The Northern Road and Bringelly Road Grade Separated Interchange

July 2015

Options Report
About this document

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End location Approximately 1000m south and 500m east of existing The Northern Road/Bringelly Road/Greendale Road intersection
Road number MR147, MR647
Road name The Northern Road, Bringelly Road, Greendale Road

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Executive summary

This Options Report looks at the opportunities and constraints associated with a grade separated interchange for The Northern Road and Bringelly Road/Greendale Road (the Proposal).

Previous investigations in 2011 identified the need for the upgrade of The Northern Road and Bringelly Road to meet increased residential and commercial development in the South West Growth Centre (SWGC) and nearby areas.

The SWGC comprises about 17,000 hectares, divided into 18 planned urban precincts with a capacity for about 110,000 new dwellings and 300,000 people (Department of Planning and Infrastructure (DP&I 2011). Precincts within this area are being progressively released for development. Future traffic growth has been predicted along both The Northern Road and Bringelly Road and as a result works has started on the upgrade of both roads to four lanes separated by wide central medians.

The original proposal to address this need involved an upgrade of the existing The Northern Road and Bringelly Road intersection.

With the announcement by the Australian Government of a western Sydney airport at Badgerys Creek, Roads and Maritime Services, in conjunction with the Australian Government, developed the $3.6 billion Western Sydney Infrastructure Plan. The Plan was developed better service both the SWGC, the proposed Broader Western Sydney Employment Area (BWSEA) and a western Sydney airport. Key features of the Plan include:

- Upgrade of The Northern Road to a minimum of four lanes between Narellan Road, Narellan and Jamison Road, South Penrith
- Construction of the new M12 Motorway with up to six lanes between the M7 Motorway and The Northern Road, Luddenham, connecting to the western Sydney airport site
- Upgrade of Bringelly Road to a minimum of four lanes between The Northern Road and Camden Valley Way
- Building the Werrington Arterial Road by upgrading Kent Road and Gipps Street to four lanes between the Great Western Highway and the M4 Motorway, including two new east facing ramps on the M4 Motorway
- Upgrading the intersection of Ross Street and the Great Western Highway, Glenbrook
- A $200 million Local Roads Package for local road upgrades (Australian Government funded).

As a result of the Western Sydney Infrastructure Plan, it has been decided the original upgrade proposal does not meet the potential increase in traffic from future development. Roads and Maritime has investigated options to improve traffic flow for The Northern Road and Bringelly Road intersection by developing a grade separated interchange to meet future demands.
Selection of a preferred option for the Proposal has involved two main stages which are documented in this report:


This process, including ultimately determining a preferred option, was based on identifying the constraints within a study area, developing options based on those constraints, and then undertaking a multi-criteria analysis of all 7 options looking at social, environmental, technical and economic aspects. Based on this analysis, option 6 was identified as the preferred alignment option.

Option 6 is detailed in **Section 5.1.8** and consists of the diversion of The Northern Road to the east of its present alignment. The diversion would occur south of Solway Road and would re-join The Northern Road at Robinson Road. The proposed intersection would be approximately 400 m east of the existing intersection.

**Section 8** provides an overview of how the preferred option selection process fits into the wider project development process (the progression to an impact assessment and project approval for the upgrade of The Northern Road and Bringelly Road intersection).
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# Introduction

## 1.1 Proposal overview

This Options Report looks at the opportunities and constraints associated with building a grade separated interchange for The Northern Road and Bringelly Road/Greendale Road (the Proposal). The Proposal is required to meet increased residential and commercial development, as identified in investigations by SKM, (2012) and ngh Environmental (2011) in the South West Growth Centre (SWGC) and nearby areas, and to meet the objectives of the Western Sydney Infrastructure Plan.

Following the announcement by the Australian Government that Badgerys Creek would be the site for the proposed Western Sydney Airport, and following the release of the Western Sydney Infrastructure Plan, Roads and Maritime has determined that the original proposal for an upgrade to the existing intersection to meet the requirements of the SWGC would not meet the requirements of the Plan and thus a grade separated interchange must now be built. This report investigates preferred alignment options for the Proposal.

The Western Sydney Infrastructure Plan consists of the following major projects:

- The upgrade of Bringelly Road to four lanes from Camden Valley Road to The Northern Road, separated by a wide central median for future upgrade to six lanes
  - Stage 1: Camden Valley Way to King Street
  - Stage 2: King Street to The Northern Road

- The upgrade of The Northern Road from Narellan Road to Mersey Road to four lanes separated by a wide central median for future upgrade to six lanes
  - Stage 1: The Old Northern Road, Narellan to Peter Brock Drive, Oran Park
  - Stage 2: Peter Brock Drive, Oran Park to Mersey Road, Bringelly
    - 2A: Peter Brock Drive, Oran Park to Robinson Road, Bringelly
    - 2B: Robinson Road, Bringelly to Solway Road, Bringelly (The Northern Road and Bringelly Road Grade Separated Interchange)
    - 2C: Solway Road, Bringelly to Mersey Road, Bringelly
  - Stage 3: Littlefields Road, Luddenham to Jamison Road, Penrith
  - Stage 4: Mersey Road, Bringelly to Littlefields Road, Luddenham

- Construction of the new M12 Motorway with up to six lanes between the M7 Motorway and The Northern Road, Luddenham, connecting to the western Sydney airport site

- A $200 million Local Roads Package for local road upgrades (Australian Government funded).

- Building the Werrington Arterial Road by upgrading Kent Road and Gipps Street to four lanes between the Great Western Highway and the M4 Motorway, including two new east facing ramps on the M4 Motorway

- Upgrading the intersection of Ross Street and the Great Western Highway, Glenbrook
The Plan has fast-tracked major projects including The Northern Road and Bringelly Road upgrades with Bringelly Road Stage 1 already being built. The Northern Road Stage 1, Stage 2A, 2C and Bringelly Road Stage 2 are currently in detailed design with construction due to start by mid-2016. In order to fit with the Western Sydney Infrastructure Plan construction schedule, The Northern Road and Bringelly Road Grade Separated Interchange is now being developed to be built alongside either The Northern Road Stages 2A/2C and Bringelly Road Stage 2.

The location of the Proposal relative to the surrounding area is presented in Figure 1-1 on the following page.

1.2 Purpose of the report

The purpose of this Report is to identify a preferred alignment option for the Proposal which provides the best social, environmental, technical and economic outcomes. In order to achieve this purpose, a staged approach to identifying the preferred alignment option has been adopted. Key stages which are outlined in this report include:

- Provides the development and overview of the Proposal in the context of the region and local area (Section 2)
- Presents an overview of project needs and project objectives, and a summary of the technical, social and environmental constraints and considerations associated with the development of options for this Proposal, based on available data (Section 3 and 4)
- Describes the process of identifying feasible options for the Proposal (Section 5)
- Documents the process carried out to identify and evaluate options for the Proposal and makes recommendations regarding the preferred option (Section 6)
- Presents a multi-criteria analysis that evaluates the identified options (Section 6)
- Recommends a preferred alignment option and next steps associated with the development of the preferred alignment option (Section 7 and 8).

1.3 Structure of the report

This Report’s structure is:

- Section 1 Introduction
- Section 2 Background
- Section 3 Proposal need and objectives
- Section 4 Proposal option considerations
- Section 5 Identification of a preferred alignment options
- Section 6 Multi criteria analysis of options and summary of findings
- Section 7 Recommendations
- Section 8 What happens next?
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Note: Source list in separate document.

Figure 1.1 is an aerial photograph of the project area, with an overlay of the proposed Western Sydney Airport and Federal and Local Government boundaries.
2 Background

2.1 Regional context

The regional context and study area for the Proposal is presented in Figure 1-1. The study area is located in the west of greater Sydney and falls within the Camden and Liverpool Local Government Areas (LGAs) and in Roads and Maritime’s Sydney region.

This section outlines the regional context for the Proposal and how the regional growth within the area is driving the need for the preferred alignment assessment and to meet the timeframes associated with long established western Sydney development and recent changes associated with a western Sydney airport at Badgerys Creek.

2.1.1 Metropolitan Strategy for Sydney to 2031

The draft Metropolitan Strategy for Sydney to 20311 was developed by the NSW Government to guide Sydney’s growth to 2031. The strategy outlines the need for ongoing investment in transport infrastructure in south west Sydney, including the arterial road network outlined in the NSW Long Term Master Plan.

2.1.2 NSW Long Term Transport Master Plan

The NSW Long Term Transport Master Plan2 identifies the Outer Sydney Orbital road as a potential component of Sydney’s future motorway network. The Master Plan identifies preservation of an outer north-south corridor potentially connecting the existing road and rail networks including the M1 Motorway north of Sydney with the Hume Highway south of Campbelltown.

2.1.3 South West Growth Centre

The South West Growth Centre (SWGC) comprises about 17,000 hectares, divided into 18 planned urban precincts with a capacity for about 110,000 new dwellings and 300,000 people (Department of Planning and Infrastructure (DP&I 2011). Precincts are being progressively released for development. The Northern Road traverses the future residential precincts of Oran Park, Marylands, Lowes Creek, Bringelly and North Bringelly, and future industrial precincts (SKM, 2012).

2.1.4 Broader Western Sydney Employment Area

The NSW Government established the Western Sydney Employment Area to provide businesses with land in a region of dedicated growth for Sydney. The announcement of a western Sydney airport meant that an extension of this area was proposed to ensure that the employment area catered for the expected increase in demand of industry associated with an airport and assisted in the protection of the development and operation of the airport. As such the Broader Western Sydney Employment Area3 (BWSEA) was established by the NSW Government. The BWSEA will provide employment

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2 Transport for NSW, NSW Long Term Transport Master Plan, December 2012, page 141

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opportunities for the increased population in the area as a result of the SWGC and a western Sydney airport.

2.1.5 **A western Sydney airport at Badgerys Creek**

In April 2014, the Australian Government announced that Badgerys Creek will be the site for a western Sydney airport. Planning for this infrastructure has commenced. At the same time, the Australian Government announced the Western Sydney Infrastructure Plan which involves major road linkages that will support a new airport. It will also help NSW and western Sydney to capitalise on the economic gains from developing an airport at Badgerys Creek while boosting the local economy and livability of western Sydney.

2.1.6 **Western Sydney Infrastructure Plan**

The Western Sydney Infrastructure Plan has been developed to meet the expected demands associated with a western Sydney airport. It involves major road and transport linkages and includes the upgrade of The Northern Road and Bringelly Road and a new east-west M12 Motorway to the airport site between the M7 Motorway and The Northern Road to support the a western Sydney airport (refer to Figure 1-1). It also involves a $200 million package of local roads upgrades to allow for improved flow of traffic outside of the major arterial roads. The Western Sydney Infrastructure Plan has given priority to Bringelly Road Upgrade with Stage 2 being upgrades between King Street and The Northern Road. Construction on Stage 2 is due to start in mid-2016.

2.1.7 **Future rail**

In April 2014, the NSW Government announced planning for a future South West Rail Link extension and a plan to identify and protect the transport corridors before they are needed.

The corridors will provide a north-south connection through the SWGC and the BWSEA, including a western Sydney airport site. The extension corridor is proposed to connect Leppington Station to Bringelly and then head in two directions: north to the Western Line near St Marys; and south to Narellan. A number of core stations are proposed in the existing and planned centres of Rossmore, Bringelly, North Bringelly, Oran Park and Narellan. A station is also proposed at Badgerys Creek to service the western Sydney airport site.

At this stage a broad conceptual corridor has been identified but a specific alignment option has not been determined.

2.1.8 **Other future road infrastructure**

The *NSW Long Term Transport Master Plan* identifies the Outer Sydney Orbital (OSO) as a potential component of Sydney’s future motorway network. The Master Plan identifies preservation of an outer north-south corridor potentially connecting the existing road and

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4 *Ibid*
7 Transport for NSW, *NSW Long Term Transport Master Plan*, December 2012, page 141
2.2 Local context

This section describes the local context in terms of the road network and surrounding land uses. The local context of the Proposal is presented in Figure 2-1.

2.2.1 Road network

2.2.1.1 The Northern Road

The Northern Road Upgrade involve widening from a two lane undivided road to a four-lane road divided by a wide central median to allow for six lanes in the future.

The Northern Road will form one of the principal transport corridors within the South West Growth Centre.

The Northern Road Upgrade would result in increased capacity to cater for the predicted future traffic and population growth within the South West Growth Centre and as a result of a western Sydney airport. The Northern Road Upgrade would also provide improved access and safety for cyclists and pedestrians by providing an off-road shared path on the southbound (eastern) side of the Proposal, with capacity for an off-road shared pathway on the northbound (western) side of the Proposal, bus priority capability at traffic lights and indented bus bays.
LOCAL CONTEXT

OPTIONS ANALYSIS FOR BRINGELLY ROAD - THE NORTHERN ROAD INTERSECTION

Figure: 2-1

Note: Source list in separate document.

Figure 2.1 is a UBD map illustrating the local context of the area.
2.2.1.2 Bringelly Road

The Bringelly Road Upgrade includes widening from two lanes to four lanes with a wide central median for upgrading to six lanes in the future.

Bringelly Road would play a major role as one of the principal arterial transport corridors in the South West Growth Centre and for a western Sydney airport.

The Bringelly Road Upgrade would result in improved safety for road users, more reliable travel times, improved access to the M7 and M5 motorways, improved access to the SWGC, improved access and more reliable travel times for road freight in Sydney’s south west, improved access and safety for cyclists and pedestrians by providing an off-road shared path, bus priority capability at traffic lights and improved landscape and urban design.

2.2.2 Surrounding land uses

The Proposal is located in a predominantly rural-residential landscape, which has been highly modified and is fragmented due to land clearing for farming and road construction. The main waterway in the area is Thompsons Creek. Other adjacent land uses comprises agricultural (grazing, horticulture), residential, public recreation, retail, industrial, commercial (such as Bringelly shopping centre), a sewerage pumping station, educational facilities (Bringelly Public School), the Boral Bringelly brickworks and vegetated areas.
3 Proposal need and objectives

3.1 Proposal need

3.1.1 Overview
The Proposal is needed, primarily, to meet the objectives of the Western Sydney Infrastructure Plan. In addition, with the development of The Northern Road Stage 2A/2C and Bringelly Road Stage 2 at detailed design and with a construction contract expected to be awarded in mid-2016, there is a need to accelerate the process for the development of the preferred alignment option. The grade separated interchange of The Northern Road Stage 2B needs to be in line with the contract associated with either The Northern Road upgrade or the Bringelly Road upgrade construction contracts. This process is therefore being accelerated so as to minimise social and environmental impacts and to ensure value for money of the Western Sydney Infrastructure Plan.

3.1.2 Existing traffic congestion
The Northern Road is a state road within Sydney’s network and is a principal north-south arterial linking the Macarthur and Penrith areas in the Sydney’s south west region. The section of The Northern Road proposed for the upgrade is predominantly a two-lane road, with occasional overtaking lanes and four lane sections and turning lanes in Narellan and Bringelly.

Bringelly Road is a state road within Sydney’s network and is a principal east-west arterial linking Bringelly to emerging South West Growth Centre precincts of Edmondson Park and Leppington and the greater Liverpool area. It is also a freight transport route with heavy vehicle volumes accounting for 10.9 per cent of traffic volume at the eastern end of Bringelly Road. The 10.1 kilometre Bringelly Road currently only has two undivided lanes, one lane in each direction.

The Bringelly Road Upgrade was developed in response to existing safety issues and predicted traffic growth. Bringelly Road was identified as having a higher than average proportion of fatal and injury crashes than the rest of NSW. The average fatality rate on Bringelly Road is nearly two and a half times higher than the state rate.

3.1.2.1 Existing intersection
The existing intersection of The Northern Road and Bringelly Road has traffic lights. The Northern Road adjacent to this intersection is signposted at 80 km/h with a 40 km/h school zone covering an area between 200 metres to 300 metres from the intersection in all directions.

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8 SKM, The Northern Road Upgrade The Old Northern Road to Mersey Road Review of Environmental Factors, Volume 1, 2012, page 7.
9 ngh Environmental, Bringelly Road Upgrade, Camden Valley Way to The Northern Road, Review of Environmental Factors, 2011, page 6
10 SKM, MR154 The Northern Road Upgrade between The Old Northern Road and Mersey Road – Traffic and Transport Assessment Report, Rev 5, August 2012, page 13
There is a sealed footpath adjacent to the southbound traffic lane extending for a distance of approximately 150 metres north of the intersection of The Northern Road/Bringelly Road\textsuperscript{11}.

