



Australian Government

BUILDING OUR FUTURE



Mulgoa Road / Castlereagh Road Corridor Upgrade

Between Glenmore Parkway, Glenmore
Park and Andrews Road, Penrith

Preferred Option Report

April 2017



BLANK PAGE

Mulgoa Road / Castlereagh Road Corridor Upgrade

Between Glenmore Parkway, Glenmore
Park and Andrews Road, Penrith

Preferred Option Report

April 2017

Prepared by Hills Environmental

Copyright notice

The concepts and information contained in this document are the property of Roads and Maritime Services. Use or copying of this document in whole or in part without the written permission of Roads and Maritime constitutes an infringement of copyright.

Disclaimer

Hills Environmental acts in all professional matters as a faithful advisor to the Client and exercises all reasonable skill and care in the provision of its professional services.

Reports are commissioned by and prepared for the exclusive use of the Client. They are subject to and issued in accordance with the agreement between the Client and Hills Environmental. Hills Environmental is not responsible for any liability and accepts no responsibility whatsoever arising from the misapplication or misinterpretation by third parties of the contents of its reports.

Except where expressly stated, Hills Environmental does not attempt to verify the accuracy, validity or comprehensiveness of any information supplied to Hills Environmental for its reports.

Where site inspections have taken place, the report is based on the information made available by the client or their nominees during the visit, visual observations and any subsequent discussions with regulatory authorities. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Hills Environmental is both complete and accurate.

Document controls

File name	161123 Mulgoa Road Castlereagh Road PREFERRED OPTION REPORT – Final - Accessible			
Report name	Mulgoa Road / Castlereagh Road Corridor Upgrade Glenmore Parkway to Andrews Road Preferred Option Report			
Document version	REF#	Date	Author	Approved for issue
	1-0	23.02.2016	S. Hill	S. Hill
	2-0	18.03.2016	S. Hill	S. Hill
	3-0	18.10.2016	S. Hill	S. Hill
	4-0	20.01.2017	S. Hill	S. Hill

Executive summary

Background

The Australian and NSW governments are planning to widen and upgrade 6.5 kilometres of Mulgoa Road / Castlereagh Road between Glenmore Parkway, Glenmore Park and Andrews Road, Penrith, to support current and future traffic demands and expected growth in the area.

Following the announcement of the Mulgoa Road / Castlereagh Road Corridor Upgrade in February 2015, Roads and Maritime started investigations and technical studies to develop several possible corridor options. This included seeking feedback and local knowledge from the community and stakeholders between August and September 2015. In October 2015, a value management workshop was held and each option evaluated by stakeholders and considered by Roads and Maritime in the selection of the preferred option.

In July 2016, the Australian and NSW governments announced a funding commitment of \$100 million to widen Mulgoa Road between Jeanette Street, Regentville and Blaikie Road, Jamisontown.

The Mulgoa Road / Castlereagh Road Corridor Upgrade (the proposal) is part of a plan to progressively upgrade a number of major arterial roads in western Sydney to deliver a more efficient, reliable network that meets the future needs of the community and the economy.

Purpose of this report

This report explains the option development and evaluation process for the proposal. The report aims to:

- Explain the strategic context and need for the upgrade
- Present relevant issues and constraints
- Document community and stakeholder involvement
- Describe the corridor options development and evaluation process including the methodology for the selection of the preferred option
- Present the preferred corridor option and related design options
- Outline the next steps for proposal development.

Need for the proposed upgrade

Traffic congestion along the Mulgoa Road / Castlereagh Road corridor is predicted to intensify as a result of continuing population and employment growth associated with current and planned developments in and around the Penrith CBD.

If no action is taken to improve the traffic flow along Mulgoa Road / Castlereagh Road, the following can be expected:

- Major congestion at a number of key intersections during peak periods in the next five to ten years extending throughout a large part of the day
- Mulgoa Road / Castlereagh Road would be highly congested and there would be increased delays and queuing along the corridor
- Local amenity and access to the Penrith CBD would continue to decline due to increased traffic, as would other road related impacts such as noise and local air quality
- The efficiency of public transport and freight would decline with reduced travel speed.

Proposal objectives

The objectives are to:

- Improve road capacity to cater to population and employment growth
- Improve the movement of goods and trucks
- Improve road safety for all users
- Support public transport use
- Encourage active transport use
- Improve amenity
- Minimise environmental and community impacts.

Options considered

For the purposes of option definition and evaluation, the proposal was divided into five sections:

- Section A - Glenmore Parkway to M4 Interchange
- Section B - M4 Interchange to Preston Street
- Section C - Preston Street to Union Road
- Section D - Museum Drive to Jack Williams Drive
- Section E - Jack Williams Drive to Andrews Road.

Options evaluated were limited to widening either to the east or to the west in each section. New alignment options (wholly separate to the existing Mulgoa Road / Castlereagh Road alignment) were not considered in detail due to cost (property acquisition and construction), the suitability of the existing alignment in servicing adjacent land uses and the need to maximise the use of existing infrastructure.

A 'do nothing' option was considered but discarded. The 'do nothing' option does not address the identified needs of the area and would therefore only be preferred in circumstances where the costs and environmental impacts outweighed the identified benefits.

Options evaluation

The options evaluation process involved information gathering (environmental investigations, design development, traffic modelling analysis), a value management process and a multi-criteria analysis, which assessed options against agreed criteria. The agreed criteria included traffic efficiency, safety, environment, property, utilities, future access, alternative transport, bus prioritisation, design standards and urban design.

The following was the outcome of the options evaluation process and has formed the basis for the further development of the proposal design:

- Provide three lanes in each direction
- Section A - Glenmore Parkway to M4 Interchange – widen to the east
- Section B - M4 Interchange to Preston Street – widen to the east (except in the vicinity of the mousehole near Wolseley Street)
- Section C - Preston Street to Union Road – widen to the west
- Section D - Museum Drive to Jack Williams Drive – widen to the west
- Section E - Jack Williams Drive to Andrews Road – widen to the west

Traffic efficiency, property impacts, environment and utilities were the main drivers for the selection of the preferred option.

An economic analysis of the preferred option was conducted and found that the benefit to road users of upgrading Mulgoa Road / Castlereagh Road to six lanes between Glenmore Parkway and

Andrews Road would exceed the capital cost of the upgrade and is therefore economically viable. The cost-benefit ratio was estimated to be 3.3 (where the break-even result is 1.0).

Staging Plan

Following the options evaluation, a staging plan was developed which divided the corridor upgrade into short, medium and long term works, subject to funding. This staging is based on traffic modelling that considered the traffic performance of Mulgoa Road / Castlereagh Road and key intersections along the route, and identified when the upgrade works would be needed to cater for the expected traffic growth.

Community and stakeholder consultation

The NSW government announced the start of planning for a future 6.5 kilometre upgrade and widening of Mulgoa Road / Castlereagh Road, between Glenmore Parkway, Glenmore Park and Andrews Road, Penrith in February 2015.

A community update was published in August 2015, identifying the scope of the project and requesting early feedback from the community. The consultation period ran from 28 August 2015 to September 2015. A number of submissions were received during the consultation period and overall there was support for the proposal. A number of key issues were raised by respondents:

- Scope of work (design recommendations)
- Traffic impacts (traffic lights at key intersections to improve traffic flow and safety for road users)
- Environmental impacts (landscape, flora and fauna)
- Pedestrian and cyclist safety and connectivity.

All comments received from the community were considered in the development of the preferred option for the corridor upgrade.

Issues and constraints

The major issues and constraints considered during the option evaluation stage of proposal development are as follows:

- Potential impacts on threatened ecological communities listed under the *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Potential for direct impacts on key fish habitat
- Presence of contaminated sites
- Impacts on existing surface flow patterns and drainage capacity due to an incremental increase in impervious surface area
- Potential for direct and indirect (visual / setting) impacts on items of historic heritage
- Flood prone land and flood evacuation routes
- Construction and operational noise impacts on noise sensitive receivers
- Positive and negative socio-economic effects including those associated with property acquisition
- Landscape character and visual impacts associated with the introduction new road infrastructure into areas with high visual sensitivity
- Presence of utilities.

Next steps

Roads and Maritime will review and consider community submissions, make changes where necessary and then confirm the preferred option. This will be followed by the development of a concept design and environmental assessment for Stage 1 between Jeanette Street and Blaikie Road. Further planning and development for Stages 2 to 6 are dependent on additional funding.

Roads and Maritime will continue stakeholder and community consultation during the next stages of the proposal. The Roads and Maritime website will be periodically updated with information about the progress of the proposal.

Contents

Executive summary	5
Contents	9
1 Introduction	11
1.1 Background	11
1.2 Proposal objectives.....	14
1.3 Report purpose and structure	14
2 Need for the proposal	15
2.1 Strategic planning context.....	15
2.2 Road network conditions.....	17
3 Issues and constraints	20
3.1 Landscape character and visual amenity	20
3.2 Biodiversity	20
3.3 Hydrology and flooding	22
3.4 Geology and soils	22
3.5 Noise and vibration	23
3.6 Air quality.....	23
3.7 Socio-economic and land use	23
3.8 Aboriginal heritage.....	23
3.9 Historic Heritage	23
3.10 Utilities.....	25
4 Community and stakeholder engagement	26
4.1 Consultation approach.....	26
4.2 Community involvement.....	26
4.3 Government agency and council involvement.....	27
4.4 Future community and stakeholder involvement	27
5 Options development.....	28
5.1 Typical cross section considerations.....	28
5.2 Strategic Options Considered	29
5.3 Approach to option development	29
5.4 Corridor widening options and sub-options	30
6 Options evaluation	40
6.1 Options evaluation process.....	40
6.2 Options evaluation outcomes.....	43
6.3 Preferred option	46
6.4 Proposal staging.....	46
7 Conclusion and next steps.....	52
References	53

Tables

Table 2-1 Average daily weekday and weekend traffic volumes (2015)	18
Table 2-2 Existing travel speeds (2015)	18
Table 4-1 August 2015 Community Update - community issues	26
Table 6-1 Options evaluation criteria.....	42
Table 6-2 Grading levels for criteria	43
Table 6-3 Preliminary staging plan.....	46

Figures

Figure 1-1 Location of the proposal.....	12
Figure 1-2 Castlereagh Road near Jack Williams Drive	13
Figure 1-3 Mulgoa Road near Surveyors Creek	13
Figure 1-4 Mulgoa Road near the Homemaker Centre.....	13
Figure 1-5 View south to Coreen Ave intersection.....	13
Figure 3-1 Vegetation communities and waterways	21
Figure 3-2 Historic heritage.....	24
Figure 5-1 Typical cross section – maximum allowance for trees.....	28
Figure 5-2 Typical cross section – limited allowance for trees.....	29
Figure 5-3 Proposal sections	31
Figure 5-4 Section A corridor widening options and site context	32
Figure 5-5 Section B corridor widening options and site context	33
Figure 5-6 Section C corridor widening options and site context	34
Figure 5-7 Section D corridor widening options and site context	35
Figure 5-8 Section E corridor widening options and site context	36
Figure 6-1 Option evaluation process.....	40
Figure 6-2 Strategic concept design - Section A	47
Figure 6-3 Strategic concept design - Section B	48
Figure 6-4 Strategic concept design - Section C	49
Figure 6-5 Strategic concept design - Section D	50
Figure 6-6 Strategic concept design - Section E	51
Figure 7-1 Next steps.....	52

Appendices

Appendix A	Community Update August 2015
Appendix B	Traffic and Transport Report
Appendix C	Constraints mapping

1 Introduction

1.1 Background

The Australian and NSW governments are planning to widen and upgrade Mulgoa Road / Castlereagh Road to support current and future traffic demands and expected growth in the area. This includes \$100 million to fast-track the first stage of the corridor upgrade between Jeanette Street, Regentville and Blaikie Road, Jamisontown.

The Mulgoa Road / Castlereagh Road Corridor Upgrade (the proposal) is part of a plan to progressively upgrade a number of major arterial roads in western Sydney to deliver a more efficient, reliable network that meets the future needs of the community and the economy.

Mulgoa Road / Castlereagh Road is a State arterial road, and is one of two main access points from Penrith to the M4 Motorway. Mulgoa Road, together with Parker Street / The Northern Road, connects Penrith City Council (PCC) Local Government Area (LGA) including its Central Business District with other parts of Greater Sydney. It carries significant traffic (2,500 – 3,800 vehicles / hour) during the morning and afternoon peak periods.

