Western Corridor Traffic and Transport Study

FOR CITY OF NEWCASTLE





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GLOSSARY OF TERMS AND ABBREVIATIONS

Term / Acronym	Definition
ABS	Australian Bureau of Statistics
CoN	City of Newcastle
DoS	Degree of Saturation
HTS	Household Travel Survey
LGA	Local Government Area
LoS	Level of Service
NSW	New South Wales
TPA	Transport Performance and Analytics
ΤZ	Travel Zone

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EXECUTIVE SUMMARY

Background

The Western Corridor of Newcastle includes the suburbs of Minmi, Fletcher and Maryland and is identified by City of Newcastle (CoN) as a major urban land release area. This area is growing rapidly, and CoN has identified the need to review and update its (year 2013) Section 94 contributions plan for this corridor. Bitzios Consulting was commissioned to assess the traffic infrastructure and the pedestrian and cyclist infrastructure needed in this area for the purposes of updating the Section 94 plan. In order to determine traffic infrastructure upgrade needs, a microsimulation traffic model has been created for the study area and used to assess issues and network requirements to cater for expected traffic levels in 2021, 2026 and 2036.

Existing Situation and Growth Challenges

The major development sites in the study area are shown in Figure ES1. Most of these developments rely on Minmi Road for access to Newcastle Link Road. With the Newcastle CBD being a major attractor to the east, there is a heavy orientation of traffic between these development areas and the intersections in the south-east of the study area.



Figure ES1: Development Areas and Road Network

An additional 3,310 dwellings are planned for this area and when added to the 2,634 dwellings which are approved or under construction, results in a total of 5,764 dwellings which need to be accommodated by the road network. This dwelling forecast aligns with the forecast population for an area slightly larger than the study area with an increase from 29,779 residents in 2016 to 42,835 residents in 2046. This growth in the study area will add nearly 50,000 vehicles per day (vpd) to the road network, most of which is orientated towards the south-east confluence of the network. Through traffic on the Newcastle Link Road corridor is forecast to increase by nearly 22,000 vpd between 2016 and 2036.

In 2017, most of the intersections in the study area operated **at a Level of Service (LoS) of 'D' or better in both** the AM and the PM peak hours. LoS E/F is typically identified as the condition where an upgrade would ordinarily be warranted. The exception to the LoS D performance is the Lake Road/Thomas Street/Newcastle Link Road intersection which operates at LoS F in the PM peak. With a heavy reliance on Minmi Road for distributing development traffic to/from the



south-east, there are significant challenges in providing sufficient road capacity in this corridor, particularly at its southern end which is already heavily trafficked.

Upgrades Needs Assessment Process

Traffic demands were calculated for each of the assessment years of 2021, 2026 and 2036 based on expected rates of development in each of the approved and planned development areas, as well as the growth in through traffic on the Newcastle Link Road corridor. **Any 'likely' road network upgrades such as the Roads and Maritime proposal to** replace the roundabout at Minmi Road / Newcastle Link Road with a major signalised intersection and the CoN upgrades proposed in the Wallsend Local Centre were then added to 2017 network **to create the 2021 'Do Minimum'** network.

The assessment then involved progressively adding traffic upgrades to the network in 2021, targeting LoS D or better **at every intersection in both the AM and PM peak hours. The 2021 'Option Model'** network was then used as the 2026 Do Minimum network and run with 2026 traffic demands. The process was repeated for 2036 and culminated in a schedule of upgrade works required for 2021, 2026 and 2036 for intersection upgrades and road link upgrades. Footpath and cycleway upgrades were also identified based on 'missing links' and logical extensions of facilities into development areas.

Traffic Infrastructure Upgrade Needs: 2021

The following upgrade needs have been identified for year 2021:

- Cowper Street / Lake Road Intersection:
 - addition of one extra circulating lane between the Southern and Western approaches; and
 - one additional exit lane on the Southern approach.
- Cowper Street / Newcastle Road Intersection:
 - change from priority control to a 4-way, one lane roundabout.
- Sandgate Road / Wilkinson Avenue / Tillie Street Intersection:
 - realign the Wilkinson Avenue approach to join Sandgate Road / Tillie Street intersection and signalise the intersection with pedestrian crossings across the Sandgate Road (E), Wilkinson Avenue and Tillie Street approaches of the intersection;
 - an additional lane on the Tillie Street approach (80m long);
 - an additional lane on the Sandgate Road departure; and
 - extend the short lane by banning peak hour kerb side parking on the approach and departure of Sandgate Road
 (W) as far as Dennis Place.
- Cowper Street / Cameron Street Intersection:
 - ban the east to north right turn movement at the Cowper Street / Cameron Street intersection and introduce traffic signals at the Minmi Road/Sandgate Road intersection to provide the east to north right turn;
 - reconfigure the intersection to incorporate an additional left turn slip lane from Minmi Road (N) to Sandgate Road (E) at the Sandgate Road/Minmi Road intersection;
 - an additional lane on the departure side of Longworth Avenue; and
 - reconfigure the intersection to allow two through lanes for eastbound traffic.
- Minmi Road / Awabakal Road Intersection:
 - introduce an additional traffic lane for the westbound traffic.
- Minmi Road / Highland Way Intersection:
 - reconfigure the current priority (T) intersection to a 4-way single lane roundabout.
- Minmi Road / Woodford Street Intersection:
 - an additional right turn lane on Woodford Street (S) and an additional departure lane on Minmi Road (E).
- Mid-block Road Capacity Improvements:
 - widen Minmi Road eastbound to two lanes between Awabakal Drive and Maryland Drive, Maryland Drive and Bottlebrush Boulevard, Bottlebrush Boulevard and Warkworth Street and Warkworth Street and Summerhill Road; and
 - widen Minmi Road southbound to two-lanes between Cowper Street/Cameron Street and Longworth Avenue/Newcastle Road.

Traffic Infrastructure Upgrade Needs: 2026

The following upgrade needs have been identified for year 2026 (in addition to those in 2021):

- Cowper Street / Kokera Street Intersection:
 - an additional lane (80m long) for the east to north movement;
 - an additional eastbound lane on the Cowper Street departure as far as Brooks Street; and
 - re-configure the eastbound kerb side lane to be a shared left and through lane.
- Cowper Street / Nelson Street Intersection:
 - an additional departure lane in Cowper Street (E) as far as Murnin Street; and
 - extend the westbound short lane between Nelson Street and Newcastle Road.
- Cowper Street / Newcastle Road Intersection:
 - an additional short northbound lane (25m long) on the northbound approach of Newcastle Road and consequently an additional short lane (60m) on the exit side of Cowper Street (E).
- Sandgate Road / Wilkinson Avenue / Tillie Street Intersection:
 - extend the two-lane section on the Tillie Street approach by 70m.
- Cowper Street / Cameron Street Intersection:
 - an additional southbound lane at the Minmi Road/Sandgate Road/Cowper Street/Cameron Street intersection; and
 - an additional northbound short lane (65m) at the Longworth Avenue approach.
- Minmi Road / Bunnings Intersection:
 - an additional departure lane northbound; and
 - re-configure the northbound approach so that the kerb side lane is shared between through and left turning traffic.
- Minmi Road / Maryland Drive Intersection:
 - re-configure the southbound left turn from priority control (give-way) to a slip lane configuration and introduce an additional traffic lane on the eastbound departure.
- Minmi Road / McNaughton Avenue Intersection:
 - additional lane eastbound and westbound; and
 - exclusive (60m) left turn lane on McNaughton Avenue.
- Minmi Road / Woodford Street Intersection:
 - an additional northbound lane between Bell Street and Minmi Road;
 - two left turn lanes on the westbound approach: one 50m lane and one full lane; and
 - an additional southbound lane on Woodford Street south of the intersection.
- Mid-block Road Capacity Improvements:
 - widen Minmi Road to two-lanes eastbound between Anna Place and Maryland Drive;
 - widen Minmi Road to three-lanes eastbound between Maryland Drive and Fletcher Street;
 - widen Minmi Road to two-lanes westbound between Bunnings and Macquarie Street and between Maryland Drive and Anna Place;
 - widen Minmi Road to two-lanes eastbound between McInnes Street and McCarthy Street and between McCarthy Street and McInnes Street;
 - widen Cowper street to two-lanes eastbound between Kokera Street and Nelson Street, between Newcastle Road and Union Street and between John Street and Minmi Road;
 - widen Cowper Street to two-lanes westbound between Union Street and Newcastle Road;
 - ban peak hour kerb side parking along Woodford Street between Minmi Road and Railway Street southbound and between Bell Street and Minmi Road northbound; and
 - ban peak hour kerb side parking along Cowper Street between Lake Road and Kokera Street and between Nelson Street and Newcastle Road eastbound and between Newcastle Road and Nelson Street westbound and between Kokera Street and Lake Road westbound.

Traffic Infrastructure Upgrade Needs: 2036

The following upgrade needs have been identified for year 2036 (in addition to those in 2021 and 2026):

- Cowper Street / Newcastle Road Intersection:
 - extend the additional short northbound traffic lane as far as Dangar Street; and
 - extend the additional short departure lane in Cowper Street (E) to a full traffic lane.
- Cowper Street / Cameron Street Intersection:
 - free-flow left turn lane from north to east traffic at the Minmi Road / Sandgate Road intersection.
- Sandgate Road / Wilkinson Avenue / Tillie Street Intersection:
 - re-configure the short lane heading east to west on Sandgate Road to a full lane between Sandgate Road/Wilkinson Avenue/Tillie Street and Minmi Road/Sandgate Road.
- Minmi Road / Bunnings Intersection:
 - introduce traffic signals with pedestrian crossings on all three approaches;
 - three through lanes and one dedicated right turn lane (35m long) on the southbound approach; and
 - three through lanes on the northbound approach.
- Minmi Road / Macquarie Street / Creek Road Intersection:
 - additional lane eastbound and westbound on Minmi Road; and
 - ban peak hour kerb side parking at the Macquarie Street approach to provide two full lanes.
- Minmi Road / Warkworth Street Intersection:
 - additional lane on Minmi Road eastbound;
 - re-configure the westbound approach, so the median lane is shared between through and right turn movements;
 - an additional through lane on the Minmi Road westbound departure; and
 - an additional 50m left turn lane on Warkworth Street.
- Minmi Road / Kurraka Drive Intersection:
 - an additional lane on Minmi Road eastbound; and
 - an additional 60m left turn short lane on Kurraka Drive.
- Minmi Road / Britannia Boulevard Intersection:
 - an additional lane on Minmi Road eastbound.
- Minmi Road / Highland Way Intersection:

It is important to note that the following upgrade will only be required if the full level of development in the model area is realised. It may be preferable that this project not be further considered now, and the (roundabout) intersection is monitored into the future to determine if this configuration needs to be changed at that time. This change, if required, would be likely to require the following:

- re-configure the roundabout to a priority type (give-way) intersection. This is required to reduce delays for the eastbound and westbound Minmi Road movements by prioritising them over the minor legs of the intersection;
- an additional left turn lane on the Highland Way northbound approach; and
- an additional traffic lane on Minmi Road eastbound.
- Minmi Road / Blue Gum Hills Road Intersection:
 - an additional traffic lane on Minmi Road eastbound;
 - an additional free flow short left turn lane on Blue Gum Hills Road (south); and
 - an additional westbound traffic lane on Minmi Road west of the intersection.
- Minmi Road / Woodford Street Intersection:
 - ban peak hour kerb side parking on Woodford Street southbound approach to provide two traffic lanes.
- Mid-block Road Capacity Improvements:
 - widen Minmi Road to two-lanes eastbound between McCarthy Street and Awabakal Drive;
 - widen Minmi Road to three-lanes eastbound between Fletcher Street and Sandgate Road;
 - widen Minmi Road to three-lanes westbound between Sandgate Road and Maryland Drive;
 - widen Minmi Road to two-lanes westbound between Summerhill Road and Bottlebrush Boulevard, between Bottlebrush Boulevard and Churnwood Drive, and between Blue Gum Hills Road and McInnes Street;
 - widen Cowper Street to two-lanes each way between Union Street and John Street;
 - ban peak hour kerb side parking on the Woodford Street Southbound to provide two lanes;
 - ban peak hour kerb side parking along Woodford Street northbound (Railway Street to Bell Street); and
 - ban peak hour kerb side parking on Sandgate Road (Minmi Road to Tillie Street).

Link Road Testing

In an attempt to reduce the scale of upgrade works required along Minmi Road between 2021 and 2036, a new 'Link Road' was tested to provide an alternative connection between Minmi Road (near Summerhill Road) and Bulkara Street, located to the west of Minmi Road. This road was tested using the 2036 Option model with all of the proposed 2036 upgrades in.