In August 2012\textsuperscript{12} a traffic and transport assessment was conducted for The Northern Road Upgrade. Analysis of heavy vehicle data concluded that:

- The Northern Road, in the vicinity of Bringelly Road, has relatively high levels of heavy vehicles compared to other locations [along The Northern Road]
- The Northern Road, in the vicinity of Bringelly Road, has a high proportion of southbound heavy vehicles, 48\% traffic, recorded between 10pm to 6am\textsuperscript{13}

Intersection analysis of The Northern Road and Bringelly Road is presented in Table 3-1 for the following year without upgrade (base case):

- 2016 – proposed opening year for The Northern Road Upgrade.

**Table 3-1 The Northern Road and Bringelly Road intersection performance (Base Case)**\textsuperscript{14}

<table>
<thead>
<tr>
<th>Case</th>
<th>Type of control</th>
<th>Intersection Volume (veh/hr)</th>
<th>Degree of saturation (DoS)</th>
<th>Avg. delay (sec)</th>
<th>Level of Service (LoS)</th>
<th>Queue length &lt;worst approach&gt;</th>
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<tr>
<td>2016 AM</td>
<td>Signalised</td>
<td>2492</td>
<td>&gt;1.0</td>
<td>27.9</td>
<td>B</td>
<td>&gt;200 &lt;The Northern Road – South&gt;</td>
</tr>
<tr>
<td>2016 PM</td>
<td>Signalised</td>
<td>2,744</td>
<td>&gt;1.0</td>
<td>&gt;100</td>
<td>F</td>
<td>&gt;200 &lt;The Northern Road – North&gt;</td>
</tr>
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The assessment concluded that considering both AM and PM peak periods, the performance of the intersection was forecast to be unacceptable (LoS D or worse, excepting 2016 AM) under the Base Case in 2016\textsuperscript{15}.

**3.1.2.1 Crash history**

Crash history for The Northern Road and Bringelly Road / Greendale Road intersection obtained from Roads and Maritime is provided in Appendix A for a 1km radius surrounding the intersection. In analysing the data it shows that 11 crashes have occurred within 100 metres of the intersection from July 2009 to June 2014. Seven of the crashes involved a truck and three occurred in the centre of the intersection. Four of the crashes occurred close to the intersection, each involved a truck and two involved the right turn lane heading north. Of the eleven crashes, six resulted in injuries with nine people injured. There have been no fatalities within the time period specified.

\textsuperscript{11} Ib\textit{id}, page 15
\textsuperscript{12} \textit{Ibid}
\textsuperscript{13} \textit{Ibid}, page 24
\textsuperscript{14} \textit{Ibid}, pages 58-61
\textsuperscript{15} \textit{Ibid}, page 61
3.1.2.2 Previously proposed intersection

The intersection of Bringelly Road with The Northern Road that was originally proposed as part of the Bringelly Road Upgrade is presented in Plate 3-1 (SKM, 2012).

This intersection was to include two 3.5-metre wide through lanes eastbound and westbound. Two right turn lanes 3.3 metres wide and 220 metres long in a dedicated turn bay into The Northern Road would be provided for westbound traffic. A single lane right turn bay 160 metres long into The Northern Road was to be provided for eastbound traffic. Left turn slip lanes 5.5-metre wide into The Northern Road and onto Bringelly Road was to be provided.

A 210 metre twin dedicated right turn bay from The Northern Road east onto Bringelly Road and a 220 metre dedicated right turn bay from The Northern Road west onto Greendale Road would be provided. Two 220 metre dedicated left turn bays would be provided from The Northern Road onto Greendale Road and Bringelly Road.

Signalised pedestrian crossings would be provided across both sides of The Northern Road, across Bringelly Road and across Greendale Road. Bringelly Road would be upgraded for a distance of 225 metres from The Northern Road. Greendale Road would be upgraded for a distance of 285 metres. A pick up/drop off bay would be provided for Bringelly Public School on Greendale Road, 165 metres from The Northern Road.

A bus priority lane at the approach of the signalised crossing and a bus bay on the departure side would be provided on the northbound and southbound carriageways.
3.1.3 Future growth

3.1.3.1 South West Growth Centre

The NSW Government established the South West Growth Centre (and the North West Growth Centre) in 2005 to streamline the supply of greenfield land for urban development, and coordinate the sustainable delivery of infrastructure during the next 25 to 30 years. As discussed in Section 2.1.3, the SWGC, comprising 18 precincts, is about 17,000 hectares and expected to accommodate about 110,000 new dwellings for 300,000 people (DP&I 2011). The original proposal was assessed as being needed to provide road capacity for the substantial traffic rise predicted in the SWGC due to increased residential and commercial development. The Northern Road Corridor Strategy (RTA 2009) was developed using the predicted increase in traffic growth in the SWGC to set out a vision for the upgrade of The Northern Road as a principal transport corridor.

Assessments of the performance of the existing intersection concluded that the intersection would be unacceptable for future traffic volume with no upgrades in 2016, 2026 and 2036\(^{20}\). The assessment concluded that with an upgraded at-grade intersection, the intersection would operate at a better Level of Service (LoS D) for the years analysed. Although a traffic assessment found that an at-grade intersection would have sufficient

\(^{20}\)SKM, MR154 The Northern Road Upgrade between The Old Northern Road and Mersey Road – Traffic and Transport Assessment Report, Rev 5, August 2012, page 61
capacity to cater for future forecast traffic under 2036\textsuperscript{21}, this assessment was completed in 2012 before the Australian government announcement of the western Sydney airport site in April 2014.

3.1.3.2  **Broader Western Sydney Employment Area**

As discussed in Section 2.1.4, the BWSEA was established by the NSW Government to provide businesses in the region with land for industry and employment, catering for transport and logistics, warehousing and office space\textsuperscript{22}. The area extends to the south west of the M4 and M7 Motorways intersection. Following the announcement of the western Sydney airport site, the BWSEA was extended by 4537 hectares to include a larger area towards The Northern Road and Elizabeth Drive intersection. The BWSEA is expected to result in an addition 212,000 jobs in the longer term.

3.1.4  **Future infrastructure**

3.1.4.1  **A western Sydney airport at Badgerys Creek**

In April 2014, the Australian Government announced the western Sydney airport site. Planning associated with the airport including a number of studies associated with the development of the site has begun. The Western Sydney Infrastructure Plan was jointly announced by the Australian and NSW governments.

3.1.4.2  **Western Sydney Infrastructure Plan**

The Western Sydney Infrastructure Plan involves major road linkages and includes the upgrade of The Northern Road and Bringelly Road and a new east-west M12 Motorway between the M7 Motorway and The Northern Road\textsuperscript{23} to support a western Sydney airport at Badgerys Creek. The Western Sydney Infrastructure Plan also covers smaller projects including the Werrington Arterial Road and local roads packages to support the upgrades of the major arterial projects. The Plan has given priority to Bringelly Road upgrades with Stage 2 between King Street and The Northern Road. Construction on Stage 2 is due to start in mid-2016\textsuperscript{24}. As such the Proposal (as presented in this Options Report) is needed to meet the objectives of the Western Sydney Infrastructure Plan.

3.1.5  **Forecast traffic**

3.1.5.1  **Traffic forecast before the announcement of a western Sydney airport**

The Northern Road Upgrade was anticipated to be developed in parallel with the development of the South West Growth Centre. This Upgrade would cater for the substantial traffic growth predicted along The Northern Road from increased residential

\textsuperscript{21} Ibid, page 91


and commercial development in the South West Growth Centre and nearby area\textsuperscript{25} (SKM, 2012).

The Northern Road Corridor Strategy (RTA 2009) was developed in response to the predicted increase in traffic growth in the SWGC. The Strategy set the vision for the development of The Northern Road as a principal transport corridor for the SWGC.

The Bringelly Road Upgrade was developed in response to existing safety issues as well as predicted traffic growth. Traffic at the eastern end of Bringelly Road at the Leppington Town Centre was forecast to increase from 11,800 Annual Average Daily Traffic (AADT) in 2007 to more than 50,000 AADT in 2036 at full development of the SWGC\textsuperscript{26}. The Bringelly Road Upgrade was identified to cater for this predicted growth.

Intersection analysis of The Northern Road and Bringelly Road for predicted traffic growth before the western Sydney airport is presented in Table 3-2 for the following years without upgrade (base case):

- 2016 – proposed opening year for The Northern Road Upgrade
- 2026 – 10 years after the proposed opening year for The Northern Road Upgrade
- 2036 - 20 years after the proposed opening year for The Northern Road Upgrade.

Table 3-2: The Northern Road and Bringelly Road intersection performance (base case)\textsuperscript{27}

| Case      | Type of control | Intersection Volume (veh/hr) | Degree of saturation (DoS) | Avg. delay (sec) | Level of Service (LoS) | Queue length <worst approach>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 AM</td>
<td>Signalised</td>
<td>2492</td>
<td>&gt;1.0</td>
<td>27.9</td>
<td>B</td>
<td>&gt;200 &lt;The Northern Road – South&gt;</td>
</tr>
<tr>
<td>2016 PM</td>
<td>Signalised</td>
<td>2,744</td>
<td>&gt;1.0</td>
<td>&gt;100</td>
<td>F</td>
<td>&gt;200 &lt;The Northern Road – North&gt;</td>
</tr>
<tr>
<td>2026 AM</td>
<td>Signalised</td>
<td>3388</td>
<td>&gt;1.0</td>
<td>&gt;100</td>
<td>F</td>
<td>&gt;200 &lt;The Northern Road – South&gt;</td>
</tr>
<tr>
<td>2026 PM</td>
<td>Signalised</td>
<td>3420</td>
<td>&gt;1.0</td>
<td>&gt;100</td>
<td>F</td>
<td>&gt;200 &lt;The Northern Road – South&gt;</td>
</tr>
<tr>
<td>2036 AM</td>
<td>Signalised</td>
<td>5168</td>
<td>&gt;1.0</td>
<td>&gt;100</td>
<td>F</td>
<td>&gt;200 &lt;The Northern Road – South&gt;</td>
</tr>
<tr>
<td>2036 PM</td>
<td>Signalised</td>
<td>5129</td>
<td>&gt;1.0</td>
<td>&gt;100</td>
<td>F</td>
<td>&gt;200 &lt;The Northern Road – North&gt;</td>
</tr>
</tbody>
</table>

\textsuperscript{25} SKM, The Northern Road Upgrade The Old Northern Road to Mersey Road Review of Environmental Factors, Volume 1, 2012, page 7.

\textsuperscript{26} ngh Environmental, Bringelly Road Upgrade, Camden Valley Way to The Northern Road, Review of Environmental Factors, 2011, page 6

\textsuperscript{27} SKM, MR154 The Northern Road Upgrade between The Old Northern Road and Mersey Road – Traffic and Transport Assessment Report, Rev 5, August 2012, pages 58-61
The assessment concluded that considering both AM and PM peak periods, the performance of the intersection was forecast to be unacceptable (LoS D or worse, excepting 2016 AM) under the Base Case in 2016, 2026 and 2036\(^{28}\).

Intersection analysis of The Northern Road and Bringelly Road is presented in Table 3-3 with an at grade intersection upgrade, in line with the pre proposed airport announcement was:

- 2016 – proposed opening year for The Northern Road Upgrade
- 2026 – 10 years after the proposed opening year for The Northern Road Upgrade
- 2036 - 20 years after the proposed opening year for The Northern Road Upgrade.

Table 3-3 The Northern Road and Bringelly Road intersection performance (original upgrade)\(^{29}\)

<table>
<thead>
<tr>
<th>Case</th>
<th>Type of control</th>
<th>Degree of saturation (DoS)</th>
<th>Avg. delay (sec)</th>
<th>Level of Service (LoS)</th>
<th>Queue length &lt;worst approach&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 AM</td>
<td>Signalised</td>
<td>0.43</td>
<td>38</td>
<td>C</td>
<td>92.6 &lt;The Northern Road – South&gt;</td>
</tr>
<tr>
<td>2016 PM</td>
<td>Signalised</td>
<td>0.65</td>
<td>39</td>
<td>C</td>
<td>182.8 &lt;The Northern Road – North&gt;</td>
</tr>
<tr>
<td>2026 AM</td>
<td>Signalised</td>
<td>0.70</td>
<td>40.3</td>
<td>C</td>
<td>&gt;200 &lt;The Northern Road – South&gt;</td>
</tr>
<tr>
<td>2026 PM</td>
<td>Signalised</td>
<td>0.74</td>
<td>38.3</td>
<td>C</td>
<td>&gt;200 &lt;The Northern Road – North&gt;</td>
</tr>
<tr>
<td>2036 AM</td>
<td>Signalised</td>
<td>0.72</td>
<td>45.0</td>
<td>C</td>
<td>&gt;200 &lt;The Northern Road – South&gt;</td>
</tr>
<tr>
<td>2036 PM</td>
<td>Signalised</td>
<td>0.84</td>
<td>43.6</td>
<td>D</td>
<td>199.1 &lt;The Northern Road – North&gt;</td>
</tr>
</tbody>
</table>

The assessment concluded that:

- The intersection would operate at LoS D or better for the years analysed
- At grade intersections would have sufficient capacity to cater for future forecast traffic under 2036\(^{30}\).

Sensitivity testing completed in 2012 to identify the scenario where The Northern Road / Bringelly Road intersection might require grade separation. The sensitivity testing identified that the need for grade separation largely depended on the right turn traffic

\(^{28}\) SKM, MR154 The Northern Road Upgrade between The Old Northern Road and Mersey Road – Traffic and Transport Assessment Report, Rev 5, August 2012, page 61
\(^{29}\) Ibid, pages 85-88
\(^{30}\) SKM, MR154 The Northern Road Upgrade between The Old Northern Road and Mersey Road – Traffic and Transport Assessment Report, Rev 5, August 2012, page 91
volume from The Northern Road south into Bringelly Road and also the left turn volume in the reverse direction. The sensitivity test showed that a grade separated intersection was not required before 2036 based on predicted traffic volume increases.

3.1.5.2 Traffic forecast post announcement of a western Sydney airport

All assessments undertaken in Section 3.1.5.1 for The Northern Road and Bringelly Road and the associated intersection were done before the announcement of the western Sydney airport and the associated Western Sydney Infrastructure Plan and Broader Western Sydney Employment Area. The proximity of this major infrastructure is expected to have a significant influence on the regional growth and traffic in the region. As such, the traffic predictions done before these announcements may have underestimated the impact of future growth on the intersection and the need for a grade separated intersection. Taking this into consideration, the Proposal is being progressed and as part of the development process will determine the extent to which the western Sydney airport and the development of the BWSEA will have on the intersection.

3.2 Proposal objectives

The objectives of the Proposal to meet the Western Sydney Infrastructure Plan are:

Table 3-4 Western Sydney Infrastructure Plan program and project objectives

<table>
<thead>
<tr>
<th>Program Objectives</th>
<th>Project Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development and demand</td>
<td>Improve transport connections to the western Sydney airport and surrounding developments including the South West Growth Centre and Broader Western Sydney Employment Area</td>
</tr>
<tr>
<td>Connectivity to airport</td>
<td></td>
</tr>
<tr>
<td>Integrated network</td>
<td>Improve road safety for pedestrians, cyclists and motorists.</td>
</tr>
<tr>
<td>Integrated network</td>
<td>Improve the flow of traffic to provide more reliable journeys.</td>
</tr>
<tr>
<td>Integrated network</td>
<td>Support public and active transport to promote sustainable and efficient journeys.</td>
</tr>
</tbody>
</table>

31 Ibid, pages 48
4 Proposal option considerations

4.1 Overview
This section outlines the social, environmental, technical and economic aspects taken into consideration when developing the Proposal options within the Study Area (refer to Section 5). This section discusses the ‘base case’ as presently identified. Section 6 will study the weighting associated with the Proposal options.

4.2 Proposal objectives
The Proposal objectives are outlined in Section 3.2. Key to meeting these objectives is providing connectivity to the existing and future road network, and capacity requirements for both the design year and future years (to 2036).

The baseline traffic and safety information to consider when developing the Proposal options is outlined in Section 4.2.1 and 4.2.2.

4.2.1 Traffic
In developing the Proposal alignment options there are number of existing traffic considerations.

A Review of Environmental Factors (REF) was undertaken by Sinclair Knight Mertz (SKM) 33 for The Northern Road Upgrade (the original proposal). This REF included a detailed traffic and transport assessments which outlined the present status and future expected increase in traffic numbers for the intersection of Bringelly Road and The Northern Road.

As outlined in Section 3.1.5, with the announcement of the western Sydney airport at Badgerys Creek it was determined that the volume increase for the intersection may have underestimated the impact of future growth and the need for a grade separated intersection. Taking this into consideration, the Proposal is being progressed.

Presently the intersection at Bringelly Road / Greendale Road and The Northern Road is an at grade intersection with traffic lights.