There are a number of key developments served by Mulgoa Road / Castlereagh Road that have contributed to increased population and employment in its immediate vicinity. These include:

- Penrith Panthers Entertainment precinct
- Penrith Station precinct
- Riverlink and Nepean River precincts
- Penrith Stadium
- Penrith Lakes
- Penrith Homemaker Centre
- New urban land releases at Glenmore Park and Thornton.

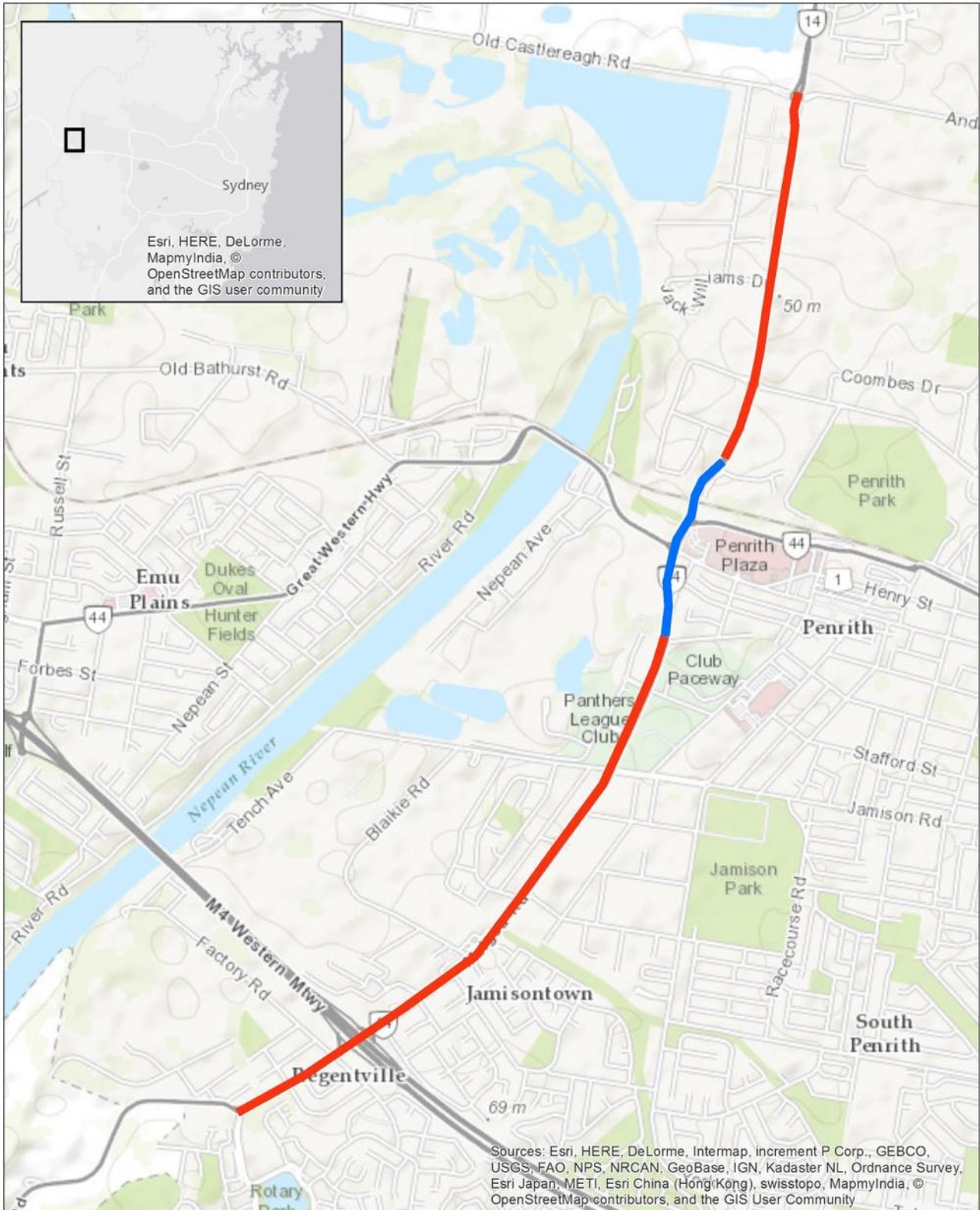
Mulgoa Road / Castlereagh Road is under increasing pressure to service these developments and an upgrade is required to support associated current and future traffic demands and expected growth in the area.

Related to the proposal is Jane Street and Mulgoa Road Infrastructure Upgrade. This was the subject of the published the *Jane Street and Mulgoa Road Infrastructure Upgrade Preferred Option Report* and would include:

- An additional lane both north and south bound on Mulgoa Road / Castlereagh Road between Museum Drive and Union Road, increasing capacity for through traffic, while providing capacity for vehicles turning left onto Mulgoa Road from Jane Street and right onto the Great Western Highway
- A longer left-turn lane along Mulgoa Road for vehicles turning onto the Great Western Highway
- Upgrading the Mulgoa Road and High Street intersection to provide increased capacity
- Upgrading the T-intersection of Jane Street and Castlereagh Road / Mulgoa Road to provide increased capacity
- Widening the existing rail underpass to allow three lanes of traffic in each direction on Castlereagh Road and a left turn lane into Jane Street.

While the Jane Street and Mulgoa Road Infrastructure Upgrade is a separate proposal, planning and staging of these two projects is being coordinated.

Figure 1-1 shows the location of both the proposal and the Jane Street and Mulgoa Road Infrastructure Upgrade.



- Jane Street / Mulgoa Road Infrastructure Project
- Mulgoa Road / Castlereagh Road Corridor Upgrade

Figure 1-1 Location of the proposal



Figure 1-2 Castlereagh Road near Jack Williams Drive



Figure 1-3 Mulgoa Road near Surveyors Creek



Figure 1-4 Mulgoa Road near the Homemaker Centre



Figure 1-5 View south to Coreen Ave intersection

1.2 Proposal objectives

The project objectives are to:

- Improve traffic efficiency
- Support residential growth
- Support employment growth
- Improve freight productivity
- Improve road safety
- Support public transport use
- Encourage active transport use
- Improve amenity
- Minimise environmental and community impacts.

In addition to the overall project objectives listed above, a number of urban design objectives and principles have been developed to guide the continuing design process.

The urban design objectives are:

- Create a more cohesive road experience recognising sense of place, the human scale.
- Reinforce active transport potential along and across the road.
- Provide visual experience of mountains, river, urban form and CBD.
- Create an attractive and active green corridor with a shady environment for walking and bikes linked to the riverside corridor
- Function as a best practice transport corridor for accessibility and connectivity for the next 30 years.
- Implement a vision based on principles consistent with the Roads and Maritime 'Beyond the Pavement' document.

1.3 Report purpose and structure

This report explains the option development and evaluation process for the proposal. The report aims to:

- Explain the strategic context and need for the upgrade
- Present relevant issues and constraints
- Document community and stakeholder involvement
- Describe the corridor options development and evaluation process including the methodology for the selection of the preferred option
- Present the preferred corridor option and related design options
- Outline the next steps for proposal development.

2 Need for the proposal

2.1 Strategic planning context

The following major strategic planning and policy documents provide direction and establish priorities that are relevant to the proposal.

2.1.1 NSW State Priorities

The NSW Government has set State Priorities in the following five groups:

- Strong budget and economy
- Building infrastructure
- Protecting the vulnerable
- Better services
- Safer communities.

Within the building infrastructure category, the proposal would specifically contribute to the priority of improving road travel reliability by aiming to ensure that 90 per cent of peak travel on key road routes is on time.

The Premier has also set twelve priorities one of which is ensuring that key infrastructure projects are delivered on time and on budget across the State.

2.1.2 A plan for growing Sydney

A *Plan for Growing Sydney* (NSW Government, 2014) sets out the NSW Government's strategy for accommodating Sydney's future population growth over the next 20 years. The plan consists of goals, directions and actions that provide a framework for strengthening the global competitiveness of Sydney and delivering strong investment and jobs growth in western Sydney.

The proposal is consistent with the Strategic Direction 1.1 Deliver Infrastructure. The proposal would also support access to Penrith which has been identified as a one of three Regional City Centres within Greater Sydney. Similarly, the proposal would support Penrith Education and Health Area which is identified as one of twenty-three Strategic Centres of Sydney.

At a broader level, the proposal would contribute to improved connections between Penrith and Sydney's growth centres including:

- North West Priority Growth Area
- Western Sydney Priority Growth Area
- Penrith and Blacktown urban corridor
- Western Sydney Employment Area
- A planned western Sydney airport.

2.1.3 NSW Long Term Transport Master Plan

The *NSW Long Term Transport Master Plan* (NSW Government, 2012) provides a framework for delivering an integrated, modern transport system by identifying NSW's transport actions and investment priorities for the next 20 years.

The plan includes a specific action to provide faster and more frequent transport services to major employment centres such as Penrith and recognises the need for better north-south connections in this area. The proposal would support this action.

The proposal is also consistent with the nominated objective of the NSW transport system to support economic growth and productivity. It would do this by contributing to a transport system that responds directly to customer needs, is more efficient, increases freight efficiency and

improves the connectivity and accessibility of people to other people, opportunities, goods and services.

2.1.4 Sydney's Bus Future

Sydney's Bus Future (NSW Government, 2013a) outlines a number of actions and initiatives designed to integrate Sydney's bus network into the wider public transport network and its role in the *NSW Long Term Transport Master Plan*.

Sydney's existing bus network includes more than 600 bus routes, with customer demand for bus travel expected to grow by 30 per cent by 2031. Sydney's Bus Future aims to provide a simplified bus network and distribute buses more evenly across the city, reducing road congestion, delay and uncertainty for bus customers.

The entire network will be simplified into a clear, three-tiered system including rapid, suburban and local service routes. Each service level will deliver to a defined level of service consistency and reliability and will be assisted by road network improvements such as this proposal.

2.1.5 Sydney's Cycling Future

The overarching goal of *Sydney's Cycling Future* (NSW Government, 2013b) is to make cycling a safe, convenient and enjoyable transport option for short trips. By helping to reduce the burden of congestion on roads and increasing capacity on the transport system, Sydney's Cycling Future target is to increase the number of people riding a bike for transport.

The proposal provides an opportunity to support cycling by providing better cycling infrastructure. The provision of better cycling infrastructure would be strongly aligned with two of the "three pillars" of Sydney's Cycling Future:

- Pillar 1 - Safe connected networks
- Pillar 3 - Partner with councils to target missing links and problem intersections in local bicycle networks.

2.1.6 Sydney's Walking Future

Once of the three pillars of *Sydney's Walking Future* (NSW Government, 2013c) is to connect people to places through safe walking networks around centres and public transport interchanges. The proposal provides an opportunity to improve connections and infrastructure for pedestrians in the vicinity of Penrith.

2.1.7 NSW Ports and Freight Strategy

The *NSW Freight and Ports Strategy* (NSW Government, 2013d) targets specific challenges associated with the forecast doubling of the NSW freight task by 2031. Providing a network that minimises congestion will support economic growth and productivity and encourage regional development. In this context the strategy identifies the need to develop and maintain capacity for freight on the road network. The proposal provides an opportunity to respond to this need.

Mulgoa Road / Castlereagh Road is not classified as a primary, secondary or tertiary freight route but is an approved 25/26 metre B-Double Route and provides important connections to the M4 Motorway (a primary freight route) and The Northern Road (a tertiary freight route). It is estimated that up to 5,600 heavy vehicles currently use the corridor per day.

Objectives of the *NSW Freight and Ports Strategy* relevant to the proposal include:

- Delivery of a freight network that efficiently supports the projected growth of the NSW economy.
- Balancing freight needs with those of the broader community and the environment.

Actions of the strategy and task actions relevant to the proposal include:

- Action 1D - Improve productivity of the road freight network
 - Task 1D-2 Provide necessary infrastructure to support High Productivity Vehicle access

- Task 1D-3 Improve access for High Productivity Vehicles on State and local roads
- Action 2B – Develop and maintain capacity for freight on the road network
 - Task 2B-2 Prioritise road infrastructure investments
- Action 3B – Manage congestion, noise and emission impacts of freight transport
 - Task 3B-1 Recognise costs of congestion
 - Task 3B-2 Mitigate noise from freight operations
 - Task 3B-3 Mitigate emissions from freight operations
- Action 3C – Prioritise safety of freight transport
 - Task 3C-2 Improve heavy vehicle safety.