The new link was forecast to attract approximately 780vph in the AM peak and 940vph in the PM peak which would equate to approximately 10,000 vpd. Whilst not an insignificant volume of traffic taken off Minmi Road, the improvements to intersections along Minmi Road were shown to be relatively small, with no significant savings in 2036 upgrades required on Minmi Road.

Also, the diverted traffic to this new link adversely affected the Warkworth Street / Minmi Road intersection in the AM peak and the Newcastle Road / Cowper Street intersection during the PM peak. The introduction of the proposed bypass will increase the AM peak right turn volumes from Minmi Road eastbound to Summerhill Road southbound. The modelling shows that the queues of right turn traffic will extend back to the Warkworth Street intersection thereby restricting traffic flows from that road. The Wakeworth Street / Minmi Road intersection would be warranted to be upgraded as it reports a LoS F with average delays in the order of 120 seconds in the AM peak with the proposed Link Road in place. In the PM peak, a significant number of trips travelling from Newcastle City Centre to Minmi would use the bypass route. These vehicles would use the Newcastle Road / Cowper Street intersection to access the bypass.

Footpath and Cycleway Upgrade Needs

Additional footpath and cycleway links have also been identified based on the assessment of missing links and new links needed to service new development areas. In total, 15 footpath projects and four (4) cycleway projects have been identified, as follows:

- Footpath projects:
 - 1: Mowane Street to Awabakal Drive
 - 2: St Andrews Way to Styles Close
 - 3: Waterside Drive to Hebrides Road
 - 4: Waterside Drive to Tartan Place
 - 5: Waterside Drive to Plattsburg Parade
 - 6: Wedgetail Street to Crestview Street
 - 7: Wedgetail Street to Crestview Street
 - 8: Pebblestone Street to Kingfisher Drive
 - 9: Pebblestone Street to Kingfisher Drive
 - 10: Tallowood Crest to Jetty Parade
 - 11: Cottonwood Chase to Weller Street
 - 12: Beech Close to Weller Street
 - 13: Along Minmi Road (between Churnwood Drive & Bellbird Close)
 - 14: Minmi Road to Glendore Parade
 - 15: Minmi Road to Yapug Close
- Cycleway projects:
 - 1: Blue Gum Hills Road to Brookfield Avenue (Northern side of Minmi Road)
 - 2: Brookfield Avenue to Blue Gum Hills Road (Southern side of Minmi Road)
 - 3: Britannia Boulevard to Brookfield Avenue
 - 4: Maryland Drive to Summerhill Road

Traffic Infrastructure Costs

Concept-level cost estimates have been prepared for each of the upgrade items identified as being needed to cater for expected traffic growth between 2017 and 2036. These costs are summarised as follows.

Period	Intersection Works	Road Widening Works	Total Cost
To 2021	\$17,247,077	\$19,233,183	\$36,480,260
2021-2026	\$10,411,277	\$18,259,274	\$28,670,551
2026-2036	\$38,655,766	\$113,877,237	\$152,533,002
Total (to 2036)	\$66,314,120	\$151,369,694	\$217,683,813

Whilst this is a significant infrastructure upgrade budget, a large proportion of the need for these upgrades is associated with 'background' traffic that was already using this infrastructure in 2017 or is part of growth in 'external' traffic. For example, the proportion of 'new development' traffic of total traffic within the study area by each year is:

- By 2021: 8% of total traffic in the study area;
- By 2026: 14% of total traffic in the study area; and
- By 2036: 26% of total traffic in the study area.

The network is already approaching capacity, and there are few committed upgrades to address issues generated by traffic that is already there. The additional development traffic will exponentially increase delays and congestion given prevailing congestion levels. This is why the quantum of upgrades needed for the network to operate at reasonable levels of service in 2036 is significant relative to the level of new development expected.

Footpath and Cycleway Infrastructure Costs

The proposed footpath and cycleway infrastructure costs are itemised as follows:

Year	Footpath Works	Cycleway Works ⁽¹⁾	Total Cost
To 2021	\$2,260,591	\$-	\$2,260,591
2021-2026	\$2,814,678	\$1,094,621	\$3,909,299
2026-2036	\$1,994,550	\$-	\$1,994,550
Total (to 2036)	\$7,069,819	\$1,094,621	\$8,164,440

(1) It is expected that additional cycleway works will be delivered as part of proposed road widening works under the Traffic Infrastructure Upgrades

Conclusions

Key conclusions from the assessment of traffic and transport infrastructure upgrades required in the Newcastle West Corridor study area are:

- site observations in 2017 revealed that there was inadequate parking, cycling and pedestrian infrastructure in parts of the study area and the Minmi Road / Cowper Street intersection is already congested;
- almost 50,000 trips per day will be added to the road network through approved and planned developments and most of this traffic relies on Minmi Road for access to the Newcastle Link Road and/or Cowper Street;
- development growth (if realised in the timeframes forecast) results in significant worsening of intersection
 performance and travel times across the study area by 2021 given that many intersections in the south-east of
 the network were approaching capacity in 2017, with minimal upgrades committed;
- the suite of proposed upgrades proposed for 2021, 2026 and 2036 reduces vehicle travel times to slightly in excess of the 2017 base case performance in 2021 however there is still some overall increase in travel times in 2026 and 2036 with the upgrades. This is partly due to the presence of more signalised intersections. Most intersections however are shown to operate at LoS D or better with the upgrades proposed;
- the potential 'Link Road' between Minmi Road (near Summerhill Road) and Bulkara Street whilst heavily used as a two-lane road, would result in a relatively small improvement at parallel intersections on Minmi Road. The traffic diverted to this new link impacts the Warkworth Street / Minmi Road intersection in the AM peak and the Newcastle Road / Cowper Street intersection during the PM peak. The Wakeworth Street / Minmi Road intersection would need to be upgraded with average delays of 120 seconds (LoS F) in the AM peak;
- The proposed suite of works (traffic, footpath and cycleways infrastructure combined) to maintain a reasonable level of service across the study area is estimated to cost (approximately):
 - \$38,740,851 by 2021;
 - An additional \$32,579,580 by 2026; and
 - An additional \$154,527,552 by 2036.

The network is approaching capacity now and further traffic will exponentially increase delays and congestion. The suite of upgrades proposed in 2021, 2026 and 2036 will provide levels of service similar to, but slightly worse than those experienced in 2017. A significant number of upgrades are required at an overall costs in excess of \$226M to cater for an expected increase of over 50,000 vpd with expected development and an increase of 22,000 vpd of through traffic. In addition, the modelling has revealed that the Newcastle Link Road corridor will be at capacity by 2036 which will affect the ability for traffic from the Minmi Road catchment to access this corridor and will generate queues back from this corridor into the study area.

1. INTRODUCTION

1.1 BACKGROUND

The Western Corridor is an urban release area centred on the suburbs on Minmi, Fletcher and Maryland in the western part of the Newcastle Local Government Area (LGA). The first Western Corridor Section 94 Contribution Plan was developed in December 1995. This plan since been subsequently amended twice; first in 2006 and then in 2013, in order to reflect changes in demography, development scale and types and increases in the construction cost of the upgrades in the schedule.

The City of Newcastle (CoN) has identified the need to update the 2013 Western Corridor Section 94 Contribution Plan.

At the time when the 2013 plan was published, a total of 67% of the area was either developed or covered by an approved development application. The Western Corridor area including the remaining 33% of 'greenfield **area'** was estimated to have the potential to contain 9,578 additional dwellings. The 2013 plan reported multiple intersections along Minmi Road incurring unacceptable Levels of Service (LoS) in at least one peak period, based on forecast 2016 traffic volumes at that time. The Plan proposed approximately \$3 million of upgrades along the Western Corridor. The majority of upgrades comprised of additional lanes along Minmi Road and minor modifications to intersection geometry. The planned suite of upgrades also included an off-road cycleway from Britannia Boulevard to Woodford Street.

1.2 Study Purpose

Bitzios Consulting has been commissioned by CoN to undertake a traffic and transport study of the Western Corridor to inform an updated 20-year works program and to provide the necessary information to recalculate contributions from planned developments. This traffic and transport study considers future road network requirements for general traffic, as well as required footpath and cycleways infrastructure, including indicative costs and staging.



The locality of the study area is shown in Figure 1.1.

Source: Google Maps Figure 1.1: Study Area and Locality



A traffic microsimulation model was created to inform the assessment of traffic infrastructure upgrade needs.

Other key tasks included:

- analysis of the existing traffic and crash data and assess the operational performance of 29 intersections in the study area;
- identification of future development and when it is expected to be constructed, calculate the trip
 generation of these developments and forecast the growth in external trips through the study area in
 order to establish study area traffic demands for 2021, 2026 and 2036;
- use of the models to understand the future year traffic performance of intersection and links in the study area and identify future operational performance issues;
- development, testing and optimisation of traffic infrastructure improvement measures to identify
 priorities for their staged implementation. As part of this work the performance of the proposed northsouth 'Link Road' west of Minmi Road was also assessed and its impact on key intersections was
 documented;
- preparation of concept-level cost estimates for the traffic infrastructure upgrades required to support future traffic levels; and
- determination of the primary bicycle and pedestrian upgrade requirements to service new development areas including cost estimates and staging.

2. EXISTING TRAFFIC AND TRANSPORT CONDITIONS

2.1 ROAD HIERARCHY

The road network within the study area contains a mix of local, regional and state roads. Newcastle Link Road and Minmi Road are the primary routes in the area, delivering traffic to, from and between the Pacific Motorway and the Newcastle CBD. The majority of traffic generated within the study area uses Minmi Road to access the Newcastle Link Road.

The classification of the roads within the study are:

- State Roads:
 - Newcastle Link Road;
 - Thomas Street;
 - Newcastle Road; and
- Lake Road;
- Regional Roads:
- Cameron Park Drive; and
- Minmi Road (the southern section between Newcastle Link Road south to Main Road, Edgeware).
- Local Roads:
- all other roads.

The study area's road hierarchy is illustrated in Figure 2.1.



Figure 2.1: Road Hierarchy

2.2 MINMI ROAD CORRIDOR

2.2.1 General

Most of the new development in the study area relies on Minmi Road (north of Newcastle Link Road). Minmi Road is a two-lane undivided road, which connects Woodford Street in the west to Cameron Street / Cowper Street in the east, linking the suburbs of Minmi, Maryland and Wallsend. Minmi Road generally services the relatively new low-density housing developments that are located on either side of this sub-arterial road. Minmi Road also links several key non-residential developments including Summerhill Waste Management Centre, Bunnings Warehouse (near Sandgate Road) and a large industrial estate (near Creek Road). There



are six signalised intersections, and five roundabouts on Minmi Road. In addition, there are several priority intersections, mostly servicing the residential developments on both either side of the road.

2.2.2 Major Intersections

The key intersections along Minmi Road (from west to east/south-east) are as follows:

- Minmi Road / Woodford Street;
- Minmi Road / Britannia Boulevard;
- Minmi Road / Kurraka Drive;
- Minmi Road / Awabakal Drive / Bellbird Close;
- Minmi Road / Churnwood Drive / Maryland Drive;
- Minmi Road / Bottlebrush Boulevard;
- Minmi Road / Summerhill Road;
- Minmi Road / Maryland Drive;
- Minmi Road / Creek Road / Macquarie Street;
- Minmi Road / Bunnings Access; and
- Minmi Road / Cameron Street / Cowper Street.

Table 2.1 provides a description of the layout of key intersections along Minmi Road.

