets would see a noticeable increase in vehicle movements. Assessment of suitable routes and access points will be addressed during the preparation of the construction traffic management plan (refer to section 8.1.6) and communicated via the methods outlined in section 7.5.4.

Impacts on public transport

Bus services would be affected by the same delays as general traffic due to reduced speed limits or during manual traffic control, however no regular bus services operate on the M4 Motorway. Consultation with bus operators would occur through the traffic and transport liaison group (refer to section 8.1.6) to advise of potential traffic delays or roads closures and to identify how this could best be managed to minimise impacts on users (such as revised timetables or services).

Disruptions to rail services may occur during construction of the viaduct over the Main Western and Carlingford Rail Lines. Where practicable, construction of the viaduct over the Main Western and Carlingford Rail Lines would be planned to coincide with pre-planned Sydney Trains rail possession periods, which are typically between 2.00 am Saturday and 2.00 am Monday. Specific shutdowns outside the planned rail possession periods may also be required. However, this would be undertaken in consultation with Sydney Trains to ensure impacts to services are minimised.

Impacts on pedestrians and cyclists

Pedestrian and cyclist facilities that would be affected by construction activities are detailed in Table 8.4. Where there is possible interaction between construction traffic and pedestrians and cyclists (eg at work site/compound access points) traffic controllers or diversions would be used to ensure adequate protection is provided and/or risks minimised.

If a temporary diversion is required for cyclists using the M4 Motorway shoulder, the alternative routes would be outlined in the Construction Traffic Management Plan and communicated to the public, including users of the pedestrian and cyclist facilities, via the methods outlined in section 7.5.4.

Table 8.4 Construction impact on pedestrians and cyclists

Location	Facility type	Description of impact
Between Church Street, Parramatta and Junction Street, Granville	Shared path	The shared path may require relocation to ensure it can continue to operate during the construction works. Where it cannot be relocated, a suitable alternative route would be provided. The shared path may be crossed occasionally by construction vehicles which would be facilitated by a traffic controller.
Between Arthur Street, Granville and Martha Street, Granville	Shared path	Shared path may require relocation
Duck River	Shared path	The shared path may be crossed occasionally by construction vehicles which would be facilitated by a traffic controller.

8.1.5 Assessment of potential operational traffic and transport impacts

Overview of findings

Modelling indicates that under the Full WestConnex scenario motorists would save motorists 14 minutes on a journey on the M4 Motorway from Church Street to Homebush Bay Drive in the AM peak, reducing travel times from 19 minutes to five minutes. In the westbound direction on the same section of road the time saving would be 10 minutes - from 15 minutes to five minutes.

Under the M4 Widening scenario alone, the most substantial travel time savings over the same section of the M4 Motorway would be nine minutes in the eastbound direction in the AM peak, with more modest improvements at other times and in other directions.

Over these time periods, increases in Parramatta Road travel times between Church Street and Homebush Bay Drive are expected with the M4 Widening and the Full WestConnex scenarios due to drivers avoiding the toll. Conversely, this eases congestion on the M4 Motorway, for drivers willing to pay the toll on a road free of traffic signals. A similar diversion of traffic onto Parramatta Road was observed when the toll was formerly implemented on the M4 Motorway (before being removed in 2010). Modelling shows that peak hour volumes would be similar to the observed traffic volume in the years prior to the removal of the toll.

While the M4 Widening project would not address or alleviate congestion on Parramatta Road east of Concord Road, a cumulative benefit is expected with the M4 East project (when delivered a few years after the M4 Widening) alleviating congestion at the eastern end of the M4 Motorway along Parramatta Road.

The M4 Widening is expected to improve road safety. The overall number of crashes in the corridor is expected to be lower with the M4 Widening (four per cent less crashes with casualties) as a result of reduced vehicle kilometres travelled.

A more detailed analysis of the detailed findings of the traffic and transport assessment is described below.

Performance across the Sydney network

Modelling has been undertaken to understand the future performance of the Sydney road network with and without the M4 Widening (2021) and the fully completed WestConnex (2031).

The M4 Widening, and fully completed WestConnex project, will improve the Sydney motorway network, giving motorists greater choice of route and trip time options. Some motorists will be prepared to pay for a faster, simpler trip, and some will seek alternative routes or modes to avoid the toll. This would have wider implications for the Sydney transport network. Two of the strongest indicators of system-wide performance are the combined distance travelled by all vehicles on the network (network vehicle kilometres travelled) and the combined time spent travelling by all vehicles (network vehicle hours travelled). These indicators have been used to calculate an average network speed (network vehicle kilometres travelled divided by network vehicle hours travelled).

With the M4 Widening in 2021, total vehicle kilometres travelled across the network would be reduced by approximately one million kilometres per day compared to if the M4 Widening was not built. In 2031, the fully completed WestConnex would also provide a small reduction in the total vehicle hours travelled and an improvement in the average network speed from 27 kilometres per hour without WestConnex to 28 kilometres per hour with WestConnex. While a change of one kilometre per hour for average network speed may appear minor, when considering that the total number of car and truck trips on the network is estimated to be 15.1 million by 2031, the cumulative benefit of this travel speed improvement would be substantial.

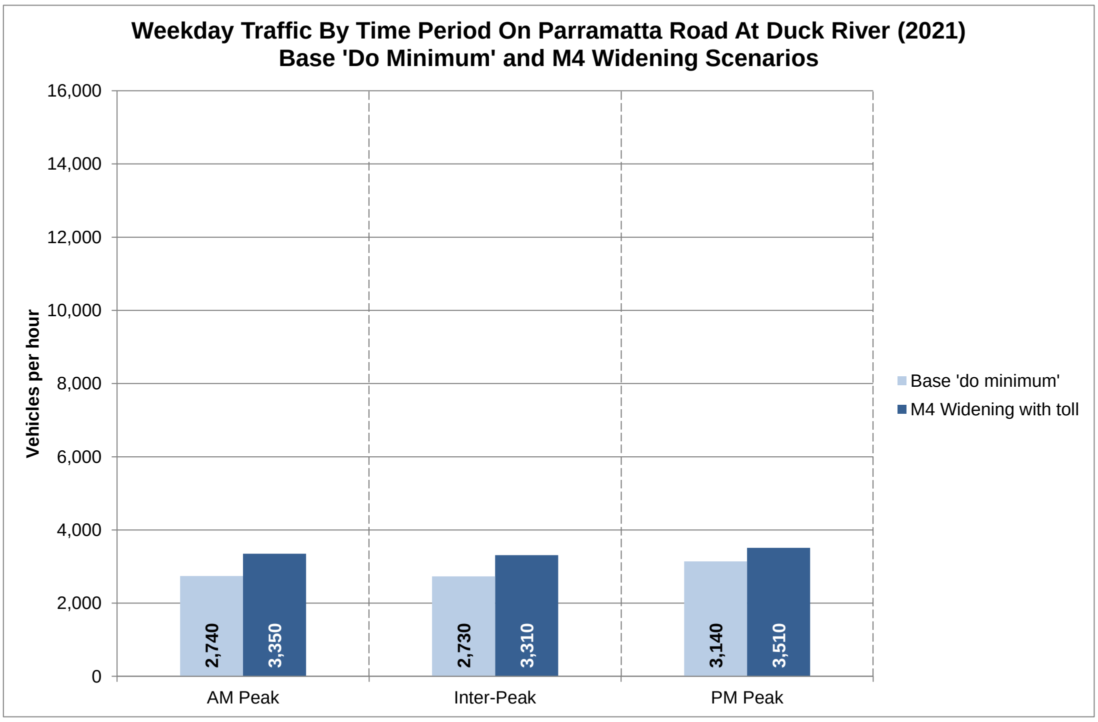
As an on-going traffic management measure, and as identified in section 8.1.6, an operational traffic review will be undertaken within 12 months of project opening to confirm the operational traffic impacts of the project on surrounding arterial roads and major intersections. Where necessary, the outcomes of the operational traffic review will be used to identify opportunities for any further operational refinement to optimise the performance of the project. This could include intersection treatments, changes to lane configuration or signal phasing.

The review will be based on actual traffic counts and will assess the level of service at major intersections between Pitt Street and Homebush Bay Drive along the M4 Motorway and on Parramatta Road

Changes to traffic volumes

Figure 8.2 shows the modelled number of vehicles passing over Duck River at Auburn on the M4 Motorway and Parramatta Road for the Base 'do minimum' and M4 Widening scenarios. Modelling indicates that the M4 Widening project is expected to reduce corridor traffic during the AM and PM peaks and the middle of the day (inter-peak) as some drivers will seek to use non-tolled routes.

With the M4 Widening project, Parramatta Road would account for 24 per cent of vehicles in the morning peak, 29 per cent in the evening peak, 33 per cent during the day and 44 per cent overnight. This can be interpreted as a diversion of toll avoiding drivers to Parramatta Road and other routes during periods of little or no congestion.



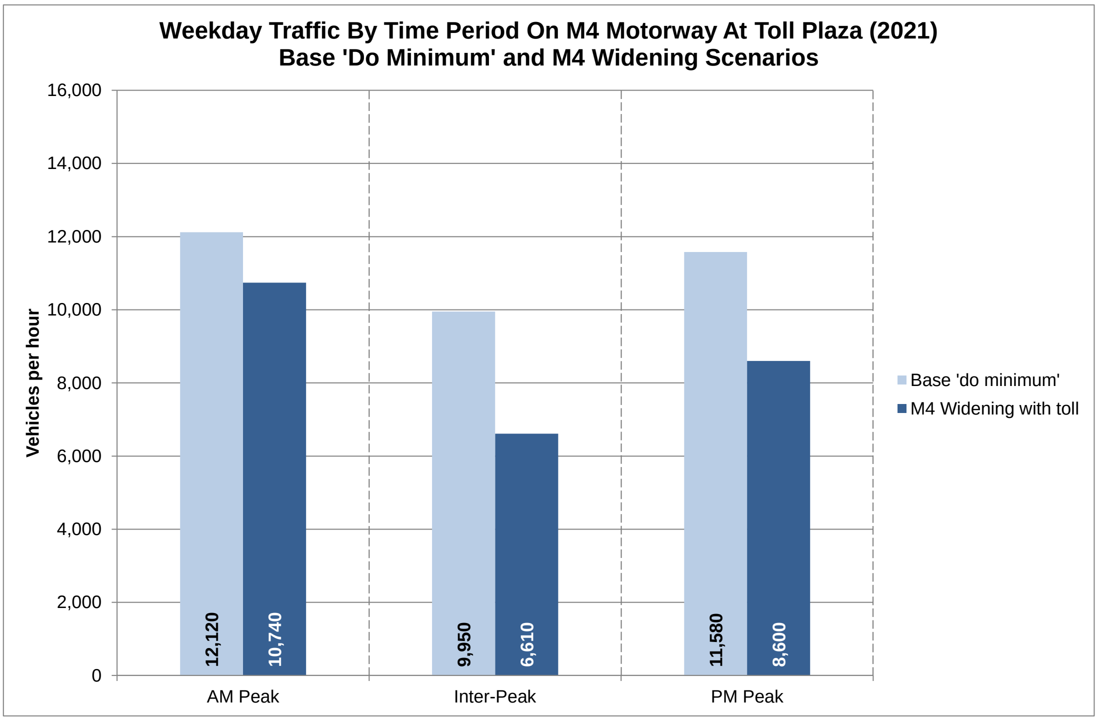
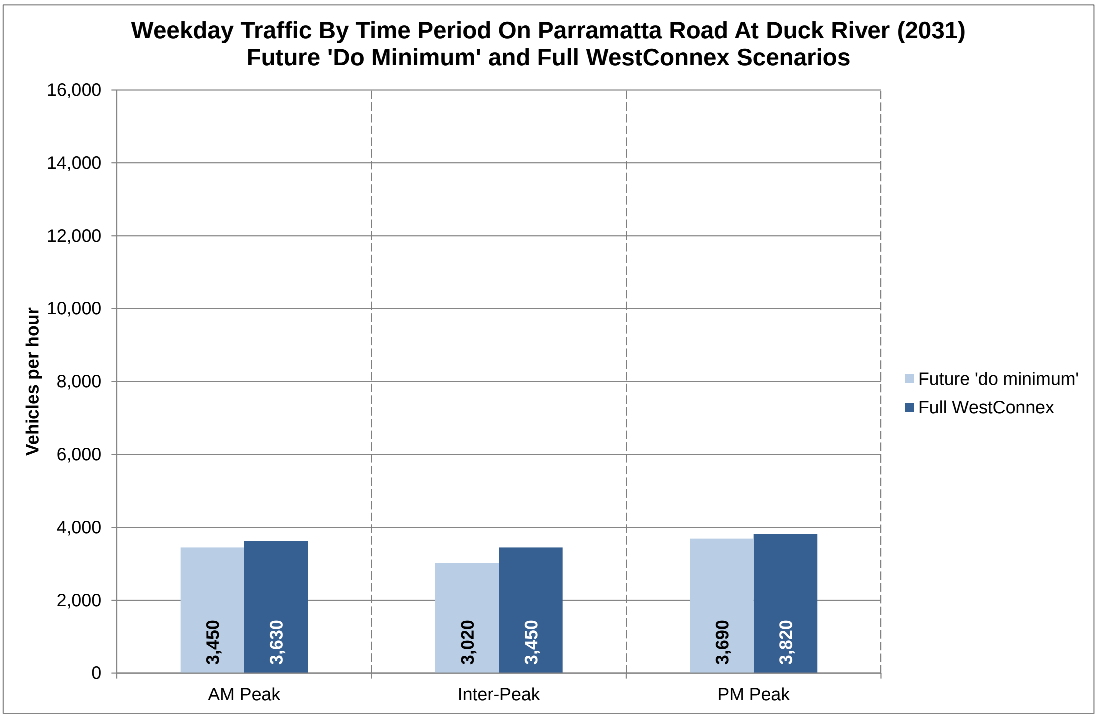


Figure 8.2 Parramatta Road and M4 Motorway traffic - Base 'do minimum' and M4 Widening scenarios (2021)

Figure 8.3 shows that in 2031 when all WestConnex projects are completed, the Full WestConnex would generate a net increase in corridor traffic in the AM peak. The net increase in corridor traffic compared to 2021 can be explained by vehicles returning to the corridor to take advantage of the faster more reliable and connected route provided by WestConnex. As congestion in other parts of the Sydney road network increases over time, vehicles using WestConnex will experience improved travel times compared to using other corridors in the network.



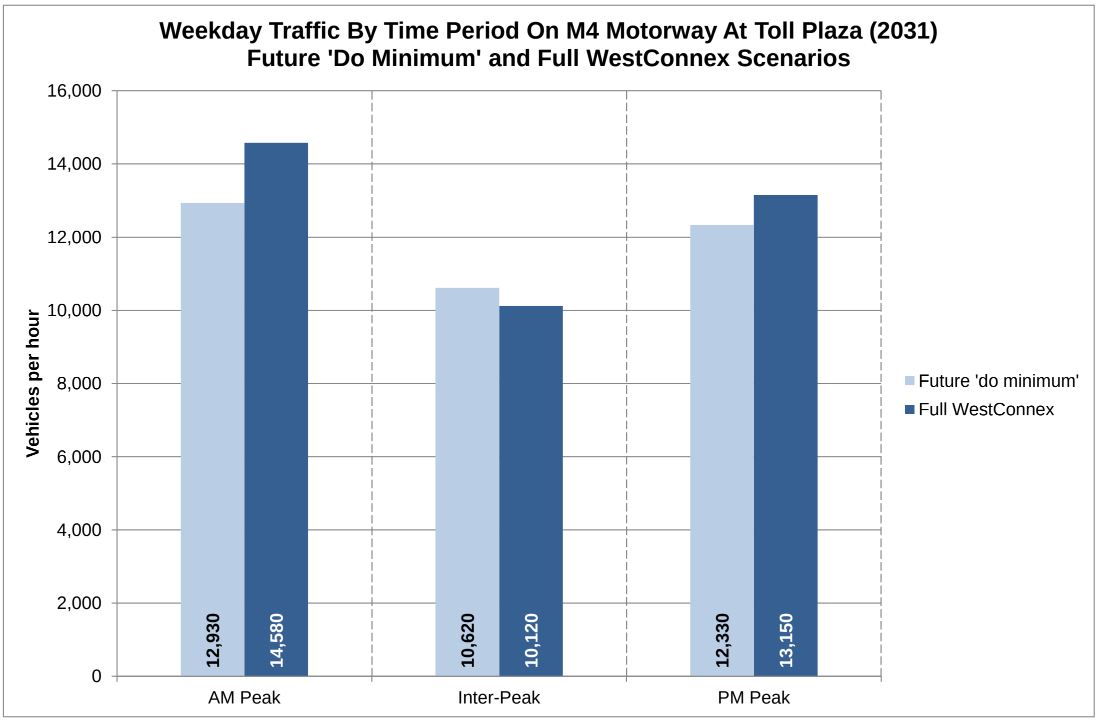


Figure 8.3 Parramatta Road and M4 Motorway traffic - Future ‘do minimum’ and Full WestConnex scenarios (2031)

Tolling Implications

This section presents the implications of the proposed toll on the widened M4 Motorway. The tolling assumptions for cars and light commercial vehicles adopted for this assessment has two components: a $1.00 flag-fall plus an additional charge of $0.37 per kilometre travelled; heavy commercial vehicles are to be tolled at three times this rate. Based on this tolling strategy the total amount payable by cars and light commercial vehicles travelling the full length of the M4 Widening would be $3.90 ($2013). As discussed in section 3.2.5, toll revenue from the M4 Widening would assist in funding the remainder of WestConnex.

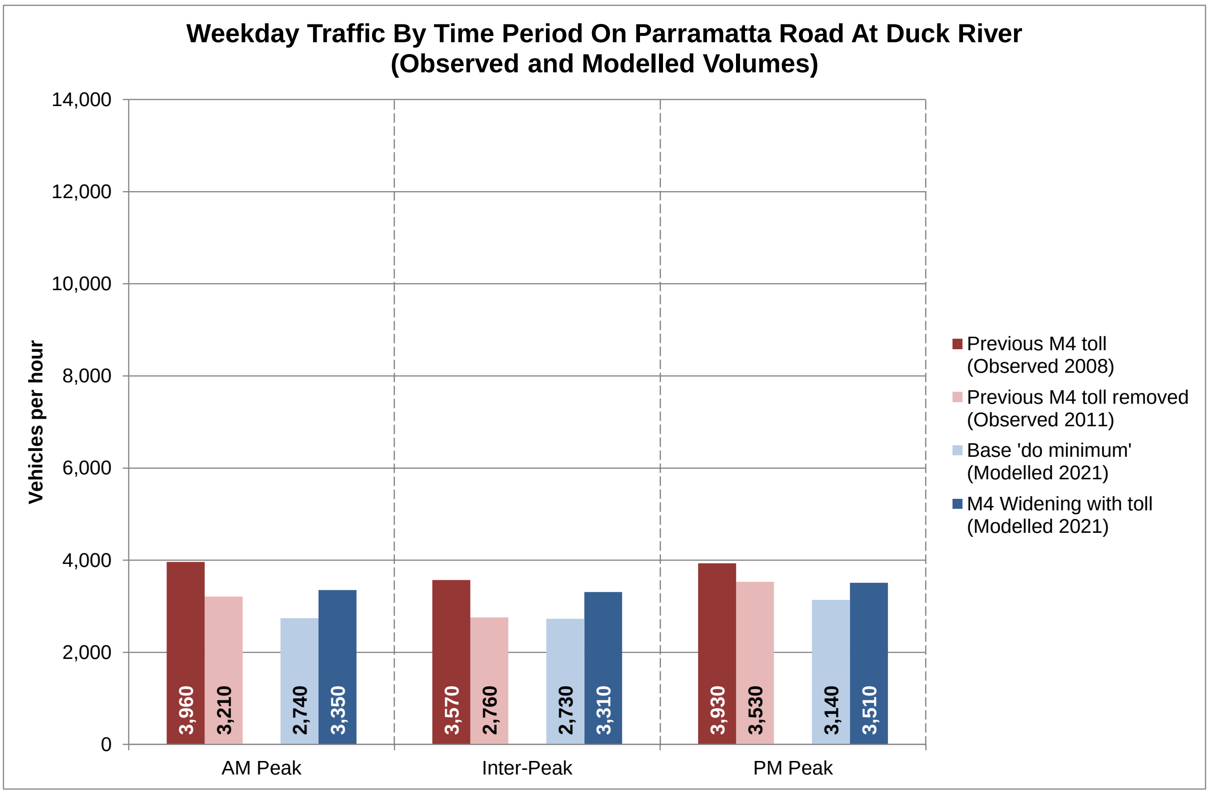
The M4 Motorway has previously operated with a single point toll. Overall weekday traffic on the M4 Motorway at the toll plaza was 23 per cent higher in 2010 after the removal of the toll than in 2009 with the toll. The M4 Motorway previously operated with a cashback scheme which would not apply when the M4 Widening project is tolled and open.