The proposal is considered consistent with the objectives, actions and tasks referenced above. It would reduce congestion on a road with connections to primary freight and tertiary freight routes route and includes design features that would better accommodate heavy vehicles and which would enhance safety for all road users.

2.1.8 NSW Road Safety Strategy

The *NSW Road Safety Strategy 2012-2021* (Transport for NSW, 2012) establishes the direction of road safety in NSW for 10 years from 2012. It supports a targeted reduction in the annual number of fatalities and serious injuries by at least 30 per cent by the end of 2021.

The strategy places particular importance on the design of safe roads and roadsides and recognises that the ongoing development and upgrade of the NSW road network is essential to improve road safety. The proposal is consistent with this direction and provides an opportunity to improve road safety through the design development process.

2.1.9 Australian Government Department of Infrastructure and Regional Development - Corporate Plan 2016-17

The Department of Infrastructure and Regional Development Corporate Plan 2016-2017 outlines a number of outcomes to deliver through their programs, divided into the following categories:

- Infrastructure - Improved infrastructure across Australia through investment in, and coordination of, transport and other infrastructure.
- Transport - An efficient, sustainable, competitive, safe and secure transport system for all transport users through regulation, financial assistance and safety investigations.
- Regional Development and Local Government - Strengthening the sustainability, capacity and diversity of regional economies including through facilitating local partnerships between all levels of government and local communities, and providing grants and financial assistance.
- Services to Territories - Good governance in the Australian territories through the maintenance and improvement of the overarching legislative framework for self-governing territories, and laws and services for non-self-governing territories.

The proposal would contribute to infrastructure and transport outcomes with the provision of improved transport infrastructure catering for a range of transport users.

2.2 Road network conditions

2.2.1 Existing traffic volumes and congestion

The Mulgoa Road / Castlereagh Road corridor between Glenmore Parkway and Andrews Road carries significant traffic and volumes have increased consistently between 1993 and 2015, with an average growth rate of 1.2 per cent per annum over this 22-year period.

In 2015, Mulgoa Road / Castlereagh Road carried between 30,000 and 44,000 vehicles per day on a typical weekday condition, depending on the specific section. On weekends traffic volumes were found to be nine to 13 per cent lower than the weekday traffic. In 2015, about 2,000 to 5,500 heavy

vehicles were counted, equating to between seven and 15 per cent of daily traffic. Table 2-1 shows 2015 average daily and weekend traffic volumes.

Table 2-1 Average daily weekday and weekend traffic volumes (2015)

Location	Average 7-days	Average weekday	Average weekend	Critical day
Castlereagh Road – 200 m north of Jack Williams Drive	29,866	31,823	24,974	33,973
Castlereagh Road - between Museum Drive and Jane Street	33,935	36,025	28,710	38,196
Mulgoa Road - between Rodley Avenue and Ransley Street	33,376	34,684	30,105	37,198
Mulgoa Road - at Surveyors Creek Bridge	43,452	44,942	39,726	49,876
Mulgoa Road - between Spencer Street and Glenmore Parkway	28,125	28,888	26,219	30,408

The Mulgoa Road / Castlereagh Road corridor between Glenmore Parkway and Andrews Road has 17 sets of traffic signals and three roundabouts which contribute to stop-start traffic conditions causing delay and congestion. During both morning and afternoon peak periods a substantial amount of turning traffic contributes to capacity problems at critical intersections.

Travel speed on Mulgoa Road / Castlereagh Road during the weekday peak period is currently well below the posted speed of 60 kilometres per hour. The 2015 survey indicates that motorists travel about 10 to 35 kilometres per hour from Museum Drive to the M4 Motorway, and about 35 to 40 kilometres per hour from Andrews Road to Museum Drive and from the M4 Western Motorway to Glenmore Parkway. The average travel speed for the entire corridor from Glenmore Parkway to Andrews Road was about 20 to 30 kilometres per hour. Table 2-2 shows 2015 surveyed traffic speeds along the corridor.

Table 2-2 Existing travel speeds (2015)

Location	Travel speed (km/h)			
	AM peak		PM peak	
	Northbound	Southbound	Northbound	Southbound
Andrews Road to Museum Drive	40	39	38	31
Museum Drive to Union Road	15	13	16	13
Union Road to Jamison Road	35	43	36	48
Jamison Road to M4	31	26	30	23
M4 to Glenmore Parkway	27	39	31	43

2.2.2 Traffic growth

The existing traffic congestion along the corridor is predicted to intensify as a result of continuing population and employment growth due to the current and planned developments around the Penrith CBD, Penrith Panthers Entertainment precinct, Thornton and the Penrith Lakes

Development. It is estimated that these and other developments are projected to increase traffic growth by two per cent per annum over the next 20 years.

Traffic modelling and analysis indicates that if no action is taken to improve the traffic flow on the Mulgoa Road / Castlereagh Road, the following can be expected (refer also to the Traffic and Transport Report included in Appendix B):

- Major congestion at a number of key intersections during peak periods in the next five to ten years extending throughout a large part of the day. Of the 16 key intersections analysed, ten intersections showed poor level of service F (where average delay per vehicle is more than 70 seconds) in 2020 either in morning or afternoon peak periods
- The Mulgoa Road / Castlereagh Road would be highly congested and there would be increased delays and queuing along the corridor
- Local amenity and access to the Penrith CBD would continue to decline due to increased traffic, as would other road related impacts such as noise and localised air quality
- The efficiency of public transport and freight would decline with reduced travel speed.

2.2.3 Road safety

There were 262 crashes recorded between 2011 and 2015 on the Mulgoa Road / Castlereagh from Andrews Road to Glenmore Parkway. About 38 per cent of crashes involved injury and 62 per cent were non-casualty crashes. The five-year crash data showed that about 133 people were injured.

It is likely that without improvements, increased traffic volumes and congestion would see safety deteriorate along Mulgoa Road / Castlereagh Road for all road users.

3 Issues and constraints

A range of investigations have occurred to support the proposal design development and option evaluation processes. These include a preliminary environmental investigation, traffic modelling / analysis, a strategic urban design analysis and utilities investigations. The following sections provide an overview of the main issues and constraints identified for the proposal. Refer also to the constraints mapping included in Appendix C.

3.1 Landscape character and visual amenity

Four precincts were developed for the proposal corridor based on general landscape character, transition points at significant gateways and general development context. The precincts are:

- Woodland Residential Zone - This extends from Glenmore Parkway to the M4 Motorway and includes the School House Creek crossing. No major development changes are envisaged for this area and it is likely to remain a low density wooded residential area. There is an opportunity to reinforce the woodland character with planting consistent with the remnant vegetation in the nearby Forest Redgum Reserve and emphasise the gateway to the Mulgoa Road scenic drive to the south. Opportunity also exists to reinforce green links along eastern side of the corridor
- Gateway Boulevard Zone - This includes the M4 Regional Gateway and extends north to Union Road. It is crossed by Surveyors Creek, Jamison Road creek, and the watercourse at the Paceway Site. A considerable amount of new development is expected in this area, which will give rise to a higher population density and mix of leisure and business uses. There is an opportunity to highlight the key creeks, gateways and open spaces along the route to create a series of open and closed views
- CBD Zone - This extends from Union Street and includes the gateway at the Great Western Highway and extends to Museum Drive. This zone relates primarily to the Jane Street and Mulgoa Road Infrastructure Upgrade rather than the current proposal
- Northern Avenue Zone - This extends from Museum Drive to Andrews Road and includes the Corridor gateway at Andrews Road and Old Castlereagh Road. Boundary Creek crosses this area. Larger sites in this light industrial area may be redeveloped over time however flood and environmental issues may preclude intense residential development. There is an opportunity to strengthen the avenue experience through tree planting in this zone.

The proposal corridor contains a series of linear and lateral views that assist wayfinding and reinforce the relationship between the road and the region. These include:

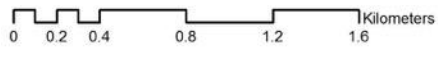
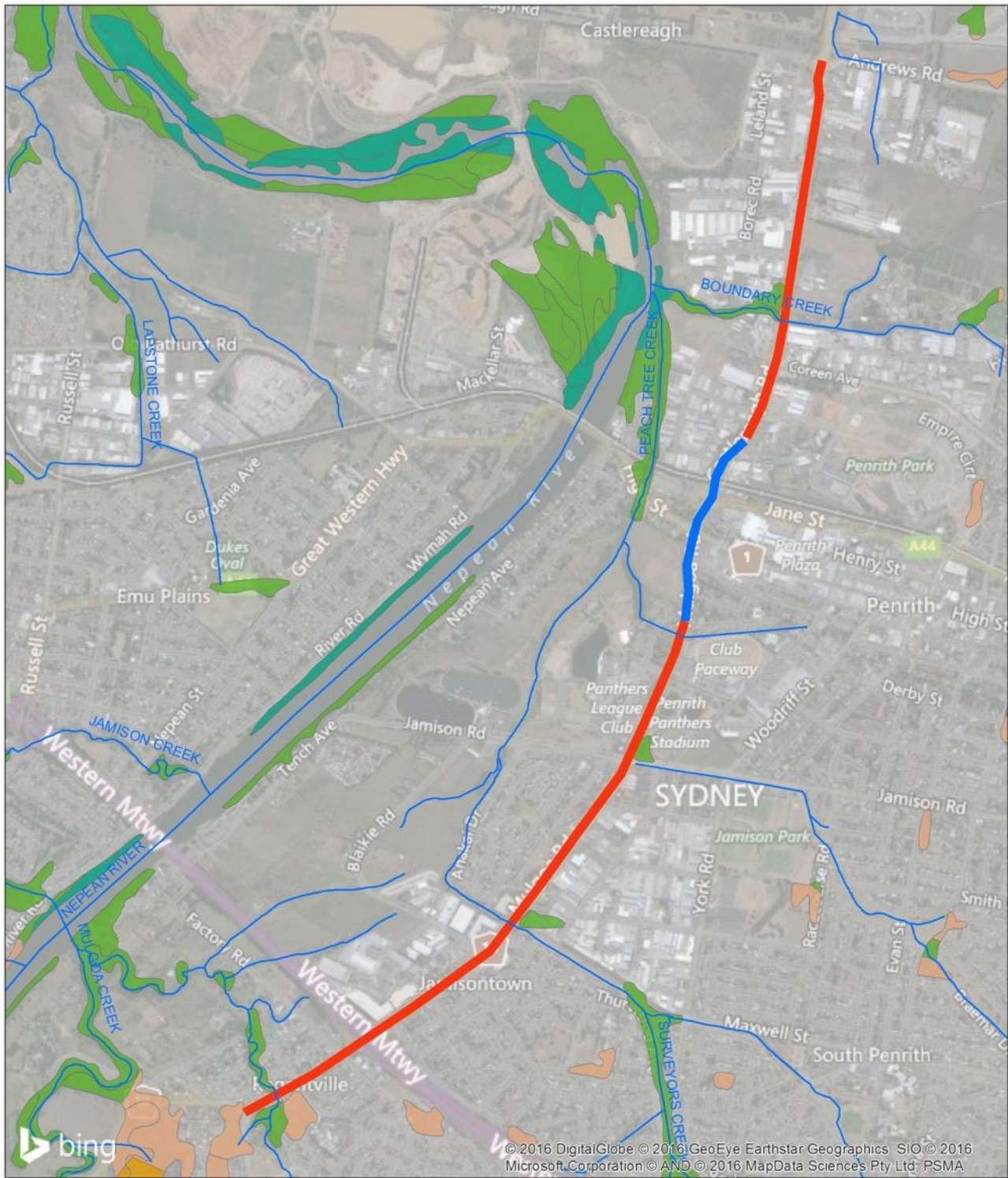
- View south towards the M4 Motorway
- View north towards Howell Oval
- Views of Blue Mountains from Mulgoa Road throughout
- Views at intersections along the road
- Wide views experienced at CBD and north of the railway.

There is an opportunity to better frame views at major streets and creek lines, while carefully locating major signage to maintain views towards open spaces.

3.2 Biodiversity

The main biodiversity issues identified for the proposal corridor are (refer also to Figure 3-1):

- Potential impacts on *Threatened Species Conservation Act 1995* (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) threatened ecological communities (Cumberland Plain Woodland, River-flat eucalypt forest)
- Possible occurrence of TSC Act and EPBC Act threatened fauna species and migratory species (or their habitats)
- Identified key fish habitat (Boundary Creek, Surveyors Creek, School House Creek).