Along The Northern Road there is a dedicated right turn lane in the northbound direction and dedicated right and left turn lanes in the southbound direction. Along Bringelly Road the dominant traffic movement at the intersection is for a right turn onto The Northern Road northbound and a non-signalised dedicated left turn slip lane into The Northern Road in a southbound direction. Greendale Road has a dedicated left turn lane into The Northern Road northbound.

As outlined in Section 3.1.2.1, crash history for The Northern Road and Greendale Road intersection obtained from Roads and Maritime is provided in Appendix A for a 1km radius surrounding the intersection. In analysing the date it shows that 11 crashes have occurred within 100 metres of the intersection from July 2009 to June 2014. Seven of the crashes involved a truck and three occurred in the centre of the intersection. Four of the crashes...
crashes occurred in close proximity, 70 metres south of the intersection, two of which involved the right turn lane heading north. Of the eleven crashes, six resulted in injuries with nine injuries in total. There have been no fatalities within the time period specified.

Access and traffic restrictions for the Boral Bringelly Brickworks is discussed in Section 4.3.1.

This has all been taken into consideration when determining the options for the Proposal.

### 4.2.2 Road safety

Road safety is inherent to any road design and provides one of the key success indicators to the Proposal.

In developing the Proposal options, the following features are key considerations for aiding road safety:

- Horizontal and vertical alignment to suit design speed
- Interchange configuration
- Appropriate signage locations
- Medians between opposing carriageways
- Appropriate sight lines at intersections including through structures
- Turning paths suitable for 19m semi-trailers and B-doubles
- Pedestrian and cycle facilities
- Intersections with traffic lights and pedestrian crossings
- Street lighting at intersections
- Design aspects that will influence maintenance such as median access and clear zones for workers

### 4.3 Land use

#### 4.3.1 Land use, zoning, property and access

Land uses within the study area include agricultural (grazing, horticulture), residential, public recreation, retail, industrial, commercial (such as Bringelly Village shops), sewerage pumping station, schools (Bringelly Public School), the Boral Bringelly Brickworks, 132kv zone substation and vegetated areas.

Bringelly Road and Greendale Road form the boundary between the Liverpool LGA to the north and the Camden LGA to the south. The Liverpool Local Environmental Plan (LEP) 2008[^34] and the Camden LEP 2010[^35] provide zoning for the land surrounding the Proposal. To the north east and south east of The Northern Road and Bringelly Road intersection, the land is zoned as Primary Production Small Lots (RU4). North west of the intersection the land is zoned as Infrastructure (SP2) for an educational establishment.

Adjacent to this land, Bringelly Park is situated, zoned as Public Recreation (RE1). To the south west of the intersection the land is zoned as Neighbourhood Centre (B1).

The properties in the study area range in size from more uniform rectangle lots along Bringelly Road, east of The Northern Road and south of Greendale Road (about 20,000 – 30,000 m²) to smaller lots north of Greendale Road (12,000 – 20,000 m²). Lots in the south east of the study area are more irregular shapes (about 20,000 – 30,000 m²). The lots that may potentially be affected by the Proposal are provided on Figure 4-1.

4.3.1.1 Boral Bringelly Brickworks

The Boral Bringelly Brickworks is located to the south west of The Northern Road and Bringelly Road intersection, and is accessible from Greendale Road (refer to Figure 2-1). The operations are owned by Boral Bricks Pty Ltd (Boral), which also owns the Badgerys Creek Quarry and Brickworks, about 5 km north east of the site.

Boral has supplied the Sydney construction market with bricks from its Bringelly and Badgerys Creek operations for the last 40 years. In 2012, Boral closed the Badgerys Creek facility to enhance its operational and economic efficiency by operating one facility in the region, rather than two. Boral now proposes to expand its existing operations at Bringelly Brickworks to meet the anticipated demand for bricks in NSW. This includes the requirement to service a joint venture with CSR Limited announced in December 2014 for clay brick productions.

The site covers an area of about 57 hectares and is situated within the northern most corner of a 385 ha property owned by Boral.

A State Significant Development Application (SSD) 5684 was approved on 3 March 2015 for expansion of the Brickworks towards the south west (refer to Figure 2-1). The consent approved:

- Expanding the existing extraction area and continuing brick making activities;
- Extracting up to 200,000 tonnes of clay/shale material a year;
- Continued importation of up to 96,000 tonnes of raw materials a year;
- Producing up to 263,500 tonnes of bricks a year;
- Handling, packaging, storing and transporting bricks by road;
- Exporting saleable overburden and spoil from the site;
- Constructing a new access driveway and two noise bunds;
- Upgrading and augmenting existing ancillary infrastructure; and
- Progressively rehabilitating the site.

The SSD approval has a number of conditions relating to traffic management including (also discussed in Section 4.2.1):

- all heavy vehicles exiting the site must travel east of the site along Greendale Road to The Northern Road and/or Bringelly Road; and

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• the dispatch of laden trucks is avoided during the peak drop-off and pick-up times at the Bringelly Public School to the greatest extent practicable, particularly prior to the upgrade of the Greendale Road/Bringelly Road intersection by Roads and Maritime.

The project has an expected life of 30 years.

4.3.1.2 Access

Greendale Road, west of The Northern Road and Bringelly Road intersection, provides access to Bringelly Public School and the Bringelly shops (Figure 2-1). Bringelly shops are also accessed via The Northern Road south of the intersection. The assessment of a grade separated interchange will need to take into consideration the potential for isolation of access to the road network and the sterilisation of lands.

4.3.2 Utilities

There are a number of utilities that are present along the existing road corridors and at The Northern Road and Bringelly Road intersection, including but not limited to, electricity lines, gas, water and optic fibre/telecommunications. These would need to be confirmed and considered as part of the development of any option for the Proposal. From available information as part of The Northern Road and Bringelly Road REFs and the detailed design works for The Northern Road and Bringelly Road general locations associated with these utilities have been identified and include:

• Power lines are located on both sides of The Northern Road and Bringelly Road. About 150 metres east of the intersection, power lines are along the northern side of Bringelly Road.

• Gas pipes are located along the southern side of Greendale Road and Bringelly Road before crossing to the northern side of Bringelly Road east of the intersection.

• Optic fibre / telecommunication lines are along the northern side of Bringelly Road and Greendale Road, the eastern side of The Northern Road, north of the intersection and the western side south of the intersection.

However, these would need to be confirmed as part of the development of the Proposal and must be considered as part of the option development and analysis.

4.3.2.1 Bringelly Zone Substation

An electrical substation is located at 30 Greendale Road, Bringelly. The substation is on the southern side of Greendale Road and about 300 metres to the west of The Northern Road and Bringelly Road intersection. The substation is operated and maintained by Endeavour Energy.

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Figure 4.1 is an aerial photograph of the project area, with an overlay of the streets, waterways and potentially impacted properties.
Environmental

4.3.3 Heritage – Non Aboriginal

4.3.3.1 Bringelly Public School

Bringelly Public School is located on a large triangular block to the north west of The Northern Road and Bringelly Road intersection at 1205 The Northern Road (Lot 50 DP 746911) (refer to Figure 4-2). Two of the early buildings on the school campus are identified as heritage items on the Liverpool Local Environmental Plan 2008 and the Department of Education and Communities register under Section 170 of the Heritage Act 1977. The listing includes everything within the heritage curtilage. The two buildings are:

- The old brick school house.
- The headmaster’s residence located along the eastern boundary of the site adjacent to The Northern Road.

Bringelly Public School was established in 1878. The headmaster’s residence was completed in June 1894. The school building consists of a Victorian style single storey school room. It was concluded that the Bringelly School Group, Primary School and residence, was locally significant as they are examples of the history of education and settlement in the region.

It was concluded that neither of the buildings would be directly impacted by the Bringelly Road Upgrade (original proposal). However, the distance between the road boundary and the heritage buildings would decrease, potentially creating visual, aural and vibratory impacts and lead to a loss in amenity. It was also concluded that The Northern Road Upgrade avoids physical impacts to the site and allows space in front of the historic school buildings fronting The Northern Road but may have some negative impact on the setting of the School Group.

4.3.3.2 WA Rogers House – 1186 The Northern Road

WA Rogers House at 1186 The Northern Road (Lot 4 DP 173593) is located to the south east of The Northern Road and Bringelly Road intersection (refer to Figure 4-2). It has local heritage significance and is identified as a heritage item in the Camden Local Environmental Plan 2010. The house was built in 1923 as the Shire Clerk’s residence and is representative of a modest, standard Edwardian style house built of brick with an iron roof.

The Northern Road Upgrade was identified as encroaching substantially on the property although there would not be direct impact on the house and garage. The mature roadside trees and some of the front yard would be directly impacted by the widening. Recommended mitigation measures for the impact resulting from The Northern Road Upgrade included relocation of the brick pillars and fencing located at the entrance of the

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40 Artefact Heritage, The Northern Road upgrade from the Old Northern Road Narellan to Mersey Road Bringelly Non Aboriginal Heritage Assessment, October 2012, page 75-81.
41 Austral Archaeology, 1002 Bringelly Road Upgrade Historical Heritage Assessment, Final Report, July 2011, page 168.
house to the new front property boundary before starting construction and an exclusion zone established around the curtilage of the property before and during works.\footnote{\textit{Ibid}, page 170.}

### 4.3.3.1 Bringelly Church – Wesleyan / Methodist Church

The Methodist / Wesleyan Church was formerly located at 991 Bringelly Road (Lot 2 DP 918331), south east of the intersection (refer to Figure 4-2). It was reputedly built in the late 1800s and burned down on 31 December 1963. The site is now vacant. It is generally a flat site, now partly covered with weeds and scrub. Site inspection revealed no structural or occupational evidence other than two large gateposts on the Bringelly Road entrance to the property.\footnote{\textit{Ibid}, page 102.}

### 4.3.4 Heritage – Aboriginal

A number of Aboriginal sites have been identified through assessment for both The Northern Road and Bringelly Road Upgrade. The assessments for the Bringelly Road and The Northern Road upgrades covered an area immediately surrounding the existing intersection of The Northern Road and Bringelly Road, further east along Bringelly Road and north and south of the existing The Northern Road. There were data gaps for the western side of Greendale Road as it was outside study area for \textit{Bringelly Road Upgrade Camden Valley Way to The Northern Road: Cultural Heritage Assessment Report, Sept 2011} (Kelleher Knightingale Consulting Pty Ltd).

All of the sites that have been identified to date are shown on Figure 4-2.

\footnote{\textit{Ibid}, page 170.}\footnote{\textit{Ibid}, page 102.}
Figure 4.2 is an aerial photograph of the project area, with an overlay of the heritage items in the area. The figure shows three non-Aboriginal heritage items, six surveyed Aboriginal items and 18 non-surveyed Aboriginal items including the Aboriginal buffer distance.
Ecology

The majority of the Study Area falls within the Biodiversity Certified Area for the SWGC with the exception of a small area around the portion of Thompsons Creek to the east of The Northern Road (refer to Figure 4-3).

Part of the study area has been surveyed for The Northern Road and Bringelly Road upgrades and the assessments for the Bringelly Road Upgrade and The Northern Road covered an area immediately surrounding the existing intersection of The Northern Road and Bringelly Road, east along Bringelly Road and immediately north and south of the existing The Northern Road.

Existing data for the region was used for the Bringelly Road Upgrade assessment.

The vegetation within the study area includes:

- Shale Plains Woodland / Cumberland Plain Woodland
- Alluvial Woodland found predominantly along Thompsons Creek
- Cleared and disturbed area with scattered trees.

The vegetation communities and their status under the NSW Threatened Species Conservation Act 1995 (TSC Act) and Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act) are presented in Table 4-1.

**Table 4-1 Identified vegetation communities**

<table>
<thead>
<tr>
<th>Vegetation Community Name</th>
<th>OEH vegetation types database / Biometric vegetation type</th>
<th>TSC Act name status (Department of Environment and Heritage 2010)</th>
<th>EPBC Act name / status (Department of the Environment Water Heritage and the Arts 2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shale Plains Woodland</td>
<td>Grey Box Forest Red Gum grassy woodland on flats of the Cumberland Plan Sydney Basin</td>
<td>Cumberland Plain Woodland (critically endangered)</td>
<td>Cumberland Plan Shale Woodlands and Shale-Gravel Transition Forest (critically endangered)</td>
</tr>
<tr>
<td>Shale Hills Woodland</td>
<td>Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin</td>
<td>Cumberland Plain Woodland (critically endangered)</td>
<td>Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (critically endangered)</td>
</tr>
</tbody>
</table>

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44 Parsons Brinckerhoff, Bringelly Road Upgrade Ecological Assessment, June 2011, page 28
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvial Woodland</td>
<td>Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Swamp Oak - Prickly Tea-tree - Swamp Paperbark swamp forest on coastal floodplains, Sydney Basin and South East Corner</td>
<td>River-Flat Eucalypt Forest on Coastal Floodplains (endangered)</td>
<td>n/a</td>
</tr>
<tr>
<td>Cleared and disturbed land with scattered trees</td>
<td>Highly disturbed areas with no or limited native vegetation</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

The fauna assessment undertaken within the Study Area as part of The Northern Road and Bringelly Road Upgrade REFs identified the Cumberland Land Snail at one location along Bringelly Road.
Figure 4.3 is an aerial photograph of the project area, with an overlay of the ecological constraints in the area. The figure shows the various woodland regions, one identified Cumberland land snail area and hatching of the non-certified biodiversity area.
Water and hydrology

Thompson Creek runs south to north to the west of The Northern Road, passing under Greendale Road about 400 metres west of The Northern Road and Bringelly Road intersection before passing under The Northern Road 700 metres north of the intersection (refer to Figure 2-1).

South Creek runs south to north to the east of The Northern Road beyond Kelvin Park Drive and passes under Bringelly Road about 2 km east from the intersection (refer to Figure 2-1).

Badgerys Creek passes under The Northern Road about 4 km north of the intersection.

The original proposal assessed:

- Retention of the existing bridge over Thompsons Creek for the southbound carriageway
- Provision of a new single span bridge over Thompsons Creek for the northbound carriageway
- Two permanent spill basins to protect water quality at Thompsons Creek (chainage 12300). This was identified from a risk assessment that was undertaken as part of the concept drainage design report (SKM 2012b). This assessment considered the risk of spills and the sensitivity of downstream waterways.

4.3.5 Noise

Based on the predicted traffic growth for The Northern Road and Bringelly Road intersection (refer to Section 3.1), it is expected that the noise levels in this region would change.

The assessment undertaken for the original proposal, to accommodate the South West Growth Centre, identified that a change in noise levels for the proposed road upgrade for the years 2016 and 2026 would be generally within the 2 dB(A) increase identified in the Road Noise Policy (DECC 2011).

While it was predicted that the noise level increase may be within the Road Noise Policy for many of the identified receivers (for the original proposal), consideration of noise mitigation options for some residences would be necessary for the development of the assessment of the preferred option as part of the original proposal. The assessment of construction noise predicted some exceedance of the Noise Management Level for linear constructions at some receivers but within Noise Management Levels for ancillary site operation.

Noting that this assessment did not take into consideration the traffic, this would need to be considered in the REF for the Proposal (following the identification of a preferred option see Section 6. However based on the location and the nature of the design (grade separated interchange), the basis for noise impacts during construction and operation

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45 SKM, The Northern Road Upgrade, Narellan to Bringelly Review of environmental Factors, October 2012, page 22
46 Ibid, page 22
47 SKM, The Northern Road Upgrade, Narellan to Bringelly Review of environmental Factors, October 2012, page 58
48 Ibid, page 35
49 Ibid, page 35
have been considered to be similar in nature until clear mitigation strategies can be determined as part of the REF for the Proposal.

4.3.6 Visual

The landscape characters for the area surrounding the intersection are generally consistent with a semi-rural area. This area has been considered to be visually enclosed by buildings and vegetation\textsuperscript{50}.

The visual assessment for The Northern Road upgrade predicted high to moderate impact from the work (the original Proposal). This was based on an at-grade intersection upgrade which would impact on the landscape character due to the sensitivity of the area (Bringelly Village shops and Bringelly Public School) and the magnitude of the work\textsuperscript{51}.

A grade separated interchange is likely to have an increased visual impact on the region, however this could be improved as a result of trenching of either Bringelly Road or the Northern Road to lower the vertical alignment. The vertical alignment was not specifically assessed as part of the grade separation and should be addressed during the concept design to minimise the visual impacts associated with the grade separation.

4.4 Constructability

Constructability will influence the identification of options as those options not using the existing road corridors will generally have less of an impact on traffic and provide more space for temporary work such as falsework for structures.

Options using pre-cast elements would provide more rapid construction, however, the spans required at intersections are influenced by sight distance and will alter the structural form. Long span options on the existing road alignment will require more complex construction staging and traffic management.