A comparison of the proportion of observed and modelled traffic volumes using the M4 Motorway and Parramatta Road under the previous and proposed tolling regime is shown in Figure 8.4.

A more simplified version showing the effects on Parramatta Road is presnted in Figure 8.5. As shown in this figure, the WRTM predicts that the M4 Widening would cause a 36 per cent reduction in M4 Motorway use at Duck River, whereas the previous M4 Motorway toll caused traffic at the toll plaza (equivalent to Duck River) to be reduced by approximately 23 per cent.

For Parramatta Road, traffic in the AM peak was 3,960 vehicles per hour in 2008 when the M4 Motorway was previously tolled and this reduced to 3,210 vehicles per hour in 2010 when the M4 Motorway toll was removed. The model predicts that with the reintroduction of a toll on the M4 Motorway, traffic numbers on Parramatta Road would increase to 3,350 vehicles per hour, which is less than when it was previously tolled.

For the PM peak, traffic on Parramatta Road was 3,930 vehicles per hour when the M4 Motorway was previously tolled in 2008 and reduced to 3,530 vehicles per hour when the toll was removed. The model predicts that with the tolled M4 Widening project, traffic numbers on Parramatta Road would increase to 3,510 vehicles per hour in the PM peak, which is again, less than it was with the previous toll.



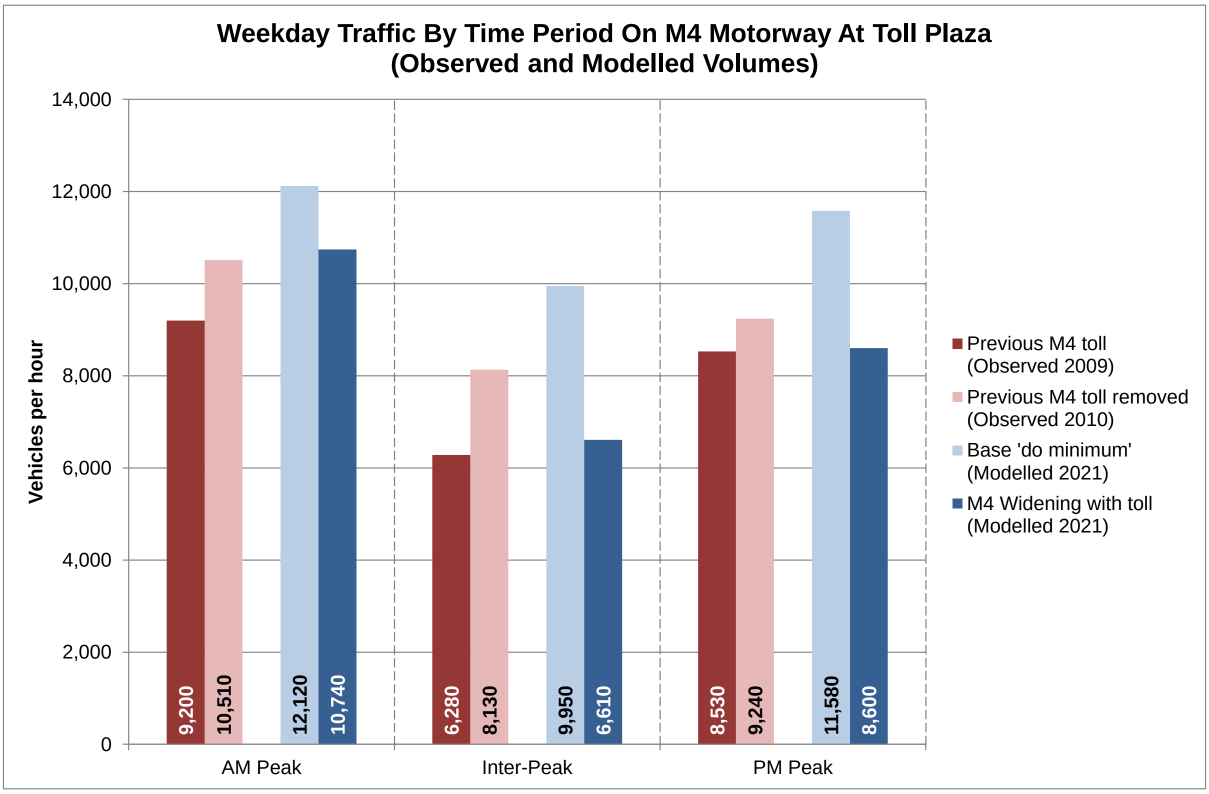
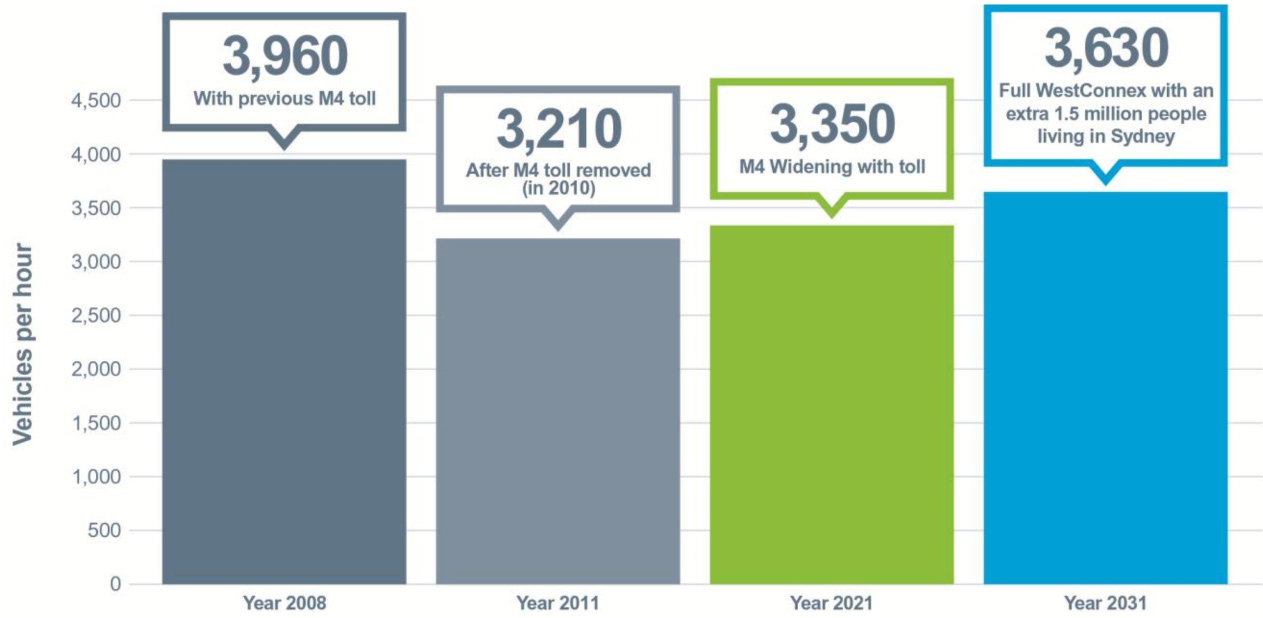


Figure 8.4 Response of weekday traffic volume to changing tolling scenarios

Weekday Traffic (AM) Parramatta at Duck River – Observed and modelled traffic volumes



Weekday Traffic (PM) Parramatta at Duck River – Observed and modelled traffic volumes

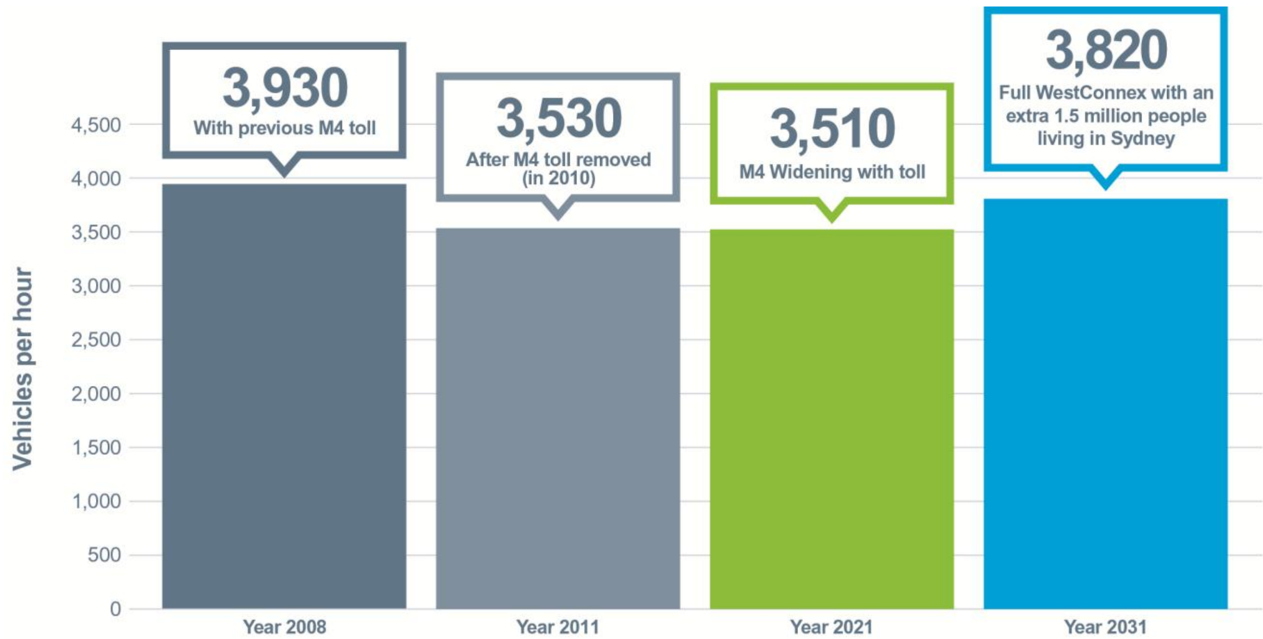


Figure 8.5 Comparison of hourly weekday traffic volume changes on Parramatta Road

While the analysis above presents hourly peak hour changes, Figure 8.6 shows a comparison of the average daily traffic volumes on Parramatta Road at Duck River and the M4 Motorway at the toll plaza over time. The figure illustrates the effect of the toll removal in 2010 when traffic volumes on Parramatta Road decreased. The figure also shows that with the M4 Widening and the reintroduction of the toll, average annual daily traffic volumes on Parramatta Road increase to a level similar to that experienced with the previous toll. Average annual daily traffic volumes on the M4 Motorway would increase as each stage of WestConnex is completed.

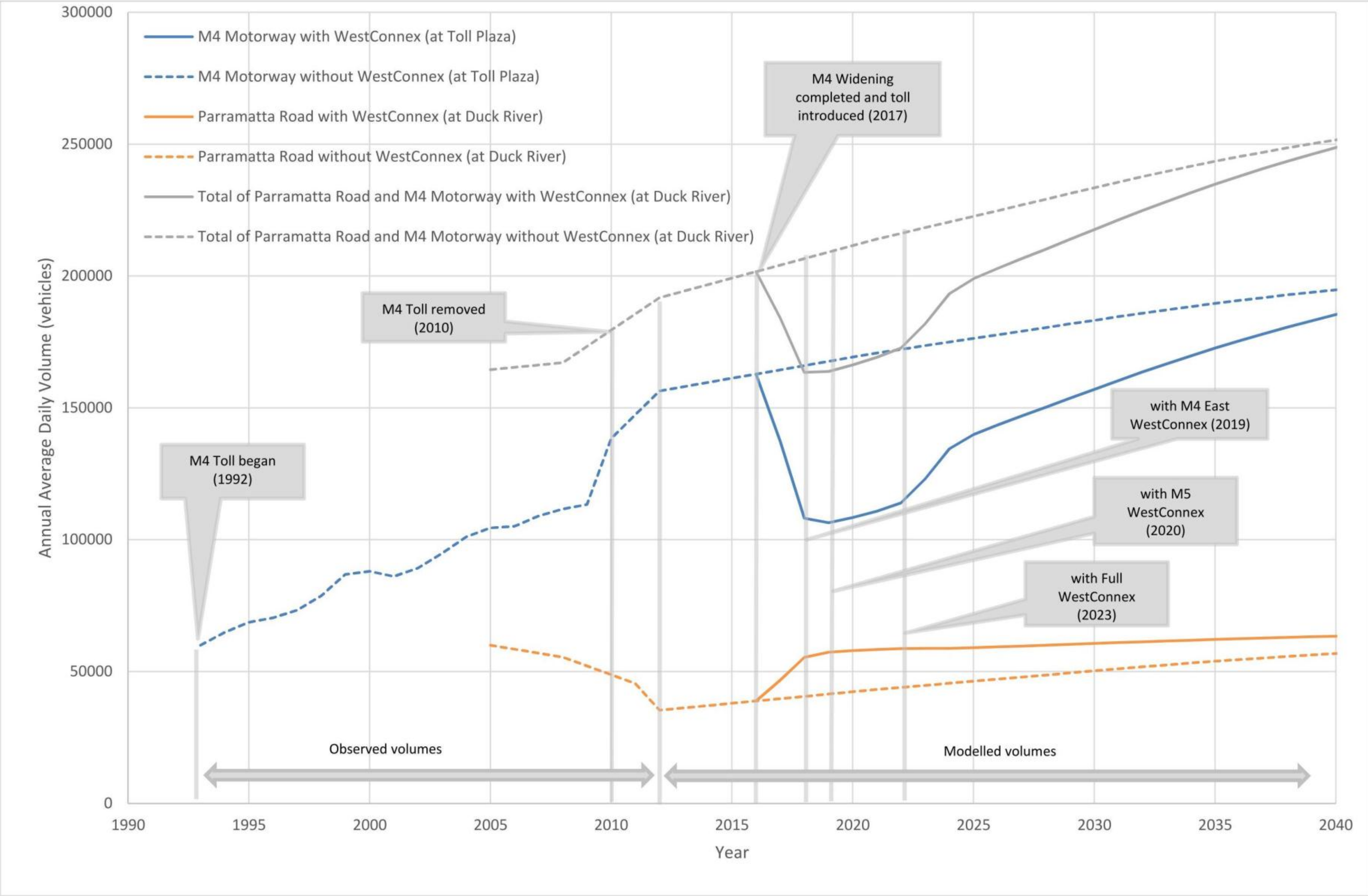


Figure 8.6 Comparison of traffic volumes on the M4 Motorway and Parramatta Road

Distribution of west-east traffic

The M4 Widening is expected to result in some growth in traffic on alternative west-east routes including Parramatta Road, Victoria Road and the M2 Motorway, primarily due to toll avoidance.

Table 8.5 shows modelled total number of vehicles on a typical weekday passing a specific 'screenline' point on key alternative west-east routes in 2021, with and without the M4 Widening project.

Table 8.5 Screenline volumes – Base 'do minimum' and M4 Widening scenarios

Road	Number of weekday vehicles	
	Base 'do minimum' (2021)	**M4 Widening (2021)**
M4 Motorway	179,620	114,890
Parramatta Road	43,990	59,370
M2 Motorway	118,050	123,940
Victoria Road	60,440	70,250

Table 8.6 is the future equivalent of Table 8.5. It shows a reduced impact on Parramatta Road and Victoria Road compared to the M4 Widening scenario as the broader network becomes more congested, increasing the travel time savings offered by M4 Motorway use.

Table 8.6 Screenline volumes – Future 'do minimum' and Full WestConnex scenarios

Road	Number of weekday vehicles	
	Future 'do minimum' (2031)	**Full WestConnex (2031)**
M4 Motorway	194,180	168,760
Parramatta Road	52,030	62,490
M2 Motorway	140,430	140,840
Victoria Road	68,250	75,770

These figures indicate that with the full WestConnex in 2031, the comparative diversion to Parramatta Road and Victoria Road is reduced, compared to with only the M4 Widening in 2021. As the population continues to grow and the broader network becomes more congested, the travel time savings offered by the M4 Motorway will become increasingly important and toll avoidance is expected to reduce.

Although the introduction of the toll with the M4 Widening causes some redistribution of trips to other roads in the network, the total number of vehicles using Parramatta Road in 2021 with the M4 Widening project (59,370) will be only marginally higher than the total number of vehicles using Parramatta Road in 2008 (55,477) when there was previously a toll on the M4 Motorway. This is despite the increase in population that will have occurred.

Modelling also indicates there would not be a significant increase in congestion on other parts of the network when compared with the 'do minimum' scenarios. For example, the same level of congestion is anticipated on Victoria Road in both the AM and PM peak periods with the full

WestConnex and without (Future ‘do minimum’ scenario). This indicates that the majority of trip redistribution to avoid the toll occurs outside of peak periods when the travel time on Victoria Road is lower and therefore the comparative benefit of using the M4 Widening is reduced.

Changes to travel times

Modelling indicates that there will be a 74 per cent travel time saving for motorists using the M4 Motorway when the full WestConnex is complete. Without the M4 Widening and remainder of the WestConnex projects, high levels of congestion would be experienced on the M4 Motorway in the future morning peak.

Modelling shows high levels of congestion on the M4 Motorway in the morning peak under the Base ‘do minimum’ scenario, with the eastbound trip from Church Street to Homebush Bay Drive taking 14 minutes. Under the M4 Widening scenario, this trip time reduces to approximately five minutes, a saving of approximately nine minutes. There would also be travel time savings in the westbound direction with this trip taking six minutes in the Base ‘do minimum’ scenario compared to five minutes in the M4 Widening scenario. The modelling shows that the M4 Motorway experiences much lower congestion in the evening peak than shown in the morning peak.

The model shows slight increases in Parramatta Road travel times with the M4 Widening scenario due to drivers avoiding the toll. For example, in the morning peak hour under the Base ‘do minimum’ scenario, the eastbound trip from Church Street to Homebush Bay Drive takes approximately 16 minutes. Under the M4 Widening scenario, this trip time increases to approximately 17 minutes. Similarly, in the westbound direction the average travel time in the morning peak on Parramatta Road increases from approximately 13 minutes under the Base ‘do minimum’ scenario to approximately 18 minutes under the M4 Widening scenario.

The increase in modelled travel times obtained for the morning peak remain consistent in the inter peak and evening peak periods.