Vegetation Data: NPWS 2002, 2008



- Watercourses
- Jane Street / Mulgoa Road Infrastructure Project
- Mulgoa Road / Castlereagh Road Corridor Upgrade
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 12 - Riparian Forest
- 9 - Shale Hills Woodland

Figure 3-1 Vegetation communities and waterways

3.3 Hydrology and flooding

The Nepean River is located generally between 500 metres and 1000 metres to the west of the proposal corridor. Three watercourses cross the proposal corridor (see Figure 3-1):

- Boundary Creek (just to the north of the Mullins Road / Coreen Avenue intersection)
- Surveyors Creek (just to the north of Blaikie Road)
- School House Creek (just to the north of the Glenmore Parkway intersection).

Part of the proposal corridor to the north of the railway line is affected by flooding and is identified as a flood planning area by the Penrith Local Environmental Plan 2010. (i.e. it is below the level of a 1:100 ARI (average recurrent interval) flood event).

An important consideration is therefore the identification of flood evacuation routes and nomination of a flood free level for any future upgrade.

A Preliminary Flood Investigation was commissioned to model to existing behaviours of flooding on the project site to determine if improvements to the flood immunity should be considered in the concept design phase. The report recommended that a minimum level of flood immunity should accommodate a 1 in 10 year event, with a higher level of flood immunity required for sections of the corridor that are required as flood evacuation routes.

3.4 Geology and soils

The geology of the proposal corridor is identified as (Clark & Jones, 1991):

- Cranebrook formation – gravel, sand, silt, clay
- Ashfield Shale - Dark-grey to black claystone-siltstone and fine sandstone-siltstone laminate
- Bringelly Shale - Shale, carbonaceous claystone, claystone, laminate, fine to medium grained lithic sandstone, rare coal and tuff
- Minchinbury Sandstone - Fine to medium-grained quartz-lithic sandstone.

The soils of the study area vary considerably in their characteristics, with some having high erosion hazard. This would be primarily a construction management issue for the proposal.

There are a number of known contaminated sites within or adjacent to the proposal corridor (identified to the Environment Protection Authority) that would require further investigation prior to any acquisition / disturbance:

- BP Express Service Station, corner Coreen Avenue and Castlereagh Road – under assessment
- Crane Enfield Metals, 2115 Castlereagh Road - Contamination currently regulated under the *Contaminated Land Management Act 1997*
- Caltex Service Station, Castlereagh Road, corner Lugard Street – under assessment
- Mirvac Industrial Site, 2101 Castlereagh Road – regulation under the *Contaminated Land Management Act 1997* required
- Caltex Service Station, 153 Coreen Avenue - under assessment
- BP Service Station, 126 Mulgoa Road – under assessment
- Former Caltex Jamisontown, 229-231 Mulgoa Road - under assessment
- 7 Eleven Service Station - 92 Mulgoa Road - Contamination currently regulated under the *Contaminated Land Management Act 1997*.

Parts of the proposal have been identified as having a high salinity potential (around Surveyors Creek, just to the north of Blaikie Road, and School House Creek). This would be primarily a construction management issue for the proposal.

3.5 Noise and vibration

The main noise sensitive receivers are residential dwellings, mainly located in the central and southern parts of the proposal corridor. Construction noise would be primarily a construction management issue for the proposal. Potential changes in operational road traffic noise as a result of changes in traffic volumes and/or road geometry are a consideration for the environmental assessment phase.

3.6 Air quality

A road upgrade within the proposal corridor could result in air quality impacts during both construction and operation. Construction air quality would be primarily a construction management issue for the proposal. Potential changes in air quality during operation as a result of changes in traffic volumes and/or road geometry are a consideration for the environmental assessment phase.

3.7 Socio-economic and land use

The proposal corridor and immediate surrounds supports a range of social infrastructure including libraries, public transport, recreational facilities, music schools and early learning centres.

The following potential socio-economic benefits are anticipated as a result of improving Mulgoa Road / Castlereagh Road through the study area:

- Travel time improvements from higher travel speeds and less congestion. This would also lead to operational cost savings for business and individuals
- Reducing the frequency and severity of crashes and more broadly improving road user safety
- Economic benefits over the construction period.

The following potential socio-economic impacts could occur as a result of the proposal:

- Disruption associated with property acquisition
- Congestion and delays during construction associated with lane occupancy and road work speed limits. This would potentially affect both buses and general traffic
- Residential amenity impacts such as noise and visual amenity.

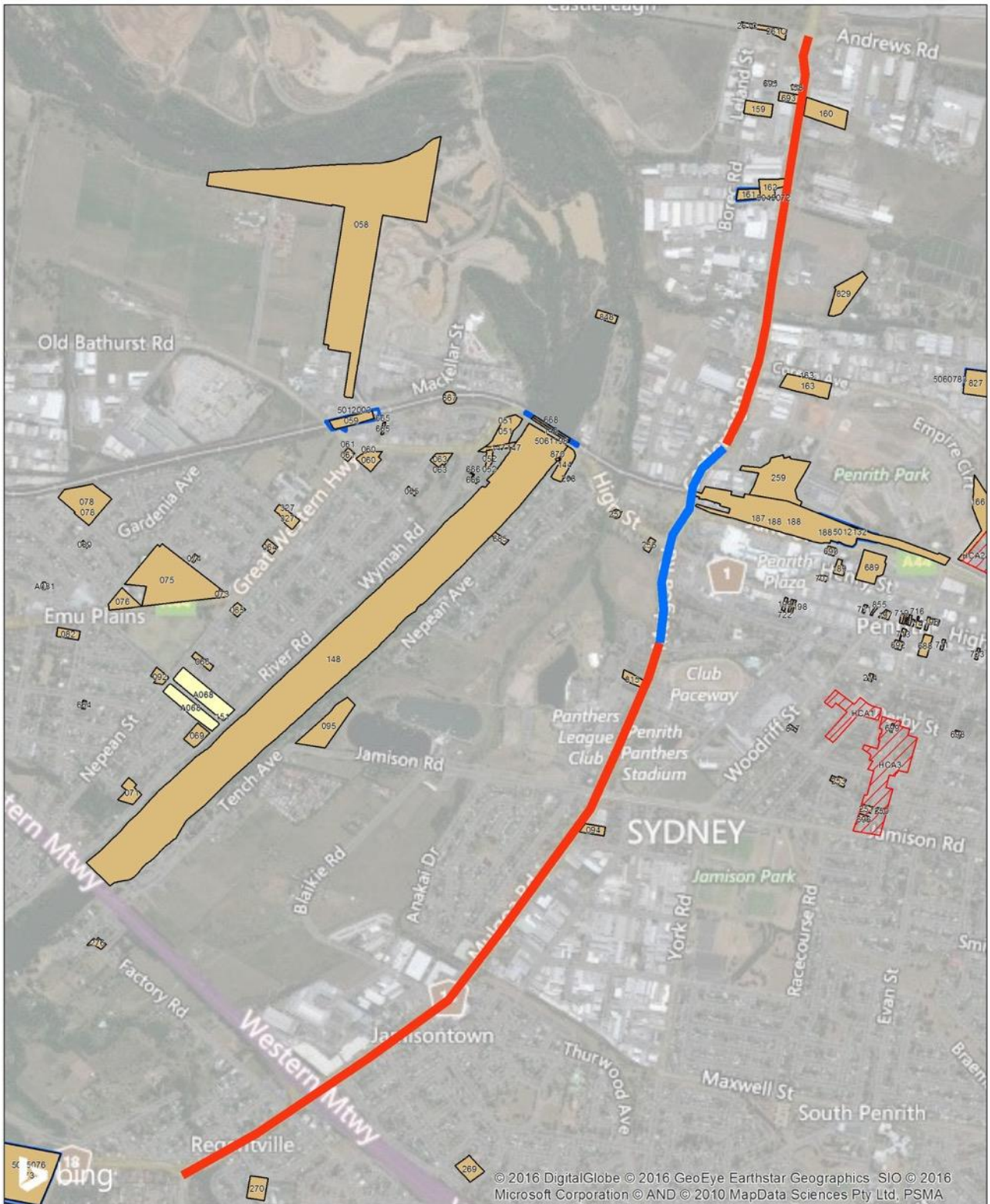
3.8 Aboriginal heritage

Much of this study area is heavily disturbed reducing the potential for Aboriginal objects to be found. Remaining archaeological potential is expected to be greatest along creek lines. While a search of the Aboriginal Heritage Information Management System (AHIMS) identified 46 Aboriginal sites in the broader area, these known sites would not be affected by the proposal. More detailed consideration of Aboriginal cultural heritage would need to occur at the environmental assessment phase.

3.9 Historic Heritage

There are a number of historic heritage items within the area, some of which would be directly or indirectly affected by proposal options. Potentially affected items are listed below (and are shown by Figure 3-2):

- Penrith Ambulance Station 668–672 High Street (local listing)
- “The Willows”, house, 65 Mulgoa Road (local listing)
- Workmens’ cottages 56–62 Mulgoa Road (local listing)
- Edwardian Cottage, 2068 Castlereagh Road (local listing)
- Victorian House, 2083–2089 Castlereagh Road (local listing)
- Castlereagh Road Alignment (local listing).



- Jane Street / Mulgoa Road Infrastructure Project
- Mulgoa Road / Castlereagh Road Corridor Upgrade
- State Heritage Act
- Conservation Area - General
- Item - General
- Item - Archaeological

Figure 3-2 Historic heritage

3.10 Utilities

Investigations to identify the utilities constraints along the corridor have included:

- Initial discussions have commenced with utility providers (Endeavour Energy and Optus have been consulted)
- Utility on-site 3D investigations (electronic tracing) undertaken by sub-contractors for the entire corridor
- Dial before you dig searches.

Potentially affected utilities include:

- Gas mains
- Telecommunications infrastructure including optic fibre
- Overhead and underground powerlines (including clearance zones around a high voltage powerline towers)
- Sewer mains (varying sizes)
- Water mains (varying sizes).

4 Community and stakeholder engagement

4.1 Consultation approach

A Communication and Engagement Plan was prepared to support development and delivery of the Mulgoa Road / Castlereagh Road Corridor Upgrade. The plan outlines the communication and engagement objectives for the proposal and presents the communications approach, tools, key messages, protocols and evaluation process to support the implementation of project communication and engagement. The plan also provides an agreed approach to communication and engagement, open communication channels and clear protocols. Roads and Maritime is committed to meeting the reasonable needs and desires of the community for information and welcomes the community's views on the proposal.

The Communication and Engagement Plan requires the development of detailed implementation plans in advance of each proposal milestone. In response to emerging interests and issues, a flexible approach will be required and the plan will be updated as required.

4.2 Community involvement

4.2.1 August 2015 community update

In August 2015, Roads and Maritime released a community update announcing the start of the project (refer to Appendix A). The update was distributed to 13,000 residents and businesses and was placed on the Roads and Maritime website. The community were invited to provide feedback on the proposal until 25 September 2015.

4.2.2 Summary of issues and responses

Roads and Maritime received 22 submissions covering eleven key issues. The comments received were categorised into eleven key issue areas, with sub-issues within these categories. Refer to Table 4-1.

Table 4-1 August 2015 Community Update - community issues

Issues	Events	Stakeholders distinct	Total
Scope of work	11	11	11
Design	7	7	7
Complaint	6	6	6
Landscaping	4	4	4
Vegetation removal	4	4	4
Fauna / Flora	4	4	4
Location of assets	3	3	3
Land acquisition	3	2	2
Bridges	3	3	3
Safety	2	2	2
Other	11	11	11
Total Event search	23	22	22

4.3 Government agency and council involvement

Initial discussions have taken place with key stakeholders in the NSW Government and local governments. A number of workshops were held that included representatives from Transport for NSW and Penrith City Council.

4.4 Future community and stakeholder involvement

Roads and Maritime proposes to seek comment on the preferred corridor and will publicly release this Preferred Option Report. Comments received from the public display of the report will be considered as part of the proposal development process.

Further consultation will be carried out in future by inviting the community to provide comments on the concept design and Review of Environmental Factors.

The following stakeholders have been identified as having a potential interest in the proposal. The list is not exhaustive and would be refined during the course of detailed environmental assessment.