4.4.1 Geotechnical

The Northern Road and Bringelly Road cross topography is typical of the shale bedrock areas in western Sydney: an undulating landscape of generally low relief with broad valleys, north-flowing streams, a few higher hills, and almost no natural outcrop due to a pervasive residual clay soil cover.

Reference to the Penrith 1:100,000 Geological series sheet indicates the alignment is underlain by Bringelly Shale, with alluvium in the vicinity of major creek lines.

The Bringelly Shale comprises a complex unit of shales and siltstones with locally thick beds of sandstone.

In the vicinity of Bringelly Road it appears that the sandstone beds are thin or absent and the unit comprises predominantly siltstones and claystones that weather to form clayey residual soil of high plasticity.

The geotechnical constraints and issues associated with this landscape include:

- Very poor subgrade conditions for pavement support
- Potentially reactive soils

\textsuperscript{50} Ibid, page 269
\textsuperscript{51} Ibid, page 279
- Potentially erodible soils
- Areas of saline soils associated with local areas of high groundwater level near the toe of slopes.

While none of these issues are a major constraint, they need to be considered in the detailed design for the Proposal.

Founding conditions for major structures such as bridges of embankments is generally good, with the stiff residual soils having bearing capacities of about 100 to 150kPa. Greater capacity can be achieved by founding on bedrock at relatively shallow depths.

Slopes excavated into Bringelly Shale require both surface protection and support. Residual soil and weathered bedrock may be supported using retaining structures, while sound bedrock may be supported with shotcrete and rock bolts.

### 4.5 Economic analysis

The cost, both initial capital and ongoing maintenance, will have a high degree of influence on the identification of options and ultimately the selection of a preferred option.

At this stage of the Proposal, economic analysis is provided as a ranking system only. A Net Present Value analysis will allow a ranking of options to see which options provide the most cost effective design outcomes. Following design development stages can improve the cost accuracy but not necessarily the ranking of options. This is discussed further in Section 6.3.5.
5 Identification of options

5.1 Options development

5.1.1 Overview

The development of options has been an iterative process through:

- Review of existing Roads and Maritime strategic designs and sketches
- Technical workshops on the gap analysis of existing constraints based on previous work for The Northern Road and Bringelly Road Upgrades
- Engineering design consultation between the consultant URS and Roads and Maritime.

This process resulted in the identification of seven options each described in detail in Section 5.1. Each of the developed options has been based on changes to the horizontal alignment and a ‘worse case’ vertical alignment.

Option 0 is the original proposal which has been previously assessed.

Options 1 to 4 were initially developed and the latter options are modified versions of these options.

All except Option 0 feature the these elements:

- Four through lanes (two lanes in each direction) with future capacity for six through lanes (three lanes in each direction) on Bringelly Road and The Northern Road
- Tie into The Northern Road Upgrade and the Stage 2 Bringelly Road Upgrade / Greendale Road
- Design speed for 90 km/hr
- Grade separated interchange with traffic lights positioned on Bringelly Road
- Diamond intersection on Bringelly Road with traffic lights
- Dual right turn treatment on all legs
- Dual left turn slip lane on Bringelly Road on load to The Northern Road southbound
- Single left turn slip lane on Bringelly Road on load to The Northern Road northbound
- Single left turn slip lane on southbound The Northern Road off load to Bringelly Road
- Single slip lane on northbound The Northern Road off load to Bringelly Road
- Off load and on load ramps connect The Northern Road to Bringelly Road
- Staggered pedestrian crossings
- A shared user path (pedestrian and cycle lanes)
- Maintain public transport services and, if possible, improve.

A summary of the elements of the options is presented in Table 5-1.
Table 5-1 Summary of design elements included in the options

<table>
<thead>
<tr>
<th>Option</th>
<th>Name</th>
<th>Deviation from current intersection location</th>
<th>The Northern Road Realignment</th>
<th>Bringelly Road / Greendale Road Realignment</th>
<th>Option allows for Bringelly Road or The Northern Road to be elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No deviations</td>
<td>-</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>Western Route</td>
<td>West</td>
<td>Yes</td>
<td>No</td>
<td>The Northern Road only</td>
</tr>
<tr>
<td>2</td>
<td>Eastern – Route 1</td>
<td>East</td>
<td>Yes</td>
<td>No</td>
<td>Either</td>
</tr>
<tr>
<td>3</td>
<td>Southern – Route 1</td>
<td>South</td>
<td>No</td>
<td>Yes</td>
<td>Either</td>
</tr>
<tr>
<td>4</td>
<td>Southern – Route 2</td>
<td>South</td>
<td>No</td>
<td>Yes</td>
<td>Either</td>
</tr>
<tr>
<td>5</td>
<td>Option 2 and Option 4</td>
<td>South east</td>
<td>Yes</td>
<td>Yes</td>
<td>Either</td>
</tr>
<tr>
<td>6</td>
<td>Eastern – Route 2</td>
<td>East</td>
<td>Yes</td>
<td>No</td>
<td>The Northern Road only</td>
</tr>
<tr>
<td>7</td>
<td>Option 4 and Option 6</td>
<td>South east</td>
<td>Yes</td>
<td>Yes</td>
<td>The Northern Road only</td>
</tr>
</tbody>
</table>
The designs for the Proposal options are preliminary and have been developed through consideration of the information provided in Section 4.

Following the identification of the preferred option (Section 6), the design will be further refined on the basis of ongoing analysis and investigation with community and stakeholder feedback.

Sketch illustrations for each of the option are presented in this section (strategic concept drawings) in Figure 5-1 (and Figure 6-1 to Figure 6-8).

The base case that has been used to evaluate the performance of each of the options against is a ‘Do nothing’ option (Option 0), in which Roads and Maritime would retain the existing alignments and configurations, however, the intersection would be widened to meet the upgrade requirements associated with the upgrade of Bringelly Road and The Northern Road to form an at-grade intersection (refer to Figure 5-1 and Figure 6-1).
Figure 5.1 is an aerial photograph of the project area, illustrating seven road alignment options.
5.1.2 Option 0 (no deviations)

A summary of the key design elements associated with Option 0 is included in Table 5-2.

<table>
<thead>
<tr>
<th>Deviation from current intersection location</th>
<th>The Northern Road Realignment</th>
<th>Bringelly Road Realignment</th>
<th>Option allows for Bringelly Road or The Northern Road to be elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>No deviation</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Bringelly Road and The Northern Road would be widened to four through lanes. Greendale Road would remain with the current two through lanes. This footprint does not allow for widening to six lanes although there is a wide median for Bringelly Road and The Northern Road which, subject to appropriate approvals and assessment, would allow these roads to be widened to six through lanes with no median.

The existing levels would remain and the cross falls would be extended for drainage. The design speed for Bringelly Road is 90 km/h. The design speed for The Northern Road is 90 km/h, the design speed for Greendale Road would not change.

This option ties into the Stage 2 Bringelly Road Upgrade and The Northern Road Upgrade.
Option 1 (western route)

A summary of the key design elements associated with Option 1 is included in Table 5-3.

<table>
<thead>
<tr>
<th>Deviation from current intersection location</th>
<th>The Northern Road Realignment</th>
<th>Bringelly Road Realignment</th>
<th>Option allows for Bringelly Road or The Northern Road to be elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>West</td>
<td>Yes</td>
<td>No</td>
<td>The Northern Road only</td>
</tr>
</tbody>
</table>

The proposed alignment diverts west from the existing The Northern Road at Loftus Road, bridges over Greendale Road about 500 metres west of intersection to The Northern Road and joins the existing The Northern Road at Dart Road. The design arrangement allows only The Northern Road to be elevated due to the location of the intersection close to existing commercial premises.

There is a potential need for the bridge over Greendale Road to be extended further south over Thompsons Creek due to its close proximity. The span length for the bridge could be up to 200 metres. This would require either a reinforced earth wall with ties to minimise property acquisition or an increased acquisition footprint associated with The Northern Road.

The current end of the Bringelly Road Upgrade Stage 2 design would need to be extended 200 metres west to the new intersection location.

Greendale Road would remain as two through lanes, except at the new intersection where it would need to be widened to accommodate turning movements onto and off The Northern Road. This may have an impact on Bringelly Public School, Bringelly shops and / or Endeavour Energy zone substation.

The design speed for Bringelly Road and The Northern Road is 90 km/h.

This option is located away from Bringelly Public School and the shopping business centre. This option is likely to have property access issues associated with Boral Bringelly Brickworks and other properties leading onto Greendale Road around the interchange. Other property access issues are considered minor and could be addressed with restrictions such as left in and left out at Loftus Road. Details associated with property access issues are further discussed in Section 6.3.2.
Option 2 (eastern route 1)

A summary of the key design elements associated with Option 2 is included in Table 5-4.

### Table 5-4 Summary of design elements of Option 2

<table>
<thead>
<tr>
<th>Deviation from current intersection location</th>
<th>The Northern Road Realignment</th>
<th>Bringelly Road Realignment</th>
<th>Option allows for Bringelly Road and/or The Northern Road to be elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>Yes</td>
<td>No</td>
<td>Either</td>
</tr>
</tbody>
</table>

The proposed alignment diverts east of the existing Northern Road at Loftus Road, bridges over Bringelly Road about 150 metres east of the existing intersection and re-joins the existing The Northern Road at Solway Road. This option can accommodate:

- The Northern Road elevated over Bringelly Road
- The Northern Road trenched under Bringelly Road.

The design speed for Bringelly Road and The Northern Road is 90 km/h.

This option provides the opportunity to tie back into The Northern Road crossing of Thompsons Creek so would require minimal design changes associated with the creek crossing.

This option would be graded to Thompson Creek and Badgerys Creek so no drainage issues are expected.

Details associated with property access issues are discussed in Section 6.3.2.

#### 5.1.2.1 Option 2 - The Northern Road over an at grade Bringelly Road

The Northern Road elevated over Bringelly Road would require a 100 metres span bridge with reinforced earth wall (RE wall) for the abutment with an about total length of around 600 metres. Due to the span, the bridge would need a voided slab or steel girders. The existing intersection is located on a hill crest and therefore the bridge would require an elevation of about eight metres to allow for minimum clearance beneath The Northern Road of 5.3 metres.

Greendale Road would need to be widened and the existing intersection would need to be built out to meet the intersection requirements. The widening of Greendale Road would impact the southern property of Bringelly Public School and Bringelly Village shops and businesses. There may also be requirements for relocation of services associated with the Bringelly Zone Substation owned by Endeavour Energy.

Details associated with property access issues are further discussed in Section 6.3.2.

#### 5.1.2.2 Option 2 – Bringelly Road Over a Trenched The Northern Road

The Northern Road trenched under Bringelly Road would require a 60 metre span bridge. Super-T bridge girders could be used for this option if there was a central median column with Type F barriers for the median along The Northern Road.

Greendale Road would not need to be widened past the existing intersection. However, due to the close proximity of the new intersection with traffic lights to the existing The
Northern Road/Bringelly Road intersection, a roundabout or other method of control would be required to be designed and built out at the existing intersection.

5.1.3 Option 3 (southern route 1)

A summary of the key design elements associated with Option 3 is included in Table 5-5.

<table>
<thead>
<tr>
<th>Deviation from current intersection location</th>
<th>The Northern Road Realignment</th>
<th>Bringelly Road Realignment</th>
<th>Option allows for Bringelly Road or The Northern Road to be elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>No</td>
<td>Yes</td>
<td>Either</td>
</tr>
</tbody>
</table>

This option consists of The Northern Road in its current location, separated at Bringelly Road on a new alignment to the south of its existing position. Bringelly Road diverts south prior to The Northern Road intersection at about 300 metres east from the existing intersection. The option would be located about 100 metres towards the south of the existing intersection.

Bringelly Road would then connect to Greendale Road at Medway Road intersection on the western side of The Northern Road.

The design speed for Bringelly Road would be 90 km/h at the intersection, although it would be reduced in design speed west of the intersection. The design speed for The Northern Road would be 90 km/h.

This option can accommodate:

- The Northern Road elevated over Bringelly Road by bridge
- The Northern Road elevated over Bringelly Road by Bringelly Road being lowered
- The Northern Road trenched under Bringelly Road.

As the intersection remains on the current alignment of The Northern Road, there would be traffic management issues during construction.

In addition any design and construction works associated with Bringelly Road to the west of the intersection would be temporary and would require further upgrade in the future to meet the design speed of 90km/h and the six lane median separated road.

The access for some properties along The Northern Road would be compromised. This option would require additional acquisition to provide a service road with limited access onto The Northern Road (left in and left out).

Details associated with property access issues are further discussed in Section 6.3.2.

5.1.3.1 Option 3 - The Northern Road over an at grade Bringelly Road

This option includes a 100 metre span bridge with reinforced earth wall (RE wall) for the abutment with a length of about 600 metres. Due to the span, the bridge would need a voided slab or steel girders. The existing intersection is located on a hill crest and therefore the bridge would require an elevation of about eight metres to allow for minimum clearance beneath The Northern Road of 5.3 metres.
The portion of Greendale Road between The Northern Road and the new intersection would be isolated by about 600 metre of RE wall.

Due to the new alignment the works would require the design and construction of the new Bringelly Road and including the crossing of Thompsons Creek, which is likely to require a bridge with about 20 metre span.

Additional work on Bringelly Road west of The Northern Road and the Thompsons Creek bridge would be required to accommodate the future six through lane scenario for connection to the west.

5.1.3.2 **Option 3 - The Northern Road over a trenched Bringelly Road**

The Northern Road elevated over Bringelly Road by Bringelly Road being trenched would require a 60 metres span bridge. Super-T bridge girders could be used for this option if there was a central median column with Type F barriers for the median along Bringelly Road. The works would require Reinforced Concrete (RC) wall for a distance of 600 metres for the abutment along Bringelly Road.

The access for some properties along The Northern Road would be compromised. This option would require additional property acquisition to provide a service road with limited access onto The Northern Road (left in and left out).

Due to the new alignment the works would require the design and construction of the new Bringelly Road and including the crossing of Thompsons Creek, which is likely to require a bridge with about 20 m span. In addition, the trenching of Bringelly Road to then bridge Thompson’s Creek may pose difficulties because of the vertical alignment.

Additional work on Greendale west of The Northern Road and the Thompsons Creek bridge would be required to accommodate the future six through lane scenario for connection to the west.

This option would be graded to South Creek so no drainage issues are expected with the lowering of Bringelly Road.

5.1.3.3 **Option 3 – Bringelly Road over a trenched The Northern Road**

The Northern Road lowered under Bringelly Road would require a 60 metre span bridge. Super-T bridge girders could be used for this option if there was a central median column with Type F barriers for the median along The Northern Road. The works would require RC wall for an approximate total distance of 600 metres for the abutment along The Northern Road.

The access for some properties along The Northern Road would be compromised. This option would require additional property acquisition to provide a service road with limited access onto The Northern Road (left in and left out).

Due to the new alignment the works would require the design and construction of the new Bringelly Road, including the crossing of Thompsons Creek, which is likely to require a bridge with a 20 metre span.

This option would be graded to Thompsons Creek so no drainage issues are expected associated with the trenching of The Northern Road.
5.1.4 Option 4 (southern route 2)

A summary of the key design elements associated with Option 4 is included in Table 5-6.

<table>
<thead>
<tr>
<th>Deviation from current intersection location</th>
<th>The Northern Road Realignment</th>
<th>Bringelly Road Realignment</th>
<th>Option allows for Bringelly Road or The Northern Road to be elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>No</td>
<td>Yes</td>
<td>Either</td>
</tr>
</tbody>
</table>

This is a variation on Option 3, moving the intersection further to the south by 300 metres to maintain existing businesses and accesses.

This option can accommodate:

- The Northern Road elevated over Bringelly Road by bridge
- The Northern Road elevated over Bringelly Road by Bringelly Road being trenched
- The Northern Road trenched under Bringelly Road.

The proposed alignment diverts Bringelly Road at Kelvin Park Drive east of The Northern Road and crosses The Northern Road at about 300 metres south of the existing intersection. Bringelly Road then connects to Greendale Road 600 metres west of The Northern Road with a simple T intersection treatment. The future connection at this point is yet to be determined.

The design speed for Bringelly Road would be 90 km/h. The design speed for The Northern Road would be 90 km/h.

As this option remains on the current alignment of The Northern Road, there would traffic management issues during construction.

The design and construction work associated with Bringelly Road to the west of the intersection for this option would be temporary and would require further upgrade in the future to meet the design speed of 90km/h and the six lane median separated road.

Details associated with property access issues are further discussed in Section 6.3.2.
Option 5 (combination of option 2 and 4)

A summary of the key design elements associated with Option 5 is included in Table 5-7.