Table 2.1:Intersection Descriptions

Intersection Description		Intersection Layout	
Woodford Street	This is a signalised T-intersection where Minmi Road provides one lane in each direction. Woodford Street provides a right turn pocket from the south approach and a left turn pocket from the north approach. No significant queues currently exist during the AM and PM peak hours.		
Britannia Boulevard	This single lane roundabout services the low- density residential area to the south. No congestion currently exists during the AM and PM peak.	Minmi Road Bigging Barriero	

	Intersection Description	Intersection Layout
Kurraka Drive	This single lane roundabout provides access to the low-density residential area to the south. There is a 'bypass' lane for westbound through traffic on Minmi Road. No congestion exists during the AM and PM peaks.	
Awabakal Drive / Bellbird Close	This is a signalised intersection providing access to the low-density residential areas to the north and south. It also provides access to an existing high school to the north. Minmi Road has a right turn pocket on both its approaches. During the AM peak some queues exist for right turning traffic the westbound approach of Minmi Road, with these queues generally clearing every signal cycle. Some queues are also present in the southern approach. No significant queues are present during the PM peak.	
Churnwood Drive / Maryland Drive	This is a signalised intersection providing access to the low-density residential areas to the north-east and south-west. It also provides access to the retail development located off Churnwood Drive. Minmi Road provides right turn pockets on both approaches. Traffic queues exist on both of the Minmi Road approaches during the AM and PM peak periods, with the long queues generally clearing in every signal cycle.	Crummed Dive
Bottlebrush Boulevard	This roundabout provides access to the low- density residential area to the south (west). Minmi Road provides two lanes in each direction on its the approaches. No congestion occurs during the AM and PM peak sites.	the second secon

	Intersection Description	Intersection Layout
Summerhill Road	This roundabout provides access to the Summerhill Waste Management Centre to the south-west. Minmi Road provides two lanes in each direction on its approaches. In the AM peak, queues of slow moving vehicles occur on the eastbound approach and no congestion occurs during the PM peak.	
Maryland Drive	This is a signalised intersection providing access to the low-density residential areas to the north. Minmi Road provides a two-lane right turn pocket in its westbound approach and a left turn pocket on its eastbound approach. Queues of slow moving traffic occur on Minmi Road eastbound during the AM peak. In the PM peak, right turn queues occur on the westbound approach but generally clear in every signal cycle.	
Creek Road / Macquarie Street	This is a signalised intersection providing access to the commercial/industrial area to the north. Minmi Road has right turn pockets in both its eastbound and westbound approaches and a left turn pocket westbound. Queues of slow moving traffic are evident eastbound on Minmi Road during the AM peak. In the PM peak, queues occurs on the westbound approach but generally each signal cycle.	
Bunnings Access	This roundabout provides access to Bunnings Warehouse. Minmi Road has one lane for through traffic in both of its approaches. The Minmi Road westbound approach also provides a left turn pocket for turns into Bunnings. Queues of slow moving traffic occur eastbound on Minmi Road during the AM peak. In the PM peak, queues occur in the westbound approach primarily as a platoon of vehicles arriving from the Cameron Street / Cowper Street intersection.	e una sub e e e a a a a a a a a a a a a a a a a

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	Intersection Description	Intersection Layout
Cameron Street / Cowper Street	This twin intersection arrangement provides access to/from Minmi Road. Sandgate Road and Cowper Street are used for access between Minmi Road and the Newcastle Link Road. In the AM peak, over 900 vph turn left from Minmi Road into Sandgate Road. In the PM peak over 600 vph turn right from Cameron Street into Minmi Road. No significant queues are present in the AM peak. In the PM peak, queues of right turning vehicles occur on Cameron Street.	Contras strate Contras strate

2.2.3 Safety Considerations

During the site visit it was observed that at the Minmi Road intersection with Churnwood Drive, vehicles turning right from Churnwood Drive onto Minmi Road have poor forward visibility of oncoming traffic from the opposite leg of the intersection (Maryland Drive). Given right turning traffic filters across opposing traffic, inadequate sightlines increase the risk of conflict between vehicles. This problem is exacerbated of a night-time when visibility is reduced. The view from the stop-line at the Churnwood Drive approach is shown in Figure 2.2.



Figure 2.2: Difficult right turn from Churnwood Drive onto eastbound Minmi Road

2.2.4 Speed Environment

The posted speed limits within the study area are shown in Figure 2.3. Minmi Road generally has a posted speed limit of 60 km/h however there is a short section in the west of the study area posted at 50 km/h. There is also a section between Blue Gum Hill Road and Brookfield Avenue which is posted at 70 km/h predominantly through a rural road environment with limited direct access from the adjacent properties. There is a school zone near the Awabakal Drive / Bellbird Close intersection, which is in operation from 8:00 - 9:30 am and 2:30 - 4:00 pm on school days.





Figure 2.3: Posted Speed Limits within the Study Area

2.3 FREIGHT ACCESS AND FREIGHT ROUTES

Figure 2.4 shows the freight routes in the study area which are:

- Newcastle Link Road, Thomas Street and Newcastle Road east of Thomas Street / Longworth Avenue which are all designated B-double and HML B-double routes; and
- Longworth Avenue and Minmi Road between Cameron Street / Cowper Street and Summerhill Road which are designated B-double routes.



Source: Roads and Maritime Restricted Access Vehicles Map

Figure 2.4: Freight Routes within the Study Area

2.4 SURROUNDING LAND USES

The Newcastle Local Environmental Plan 2012 Land Zoning Maps 1B, 2A, 2B and 2C, and the Lake Macquarie Local Environmental Plan 2014 Land Zoning Maps 8A, 8B and 8C, shows that the study area is includes and is surrounded by the following land use zones:

- B1 Neighbourhood Centre;
- B2 Local Centre;
- E1 National Parks and Nature Reserves;
- E2 Environmental Conservation;
- E3 Environmental Management;
- E4 Environmental Living;
- IN1 General Industrial;
- IN2 Light Industrial;
- R2 Low Density Residential;
- R3 Medium Density Residential;
- RE1 Public Recreation;
- RE2 Private Recreation; and
- SP2 Infrastructure.

Figure 2.5 shows the land use zoning within and surrounding the eastern parts of the study area in the vicinity of Minmi Road and Longworth Avenue.



Source: Newcastle Local Environmental Plan 2012

Figure 2.5: Land Zoning - Minmi Road to Longworth Avenue



Figure 2.6 shows the land use zoning in the south-eastern parts of the study area between Newcastle Road and Newcastle Link Road via Thomas Street.



Source: Newcastle Local Environmental Plan 2012

Figure 2.6: Land Zoning - Newcastle Road to Newcastle Link Road via Thomas Street

Figure 2.7 shows the land use zoning in the southern parts of the study area along Newcastle Link Road.



Source: Lake Macquarie Local Environmental Plan 2014

Figure 2.7: Land Zoning - Newcastle Link Road

The majority of the study area contains low density residential zones. Local centre and recreation zones are spread throughout the study area with western parts of the study area including environmental conservation area and eastern parts of the study area surrounded by light industrial and medium density residential zones.

2.5 DEMOGRAPHICS

2.5.1 Population

Population forecasts published by NSW Transport Performance Analytics (TPA) which is based on Australian Bureau of Statistics (ABS) 2016 Census data are shown in Figure 2.9. The ABS shown has been combined for the Travel Zones (TZs) within and immediately adjacent to the study area as per Figure 2.8.



Adapted from NSW Travel Zone Explorer

Figure 2.8: Travel Zones included in the Study Area

The TPA data indicates that the **study area's** population is expected to increase by 50% over the next three decades, from approximately 30,000 to 43,000 people. The highest population increase is forecast for the Minmi TZs where the population is expected to grow by over 300 percent, followed by Fletcher, Jesmond and Maryland.



Source: NSW Travel Zone Explorer

Figure 2.9: 2021 - 2046 Population Forecasts



Figure 2.10 provides average annual population growth forecasts for every 5-year period until 2046. An average growth rate of 1.3 % p.a. is predicted in the 25-year period between 2021 and 2046.



Source: NSW Travel Zone Explorer

Figure 2.10: 2021-2046 Average Annual Population Forecasts

2.5.2 Employment

The number of people employed within the study area is forecast to increase by approximately 4,000 between 2016 and 2046 as shown in Figure 2.11 below.



Source: NSW Land Use Planner - Employment

Figure 2.11: 2021-2046 Employment Forecasts

2.6 CURRENT TRAVEL PATTERNS

2.6.1 Trip Purpose

The study area is situated in the Newcastle LGA, where on average 558,000 trips are made on a typical weekday. Figure 2.12 below shows the purpose of trips from the LGA in 2016/17.

Social recreation trips make up 25% of all trips, followed by work trips, including business trips, and shopping trips (22% and 18% respectively). Education or child care-related trips constitute only 5% of all trips.

Although work trips make up approximately 22% of all trips, they account for 31% of all kilometres travelled.

16% 3% 14% 25% 5% 25% 18% 7% 18%

- Commute
- Work related business

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- Education/Child Care
- Shopping
- Personal business
- Social recreation
- Serve passenger
- Other

Figure 2.12: Purpose of Travel – Newcastle LGA

2.6.2 Public Transport Networks and Services

Data for public transport services within the study area was obtained from the Transport for NSW website. Table 2.2 details the bus services and Figure 2.13 shows these routes within and around the Wallsend Town Centre. Bus services and stop locations along Minmi Road and Woodford Street corridors are shown in Figure 2.14.

Route Number	Route Direction	Route Reference in Figure 2.13	Stops
222	Wallsend to Newcastle Via Lambton	Cf	231, 222
231	Newcastle to Wallsend Via Jesmon	Cf	231, 222
230	Newcastle to Wallsend Via North Lambton	cd	226, 267, 222, 235, 230
235	Newcastle to Wallsend Via Hamilton	cd	226, 267, 261, 235, 230
267	Wallsend to West Wallsend	he	260, 270, 261, 226, 267
160	Woodonga to Albury Via Birallee and Oakmount (Loop Service)	ae	260,270,261,
260	University of Newcastle to Minimi Via Wallsend Maryland & Fletcher	be	261, 226, 231
261	University of Newcastle to Minimi Via Wallsend Maryland	be	226, 230, 260, 267
270	University of Newcastle to Toronto West	he	260, 270, 267
226	Newcastle to Glendale	be	260, 270, 267
224	Wallsend to Newcastle Via Kotara	ch	224, 267, 270

 Table 2.2:
 Bus Services and Stop Locations – Wallsend Town Centre





Figure 2.13: Bus Service Routes and Stops – Wallsend Town Centre and Surrounding





Figure 2.14: Bus Service Routes and Stops – Minmi Road

2.7 TRAFFIC VOLUMES AND PATTERNS

2.7.1 Intersection Counts

Intersection count data, collected by Seca Solution for the AM and PM peak periods on Wednesday 2nd November and Thursday 10th November 2016, was provided by Council for the following locations:

- 101 Woodford Street at Newcastle Link Road;
- 102 Woodford Street at Minmi Road;
- 103 Brookfield Avenue at Minmi Road;
- 104 Highland Way at Minmi Road;
- 105 Britannia Blvd at Minmi Road;
- 106 Kurraka Dr at Minmi Road;
- 107 Awabakal Drive at Minmi Road;
- 108 Churnwood Drive at Minmi Road;
- 109 Bottlebrush Blvd at Minmi Road;
- 110 Warkworth Street at Minmi Road;
- 111 Summerhill Road at Minmi Road;
- 112 McNaughton Ave at Minmi Road;
- 113 Maryland Drive at Minmi Road;
- 114 Creek Road at Minmi Road;
- 115 Minmi Road at Bunnings;
- 116 Sandgate Road at Minmi Road; and
- 117 Cowper Street at Minmi Road.

Turn count surveys were undertaken by Traffic Data and Control (TDC) on Thursday 2nd March 2017 for the AM and PM peak periods at the following intersections:

- 118 Tillie Street at Sandgate Road;
- 119 Tillie Street at Wilkinson Avenue;
- 120 Cameron Street at Tillie Street;
- 121 Walford Street at Thomas Street;
- 122 Newcastle Road at Longworth Avenue;
- 123 Newcastle Road at Cowper Street;
- 124 Cowper Street at Kokera (Shopping Centre Access);
- 125 Thomas Street at Metcalfe Street;
- 126 Cowper Street at Lake Road;
- 127 Lake Road at Newcastle Link Road;
- 128 Newcastle Link Road at Minmi Road (South); and
- 129 Cowper Street at Nelson Street.

Commercial Vehicles

The AM and PM peak traffic data were analysed for Minmi Road at its intersection with Bunnings Warehouse to determine the proportion of commercial vehicles (light and heavy vehicles) in the total traffic mix. In the AM peak (between 7.30 am and 9.30 am) the proportion of commercial vehicle in the two-way traffic is 5.6%. In the PM peak (between 4.30 pm and 6.30 pm), the proportion is 1.8%. In the AM peak the westbound traffic on Minmi Road contains a relatively high proportion of commercial vehicles, measuring 9.1% of the total traffic flow.



2.7.2 Weekday AM Peak Period

The weekday AM peak turning movements at all key intersection within the corridor are summarised in Figure 2.15 and Figure 2.16 below.

Western Corridor Traffic and Transport Study Traffic Survey Data Analysis
AM Peak (0800-0900)

Section 1 of 2: Newcastle Link Road, Woodford Street and Minmi Road





Figure 2.15: AM Peak (8.00-9.00am) Turning Movement Counts Summary – Section 1





Western Corridor Traffic and Transport Study Traffic Survey Data Analysis

AM Peak (0800-0900)

Section 2 of 2: Thomas Street, Newcastle Road, Cameron Street, Cowper Street and Lake Road



Figure 2.16: AM Peak (8.00-9.00am) Turning Movement Counts Summary – Section 2





2.7.3 Weekday PM Peak Period

The weekday AM peak turning movements at all key intersection within the corridor are summarised in Figure 2.17 and Figure 2.18 below.