- Penrith City Council
- NSW Planning and Environment
- Transport for NSW
- Busways
- NSW Office of Water
- Environmental Protection Authority
- Office of Environment and Heritage
- Penrith Valley Chamber of Commerce
- The local Aboriginal community
- Emergency services
- Endeavour Energy and Jemena
- Optus, Telstra, NBN Co
- Sydney Water
- Landowners, residents and local businesses.

5 Options development

5.1 Typical cross section considerations

The first step in the option development process involved determining the appropriate typical cross section for the project. Traffic modelling scenarios were then considered to ensure consistency with the project objectives, including the need to improve current and projected levels of service for traffic along the proposal corridor.

The following were considered in the development of a typical cross section for the proposal:

- Minimising the impact on properties along the corridor
- Minimising impact on utilities
- Ensuring that the road corridor meets all the current road standards
- Maximising the opportunities for Urban Design Outcomes along the corridor
- Ultimate section allowing for the ultimate outcome from a road design and Urban Design perspective
- Reduce the widths of lanes to accommodate space on the verge for tree planting.

Following a balanced consideration of the above factors, two typical six-lane mid-block cross sections were developed for the proposal. One cross section maximises the allowance for trees / landscaping (see Figure 5-1) while the other has a more limited allowance for trees / landscaping (see Figure 5-2). It is expected that a combination of these two approaches would apply throughout the proposal corridor.

Cross sections are still under consideration and will be confirmed as part of the design development process, following consideration of community comment on the proposal and in consultation with key stakeholders including Penrith City Council.

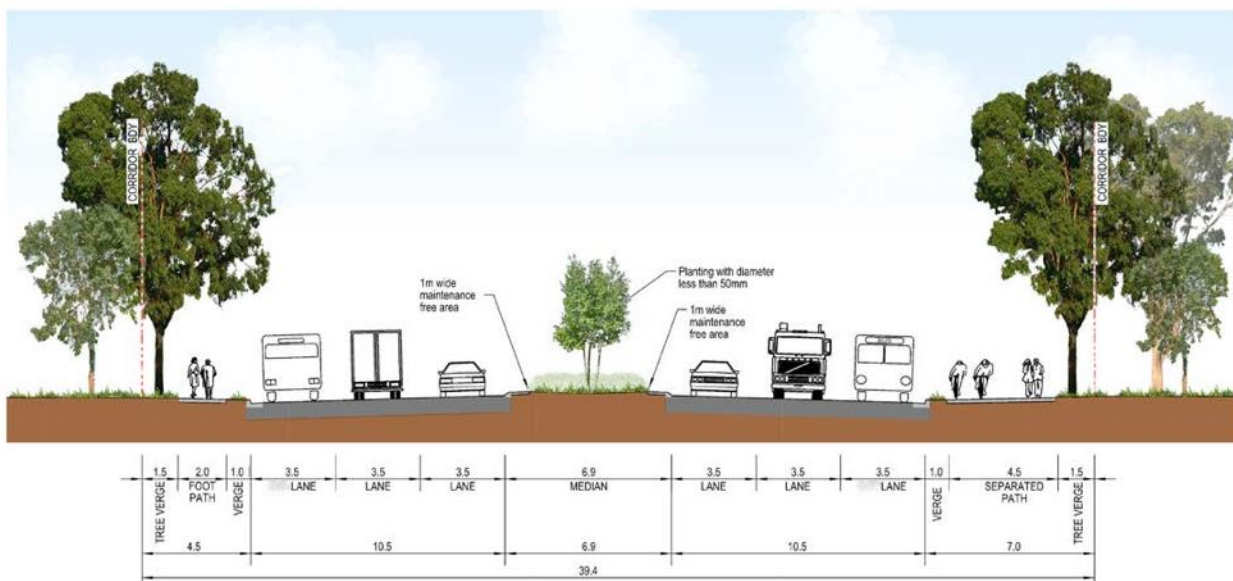


Figure 5-1 Typical cross section – maximum allowance for trees

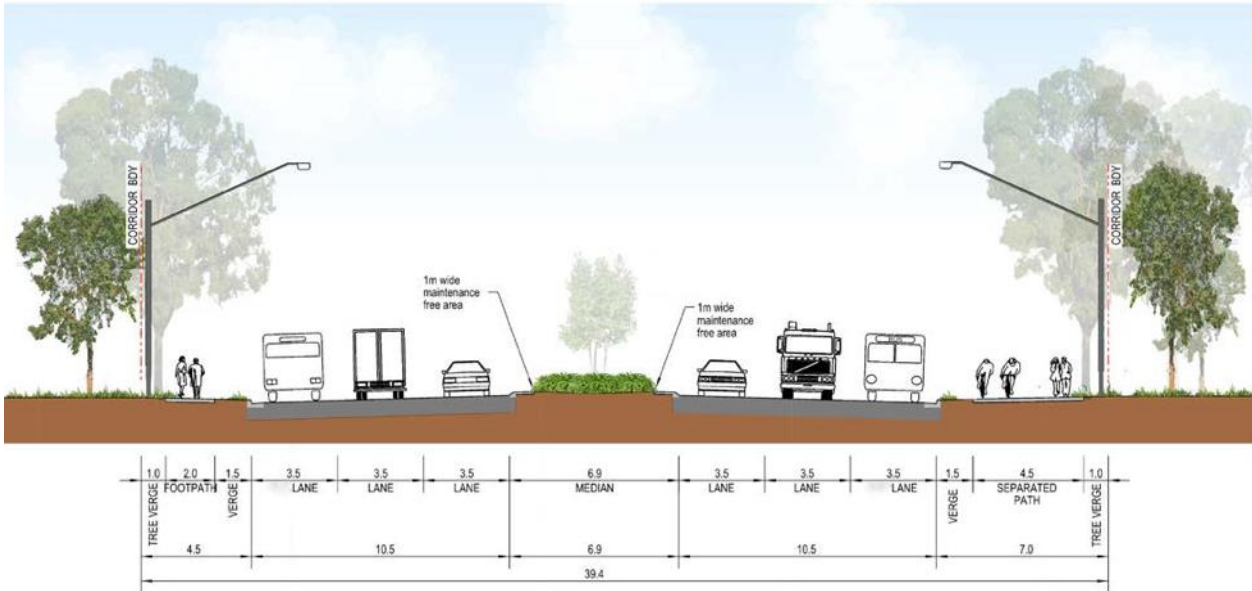


Figure 5-2 Typical cross section – limited allowance for trees

5.2 Strategic Options Considered

The Mulgoa Road / Castlereagh Road Corridor Upgrade project team looked at a number of options for the corridor between Andrews Road and Glenmore Parkway, these included:

- 1) New Corridor – due to the constraints within the existing corridor an alternative corridor was considered. New alignment options (wholly separate to the existing Mulgoa Road / Castlereagh Road alignment) were not considered in detail due to cost (property acquisition and construction), the suitability of the existing alignment in servicing adjacent land uses and the need to maximise the use of existing infrastructure.
- 2) Tidal Flow – A tidal flow option was considered. However, due to the number of intersections along the corridor, this would have created safety and design issues,
- 3) Widening on both sides – A option to widen on both sides of the road was considered by the Project Team,
- 4) Widening to the West – Widening the road to the west to avoid complete reconstruction was considered by the Project team
- 5) Widening to the East – Widening the road to the east to avoid complete reconstruction was considered by the Project team
- 6) Do-nothing - A ‘do nothing’ option was considered but discarded. The ‘do nothing’ option does not meet the proposal objectives or address the identified need and would therefore only be preferred in circumstances where the costs and environmental impacts of proceeding were assessed as outweighing identified benefits.

The shortlisted options identified included: widening either to the east or to the west in each section.

5.3 Approach to option development

Corridor widening options within and adjacent to the existing road alignment were then developed. This was an iterative process involving a number of inputs, including preliminary environmental investigations, property impacts, utility impacts, road design requirements, key stakeholder inputs and technical workshops including a Safety in Design and Constructability Workshop.

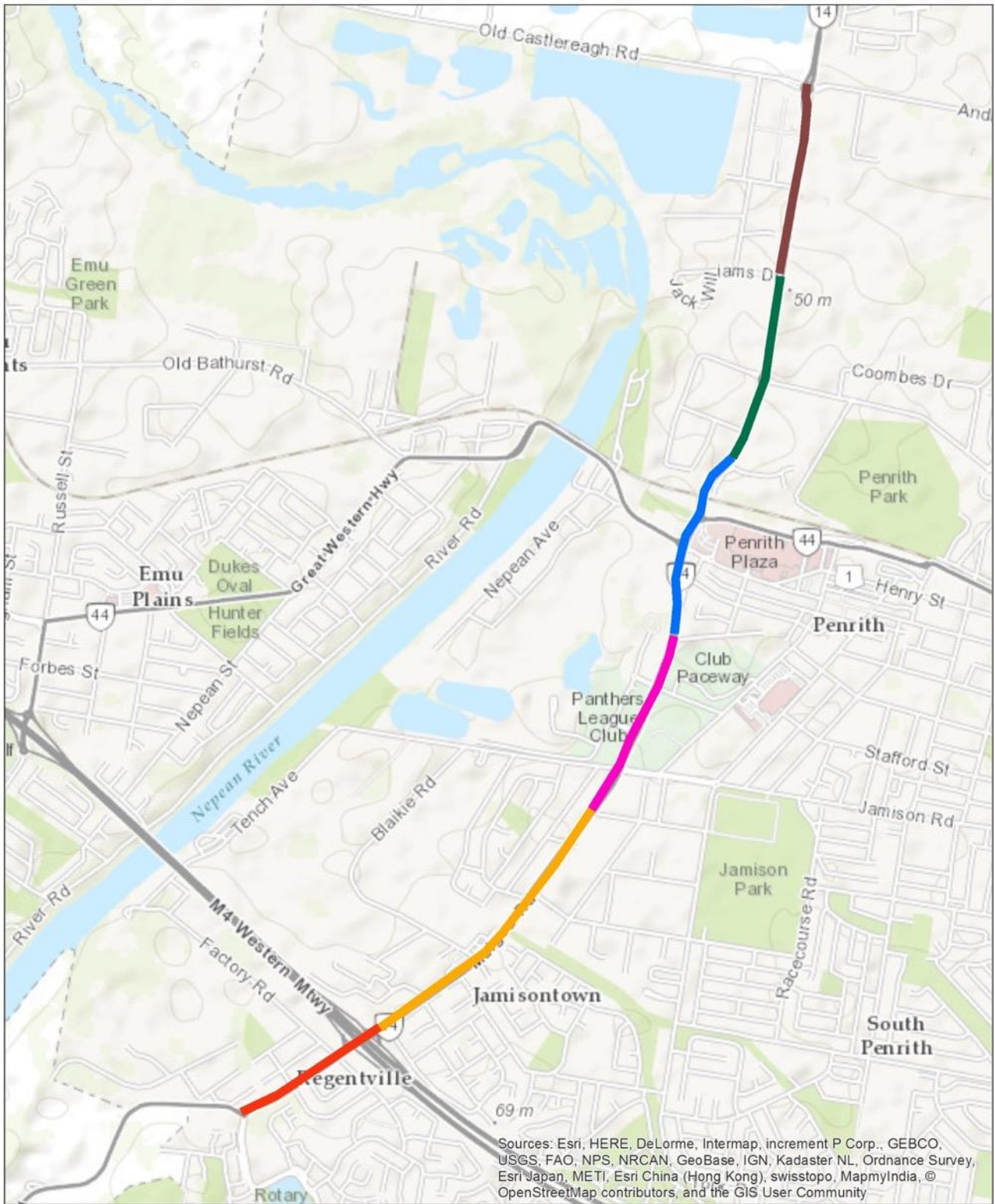
For the purposes of corridor widening option definition and analysis, the proposal was divided into the following five sections (as shown by Figure 5-3).

- Section A - Glenmore Parkway to M4 Interchange
- Section B - M4 Interchange to Preston Street
- Section C - Preston Street to Union Road
- Section D - Museum Drive to Jack Williams Drive
- Section E - Jack Williams Drive to Andrews Road.

Following development of the corridor widening options a number of location specific design sub-options were developed for evaluation.

5.4 Corridor widening options and sub-options

The specific options and sub-options considered for each of the five sections are described in Section 5.2.1 through to Section 5.2.6. Figure 5-3 shows the location of the five proposal sections while Figure 5-4 through to Figure 5-8 show the widening options for each section.