<table>
<thead>
<tr>
<th>Deviation from current intersection location</th>
<th>The Northern Road Realignment</th>
<th>Bringelly Road Realignment</th>
<th>Option allows for Bringelly Road or The Northern Road to be elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>South east</td>
<td>Yes</td>
<td>Yes</td>
<td>Either</td>
</tr>
</tbody>
</table>

This is a combination of Option 2 and Option 4 and involves moving the intersection to the south west. The proposed alignment diverts Bringelly Road at Kelvin Park Drive and crosses The Northern Road at about 170 metres south of the existing intersection. Bringelly Road then connects to Greendale Road 850 metres west of The Northern Road.

The design speed for Bringelly Road and Northern Road would be 90 km/h.

This option can accommodate:

- The Northern Road elevated over Bringelly Road by bridge
- The Northern Road elevated over Bringelly Road by Bringelly Road being trenched
- Bringelly Road elevated over The Northern Road by The Northern Road being trenched
- Bringelly Road elevated over The Northern Road.

For all sub-options of this option (see Section 5.1.7.1 to Section 5.1.7.4) the existing intersection remains and construction of the new intersection can occur offline to reduce traffic impacts during construction.

All sub-options would require the design and construction of the new Bringelly Road, including the crossing of Thompsons Creek, which is likely to require a bridge with a 20 metre span.

Additional work on Bringelly Road west of The Northern Road would be required to accommodate the future six through lane scenario in the future for connection to the west.

Details associated with property access issues are discussed in Section 6.3.2.

5.1.4.1 Option 5 – The Northern Road over an at grade Bringelly Road

This option would include a bridge over Bringelly Road (100 metre span) with a reinforced earth wall (RE wall) for the abutment with an length of about 600 metres. Due to the span, the bridge would need a voided slab or steel girders. The existing intersection is located on the side of a hill crest and therefore the bridge would require an elevation of about eight metres to allow for minimum clearance beneath The Northern Road of 5.3 metres. This would mean that there would be a visual impact associated with the option for the surrounding community. This is discussed further in Section 6.

5.1.4.2 Option 5 - The Northern Road over a trenched Bringelly Road

This option would involve The Northern Road elevated over Bringelly Road by Bringelly Road being trenched. This would require a 60 metre span bridge. Super-T bridge girders
could be used for this option if there was a central median column with Type F barriers for the median along Bringelly Road. The option would require RE wall for a distance of about 600 metres for the abutment along Bringelly Road.

The access for some properties along The Northern Road would be compromised. This option would require additional acquisition to provide a service road with limited access onto The Northern Road. This is discussed further in Section 6.3.2.

Due to the new alignment, the works would require the design and construction of the new Bringelly Road, including the crossing of Thompsons Creek, which is likely to require a bridge with about 20 metre span. In addition the trenching of Bringelly Road to then bridge Thompsons Creek may pose difficulties because of the vertical alignment.

Additional works on Bringelly Road west of The Northern Road and the Thompsons Creek bridge would be required to accommodate a future six through lane scenario for connection to the west.

This option would be graded to South Creek so no drainage issues are expected associated with the trenching of the Bringelly Road.

5.1.4.3 Option 5 – Bringelly Road over an at grade The Northern Road

This option would include a bridge over The Northern Road which would be a 100 metre span bridge with RE wall for the abutment with length of about 600 metres. Due to the span, the bridge would need a voided slab or steel girders.

The existing intersection is located on the side of a hill crest and therefore the bridge would require an elevation of about 8 metres to allow for minimum clearance beneath Bringelly Road of 5.3 metres. This would mean that there would be a visual impact associated with the works for the surrounding community.

Both Greendale Road and The Northern Road would remain in the same location so access for these properties would not be affected.

5.1.4.4 Option 5 – Bringelly Road over a trenched The Northern Road

This option would include The Northern Road trenched under Bringelly Road which would require a 60 metre span bridge. Super-T bridge girders could be used for this option if there was a central median column with Type F barriers for the median along The Northern Road. The works would require RC wall for a distance of about 600 metres for the abutment along The Northern Road.

Due to the new alignment, the works would require the design and construction of the new Bringelly Road and including the crossing of Thompsons Creek, which is likely to require a bridge with about 20 metre span.

This option would be graded to Thompsons Creek so no drainage issues are expected with the trenching of The Northern Road.
Option 6 (Eastern Route 2)

A summary of the key design elements associated with Option 6 is included in **Table 5-8.**

<table>
<thead>
<tr>
<th>Deviation from current intersection location</th>
<th>The Northern Road Realignment</th>
<th>Bringelly Road Realignment</th>
<th>Option allows for Bringelly Road or The Northern Road to be elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>Yes</td>
<td>No</td>
<td>The Northern Road Only</td>
</tr>
</tbody>
</table>

The proposed alignment diverts The Northern Road alignment to the east, south of Solway Road and re-joins The Northern Road at Robinson Road. The option includes the intersection located about 400 metres east of the existing intersection.

This option only allows The Northern Road to be located over Bringelly Road with a bridge. The bridge span would be about 100 metres with a reinforced earth wall about 600 metres long. The new intersection would be on a flatter section of Bringelly Road and the bridge elevation would be lower than for options 2 and 3.

The existing intersection would be maintained with traffic lights or a roundabout.

The design speed for Bringelly Road and The Northern Road would be 90 km/h.

The new intersection can be constructed predominantly without impact to current traffic.

This option provides the opportunity to tie back into Greendale Road crossing of Thompsons Creek and would require minimal design changes associated with creek crossing.

There is no requirement for the build out of Greendale Road at this point and as such this option may allow some flexibility for future expansion of Bringelly Road/Greendale Road to the future Outer Sydney Orbital road.

Details associated with property access issues are discussed in **Section 6.3.2.**
Option 7 (Combination of Option 4 and 6)

A summary of the key design elements associated with Option 7 is included in Table 5-9.

<table>
<thead>
<tr>
<th>Deviation from current intersection location</th>
<th>The Northern Road Realignment</th>
<th>Bringelly Road Realignment</th>
<th>Option allows for Bringelly Road or The Northern Road to be elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>Yes</td>
<td>Yes</td>
<td>The Northern Road Only</td>
</tr>
</tbody>
</table>

This is a combination of Option 4 and Option 6, deviating both The Northern Road and Bringelly Road. The Northern Road would divert east at Solway Road and re-join at Robinson Road. Bringelly Road would divert south at Kelvin Park Drive and re-join Greendale Road. This option locates the intersection 400 metres east and 50 metres to the south of the existing intersection. The Northern Road alignment bridges over Bringelly Road with off load and load ramps servicing Bringelly Road. The ramps will terminate with traffic lights for the dual right turn movement plus a left turn slip lane on all legs.

The Northern Road elevated over Bringelly Road would require a 100 metre span bridge with reinforced earth wall for the abutment. Due to the span, the bridge would need a voided slab or steel girders. The existing intersection is located on a hill crest and therefore the bridge would be about 8 metres elevation.

Details associated with property access issues are further discussed in Section 6.3.2.
Multi criteria analysis of options

5.2 Overview

This Section evaluates each of the seven options identified in Section 5 against the objectives identified in Section 3 and the proposal considerations identified in Section 4.

The overarching purpose of the Proposal is to improve the accessibility of The Northern Road and Bringelly Road to accommodate for the future traffic growth generated from the South West Growth Centre and the Western Sydney Infrastructure Plan and future proofing to improve forecast traffic congestion within the study area.

5.3 Methodology

Performance against each of the Proposal objectives and considerations has been scored 0–5 (poor – excellent), with 2.5 equating to neutral (no improvement or impact). The methodology and considerations for this scoring is outlined under each of the option consideration sections (refer to Section 6.3).

5.4 Analysis of options

5.4.1 Proposal objectives

The key to meeting the objectives for this Proposal, as outlined in Section 3 and Section 6.1, is progressing with a grade separation to allow for connectivity to the existing and future road network, and capacity requirements for both the design year and future years (to 2036).

5.4.1.1 Traffic

Current traffic modelling provides the following projected traffic volumes (Table 6-1). It is important to note that this traffic modelling does not include the Western Sydney Infrastructure Plan as a consideration.

Table 6-1 Average AM peaks

<table>
<thead>
<tr>
<th>Location</th>
<th>2011</th>
<th>2016</th>
<th>2021</th>
<th>2026</th>
<th>2031</th>
<th>2036</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Northern Road northbound</td>
<td>845</td>
<td>1276</td>
<td>2036</td>
<td>2326</td>
<td>1669</td>
<td>1775</td>
</tr>
<tr>
<td>The Northern Road southbound</td>
<td>666</td>
<td>709</td>
<td>791</td>
<td>1044</td>
<td>1136</td>
<td>1115</td>
</tr>
<tr>
<td>Bringelly Road eastbound</td>
<td>433</td>
<td>769</td>
<td>1041</td>
<td>1369</td>
<td>1204</td>
<td>1223</td>
</tr>
<tr>
<td>Bringelly Road westbound</td>
<td>189</td>
<td>306</td>
<td>640</td>
<td>1063</td>
<td>706</td>
<td>1150</td>
</tr>
<tr>
<td>Greendale Rd eastbound</td>
<td>38</td>
<td>76</td>
<td>250</td>
<td>510</td>
<td>638</td>
<td>676</td>
</tr>
<tr>
<td>Greendale Rd westbound</td>
<td>29</td>
<td>54</td>
<td>108</td>
<td>212</td>
<td>303</td>
<td>619</td>
</tr>
</tbody>
</table>

The mid-block volumes presented in Table 6-2 are based on the CUBE model used by AECOM in “Bringelly Road Upgrade Review of Environmental Factors: Traffic and Transport Modelling Assessment”. The model indicates the generally adopted cross...
section of dual carriageways with two lanes in each direction would be suitable for The Northern Road capacity up to 2026 after which time the additional through lanes would be required. Bringelly Road capacity is currently being augmented for the through carriageway by upgrading to dual carriageway with two lanes in each direction. Potential for upgrade to 6 lanes is provided and will be required in accordance with the modelling in 2036.

One important factor that has not been included in this modelling is the impact that development of western Sydney airport may have and the associated development of the Western Sydney Infrastructure Plan and the Broader Western Sydney Employment Area. The proximity of this major infrastructure will influence the regional growth and traffic in the region. As such, the traffic predictions undertaken prior to these announcements may have underestimated the impact of future growth on the intersection and the need for a grade separated intersection. Roads and Maritime are currently reviewing this modelling and its impact may need to be included in future assessment.

Table 6-2 Typical mid-block capacities for urban roads with interrupted flow

<table>
<thead>
<tr>
<th>Type of Lane</th>
<th>One Way Mid Block Capacity (Vehicle / hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median of Inner Lane - Divided Road</td>
<td>1000</td>
</tr>
<tr>
<td>Median of Inner Lane - Undivided Road</td>
<td>900</td>
</tr>
<tr>
<td>Median Lane (of a 3 Lane Carriageway - Divided Road)</td>
<td>1000</td>
</tr>
<tr>
<td>Median Lane (of a 3 Lane Carriageway - Undivided Road)</td>
<td>900</td>
</tr>
<tr>
<td>Kerb lane - Adjacent to Parking Lane</td>
<td>900</td>
</tr>
<tr>
<td>Kerb lane - Occasional Parked Vehicles</td>
<td>600</td>
</tr>
<tr>
<td>Kerb lane - Clearway Conditions</td>
<td>900</td>
</tr>
</tbody>
</table>

Source: Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis, Section 5.2.1, Table 5.1

Connectivity to the network for the various options varies with the configuration of roads and intersections within each option. The immediate requirements are to connect an upgraded four lane dual carriageway of Bringelly Road to a similarly upgraded Northern Road. Greendale Road at present, and for the foreseeable future, connects only local traffic from the west of The Northern Road/Bringelly Road intersection servicing the Boral Bringelly Brickworks and Bringelly Zone Substation.
5.4.1.2 Road safety

With the construction of two divided carriageways for Bringelly Road approaches, all options except Option 0 are likely to reduce the number of head-on crashes, which accounted for 3.8 per cent of the crashes recorded in the five-year period from 2004 to 2008. The likelihood of intersection crashes, which accounted for 61.5 per cent of all recorded crashes along Bringelly Road, would also be reduced with the provision of deceleration/slip lanes along Bringelly Road and signalised intersections being introduced.

Crash data along The Northern Road from the March quarter of 2005 to 2010 was analysed by SKM in their report “MR154 THE NORTHERN ROAD UPGRADE Between The Old Northern Rd & Mersey Rd” TRAFFIC AND TRANSPORT ASSESSMENT REPORT

The analysis showed that the majority of accidents in this section of The Northern Road are caused by opposed turning movements. This is likely a result of a large number of turning movements taking place within a high speed section (80km/h) in a constrained area of The Northern Road. With the introduction of a grade separated interchange these opposing turning movements would be reduced in all but Option 0.

5.4.1.3 Proposal objectives

As outlined in Section 3.2, the objectives of the Proposal are:

Table 6-3 Western Sydney Infrastructure Plan program and project objectives

<table>
<thead>
<tr>
<th>Program Objectives</th>
<th>Project Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development and demand</td>
<td>Improve transport connections to the proposed western Sydney airport and surrounding developments including the South West Growth Centre and Broader Western Sydney Employment Area</td>
</tr>
<tr>
<td>Connectivity to airport</td>
<td></td>
</tr>
<tr>
<td>Integrated network</td>
<td>Improve road safety for pedestrians, cyclists and motorists.</td>
</tr>
<tr>
<td>Integrated network</td>
<td>Improve the flow of traffic to provide more reliable journeys.</td>
</tr>
<tr>
<td>Integrated network</td>
<td>Support public and active transport to promote sustainable and efficient journeys.</td>
</tr>
</tbody>
</table>

While some of these objectives are discussed in further detail in this Section, all options of the options meet the Proposal objectives, with the exception of Option 0. As such these have all been allocated the same score of 5 (refer to Section 6.4).

5.4.2 Land use

5.4.2.1 Land use, zoning, property and access

The assessment of options considered the following property related issues:

- The number of properties intersected requiring acquisition
- Where there are existing land access arrangements in place
- Where acquisition is required, to minimise dwellings being directly under the proposed option alignment and portions of properties being sterilised.
Refer to Figure 6-1 for the property constraints that within the study area (i.e. properties that may be affected for all options). Property constraints associated with each option are provided on Figure 6-1 to Figure 6-8. A summary of the potential impact to properties is provided in Table 6-4.

### Table 6-4 Summary of potential impact to properties

<table>
<thead>
<tr>
<th>Option</th>
<th>Impacted Properties</th>
<th>Number of properties with existing access agreements</th>
<th>Number of properties without existing access agreements</th>
<th>Dwelling impacted</th>
<th>Number of properties that will have access issues or a portion sterilised</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>55</td>
<td>2</td>
<td>53</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>1</td>
<td>34</td>
<td>0</td>
<td>34</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>41</td>
<td>5</td>
<td>36</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>46</td>
<td>5</td>
<td>41</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>12</td>
<td>38</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>35</td>
<td>3</td>
<td>32</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>41</td>
<td>13</td>
<td>28</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>50</td>
<td>5</td>
<td>45</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

Option 2 impacts the most number of dwellings with 15 dwellings impacted and an additional five property access points impacted. Option 0 impacts 19 property access points, including the school, and impacts two dwellings. The school dwelling is impacted under options 1 and 2. No options impact the dwelling or property access for the shop, however, options 3 and 4 impact the shop property. Options 6 and 7 impact the least amount of dwellings and property access points, with option 7 impacting 5 dwellings and option 6 impacting 6 dwellings.

As detailed design is progressed, there may be opportunities to reduce the curtilage impacts. The use of reinforced concrete walls rather than batters would assists with minimising impacts where they are in close proximity to the Proposal option.

### Boral Bringelly Brickworks

The Bringelly Brickworks is located to the south west of The Northern Road and Bringelly Road intersection, accessed off Greendale Road.

As discussed in Section 4.3.1, the Boral Bringelly Brickworks have an SSD approval to expand. This approval has a number of conditions relating to traffic management including:

- all heavy vehicles exiting the site travel east of the site along Greendale Road to The Northern Road and/or Bringelly Road; and
• the dispatch of laden trucks is avoided during the peak drop-off and pick-up times at the Bringelly Public School to the greatest extent practicable, particularly prior to the upgrade of the Greendale Road/Bringelly Road intersection by Roads and Maritime.

These conditions are largely related to the fact that the trucks have difficulty negotiating the left hand turn from Greendale Road onto The Northern Road. The original proposal (Option 0) would not address this issue without impacting on the Bringelly Public School.

Further, the Boral Bringelly Brickworks is a constraint for the western and southern options (Options 1, 3, 4, 5 and 7). There may be further opportunities to reduce the constraint presented by the brickworks if elements of the site can be reconfigured to release land in the north eastern corner of the site. This report does not consider those options and views the brickworks as a fixed constraint (i.e. land release is not possible).