The Future ‘do minimum’ scenario shows high levels of congestion on the M4 Motorway in the morning peak with the eastbound trip from Church Street to Homebush Bay Drive taking 19 minutes. This trip time reduces to about five minutes under the Full WestConnex scenario, a saving of 14 minutes or 74 per cent. There is also expected to be morning peak travel time savings in the westbound direction on the M4 Motorway. The westbound trip between Church Street and Homebush Drive is predicted to take 15 minutes under the Future ‘do minimum’ scenario compared to nine minutes under the Full WestConnex scenario.

In the evening peak under the Full WestConnex scenario, the M4 Motorway is expected to experience much lower congestion when compared to the morning peak. Beneficial travel time savings are also expected with the Full WestConnex operational. The eastbound trip from Church Street to Homebush Bay Drive is predicted to reduce from approximately 11 minutes under the Future ‘do minimum’ scenario to approximately five minutes under the Full WestConnex scenario. Similar travel time savings are expected for westbound travel.

In the future scenarios, increases in Parramatta Road travel times between Church Street and Homebush Bay Drive are likely to occur with, or without, implementation of the fully completed WestConnex. The modelling shows increases in Parramatta Road travel times with WestConnex due to drivers avoiding the M4 Widening toll. The most pronounced increase in travel time is predicted in the morning peak westbound journey with a six minute increase modelled.

As discussed in Section 8.1.3, a similar diversion of traffic onto Parramatta Road was observed when the toll was formerly implemented on the M4 Motorway, resulting in congestion through areas such as Auburn and Granville.

The NSW Government through the LTTMP is developing an integrated package of transport improvements with WestConnex including complementary enhancements to the existing road network including Parramatta Road. It is considered that the medium to long-term benefits of the improvements along with the completion of the full WestConnex would offset the short-term impacts for road users on Parramatta Road in this section.

Table 8.7, Table 8.8 and Table 8.9 present modelled travel times for the five scenarios presented above.

Table 8.7 Morning peak travel times between Homebush Bay Drive and Church Street

	Travel Time (minutes)			
	M4 Motorway		Parramatta Road	
Scenario	Eastbound	Westbound	Eastbound	Westbound
Existing case (2012)	12	5	14	12
Base ‘do minimum’ (2021)	14	6	16	13
M4 Widening (2021)	5	5	17	17
Future ‘do minimum’ (2031)	19	15	19	18
Full WestConnex (2031)	5	9	20	26

Table 8.8 Evening peak travel times between Homebush Bay Drive and Church Street

	Travel Time (minutes)			
	M4 Motorway		Parramatta Road	
Scenario	Eastbound	Westbound	Eastbound	Westbound
Existing case (2012)	5	7	12	13
Base ‘do minimum’ (2021)	6	7	14	14
M4 Widening (2021)	5	5	18	18
Future ‘do minimum’ (2031)	11	11	21	18
Full WestConnex (2031)	5	5	24	23

Table 8.9 Inter-peak travel times between Homebush Bay Drive and Church Street

	Travel Time (minutes)			
	M4 Motorway		Parramatta Road	
Scenario	Eastbound	Westbound	Eastbound	Westbound
Existing case (2012)	5	5	12	11
Base ‘do minimum’ (2021)	5	5	13	12
M4 Widening (2021)	5	5	16	16
Future ‘do minimum’ (2031)	8	5	16	13
Full WestConnex (2031)	5	5	18	18

In addition to the travel time savings discussed above, the M4 Widening project would also deliver improvements in travel time reliability. This benefit would generally result from:

- The increased lane capacity provided by the project would result in a smoother traffic flow without the stop / start conditions experienced currently.
- The additional lanes also provide spare capacity so that traffic is delayed to a lesser extent by minor incidents such as break downs and minor crashes (safety is discussed further below).

Interchange and intersection performance

A summary of interchange and intersection performance for sections of the project is provided below. Further detail on intersection performance indicators can be found in the *M4 Widening Traffic and Transport Working Paper* (Appendix *D*). The average delay assessed for signalised intersections is for all movements and is expressed in seconds per vehicle. It is generally accepted that in the long term (15 years plus), when future conditions have been taken into account, LoS should be D or better. In the short term, intersections should be operating at LoS C or better.

The traffic volumes used for the intersection analysis were taken from the WRTM. The analysis below is based on modelled traffic volumes as opposed to the actual traffic counts used to assess existing operations. The modelled trip distribution may differ from actual counts, within the tolerances allowed within the model, resulting in variations in operational performance from those obtained for the existing network assessment. The assessment of interchange and intersection performance using forecast future traffic volumes without the M4 Widening project (being the Future 'do minimum' scenario) is undertaken to provide a base case against which to evaluate the impact of the project under the same forecast future traffic conditions.

Roads and Maritime will continue to prioritise improvements to the overall network including prioritising works to address intersection congestion where required.

Granville

Modelling shows that with the M4 Widening, the morning peak would result in reduced performance at Parramatta Road intersections due to increased traffic volumes, with road users seeking to exit the tolled motorway to use Parramatta Road as an alternative.

The M4 Widening is not expected to result in a large change in intersection performance, with improved performance at the Parramatta Road/Bold Street intersection offsetting worse performance at the neighbouring Parramatta Road/Good Street intersection.

Modelling indicates that, with and without the full WestConnex, intersections are generally operating over capacity, although under the Full WestConnex scenario, further deterioration in level of services is expected at the Parramatta Road/Good Street intersection during the morning peak (from LoS D to F).

Clyde and Rosehill

Modelling indicates that with the M4 Widening in the morning peak, two of the four modelled intersections in Clyde/Rosehill operate under capacity with no significant performance issues when compared with the Base 'do minimum' flows. However, the intersection of James Ruse Drive and Prospect Street is expected to be operating at capacity with more congestion when compared to the situation without the project.

With the M4 Widening, in the evening peak the intersections of James Ruse Drive with Parramatta Road and Prospect Street are expected to be operating over capacity with the other intersections operating under capacity.

Modelling indicates that under the Full WestConnex scenario, in the morning peak three of the four modelled intersections would be operating above capacity. The intersection of James Ruse Drive/Prospect Street and James Ruse Drive/M4 Motorway westbound off-ramp are expected to be more congested with the full WestConnex than without.

Auburn

Modelling indicates that with the M4 Widening morning peak, performance would be similar with and without the M4 Widening at the intersections of Silverwater Road/M4 Motorway eastbound ramps and Silverwater Road/Parramatta Road. The intersection of Silverwater Road/Carnarvon Street is expected to operate at capacity and LoS D, which is better than the situation without the M4 Widening. The intersection of Silverwater Road/M4 Motorway westbound ramps intersection is expected to improve to LoS B compared to LoS D without the M4 Widening.

In the evening peak, the intersection of Silverwater Road/Carnarvon Street is expected to operate at capacity with a LoS C, which is better than the situation without the M4 Widening. The intersection of Parramatta Road/Rawson Street/Duck Street shows deterioration in performance when compared to the situation without the M4 Widening.

Under the Full WestConnex scenario, in the morning peak, four of the five intersections are expected to be operating above capacity, with the remaining intersection at capacity. There is minimal difference with and without WestConnex. In the evening peak the intersections of Silverwater Road/Carnarvon Street and Silverwater Road/Parramatta Road operate in excess of their theoretical capacity. Performance with and without WestConnex is expected to be similar.

Lidcombe and Sydney Olympic Park

With the M4 Widening in the morning peak, the intersection of Hill Road/Parramatta Road is expected to experience an increase in traffic when compared to the situation without the M4 Widening. This causes the intersection to operate at LoS F and well beyond capacity. Network issues at the M4 Motorway off-ramp and the Hill Road/Carter Street intersection would be further exacerbated with the M4 Widening due to an increase in traffic.

With the M4 Widening in the evening peak, the intersection of Hill Road/Parramatta Road is expected to experience an increase in traffic. As with the morning peak this causes the intersection to operate at LoS F and well beyond capacity. Network issues at the M4 Motorway off-ramp and the Hill Road/Carter Street intersection would be further exacerbated with the M4 Widening due to an increase in traffic.

Under the Full WestConnex scenario morning peak and evening peak, further increases in traffic yield are likely to mean poor performance in the Hill Road corridor, with minimal difference with and without WestConnex.

The M4 Motorway off-ramp after the WestConnex is complete is expected to improve in performance due to a reduction in off-ramp traffic. A reduction in traffic into and out of Carter Street with WestConnex is expected to see a substantial improvement in the performance of this intersection.

Homebush West and Strathfield
The inclusion of an additional on-ramp servicing the M4 Motorway and the removal of the right turn movement from Homebush Bay Drive southbound to the existing westbound M4 Motorway on-ramp would deliver significant improvements for the Centenary Drive/M4 Motorway westbound ramps. Similar improvements in performance are also expected under the Full WestConnex scenario.

North Strathfield and Strathfield
With and without the M4 Widening the morning peak and evening peak three of the four modelled intersections in Strathfield and North Strathfield operate under capacity. In both scenarios the Concord Road/Leicester Avenue/Parramatta Road intersection is expected to exceed capacity in both the morning peak and evening peak.

Under the Full WestConnex scenario, morning peak and evening peak is expected to see the Concord Road/Leicester Avenue/Parramatta Road remain over capacity at LoS F. The morning peak at the intersection of M4 Motorway/Parramatta Road is expected to see improved performance operating at LoS C which compares favourably with a LoS F without WestConnex.

Freight transport

Modelling indicates that without the M4 Widening there would be substantial heavy vehicle traffic on the M4 Motorway west of Westmead, and consistently high volumes along the M4 Motorway.

Table 8.10 presents the daily heavy commercial vehicle traffic volumes with M4 Widening and indicates a forecast redistribution of heavy vehicles to Parramatta Road and other network routes.

Table 8.10 Weekday heavy commercial vehicle distribution – Base ‘do minimum’ and M4 Widening scenarios

	Number of weekday heavy commercial vehicles	
Road	**Base ‘do minimum’ (2021)**	**M4 Widening (2021)**
M4 Motorway	27,060	13,138
Parramatta Road	1,408	3,517
M2 Motorway	12,542	13,984
Victoria Road	5,862	7,363

When all WestConnex projects are completed, there is expected to be less redistribution of heavy vehicle traffic away from the M4 Motorway than immediately after the M4 Widening’s construction due to overall increasing network congestion as Sydney’s population grows by more than 1.5 million people. This will over time make a quicker trip on a tolled road more attractive and there is expected to be a gradual drift of toll avoiding drivers back to using the motorway.

Road safety

The M4 Widening is likely to improve road safety, with up to 36 fewer crashes a year on the combined M4 Widening/Parramatta Road corridor.

Traffic modelling can be used to estimate the number of crashes on the M4 Motorway and Parramatta Road with and without the M4 Widening using an assumed number of crashes per vehicle kilometre travelled. Table 8.11 presents modelled crash estimates for the Existing case, Base ‘do minimum’ and M4 Widening scenarios.

These figures show a decline in crashes on the widened M4 Motorway as a result of reduced vehicle kilometres travelled. There is a corresponding forecast relocation of traffic and therefore crashes to Parramatta Road as some motorists would use this road to avoid the toll. The overall number of crashes in the corridor is expected to be lower with the M4 Widening (four per cent less crashes with casualties).

Table 8.11 Crash estimates for the M4 corridor (including both Parramatta Road and the M4 Motorway) between Parramatta and Homebush Bay Drive

	Existing case (2012)	Base ‘do minimum’ (2021)	M4 Widening (2021)
Crashes with casualties	142	160	154
Crashes without casualties	230	257	227

Induced traffic

An assessment of ‘induced demand’ (ie additional traffic on the road network that might result from implementation of the project) was carried out by the BTS using the STM. The assessment showed that no significant increase in overall road traffic demand was anticipated as a result of the project.

Impacts on bus services

Tolling of the widened M4 Motorway is expected to lead to traffic volume increases on Parramatta Road between Granville and North Strathfield and also on Victoria Road. This additional traffic is expected to affect buses in a similar way to general traffic. Parramatta Road between Granville and Strathfield is not a priority bus route between Parramatta and Sydney CBD in the LTTMP. Buses either cross Parramatta Road or utilise parts of Parramatta Road to a limited extent.

Increased travel times of up to four minutes for buses using Parramatta Road are expected to be as follows under the M4 Widening scenario:

- Route M92: This Metrobus route has approximately nine minutes scheduled time for peak period trips on Parramatta Road between James Ruse Drive and John Street, Lidcombe. The additional journey time would be between 1.6 and 3.4 minutes per one way bus journey if the travel time impact for buses is proportional to the impact for general traffic.
- Route 909: This route has a scheduled peak period running time of 10 minutes on Parramatta Road between Alfred Street, Granville and Station Road, Auburn. The additional journey time would be up to four minutes per one way bus journey if the travel time impact for buses is proportional to the impact for general traffic.
- Route 450, 525 and 526: These routes deliver a combined peak frequency of 10 buses per hour over the one kilometre between Underwood Road and Leicester Avenue, Strathfield. Modelling shows that no substantial travel time increase over this section of Parramatta Road is expected.

For the bus routes crossing Parramatta Road, there are likely to be additional delays incurred due to the need to cross an increased east-west general traffic flow on Parramatta Road. However, there are also some small traffic reductions on roads elsewhere along these routes so the net impacts may be considered negligible.

Three Sydney Olympic Park special event routes are likely to incur some delays which will vary in severity according to traffic conditions on Parramatta Road at different times in the day.

With the M4 Widening there is a small diversion of general traffic from the M4 Motorway to Great Western Highway between the Cumberland Highway junction and Pitt Street, Parramatta. This section already has Transitway bus priority facilities which are sufficient to minimise the impact of the diverted traffic on bus service operations.

During the commuter peak periods there are currently 10 buses per hour on Church Street, Parramatta between Great Western Highway and Granville. There are limited bus priority measures currently provided on this road, but it does operate with peak period clearway conditions. The traffic flow is likely to increase with the M4 Motorway Widening in place and this is expected to affect traffic speeds and therefore service reliability for the four bus routes involved (M91, 810, 811 and 907).

Traffic volumes on Homebush Bay Drive are expected to fall following the opening of the M4 Widening. Only one existing regular bus route would benefit from this small change in traffic volume – the peak hours only route 533 from Chatswood to Sydney Olympic Park. These buses are allowed approximately eight minutes in the current timetable for travel between Rhodes and Underwood Road.

Five Sydney Olympic Park special event bus routes that use Homebush Bay Drive would also benefit from the slightly reduced traffic volumes during peak periods.

Leicester Avenue at Strathfield is the route used by cross regional services 450, 459, 525 and 526. Between 11 and 12 buses per hour currently travel over this section of road. Sydney Olympic Park special event bus route 4 also uses Leicester Avenue. Traffic levels on this stretch of road are expected to decline marginally following implementation of the M4 Widening project and this should help to improve bus service reliability on these routes. For route 459, traffic volumes on Concord Road north of Parramatta Road are likely to be lower with the M4 Widening, so this route is likely to benefit from some limited time savings.

Opportunities to improve public transport patronage would be considered as part of the urban revitalisation of Parramatta Road currently being developed by Urban Growth in partnership with Transport for NSW and DP&E. Opportunities could include priority bus measures at key intersections however these are not considered further as part of the M4 Widening project.

Impacts on rail services

While the project is not expected to induce travel demand, the M4 Widening would encourage a modal shift from road to rail for some travellers where rail offers a potential alternative.

Increased traffic volumes on the local road network may have some effect on access to rail stations by bus and car with about half of all rail passengers (across the rail network) accessing stations by these modes. However, station access is only one component of the overall passenger trip. Given the high frequency of train services at all stations in the area (with the exception of the Carlingford Line services) access delays are likely to have only a minimal impact on mode choice.

Overall the M4 Widening project is expected to have some marginal impacts on rail patronage but the net effect is unlikely to be significant.

Impact on pedestrians and cyclists

The redistribution of west–east traffic away from the M4 Motorway would increase traffic on alternative parallel routes, particularly Parramatta Road which is used by pedestrians and cyclists. The signalised intersections along Parramatta Road have controlled pedestrian crossings and these facilities would not be impacted by the project. Therefore, pedestrian ability to cross Parramatta Road would not be impacted by the increase in traffic volumes on the road. The M4 Widening project does not impact on local or arterial roads and their associated footpaths.

The off-road pedestrian and shared paths described in section 8.1.2 would be maintained and cyclists would continue to be able to use the shoulders of the M4 Motorway west of Church Street as is the case at present. Motorway ramp bicycle crossings would be provided in accordance with standard motorway design practice. Therefore, no operational impacts on cyclists and pedestrians are expected as a result of the M4 Widening project.

Cumulative traffic and transport impacts

The M4 Widening is expected to alleviate congestion on the M4 Motorway. On its own, widening of the M4 Motorway would allow improved traffic flows and faster travel times along its route, but will not address or alleviate congestion on Parramatta Road east of Concord Road. When the M4 East project is delivered a few years after the M4 Widening a cumulative benefit is expected with alleviated congestion at the eastern end of the M4 Motorway along Parramatta Road.

Strategic modelling also indicates that when all WestConnex projects are operational an average of around 4,500 fewer trucks and 20,000 fewer cars per day are expected to travel on the section of Parramatta Road between Concord Road and Camperdown. This strategic modelling was based on the same traffic assumptions as the M4 Widening traffic assessment.

Other developments in the Sydney motorway network are likely to affect and be affected by the M4 Widening. These include completion of the M5 Motorway widening and construction of NorthConnex. Under current motorway network operations, the existing M4 Motorway provides an untolled alternative to east-west travel, and attracts patronage from travellers for whom the M2 Motorway and M5 Motorway provide shorter tolled alternatives. Widening of these motorways makes them more attractive than the future widened and tolled M4 Motorway. These changes in the road network have been incorporated into the WRTM and are reflected in traffic forecasts.

The NSW Government's strategy for the rail network across Sydney is presented in Sydney's Rail Future, Modernising Sydney's Trains (Sydney's Rail Future) (TfNSW, 2012). The focus of the Government's approach is to modernise Sydney's rail network so that it is better able to meet forecast demand. A significant component of the approach is to provide customers with real alternatives to using their car or other transport modes.

Specific components of the strategy aim to address existing capacity constraints on the Main Western Rail Line in the M4 Motorway corridor:

- Operational pattern changes to facilitate the reliable operation of a 20 trains per hour peak service on the Main Western Rail Line.
- A greater focus on express services to/from the Sydney CBD for Parramatta, Blacktown and Penrith.
- Provision of a Lidcombe turnback for T3 Bankstown Rail Line services, releasing capacity for both T1 Western Rail Line and T2 Inner West and South Rail Line services.

- The introduction of high frequency metro-style services on the future North West Rail Link will give customers from the North West an attractive alternative service to the Main Western Rail Line for travel to and from the Lower North Shore and CBD.
- In the longer term, the second harbour crossing and new CBD rail line will significantly increase the capacity of the rail network with up to 14 additional trains per hour possible on the Main Western Rail Line.
- On the Blue Mountains Rail Line, signalling improvements will support faster journey times and rolling stock improvements, including potentially longer trains to meet growing demand, will deliver a more attractive rail service for longer distance customers in this corridor.

The cumulative effect of rail network improvements would result in a change to the use of rail and road travel in the M4 Motorway corridor.

8.1.6 Environmental management measures

Options development and concept design investigations described in Chapters 4 and 5 have sought to minimise traffic and transport impacts as far as possible.

Project-specific management and mitigation measures have been developed with the aim of minimising or mitigating, as far as practical, the traffic and transport impacts during construction and operation as described above. The management and mitigation measures draw on best management practice, government standards and guidelines, and specialist knowledge. Potential impacts and site-specific management measures identified to manage those impacts for implementation during the pre-construction, construction and operational phases are summarised in the table below.