- Section A
- Section B
- Section C
- Section D
- Section E
- Jane Street / Mulgoa Road Infrastructure Project

Figure 5-3 Proposal sections



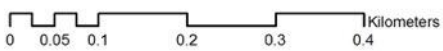
0 0.04 0.08 0.16 0.24 0.32 Kilometers

Aerial image: Nearmap 14/12/2015



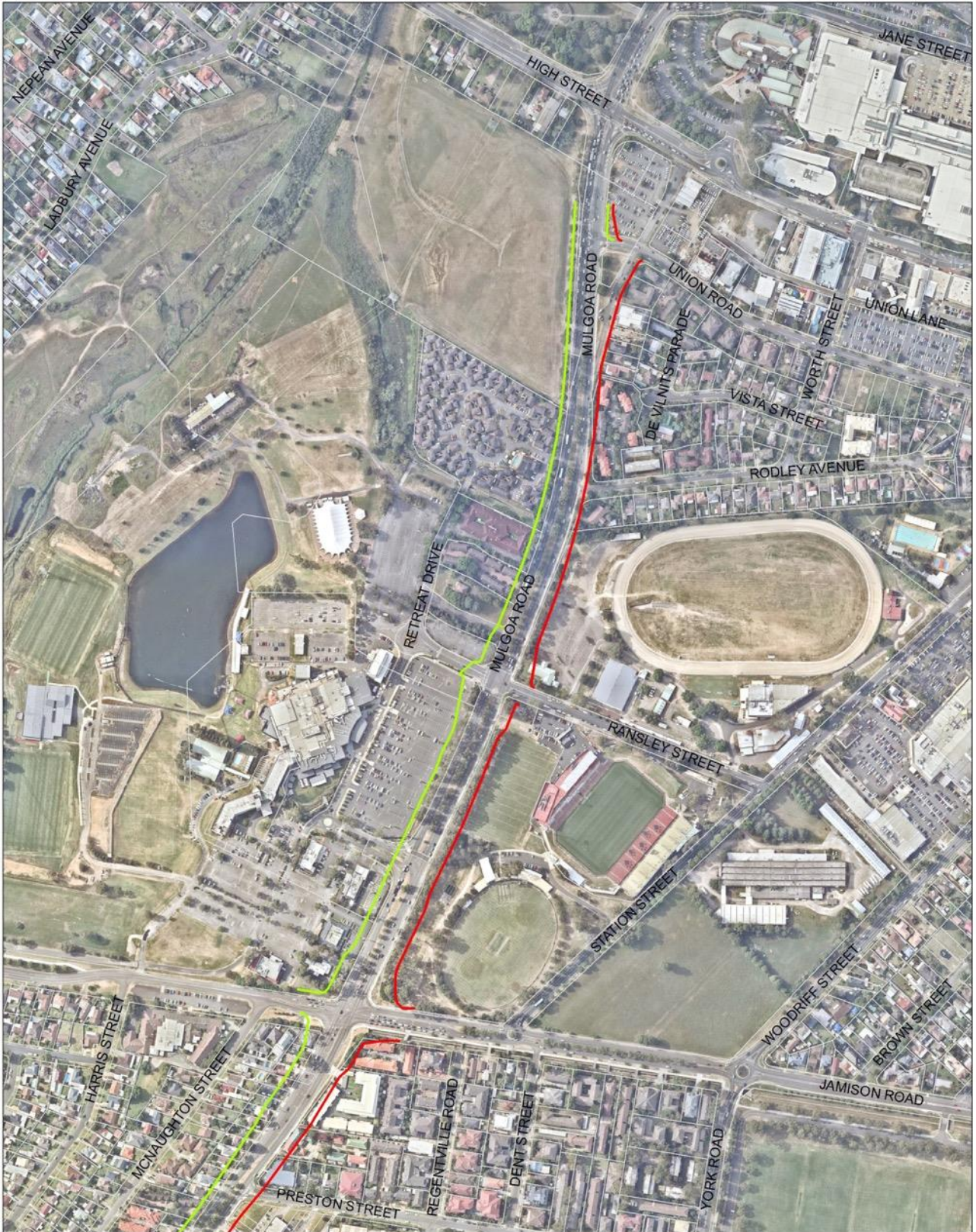
- Option 1 - Widening East
- Option 2 - Widening West

Figure 5-4 Section A corridor widening options and site context



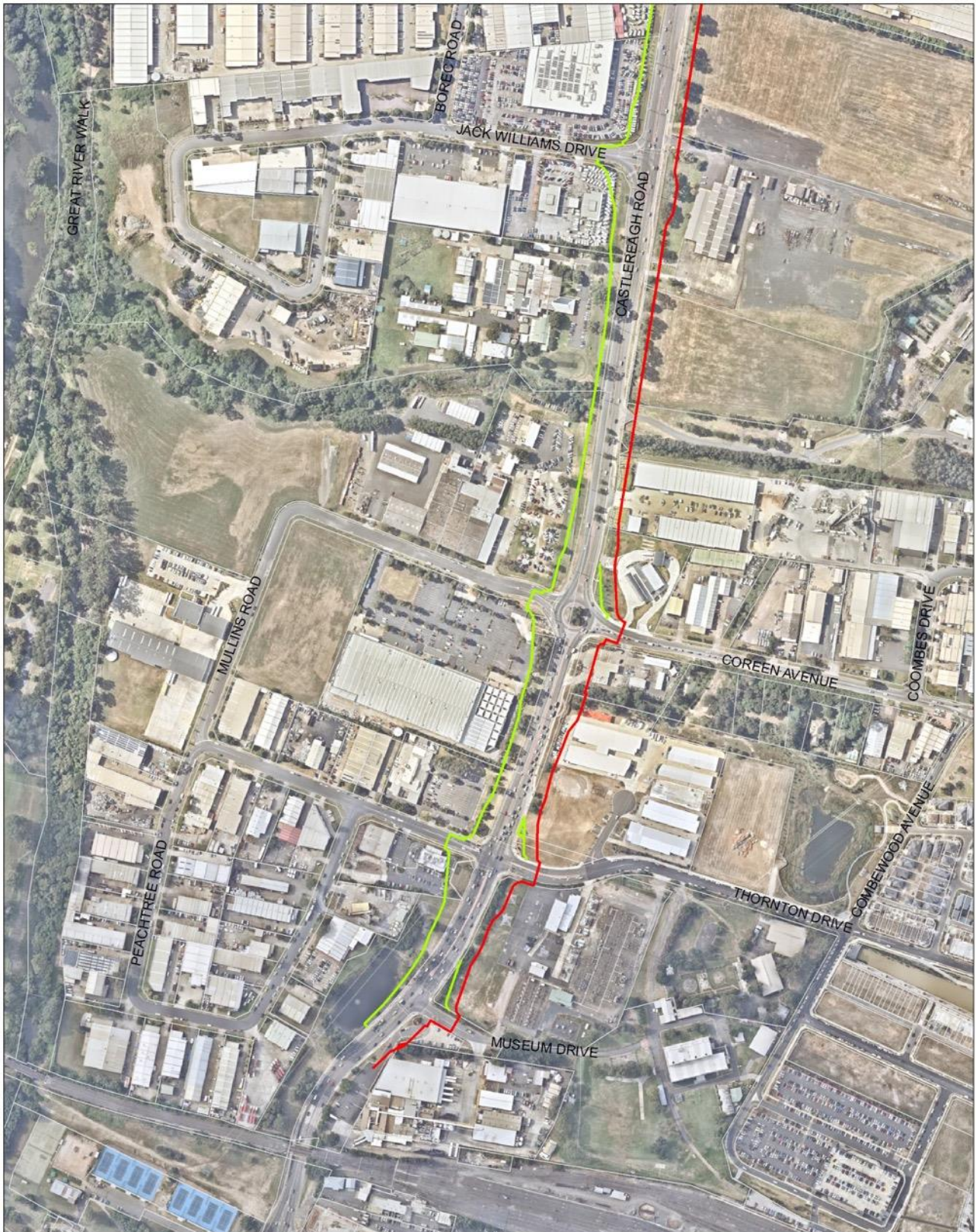
- Option 1 - Widening East
- Option 2 - Widening West

Figure 5-5 Section B corridor widening options and site context



- Option 1 - Widening East
- Option 2 - Widening West

Figure 5-6 Section C corridor widening options and site context



0 0.04250.085 0.17 0.255 0.34 Kilometers



- Option 1 - Widening East
- Option 2 - Widening West

Figure 5-7 Section D corridor widening options and site context



- Option 1 - Widening East
- Option 2 - Widening West

Figure 5-8 Section E corridor widening options and site context

5.4.1 Glenmore Parkway to M4 Interchange section

Widening options

The following widening options were considered for this section:

- Option A1 – Widening on the eastern side (refer to Figure 5-4). This would involve full acquisition of nine residential properties as well as strip acquisition along Schoolhouse Creek reserve and the park between Jeanette Circuit and Schoolhouse Road. Vegetation communities at Schoolhouse Creek would be affected as would utilities including a gas main, Telstra infrastructure, overhead power lines and a sewer main.
- Option A2 – Widening on the western side (refer to Figure 5-4). This would involve full acquisition of twenty-six residential properties as well short strip acquisition of along Schoolhouse Creek. Affected utilities would include a water main and Telstra infrastructure.

Other design considerations for this section

In addition to the widening options identified above, the following specific design considerations were identified for this section:

- Layout of the Glenmore Parkway / Mulgoa Road intersection (specifically whether to provide priority to traffic from Glenmore Parkway or from Mulgoa Road south)
- Access to / from Factory Road (close access from Mulgoa Road to Factory Road, provide left-in only access or provide for left-in left-out movements).

5.4.2 M4 Interchange to Preston Street section

Widening options

The following widening options were considered for this section:

- Option B1 – Widening on the eastern side (refer to Figure 5-5). This would involve full acquisition of nineteen residential properties, a townhouse development and a service station as well as the strip acquisition of industrial lands. There would be some impact on vegetation communities between Blaikie Street and Wolseley Street, bridge structures across Surveyors Creek and utilities including a 150 millimetre gas main, Telstra infrastructure, underground power lines, 500 millimetre sewer and a 150 millimetre water main.
- Option B2 – Widening on the western side (refer to Figure 5-5). This would involve full acquisition of seventeen residential properties, four townhouse complexes, a service station as well short strip acquisition of commercial lands. There would be impacts on vegetation communities between Blaikie Street and Wolseley Street, bridge structures across Surveyors Creek and utilities including Telstra infrastructure, underground power lines and a water main.

Other design considerations for this section

In addition to the widening options identified above, the following specific design considerations were identified for this section:

- Number of through lanes on Mulgoa Road under the M4 Motorway.
- Number of slip lanes for access to the M4 Motorway eastbound entry ramp
- Whether to retain or remove the grade separated access located at the Mulgoa Road / Wolseley Street intersection.

5.4.3 Preston Street to Union Road section

Widening options

The following widening options were considered for this section:

- Option C1 – Widening on the eastern side (refer to Figure 5-6). This would involve full acquisition of two apartment complexes, two townhouse complexes and one residential property. This option would require full acquisition of heritage listed workman’s cottages as well as partial acquisition of private open space. There would be some impact on native vegetation near the Jamison Road intersection and utilities including a gas main, Telstra infrastructure, underground power lines, sewer mains and a water main would be affected
- Option C2 – Widening on the western side (refer to Figure 5-6). This would involve full acquisition of 14 residential properties and two townhouse complexes as well as partial acquisition along the frontage of a retirement village, fast food outlets, Panthers and the vacant ‘Carpenter Site’. Full acquisition of the heritage listed ‘The Willows’ would be required and utilities including a gas main, Telstra infrastructure, underground power lines, a sewer main and a water main would be affected.

Other design considerations for this section

In addition to the widening options identified above, the following specific design considerations were identified for this section:

- Provision of one or two left-turn slip lanes for traffic turning left from Jamison Road westbound into Mulgoa Road southbound
- Whether to allow right-turns across three lanes of through traffic at Union Road, ban the right-turn to Union Road and extend the right-turn lane to High Street, or upgrade the Union Street intersection to a signalised four-leg intersection.