5.4.2.2 Utilities

Major utilities in the area include electricity transmission lines both overhead and underground. These feed to Bringelly Zone Substation on Greendale Road and cross The Northern Road north of the Bringelly Road intersection. All options will be impacted.

Other utilities include Telstra cabling along both Bringelly Road and The Northern Road, water mains and gas mains are generally contained within the existing road reserve. Alignment options that retain the existing road corridor (Options 0, 3, and 4) will impact these options while those options generally outside the corridor (Options 1, 2, 5, 6, and 7) will only impact where crossing or entering the existing roadways.

Bringelly Zone Substation

The Bringelly Zone Substation is owned by Endeavour Energy and is located at 30 Greendale Road, Bringelly. The substation is a constraint for Options 1 and 2 only.

5.4.2.3 Summary

Based on the information presented above, a score has been applied to each option (refer to Table 6-5) using the matrix present below as a result of the number of properties that would be impacted by the options, and the number of dwellings that would be intersected by the option. These are the two key issues outlined in this section.

Further, if the option intersects the Bringelly Public School or Bringelly Zone Substation, it has been allocated a score of 0. This is considered an unacceptable outcome for the preferred option.
### Options Report
The Northern Road and Bringelly Road Grade Separated Interchange

<table>
<thead>
<tr>
<th>No of dwellings intersected</th>
<th>0-20 properties impacted</th>
<th>20-30 properties impacted</th>
<th>30-40 properties impacted</th>
<th>40-50 properties impacted</th>
<th>50-60 properties impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2-3</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4-5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6-7</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8+</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 6-5 MCA for impact Land use, Zoning, Property and Access

<table>
<thead>
<tr>
<th>Option</th>
<th>Impacted Properties</th>
<th>Dwelling impacted</th>
<th>Intersects Substation or School (Y/N)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>55</td>
<td>2</td>
<td>Y</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>34</td>
<td>11</td>
<td>Y</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>41</td>
<td>15</td>
<td>Y</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>46</td>
<td>7</td>
<td>N</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>4</td>
<td>N</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>35</td>
<td>6</td>
<td>N</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>41</td>
<td>6</td>
<td>N</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>50</td>
<td>5</td>
<td>N</td>
<td>2</td>
</tr>
</tbody>
</table>
Figure 6.1 is an aerial photograph of the project area, with an overlay of all the surrounding constraints. This figure illustrates option 0 utilising the existing alignment of The Northern Road and Bringelly Road intersection.

OPTIONS ANALYSIS FOR BRINGELLY ROAD - THE NORTHERN ROAD INTERSECTION

OPTION 0 - CONSTRAINTS

Legend
- Option 0
- Streets
- Waterways
- Property Access Impacted
- Dwelling Impacted
- Impacted Properties
  - Cumberland Land Snail
  - Non-Aboriginal Heritage
  - RMS Non Aboriginal Heritage Item

Vegetation Community
>10% cover
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 9 - Shale Hills Woodland

Vegetation Community
<10% cover
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 9 - Shale Hills Woodland

Note: Source list in separate document.

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Figure 6.2 is an aerial photograph of the project area, with an overlay of all the surrounding constraints. This figure illustrates option 1 utilising an alignment with a western skewed The Northern Road and Bringelly Road intersection.
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Legend
- Option 2
- Streets
- Waterways
- Property Access Impacted
- Dwelling Impacted
- Impacted Properties
- Cumberland Land Snail
- RMS Non-Aboriginal Heritage Items
- Non-Aboriginal Heritage

Vegetation Community >10% cover
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 9 - Shale Hills Woodland

Vegetation Community <10% cover
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 9 - Shale Hills Woodland

Note: Source list in separate document.

Figure 6.3 is an aerial photograph of the project area, with an overlay of all the surrounding constraints. This figure illustrates option 2 utilising an alignment with an eastern skewed The Northern Road and Bringelly Road intersection.

OPTIONS ANALYSIS FOR BRINGELLY ROAD - THE NORTHERN ROAD INTERSECTION

OPTION 2 - CONSTRAINTS

File No: 43168369.005.mxd Drawn: STB Approved: II Date: 26/04/2015

Revision: A3
Edited to remove personal details and any other non-relevant content.

**Options Analysis for Bringelly Road - The Northern Road Intersection**

**Figure 6.4** is an aerial photograph of the project area, with an overlay of all the surrounding constraints. This figure illustrates option 3 utilising a southern skewed The Northern Road and Bringelly Road intersection. This option also illustrates an upgraded Greendale Road and Robinson Road Intersection.

**Legend**

- Option 3
- Streets
- Waterways
- Property Access Impacted
- Dwelling Impacted
- Impacted Properties
- Cumberland Land Snail
- Non-Aboriginal Heritage Items
- RMS Non Aboriginal Heritage Items

**Vegetation Community**

- >10% cover
  - 10 - Shale Plains Woodland
  - 11 - Alluvial Woodland
  - 9 - Shale Hills Woodland

- <10% cover
  - 10 - Shale Plains Woodland
  - 11 - Alluvial Woodland
  - 9 - Shale Hills Woodland

**Note:** Source list in separate document.

**Option 3 - Constraints**
Figure 6.5 is an aerial photograph of the project area, with an overlay of all the surrounding constraints. This figure illustrates option 4 utilising an alignment with a southern skewed The Northern Road and Bringelly Road intersection.

Note: Source list in separate document.

Figure 6-5

OPTIONS ANALYSIS FOR BRINGELLY ROAD - THE NORTHERN ROAD INTERSECTION

OPTION 4 - CONSTRAINTS

Legend

- Option 4
- Streets
- Waterways
- Property Access Impacted
- Dwelling Impacted
- Impacted Properties
- Cumberland Land Snail
- Non-Aboriginal Heritage
- RMS Non Aboriginal Heritage Items
- Vegetation Community

>10% cover
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 9 - Shale Hills Woodland

<10% cover
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 9 - Shale Hills Woodland

Vegetation Community

Non-Aboriginal Heritage

RMS Non Aboriginal Heritage Items

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Figure 6.6 is an aerial photograph of the project area, with an overlay of all the surrounding constraints. This figure illustrates option 5 utilising an alignment with a south-eastern skewed The Northern Road and Bringelly Road intersection.

Legend
- Option 5
- Streets
- Waterways
- Property Access
- Dwelling Impacted
- Impacted Properties
- Cumberland Land Snail
- Non-Aboriginal Heritage
- RMS Non Aboriginal Heritage Items

Vegetation Community
- >10% cover
  - 10 - Shale Plains Woodland
  - 11 - Alluvial
  - 9 - Shale Hills Woodland

Vegetation Community
- <10% cover
  - 10 - Shale Plains Woodland
  - 11 - Alluvial
  - 9 - Shale Hills Woodland

Note: Source list in separate document.
Figure 6.7 is an aerial photograph of the project area, with an overlay of all the surrounding constraints. This figure illustrates option 6 utilising an alignment with an eastern skewed The Northern Road and Bringelly Road intersection. This option also has an eastern tie-in past Kelvin Park Drive and a western tie-in at the existing The Northern Road and Bringelly Road intersection.

Legend
- Option 6
- Streets
- Waterways
- Property Access Impacted
- Dwelling Impacted
- Impacted Properties
- Cumberland Land Snail
- Non-Aboriginal Heritage
- RMS Non Aboriginal Heritage Items

Vegetation Community
>10% cover
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 9 - Shale Hills Woodland

<10% cover
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 9 - Shale Hills Woodland

Note: Source list in separate document.
OPTIONS ANALYSIS FOR BRINGELLY ROAD - THE NORTHERN ROAD INTERSECTION

Figure 6.8 is an aerial photograph of the project area, with an overlay of all the surrounding constraints. This figure illustrates option 7 utilising an alignment with an eastern skewed The Northern Road and Bringelly Road intersection. This option also has a diamond intersection with an eastern tie-in past Kelvin Park Drive and a western tie-in past Hutchinson Road.

Legend
- Option 7 Streets
- Waterways
- Property Access Impacted
- Dwelling Impacted
- Impacted Properties
- Cumberland Land Snail
- Non-Aboriginal Heritage
- RMS Non Aboriginal Heritage Items

Vegetation Community
>10% cover
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 9 - Shale Hills Woodland

Vegetation Community
<10% cover
- 10 - Shale Plains Woodland
- 11 - Alluvial Woodland
- 9 - Shale Hills Woodland

Note: Source list in separate document.

Figure: 6-8
Environmental

Roads and Maritime seeks to minimise the environmental impact of infrastructure delivery. The supporting objective for the environment is to minimise impact to the local environment.

5.4.2.4 Heritage – Non Aboriginal

The three main non-Aboriginal sites identified in the vicinity of the proposed options are:

- Bringelly Public School
- WA Rogers 1186 The Northern Road
- Bringelly Church / former Wesleyan Methodist Church.

Refer to Figure 6-1 to Figure 6-8 for the non-Aboriginal heritage constraints associated with each option. A summary of the potential impact to non-Aboriginal heritage items is provided in Table 6-6.

A score has been allocated to each option based on the potential impacts of each option on non-Aboriginal heritage items. A score of 5 means there no known potential for impact on non-Aboriginal heritage items. A score of zero means there is a potential for a significant impact on one or more non-Aboriginal heritage items.

Table 6-6 Summary of potential impact to known non-Aboriginal heritage features

<table>
<thead>
<tr>
<th>Option</th>
<th>Potential curtilage impact to Bringelly Public School</th>
<th>Potential curtilage impact to WA Rogers 1186 The Northern Road</th>
<th>Potential curtilage impact to Bringelly Church / former Wesleyan Methodist Church</th>
<th>Score out of 5 (5 is a low potential for impact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Minor along Bringelly Road southern boundary</td>
<td>Potential visual and loss of amenity</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>Minor along Bringelly Road southern boundary</td>
<td>No</td>
<td>No</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Minor along Bringelly Road southern boundary</td>
<td>Mainly visual impacts and loss of amenity to house. Option avoids impact and reduces impact to item from The Northern Road upgrade. Option would place roadway on eastern and western sides of site which may alter overall impact.</td>
<td>Yes</td>
<td>1</td>
</tr>
</tbody>
</table>
## 5.4.2.5 Heritage – Aboriginal

A number of Aboriginal sites have been identified through assessment for both The Northern Road and Bringelly Road Upgrade. However, there are data gaps for the western side of Greendale Road as it was outside study area for CHAR Bringelly Road Upgrade, September 2011 (Kelleher Knightingale Consulting Pty Ltd).

<table>
<thead>
<tr>
<th>Option</th>
<th>Number of known Aboriginal heritage features impacted</th>
<th>Comment</th>
<th>Score out of 5 (5 is a low potential for impact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>No data for The Northern Road portion of option</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>No data for The Northern Road portion of option</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>Data gap for western portion and most of eastern portion of option outside study area for CHAR Bringelly Road Upgrade, Sept 2011 (Kelleher Knightingale Consulting Pty Ltd).</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>Data gap for western portion and some of eastern portion of option outside study area for CHAR Bringelly Road Upgrade, Sept 2011 (Kelleher Knightingale Consulting Pty Ltd). No data for rest of option.</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 6-7 presents the known aboriginal heritage constraints associated with each option. A summary of the potential impact to known aboriginal heritage items is provided in Table 6-7.

Table 6-7 also provides a score that has been allocated to each option based on the potential for impacts on known Aboriginal heritage items. A score of 5 means there no known potential for impact on Aboriginal heritage items. A score of zero means there is a potential for a significant impact on five or more Aboriginal heritage items.

As a result of the data gaps it is difficult to differentiate the potential impact for each of the options on Aboriginal heritage. As such, the score provided here will have a low weighting in the multi-criteria analysis (Section 6.4).

Table 6-7 Summary of potential impact to known Aboriginal heritage features

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Data gap for western portion on Bringelly Road and all of deviated The Northern Road</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>Data gap for all of deviated The Northern Road</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>Data gap for western portion on Bringelly Road and all of deviated The Northern Road</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 6-1 to Figure 6-8 presents the known aboriginal heritage constraints associated with each option. A summary of the potential impact to known aboriginal heritage items is provided in Table 6-7.

Table 6-7 Summary of potential impact to known Aboriginal heritage features

5.4.2.6 Ecology

The majority of the area is covered by Biodiversity Certification excepting a small area to the north east of The Northern Road. The vegetation communities that present a constraint to the Proposal are the following:

- Shale Plains Woodland (forms part of the Critically Endangered Cumberland Plain Woodland)
- Shale Hills Woodland (forms part of the Critically Endangered Cumberland Plain Woodland)
- Alluvial Woodland (forms part of the Endangered River-Flat Eucalypt Forest on Coastal Floodplains).

The approximate areas of each of these vegetation communities within the footprint of each option is presented in Table 6-8 and figures for each option are presented in Figure 6-1 to Figure 6-8.

The data for these calculations is sourced from the GIS vegetation data provided by Roads and Maritime and calculated using GIS. The source and currency of this data is unknown and would need to be verified through field surveys. Although the calculations are provided in square metres, they should not be used as definitive areas. They are intended to be used in the context of comparison between options of the broad scale of clearing.
Table 6-8 Summary of potential impact to known ecology areas, approximate area (m²) that may be cleared

<table>
<thead>
<tr>
<th>Option</th>
<th>Total area of significant vegetation (sum of &gt;10% and &lt;10% for all 3 types)</th>
<th>Shale Plains Woodland &gt; 10% canopy cover</th>
<th>Shale Plains Woodland &lt; 10% canopy cover</th>
<th>Alluvial Woodland &gt; 10% canopy cover</th>
<th>Alluvial Woodland &lt; 10% canopy cover</th>
<th>Shale Hills Woodland &gt; 10% canopy cover</th>
<th>Shale Hills Woodland &lt; 10% canopy cover</th>
<th>Total area &gt;10% canopy cover</th>
<th>Total area &lt;10% canopy cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>76,704</td>
<td>0</td>
<td>46,122</td>
<td>0</td>
<td>7,098</td>
<td>0</td>
<td>23,484</td>
<td>0</td>
<td>76,704</td>
</tr>
<tr>
<td>1</td>
<td>61,049</td>
<td>5,415</td>
<td>20,592</td>
<td>15,005</td>
<td>6,573</td>
<td>0</td>
<td>13,464</td>
<td>20,420</td>
<td>40,629</td>
</tr>
<tr>
<td>2</td>
<td>73,887</td>
<td>4,487</td>
<td>41,366</td>
<td>1,417</td>
<td>13,113</td>
<td>0</td>
<td>13,504</td>
<td>5,904</td>
<td>67,983</td>
</tr>
<tr>
<td>3</td>
<td>52,823</td>
<td>9,791</td>
<td>12,694</td>
<td>2,221</td>
<td>5,493</td>
<td>0</td>
<td>22,624</td>
<td>12,012</td>
<td>40,811</td>
</tr>
<tr>
<td>4</td>
<td>69,524</td>
<td>8,233</td>
<td>25,608</td>
<td>5,521</td>
<td>1,789</td>
<td>0</td>
<td>28,373</td>
<td>13,754</td>
<td>55,770</td>
</tr>
<tr>
<td>5</td>
<td>47,852</td>
<td>2,331</td>
<td>25,718</td>
<td>6,485</td>
<td>3,520</td>
<td>0</td>
<td>9,798</td>
<td>8,816</td>
<td>39,036</td>
</tr>
<tr>
<td>6</td>
<td>27,794</td>
<td>1,274</td>
<td>18,953</td>
<td>0</td>
<td>5,375</td>
<td>0</td>
<td>2,192</td>
<td>1,274</td>
<td>26,520</td>
</tr>
<tr>
<td>7</td>
<td>97,233</td>
<td>12,012</td>
<td>47,331</td>
<td>5,226</td>
<td>4,208</td>
<td>0</td>
<td>28,456</td>
<td>17,238</td>
<td>79,995</td>
</tr>
</tbody>
</table>

Based on the available information in approximate order of magnitude for total overall significant vegetation clearing (both more than ten percent canopy cover and less than ten per cent canopy cover for all three vegetation types):

- Option 6 would require the least clearing
- Option 1, 3 and 5 have a similar order magnitude
- Option 0, 2 and 4 have a similar order magnitude
- Option 7 the most clearing.

The values for vegetation with more than ten per cent canopy cover are likely to indicate higher value, intact tracts of vegetation. Considering the area more than ten per cent canopy cover across the three types of vegetation for areas:

- Option 0 has no clearing (but a high proportion of vegetation with less than 10% cover)
- Option 6 would require the least clearing
- Option 2 and 5 have a similar order magnitude
- Option 1, 3 and 4 have a similar order magnitude
- Option 7 the most clearing.
Based on these conclusions, a score has been allocated to each option (refer to Table 6-8).
A score of 5 means the option has the potential to have a small impact on ecology, and a score of 0 means the option has the potential to have a large impact on ecology.