Impact	REF#	Environmental management measures	Responsibility	Timing
Construction traffic and road safety impacts	TT-1	• A traffic and transport liaison group will be established prior to commencement of construction. The traffic and transport liaison group will be consulted during preparation of the construction traffic management plan to ensure impacts are minimised.	WDA Contractor	Pre-Construction
Construction traffic and road safety impacts	TT-2	• A construction traffic management plan will be developed, approved, implemented and monitored as part of the project. The construction traffic management plan would focus on maintaining general traffic flow and specifying appropriate site accesses and construction traffic routes. It would include: – Traffic Control Plans showing the access arrangements and the detail of required signs and devices – Vehicle Management Plans showing access to work sites and direction of travel – Pedestrian and Cyclist Management Plans	Contractor	Pre-construction

Impact	REF#	Environmental management measures	Responsibility	Timing
		– Management strategy for other road users – Management strategy for access to adjacent properties – Hours of operation, including prohibitions on queuing outside sites prior to commencement of working hours – Road safety audit requirements – Any localised improvements/adjustments to existing traffic management arrangements.		
Construction impacts on motorway traffic and local roads	TT-3	Construction staging and temporary works will be developed and implemented to minimise conflicts with the existing road network and to maximise the separation between work areas and travel lanes.	Contractor	Construction
Construction impacts on motorway traffic and local roads	TT-4	Lane occupancies will be planned with the aim of minimising the actual work area, limiting obstructions and restrictions, maximising road capacity and avoiding peak traffic periods.	Contractor	Construction
Construction impacts on motorway traffic	TT-5	Existing motorway capacity will be maintained during the morning peak and evening peak periods by maintaining the number of through lanes.	Contractor	Construction
Construction impacts on motorway traffic	TT-6	Monitoring of the motorway and work sites will be undertaken using CCTV and mobile patrols where required to assist management of incidents.	Contractor	Construction
Construction impacts on pedestrians and cyclists	TT-7	Access for bicycles along the motorway (where currently available) will be maintained or an alternative route provided and signposted, with the exception of times when work is being undertaken in the shoulder. This work will include temporary diversions or stop/go conditions under traffic control.	Contractor	Construction
Construction impacts on pedestrians and cyclists	TT-8	Access to existing shared paths will be maintained subject to the need for temporary diversions.	Contractor	Construction
Network performance	TT-9	An operational traffic review will be undertaken within 12 months of opening to confirm the operational traffic impacts of the project on the M4 Motorway and parallel road and their major intersections. The assessment will be based on actual traffic counts and will assess the level of service at major intersections between Pitt Street and Homebush Bay Drive along the M4	WDA / Roads and Maritime	Operation

Impact	REF#	Environmental management measures	Responsibility	Timing
		Motorway and on Parramatta Road. Where necessary, the outcomes of the operational traffic review will be used to identify opportunities for any further operational refinement to optimise the performance of the project. This could include intersection treatments, changes to lane configurations or changes to signal phasing.		

8.2 Noise and vibration

This section reviews the potential noise and vibration impacts of the project. Full details of the assessment undertaken are presented in the *WestConnex M4 Widening Construction and Operational Road Traffic Noise and Vibration Impact Assessment* (SLR, 2014) (Volume 2 – Working Paper E) with a summary provided below. The assessment has been prepared to address relevant DGRs as documented in the table below.

Director-General's Requirements	Where addressed in EIS
• An assessment of the noise impacts of the project during operation, consistent with the Road Noise Policy (Environment Protection Authority 2011). The assessment must include specific consideration of impacts to receivers (dwellings, child care centres, educational establishments, hospitals, motels, nursing homes, or places of worship), as relevant and identify reasonable and feasible mitigation measures.	Section 8.2.3
• An assessment of construction noise and vibration impacts, consistent with the Interim Construction Noise Guideline (Department of Environment, Climate Change and Water 2009), and Assessing Vibration: a technical guideline (Department of Environment and Conservation 2006).	Section 8.2.4 – 8.2.6

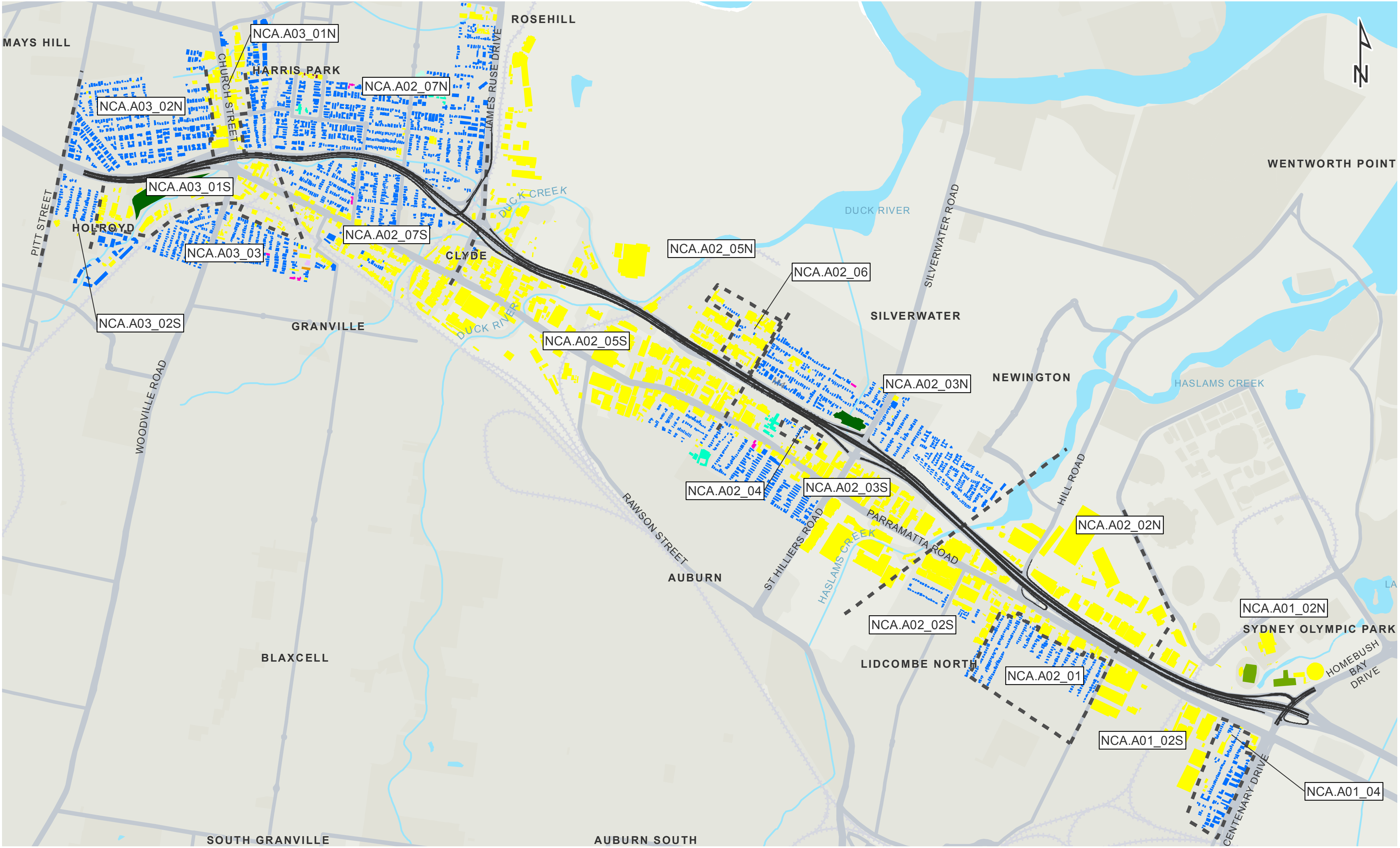
8.2.1 Existing environment

The existing ambient noise environment surrounding the project corridor is typical of urban and suburban areas where the ambient noise environment is primarily influenced by road traffic. Noise levels are typically lower at night when compared with daytime and evening periods. This is characteristic of urban and suburban areas where the ambient noise environment is primarily influenced by road traffic.

There are a range of noise sensitive receivers adjacent to the project corridor. All residences (such as hotels, hostels and apartments) are considered to be sensitive receivers during both construction and operation. All commercial receivers are considered to be sensitive to construction noise and vibration impacts and operational vibration impacts. Other nearby receivers sensitive to noise and vibration during both construction and operation include educational institutions, child care centres, hospitals, nursing homes, places of worship and open space.

Figure 8.7 shows the location of the various types of sensitive receptors as well as the noise catchment areas (NCA) (14 in total) that have been used for assessment.

To quantify and characterise the existing ambient noise environment across the proposal both unattended and attended noise monitoring was undertaken during February and March 2013. Figure 8.7 shows the locations where unattended noise monitoring occurred. The results of the noise monitoring are reported in section 4.5 and section 4.6 of the Noise and Vibration Working Paper.



KEY

- Project design
- Noise catchment areas

Sensitive receivers

- Commercial
- Open Space (Active)
- Open Space (Passive)
- Other (Childcare)
- Other (Educational)
- Other (Library)
- Other (Medical)
- Other (Place of Worship)
- Other (Public Building)
- Residential

0 0.5 1
Km

Noise sensitive receivers and NCAs **Figure 8.5**

8.2.2 Noise and vibration criteria

Road traffic noise

For traffic operating on public roads, the *NSW Road Noise Policy* (EPA, 2011) (RNP) provides criteria for assessing potential road traffic noise impacts. Table 8.12 shows the residential criteria while Table 8.13 provides the criteria for other land uses.

Table 8.12 RNP criteria – residential

Road Category	Type of Project/Land Use	Assessment Criteria (dBA)	
		Daytime (7 am – 10 pm)	**Night-time (10 pm – 7 am)**
Freeway/arterial/ sub-arterial roads	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	LAeq(15hour) 60 (external)	LAeq(9hour) 55 (external)

Table 8.13 RNP criteria – other sensitive land uses

Existing Sensitive Land Use	Assessment Criteria (dBA)		Additional Considerations
	Daytime (7 am – 10 pm)	**Night-time (10 pm – 7 am)**	
School Classrooms	LAeq(1hour) 40 (internal)	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
Places of Worship	LAeq(1hour) 40 (internal)	LAeq(1hour) 40 (internal)	The criteria are internal, ie the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established which activities in these areas may be affected by road traffic noise.
Open Space (Active Use)	LAeq(15hour) 60 (external) when in use	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
Open Space (Passive Use)	LAeq(15hour) 55 (external) when in use	-	Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg playing chess, reading.

In addition to the noise criteria in Table 8.12 and Table 8.13, the RNP describes a ‘Relative Increase Criteria’ of 12 dB above existing traffic noise. This criterion is primarily intended to protect existing quiet areas from excessive changes in noise. For a road in the same location, and with the same mix in traffic, a 12 dB increase in road traffic noise levels would require a 16-fold increase in traffic.

Sleep disturbance

Guidance for the assessment of sleep disturbance given in the RNP is reproduced as follows:

> *‘Triggers for, and effects of sleep disturbance from, exposure to intermittent noise such as noise from road traffic are still being studied. There appears to be insufficient evidence to set new indicators for potential sleep disturbance due to road traffic noise. The NSW Roads and Traffic Authority’s Practice Note 3 (NSW Roads and Traffic Authority 2008) outlines a protocol for assessing and reporting on maximum noise levels and the potential for sleep disturbance.’*

The *Environmental Noise Management Manual* (ENMM) – Practice Note III (Roads and Traffic Authority (RTA) 2001) protocol for assessing the potential for sleep disturbance is determined by performing LAFmax – LAeq(1hr) calculation on individual vehicle passby noise measurements. The number of night-time passby events where the LAFmax – LAeq(1hr) difference is greater than 15 dB is to be determined.

With regard to reaction to potential sleep disturbance events, the RNP gives the following guidance:

> *‘From the research on sleep disturbance to date it can be concluded that:*
>
> - *maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep*
> - *one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.’*

It is generally accepted that internal noise levels in a dwelling, with the windows open are 10 dB lower than external noise levels. Based on a worst case minimum attenuation (windows open) of 10 dB, the first conclusion above suggests that short term external noises of 60 dBA to 65 dBA are unlikely to cause awakening reactions.

The second conclusion suggests that one or two noise events per night with maximum external noise levels of 75 dBA to 80 dBA are not likely to significantly affect health and wellbeing.

Construction noise

The *Interim Construction Noise Guideline* (DECCW 2009) requires project specific Noise Management Levels (NMLs) to be established for noise affected receivers. In the event construction noise levels are predicted to be above the NMLs, all feasible and reasonable work practices need to be investigated to minimise noise emissions.

NMLs for residential receivers are set at the overall single-figure background noise level (known as RBL) plus 10 dBA during recommended standard hours for construction, and RBL plus 5 dBA for construction outside the recommended standard hours. Receivers are considered to be highly noise affected if daytime $LA_{eq15minute}$ construction noise levels exceed 75 dB(A).

Table 8.14 shows the NMLs for residential receivers by NCA as well as the sleep disturbance screening criterion.

Table 8.14 Residential receiver NMLs for construction

NCA	Receiver Type	Standard Construction (RBL[1] + 10dBA)	Out of Hours (RBL[1] + 5dbA)			Sleep disturbance (RBL[1] + 15dbA)
		Day	Day[2]	Evening	Night	
East of project area (Welfare Street)	Residential	58	53	53	51	61
NCA.A01_04_RES	Residential	66	61	59	55	65
NCA.A02_01_RES	Residential	62	57	57	52	62
NCA.A02_03N_RES	Residential	65	60	57	54	64
NCA.A02_03S_RES	Residential	68	63	63	59	69
NCA.A02_04_RES	Residential	68	63	63	59	69
NCA.A02_06_RES	Residential	66	61	60	54	64
NCA.A02_07N_RES	Residential	62	57	57	51	61
NCA.A02_07S_RES	Residential	61	56	56	50	60
NCA.A03_02N_RES	Residential	68	63	63	56	66
NCA.A03_02S_RES	Residential	65	60	60	54	64
NCA.A03_03_RES	Residential	65	60	60	54	64

[1] RBL: Rating background level

[2] Saturday 1.00pm to 6.00pm and Sunday 8.00am to 6.00pm

Table 8.15 NMLs for other sensitive receptors

Land Use	NML LAeq(15minute) (Applied when the property is in use)
Classrooms at schools and other education institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of Worship	Internal noise level 45 dBA
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg reading, meditation)	External noise level 60 dBA
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS 2107 for specific uses.

For sensitive receivers such as schools and places of worship, the NMLs presented in Table 8.18 are based on internal noise levels. For the purpose of the assessment, it has been conservatively assumed that all schools and places of worship have windows that can be opened. On the basis that external noise levels are typically 10 dB higher than internal noise levels when windows are open, an external LAeq (15 minute) NML of 55 dBA has been adopted.

The Interim Construction Noise Guideline and AS2107 does not provide specific guideline noise levels for childcare centres. Childcare centres generally have internal play areas and sleep areas. For internal play areas an internal NML of LAeq (15 minute) 55 dBA has been adopted and for sleeping areas, an internal NML of LAeq (15 minute) 40 dBA (when in use) has been adopted.

For commercial premises, including offices, retail outlets and small commercial premises an external NML of LAeq (15 minute) 70 dBA has been adopted. An external NML of LAeq (15 minute) 75 dBA has been adopted for industrial premises.

Construction traffic noise

When trucks and other vehicles are operating within the boundaries of the various construction sites, road vehicle noise contributions are included in the overall predicted LAeq (15 minute) construction site noise emissions. When construction related traffic moves onto the public road network a different noise assessment methodology is applied, as vehicle movements would be regarded as 'additional road traffic' rather than as part of the construction site.

The Interim Construction Noise Guideline does not provide specific guidance in relation to acceptable noise levels associated with construction traffic. For assessment purposes, guidance is taken from the RNP. One of the objectives of the RNP is to apply relevant permissible noise increase criteria to protect sensitive receivers against excessive decreases in amenity. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

On this basis, construction traffic NMLs set at 2 dB above the existing road traffic noise levels during the daytime and night-time periods are considered appropriate to identify the onset of potential noise impacts.

Construction vibration

Vibration damage goals

British Standard BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2 sets guide values for vibration based on the lowest vibration levels above which damage has been credibly demonstrated. Table 8.16 shows the recommended guideline limits.

Table 8.16 Transient vibration guide values – Minimal risk of cosmetic damage

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and Above
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Unreinforced or light framed structures. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Note that where continuous vibration gives rise to magnification of vibration by resonance (specific conditions where the structure can readily store and transfer vibration energy), then the guide values in Table 8.16 may need to be reduced by up to 50 per cent.

For most sources of intermittent vibration during construction, such as rockbreakers, piling rigs, vibratory rollers and excavators, the predominant vibration energy occurs at frequencies usually in the 10 Hz to 100 Hz range. On this basis a vibration damage screening level of 7.5 mm/s has been adopted for the purpose of assessing potential impacts.

In the lower frequency region below 4 Hz the guide values for building types are reduced as a high displacement is associated with relatively low peak component particle velocity. To minimise risk of structural damage a guide value of 3.7 mm/s has been adopted.

Human comfort goals for construction vibration
For most construction activities that generate perceptible vibration in nearby buildings, the character of the vibration emissions is intermittent. The publication *Assessing Vibration: a technical guideline* (DEC, 2006) nominates preferred and maximum vibration goals for critical areas, residences and other sensitive receptors. Refer to Table 8.17.

Table 8.17 Preferred and maximum vibration dose values for intermittent vibration

Location	Daytime ($m/s^{1.75}$)		Night time ($m/s^{1.75}$)	
	Preferred	Maximum	Preferred	Maximum
Critical areas (eg hospital operating theatres, precision laboratories)	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Table 8.18 shows indicative safe working distances for some construction activities (depending on specific type of plant and geotechnical conditions) (Transport for NSW, 2012)

Table 8.18 Recommended working distances for vibration intensive plant

Plant Item	Rating/Description	Working Distance	
		Cosmetic Damage BS 7385	Human Response BS 6472
Vibratory Roller	<50kN (Typically 1-2 tonnes)	5m	15 to 20m
	<100kN (Typically 2-4 tonnes)	6m	20m
	<200kN (Typically 4-6 tonnes)	12m	40m
	<300kN (Typically 7-13 tonnes)	15m	100m
	>300kN (Typically 13-18 tonnes)	20m	100m
	>300kN (>18 tonnes)	25m	100m
Small Hydraulic Hammer	300kg – 5 to 12 t excavator	2m	7m
Medium Hydraulic Hammer	900kg – 12 to 18t excavator	7m	23m
Large Hydraulic Hammer	1600kg – 18 to 34t excavator	22m	73m
Vibratory Pile Driver	Sheet piles	2 to 20m	20m
Pile Boring	≤800mm	2m (nominal)	N/A
Jackhammer	Hand held	1m (nominal)	Avoid contact with structure

8.2.3 Assessment of potential operational noise impacts

Approach to assessment

To assess road traffic noise impacts noise modelling of the project area was carried out. The modelling allows for traffic volume and mix, type of road surface, vehicle speed, road gradient, reflections off building surfaces, ground absorption and shielding from ground topography and physical noise barriers. The model calculates noise levels at receiver points for every ground and first floor facade of each noise sensitive receiver over the entire project area. The Noise and Vibration Working Paper includes further details on noise model inputs, assumptions and validation.

Noise modelling was undertaken using traffic modelling outputs based on the following scenarios. Predicted noise levels were then considered against RNP criteria.