Western Corridor Traffic and Transport Study Traffic Survey Data Analysis

PM Peak (1630-1730)

Section 1 of 2: Newcastle Link Road, Woodford Street and Minmi Road





Figure 2.17: PM Peak (4.30-5.30pm) Turning Movement Counts Summary – Section 1







Western Corridor Traffic and Transport Study Traffic Survey Data Analysis

PM Peak (1630-1730)

Section 2 of 2: Thomas Street, Newcastle Road, Cameron Street, Cowper Street and Lake Road



Figure 2.18: PM Peak (4.30-5.30pm) Turning Movement Counts Summary – Section 2





2.7.4 Link Counts

Mid-block link traffic volumes were collected by TDC on Thursday 2nd March 2017 for the AM and PM peak periods at the following locations within the study area:

- Newcastle Link Road (West of Lake Road); and
- Minmi Road (North of Cowper Street).

2.7.5 Origin-Destination Surveys

Origin-destination surveys were undertaken on Thursday 2nd March 2017 by Matrix for the AM and PM peak periods, considering the following 10 locations:

- 1 Newcastle Link Road (West of Woodford Road);
- 2 Minmi Road South (South of Newcastle Link Road);
- 3 Lake Road (South of Newcastle Link Road);
- 4 Walford Road (South of Thomas Street);
- 5 Metcalfe Street (South of Thomas Street);
- 6 Newcastle Road (East of Thomas Street);
- 7 Cameron Street (East of Minmi Road);
- 8 Maryland Drive (North of Minmi Road);
- 9 Maryland Drive West (North of Minmi Road); and
- 10 Woodford Street (North of Minmi Road).

Origin-destination survey locations are shown in Figure 2.19. Outcomes from the survey were used to develop a traffic matrix for the study area.



Figure 2.19: Origin-Destination Survey Locations

2.7.6 Travel Times and Speed

Bitzios Consulting commissioned travel time surveys to be conducted along Minmi Road and Newcastle Link Road. The surveys were conducted by TDC, for the AM and PM peak periods on Wednesday 15th March 2017. In order to verify localised delays at various locations, the route was separated into a number of subsections. The clockwise and counter-clockwise routes are shown in Figure 2.20.

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Figure 2.20: Travel Time Survey Routes

Results from the travel time survey were used to calculate average travel speeds along the Minmi Road corridor. The AM and PM peak average travel speeds are shown in Figure 2.21 and Figure 2.22.

In the AM peak the average speed drop substantially eastbound between the Maryland Drive and Cowper Street intersections. This is attributed to queues of slow moving vehicles on the Minmi Road eastbound carriageway. In the westbound direction, vehicles generally maintain average speeds between 40 and 50 km/h.





In the PM peak the average speeds on Minmi Road corridor are within the 40 kmh and 50 km/h range. The only exception is the short section in the between the Bunnings access and Cowper Road, as shown in Figure 2.22.
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Figure 2.22: Average Speed on Minmi Road Corridor – 2017 PM Peak

It should be noted that during the site visit, a work zone of 40km/h was identified between Brookfield Avenue and Highland Way.

2.8 CONGESTION HOTSPOTS

During site visits, significant queues were observed during the AM peak eastbound along Minmi Road between the Summerhill Road and Cowper Street intersections. These queues were observed to be caused by downstream capacity constraints at the Bunnings roundabout. It should be noted the queue was observed to be slow moving and no cars were observed to have stopped. The queueing was maintained to Creek Road after 9:00am.



Figure 2.23: Queueing due to the construction along Minmi Road

Other observed congestion hotspots included the following intersections:

- Minmi Road / Awabakal Drive;
- Minmi Road / Maryland Drive / Churnwood Drive;
- Minmi Road / Maryland Drive (right turn);
- Minmi Road / Cowper Road; and
- Bunnings roundabout.

Queuing at the above signalised intersections cleared within a single cycle. As such, traffic along Minmi Road was mostly free flowing. The largest queues (with the exception of the road works area) occurred on the right movement on the eastern leg of the Minmi Road / Maryland Drive intersection.

2.9 Crash Data Analysis

2.9.1 Overall Statistics

Roads and Maritime provided five-year crash data, between 1st July 2011 and 30th June 2016, for Minmi Road, Longworth Avenue and a section of Woodford Street within the study area. Across the five-year period, a total of 92 crashes were reported on Minmi Road, equating to an average of 18.4 crashes per year. Figure 2.24 illustrates the number of crashes between 2011-12 and 2015-16.





Figure 2.25 illustrates the proportion of crashes occurring during different conditions, sorted by natural lighting and surface condition.





2.9.2 Causality Crash Analysis

Of the 92 crashes, 61 crashes resulted in casualties of some degree, with the remaining 31 crashes resulting in vehicle damage only. Table 2.4 summarises crash severity and number of casualties. In the period of assessment one person was killed, whilst 15 were seriously injured.

Table 2.3:Crash Severity and the Number of Casualties

Crash Severity	verity No. of Crashes %		No. of Casualties
Fatal	1	1%	1
Serious Injury	15	16%	16
Moderate Injury	30	33%	37
Minor Injury	9	10%	10
Uncategorised	6	7%	7
Damage Only	31	34%	-
TOTAL	92	100%	71

2.9.3 Crash Type

Table 2.4 provides a breakdown of all crash types which occurred in the study area, including the number of crashes and casualties. The most common types of crashes throughout the study area include 'off-road objects', 'rear end'; and 'right through' movements.

Table 2.4:Crash Type Summary

Crash Type	No. of crashes	%	No. of Casualties	%
Cross traffic	3	3%	1	1%
Emerging from drive	4	4%	5	7%
Fell in/from vehicle	1	1%	1	1%
Head on	4	4%	5	7%
Left near	2	2%	1	1%
Left rear	3	3%	5	7%
Left turn sideswipe	2	2%	1	1%
Off left/left bend	2	2%	1	1%
Off left/right bend	1	1%	0	0%
Off left/right bend, hit object	9	10%	4	6%
Off left/left bend, hit object	3	3%	3	4%
Off road to left, hit object	6	7%	2	3%
Off road to right, hit object	3	3%	2	3%
Off road to left	2	2%	0	0%
Off right/left bend, hit object	3	3%	3	4%
Off right/right bend, hit object	1	1%	1	1%
Other opposing	1	1%	1	1%
Other same direction	1	1%	1	1%
Out of control on bend	3	3%	2	3%
Overtake turning	1	1%	1	1%

Crash Type	No. of crashes	%	No. of Casualties	%
Parked	1	1%	1	1%
Ped far side	1	1%	2	3%
Ped nearside	1	1%	2	3%
Rear end	16	17%	8	11%
Right near	1	1%	1	1%
Right rear	3	3%	3	4%
Right through	11	12%	8	11%
U turn	3	3%	6	8%
TOTAL	92	100%	71	100%

2.9.4 Section 1 – Minmi Road

In the five-year period ending June 2016, a total of 65 crashes were recorded along the 7.8 km section of Minmi Road. Over the five-year period, Minmi Road had an average of 13 crashes per year, where the majority of crashes occurred during the day and when the road surface was dry.

The following three clusters are identified on Minmi Road:

- Cluster 1: section between Summer Hill Road and Creek Road;
- Cluster 2: section between Cowper Street and Bunnings Roundabout; and
- Cluster 3: McCartney Street / Blue Gum Hills Road.

The locations are shown in Figure 2.26.



Figure 2.26: Section 1 Crash Cluster Locations

Cluster 1: Section between Summer Hill Road and Creek Road

This section extends between the Summer Hill Road roundabout intersection with Minmi Road in the west and 300m east of Creek Rd, encompassing approximately 1.4km. During the five-year period, a total of 26 crashes were reported within this section. These crashes resulted in 25 casualties, including one fatality.

Cluster 1 accounts for 40% of crashes on Minmi Road over the five year period. Within the 2011-2012 year, a total of eight crashes occurred. Of the total crashes, 76% occurred in dry conditions and an equal number of crashes took place in daylight and darkness.

Most crashes were caused by 'right through' movements, equating to 31% of crashes along this section. The 'right through' type crashes resulted in seven casualties. Five crashes were 'rear end' crashes, equating to 19% of crashes along the segment of Minmi Road and resulting in three casualties, including one fatality. The recorded fatal crash occurred approximately 200m east of Creek Road.

Cluster 2: Section between Cowper St and Bunning's Warehouse

Along this section, a total of eight crashes were recorded between 2011-12 and 2015-16, resulting in three casualties.

Of the crashes along this section, six (75%) were 'rear end' crashes. It was observed that most 'rear end' crashes occurred on the eastbound approach of the roundabout with Bunnings entrance. A majority of crashes occurred when the road surface was dry.

Cluster 3: McCartney St / Blue Gum Hills Road

Another crash cluster was identified at the entrance of the Minmi Cemetery, to the east of Minmi Road intersection with Woodford Street. Two crashes resulted in serious injuries.

Of the four crashes, two occurred during the day and the other two at night. All recorded crashes at this location occurred in dry conditions. These crashes occurred on the westbound carriageway near the bend.

2.9.1 Section 2 – Longworth Avenue

In the five-year period, a total of 10 crashes were recorded on Longworth Avenue, resulting in nine casualties. From the data provided, it was also found 90% of crashes occurred in dry conditions. Additionally, an equal number of crashes occurred in the day and night.

'Head on' type crashes most commonly occurred on Longworth Avenue, making up 30% of crashes recorded on this road. 'Head on' incidents resulted in six casualties over the six-year period, where three resulted in severe injuries.

A single cluster was observed at the intersection of Longworth Avenue and Bean Street, where three crashes occurred, including two casualties. Of the three crashes, two were 'head on' incidents, one resulting in serious injury. All three crashes occurred in dry conditions, with one crash occurring after dark.

2.9.2 Section 3 – Woodford Street

In the five-year period, a total of eight crashes were recorded on the 2 kilometres long section of Woodford Street between Minmi Road and Newcastle Link Road. Out of the eight crashes, three resulted in casualties. Of the crashes recorded, 75% of crashes occurred during daylight hours and 63% occurred in dry conditions.

The type of crashes that occurred on Woodford Street varied and no common crash type was observed. Table 2.5 summarises the type of crash and the number of crashes that occurred along Woodford Street.

Table 2.5Various types of crashes along Woodford Street

Crash Severity	No. of Casualties
Cross traffic	1
Head on	1
Left turn sideswipe	1
Off left/right bend, hit object	1
Off road to right, hit object	1
Parked	1
Right rear	1
U turn	1
Grand Total	8

Throughout Woodford Street, two clusters were identified: one near the Minmi Road intersection and the other near Bell Street intersection.

Cluster 1 - Minmi Road / Woodford Street

Two crashes reported at the Minmi Road / Woodford Street intersection. One crash was caused by a 'cross traffic turn' movement while the other was caused by a 'left turn sideswipe'. Both incidents took place during the day in dry conditions.

Cluster 2 - Bell Street / Woodford Street

Two crashes were reported in the five-year period. One crash involved a parked car, whilst the other crash involved a vehicle driving off the road and hitting an object. Both crashes occurred in wet weather, with one crash occurring at night.

2.10 PARKING

In relation to Figure 2.27, kerbside parking is restricted along Minmi Road. The exceptions are as follows:

- Kerbside parking 1: On the southern side of Minmi Road between Britannia Boulevard and Highland Way;
- Kerbside parking 2: At two locations on the northern side of Minmi Road between Summerhill Road and Maryland Drive;
- Kerbside parking 3: A short section north of Minmi Road to the east of Maryland Drive; and
- Kerbside parking 4: On the southern side of Minmi Road between Macquarie Street and Fletcher Street.

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Figure 2.27: Existing Location of Kerbside Parking

Private off-street car parks are provided at the following locations:

- Fletcher Village;
- Bunnings Warehouse;
- Aldi Store; and
- The industrial/commercial area west of Creek Road.

During site visits, some vehicles were observed to park illegally within the verge near the shared path. As seen in Figure 2.28, a cluster of cars was observed to park on the southern side of Minmi Road, close to Maryland Drive.



Figure 2.28: Cars obstruct shared path along Minmi Road northbound to Caltex Station

3. YEAR 2017 NETWORK PERFORMANCE MODELLING

3.1 BASE MODEL CALIBRATION AND VALIDATION

3.1.1 Overview

The traffic modelling software VISSIM was used to create a microsimulation model for the study area. The model network is shown in Figure 3.1. The model was calibrated and validated in accordance with the *RMS Traffic Modelling Guidelines, February 2013.* The existing base case model represented:

- the AM peak period between 8.00 am and 9.00 am, with a 30-minute warm up and call down period on either side of the peak hour, capturing school zone between 8.00 am and 9.30 am; and
- the PM peak period between 4:30 pm and 5:30 pm, with a 30-minute warm up and call down period on either side of the peak hour.