5.4.4 Museum Drive to Jack Williams Drive section

Widening options

The following widening options were considered for this section:

- Option D1 – Widening on the eastern side (refer to Figure 5-7). This would involve full acquisition of two service stations (including land affected by contamination) and partial acquisition of industrial lands. Utilities including gas mains, Telstra infrastructure, high voltage overhead and underground power lines, the clearance zone around a high voltage powerline tower and a water main would be affected
- Option D2 – Widening on the western side (refer to Figure 5-7). This would involve partial acquisition of industrial lands and would affect native vegetation around Boundary Creek. Utilities including a Telstra infrastructure, high voltage overhead and underground power lines, the clearance zone around a high voltage powerline tower and water mains would be affected.

Other design considerations for this section

With the widening of Castlereagh Road to six lanes, strategic design development has assumed an upgrade of the Coreen Avenue intersection to a four-leg traffic-light intersection. A further design consideration is whether or not to provide slip lane for southbound traffic on Castlereagh Road, turning left into Coreen Avenue to travel east.

5.4.5 Jack Williams Drive to Andrews Road section

Widening options

The following widening options were considered for this section:

- Option E1 – Widening on the eastern side (refer to Figure 5-8). This would involve partial acquisition of industrial lands (including land affected by contamination) and full acquisition of a local heritage item (Victorian House). Utilities including gas mains, Telstra infrastructure, high voltage overhead and underground power lines, the clearance zone around a high voltage powerline tower and water mains would be affected
- Option E2 – Widening on the western side (refer to Figure 5-8). This would involve full acquisition of a service station (including land affected by contamination), one full acquisition of an industrial complex, partial acquisition of industrial lands and would affect locally listed heritage items. Utilities including Telstra infrastructure, high voltage overhead and underground power lines and a water main would be affected.

Other design considerations for this section

In addition to the widening options identified above, the following specific design considerations for an upgraded Castlereagh Road / Andrews Road intersection were identified:

- The number of slip lanes for westbound traffic on Andrews Road turning right into Castlereagh Road, northbound
- The number of slip lanes for westbound traffic on Andrews Road turning left into Castlereagh Road, southbound
- The number of slip lanes for northbound traffic on Castlereagh Road turning right into Andrews Road, eastbound.

6 Options evaluation

6.1 Options evaluation process

6.1.1 Overview of the process

The options evaluation process has involved several stages. The initial stages serve an information gathering role and culminate in a multi-criteria analysis, which reviews identified options against agreed criteria. The various stages of the option evaluation process are illustrated by Figure 6-1 and discussed in Section 6.1.2 through Section 6.1.6.



Figure 6-1 Option evaluation process

6.1.2 Traffic modelling

To assist the options evaluation process, traffic modelling and analysis was undertaken. The analysis contributed to an understanding of the following:

- Existing road network performance including daily traffic volumes, peak traffic volumes and congestion (travel speeds)
- Future network performance without any improvements including traffic volumes and levels of service at key intersections
- Existing road safety performance

- Relative performance of options with reference to traffic efficiency (average travel speed, vehicle kilometres travelled, vehicle hours travelled, level of service)
- Relative performance of options with reference to road safety
- Evaluation of specific intersection layout options.

6.1.3 Preliminary environmental investigation

A preliminary environmental investigation was undertaken for the proposal corridor in mid-2015. The main purpose of the investigation to use a site inspection and desktop review to identify environmental issues early to allow for consideration as part of the design process. The main findings of the investigation are reviewed in Chapter 3.

6.1.4 Urban design

An urban design vision and strategic urban design were developed for the proposal. The urban design objectives and principles have been provided in Section 1.2. The urban design vision is as follows:

Mulgoa Road, as shown in the Minister for Roads' announcement, will be an attractive green corridor gateway to Penrith that takes its identity and character from its unique relationship to the regional geography of the mountains and river while providing for various modes of movement that encourage active and public transport and demonstrates a sustainable approach to infrastructure. It will help to connect the city to the Nepean River and the Green Bridge and contribute to the green infrastructure of Penrith and Western Sydney to provide shade, cooling, healthy air and water quality essential for a liveable city.

6.1.5 Value Management and Options Evaluation Workshop

Value Management and Options Evaluation Workshop took place on the 27 October 2015. The workshop used a structured process to ensure that key issues were identified and that the option endorsed by the group best meets essential requirements and objectives. Attendees included representatives from Roads and Maritime, Penrith Valley Chamber of Commerce, Penrith City Council, specialist consultants and a facilitator.

The value management process had the following five phases:

- Information Phase – review of project background and presentation of corridor alignment options.
- Analysis Phase – review of the underlying issues and constraints with the potential to impact the options being considered. This phase enabled participants to clarify objectives, to express concerns and to make suggestions regarding the designs presented. The project objectives were also revisited and confirmed during this phase
- Option Assessment Phase - in this phase of the workshop, the participants were asked to consider each of the available options in more detail in an effort to identify the alignment that best meets project objectives. The group was also asked to consider the advantages and disadvantages of the options under consideration. This was done to assist in identifying the preferred alignment option to be taken forward
- Creative Phase – this phase involved a general brainstorming of ideas to improve the corridor alignment recommended by the group. The ideas were also aimed at achieving the project objectives bearing in mind the constraints and issues discussed earlier in the workshop.
- Judgement Phase - the ideas for option improvement generated in the Creative Phase were assessed by the group in terms of practicality, viability and cost effectiveness. Each idea was discussed and rated using the following criteria:
 - Recommended for implementation;
 - Good Idea - needs further investigation; or
 - Not practical.

The outcomes of the workshop, particularly the Option Assessment Phase, were considered by Roads and Maritime in subsequent stages of evaluation and the selection of the preferred option.

6.1.6 Risk Management Workshop

A risk management workshop took place on 10 November 2015. The purpose of the workshop was to identify project risks and develop mitigation strategies to address the identified risks.

6.1.7 Constructability Workshop

A constructability workshop was held on 24 November 2015. Its purpose was to identify constructability issues and potential mitigation measures for further consideration as a result of the strategic design.

6.1.8 Health and Safety in Design Workshop

A health safety in design workshop took place on 24 November 2015 (in combination with the Constructability Workshop) following a site visit on 6 November 2015. The outcome of the workshop was an initial register of health and safety in design issues (issue and potential consequences) and potential measures for consideration by the project team in finalising the strategic design.

6.1.9 Multi-criteria analysis

Multi-criteria analysis is a technique used to assist decision making. It provides a framework for understanding the outcomes that might be expected from alternative options or strategies by using agreed criteria and a structured approach to rating or grading different courses of action.

In this case the criteria listed in Table 6-1 were agreed within the project team. As the aim was simply to understand the relative performance of each option to assist decision making the criteria were all considered to have the same importance (ie they were not weighted).

No cost related criteria were included as part of the initial analysis. Instead the preferred approach was to undertake an economic analysis of the preferred option (selected on the basis of on non-cost criteria) to ensure it would provide value for money.

Table 6-2 shows the six grading levels used, and identify whether there would be improvement, no change or deterioration with reference to the existing situation. These grading levels allow the differences between options to be easily identified. The discussion which follows in Section 6.2.1 through to 6.2.5 focuses only on those criteria which show a clear difference between options.

Table 6-1 Options evaluation criteria

Criteria	Description
Traffic efficiency	The performance of the option with reference to average travel speed, vehicle kilometres travelled, vehicle hours travelled, level of service.
Road safety	The potential of the option to contribute to improved road safety or conversely any identifies safety issues.
Environmental impacts	The potential impacts of the proposal on the environment having regard to biodiversity, waterways, heritage and other relevant aspects.
Utility Impacts	The impact of the option on utilities and the extent of required relocation and / or protection.
Property impacts	The extent of property acquisition required for the option.
Future development and access	The ability of the option to accommodate access to future development.

Criteria	Description
Bus prioritisation	The ability of the option to accommodate bus prioritisation.
Alternative transport	The ability of the option to accommodate pedestrians and cyclists.
Design standards	The alignment of the option with contemporary design standards.
Urban design outcomes	The alignment of the option with the urban design objectives principles set for the proposal.

Table 6-2 Grading levels for criteria

Grading level	Description
5	Improvement
4	Minor improvement
3	No change / negligible change
2	Minor impact
1	Impact

6.2 Options evaluation outcomes

6.2.1 Glenmore Parkway to M4 Interchange

Widening options

The analysis for this section identified environmental impacts, utility impacts and property impacts as the criteria which best differentiated between the options. Against other criteria the performance of these options was similar. Option A1 (widening east) would affect substantially fewer residential properties and would require less complex and costly utility relocations. It would however affect a larger amount of mapped Alluvial Woodland near School House Creek (which potentially corresponds to the NSW listed River-flat eucalypt forest endangered ecological community).

After consideration of these factors, widening to the east was selected as the preferred option for this section. The large difference in property impacts was the main driver of the decision.

Intersection design considerations

The current preferred approach for the Glenmore Parkway / Mulgoa Road intersection is to provide a signalised T-intersection with priority for traffic from Mulgoa Road south (refer to Figure 6-2 in Section 6.3). While giving priority to Glenmore Parkway would have better traffic efficiency outcomes (including a better level of service at both the Glenmore Parkway intersection and the Schoolhouse Road intersection), it would have greater property and environmental impacts and was therefore on balance not preferred.

The current preferred approach for Factory Road is to allow left-in only movements (refer to Figure 6-2 in Section 6.3). This maintains fairly direct access to the community facilities on Factory Road. Returning to Mulgoa Road to travel north involves some additional travel distance, but is facilitated by the traffic signals at Spencer Street.

Both of these preferred approaches are preliminary and subject to further review as part of the design development process.

6.2.2 M4 Interchange to Preston Street

Widening options

The analysis for this section identified utility impacts and property impacts as the criteria which best differentiated between the options. Against other criteria the performance of these options was similar. Option B2 would have greater property impacts (17 residential properties, four townhouse complexes, a service station and short strip acquisition of commercial lands) and would require less complex and costly utility relocations.

After consideration of these factors, widening to the east was selected as the preferred option for this section (except in the vicinity of the grade separated access to the Homemaker Centre – see below). The difference in property impacts and fewer utility relocations were the main drivers of the decision.

Intersection design considerations

The current preferred approach is to provide three through lanes in each direction on Mulgoa Road at the M4 Motorway interchange. This provides better traffic efficiency outcomes with similar environmental, property, utility and other impacts to provision of fewer through lanes.

For the southbound traffic entering the M4 Motorway to travel east, the current preferred approach is to provide two slip lanes rather than one. In this case the traffic efficiency benefits of providing two slip lanes were assessed as outweighing the increased environmental and property impacts of the larger footprint.

The current preferred approach is to replace the grade separated access (mousehole) that provides for right-turn movements from Mulgoa Road (southbound) into Wolseley Street, with dual right-turn lanes. While this would increase delay for the right-turn movement from the current zero to between 58 seconds and 71 seconds in 2036, traffic modelling indicates that the overall intersection would still operate satisfactorily at level of service B. The position of the mousehole is fixed, so if it were to be retained more extensive property acquisition on the eastern side of Mulgoa Road would be needed for the proposed additional lanes. This would affect single storey residences and a townhouse development. In contrast, the intersection can be designed with the dual right-turn lanes positioned so that the larger amount of acquisition occurs on the western road frontage.

These preferred approaches are preliminary and subject to further review as part of the design development process.

6.2.3 Preston Street to Union Road

Widening options

The analysis for this section identified environmental impacts, utility impacts and property impacts as the criteria which best differentiated between the options. Against other criteria the performance of these options was similar. Option C1 would have greater property impacts (two apartment complexes, two townhouse complexes and residential property), would require full acquisition of the heritage listed workman's cottages at 56–62 Mulgoa Road, Jamisontown, and would affect an area of Alluvial Woodland (potential River-flat Eucalypt Forest endangered ecological community). Option C2 would affect the heritage listed "The Willows" and would require more complex and costly utility relocations, but would require acquisition of fewer properties and would not affect mapped native vegetation communities.

After consideration of these factors, widening to the west was selected as the preferred option for this section. The difference in property impacts and the presence of mapped Alluvial Woodland to the east were the main drivers of the decision.

Intersection design considerations

The current preferred approach is to provide two westbound slip lanes for the left-turn from Jamison Road to Mulgoa Road (southbound). While this would result in a slightly greater property

impact and more utility adjustments, it would also provide better network outcomes including improved levels of service at the Jamison Road / Mulgoa Road intersection as well as the Ransley, High Street and Union Road intersections.

The current preferred approach is to provide a signalised intersection at Union Road. This approach performed best from a traffic efficiency perspective and can be modified to accommodate access from future developments to the west. Allowing unsignalised right-turn movements from Mulgoa Road across three traffic lanes into Union Road was not considered acceptable from a road safety perspective.