- **Base 'do minimum' ('no build')** - forecast road traffic volumes assuming that the M4 Widening and the remainder of the WestConnex projects are not built (2017).
- **M4 Widening ('build')** - forecast road traffic volumes with the widened M4 Motorway, without any other WestConnex projects (2017).
- **Future 'do minimum' (10 years after project opening) 'no build' -** the road traffic volumes due to general traffic growth that would have occurred without the M4 Widening or other WestConnex project (2027).
- **Full WestConnex (10 years after project opening) 'build'** - the road traffic volumes based on worst-case traffic assuming all WestConnex project are operational (2027).

Predicted operational noise levels

Due to the forecast reduction in traffic volumes, the total road traffic noise at receivers adjacent to the M4 Motorway is generally predicted to reduce as a result of the project. Exceptions to this are adjacent to the new viaduct and at locations near to secondary roads that are forecast to see an increase in traffic due to the project, such as on certain parts of Parramatta Road.

Notwithstanding the general decrease in noise levels at receivers adjacent to the motorway, predicted noise levels for the 'build' scenarios are typically above the RNP noise goals at the majority of immediately adjacent receivers. This is because these receivers already experience a high level of traffic noise.

The forecast traffic numbers for the 'build' scenarios indicates an increase in vehicles along sections of Parramatta Road (predominantly between Church Street, Granville and Silverwater Road, Auburn). For receivers immediately adjacent to these sections of Parramatta Road, the change in vehicle numbers and composition (ie percentage of heavy vehicles) generally results in increases in predicted noise levels of more than 2 dB to the total road traffic noise. Table 8.22 provides a summary of the changes to numbers of receivers with predicted operational noise levels above the base criteria.

Table 8.19 Summary of operational noise predictions – RNP base criteria

		2017 Scenario				2027 Scenario			
		No Build		Build		No Build		Build	
Receiver	Floor	Day	Night	Day	Night	Day	Night	Day	Night
Receivers with Predicted Noise Level above RNP Base Criteria[1]									
Residential	All	1608	1876	841	668	1715	2060	1457	1167
	1	801	972	401	291	871	1100	714	551
	2	533	608	266	220	562	651	483	378
	>2	274	296	174	157	282	309	260	238
Other (Educational)	All	25	n/a	25	n/a	25	n/a	25	n/a
Other (Worship)	All	18	18	18	14	18	18	18	15
Other (Active)	All	4	n/a	1	n/a	4	n/a	4	n/a
Other (Passive)	All	2	n/a	2	n/a	2	n/a	2	n/a

[1] Consistent with the RNP and Roads and Maritime policy, assessment locations at receivers are limited to the two most affected floors.

Feasible and reasonable noise mitigation will be considered in accordance with the *NSW Road Noise Policy* (EPA 2011) and the *Environmental Noise Management Manual* (RTA 2001). Specifically, noise mitigation (beyond the adoption of traffic management and other road design measures) will be considered in the following circumstances:

> *The predicted 'build' noise level exceeds the RNP base criteria for redeveloped roads and the noise level increase due to the project (ie the noise predictions for the 'build' minus the 'no build') is greater than 2 dB.*
>
> *OR*
>
> *The predicted 'build' noise levels are acute (≥65 dBA LAeq(15hour) or ≥60 dBA LAeq(9hour)) regardless of the incremental impact of the project.*

Where exceedances of the noise criteria are identified, the RNP describes noise mitigation measures to be considered in order of priority:

- Road design and traffic management.
- Low noise pavement surfaces.
- In-corridor noise barriers/mounds.
- At-property treatments or localised barriers/mounds.

The project includes use of a low noise pavement on the M4 Motorway (refer to Chapter 6) and has located the viaduct on the southern side - further away from sensitive receivers to the north.

Additional feasible and reasonable noise mitigation measures, including noise barriers and property treatments, are considered for receivers which qualify on the basis of predicted residual noise levels and/or a project related increase in noise above certain specified thresholds. Guidance for the reasonable and feasible assessment of additional noise mitigation is taken the Environmental Noise Management Manual.

Indicative locations and heights of proposed noise barriers are described in 5.3.11 and shown on Figure 5.1 to Figure 5.3. Indicative heights range from 3.5 metres to 7.5 metres and would comprise additional noise barriers and extended existing noise barriers.

Further to the inclusion of the optimised project noise barriers, a total of 186 sensitive 'receivers' are predicted to be eligible for consideration of property treatment as part of the M4 Widening project.

This number consists of:

- 159 residential receivers with noise levels less than 10 dB above the RNP base criteria
- 20 residential receivers with noise levels 10 dB or more above the RNP base criteria
- Four places of worship (part of Rodger Page Church)
- Three educational facilities (part of Auburn North Public School).

For individual residential receivers Roads and Maritime does not consider it reasonable to consider noise mitigation above the ground and first floor.

A number of residential receivers that have been identified exceeding the RNP criteria are multi-storey apartment buildings. A further feasible and reasonable review of architectural treatments at multi-storey apartments will be completed during detailed design. Receivers that are eligible for consideration of property treatment are listed in Appendix E of the Noise and Vibration Working Paper (Volume 2 – Working Paper E).

8.2.4 Assessment of potential construction noise impacts

Approach to assessment

To quantify noise levels from the construction activities a noise prediction model was developed. The concept designs for the project, local terrain, receiver buildings and structures were digitised in the noise model to develop a three-dimensional representation of the construction sites and surrounding environment.

Typical LAeq (15 minute) noise levels at the nearest noise sensitive receivers in each NCA were then calculated (at the worst-affected floor level) for the construction scenarios outlined in Table 8.20.

Consistent with the requirements of the Interim Construction Noise Guideline the construction noise impact predictions represent a worst-case assessment. They are representative of the 'noisiest' construction periods allowing for the simultaneous operation of noise intensive construction plant in proximity to adjacent receivers. For most construction activities, it is expected that the construction noise levels would frequently be lower than those that have been predicted at the most-exposed receiver.

Table 8.20 Summary of airborne construction noise scenarios

Construction activity	Locations	Scenarios	Scenario Sound Power Level (dBA)	Approximate duration of works at any locality[1]
Main Corridor/ Ramp Works	General carriageway and ramp footprint (concept design)	Site clearing and bulk earthworks	117	2-4 weeks
		Excavation and installation of drainage	105	2-4 weeks
		Pavement works including laying concrete and asphaltic surfaces	119	2-4 weeks
		Slope Stability and Retaining Wall Works	112	Up to 3 months
		Installation of Street Lighting and ITS Infrastructure	111	1-2 weeks
		Linemarking	102	1-2 week
		Landscaping	105	2 weeks
Construction Compounds	General footprint of compound	Establishment of construction compounds and worksites	104	Intermittent activity, up to 2 years at some locations
		Deliveries of demountable office facilities	105	
		Installation of temporary boundary fencing	99	
		Establishing stockpiles and materials storage areas	110	
Structures – Bridge & Viaduct Construction	Church St to James Ruse Drive Viaduct Church Street Bridge Bridge Over Western Rail Line Bridge over Carlingford Line Bridge over James Ruse Drive Bridge over Wentworth Street Bridge over Denihey Street Bridge Over Duck Creek	Laydown pad, temporary platforms and establishments	105	4 weeks
		Unloading of truss bridge and pre-assembly onsite	102	2-4 weeks
		Piling (Vibratory)	113	2-4 week
		Piling (Bored)	105	2-4 week
		Abutments	107	2-3 weeks
		Erection of bridge truss, Erection/dismantling of scaffolding & Erection of bridge decking	104	4-6 weeks

[1] Limited information is available on the approximate durations of the activities at this phase of the proposal, and hence, the key activities determined have only had high level assumptions made with respect to proposed duration, based on previous similar activity type.

Predicted construction noise levels

Table 8.21 summarises NML exceedances across all NCAs for each of the construction activity groups described in Table 8.20. The range of predicted exceedances represents the range of exceedances for different construction scenarios, with some scenarios being considerably more noise intensive than others.

Table 8.21 Summary of airborne construction NML exceedances across all NCAs

Construction activity	Receiver type	Worst-case NML exceedance at nearby receptors (dB) (least noise intensive scenario – most noise intensive scenario)	
		Standard Construction Hours	**Out of Hours Works**
Main Corridor/Ramp Works	Residential	2 – 32	1 – 43
	Commercial	1 – 26	1 – 26
	Other sensitive	0 – 12	0 – 6
Construction Compounds	Residential	8 – 49	2 – 60
	Commercial	11 – 41	11 – 41
	Other sensitive	-	-
Structures – Bridge & Viaduct Construction	Residential	23 - 34	28 - 45
	Commercial	9 - 32	9 - 32
	Other sensitive	-	-

Due to the proximity of works to receivers, the predicted noise levels indicate high worst-case exceedances of the NMLs of up to 48 dB (standard hours) and 59 dB (outside standard hours) for construction at the nearest residences. Commercial receivers are predicted to be subject to high NML exceedances of over 20 dB. Other sensitive receptors are predicted to be subject to high NML exceedances of over 20 dB. However, it should be noted that the predicted construction noise exceedances shown in Table 8.27 are not expected to be consistently high for the entire duration of the activity and would vary throughout the project corridor

The residential NCA most affected by noise from construction of the main corridor/ramp works is NCA.A02_07N. Around 23 properties are worst-affected in the NCA. Construction of bridges and viaducts would most affect NCA.A02_07S_RES with 16 properties worst-affected. These counts are based on the total number of receiver buildings predicted to be subject to worst-case daytime construction noise levels above the highly noise affected level (75 dBA) at any time in the entire construction schedule. This is generally limited to periods when noise intensive activities are located immediately adjacent to residences. It is therefore expected that the number of noise affected receivers on a typical day to day basis would be considerably less than these estimates.

The most noise intensive works are site clearing and pavement works which may require use of a rockbreaker. Impacts from each of these activities are expected to last for about two weeks in total at any single receiver during the Main Corridor/Ramp works (refer to Table 8.20).

Predicted LA1 (1minute) noise levels at the nearest noise sensitive receivers indicate that the sleep disturbance screening criterion is likely to be exceeded when night works are occurring adjacent to residential receivers for the majority of works scenarios. This level of noise is typical for construction works using noise intensive equipment in built up areas.

Construction noise mitigation and management measures would be implemented to minimise the extent of exceedances identified above and would be included in the Construction Noise and Vibration Management Plan (CNVMP) prepared for the project (refer to section 8.2.7). Table 8.25 identifies typical construction noise mitigation measures that would also be considered during the preparation of the CNVMP, with accompanying estimates of anticipated noise reduction that would typically be achieved by each measure.

Noise monitoring of construction activities would also be used to assess actual impacts against construction noise criteria and determine compliance.

Table 8.22 Summary of airborne construction NML exceedances across all NCAs

Typical construction noise mitigation and management measures	Potential noise reduction (dBA)
Schedule construction works within the standard construction hours	No reduction during standard construction hours Eliminates out-of-hours noise impacts
Temporary acoustic fencing/barriers	Typically around 5 to 10 dB
Portable temporary screens	Up to around 15 dB
Construct operational noise walls	5-10 dB
Install operational property treatments	Variable
Avoid the coincidence of noisy plant working simultaneously close together	Up to 3dB for halving the number of similar dominant plant items working together
Shut down equipment when not in use	Negligible reduction in comparison to worst-case predictions, however eliminates noise source during less noise intensive works
Maximise offset distance between noisy plant items and nearby noise sensitive receivers	Approximately 6dB reduction per doubling of offset distance
Loading and unloading should be carried out away from sensitive receivers	Approximately 6dB reduction per doubling of offset distance

8.2.5 Assessment of potential construction road traffic noise impacts

Assessment of construction road traffic noise levels assumed additional heavy construction vehicle movements on public roads would be mainly required during daytime hours, with some heavy vehicle movements required to support night time construction works (when required for safety reasons or to minimise disruption to the road network). It also assumed use of the haulage routes identified in Table 6.1 and used the maximum daily forecast number of heavy vehicle movements from Table 8.2 added to the existing vehicle volume data, where available.

The assessment found compliance with the 2 dB allowance at all locations where existing traffic volume data is available. This is generally where the proposed haulage routes are on arterial and sub-arterial roads that have significant existing traffic flows.

Noise impacts may be greater where heavy construction-related vehicles need to access site compounds via local roads. Opportunities to minimise construction road traffic noise impacts on local streets would be identified during the preparation of the CNVMP (refer to section 8.2.7). Principles include minimising night time traffic and using arterial and sub-arterial roads where possible.

Additional assessment for night time truck movements on public roads when required would be undertaken during CNVMP preparation when a finalised Construction Traffic Management Plan is available.

8.2.6 Assessment of potential construction vibration impacts

Approach to assessment

Construction vibration was assessed by reference to the proposed location of work areas, the location of vibration sensitive receivers and the recommended safe working distances shown in Table 8.18.

Cosmetic damage assessment

The separation distance(s) between the proposed works and the nearest receivers would generally be sufficient so that nearby buildings are unlikely to suffer 'Cosmetic Damage' for most of the proposed construction equipment. However, based on the general work zones, some items of construction equipment have the potential to be operated within 20 metres of residential receivers and within the recommended safe working distances. The required locations for vibration intensive equipment will be reviewed during detailed design when more specific information is available.

Attended vibration monitoring or vibration trials will be undertaken when proposed works are within the safe working distances to ensure that levels remain below the criterion. Building condition surveys will also be completed both before and after the works at any potentially affected properties to identify existing damage and any proposal related damage.

Human comfort vibration assessment

Vibration at the nearest receivers is likely to be perceptible at times during the works because some items of proposed construction equipment may need to be used within 20 metres of residential receivers and within the recommended safe working distances.

8.2.7 Environmental management measures

Options development and design refinements described in Chapters 4 and 5 and section 8.2.3 have sought to minimise noise and vibration impacts as far as possible.

Project-specific management and mitigation measures have been developed with the aim of minimising or mitigating, as far as practical, the noise and vibration impacts during construction and operation as described above. The management and mitigation measures draw on best management practice, government standards and guidelines, and specialist knowledge. Potential impacts and site-specific management measures identified to manage those impacts for implementation during the pre-construction, construction and operational phases are summarised in the table below.

Impact	REF#	Environmental management measures	Responsibility	Timing
Operational Road traffic noise	NV-1	• Implementation of new noise barriers and increased height of some existing noise barriers as identified in Table 5.4 and shown on Figure 5.1 to Figure 5.3, and subject to refinement during detailed design. • Where residual impacts remain after all feasible and reasonable approaches have been exhausted, noise mitigation in the form	WDA	Pre-Construction

Impact	REF#	Environmental management measures	Responsibility	Timing
		of acoustic treatment of existing individual dwellings will be considered, where feasible and reasonable.		
Operational Road traffic noise	NV-2	Within 12 months of the commencement of operation of the project an operational noise review will be undertaken. This will include: • Monitoring to compare actual noise performance of the project against predicted noise performance. • An assessment of the performance and effectiveness of applied noise mitigation measures together with a review and if necessary, reassessment of all feasible and reasonable mitigation measures. • Identification of any additional feasible and reasonable measures that will be implemented with the objective of meeting the criteria in the NSW Road Noise Policy (EPA 2011), when these measures will be implemented and how their effectiveness will be measured and reported.	WDA	Operation
Construction noise and vibration	NV-3	• A Construction Noise and Vibration Management Plan (CNVMP) will be prepared for the project. The CNVMP will: – Assist in ensuring that the noise during construction complies where possible with the construction noise management levels set for the project. – Determine noise and vibration monitoring, reporting and response procedures. – Describe specific mitigation treatments, management methods and procedures to be implemented to control noise and vibration during construction such as those identified in Table 8.29 above. – Describe construction timetabling to minimise noise impacts including time and duration restrictions, respite periods and frequency. – Describe procedures for notifying residents of construction activities likely to affect their amenity through noise and vibration. – Define contingency procedures to be implemented in the event of non-compliances and/or noise complaints.	Contractor	Pre-Construction
Construction Vibration	NV-4	• The following vibration mitigation measures will be specifically considered during the preparation of the CNVMP: – Relocate vibration generating plant and equipment to areas within the site in order	Contractor	Pre-Construction

Impact	REF#	Environmental management measures	Responsibility	Timing
		to lower the vibration impacts. – Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment. – Use lower vibration generating items of excavation plant and equipment eg smaller capacity rockbreaker hammers. – Minimise consecutive works in the same locality (if applicable). – Use dampened rockbreakers and/or ‘city’ rockbreakers to minimise the impacts associated with rockbreaking works. – If vibration intensive works are required within the safe working distances, conduct vibration monitoring or attended vibration trials to ensure that levels remain below the cosmetic damage criterion. – Conduct building condition surveys both before and after the works to identify existing damage and any damage due to the works.		

8.3 Visual amenity, built form and urban design

This section documents the visual aspects and impacts of the project including those relating to landscape character, views, built form and overshadowing. Full details of the assessment undertaken are presented in the *WestConnex M4 Widening Urban Design Concept, Landscape Character and Visual impact Assessment Report* (KI Studio, 2014) (Volume 3 – Working Paper F) with a summary provided below. The assessment has been prepared to address relevant DGRs as documented in the table below.

Director-General's Requirements	Where addressed in EIS
Visual Amenity, Built Form and Urban Design — including but not limited to: • development of urban design objectives, including consistency with existing (and desired) character of the area (and, where appropriate, the WestConnex Urban Revitalisation Project);	Section 5.2.2 Section 8.3.2 Working Paper F
• rationale for the overall design (length, height, width and appearance) and an assessment of the built form (materials and finishes) and urban design (bulk and scale) of the project, including:	Section 8.3.3 Working Paper F
– details of pedestrian and cyclist access (dedicated or shared-use), and public transport and emergency vehicle access, including integration of the project with existing M4 cycleway and future pedestrian and cycle network in the local, regional and metropolitan context,	Section 8.3.3 Section 5.3.9
– design relationship to the existing M4 Western Motorway and adjoining built forms and streetscapes, and	Section 8.3.3 Working Paper F
– views to and from the project alignment.	Section 8.3.5 Working Paper F
• consideration of design, and safety measures, for pedestrian and cycle access in vicinity of the project;	Section 8.3.3
• an assessment of the construction and operational visual and amenity impacts of the project (height, scale and/or lighting) on the local and regional area, particularly on:	Section 8.3.4 Section 8.3.5 Working Paper F
– existing and future residential properties adjacent to the project alignment,	
– adjoining commercial, industrial, cultural and recreational land uses, and	
– significant vantage points in the public domain;	
• overshadowing impacts of the viaducts and ramps on existing and proposed public domain, open space, and residential, and commercial land uses.	Section 8.3.5 Working Paper F

8.3.1 Assessment methodology

The approach to assessment has involved the following sequence of activities:

- Contextual analysis including establishing a study area and considering existing land use, connectivity and the natural features of the area.
- Landscape character analysis which identified the character and qualities of the motorway corridor and adjacent precincts.

- Review of the existing built form language of the various structures along the motorway.
- Setting of urban design vision, objectives and principles.
- Identification of key constraints and opportunities and development of WDA concept design strategies.
- Landscape character and visual impact assessment using the Roads and Maritime *Guideline for Landscape Character and Visual Impact Assessment, EIA-N04* (2013).
- Landscape character impact is based on the aggregate of an area's built, natural and cultural character and sense of place and is measured by the combination of the area's sensitivity and the magnitude (scale, character and distance).
- In order to determine the visual impact, sensitivity values were assigned to the various viewpoints. The selected viewpoints are representative of the various landscape character zones identified within the visual catchment of the project. Landscape character zones were omitted where there would be no exposure and therefore a negligible visual impact. Figure 8.8 illustrates how the level of sensitivity and magnitude are combined to achieve an overall level of impact for both the landscape character impact and the visual impact.
- Overshadowing assessment to quantify shadowing impacts on public domain, open space, and residential and commercial land uses.