Figure 3.1: Western Corridor VISSIM Model Network

3.1.2 Input Data

A wide variety of data sets were used to build, calibrate and validate the models. These included:

- intersection turn counts by vehicle classes;
- origin-destination surveys;
- travel time surveys;
- SCATS Intersection Diagnostic Monitor (IDM) signal data;
- aerial photography; and
- site observations.

3.1.3 Base Model Coding

The VISSIM model was coded using knowledge obtained from site visits and road layouts based on Google Maps and other mapping programs. Model parameters were left as the VISSIM defaults. Some of the key features of the model coding that should be noted are:

- movements within intersections and approaching zebra crossings are controlled by "Priority Rules" to ensure appropriate give-way behaviours;
- all pedestrian crossings are included in the model;
- vehicle inputs, releasing all vehicles into the model, are consistent with the posted speed along the relevant roads; and
- reduced speed areas have been included in to more accurately reflect driver behaviour when approaching stop lines and completing some manoeuvres.

3.1.4 VISSIM Model Calibration and Validation Outcomes

The 2017 VISSIM model was calibrated and validated as per the Roads and Maritime guidelines. Model calibration and validation results are documented in a separate technical note, provided in Appendix A. The base year 2017 VISSIM models have been calibrated and validated adequately and are fit for the study purpose.

3.2 PERFORMANCE METRICS

The Levels of Service (LoS) for each intersection have been assessed based on average delay in accordance with the Roads and Maritime guidelines (Guide to Traffic Generating Developments, Issue 2.2, Roads and Maritime Services, October 2002). The LoS thresholds are summarised in Table 3.1.

Level of Service (LoS)	Average Delay per vehicle (sec/veh)	Traffic Signals, Roundabouts	Give Way and Stop Signs
А	≤14	Good operation.	Good operation.
В	15 to 28	Good with acceptable delays and spare capacity.	Acceptable delays and spare capacity.
С	C 29 to 42 Satisfactory.		Satisfactory, but accident study required.
D	43 to 56	Operating near capacity.	Near capacity and accident study required.
E	57 to 70	At capacity; at signals, incident will cause excess delays. Roundabout require other control mode.	At capacity, requires other control mode.
F	> 70	Flow breakdown; forced flow.	Intersection failure.

Table 3.1:	Intersection	Level of	Service	Criteria

The guidelines recommend that for priority intersections, such as roundabouts and sign-controlled intersections, the LoS value is determined by the critical movement with the longest delay, whereas for a signalised intersection the LoS criteria is based on average delay.

3.3 INTERSECTION PERFORMANCE

3.3.1 LoS and Delay

The peak hour performance of each intersection within the study area is summarised in Table 3.2.

In the AM peak hour, the Minmi Road / Creek Road / Macquarie Street intersection is shown to experience congestion with an average delay of 43 seconds (LoS D). The Minmi Road / Cameron Street / Cowper Street intersection also experience substantial congestion in both the AM and PM peak periods.

Intersection Level of Service – 2017 AM and PM Peak

consulting

Table 3.2:Intersection Level of Service - 2017	AM and PM I	Peak	
Intersection	Intersection Control	LoS – AM (delay in seconds)	LoS – PM (delay in seconds)
Woodford Street / Newcastle Link Road / Cameron Park Drive	6	C (36)	C (42)
Woodford Street / Minmi Road	6	B (18)	B (19)
Brookfield Avenue / Minmi Road	GIVE	A (1)	A (1)
Minmi Road / Highland Way	GIVE	A (0)	A (1)
Minmi Road / Britannia Boulevard	Ŵ	A (4)	A (3)
Kurraka Drive / Minmi Road	Ŵ	A (1)	A (1)
Awakabal Drive / Minmi Road / Bellbird Close	GIVE	B (23)	B (18)
Maryland Drive / Minmi Road / Churnwood Drive	6	B (24)	B (26)
Minmi Road / Bottlebrush Boulevard	∇	A (6)	A (3)
Warkworth Street / Minmi Road	GIVE	A (2)	A (3)
Minmi Road / Summerhill Road	Ŵ	A (5)	A (4)
McNaughton Avenue / Minmi Road	GIVE	A (4)	A (1)
Maryland Drive / Minmi Road	8	B (16)	B (17)
Creek Road / Minmi Road / Macquarie Street	6	D (43)	B (27)
Minmi Road / Bunnings	$\mathbf{\nabla}$	A (9)	A (11)
Sandgate Road / Minmi Road	GIVE	A (7)	A (4)
Cameron Street / Longworth Avenue / Cowper Street / Minmi Road	6	C (34)	C (39)
Sandgate Road / Tillie Street	GIVE	A (12)	A (6)
Tillie Street / Wilkinson Avenue	GIVE	A (4)	A (13)
Tillie Street / Douglas Street / Cameron Street	GIVE	A (5)	A (3)
Thomas Street / Walford Street	8	B (24)	A (14)
Longworth Avenue / Newcastle Road / Thomas Street	$\overline{\mathbf{A}}$	A (14)	A (11)
Newcastle Road / Cowper Street	GIVE	A (6)	A (6)
Kokera Street / Cowper Street	\mathbf{a}	A (11)	A (9)
Metcalfe Street / Thomas Street	8	B (17)	B (22)
Lake Road / Cowper Street	\mathbf{a}	A (6)	B (28)
Lake Road / Thomas Street / Newcastle Link Road	6	D (49)	F (71)
Newcastle Link Road / Minmi Road	V	B (17)	C (35)
Nelson Street / Cowper Street	8	B (19)	B (17)

3.3.2 Worst Performing Movements

The following section discusses movements at each intersection that experience significant delays.

Woodford Street / Newcastle Link Road / Cameron Park Drive

The right turn from Newcastle Link Road (W) to Cameron Park Drive (S) experiences a LoS E and F in the AM and PM peaks respectively. Furthermore, the right turn from Cameron Park Drive (S) to Newcastle Link Road (E) experiences a LoS E during the PM Peak.

Awakabal Drive Minmi Road / Bellbird Close

The right turn from Bellbird Close (S) to Minmi Road (E) experiences a LoS F during the AM peak. Furthermore, the right turn from Minmi Road (E) to Awakabal Drive (N) and the left turn from Bellbird Close (S) to Minmi Road (W) both experience a LoS E during the PM peak.

Creek Road / Minmi Road / Macquarie Street

The right turn from Macquarie Street (S) to Minmi Road (E) (11 vehicles) experiences a LoS E during the AM Peak. Furthermore, the right turn from Minmi Road (E) to Creek Road (N) experiences a LoS E during the PM Peak.

Cameron Street / Longworth Avenue / Cowper Street / Minmi Road

The right turn from Longworth Avenue (E) to Cameron Street (N) and the right turn from Cowper Street (S) to Longworth Avenue (E) both experience a LoS F during the AM and PM Peak. Furthermore, the right turn from Minmi Road (W) to Cowper Street (S) experiences a LoS E during the AM and PM Peak.

Thomas Street / Walford Street

The right turn from Thomas Street (W) to Walford Street (S) experiences a LoS E in the AM Peak.

Metcalfe Street / Thomas Street

The right turn from Metcalfe Street (N) to Thomas Street (W), the right turn from Thomas Street (E) to Metcalfe Street (N) and the right turn from Metcalfe Street (S) to Thomas Street (E) all experience a LoS E during the AM Peak.

The right, through and left movements from Metcalfe Street (N) to Thomas Street (E & W) and Metcalfe Street (S) all experience a LoS F during the PM Peak. Furthermore, the right turn from Thomas Street (W) to Metcalfe Street (S) experiences a LoS F during the PM Peak.

Lake Road / Cowper Street

The right turn from Cowper Street (E) to Lake Road (N) experiences a LoS E during the PM Peak.

Lake Road / Thomas Street / Newcastle Link Road

The through movement from Thomas Street (E) to Newcastle Link Road (W) and the right turn from Newcastle Link Road (W) to Lake Road (S) both experience a LoS F during the AM Peak. Furthermore, the right turn from Lake Road (S) to Thomas Street (E) experiences a LoS E during the AM Peak.

The right, through and left movements from Lake Road (N) to Newcastle Link Road (W), Lake Road (S) and Thomas Street (E), the through movement from Thomas Street (E) to Newcastle Link Road (W) and the through and left movements from Lake Road (S) to Lake Road (N) and Newcastle Link Road (W) all experience a LoS F during the PM Peak. Furthermore, the right turn from Newcastle Link Road (W) to Lake Road (S) experiences a LoS E.

Newcastle Link Road / Minmi Road

The through and left movements from Newcastle Link Road (E) to Newcastle Link Road (W) and Minmi Road (S) both experience a LoS E during the PM Peak.

3.4 TRAVEL TIMES

The eastbound and westbound travel times on Minmi Road are shown graphically in Figure 3.2 and Figure 3.3. In the eastbound direction, the AM peak travel times are longer than the PM peak by approximately 2 minutes 15 seconds. This is attributed to slow moving traffic on the eastbound Minmi Road. In the westbound direction the PM peak travel times are longer than the AM peak by approximately half a minute. What the comparison of the graphs also **show is the travel time variability effects eastbound due to the 'confluence' of** traffic in more heavily trafficked south-east of the model, compared to the divergence of traffic westbound which shows more uniform speed profiles.







Figure 3.3: 2017 Westbound (counter clock-wise) Travel Time on Minmi Road

4. FUTURE YEAR TRAFFIC DEMANDS AND ASSESSMENT PROCESS

4.1 OVERVIEW

Two key components in the development of future year models were:

- an estimation of future traffic volumes; and
- future transport network including committed network improvements.

Information regarding future developments was provided by CoN. This chapter summarises the all key future developments: their estimated traffic generation, forecast trip distribution throughout the road network and the increase in through (background) traffic within the study area. This chapter also summarises the key committed network improvements within the study are.

Finally, this chapter outlines the process for the assessment of network deficiencies within the study area and how the 2021, 2026 and 2036 networks were subsequently developed, tested and optimised.

4.2 DEVELOPMENT AREAS

4.2.1 Planned Future Developments and Approved Developments

The Western Corridor has experienced growth in residential developments and population which is forecast to continue into the foreseeable future. The Western Corridor has been divided into different sections which make up the Area of Contribution Plan under the Section 94 Contributions Plan 2013. New developments are proposed in Elermore Vale, Wallsend, Fletcher, Minmi and Cameron Park.

Within the study area, a total of nine areas were identified where residential developments or other developments, have recently been completed or are being planned to be implemented in the future. Of the nine areas, the following four areas are currently being planned for new development:

Planned Future Developments

- Coal and Allied Part 3A site;
- 505 Minmi Road site;
- Xstrata Coal site; and
- seniors living site.

The remaining five areas already include a range of developments and additional developments that have been approved. These areas are:

Approved Developments

- Nikkinba Ridge;
- Hidden Waters;
- St Andrews Way;
- Sanctuary Estate; and
- The Outlook.

The locations of these development areas are shown in Figure 4.1.





4.2.2 Coal and Allied

Coal and Allied is located within Cameron Park, Minmi and Fletcher. At the time of the publication of the Newcastle Western Corridor Section 94 Background Document, (August 2013), a total of 1,672 dwellings were expected, including 152 seniors living dwellings. The Coal and Allied development is estimated to house approximately 4,800 residents.

4.2.3 505 Minmi Road

505 Minmi Road is located within Fletcher. At the time of the publication of the Newcastle Western Corridor Section 94 Background Document (August 2013), a total of 110 dwellings were expected, housing approximately 300 residents.

4.2.4 Xstrata Coal

Xstrata Coal is located within Wallsend, Elermore Vale, Cameron Park, Edgeworth and Glendale. At the time of the publication of the Newcastle Western Corridor Section 94 Background Document (August 2013), a total of 1,200 dwellings were expected, housing approximately 3,600 residents.

4.2.5 Seniors Living

Seniors Living – Elermore Vale is located within Elermore Vale. At the time of the publication of the Newcastle Western Corridor Section 94 Background Document (August 2013), a total of 150 seniors dwellings were expected, housing approximately 225 residents.

4.2.6 Nikkinba Ridge Estate

Nikkinba Ridge is located within Fletcher. At the time of the publication of the Newcastle Western Corridor Section 94 Background Document (August 2013), a total of 148 dwellings had been constructed, with a further 188 approved for release. It was expected that 463 dwellings would be constructed within Nikkinba

Ridge, housing an estimated 1,400 residents. The proposed development also includes the expectation that 32 of the 463 dwellings will be medium density dwellings.

4.2.7 Hidden Waters

Hidden Waters is located within Fletcher. At the time of the publication of the Newcastle Western Corridor Section 94 Background Document (August 2013), a total of 110 dwellings had been constructed, with a further 174 approved for release. It was expected that 427 dwellings would be constructed within Hidden Waters, housing an estimated 1,350 residents.