**Table 6-9 Summary of potential impact to known ecology areas**

<table>
<thead>
<tr>
<th>Option</th>
<th>Approximate Area (m²) that may be cleared - Total area of significant vegetation (sum of &gt;10% and &lt;10% for all 3 types)</th>
<th>Approximate Area (m²) that may be cleared - Total area - &gt;10% canopy cover</th>
<th>Approximate Area (m²) that may be cleared - Total area - &lt;10% canopy cover</th>
<th>Score out of 5 (5 is a low potential for impact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>76,704</td>
<td>0</td>
<td>76,704</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>61,049</td>
<td>20,420</td>
<td>40,629</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>73,887</td>
<td>5,904</td>
<td>67,983</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>52,823</td>
<td>12,012</td>
<td>40,811</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>69,524</td>
<td>13,754</td>
<td>55,770</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>47,852</td>
<td>8,816</td>
<td>39,036</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>27,794</td>
<td>1,274</td>
<td>26,520</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>97,233</td>
<td>17,238</td>
<td>79,995</td>
<td>2</td>
</tr>
</tbody>
</table>

The fauna assessment undertaken within the Study Area as part of The Northern Road and Bringelly Road Upgrade REFs identified the Cumberland Land Snail at one location along Bringelly Road. It is considered that regardless of the option the potential for impact is the same due to the transient nature of fauna. As such there is no specific score associated with fauna.

### 5.4.2.7 Water and hydrology

Thompsons Creek is in close proximity to The Northern Road and Bringelly Road intersection. A summary of the potential impact to waterway crossings is presented in Table 6-10 and figures for each option are presented Figure 6-1 to Figure 6-8.

Based on these on this information, a score has been allocated to each option. A score of 5 means the option is unlikely to impact on waterways, and a score of 0 means the option has the potential to have a large impact on waterways.
### Table 6-10 Summary of potential impact to waterway crossings

<table>
<thead>
<tr>
<th>Option</th>
<th>Number of new waterway crossings</th>
<th>The Northern Road (north) crosses Thompsons Creek and a new waterway crossing would be required</th>
<th>Bringelly Road / Greendale Road</th>
<th>Score out of 5 (5 is a low potential for impact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>The existing bridge is expected to remain</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>The Northern Road (south) crosses Thompsons Creek at new location.</td>
<td>A new upgrade of Thompsons Creek would be required to meet the 4 lane configuration.</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>The Northern Road (north) crosses Thompsons Creek at new location.</td>
<td>Potential need for Greendale Road crossing of Thompsons Creek to require an upgraded</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>The Northern Road (north) crosses Thompsons Creek and a new waterway crossing would be required</td>
<td>Bringelly Road crosses Thompsons Creek at new location.</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>The Northern Road (north) crosses Thompsons Creek and a new waterway crossing would be required</td>
<td>Bringelly Road crosses Thompsons Creek at new location.</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>The Northern Road (north) crosses Thompsons Creek at new location.</td>
<td>Bringelly Road crosses Thompsons Creek at new location.</td>
<td>3</td>
</tr>
</tbody>
</table>
The Northern Road (north) crosses Thomsons Creek and a new waterway crossing would be required. The existing bridge is expected to remain.

Bringelly Road crosses Thomsons Creek at new location.

Options 1, 2, 5 and 7 require two new crossings of Thomsons Creek. Options 3 and 4 require one new crossing. Although the crossing for Option 0 and 6 would be required to be upgraded, this crossing for Thomsons Creek is the same as assessed in The Northern Road Upgrade REF.

5.4.2.8 Noise

As discussed in Section 4.3.7, based on the predicted traffic growth for The Northern Road and Bringelly Road intersection, it is expected the noise levels in this region would change as a result of this growth.

The assessment undertaken for the original proposal, identified that a change in noise levels for the proposed road upgrade for the years 2016 and 2026 would be generally within the 2 dB(A) increase identified in the Road Noise Policy (DECC 2011).

Noting that this assessment did not take into consideration the traffic growth as a result of the western Sydney airport and associated Western Sydney Infrastructure Plan and Broader Western Sydney Employment Area, this would need to be considered in the REF for the Proposal (following the identification of a preferred option; refer to Section 8).

In relation to the ongoing operational noise impact from the different operations (based on design), the potential for noise impact during the operation of all of the options is broadly similar for all options other than Option 0 (as all other options are grade separated). Consideration of noise mitigation options would be necessary for the development of the assessment of the preferred option to minimise the noise impacts associated with a grade separated design.

In relation to the construction noise associated with the options, Option 5, 6 and 7 locate the new intersection away from the existing alignments which allows offline construction and may assist in reducing the length of the period construction. Options 0, 2 and 3 may have a relatively greater noise impact during construction on the Bringelly township, due the proximity of the intersection to the shops and school.

Based on this information, a score has been allocated to each option (refer to Table 6-11). A score of 5 means the option is likely to have the lowest noise impact during construction and operation, and a score of 0 means the option has the potential to have a significant noise impact in comparison to the other options.
## Table 6-11 Summary of potential impact to the noise environment

<table>
<thead>
<tr>
<th>Option</th>
<th>Score out of 5 for Construction</th>
<th>Score out of 5 for Operation</th>
<th>Overall (divided by 2)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2.5</td>
<td>Growth predictions for traffic would result in operational noise impacts. Construction impacts would be for a longer period time, due to road closures, traffic diversions and proximity to the Bringelly Village.</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>Growth predictions for traffic and grade separation would result in operational noise impacts. Construction impacts would be minimised due to separation from existing intersection.</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>Growth predictions for traffic and grade separation would result in operational noise impacts. Construction impacts would be for a longer period time, due to road closures, traffic diversions and proximity to the Bringelly Village.</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>Growth predictions for traffic and grade separation would result in operational noise impacts. Construction impacts would be for a longer period time, due to road closures, traffic diversions and proximity to the Bringelly Village.</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>Growth predictions for traffic and grade separation would result in operational noise impacts. Construction impacts would be minimised due to separation from existing intersection.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>Growth predictions for traffic and grade separation would result in operational noise impacts. The new intersection would be located away from the existing alignment which allows offline construction and may assist in reducing the length of the period construction (and therefore noise impacts).</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>3</td>
<td>3.5</td>
<td>Growth predictions for traffic and grade separation would result in operational noise impacts. However, separation from Bringelly Village will help to minimise impacts. The new intersection would be located away from the existing alignment which allows offline construction and may assist in reducing the length of the period construction (and therefore noise impacts).</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>3</td>
<td>3.5</td>
<td>Growth predictions for traffic and grade separation would result in operational noise impacts. However, separation from Bringelly Village will help to minimise impacts. The new intersection would be located away from the existing alignment which allows offline construction and may assist in reducing the length of the period construction (and therefore noise impacts).</td>
</tr>
</tbody>
</table>

5.4.2.9 Visual

The existing intersection is located on a hill crest. The options with The Northern Road elevated over Bringelly Road by bridge located closer to the current intersection would have greater visual impact as the bridge would be about eight metres elevation. This includes those sub options within Options 2, 3 and 7.

Those options that are located to the east and west of the current intersection (i.e. away from the hill crest on the current alignment) would have a lower visual impact (less visible from the skyline) on the Study Area.
The original proposal option (option 0) would have the lowest visual impact on the Study Area.

Based on this information, a score has been allocated to each option (refer to Table 6-12). A score of 5 means the option is likely to have the lowest visual impact, and a score of 0 means the option has the potential to have a higher visual impact on the Study Area.

**Table 6-12 Summary of potential impact to visual amenity of the study area**

<table>
<thead>
<tr>
<th>Option</th>
<th>Score out of 5 (5 is a low potential for impact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

### 5.4.3 Constructability

Those Options that have the majority of the alignment outside the existing road corridor (Options 1, 2, 5, 6, and 7) will limit the impact on construction staging and constructability, especially in terms of impact on existing traffic flows. Traffic management of all options at the interface with existing roads will be of concern however this does not impact any option more than any other. These have been allocated a score of 3 out of 5 for the purposes of the multi-criteria analysis (Section 6.4).

Off-line structures on these options (Options 1, 2, 5, 6, and 7) will be easier to construct as more efficient construction methods not limited by the proximity of traffic may be used. These have been allocated a score of 4 out of 5 for the purposes of the multi-criteria analysis (Section 6.4).

#### 5.4.3.1 Geotechnical

**Table 6-13** present the geotechnical considerations for each option based on information available from The Northern Road and Bringelly Road REFs and the geotechnical works undertaken as part of the detailed design works for The Northern Road Upgrade and the Bringelly Road Stage 2 Upgrade. As noted below the geotechnical issues are similar for each option. As such, no score has been allocated for inclusion in the multi-criteria analysis (Section 6.4).
### Table 6-13 Summary of potential impacts due to geotechnical issues

<table>
<thead>
<tr>
<th>Option</th>
<th>Very poor subgrade conditions</th>
<th>Reactive soils</th>
<th>Erodible soils</th>
<th>Saline Soils</th>
<th>Founding Conditions</th>
<th>Batter support</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Possible deeper alluvium at Thompsons Creek crossing</td>
<td>n/a</td>
</tr>
<tr>
<td>2</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Shallow bedrock at grade separation</td>
<td>Required where carriageway in trench</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Shallow bedrock at grade separation</td>
<td>Required where carriageway in trench</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Shallow bedrock at grade separation</td>
<td>Required where carriageway in trench</td>
</tr>
<tr>
<td>5</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Shallow bedrock at grade separation</td>
<td>Required where carriageway in trench</td>
</tr>
<tr>
<td>6</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Shallow bedrock at grade separation</td>
<td>Required where carriageway in trench</td>
</tr>
<tr>
<td>7</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Shallow bedrock at grade separation</td>
<td>Required where carriageway in trench</td>
</tr>
</tbody>
</table>

### 5.4.4 Economic analysis

A preliminary economic analysis has been undertaken for the identified options (Table 6-14). Total costs were calculated using the estimated costs for roads, bridges and retaining walls. Road cost was calculated based on road costs of similar recent projects in the area. Bridge costs for the grade-separated options were based on the square metre costs for bridge deck, taken from similar recent projects in the area. Retaining wall costs were based on a face area rate from *Rawlinsons Construction Cost Guide*. Contingency costs are ten per cent of the total cost for each option. Costs associated with property acquisitions
was not included as part of the initial economic analysis. Property impacts have been assessed as part of Section 6.3.2.

Table 6-14 Option Capital Costings (Au$)

<table>
<thead>
<tr>
<th>Option</th>
<th>Total Cost</th>
<th>Contingency Cost</th>
<th>Total + Contingency Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 0</td>
<td>$5,650,034.00</td>
<td>$565,003.40</td>
<td>$6,215,037.40</td>
</tr>
<tr>
<td>Option 1</td>
<td>$74,171,050.00</td>
<td>$7,417,105.00</td>
<td>$81,588,155.00</td>
</tr>
<tr>
<td>Option 2</td>
<td>$57,594,544.48</td>
<td>$5,759,454.45</td>
<td>$63,353,998.92</td>
</tr>
<tr>
<td>Option 3</td>
<td>$74,284,522.97</td>
<td>$7,428,452.30</td>
<td>$81,712,975.27</td>
</tr>
<tr>
<td>Option 4</td>
<td>$78,715,122.20</td>
<td>$7,871,512.22</td>
<td>$86,586,634.42</td>
</tr>
<tr>
<td>Option 5</td>
<td>$77,053,781.00</td>
<td>$7,705,378.10</td>
<td>$84,759,159.10</td>
</tr>
<tr>
<td>Option 6</td>
<td>$58,706,875.00</td>
<td>$5,870,687.50</td>
<td>$64,577,562.50</td>
</tr>
<tr>
<td>Option 7</td>
<td>$80,437,775.00</td>
<td>$8,043,777.50</td>
<td>$88,481,552.50</td>
</tr>
</tbody>
</table>

Maintenance costs were calculated as a base rate of $50,000 per lane per kilometre per year (Table 6-15). It is expected that maintenance costs associated with the grade separated interchange would be similar in nature and that only the variation in length would be a differentiator. In light of this Option 7, at 1.6 km long, results in the most expensive option to maintain.

Table 6-15 Maintenance costs (Au$)

<table>
<thead>
<tr>
<th>Option</th>
<th>Unit Cost</th>
<th>Cost / Lane / km / year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 0</td>
<td>1.30</td>
<td>$50,000</td>
<td>$65,000</td>
</tr>
<tr>
<td>Option 1</td>
<td>13.50</td>
<td>$50,000</td>
<td>$675,000</td>
</tr>
<tr>
<td>Option 2</td>
<td>10.70</td>
<td>$50,000</td>
<td>$535,000</td>
</tr>
<tr>
<td>Option 3</td>
<td>13.20</td>
<td>$50,000</td>
<td>$660,000</td>
</tr>
<tr>
<td>Option 4</td>
<td>14.04</td>
<td>$50,000</td>
<td>$702,000</td>
</tr>
<tr>
<td>Option 5</td>
<td>15.20</td>
<td>$50,000</td>
<td>$760,000</td>
</tr>
<tr>
<td>Option 6</td>
<td>11.00</td>
<td>$50,000</td>
<td>$550,000</td>
</tr>
<tr>
<td>Option 7</td>
<td>16.00</td>
<td>$50,000</td>
<td>$780,000</td>
</tr>
</tbody>
</table>

Note: Assumed costs only

The analysis has utilised Net Present Value (NPV) techniques to compare the relative costs of each option (Table 6-16). The analysis has been undertaken for ranking purposes only and the values used do not necessarily represent an accurate cost for project funding. The analysis adopts an initial capital cost and amortises an assumed maintenance cost for a 20 year and 40 year period for various interest rates (4%, 7% and 10%), sourced from NSW Treasury. Each option is then scored 1 out of 5 based on NPV for the multi-criteria options analysis (with being the best i.e. least expensive).
Table 6-16 Net present value costs (Au$)

<table>
<thead>
<tr>
<th>Year</th>
<th>4%</th>
<th>7%</th>
<th>10%</th>
<th>Scored 1 out of 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 0</td>
<td>$6,533,405.21</td>
<td>$6,338,644.93</td>
<td>$6,203,415.64</td>
<td>5</td>
</tr>
<tr>
<td>Option 1</td>
<td>$83,344,520.28</td>
<td>$81,322,009.62</td>
<td>$79,917,705.51</td>
<td>3</td>
</tr>
<tr>
<td>Option 2</td>
<td>$64,865,369.07</td>
<td>$63,262,432.10</td>
<td>$62,149,301.07</td>
<td>4</td>
</tr>
<tr>
<td>Option 3</td>
<td>$83,254,138.36</td>
<td>$81,276,572.37</td>
<td>$79,903,475.02</td>
<td>3</td>
</tr>
<tr>
<td>Option 4</td>
<td>$88,255,531.29</td>
<td>$86,152,120.20</td>
<td>$84,691,643.93</td>
<td>2</td>
</tr>
<tr>
<td>Option 5</td>
<td>$87,382,429.02</td>
<td>$85,105,231.83</td>
<td>$83,254,089.43</td>
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<tr>
<td>Option 6</td>
<td>$66,181,554.49</td>
<td>$64,533,582.84</td>
<td>$63,389,355.05</td>
<td>4</td>
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<td>Option 7</td>
<td>$91,310,038.06</td>
<td>$88,912,986.40</td>
<td>$87,248,625.98</td>
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</table>

5.5 Multi-criteria options analysis summary

A summary of the performance of each of the seven options against the Proposal objectives presented in Section 3.2 and the Proposal options considerations identified in Section 4 of this report is presented in Table 6-17.

The overarching purpose of the Proposal is to improve the accessibility of The Northern Road and Bringelly Road to accommodate for the future traffic growth generated from the South West Growth Centre and future proofing to improve forecast traffic congestion within the Study Area. All options meet this overall criteria.

All options of the options meet the Proposal outcomes, with the exception of Option 0 (refer to Section 6.3.1. As such these have all been allocated the same score.

All options considerations were allocated a score in Section 6.3. These are summarised in Table 6-17.

Due to the data gaps associated with Aboriginal heritage information, these scores have been divided by 2.