Figure 8.8 Landscape character and visual impact grading matrix

Sensitivity \ Magnitude	high	moderate	low	negligible
high	high impact	high- moderate	moderate	negligible
moderate	high- moderate	moderate	moderate-low	negligible
low	moderate	moderate-low	low	negligible
negligible	negligible	negligible	negligible	negligible

8.3.2 Existing environment

Existing landscape character

Seven landscape character zones were identified along the M4 Motorway corridor which primarily reflect the character of surrounding areas (refer to Figure 8.9). Within the motorway corridor, two distinct areas were identified. For the western section (landscape character zones 1 to 4), the motorway is generally above ground and does not have a green median, while in the eastern section (landscape character zones 5 to 7) the motorway is predominantly on ground or within a cutting, creating a more enclosed character. This enclosed character is contributed to by an established ribbon of vegetation along the verges.

Landscape character zone map Figure 8.7

Table 8.23 Landscape character zone descriptions

Zone	Description	Character
Zone 1 Parramatta/Holroyd	Northern side – High sensitivity	Predominantly residential
	Southern side – Moderate sensitivity	Predominantly commercial and open space
Zone 2 – Harris Park/Granville	Northern side – High sensitivity	Predominantly residential (various densities) Urban watercourse (A'Becketts Creek corridor)
	Southern side – High sensitivity	Residential
Zone 3 – Industrial/Speedway	Moderate sensitivity	Industrial
Zone 4 – Duck River Crossing	Moderate sensitivity	Green watercourse corridor (Duck River) Commercial industrial to the south of the motorway
Zone 5 – Duck River to Haslams Creek	Northern side – High sensitivity	Commercial/industrial Residential from Silverwater east to Newington
	Southern side – Low sensitivity	Commercial/industrial Small residential/education pockets
Zone 6 – Carter Street Precinct	Northern side – Low sensitivity	Commercial/industrial Identified for urban activation (housing, retail, office-based employment)
	Southern side – Low sensitivity	Commercial/industrial Remnant vegetation at entrance to Hill Road.
Zone 7 – Olympic Park	Northern side – Moderate sensitivity	Sydney Olympic Park Commercial
	Southern side – Low sensitivity	Commercial/markets Residential pockets

Built form and language

The form language of bridge structures within the motorway corridor is currently inconsistent. Circular forms tend to dominate the existing viaduct structure, yet angular shapes occur at a number of locations contributing to its incoherent character. Screens on local road overpasses and pedestrian bridges tend to express a common form language with the use of curved screens.

Retaining walls are located in the vicinity of Wentworth Street and consist of precast concrete panels with vertical ribbing. Precast interlocking concrete components are used along Martha and Junction Streets.

Four types of noise walls occur in the project corridor: transparent panels, precast concrete panels with artistic motifs, plain precast concrete panels and wavy concrete walls (along the on-ramp near Silverwater Road).

Land use and connectivity

The project interfaces with a number of land uses, including residential neighbourhoods, industrial and commercial precincts and recreation areas. There are varying levels of connectivity for pedestrians and cyclists along and across the motorway corridor. This includes:

- North-south routes from the residential areas of Granville, Holroyd, and further south from Merrylands to Parramatta.
- A shared-path running along the southern side of the motorway corridor between Church Street and Burnett Street.
- Links between the residential areas of Rosehill/Harris Park to the north and Granville to the south of the corridor including cycle routes to Granville and Clyde Rail Stations. The strong east-west route provided a shared-path is dominant.
- Links between residential areas of Silverwater to the north and Auburn to the south of the motorway corridor including to Auburn town centre and rail station. The strong east-west route along a shared footpath is again dominant.
- Links between the residential areas of Newington to the north and Lidcombe to the south of the motorway corridor.
- An interruption to east-west connectivity at Haslams Creek.
- Strong connections to Sydney Olympic Park from the west and south of the motorway corridor.
- Limited options on dedicated shared paths for users travelling east of Sydney Olympic Park along the motorway corridor.

Desired future character

Local plans and strategies often articulate the desired future character of neighbourhoods and include controls on development to achieve their stated aims. In this case, the relevant local plans generally recognise the role of the M4 Motorway as a regional transport corridor and include objectives, zoning and other controls consistent with that purpose. In general terms this means designating land for infrastructure and ensuring that any development that occurs does not adversely affect its operation.

The desired future character of the motorway corridor is also expressed through the urban design vision, objectives and principles that have been set for the project (refer to section 5.2.2 and to Appendix F). WestConnex also provides opportunities for urban revitalisation that could activate passive spaces for the community and rejuvenate existing green space.

8.3.3 Design rationale

The urban design concept has been developed consistent with the urban design objectives and principles that were introduced in section 5.2.2 and which are explained in detail in Chapter 6 of Urban Design, Landscape Character and Visual Working Paper (Appendix F). It is subject to refinement during detailed design.

The design focuses on limiting visual and landscape character impacts by retaining a compact footprint and proposing mitigation strategies to address identified impacts. Landscape strategies would be further developed to enhance the remnant ecological corridors, particularly in the western section, and reinforce the existing motorway parkland character in the eastern section.

It is envisaged that the cycle routes will remain as existing construction works are complete. Improvements to lighting beneath the viaduct and cycle underpasses would assist with safety and security where practical. Improvements to Martha Street would improve the pedestrian/cyclist experience by providing a consistent width of path.

Western section – Church Street, Granville to Duck River

The design of the western section of the project from Church Street, Granville to Duck River builds upon the existing built form language as far as practical and takes into account construction issues in order to minimise disruption and other impacts to the community. It aims to deliver a simple form language that utilises other roadside components to create a uniform, contemporary appearance. Key features of the design approach are referred to in Chapter 8 of the Urban Design, Landscape Character and Visual Working Paper (refer Appendix F).

Eastern section

The eastern section of the project extending from Duck River to the Homebush Bay Drive interchange involves widening the existing motorway carriageways at grade. The WDA concept design seeks to emulate the existing situation in this section and the urban design strategy focuses primarily on vegetative screening opportunities and consistency of built form elements. Key features of the design approach are referred to in Chapter 8 of the Urban Design, Landscape Character and Visual Working Paper.

8.3.4 Assessment of potential construction impacts

There are three main types of works likely to have visual impacts during construction – bridge/viaduct works, motorway widening works (central median and side works) and construction compounds.

Bridge and viaduct works

Bridge and viaduct works would involve construction works for abutments, piers and the bridge superstructure between Church Street, Granville and Wentworth Street, Clyde, at Deniehy Street, Clyde and at Duck River. Visually this would mean ground based construction activities as well as views of the bridge superstructure in various stages of completion as it is progressively built using cranes and other equipment.

The areas most affected by the bridge and viaduct works would be would be the residential streets in Granville located to the south of the motorway between the Western Rail Line and the Carlingford Rail Line. Areas to the north of the motorway would have less direct views of bridge construction due to screening by the existing viaduct, while areas to the east and west are generally less sensitive land uses (industrial and commercial).

Motorway widening works

The central median works would involve construction adjacent to the inside ('fast') lane of the motorway and would include excavation, pavement construction, drainage works and service utilities works. The side works would involve construction adjacent to the outside ('slow') lane and shoulder of the motorway, including drainage and excavation works, pavement widening in some locations, drainage works, service utilities, installation of signage, noise mound and wall construction and landscaping.

Median and side work site establishment would involve the placement of temporary concrete safety barriers and fencing to create a safe work zone. Screening fencing would be installed along the barriers where required.

The existing motorway sits generally on fill but with well-vegetated embankments and noise walls mostly screening the corridor from surrounding land uses. At locations where side works require the removal of vegetation, visual exposure to the corridor would be increased meaning short-term visual impacts for people adjacent to the corridor. There may also be some minor impacts on road users and those residences located adjacent to the motorway associated with light spill from night-time construction works.

While construction of the entire project is estimated to take about two years, construction works at any one location along the corridor would occur over a much shorter period (refer to Figure 6.1 in Chapter 6).

Although noticeable to road users and some surrounding residents, the visual impacts of construction works within the corridor would be short-term and generally rated as low to moderate. The provision of some screening fencing between the motorway and the construction sites would reduce the visual impact of construction and limit distractions for road users.

Construction site compounds

Given that the project would be constructed under traffic there would be no opportunity to locate construction site compounds between the two motorway carriageways, and limited opportunity to locate them within the motorway corridor (except in the bridge works sections). The project includes the establishment of construction site compounds at locations outside the motorway corridor but as close as possible to the motorway (refer section 6.4).

Construction site compounds would comprise offices and material laydown areas and be fenced and generally covered in hardstand. Offices would generally be prefabricated and material storage areas would include purpose-built temporary structures as required.

In some cases construction site compounds would be visible from surrounding land uses and from within the motorway corridor. Where construction site compounds are to be used at night the potential for light spill would need to be carefully managed to minimise impacts on adjacent residents.

The potential visual impacts associated with the introduction of construction site compounds are considered to be low to moderate.

8.3.5 Assessment of potential operational impacts

Landscape character assessment

Table 8.24 shows the outcomes of the landscape character assessment on the identified landscape character zones. The table indicates that the project would have a limited landscape character impact. This outcome is mainly driven by the existing nature of the motorway and the limited scale of the expansion. The highest impact occurs within Zone 2, along the southern verge, and is due the sensitivity of the adjacent residential land use. In most other areas either the land use, or the minimal impact of the project outside the existing motorway corridor, limit the landscape character impact. Overall the project was assessed to have a moderate-low impact.

Table 8.24 Landscape character impacts

Zone	Sensitivity	Magnitude	Impact
Zone 1 (north)	High	Low	Moderate
Zone 1 (south)	Moderate	Low	Moderate-low
Zone 2 (north)	High	Negligible	Negligible
Zone 2 (south)	High	Moderate	Moderate-high
Zone 3 (north)	Moderate	Moderate	Moderate
Zone 3 (south)	Low	High	Moderate
Zone 4	Moderate	Low	Moderate
Zone 5 (north)	High	Low	Moderate
Zone 5 (south	Low	Low	Low
Zone 6 (north)	Low	High	Moderate
Zone 6 (south)	Low	Moderate	Moderate-low
Zone 7 (north)	Moderate	Negligible	Negligible
Zone 7 (south)	Low	Low	Low

Visual impact assessment

Visual impact was assessed by reference to visual catchment of the project and key viewpoints as defined by either by topographical features, built form elements or screening vegetation (refer to Chapter 9 of the Urban Design, Landscape Character and Visual Working Paper). A total of 22 viewpoints outside the corridor and four viewpoints within the corridor were considered.
Table 8.25 summarises the outcomes of the visual impact assessment. It shows that eight viewpoints were assessed as having a moderate-high or high impact.

Table 8.25 Visual impact assessment outcomes

Viewpoint	Location	Sensitivity	Magnitude	Impact
Outside corridor				
1	Holroyd Sportsground – view east	Moderate	Low	Moderate-low
2	Karung Reserve – view east	High	Negligible	Negligible
3	Church Street – view east	Low	Moderate	Moderate-low
4	A'Beckett's Creek – view east	Low	Moderate	Moderate-low
5	Western Rail Line – view west	Low	High	Moderate
6	Parramatta Road – view north-east	Low	Moderate	Moderate-low
7	Prince Street – view north	High	Moderate	Moderate-high
8	A'Beckett Street – view east	High	High–moderate	Moderate/high-High
9	Arthur Street – view south	High	Negligible	Negligible
10	Arthur Street/A'Beckett Street – view south-west	High	Negligible	Negligible
11	Alfred Street – view north	High	Moderate	Moderate-high

Viewpoint	Location	Sensitivity	Magnitude	Impact
12	Arthur Street – view north	High	High	High
13	Hamilton Street – view north-east	High	Moderate	Moderate-high
14	Wentworth Street – view south-east	Moderate	Low	Moderate-low
15	Martha Street – view east	Moderate	High	Moderate-high
16	Harbord Street – view north	Moderate	Moderate	Moderate
17	Shared path at Duck River – view east	Low	Moderate	Moderate-low
18	Adderley Street West – view east	Low	Low	Low
19	Deakin Street – view east	High	Low	Moderate
20	Parkland near Newington – view west	Moderate	High	Moderate-high
21	Hill Road – view east	Moderate	High	Moderate-high
22	Pullman Hotel – view south	High	Negligible	Negligible
Within corridor				
A	At A'Beckett Street prior to intersection with Alfred Street – view east	Low	Low	Low
B	At Martha Street – view west	Low	High	Moderate
C	At Stubbs Street overpass – view west	Low	Moderate	Moderate-low
D	At Hill Road – view of the northern motorway verge	Low	High	Moderate

A detailed assessment of all viewpoints can be found in Chapter 9 of the Urban Design, Landscape Character and Visual Working Paper.

Figures 8.5 to 8.8 provide an indicative illustration of typical changes that would be associated with the project at a number of locations along the corridor.

Existing

Site photo with viaduct shown indicatively.

Figure 8.10 Existing view and indicative montage looking east along A'Beckett Street

Existing

Site photo with viaduct shown indicatively.

Figure 8.11 Existing view and indicative montage looking along the shared path west of the Cumberland Rail Line

Existing

Site photo with retaining wall and landscaping shown indicatively

Figure 8.12 Existing view and indicative montage looking west along Martha Street

Existing

Site photo with viaduct shown indicatively.

Figure 8.13 Existing view and indicative montage looking north east along Arthur Street

Overshadowing

Figure 8.14 illustrates the expected shadow impacts to the areas south of the viaduct, in the vicinity of Arthur Street. This location is where the viaduct is likely to have the highest overshadowing due to the height of the structure.

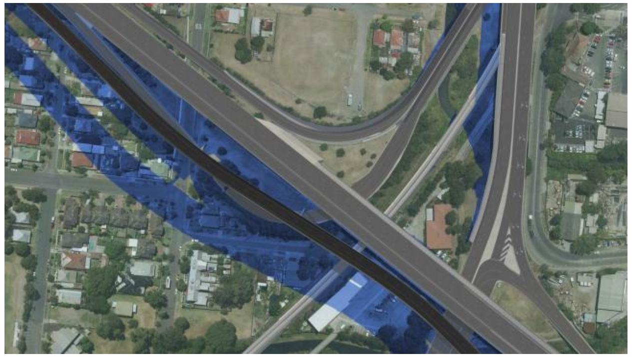
While the largest overshadowing would occur during the winter months early in the morning, there would be minimal impact in the afternoon. During the summer solstice, the overall overshadowing is fairly contained and impacts are limited.

Figure 8.15 illustrates the expected shadow impacts to the areas south of the viaduct, in the vicinity of Good Street.

Due to the orientation of the alignment, the overshadowing is more prominent compared to Arthur Street, even though the viaduct height is lower. The overshadowing mainly affects green areas and residual spaces with the exception of a few residences.

The largest overshadowing would occur during the winter months early in the morning and late afternoon. During the summer solstice, the overall overshadowing is negligible.

Figure 8.14 Overshadowing in the vicinity of Arthur Street



June 21 – 9:00am

June 21 – 12:00pm

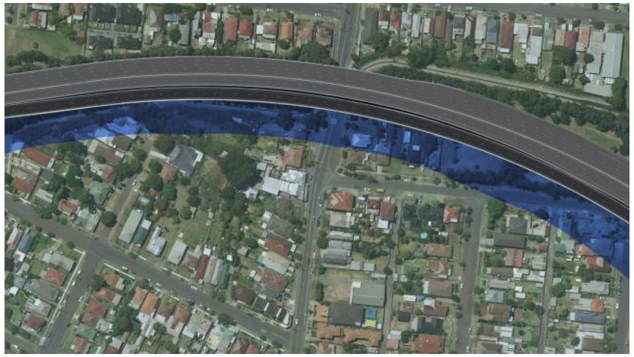
June 21 – 3:00pm

December 21 – 9:00am

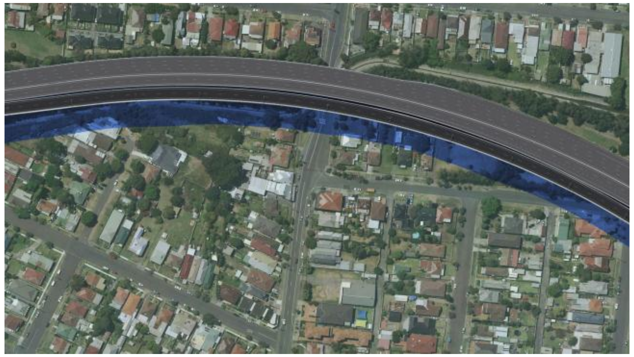
December 21 – 12:00pm

December 21 – 3:00pm

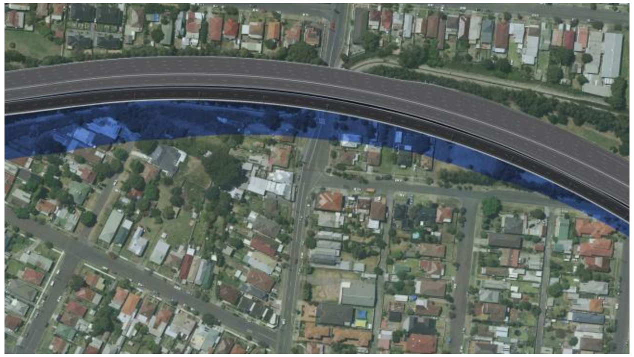
Figure 8.15 Overshadowing in the vicinity of Good Street



June 21 – 9:00am



June 21 – 12:00pm



June 21 – 3:00pm

December 21 – 9:00am

December 21 – 12:00pm

December 21 – 3:00pm

8.3.6 Environmental management measures

Options development and design refinements described in Chapters 4 and 5 have sought to minimise landscape character and visual impacts as far as possible.

Project-specific management and mitigation measures have been developed with the aim of minimising or mitigating, as far as practical, the landscape character and visual impacts during construction and operation as described above. The management and mitigation measures draw on best management practice, government standards and guidelines, and specialist knowledge. Potential impacts and site-specific management measures identified to manage those impacts for implementation during the pre-construction, construction and operational phases are summarised in the table below.

Impact	Ref#	Environmental management measures	Responsibility	Timing
Visual impacts	V-1	A detailed landscape plan will be prepared for the project. The landscape plan will build on the finding of the Urban Design, Landscape Character and Visual Working Paper and will include detailed set out, species and planting guides.	Contractor	Detailed design
Visual impacts	V-2	Where practicable, the height of retaining walls will be minimised allowing introduction of a batter and construction of reinforced soil wall to allow reinstatement of planting along verges.	Contractor	Detailed design
Visual impacts	V-3	Built elements, including noise walls will be further refined consistent with the urban design vision, objectives and principles for the project.	Contractor	Detailed design
Construction visual impacts	V-4	The visual impact of construction site compounds on adjacent residential areas will be minimised through the careful planning and positioning of temporary offices, other plant and material laydown areas, and specific management of lighting and potential for light spill within the identified construction site compounds.	Contractor	Construction
Construction visual impacts	V-5	Vegetation, mature or otherwise, currently located between construction site compounds and adjacent residential areas will be retained where practicable to screen views.	Contractor	Construction
Construction visual impacts	V-6	Vegetation clearance will be limited to that required to construct the project. Where practicable landscaping would be progressively introduced to provide screening between adjacent residences and the motorway corridor.	Contractor	Construction
Construction visual impacts	V-7	Where possible, some screening fencing will be introduced between the motorway carriageways and the work sites in the median and to the sides of the motorway to reduce the visual impact of construction and limit distractions for road users.	Contractor	Construction

8.4 Soils, water and waste

This section documents the potential impacts of the project on soils and water, and in relation to waste generation. Full details of the assessment undertaken are presented in the *WestConnex M4 Widening Soils, Water and Waste Technical Study* (SMEC, 2014) (Volume 3 – Working Paper G). The assessment has been prepared to address relevant DGRs as documented below.