4.2.8 St Andrews Way

St Andrew Way is located within Fletcher. It is the smallest development area within the Western Corridor with only 25 dwellings approved, but yet to be released, at the time of the publication of the Newcastle Western Corridor Section 94 Background Document (August 2013), the expected population of St Andrews Way is expected to be around 75 residents.

4.2.9 Sanctuary Estate

Sanctuary Estate is located to the north of Fletcher. At the time of the publication of the Newcastle Western Corridor Section 94 Background Document (August 2013), a total of 80 dwellings had been constructed, with a further 185 approved for release. Sanctuary Estate is expected to be the largest estate within Fletcher with an expected 836 dwellings, including 77 medium density dwellings, housing approximately 3,000 residents.

4.2.10 The Outlook

The Outlook is located within Fletcher. At the time of the publication of the Newcastle Western Corridor Section 94 Background Document (August 2013), a total of 42 dwellings had been constructed, with a further 117 approved for release. The Outlook is proposed to contain the highest proportion of medium density dwellings, with over 25% of all dwellings to be medium density. A total of 618 dwellings are expected, housing approximately 1,850 residents.

4.3 TRAFFIC GENERATION

4.3.1 Traffic Generation Rates

Traffic generation rates were taken from the Roads and Maritime *Guide to Traffic Generating Developments* and are summarised in Table 4.1.

Table 4.1:Traffic Generation Rates

Development	Weekday Peak Rate	Daily Rate	
Seniors Living	0.2 per dwelling	2.0 per dwelling	
Low Density Housing	0.85 per dwelling	9.0 per dwelling	
Medium Density Housing – Up to 2 bedrooms	0.4 per dwelling	4.0 per dwelling	

Source: Roads and Maritime Services Guide to Generating Traffic Developments

The number of trips expected to be generated from future developments were calculated using the above traffic generation rates.

4.3.2 Traffic Generation of Planned Future Developments

Table 4.2 summarises the expected number of the dwellings in each area, the associated traffic generation rate, the estimated number of vehicle trips during the weekday peak hour and the daily vehicle trips generated.

 Table 4.2:
 Traffic Generation by Proposed Planned Future Developments

Development Areas	Expected Dwellings	Weekday Peak Hour Vehicle Trip Rate	Vehicle Trips/hour	Daily Vehicle Trip Rate	Vehicle Trips/day
Coal & Allied Part 3A	1,520	0.85 per dwelling	1,290	9 per dwelling	13,680
Seniors living component – part of Coal & Allied Part 3A	152	0.20 per dwelling	30	2 per dwelling	304
505 Minmi Road	110	0.85 per dwelling	94	9 per dwelling	990
Xstrata	1,200	0.85 per dwelling	1,020	9 per dwelling	10,800
Seniors Living – Elemore Vale	150	0.20 per dwelling	30	2 per dwelling	300
TOTAL	3,130		2,470		26,075

In summary, a total of 2,470 additional trips are expected to be generated during the peak hours from the proposed 3,130 residential dwellings in the "Planned Future Development" areas.

4.3.3 Traffic Generation of Approved Developments

This section summarises the additional traffic that needs to be added to base year traffic to account for approved developments in future year modelling. Developments in these areas are at different stages of construction which include:

- houses recently constructed;
- approved and released for construction; and
- approved and not yet released for construction.

Table 4.3 summarises the weekday peak hour and daily vehicle trips from developments at various stages.

Table 4.3:Traffic Generation by Approved Developments

Development Stage	Expected Dwellings	Weekday Peak Hour Vehicle Trip Rate	Vehicle Trips/hour	Daily Vehicle Trip Rate	Vehicle Trips/day
Recently Constructed Houses	380	0.85 per dwelling	325	9 per dwelling	3,420
Approved – Released	664	0.85 per dwelling	565	9 per dwelling	5,978
Approved – Not yet released	1,590	0.85 per dwelling	1,220	9 per dwelling	12,820
TOTAL	2,634	0.85 per dwelling	2,110	9 per dwelling	22,220

A total of 2,110 vehicle trips are expected to be generated during the peak hours from already approved developments, including all recently constructed developments.

4.3.4 Summary (Planned and Approved Developments)

The combination of planned and approved developments within the study area are expected to generate 4,580 vehicular trips during peak hours from a total of 5,764 low density residential and senior living dwellings. This is summarised in Table 4.4.

 Table 4.4:
 Traffic Generation Summary (Planned plus Approved Developments)

Development Stage	Expected Dwellings	Weekday Peak Hour Vehicle Trip Rate	Vehicle Trips/hour	Daily Vehicle Trip Rate	Vehicle Trips/day
Planned	3,130	Various	2,470	Various	26,075
Approved	2,634	Vanous	2,110	Vanous	22,220
TOTAL	5,764	-	4,580	-	48,295

4.4 TRIP DISTRIBUTION

Results from the origin-destination (OD) surveys conducted on Thursday, 2nd March 2017 were interrogated to determine the traffic distribution pattern. The survey was conducted between 7:30am and 9:30am and between 4.00pm and 6.00pm. The eastern extent of the OD survey at Maryland Drive (West) was assumed to be representative of all trips attracted/generated from the key section of Minmi Road under consideration as shown in Figure 4.2.





The locations of major attractors of trips from the study area, including suburbs and key routes, are summarised in Table 4.5. The inbound and outbound trip distributions for both the AM and PM peak periods to/from Maryland Drive (West) are also summarised in the table.

 Table 4.5:
 Minmi Road Corridor Peak Hours Outbound and Inbound Trip Proportions

Dectination	AM Peak		PM Peak		
Destination	Outbound	Inbound	Outbound	Inbound	
Pacific Highway (North)	10%	22%	17%	18%	
Hunter Expressway	10%	9%	16%	10%	
Newcastle CBD	12%	16%	10%	10%	
Edgeworth	5%	6%	2%	3%	
Lake Road	11%	11%	7%	11%	
Charlestown	4%	7%	3%	2%	
Sandgate	13%	1%	19%	0%	
Other (local)	35%	28%	26%	46%	

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Apart from local trip-making, the following four locations are the major attractors of Minmi Road corridor trips:

- Pacific Highway (north via Woodford Street);
- Hunter Expressway / Pacific Highway (south);
- Newcastle CBD; and
- Lake Road.

In the AM peak, each of the above four locations attract between 10% and 12% of all trips originating from the corridor. In the PM peak, each of these locations generate between 11% and 18% each of all the trips travelling into the corridor.

Figure 4.3 to Figure 4.6 summarise the inbound and outbound trip distributions associated with the Minmi Road corridor.

The traffic generation and traffic distribution calculations presented above were used as the basis to add to the base year traffic demands and then to assign this traffic to the calibrated and validated road network models. These models reflect 'Do Minimum' network conditions in the future years for further consideration.





Figure 4.3: Outbound (from development areas) Trip Distribution - AM Peak





Figure 4.4: Inbound (to development areas) Trip Distribution - AM Peak





Figure 4.5: Outbound (from development areas) Trip Distribution - PM Peak





Figure 4.6: Inbound (to development areas) Trip Distribution - PM Peak

4.5 ESTIMATION OF EXTERNAL TRAFFIC GROWTH

The traffic model includes various external travel zones. One example is the west to east movement between M1/Hunter Expressway and Newcastle City Centre. These external movements are forecast to grow in the future assessment years. The Sydney Strategic Travel Model (STM) was interrogated to understand the growth in external traffic through the study area. A total of eight key external travel zones have been identified as shown in Figure 4.7. A significant number of vehicles travel between these zones through the study area.



Figure 4.7: Key External Travel Zones

The growth in external traffic though the study area from the STM is summarised in Table 4.6.

Table 4.6: Growth in External Traffic – AM and PM Peaks (2 hour STM volumes)

Traffic Crowth	2016 te	o 2026	2016 to 2036		
	AM	PM	AM	PM	
Growth in Through Traffic	2,600	2,810	4,125	3,900	

4.6 FUTURE TRANSPORT NETWORK

In consultation with CoN and Roads and Maritime, a number of improvements have been identified on both State and Local Roads as being committed or highly likely to be implemented. These works have been included in the future year 'Do Minimum' networks.

4.6.1 Committed Works

State Roads

During the course of this study Roads and Maritime was undertaking a parallel study to develop corridor strategy for Newcastle Link Road and Thomas Street between M1 Pacific Motorway and Newcastle Road. No information on future infrastructure improvements for this corridor was available at the time of this study. However, Roads and Maritime did indicate a potential upgrade of the existing roundabout at the intersection of Newcastle Link Road and Minmi Road to a traffic signals. The configuration included free flow left turn lanes on the southbound, westbound and northbound approaches. The indicative layout of the intersection is shown in Figure 4.8.



Figure 4.8: Newcastle Link Road / Minmi Road intersection – Future Improvement Option

Local Roads

CoN was developing a draft Public Domain Plan and Traffic Plan for the Wallsend Local Centre. As part of the plan a number of improvement options were being considered including improvements at key intersections on Cowper Street. In consultation with the Bitzios Consulting study team, concept plans were developed for the following three intersections:

- Cowper Street / Kokera Street;
- Cowper Street / Nelson Street; and
- Cowper Street / Newcastle Road.

Locations of these intersections are shown in Figure 4.9 and the upgrade proposals are detailed below.

CoN has an intent to ensure that the Wallsend Town Centre supports walking and cycling movements and local traffic accessibility. This will influence decisions regarding the geometric scale of intersection upgrades in this area.



Figure 4.9: Proposed Intersection Upgrades at Wallsend Local Centre

Cowper Street / Kokera Street

The existing roundabout is proposed to be upgraded to a signalised intersection with the layout is shown in Figure 4.10. The proposed layout will include a right turn bay on the westbound approach. It is also proposed to provide pedestrian crossing facilities on all three approaches.



Figure 4.10: Proposed Layout of the Cowper Street / Kokera Street Intersection

Cowper Street / Nelson Street

It is proposed to introduce signalised pedestrian crossings on the southbound and westbound approaches. This will necessitate the existing priority controlled left turn from north to east to be signalised. The proposed layout is shown in Figure 4.11.



Figure 4.11: Proposed Layout of the Cowper Street / Nelson Street Intersection

Cowper Street / Newcastle Road

It is proposed to introduce a roundabout at the location of the existing priority intersection. The proposed layout is shown in Figure 4.12. The proposed roundabout configuration will improve traffic flows at this intersection especially traffic flows on Newcastle Road (south) which provides connectivity between Thomas Street and Cowper Road. It is required to promote this connectivity as an alternative to Thomas Street.



Figure 4.12: Proposed Layout of the Cowper Street / Newcastle Road Intersection

Minmi Road

Work is in progress on the Minmi Road upgrade between Macquarie Street and Bunnings Access Road. It is proposed to introduce an additional traffic lane in Minmi Road eastbound.

4.7 FUTURE YEAR NETWORK DEVELOPMENT PROCESS

A three-stage process was adopted with each stage includes identification of network issues and development of improvement measures for each of the following thee assessment years: 2021, 2026 and 2036. The process is summarised in Figure 4.13.

In Stage 1, a Do Minimum VISSIM model was developed for 2021 traffic conditions. The model includes all road improvements identified including the proposed Newcastle Link Road / Minmi Road intersection upgrade and the proposed intersection improvements on the Cowper Street. The 2021 Do Minimum VISSIM model was interrogated to identify network congestion hot spots and pinch points. A set of network improvement measures was developed to address the congestion issues. The 2021 Do Minimum VISSIM model was updated to develop the 2021 "option" model by incorporating the network improvement measures.

As part of the Stage 2 process, the 2026 Do Minimum model was developed by incorporating the 2021 option model but introducing 2026 project traffic demands. The same process was repeated until a 2026 option model was developed. Stage 3 repeated the Stage 2 process for year 2036.



Figure 4.13: Network Assessment and Network Improvement Process

Table 4.7 summarises the three stages. The key outcome of the process is the identification of network improvement measures and their staging for the intermediate years 2021 and 2026.

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	Stage 1 (2021)		Stage 2 (2026)		Stage 3 (2036)		
	Do Minimum	Option Model	Do Minimum	Option Model	Do Minimum	Option Model	
Road Network	2017 + Committed Improvements	2021 Do Minimum + Improvements	2021 Option Model Network	2026 Do Minimum + Improvements	2026 Option Model Network	2036 Do Minimum + Improvements	
Traffic Demand	Existing Traffic + 2021 External Traffic Growth + 2021 Development Traffic		Existing Traffic + 2026 External Traffic Growth + 2026 Development Traffic		Existing Traffic + 2036 External Traffic Growth + 2036 Development Traffic		

5. 2021 NETWORK ASSESSMENT

5.1 2021 DO MINIMUM ASSESSMENT

5.1.1 2021 Link Traffic Volumes – AM and PM Peaks

The link / network volumes for the Do Minimum 2021 AM and PM peak period have been extracted from VISSIM as shown in Figure 5.1 and Figure 5.2.