Based on available information, the multi-criteria analysis identified Option 6 as the best performing option overall with a score of 33.5. Options 5 also performed well with a score of 30.5.
### Table 6-17 Summary table showing multi-criteria analysis of options against proposal option considerations

<table>
<thead>
<tr>
<th>Options</th>
<th>Meets Objectives(^{52})</th>
<th>Land use, Zoning and Property</th>
<th>Non-Aboriginal Heritage</th>
<th>Aboriginal Heritage</th>
<th>Ecology</th>
<th>Water</th>
<th>Noise</th>
<th>Visual</th>
<th>Economic Analysis</th>
<th>Total Score</th>
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<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0.5</td>
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<td>4</td>
<td>2.5</td>
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<td>5</td>
<td>23</td>
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<tr>
<td>1</td>
<td>5</td>
<td>0</td>
<td>4</td>
<td>1.5</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>27.5</td>
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<tr>
<td>2</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>20</td>
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<td>5</td>
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<td>2</td>
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<td>2</td>
<td>3</td>
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</tr>
<tr>
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</tr>
<tr>
<td>6</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>3.5</td>
<td>4</td>
<td>4</td>
<td>33.5</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>0.5</td>
<td>2</td>
<td>3</td>
<td>3.5</td>
<td>1</td>
<td>1</td>
<td>23</td>
</tr>
</tbody>
</table>

\(^{52}\) Refer to Section 3.2
5.5.1 Risks

Risks to each of the options include the following:

1. Change in forecast traffic demand as the western Sydney airport site and surrounding land is developed
2. Change in land use as land re-zoning takes place
3. Property Acquisition delaying construction
4. Other stakeholders such as utility authorities may have proposed facilities currently unknown that may affect route options e.g. NBN
5. South West Rail Link extension may impact route and exclude some options
6. Unknown stakeholders may create adverse impact on some route options by generating disruptions to alignments
7. Local Council requirements (e.g. flood level increases on property) may preclude some route options
8. Increase impact on non-certified vegetation.

6 Recommendations

It is recommended that Option 6 be further developed as the preferred option for the grade separated interchange of The Northern Road and Bringelly Road. The option allows for the development of the intersection and allows for future proofing for further upgrades and development of Bringelly Road to the west, but with a reduced impact on present property dynamics and previously identified constraints.

7 What Happens Next

7.1 Environmental Impact Assessment

A detailed Environmental Impact Assessment under Part 5 of the Environmental Planning and Assessment Act 1979 will be conducted.

Environmental assessment will also involve further refinement of the preferred option based on detailed input from technical investigations and community consultation.

7.2 Design Development

This options report has provided a strong understanding of the Proposal issues and has presented justification for movement towards a concept design for the preferred alignment option.

The concept design will assess the requirements associated with the vertical alignment to minimise the potential for visual and noise impacts and will establish a more robust horizontal alignment.

Once the concept design has been completed and planning approval secured the design will progress to a detailed design.
7.3 Preferred Option: Implementation

Stage 2 of the Bringelly Road Upgrade and The Northern Road Upgrade are presently in the detailed design phase and are expected to be released for construction in mid-2016. There is a need to fast track the options assessment, REF, concept and detailed design so that the preferred option can be incorporated into one of construction works packages for The Northern Road or Bringelly Road Upgrade projects.

These works will address the increased traffic resulting from the residential and commercial development in the region, including the western Sydney airport. As the Western Sydney Infrastructure Plan has given priority to The Northern Road and Bringelly Road Upgrade projects, the implementation of the preferred option will be given high priority.

Following the selection of a preferred option, a Review of Environmental Factors (REF) will be required prior to design finalisation. The study area for the REF will include the preferred option concept design footprint with a contingency buffer to allow for uncertainty prior to the design being finalised.

Following the concept design and REF, the assessed and approved preferred alignment option would then progress to implementation. This would involve:

- Detailed design: Detailed specifications and working drawings of the preferred option would be prepared to support detailed costing and construction
- Property acquisition: Before any construction activities, property that would be affected by the Proposal and which is not owned by Roads and Maritime would need to be acquired. Acquisition would be carried out in accordance with: − The Roads and Maritime Land Acquisition Guide − The Roads Act 1993 − The Land Acquisition (Just Terms Compensation) Act 1991
- Construction: Roads and Maritime program for construction will be detailed within the REF.

8 References

State Significant Development Assessment Bringelly Brickworks Extension Project (SSD 5684), Department of Planning and Environment

Bringelly Road Upgrade, Camden Valley Way to The Northern Road, Review of Environmental Factors, ngh Environmental, 2011

NSW Long Term Transport Master Plan, Transport for NSW, December 2012

The Northern Road Upgrade – The Old Northern Road to Mersey Road, Review of Environmental Factors, Sinclair Knight Mertz, 2012

## 9 Terms and Acronyms

<table>
<thead>
<tr>
<th>Term / Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>The potential ability of an individual or group to reach a destination. It is distinguished from mobility which is the propensity of that individual or group to make a journey</td>
</tr>
<tr>
<td>ADDT</td>
<td>Annual Average Daily Traffic</td>
</tr>
<tr>
<td>AHIMS</td>
<td>Aboriginal Heritage Information Management System</td>
</tr>
<tr>
<td>Alignment</td>
<td>The general route in plan and elevation</td>
</tr>
<tr>
<td>Amenity</td>
<td>The degree of pleasantness of an area or place</td>
</tr>
<tr>
<td>Base Case</td>
<td>The base case in terms of options comparison is a ‘do nothing’ scenario’, in which Roads and Maritime would retain the existing alignments and configurations of the road network under investigation</td>
</tr>
<tr>
<td>BCR</td>
<td>Benefit to Cost Ratio - The ratio of discounted future benefits divided by the future value of discounted costs. A figure of less than 1.0 suggests that the project is uneconomic</td>
</tr>
<tr>
<td>Carriageway</td>
<td>The portion of a roadway devoted to vehicular traffic generally delineated by kerbs, a verge or a median</td>
</tr>
<tr>
<td>Concept Design</td>
<td>Initial functional layout of a concept, such as a road or road system, to provide a level of understanding to later establish detailed design parameters</td>
</tr>
<tr>
<td>DECC</td>
<td>Department of Environment and Climate Change (now Environment Protection Authority and Office of Environment and Heritage)</td>
</tr>
<tr>
<td>Detailed Design</td>
<td>Final detailed layout which completely describes the road or road system through solid modelling and drawings, and which forms the basis for construction</td>
</tr>
<tr>
<td>DoS</td>
<td>Degree of Saturation</td>
</tr>
<tr>
<td>DP&amp;I</td>
<td>Department of Planning and Infrastructure (now Department of Planning and Environment)</td>
</tr>
<tr>
<td>EPBC Act</td>
<td>Commonwealth Environment Protection and Biodiversity Conservation Act 1999</td>
</tr>
<tr>
<td>GIS</td>
<td>Geospatial Information System</td>
</tr>
<tr>
<td>Term / Acronym</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
</tr>
<tr>
<td>LoS</td>
<td>Loss of Service Level - A qualitative descriptor of the road environment describing the ability of vehicles to manoeuvre.</td>
</tr>
<tr>
<td></td>
<td>LOS A: Generally free flow conditions with vehicles unimpeded in manoeuvring in the traffic stream</td>
</tr>
<tr>
<td></td>
<td>LOS B: Stable flow with manoeuvring traffic stream only slightly restricted with the possibility of slight delays</td>
</tr>
<tr>
<td></td>
<td>LOS C: Stable flow with manoeuvring becoming more restricted however any delays are acceptable</td>
</tr>
<tr>
<td></td>
<td>LOS D: Approaching unstable flow with delays common but tolerable</td>
</tr>
<tr>
<td></td>
<td>LOS E: Unstable flow with traffic stream congested and with intolerable delays</td>
</tr>
<tr>
<td></td>
<td>LOS F: Forced flow with movement of traffic stream at very slow speed</td>
</tr>
<tr>
<td>LGA</td>
<td>Local Government Area</td>
</tr>
<tr>
<td>MVKM</td>
<td>Million Vehicle Kilometres</td>
</tr>
<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>RC Wall</td>
<td>Reinforced Concrete Wall</td>
</tr>
<tr>
<td>REF</td>
<td>Review of Environmental Factors</td>
</tr>
<tr>
<td>RE Wall</td>
<td>Reinforced Earth Wall</td>
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<tr>
<td>Roads and Maritime</td>
<td>Roads and Maritime Services</td>
</tr>
<tr>
<td>RTA</td>
<td>Roads and Traffic Authority (now Roads and Maritime)</td>
</tr>
<tr>
<td>SKM</td>
<td>Sinclair Knight Mertz</td>
</tr>
<tr>
<td>SSD</td>
<td>State Significant Development</td>
</tr>
<tr>
<td>TSC Act</td>
<td>NSW Threatened Species Conservation Act 1995</td>
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</table>
Appendix A – Crash Data
# Detailed Crash Report

NOTES: 6395 - Within 1km of The Northern Rd and Greendale Rd - July09 to June14

<table>
<thead>
<tr>
<th>Crash No.</th>
<th>Date</th>
<th>Day of Week</th>
<th>Time</th>
<th>Distance</th>
<th>ID Feature</th>
<th>Loc Type</th>
<th>Alignment</th>
<th>Weather</th>
<th>Surface Condition</th>
<th>Speed Limit</th>
<th>No. of Txs</th>
<th>Tu Type/Object</th>
<th>Age/Sex</th>
<th>Street Travelling</th>
<th>Speed Travelling</th>
<th>Manoeuvre</th>
<th>Degree of Crash</th>
<th>Killed</th>
<th>Injured</th>
<th>Factors</th>
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<tbody>
<tr>
<td>728395</td>
<td>17/10/2010</td>
<td>Sun</td>
<td>10:30</td>
<td>40 m</td>
<td>E THE NORTHERN RD</td>
<td>2WY</td>
<td>STR</td>
<td>Fine</td>
<td>Dry</td>
<td>70</td>
<td>3</td>
<td>CAR M75 W in BRINGELLY RD</td>
<td>40 Proceeding in lane</td>
<td>0</td>
<td>Stationary</td>
<td>I 0 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E43308708</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RUM: 30</td>
<td>Rear end</td>
<td></td>
<td></td>
<td></td>
<td>CAR M U W in BRINGELLY RD</td>
<td>0 Stationary</td>
<td>0</td>
<td>Stationary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>671887</td>
<td>16/06/2009</td>
<td>Tue</td>
<td>02:30</td>
<td>100 m</td>
<td>W MEDWAY RD</td>
<td>2WY</td>
<td>STR</td>
<td>Fine</td>
<td>Dry</td>
<td>60</td>
<td>1</td>
<td>CAR M18 W in GREENDALE RD</td>
<td>90 Proceeding in lane</td>
<td>0</td>
<td>Stationary</td>
<td>I 0 2 S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E12453898</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RUM: 71</td>
<td>Off rd left -&gt; obj</td>
<td>Utility pole</td>
<td>1</td>
<td>CAR M26 W in BRINGELLY RD</td>
<td>0 Stationary</td>
<td>0</td>
<td>Stationary</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>783065</td>
<td>26/01/2012</td>
<td>Thu</td>
<td>00:27</td>
<td>100 m</td>
<td>W MEDWAY RD</td>
<td>2WY</td>
<td>STR</td>
<td>Raining</td>
<td>Wet</td>
<td>80</td>
<td>1</td>
<td>4WD M33 W in GREENDALE RD</td>
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<td>0</td>
<td>Stationary</td>
<td>N 0 0</td>
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<td></td>
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<tr>
<td>E74226377</td>
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<td></td>
<td>RUM: 71</td>
<td>Off rd left -&gt; obj</td>
<td>Tree/bush</td>
<td>1</td>
<td></td>
<td>0 Stationary</td>
<td>0</td>
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<td></td>
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<tr>
<td>742743</td>
<td>29/01/2011</td>
<td>Sat</td>
<td>17:10</td>
<td>500 m</td>
<td>W THE NORTHERN RD</td>
<td>2WY</td>
<td>CRV</td>
<td>Fine</td>
<td>Dry</td>
<td>80</td>
<td>1</td>
<td>CAR F37 W in GREENDALE RD</td>
<td>80 Proceeding in lane</td>
<td>0</td>
<td>Stationary</td>
<td>I 0 3 S</td>
<td></td>
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<td>E43999742</td>
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<td></td>
<td></td>
<td>RUM: 87</td>
<td>Off lft/lft bnd-&gt;obj</td>
<td>Embankment</td>
<td>1</td>
<td></td>
<td>0 Stationary</td>
<td>0</td>
<td>Stationary</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>610203</td>
<td>25/02/2008</td>
<td>Mon</td>
<td>12:20</td>
<td>60 m</td>
<td>S BRINGELLY RD</td>
<td>2WY</td>
<td>STR</td>
<td>Fine</td>
<td>Dry</td>
<td>60</td>
<td>2</td>
<td>CAR M74 S in THE NORTHERN RD</td>
<td>5 Pulling out</td>
<td>0</td>
<td>Stationary</td>
<td>N 0 0</td>
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</tr>
<tr>
<td>E33129305</td>
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<td></td>
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<td></td>
<td></td>
<td>RUM: 42</td>
<td>Leaving parking</td>
<td>0</td>
<td>2</td>
<td>CAR M54 S in THE NORTHERN RD</td>
<td>30 Proceeding in lane</td>
<td>0</td>
<td>Stationary</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>777281</td>
<td>02/12/2011</td>
<td>Fri</td>
<td>14:05</td>
<td>65 m</td>
<td>S BRINGELLY RD</td>
<td>2WY</td>
<td>STR</td>
<td>Fine</td>
<td>Dry</td>
<td>60</td>
<td>2</td>
<td>TRK M18 S in THE NORTHERN RD</td>
<td>60 Proceeding in lane</td>
<td>0</td>
<td>Stationary</td>
<td>I 0 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E46547450</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RUM: 32</td>
<td>Right rear</td>
<td>0</td>
<td>2</td>
<td>TRK F47 S in THE NORTHERN RD</td>
<td>0 Wait turn right</td>
<td>0</td>
<td>Stationary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>627394</td>
<td>17/06/2008</td>
<td>Tue</td>
<td>09:15</td>
<td>75 m</td>
<td>S BRINGELLY RD</td>
<td>2WY</td>
<td>STR</td>
<td>Fine</td>
<td>Dry</td>
<td>80</td>
<td>2</td>
<td>TRK M52 S in THE NORTHERN RD</td>
<td>20 Proceeding in lane</td>
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<td>Stationary</td>
<td>I 0 1</td>
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<td>RUM: 32</td>
<td>Right rear</td>
<td>0</td>
<td>2</td>
<td>TRK F23 S in THE NORTHERN RD</td>
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<td>Stationary</td>
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</tr>
<tr>
<td>857670</td>
<td>14/11/2013</td>
<td>Thu</td>
<td>07:50</td>
<td>200 m</td>
<td>S BRINGELLY RD</td>
<td>2WY</td>
<td>STR</td>
<td>Fine</td>
<td>Dry</td>
<td>60</td>
<td>3</td>
<td>CAR F28 S in THE NORTHERN RD</td>
<td>50 Proceeding in lane</td>
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<td>Stationary</td>
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<td>E54906880</td>
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<td></td>
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<td>RUM: 30</td>
<td>Rear end</td>
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<td>3</td>
<td>CAR M31 S in THE NORTHERN RD</td>
<td>0 Stationary</td>
<td>0</td>
<td>Stationary</td>
<td></td>
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<td></td>
<td></td>
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<td>790486</td>
<td>13/02/2012</td>
<td>Mon</td>
<td>06:00</td>
<td>970 m</td>
<td>S BRINGELLY RD</td>
<td>2WY</td>
<td>CRV</td>
<td>Fine</td>
<td>Dry</td>
<td>80</td>
<td>1</td>
<td>TRK M50 S in THE NORTHERN RD</td>
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<td>Stationary</td>
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<td></td>
<td></td>
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<td>818570</td>
<td>22/11/2012</td>
<td>Thu</td>
<td>16:30</td>
<td>70 m</td>
<td>S GREENDALE RD</td>
<td>2WY</td>
<td>STR</td>
<td>Fine</td>
<td>Dry</td>
<td>60</td>
<td>2</td>
<td>TRK M35 S in THE NORTHERN RD</td>
<td>20 Forward from drive</td>
<td>0</td>
<td>Stationary</td>
<td>N 0 0</td>
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<tr>
<td>E49447735</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>RUM: 47</td>
<td>Emerging from drive</td>
<td>TRK M50 S in THE NORTHERN RD</td>
<td>20 Pull out opposite</td>
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Rep ID: DCR01 Office: Sydney User ID: molonejt

Page 1 of 3

Generated: 16/04/2015 15:33
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**Report Totals:**
- Total Crashes: 27
- Fatal Crashes: 0
- Injury Crashes: 13
- Killed: 0
- Injured: 19

Crashid dataset 6395 - Within 1km of The Northern Rd and Greendale Rd - July09 to June14

**Note:** Data for the 9 month period prior to the generated date of this report are incomplete and are subject to change.