Director-General's Requirements	Where addressed
Construction and operational erosion and sediment and water quality impacts on Haslams Creek, Duck River, Duck Creek and A'Becketts Creek, including an assessment of:	
• potential water quality impacts and mitigation measures to manage water pollution, with reference to relevant public health and environmental water quality criteria, including those specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000), and any applicable regional, local or site-specific guidelines	Sections 8.4.3, 8.4.4
• proposed storm water management system and management measures for the containment of pollutants and minimisation of leachate and sediment mobilisation	Section 5.3.5 Section 8.4.5
• management of and disposal strategies for acid sulfate soils, in accordance with the Acid Sulfate Soils Manual (ASSMAC)	Section 8.4.5
• waste handling	Section 8.4.5
Management of waste, including:	
• classification of waste taking into account the Waste Classification Guidelines (Department of Environment, Climate Change and Water 2009)	Section 8.4.3
• waste handling, stockpiling and transportation	Sections 8.4.3, 8.4.4, 8.4.5
• quantification of bulk earthworks and spoil balance, and reuse or disposal of excess spoil	Section 8.4.3
• preliminary assessment and remediation strategies for contaminated land.	Sections 8.4.3, 8.4.4, 8.4.5

8.4.1 Assessment methodology

Contaminated land

Preliminary (Phase 1) and detailed (Phase 2) site assessments were undertaken by GHD (2013, 2014 respectively) to identify potential contamination and acid sulfate soils (ASS) that may be impacted by the project. The framework for the soil and land contamination assessment was developed in accordance with guidelines 'made or approved', by the EPA, under section 105 of the (NSW) *Contaminated Land Management Act 1997*.

Acid sulfate soils

ASS is the common name given to sediments and soils containing iron sulfides which, when exposed to oxygen generate sulfuric acid. The relatively specific conditions under which ASS are formed usually limit their occurrence to low lying parts of coastal floodplains, rivers and creeks.

Assessment of ASS comprised an initial review of ASS Risk Maps from the NSW Natural Resource Atlas with subsequent field testing and laboratory analysis.

Hazardous materials

The Phase 1 preliminary site assessment (GHD 2013) included consideration of the potential presence of hazardous materials within the project footprint. This involved:

- Searches of the EPA's environment protection licence register to identify sites licenced to handle hazardous materials.
- Dangerous goods searches with WorkCover NSW of the Stored Chemical Information Database and microfiche records held by WorkCover NSW.

This identified six sites that potentially contained hazardous materials.

Sediments

The Phase 2 detailed site assessment (GHD 2014) included collection of sediment samples in A'Becketts Creek, Duck River, Duck Creek and Haslams Creek at eight accessible locations using a stainless steel hand auger. Samples were collected at the surface and up to 0.4 metres below the estimated level of sediment. For subsurface samples, characteristics of the stratum were noted together with any obvious visual or olfactory evidence of potential sediment contamination. Sediment samples were submitted for analysis at a NATA certified testing laboratory for a range of analytes. Results were considered with reference to the Interim Sediment Quality Guideline detailed in Table 3.5.1 in the *Australian Water Quality Guidelines for Fresh and Marine Waters* (Australian and New Zealand Environment and Conservation Council (ANZECC) 2000).

Water quality

Assessment of likely and potential impacts of the project on surface water quality has included:

- Review of existing literature relating to the project, available water quality data and existing conditions using available non-project literature to obtain background information on catchment history and land use to aid in interpreting the existing conditions.
- Assessment of the impact of construction activities on water quality with reference to the ANZECC 2000 water quality guidelines with regard to aquatic ecosystems, visual; amenity, primary/secondary contact recreation, and aquatic foods (cooked).
- Review of water quality treatment measures that could be used to mitigate the impact of construction on water quality, following the principles of *Managing Urban Stormwater–Soils and Construction Volume 1* (Landcom 2004) and *Volume 2D* (DECC 2008).
- Assessment of the water impacts of the project during operation.
- Review of water quality treatment measures that could be used to mitigate the impact of the operation of the project on water quality following the principle of *Procedure for Selecting Treatment Strategies to Control Road Runoff'* (RTA 2003), *RMS Water Policy* (RTA, 1997), and *RMS Code of Practice, Water Management* (RTA 1999).

Field investigation, sample collection and analysis was undertaken consistent with the methodologies outlined above. The Phase 1 preliminary site assessment included searches of the NSW Groundwater Works website to identify licenced groundwater boreholes in or within close proximity to the project. Reviews were undertaken of drillers logs where available to ascertain the character of the underlying material and to identify the nominal depth to the watertable. Hydrogeological maps covering the project area were also reviewed.

The Phase 2 detailed site assessment comprised:

- Drilling of 13 groundwater boreholes.
- Groundwater sampling of these boreholes and 10 groundwater wells installed as part of the Roads and Maritime geotechnical investigation.
- Analysis of selected groundwater samples by a NATA accredited laboratory for a range of contaminants of potential concern.

Waste

The POEO Act covers the requirements for waste generators in terms of storage and correct disposal of waste and their responsibility for the correct management of waste, including final disposal. Under the POEO Act and its regulations, guidelines have been established for the classification of waste and these have been considered in the assessment of waste generated by the project and subsequent development of mitigation and management measures.

Quantities and types of wastes that would be generated from the project were identified from the project constructability review and were used as the basis for the preliminary classification in accordance with the *Waste Classification Guidelines* (DECCW 2009). Resource use for the project was assessed by reviewing existing information and estimating the resources required for construction and their likely sources.

8.4.2 Existing environment

Geology

The geology of the area is derived from the Wianamatta Group and is predominantly underlain by the Ashfield and Bringelly Shale formations, overlying the Hawkesbury Sandstone formation (Department of Mineral Resources and Energy 1991).

These geological units are overlain by Quaternary aged Alluvium (Qha) around the creek lines. This comprises quartz sand, silty sand, silt and clay.

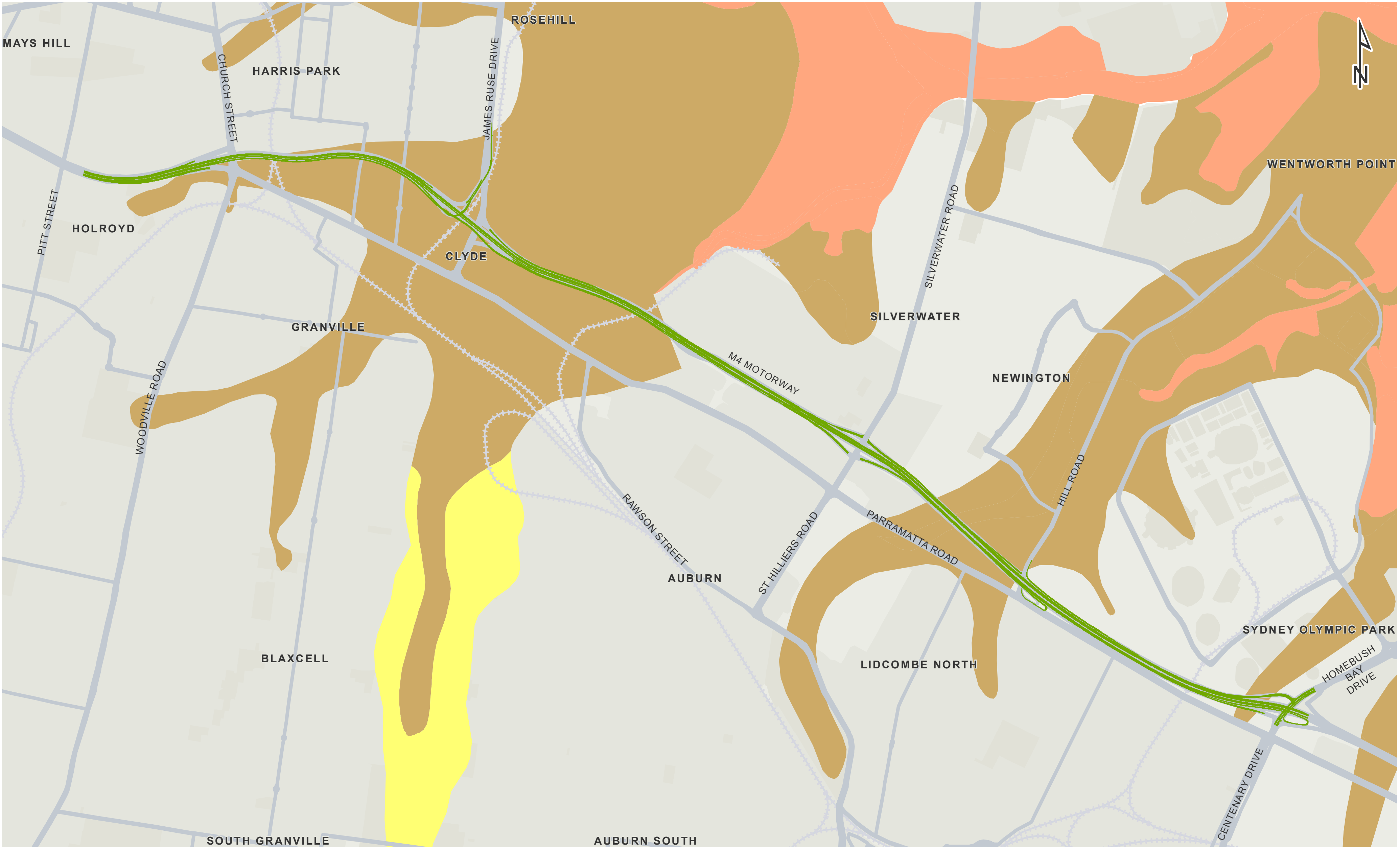
Soils

Four main soil landscapes have been identified within the project area in accordance with Soil Landscapes of Sydney (Soil Conservation Service of NSW 1989). These are:

- Birrong – high soil erosion hazard.
- Blacktown – generally moderate soil erosion potential ranging from low to high and poor soil drainage.
- Glenorie – high soil erosion hazard.
- Disturbed terrain (greater than four metres elevation) – including areas of fill or have heavy ground disturbance through general urban development.

Acid sulfate soils

The Phase 1 preliminary site assessment identified the potential for ASS to occur along the entire alignment. The Phase 2 detailed site assessment indicated that potential ASS (PASS) are present within the alluvial clay strata in areas mapped as potential ASS. Areas of PASS are shown in Figure 8.16.



KEY

Project design

Acid sulfate risk

High probability of occurrence

Disturbed Terrain

No known occurrence

Areas of potential acid sulfate soils Figure 8.14

Sediments

Sydney Harbour, including the Parramatta River, has a highly urbanised and industrialised catchment with a long history of contamination (Birch and Taylor 1999). Duck River, Duck Creek, Haslams Creek and A'Becketts Creek are located within the upper catchment.

Sediments in Sydney Harbour are known to be contaminated by a wide range of chemicals including metals, organochlorine compounds (Birch and Taylor 1999) and polycyclic aromatic hydrocarbons (McCready et al 2000). Sediments play a significant role in the storage and transport of contaminants and they are increasingly being used to identify sources of toxicants, to determine dispersion pathways and to locate contaminant sinks in aquatic systems (Birch et al 2000).

Stormwater runoff from urban catchments is widely recognised as a major source of contamination. In highly urbanised catchments, road surfaces have been shown to constitute up to 22 per cent of total catchment area and contribute up to 26 per cent of total runoff volumes with commensurate contributions of total 'heavy metal loads of 19 to 40 per cent (Davis and Birch 2009).

Urban stormwater and drainage systems provide pathways for contaminants to enter receiving waters, including metals bound to soils and consequently sediments of urban waterways frequently exhibit elevated metal concentrations (Birch et al 2001). Strong declining heavy metal trends away from canals discharging into the upper parts of many harbour embayments suggests that stormwater is a major source of contamination (Birch and Taylor 1999).

The Phase 2 detailed site assessment included collection of sediment samples from A'Becketts Creek, Duck River, Duck Creek and Haslams Creek (refer Appendix G for sample locations). Of the analytical results with concentrations above the laboratory limit of detection, metals, PAH, dieldrin, and asbestos recorded concentrations above the relevant screening criteria (Table 3.5.1 in the ANZECC 2000 guidelines).

Contaminated land

The M4 Widening project covers 7.5 kilometres of existing road network between the Pitt Street overpass at Parramatta and Homebush Bay Drive, Homebush. The route covers an area of diverse characteristics and is surrounded by a number of potentially contaminating land uses including industrial complexes, landfill sites and railway facilities. There is potential for contaminated land to occur within the vicinity of the project due to old industrial areas and numerous contaminated sites located along the Parramatta River.

The Phase 1 preliminary site assessment identified certain areas as having a high or high to moderate risk of contamination (refer to Table 8.26).

Table 8.26 Areas of high or high to moderate risk of contamination

Project section	Area
Pitt Street to Church Street	Near the battery recycling depot. There is potential for heavy metal contaminants and low pH.
Church Street to Deniehy Street	Cement bound asbestos fragments were observed beneath the M4 Motorway to the northern of A'Beckett Street and the corner of Alfred Street. On the eastern side of the James Ruse Drive Junction in a landscaped area beneath the M4 Motorway a grassed over stockpile (approximately 60 m by 20 m by 2 m) was observed in weathered portions of the stockpile to contain cement bound asbestos containing materials and potentially acid sulfate soils. Additionally the fill in these areas may contain other contaminants including hydrocarbons, pesticides and heavy metals, and possible acid sulfate soils (in the stockpile at James Ruse Drive).

Project section	Area
	A section of Duck Creek beneath the M4 Motorway and James Ruse Drive junction was observed to be heavily contaminated by rubbish as well as potential sewage/leachate. The source of this was not identified. There is potential for a range of contaminants including hydrocarbons, heavy metals, asbestos, polycyclic aromatic hydrocarbons and nutrient contaminants.
Junction Street to Silverwater Road	On the northern side of the M4 Motorway between Junction Street and Newton Street North is a soil and brick recycling facility; this was historically used as a landfill site. To the east of Stubbs Street there is evidence of fill materials (earth mounds, concrete rubble) along the vegetation strip. Waste odours were also noted in the eastern most portion of this area. Landfill and fill materials have the potential for a variety of contaminants including hydrocarbons, pesticides, heavy metals and asbestos, as well as explosive and toxic landfill and volatile organic fugitive gases.
Silverwater Road to Homebush Bay Drive	On the vegetation strip between Wetherill Street and Day Street South many of the mature trees are either distressed or have died. On the southern side of the M4 Motorway, to the east of Hill Road, between the M4 Motorway and Parramatta Road an area of open space has about 10 partially vegetated stockpiles over an area of approximately 50 m by 20 m. Fill materials included soils, brick, concrete and timber. On the southern side of the M4 Motorway between Birnie Street and Homebush Bay Drive, fill materials were observed in the vegetated strip between Parramatta Road and the M4 Motorway. To the east of Homebush Bay drive a portion of the open space area is used as a recycling centre (fill soils and trees). Fill materials have potential for a variety of contaminants including hydrocarbons, pesticides, heavy metals and asbestos.
	Two service stations occur to the south of the vegetation strip along Parramatta Road. These have potential for hydrocarbon and metals contamination.

Water quality

A review of existing and historic water quality in the Parramatta River estuary is provided in the *Parramatta River Estuary Coastal Zone Management Plan* (Cardno 2012). It notes that key water quality parameters of concern for management are dissolved oxygen (DO), pH, turbidity, nutrients (nitrogen, phosphorus), algal concentrations, and pathogens (faecal coliforms and enterococci).

With regard to human recreation, poor water quality has impacted on recreational usage of the estuary for activities such as swimming and fishing, with limited areas of the Parramatta River estuary considered suitable for primary and secondary contact recreational activities. Cardno Lawson Treloar (2008) note that dioxins in fish and prawns is a concern and that subsequent to an investigation undertaken by the NSW Food Authority, signage advising limiting consumption of fish and prawns was placed near popular recreational fishing spots around Sydney Harbour, including those in the Parramatta River estuary.

Analysis of monitoring data indicates that average concentrations of water quality parameters are in excess of the ANZECC (2000) aquatic ecosystem health guidelines for south-east Australian estuaries (Cardno, 2012). The exception is for pH for which the average values are in the acceptable range. Particular hotspots include Duck River and the Silverwater Bridge area. It is likely that these locations are impacted by sewer overflows due to the high concentrations of nutrients, faecal coliforms and enterococci, along with the low DO values. The high levels of nutrients at all sites indicate that nutrients entering the estuary via stormwater is a key issue and there is potential for algal blooms.

Groundwater

Groundwater is likely to be present in alluvium, shale and sandstone units associated with the study area. Based on a search of licensed groundwater boreholes in the vicinity of the project, groundwater is not used as a potable water source.

Groundwater levels vary across the project area. The Roads and Maritime (2014) geotechnical investigation recorded levels ranging from 0.1 metres AHD to 5.2 metres AHD between 7 and 11 March 2014. The Phase 2 detailed site assessment (GHD 2014) recorded levels ranging from 0.95 metres AHD to 13.48 metres AHD.

Groundwater parameters were observed to be reasonably consistent across the project site and within each of the strata as follows:

- Dissolved oxygen: results range from low to moderate oxygen levels typical of fresh/brackish groundwater.
- Electrical conductivity: results suggest that the groundwater is generally brackish to saline (1,298–24,759 µS/cm), which is expected for groundwater in the Ashfield Shale as this unit was formed in a marine environment.
- pH: readings were generally circumneutral which is typical for fresh/brackish groundwater.
- Oxidation-reduction potential indicated reducing conditions in many of the monitoring wells while some indicted potential oxidising conditions.

8.4.3 Assessment of potential construction impacts

Soils and sediments

Construction would involve the removal of existing vegetation and removal/modification of existing built features (eg paved surfaces) which would expose soils. Excavation would involve the stockpiling of spoil prior to reuse or removal from site. These and related construction activities would give rise to potential for erosion of unconsolidated material and entrainment by runoff and subsequent transport off site.

Soils transported into local waterways could have a number of impacts including:

- Reduced hydraulic capacity due to deposition of material within the channel.
- Degraded water quality including lower DO levels, increased nutrients (nitrogen (N), phosphorus (P)), increased turbidity, and altered pH.
- Increased levels of nutrients, metals and other pollutants transported via sediment and runoff to receiving waterways leading to increased potential for bioaccumulation of heavy metals in aquatic species.
- Increased sedimentation smothering aquatic life and affecting aquatic ecosystems.

Impacts from eroded material transported off the project site and deposited in terrestrial environments may include smothering of terrestrial vegetation and reduced visual amenity. Once dry, this material could form a source of dust emissions which could also impact on local amenity, particularly where deposition and occurred in proximity to residential areas, sensitive land uses such as schools and child care centres, and public open space.

A preliminary erosion and sedimentation assessment has been undertaken for the project in accordance with the Erosion and Sedimentation Risk Assessment Procedure (RTA 2004). This identified the project works to be low risk with reference to the following considerations:

- The size of the project and area of project corridor allows for maintenance and installation of controls.
- Slopes are less than five per cent grade and an R factor (rainfall erosivity) of 3500 for this area of Sydney presents as a low erosion hazard.
- Soils being exposed are generally within the existing road formation and adjacent to operational drainage networks.
- No SEPP 14 wetlands are located within the project area.

Construction of the bridge over Duck River would involve installation of up to four piers within the channel. Temporary access to the pier locations for construction would require the removal of vegetation including mangroves which presently assist in stabilising the channel bed and banks in turn reducing the potential for erosion/scour and mobilisation of sediments.