Figure 5.1: Link Volumes - 2021 Do Minimum, AM



Figure 5.2: Link Volumes - 2021 Do Minimum, PM

5.1.2 Intersection Analysis

The 2021 Do Minimum AM and PM intersection traffic performance is compared against the 2017 AM and PM peak periods in Table 5.1. Most of the key intersections along Minmi Road, Newcastle Link Road and Thomas Street operate at LoS E-F with substantial delays for general traffic.

In the AM peak, significant delays and queue build-up for the general eastbound traffic is observed at:

- Lake Road / Cowper Street and Lake Road / Thomas Street / Newcastle Link Road intersections as shown in Figure 5.3;
- Kurraka Drive / Minmi Road, Awakabal Drive / Minmi Road / Bellbird Close, Maryland Drive / Minmi Road / Churnwood Drive intersections as shown in Figure 5.4; and
- Woodford Street / Newcastle Link Road / Cameron Park Drive intersections as shown in Figure 5.5.



Figure 5.3: Queues along Thomas Street and Newcastle Link Road– 2021 Do Minimum, AM Peak



Figure 5.4: Queues along Minmi Road- 2021 Do Minimum, AM Peak



Figure 5.5: Queues along Newcastle Link Road – 2021 Do Minimum, AM Peak

In the PM peak, significant delays and queue build-up for the general traffic is observed at:

 Lake Road / Thomas Street / Newcastle Link Road, Thomas Street / Walford Street and Longworth Avenue / Newcastle Road / Thomas Street intersections as shown in Figure 5.6.



Figure 5.6: Queues along Thomas Street and Newcastle Link Road – 2021 Do Minimum, PM Peak

Table 5.1:

2021 Do Minimum Intersection Performance - AM and PM Peak Periods

Intersection	Intersection Control	LOS - AM (2017) (delay in seconds)	LOS - AM (2021) (delay in seconds)	LOS - PM (2017) (delay in seconds)	LOS - PM (2021) (delay in seconds)
Woodford Street / Newcastle Link Road / Cameron Park Drive	8	C (36)	E (67)	C (42)	D (49)
Woodford Street / Minmi Road		B (19)	B (25)	B (19)	B (28)
Brookfield Avenue / Minmi Road	GIVE	A (5)	A (5)	A (5)	A (5)
Minmi Road / Highland Way	GIVE	A (8)	C (34)	A (7)	A (12)
Minmi Road / Britannia Boulevard	Ŵ	A (6)	C (34)	A (5)	A (7)
Kurraka Drive / Minmi Road	Ø	A (7)	F (175)	A (4)	A (4)
Awakabal Drive / Minmi Road / Bellbird Close		B (24)	F (110)	B (18)	B (20)
Maryland Drive / Minmi Road / Churnwood Drive		B (25)	E (63)	B (27)	B (28)
Minmi Road / Bottlebrush Boulevard	Ø	A (10)	D (53)	A (6)	A (9)
Warkworth Street / Minmi Road	GIVE	B (18)	C (43)	A (11)	A (14)
Minmi Road / Summerhill Road	Ŵ	A (7)	B (25)	A (12)	B (19)
McNaughton Avenue / Minmi Road	GIVE	D (45)	F (332)	B (27)	B (26)
Maryland Drive / Minmi Road	8	B (17)	F (85)	B (18)	B (20)
Creek Road / Minmi Road / Macquarie Street		C (38)	D (53)	B (28)	C (31)
Minmi Road / Bunnings	V	A (15)	B (17)	B (27)	C (36)
Sandgate Road / Minmi Road	GIVE	B (25)	F (79)	B (29)	C (35)
Cameron Street / Longworth Avenue / Cowper Street / Minmi Road	8	C (34)	C (41)	C (39)	D (46)
Sandgate Road / Tillie Street	GIVE	B (16)	B (17)	C (35)	D (48)
Tillie Street / Wilkinson Avenue	GIVE	B (26)	C (33)	E (57)	F (276)
Tillie Street / Douglas Street / Cameron Street	GIVE	C (40)	E (69)	C (34)	E (58)
Thomas Street / Walford Street		B (24)	D (52)	A (14)	F (84)
Longworth Avenue / Newcastle Road / Thomas Street	V	E (69)	F (76)	B (27)	F (136)
Newcastle Road / Cowper Street	GIVE	B (29)	B (26)	B (27)	C (37)
Kokera Street / Cowper Street	Ŵ	B (20)	C (42)	B (17)	B (18)
Metcalfe Street / Thomas Street		B (17)	B (24)	B (22)	D (48)
Lake Road / Cowper Street	V	A (11)	E (58)	E (59)	E (58)
Lake Road / Thomas Street / Newcastle Link Road	8	D (49)	F (91)	F (72)	F (124)
Newcastle Link Road / Minmi Road	V	B (28)	C (36)	E (61)	F (80)
Nelson Street / Cowper Street		B (19)	B (21)	B (18)	B (17)

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A detailed analysis of intersection identified the failing movements at the following intersections:

- Minmi Road / Kurraka Drive: the southbound to westbound right turn movement experience 175 seconds delay in the 2021 AM peak. The AM peak volume of the right turning traffic is only 46 vehicles /hour. This is primarily a safety issue for this low volume of traffic not being able to select gaps. Some of this traffic may decide instead to turn left and u-turn elsewhere, or the right turn may be banned in the future to address the safety issue.
- Minmi Road / MacNaughton Avenue: the southbound to westbound right turn movement experience 332 seconds delay in the 2021 AM peak. The AM peak volume of the right turning traffic is only 7 vehicles /hour. This is primarily a safety issue for this low volume of traffic not being able to select gaps. Some of this traffic may decide instead to turn left and u-turn elsewhere, or the right turn may be banned in the future to address the safety issue.
- Tillie Street/Wilkinson Avenue: the westbound to northbound left turn movement experience 276 seconds delay in the 2021 PM peak. The PM peak volume of the right turning traffic is only 6 vehicles /hour. This is primarily a safety issue for this low volume of traffic not being able to select gaps. Some of this traffic may decide instead to turn left and u-turn elsewhere, or the right turn may be banned in the future to address the safety issue.

In addition, the northbound through movement at the Longworth Avenue/Newcastle Road/Thomas Street roundabout intersection will experience substantial delays in the 2021 PM peak.

5.1.3 Travel Times

Figure 5.7 and Figure 5.8 compare the 2021 Do Minimum AM peak clockwise and counter-clockwise cumulative travel times with the existing 2017 cumulative travel times. In the AM peak (clockwise direction of travel), an increase in travel time of nearly 20 minutes is predicted between Woodford Street and the Bunnings intersection, with over-capacity conditions at the south-east end of Minmi Road. In the AM peak (counter clockwise direction of travel), an increase in travel time by about 14 minutes is expected on approach to the Lake Road intersection, which is well over capacity.



Figure 5.7: 2021 Do Minimum Travel Time – Clockwise, AM Peak





Figure 5.9 and Figure 5.10 compare the 2021 Do Minimum PM peak clockwise and counter clockwise cumulative travel times with the 2017 PM cumulative travel times. In the PM peak (clockwise direction of travel) the Minmi Road intersection with the Newcastle Link Road is where travel times diverge significantly by about five minutes . In the PM peak (counter clockwise direction of travel), there is a sharp increase in travel times at the Lake Road intersection which is well over capacity, and then from Lake Road through to the Bunnings roundabout.



Figure 5.9: 2021 Do Minimum Travel Time – Clockwise, PM Peak





Figure 5.10: 2021 Do Minimum Travel Time – Counter Clockwise, PM Peak

5.1.4 2021 Do Minimum Traffic Performance Summary

In the event the predicted traffic growth is achieved, traffic demands along Minmi Road and Newcastle Link Road will be higher than the theoretical capacity. The 2021 Do Minimum traffic modelling predicts poor LoS at E/F for most of the intersections within the study area. In the AM peak, delays, queues and travel times in the eastbound direction will increase substantially while in the PM peak, the westbound vehicles will experience substantial delays, queues and increased travel time.

5.2 2021 Option Model Traffic Performance

5.2.1 2021 Option Model Network Changes

The 2021 Option Model was developed in order to identify key intersections / pinch points within the network which would require further improvements for the future year network.

5.2.2 Proposed Improvements for Year 2021

This section summarises the proposed improvements made to the 2021 network in order to cater for the increased 2021 traffic demand. Appendix B shows the intersection improvements made within the study area for Year 2021. The improvements were:

Cowper Street / Lake Road Intersection

- addition of one extra circulating lane between the Southern and Western approaches; and
- one additional exit lane on the Southern approach.

Cowper Street / Newcastle Road Intersection

The following modifications to Council design are required to service the 2021 traffic volumes:

- an additional traffic lane on the Cowper Street eastbound approach;
- the number of traffic lanes in the Newcastle Road northbound approach is reduced to one as shown in Figure 5.11.


Figure 5.11: Modified Layout of the Cowper Street / Newcastle Road Intersection

Sandgate Road / Wilkinson Avenue / Tillie Street Intersection

- realign the Wilkinson Avenue approach to join Sandgate Road/Tillie Street intersection and signalise the intersection with pedestrian crossings across the Sandgate Road (E), Wilkinson Avenue and Tillie Street approaches of the intersection;
- an additional lane on the Tillie Street approach (80m long) and on its departure (40m long);
- an additional lane on the Sandgate Road departure; and
- extend the short lane by banning peak hour kerb side parking on the approach and departure of Sandgate Road (W) as far as Dennis Place.

There are opportunities to refine the proposed design of this intersection. For example, it is possible to ban some turning movements including the ban of the eastbound to southbound right turn from Sandgate Road. The proposed ban will simplify traffic signal phase arrangement thereby improve traffic performance at this intersection. Council / Roads and Maritime will need to consider the design refinement during the concept design and option testing phase should this upgrade project proceed. It is beyond the scale of assessment/scope to consider this intersection upgrade detail to this extent in such a large network model.

Cowper Street / Kokera Street Intersection

The following modifications to Council design are required to service the 2021 traffic volumes:

- an additional traffic lane on the Cowper Street westbound approach:
- the exclusive left turn is proposed to be shared between left and through traffic as shown in Figure 5.12.





Figure 5.12: Modified Layout of the Cowper Street / Kokera Street Intersection

Cowper Street / Nelson Street Intersection

The following modifications to Council design are required to service the 2021 traffic volumes:

 the exclusive right turn lane on the westbound approach is proposed to be shared between right and through traffic as shown in Figure 5.13;



Figure 5.13: Modified Layout of the Cowper Street / Nelson Street Intersection

Cowper Street / Cameron Street Intersection

- ban the east to north right turn movement at the Cowper Street/Cameron Street intersection and introduce traffic signals at the Minmi Road/Sandgate Road intersection to provide the east to north right turn;
- reconfigure the intersection to incorporate an additional left turn slip lane from Minmi Road (N) to Sandgate Road (E) at the Sandgate Road/Minmi Road intersection;
- an additional lane on the departure side of Longworth Avenue; and
- reconfigure the intersection to allow two through lanes for eastbound traffic.

Further design refinement including additional right turn lane on the southbound approach should be considered during the concept design and option testing phase.

Minmi Road / Awabakal Road Intersection

• introduce an additional traffic lane for the westbound traffic.

Minmi Road / Highland Way Intersection

• reconfigure the current priority (T) intersection to a 4-way single lane roundabout.

Minmi Road / Woodford Street Intersection

• an additional right turn lane on Woodford Street (S) and an additional departure lane on Minmi Road (E).

Mid-block Road Capacity Improvements

- widen Minmi Road eastbound to two lanes between Awabakal Drive and Maryland Drive, Maryland Drive and Bottlebrush Boulevard, Bottlebrush Boulevard and Warkworth Street and Warkworth Street and Summerhill Road; and
- widen Minmi Road southbound to two-lanes between Cowper Street/Cameron Street and Longworth Avenue/Newcastle Road.

5.2.3 Intersection Analysis

The 2021 Option Model network performance was compared with the 2021 Do Minimum and the Base 2017 models network performance. Table 5.2 shows how the network performance for each scenario compares with one another.