These preferred approaches are preliminary and subject to further review as part of the design development process.

6.2.4 Museum Drive to Jack Williams Drive

Widening options

The analysis for this section identified traffic efficiency, utility impacts and property impacts as the criteria which best differentiated between the options. Against other criteria the performance of these options was similar. Option D1 would result in slightly better traffic efficiency outcomes (with reference to average travel speed, vehicle kilometres travelled and vehicle hours travelled) but would have greater property and utility impacts, including full acquisition of two service stations. Option D2 would involve partial acquisition of industrial lands along the road frontage and would affect a small area of Alluvial Woodland (potential River-flat Eucalypt Forest endangered ecological community) associated with Boundary Creek.

After consideration of these factors, widening to the west was selected as the preferred option for this section. The difference in property impacts was the main driver of the decision.

Intersection design considerations

The current preferred approach is to provide a slip lane for left-turn movements from Castlereagh Road to Coreen Avenue, eastbound. This is subject to further review as part of the design development process.

6.2.5 Jack Williams Drive to Andrews Road

Widening options

The analysis for this section identified traffic efficiency, utility impacts and property impacts as the criteria which best differentiated between the options. Against other criteria the performance of these options was similar. Option E1 would result in slightly better traffic efficiency outcomes (with reference to average travel speed, vehicle kilometres travelled and vehicle hours travelled) but would have greater utilities impacts. Both options would affect locally significant heritage items.

After consideration of these factors, widening to the west was selected as the preferred option for this section. The difference in utility impacts was the main driver of the decision.

Intersection design considerations

The current preferred approach is to provide a four-way signalised intersection at the Castlereagh Road / Andrews Road intersection including:

- Two slip lanes for the right-turn movement from Andrews Road in Castlereagh Road, northbound
- Two slip lanes for the left-turn movement from Andrews Road in Castlereagh Road, southbound
- Two slip lanes for the right-turn movement from Castlereagh Road into Andrews Road, eastbound.

These preferred approaches are preliminary and subject to further review as part of the design development process.

6.3 Preferred option

The following was the outcome of the options evaluation process and has formed the basis of the strategic concept design (which is shown by Figure 6-2 through to Figure 6-6):

- Provide three lanes in each direction
- Section A, Glenmore Parkway to M4 Interchange – widen to the east
- Section B, M4 Interchange to Preston Street – widen to the east (except in the vicinity of the mousehole near Wolseley Street)
- Section C, Preston Street to Union Road – widen to the west
- Section D, Museum Drive to Jack Williams Drive – widen to the west
- Section E, Jack Williams Drive to Andrews Road – widen to the west

An economic analysis of the preferred option was conducted in accordance with the *Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives* (Transport for NSW, 2013). The economic analysis found that the benefit to road users of upgrading Mulgoa Road / Castlereagh Road to six lanes between Glenmore Parkway and Andrews Road would exceed the capital cost of the upgrade and is therefore economically viable. The cost-benefit ratio was estimated to be 3.3 (where the break-even result is 1.0).

6.4 Proposal staging

A staging plan has been developed based on short , medium and long term requirements. The staging is based on traffic modelling that has considered the traffic performance of the Mulgoa Road / Castlereagh Road and key intersections along the route, and identified when sections of the overall upgrade will be required to cater for the expected growth. The staging plan is summarised in Table 6-3.

Table 6-3 Preliminary staging plan

Period	Components
Short-term	<ul style="list-style-type: none">• Mulgoa Road upgrade (six lanes) between the M4 and Blaikie Road• Mulgoa Road upgrade (six lanes) between Glenmore Parkway and the M4• Castlereagh Road upgrade (six lanes) between Coreen Avenue and Museum Drive• Convert Andrews Road roundabout to traffic signal
Medium-term	<ul style="list-style-type: none">• Upgrade Mulgoa Road between Union Road and Blaikie Street
Long-term	<ul style="list-style-type: none">• Mulgoa Road upgrade (six lanes) between Andrews Road and Coreen Avenue



Figure 6-2 Strategic concept design - Section A

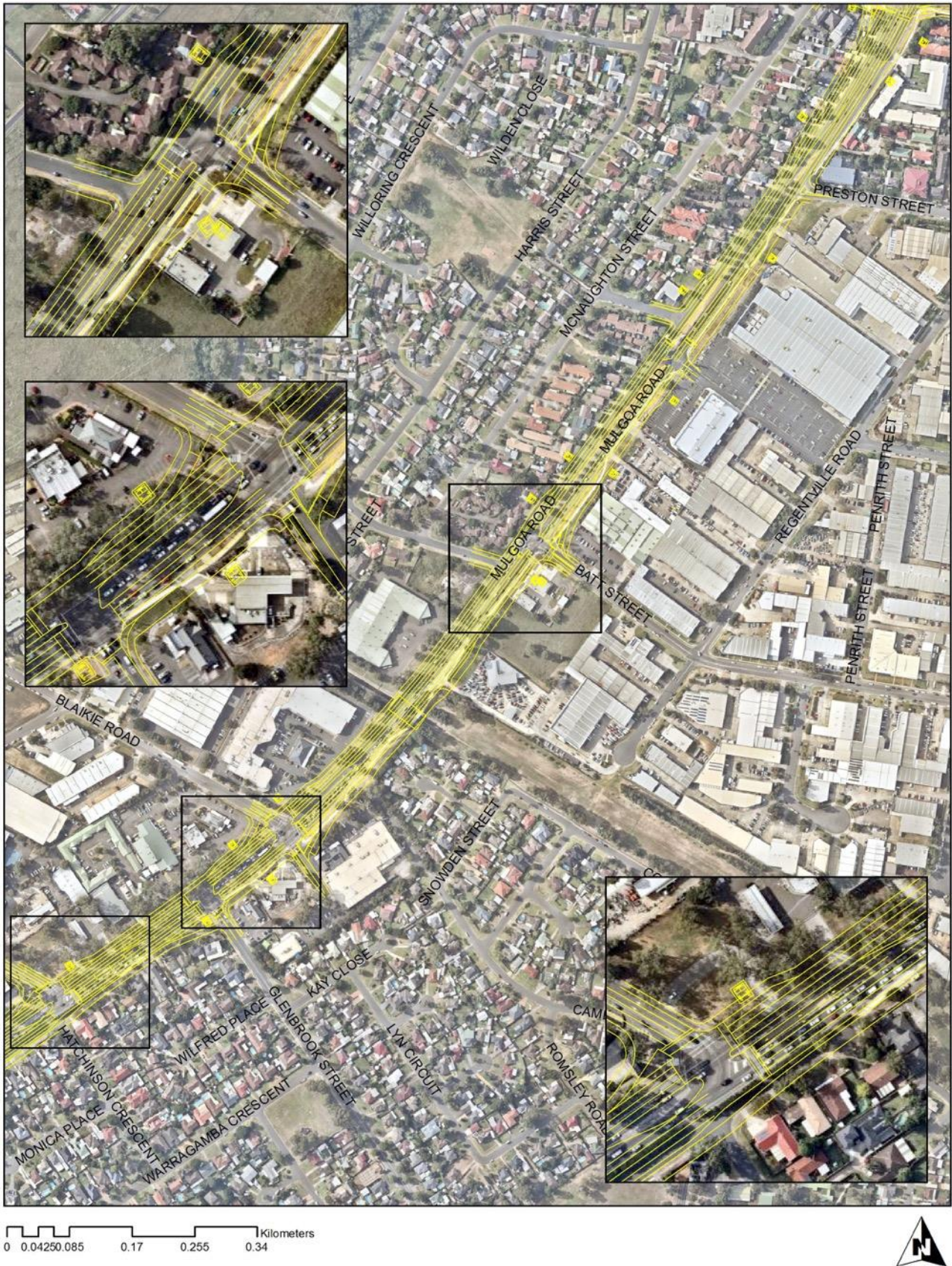


Figure 6-3 Strategic concept design - Section B



Figure 6-4 Strategic concept design - Section C



Figure 6-5 Strategic concept design - Section D



Figure 6-6 Strategic concept design - Section E

7 Conclusion and next steps

The options evaluation process for the upgrade to Mulgoa Road / Castlereagh Road between Andrews Road and Glenmore Parkway has considered a range of environmental, social and engineering constraints / issues and has involved preliminary consultation with key stakeholders.

The preferred option is:

- Provide three lanes in each direction
- Section A, Glenmore Parkway to M4 Interchange – widen to the east
- Section B, M4 Interchange to Preston Street – widen to the east (except in the vicinity of the mousehole near Wolseley Street)
- Section C, Preston Street to Union Road – widen to the west
- Section D, Museum Drive to Jack Williams Drive – widen to the west
- Section E, Jack Williams Drive to Andrews Road – widen to the west.

The next steps for the proposal are outlined in Figure 7-1. Following public exhibition of the preferred option, Roads and Maritime will consider community submissions, make changes where necessary and then confirm the preferred option. For stage one between the M4 Motorway and Blaikie Road, this will be followed by development of a concept design and environmental assessment. Further planning and development for stages two to six are dependent on additional funding.

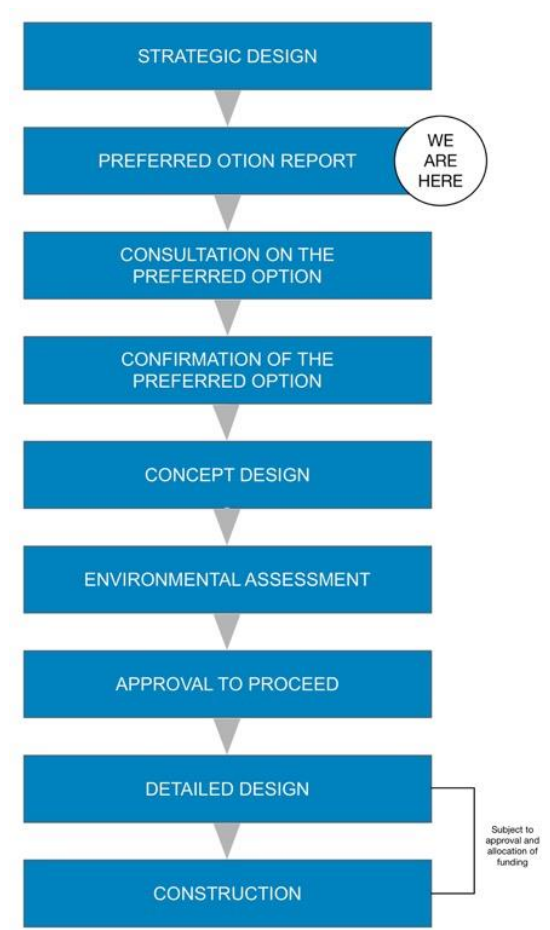


Figure 7-1 Next steps

Roads and Maritime will continue stakeholder and community consultation during the next stages of the project. The Roads and Maritime website will be periodically updated with information about the progress of the proposal.

References

Clark, N. R. & Jones, D. C., 1991. *Penrith 1:100 000 Geological Sheet 9030*, Sydney: Geological Survey of New South Wales.

NSW Government, 2012. *NSW Long Term Transport Master Plan* , Sydney: Transport for NSW.

NSW Government, 2013a. *Sydney's Bus Future*, Sydney: Transport for NSW.

NSW Government, 2013b. *Sydney's Cycling Future: Cycling for everyday transport*, Sydney: Transport for NSW.

NSW Government, 2013c. *Sydney's Walking Future: Connecting people and places*, Sydney: Transport for NSW.

NSW Government, 2013d. *NSW Freight and Ports Strategy*, Sydney: Transport for NSW.

NSW Government, 2014. *Plan for Growing Sydney* , Sydney: NSW Government.

Transport for NSW, 2012. *NSW Road Safety Strategy 2012-2021* , Sydney: Transport for NSW.

Transport for NSW, 2013. *Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives* , Sydney: Transport for NSW.

Appendix A – Community Update

August 2015

Appendix B – Traffic and Transport Report

Appendix C – Constraints Mapping



rms.nsw.gov.au/MulgoaRoadCastlereaghRoad



1800 733 084



Mulgoa Road / Castlereagh Road Corridor Upgrade
Roads and Maritime Services
PO Box 973
Parramatta CBD NSW 2124

April 2017
RMS 17.146
ISBN: 978-1-925582-25-3