Duck River and its tributaries drain a heavily urbanised catchment with historical and current land use having a significant influence on sediment quality. As noted in section 8.4.2, previous investigations have identified trace metal concentrations in Duck River higher than reported background concentrations for the Port Jackson Estuary. Similar findings were made with regard to the sediment sampling and analysis undertaken as part of the Phase 2 detailed site assessment.

Duck River is tidal in this location and there are two tidal cycles daily. Tidal movement of water along the channel would have potential to entrain disturbed sediments and transport them both downstream to the Parramatta River estuary on the outward tide and upstream on the inward tide. The bidirectional movement of water in the channel would serve to limit the extent to which sediments were transported. Given the broader distribution of contaminated sediment within the wider Parramatta River estuary, the relatively limited works proposed within Duck River and the extensive management measures proposed in section 8.4.5, it is not anticipated there would be any material impacts associated with sediment disturbance. Disturbance of sediments would also have potential for localised short term increases in turbidity.

Water quality

Potential impacts on water quality from construction activities would be associated with:

- Disturbance/mobilisation of sediment associated with the clearing of riparian vegetation and removal of mangroves at Duck River associated with pier construction adjacent to and within the channel, and with providing access to the pier locations for construction.
- Exposure and mobilisation of exposed soils during construction such as from cleared areas and stockpiles.
- Accidental spills of chemical or hazardous materials.
- Inadequate management of runoff, sediment controls from the construction site.
- Potential disturbance and exposure of ASS to the air (oxidising conditions) resulting in potential for acidic runoff to reach receiving waterways.

Potential impacts could include:

- Degraded water quality including lower DO levels, increased nutrients, increased turbidity, and altered pH.
- Increased sedimentation smothering aquatic life and affecting aquatic ecosystems.

- Increased levels of nutrients, metals and other pollutants, transported via sediment and runoff to receiving waterways.
- Fuel, chemicals, oils, grease and petroleum hydrocarbon spills from construction machinery directly polluting the river and soils.
- Spills of concrete during concrete pours directly or indirectly polluting receiving waterways.
- Contamination from site compounds, chemical storage areas and washdown locations.
- Increased levels of litter from construction activities polluting receiving waterways.
- Contamination of receiving waterways as a result of disturbance of contaminated land.
- Acid runoff from disturbance of ASS during construction.
- Tannin leachate from cleared/mulched vegetation (this impact would likely be minor provided as vegetation clearance would be minimal and any cleared vegetation would be removed from site as soon as practicable after clearing.

The project is located on the southern side of the Parramatta River within the A'Becketts Creek, Duck Creek, Duck River, Haslams Creek and Powells Creek subcatchments, which all drain to the Parramatta River. These catchments are highly urbanised with large sections of open channels replaced with concrete-lined channels. Water quality is influenced by runoff from a diverse variety of sources, with the M4 Motorway drainage being only one of these.

As previously noted, existing water quality in the Parramatta River estuary is degraded with average concentrations of water quality management parameters (except for pH) being above the ANZECC (2000) aquatic ecosystem health guidelines for south-east Australian estuaries. Long term impacts on water quality in receiving waters are unlikely to be significant but given the increased motorway catchment area, there could be an incremental impact further reducing water quality.

Provided appropriate controls are implemented during construction, short term impacts are expected to be manageable and similarly have no material impact on receiving water quality.

Acid sulfate soils

The potential for ASS exists along the majority of the project, particularly in proximity to existing drainage channels. The principal risk is associated with disturbance and exposure of ASS to the air from excavation and construction works such as dewatering. If not appropriately managed, this could result in oxidation of ASS (over a period of weeks or months) with subsequent potential for highly acidic runoff that would impact groundwater, soils and waterways, as well as built environment elements.

The environmental impacts of acid drainage can include fish kills, fish disease, oyster damage and mortality, adverse effects on aquatic ecosystems, release of heavy metals from contaminated sediments, human and animal health impacts from polluted water, adverse impacts on soil structure and arability, and damage to built structures such as bridges (Ahern et al 1998). Within the context of the project, this could impact on water quality and aquatic ecosystems in both the immediate receiving waterways (A'Becketts Creek, Duck Creek, Duck River, Haslams Creek) and the broader Parramatta River estuary.

Contaminated land and hazardous materials

There is potential for contaminated land to be disturbed as a result of construction activities associated with excavation and other ground-engaging activities. Construction would also require the temporary occupation of ancillary sites for use as construction compounds and/or materials storage area. Potential environmental impacts associated with the project include:

- Inappropriate handling/disposal of contaminated or hazardous waste.
- Adverse effects on human health (construction personnel, travelling public or nearby communities).
- Release of contaminants into underlying soils.
- Release of contaminants into groundwater.
- Movement of contaminated sediments into waterways.
- Adverse effects on flora and fauna.

The Phase 2 detailed site assessment identified the primary contamination issues with respect to human health and surface water/groundwater as being:

- Asbestos fragments as well as fibres in fill soils.
- PAHs in fill soils.
- Hydrocarbons (naphthalene) in groundwater.
- Lead, mercury, PAH and asbestos in sediments in A'Becketts Creek, Haslams Creek, Duck Creek and Duck River.
- PASS soils and sediments.
- Potential for hydrocarbon and landfill gas associated with a closed landfill to the north of the M4 Motorway.

The Phase 2 detailed site assessment identified three areas within the project area considered to represent a high risk to site users. These relate to the presence of asbestos at:

- The landscaped stockpile on the eastern side of the James Ruse Drive Junction.
- In land to the north of the M4 Motorway adjacent to the east and west of Deniehy Street.
- In an area of public access beneath the M4 Motorway to the east of Alfred Street.

Areas of high risk contamination will be further investigated prior to construction and appropriate remediation/mitigation measures will be implemented where required (refer section 8.4.5). Other contamination recorded in soil, such as PAHs and the potential risks associated with a former landfill, are not considered to present an imminent risk of harm to human health or the environment but would require appropriate management during construction.

The Phase 2 detailed site assessment concluded there was potential for latent contamination from hydrocarbons, heavy metals, asbestos, PAH contaminants associated with road usage; and hydrocarbons, pesticides, heavy metals and asbestos associated with illegal dumping or fill soils. This would also require appropriate management during construction.

Two commercial properties and three residential properties would be acquired for the project. Based on the age and the structure of buildings on these properties, there is potential for hazardous building materials to be present. Further assessment would be required prior to any demolition works that may be required as part of the construction in order to identify what management measures would be required during demolition to effectively manage risks to human health and environment.

Groundwater

The main potential impacts on groundwater associated with construction activities relate to:

- Interference to aquifers resulting in a decrease or change in groundwater levels impacting upon groundwater users and groundwater dependent ecosystems.
- Pollution of groundwater.

The risk of these impacts is considered to be low as, apart from piling, no construction activities would potentially interfere with any aquifers. No dewatering would be required for piling activities. Groundwater is not used as a potable water source within, or in proximity to, the project area and is therefore not expected to impact on the groundwater resource.

Exposure of ASS has potential for acid generation if not managed appropriately. Acidic runoff could impact on a range of environmental aspects including groundwater. Effective management of ASS is well understood and there are established guidelines to manage this risk. The likelihood of this impact is therefore considered to be low.

Waste

Waste generated during construction would primarily be from civil works associated with site preparation, relocation of utilities, and construction of road infrastructure and landscaping. Waste-generating activities would include:

- Vegetation clearance, generating green waste such as logs and mulched material.
- Construction of temporary construction compounds, construction roads, ancillary sites and alternative property access would require vegetation clearance, road surface grading, temporary drainage structure installation and the placement of gravel road base where required, generating general asphalt waste, pipe cuts and green waste.
- Installation of environmental controls, fencing, silt fences and lockable gates, generating material off-cuts.
- Demolition of kerbs, fencing, pavements, concrete noise walls, barriers, signage, lighting, parapets, existing toll plaza and gantries.
- Excavation of existing batters, for retaining walls, for drainage, piling for viaduct structure, piers and bridge abutments.
- Construction of the ultimate project involving earthworks, placement of pavement layers, drainage, piling and piers to viaduct footings, concrete pour, utilities placement and protection, installation of tolling infrastructure including gantries and control systems, lighting, fencing and road furniture.
- Installation of prefabricated bridge deck, prefabricated piers and viaduct units, precast barriers and guard rails, prefabricated culvert units, generating general construction waste.

Waste streams would include the following:

- Surplus spoil (excavated soil, sediment, rock) from bulk earthworks which is unable to be reused within backfilling or restoration.
- Contaminated soils that may be exposed during construction, and if exposed, would require offsite disposal.
- Concrete, pavement, steel and other materials from demolition of kerbs, fencing, pavements, concrete noise walls, barriers, signage, lighting, parapets, existing toll plaza and gantries.

- Surplus material from construction and general site reinstatement, such as fencing, sediment, concrete, steel, formwork, and sand bags.
- Packaging materials from items delivered to site, such as pallets, crates, cartons, plastics and wrapping materials.
- Vegetative waste from clearance and grubbing.
- Plant and vehicle maintenance waste, such as oil containers.
- General office wastes generated by onsite personnel, such as paper, cardboard, beverage containers and food wastes.
- Sewage waste generated through the use of personnel facilities.

Stockpiled materials can also cause impacts when materials are mixed. For example, mixing of topsoils with subsoils, mixing of suitable and unsuitable material or mixing contaminated material can lead to materials that would have ordinarily been reused being rendered as waste.

Earthworks would be required for across the project including for road widening, bridge construction and drainage. Based on estimates drawn from the concept design, it is predicted that about 110,000 cubic metres of imported fill would be required for construction of the project. It is predicted that there would be about 5,600 cubic metres of excavation material that could be beneficially reused as fill for the project. Imported fill would either be virgin excavated natural material (VENM) or would comply with the conditions attached to a relevant resource recovery exemption.

It is estimated that about 51,000 cubic metres of spoil material would be produced through excavation activities that would be unsuitable for reuse on site. This would be transported for beneficial reuse off-site in accordance with a relevant EPA resource recovery exemption or disposed of at a licensed waste facility.

The Phase 2 detailed site assessment included a preliminary waste classification for fill soils. Based on this, fill soils would be classified as general solid waste (where no asbestos is observed) or special waste (asbestos) (for the location at/near BH215). Further waste classification would be required during construction to determine appropriate soil management and disposal. The underlying natural soils have recorded concentrations that would be classified as general solid waste but if uncontaminated are likely to satisfy the criteria for VENM. Soils defined as PASS would require disposal in accordance with the NSW DECC (2009) guidelines for ASS.

8.4.4 Assessment of potential operational impacts

Soils and sediments

Following construction, cleared areas would be paved/landscaped and scour protection installed at drainage outlets. There would be no exposed areas of topsoil and therefore little or no risk of soil erosion and entrainment of unconsolidated material by wind or runoff.

The installation of piers in the Duck River channel would reduce the overall channel cross-section resulting in localised increases in flow velocities. This would give rise to potential for scour (increased through removal of mangroves), and entrainment and transportation of sediments. Over the longer term, the channel would adjust to a new equilibrium condition which would involve a wider and/or deeper channel.

As noted previously, the tidal nature of water movement would serve to limit the extent to which entrained sediments were transported. Increased turbidity would also be associated with entrainment and transport of sediments. The potential for bank and bed scour can be reduced through provision of appropriate scour protection such as channel armouring (eg rip rap).

Water quality

Following completion of construction, including rehabilitation of exposed areas where vegetation and/or impervious surfaces had been removed, there would be minimal exposed areas of bare ground that could represent a potential source of unconsolidated material with potential for entrainment. As such, there would be little or no risk of soil erosion and transport of eroded sediments to receiving waterways.

Scour at drainage discharge points has potential for erosion and subsequent entrainment of material and transportation to receiving waterways. Provided this is adequately managed through appropriate design considerations such as incorporation of flow velocity reduction measures and scour protection, the likelihood of such impacts would be low.

Water quality risks during operation would largely be associated with the runoff of pollutants from the road surface. Typically, pollutants associated with road runoff are:

- Sediments from the paved surface from pavement wear and atmospheric deposition.
- Heavy metals such as lead, zinc, copper, cadmium, chromium and nickel attached to particles washed off the motorway pavement.
- Oil and grease and other hydrocarbon products.
- Rubber particles from wearing off tyres on the road pavement.
- Brake pad dust which could potentially include asbestos from older brake pads.
- Nutrients (N, P).

These deposits build up on road surfaces and pavement areas during dry weather and can be washed off and transported to waterways during rainfall periods.

Material deposited by motorists, such as non-biodegradable litter and food wastes, could also impact water quality, amenity and aquatic ecosystems if transported into receiving waterways.

During operation there would be a risk of accidental spillage of fuel, chemicals or other hazardous liquids as a result of vehicle leakage or road accidents on the motorway. While the likelihood of such potential spills would be low, the impact on the receiving environment could be considerable as spills of this nature would pollute receiving waterways if not adequately managed or mitigated.

Existing water quality in the Parramatta River estuary is degraded with average concentrations of water quality management parameters being above the ANZECC (2000) aquatic ecosystem health guidelines for south-east Australian estuaries. Polluted runoff would further degrade receiving water quality.

Acid sulfate soils

Negligible impact from ASS is expected once construction has been completed and disturbed areas have been stabilised.

Contaminated land and hazardous materials

Incidents such as vehicle accidents on the widened motorway could result in spillage of contaminants or hazardous materials on to the roadway. If not contained and/or cleaned up promptly, there would be potential for these to enter the drainage system and be discharged to receiving waterways. This in turn could impact negatively on water quality and aquatic ecosystems.

Groundwater

There is unlikely to be any material impact on groundwater associated with operation of the project. In the event that it is necessary to dewater construction sites, further investigation would be undertaken with regard to treatment and disposal of groundwater.

Waste

During operation of the project, small quantities of waste would be generated and would potentially include spills and leakages from vehicles, litter generated by road users and sediment from the water quality control basin. In addition, small quantities of waste would be generated from road maintenance and repair activities. The volume of operational waste would be minor and would be classified and disposed of to an appropriately licensed landfill.

8.4.5 Environmental management measures

Options development and early construction planning, described in Chapters 4, 5 and 6, have sought to minimise soils, water and waste related impacts as far as possible.

Project-specific management and mitigation measures have been developed with the aim of minimising or mitigating, as far as practical, the soils, water and waste related impacts during construction and operation as described above. The management and mitigation measures draw on best management practice, government standards and guidelines, and specialist knowledge. Potential impacts and site-specific management measures identified to manage those impacts for implementation during the pre-construction, construction and operational phases are summarised in the table below.

Impact	Ref#	Environmental management measures	Responsibility	Timing
Managing impacts on soil and water in general	SWW-1	A Soil and Water Management Plan will be prepared for the project in accordance with: • *Managing Urban Stormwater–Soils and Construction, Volume 1 Managing Urban Stormwater, 4th edition* ('the Blue Book'). • *Managing Urban Stormwater–Soils and Construction, Volume 2D Main Road Construction*.	Contractor	Pre-construction
Erosion risk – general	SWW-2	• Measures will be implemented during construction to minimise the risk of erosion, sedimentation and pollution. These measures may include: • Avoid disturbance where practicable, otherwise minimise the area of disturbance, particularly on and adjacent to river banks. • Designate of 'no-go' zones for construction plant and equipment. • Install upstream diversion channels to direct clean runoff from upstream	Contractor	Construction

Impact	Ref#	Environmental management measures	Responsibility	Timing
		catchments around or through disturbed areas (maintaining separation from runoff containing sediment). • Shape disturbed land to minimise slope lengths and gradients and improve drainage. • Install/line catch drains to carry any sediment laden runoff to appropriate sediment control measures. • Minimise stockpiling of material. • Remove cleared or excavated materials as soon as practicable after excavation and appropriately dispose of or stockpile off-site. • Locate stockpiles away from drainage lines and creek channels. • Seed disturbed areas for temporary soil stabilisation. • Employ appropriate measures to prevent/minimise wind-blown dust from leaving the site (eg watering). • Establish designated areas for plant and construction material storage within site compounds and other locations within the project area. • Store all chemicals and fuels associated with construction in secure roofed and bunded areas. • Retain erosion and sediment controls until disturbed areas are stabilised.		
Erosion from disturbed areas	SWW-3	• Measures will be implemented during operation to minimise the risk of erosion and sedimentation. These measures may include: • Undertake post-construction monitoring to ensure successful establishment of landscaping and vegetation cover. • Undertake remedial planting in locations where vegetation cover has not established or has only partially established.	Contractor	Operation
Erosion risk and mobilisation of sediment associated with Duck River bridge pier	SWW-4	• The following measures will be implemented to address erosion and sedimentation risk near the Duck River bridge works. • Minimise the area of mangroves to be cleared. • Install temporary coffer dams (sheet	Contractor	Construction

Impact	Ref#	Environmental management measures	Responsibility	Timing
construction		piling) or suitable alternative around pier construction locations. • Use silt curtain, subject to consideration of tidal flow velocities. • Program works likely to disturb aquatic sediments to 'slack water' periods. • Conduct water quality monitoring.		
Operational water quality impacts	SWW-5	• Detailed design would consider practicable measures to optimise pollution mitigation. This would include vegetated swales with rock check dams and spill management basins where space permits.	Contractor	Pre-construction
Disturbance of ASS	SWW-6	• An ASS Management Plan will be prepared in accordance with the *Acid Sulfate Soils Manual* and Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze.	Contractor	Pre-construction
Disturbance of contaminated or potentially contaminated land	SWW-7	• A Contaminated Land Management Plan (including a Remediation Action Plan where required) will be prepared in accordance with relevant EPA guidelines.	Contractor	Pre-construction
	SWW-8	• Excavated material that is not suitable for on-site reuse or recycling will be transported to a site that may legally accept that material for reuse or disposal. • Soils leaving the site will be waste classified so that correct resource recovery and or off-site disposal occur.	Contractor	Construction
	SWW-9	• An Asbestos Management Plan will be developed for the construction of the project in accordance with the *National Environment Protection (Assessment of site contamination) Measure 1999*. • The Plan will include an unexpected finds procedure to address any previously unidentified asbestos contamination encountered during construction. • Further investigation of the area of public access beneath the M4 Motorway to the east of Alfred Street will be undertaken to assess the level and extent of asbestos in this area.	Contractor	Pre-construction
Inappropriate disposal of	SWW-10	• Where excavated material cannot be classified as virgin excavated natural	Contractor	Construction

Impact	Ref#	Environmental management measures	Responsibility	Timing
excavated material that cannot be reused in the project		material, it will be classified and disposed of to an appropriately licensed landfill in accordance with the *Waste Classification Guidelines–Part 1: Classifying Waste* and *Part 2: Immobilisation of Waste*.		
Disturbance of contaminated groundwater	SWW-11	• Further assessment of the extent and source of hydrocarbon contamination associated with BH101 (located at the junction of Church Street/Great Western Highway) will be undertaken to inform the requirements of any specific remediation or management measures during construction.	Contractor	Pre-construction
Disturbance of hazardous materials	SWW-12	• Assessment of the two commercial properties and the four residential properties being acquired will be undertaken for the presence of hazardous building materials.	Contractor	Pre-construction
Inappropriate handling and/or disposal of waste	SWW-13	• A project-specific Resource and Waste Management Plan (RWMP) will be prepared in accordance with the Roads and Maritime Waste Minimisation & Management Guidelines and applicable Roads and Maritime QA Specifications.	Contractor	Pre-construction
	SWW-14	• All wastes, including contaminated wastes, will be identified and classified in accordance with *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes*. • Disposal of any non-recyclable waste will be in accordance with the POEO Act and *Waste Classification Guidelines: Part 1 Classifying Waste*.	Contractor	Construction