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2021 Option Model Intersection Performance – AM and PM Peak Periods

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Table 5.2: 2021	2021 Option Model Intersection Performance – AM and PM Peak Periods								
Intersection	Intersection Control	LOS – AM (2017) (delay in seconds)	LOS – AM (2021 Do Minimum) (delay in seconds)	LOS – AM (2021 Option Model) (delay in seconds)	LOS – PM (2017) (delay in seconds)	LOS – PM (2021 Do Minimum) (delay in seconds)	LOS – PM (2021 Option Model) (delay in seconds)		
Woodford Street / Newcastle Link Road / Cameron Park Drive	8	C (36)	E (67)	B (41)	C (42)	D (49)	D (56)		
Woodford Street / Minmi Road		B (19)	B (25)	C (39)	B (19)	B (28)	C (39)		
Brookfield Avenue / Minmi Road	GIVE	A (5)	A (5)	A (10)	A (5)	A (5)	A (7)		
Minmi Road / Highland Way	GIVE	A (8)	C (34)	A (7)	A (7)	A (12)	A (10)		
Minmi Road / Britannia Boulevard	\heartsuit	A (6)	C (34)	A (7)	A (5)	A (7)	A (9)		
Kurraka Drive / Minmi Road	\heartsuit	A (7)	F (175)	A (14)	A (4)	A (4)	A (6)		
Awakabal Drive / Minmi Road / Bellbird Close		B (24)	F (110)	B (28)	B (18)	B (20)	B (18)		
Maryland Drive / Minmi Road / Churnwood Drive		B (25)	E (63)	B (27)	B (27)	B (28)	B (29)		
Minmi Road / Bottlebrush Boulevard	Ø	A (10)	D (53)	A (7)	A (6)	A (9)	A (10)		
Warkworth Street / Minmi Road	GIVE	B (18)	C (43)	C (43)	A (11)	A (14)	A (15)		
Minmi Road / Summerhill Road	Ŵ	A (7)	B (25)	B (45)	A (12)	B (19)	B (18)		
McNaughton Avenue / Minmi Road	GIVE	D (45)	F (332)	E (60)	B (27)	B (26)	B (28)		
Maryland Drive / Minmi Road	8	B (17)	F (85)	B (22)	B (18)	B (20)	B (22)		
Creek Road / Minmi Road / Macquarie Street	8	C (38)	D (53)	C (32)	B (28)	C (31)	C (31)		
Minmi Road / Bunnings	Ø	A (15)	B (17)	B (16)	B (27)	C (36)	C (38)		
Sandgate Road / Minmi Road	GIVE	B (25)	F (79)	B (24)	B (29)	C (35)	C (34)		
Cameron Street / Longworth Avenue / Cowper Street / Minmi Road		C (34)	C (41)	C (33)	C (39)	D (46)	D (45)		
Sandgate Road / Tillie Street		B (16)	B (17)	С	C (34)	D (48)	С		
Tillie Street / Wilkinson Avenue		B (26)	C (33)	(36)	E (57)	F (256)	(35)		
Tillie Street / Douglas Street / Cameron Street	GIVE	C (40)	E (69)	C (33)	C (34)	E (58)	B (17)		
Thomas Street / Walford Street	8	B (24)	D (52)	B (27)	A (14)	F (84)	B (20)		
Longworth Avenue / Newcastle Road / Thomas Street	Ø	E (69)	F (76)	E (70)	B (27)	F (136)	F (122)		
Newcastle Road / Cowper Street	GIVE	B (29)	B (26)	C (38)	B (27)	C (37)	C (34)		
Kokera Street / Cowper Street	V	B (20)	C (42)	D (47)	B (17)	B (18)	C (41)		
Metcalfe Street / Thomas Street	8	B (17)	B (24)	B (18)	B (22)	D (48)	B (28)		
Lake Road / Cowper Street	$\mathbf{\nabla}$	A (11)	E (58)	E (59)	E (59)	E (58)	D (50)		
Lake Road / Thomas Street / Newcastle Link Road		D (49)	F (91)	F (74)	F (72)	F (124)	E (58)		
Newcastle Link Road / Minmi Road	\heartsuit	B (28)	C (36)	A (8)	E (61)	F (80)	A (9)		
Nelson Street / Cowper Street		B (19)	B (21)	D (46)	B (18)	B (17)	B (21)		

5.2.4 Travel Time Analysis

The 2021 Option Model travel time was compared to the 2021 Do Minimum and the Base 2017 models. Figure 5.14 through Figure 5.17 compare the clockwise and counter clockwise cumulative travel times. The results **show that the upgrades in the 2021 Option Model ('Do Something') mitigate most of the travel time impacts** that would occur if nothing was done. With some of the interventions however aimed at improving conditions in the peak direction of travel in the AM, then counter-peak direction does worsen, particularly along sections of the Newcastle Link Road.



Figure 5.14: 2021 Travel Time – Clockwise, AM Peak













5.2.5 2021 Option Model Traffic Performance Summary

The 2021 Option Model provides a significant travel benefit to the study area when compared to the 2021 Do Minimum scenario. It is noted that some specific intersections are shown to experience a decrease in performance when compared to the Do Minimum scenario. This is partly due to the increase in traffic flow to key intersections as a result of increased upstream capacity **essentially 'flooding' the next downstream pinch** point. Overall though, the increased capacity provided at pinch points leads to significant improvements in travel time in both the AM and PM peak hour.

6. 2026 NETWORK ASSESSMENT

6.1 2026 Do Minimum Traffic Performance

6.1.1 Do Minimum Network Assumptions

The Do Minimum 2026 VISSIM Model was developed using the 2021 Option Model road network and the traffic demand for year 2026. This was done to identify key intersections / pinch points within the network which would require further improvements for the future year network.

6.1.2 2026 Link Traffic Volumes – AM and PM Peaks

The link / network volumes for the Do Minimum 2026 AM and PM peak period have been extracted from VISSIM as shown in Figure 6.1 and Figure 6.2.



Figure 6.1: Link Volumes - 2026 Do Minimum, AM





6.1.3 Intersection Analysis

The 2026 Do Minimum AM and PM intersection traffic performance is compared against the 2017 and 2021 Option Model in Table 6.1. Most of the key intersections along Minmi Road, Newcastle Link Road and Thomas Street operate at LoS E-F with substantial delays for general traffic.

In the AM peak, significant delays and queue build-up for the general eastbound traffic is observed at:

- Woodford Street / Newcastle Link Road / Cameron Park Drive intersection as shown in Figure 6.3;
- along Minmi Road at Minmi Road / Kurraka Drive, Minmi Road / Awabakal Drive and Minmi Road / Highland Way intersections as shown in Figure 6.4; and
- along Minmi Road at Minmi Road / Bottlebrush Boulevard, Warkworth Street / Minmi Road and Minmi Road / Summerhill Road intersections as shown in Figure 6.5.



Figure 6.3: Queues at Woodford Street / Newcastle Link Road- 2026 Do Minimum, AM Peak







Figure 6.5: Minmi Road Queues (Summerhill-Warkworth)–2026 Do Minimum, AM Peak

In the PM peak, significant delays and queue build-up for the general eastbound traffic is observed at:

- Lake Road / Thomas Street / Newcastle Link Road intersection as shown in Figure 6.6; and
- along Minmi Road at Minmi Road / Bunnings and Sandgate Road / Minmi Road intersections as shown in Figure 6.7.





Figure 6.6: Queues at Lake / Thomas / Cowper – 2026 Do Minimum, PM Peak



Figure 6.7: Queues at Minmi / Bunnings / Sandgate – 2026 Do Minimum, PM Peak

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2026 Do Minimum Intersection Performance - AM and PM Peak Periods

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Table 6.1:2026 Do Minimum Intersection Performance – AM and PM Peak Periods									
Intersection	Intersection Control	LOS – AM (2017) (delay in seconds)	LOS – AM (2021 Option Model) (delay in seconds)	LOS – AM (2026 Do Minimum) (delay in seconds)	LOS – PM (2017) (delay in seconds)	LOS – PM (2021 Option Model) (delay in seconds)	LOS – PM (2026 Do Minimum) (delay in seconds)		
Woodford Street / Newcastle Link Road / Cameron Park Drive		C (36)	E (67)	D (49)	C (42)	D (49)	E (60)		
Woodford Street / Minmi Road		B (19)	B (25)	C (40)	B (19)	B (28)	D (45)		
Brookfield Avenue / Minmi Road	GIVE	A (5)	A (5)	C (40)	A (5)	A (5)	A (10)		
Minmi Road / Highland Way	GIVE	A (8)	C (34)	A (11)	A (7)	A (12)	A (14)		
Minmi Road / Britannia Boulevard		A (6)	C (34)	A (11)	A (5)	A (7)	A (15)		
Kurraka Drive / Minmi Road		A (7)	F (175)	D (45)	A (4)	A (4)	A (6)		
Awakabal Drive / Minmi Road / Bellbird Close	8	B (24)	F (110)	C (36)	B (18)	B (20)	B (18)		
Maryland Drive / Minmi Road / Churnwood Drive		B (25)	E (63)	C (36)	B (27)	B (28)	C (31)		
Minmi Road / Bottlebrush Boulevard	\diamond	A (10)	D (53)	F (86)	A (6)	A (9)	A (12)		
Warkworth Street / Minmi Road	GIVE	B (18)	C (43)	F (157)	A (11)	A (14)	A (13)		
Minmi Road / Summerhill Road	V	A (7)	B (25)	F (94)	A (12)	B (19)	B (21)		
McNaughton Avenue / Minmi Road	GIVE	D (45)	F (332)	F (80)	B (27)	B (26)	D (46)		
Maryland Drive / Minmi Road		B (17)	F (85)	B (19)	B (18)	B (20)	B (21)		
Creek Road / Minmi Road / Macquarie Street		C (38)	D (53)	C (31)	B (28)	C (31)	C (33)		
Minmi Road / Bunnings	\diamond	A (15)	В (17)	B (24)	B (27)	C (36)	D (54)		
Sandgate Road / Minmi Road	GIVE	B (25)	F (79)	B (29)	B (29)	C (35)	D (47)		
Cameron Street / Longworth Avenue / Cowper Street / Minmi Road		C (34)	C (41)	C (35)	C (39)	D (46)	D (44)		
Sandgate Road / Tillie Street		B (16)	B (17)	C (33)	C (34)	D (48)	C (32)		
Tillie Street / Wilkinson Avenue	GIVE	B (26)	(33)		E (57)	F (256)			
Tillie Street / Douglas Street / Cameron Street	GIVE	C (40)	E (69)	C (33)	C (34)	E (58)	B (18)		
Thomas Street / Walford Street		B (24)	D (52)	C (33)	A (14)	F (84)	C (31)		
Longworth Avenue / Newcastle Road / Thomas Street		E (69)	F (76)	E (62)	B (27)	F (136)	F (118)		
Newcastle Road / Cowper Street	GIVE C	B (29)	B (26)	E (60)	B (27)	C (37)	D (45)		
Kokera Street / Cowper Street		B (20)	C (42)	D (54)	B (17)	B (18)	C (41)		
Metcalfe Street / Thomas Street		B (17)	B (24)	B (20)	B (22)	D (48)	С (37		
Lake Road / Cowper Street	\bigotimes	A (11)	E (58)	F (76)	E (59)	E (58)	C (33)		
Lake Road / Thomas Street / Newcastle Link Road		D (49)	F (91)	F (92)	F (72)	F (124)	E (64)		
Newcastle Link Road / Minmi Road	$\overline{\mathbf{v}}$	B (28)	C (36)	D (45)	E (61)	F (80)	E (61)		
Nelson Street / Cowper Street		B (19)	B (21)	D (57)	B (18)	B (17)	B (22)		

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6.1.4 Travel Time Analyses

Figure 6.8 and Figure 6.9 compare the 2026 Do Minimum AM peak clockwise and counter clockwise cumulative travel times with the existing 2017 and the 2021 Option Model cumulative travel times. Comparing the 2026 Do Minimum and the 2021 Option Model for the AM peak (clockwise direction of travel), a jump in in travel time of about 10 minutes is predicted at the Maryland Drive intersection. In the counter clockwise direction of travel, there are clear travel time increases at Cameron Park Drive and between Churnwood Drive and the Bunnings roundabout.











Figure 6.10 and Figure 6.11 compare the 2026 Do Minimum PM peak clockwise and counter clockwise cumulative travel times with the 2017 and the 2021 Option Model PM cumulative travel times. Comparing the 2026 Do Minimum and 2021 Option Model 2021 in the PM peak (clockwise direction of travel) shows jump in travel time on approach to Cameron Park Drive. In the PM peak counter clockwise direction of travel, there is a steady increase in travel times between Lake Road and the Bunnings roundabout.



Figure 6.10: 2026 Do Minimum Travel Time – Clockwise, PM Peak



Figure 6.11: 2026 Do Minimum Travel Time – Counter Clockwise, PM Peak

6.1.5 2026 Do Minimum Traffic Performance Summary

In the event the predicted traffic growth is achieved, traffic volumes along Minmi Road and Newcastle Link Road will be higher than the theoretical capacity. The 2026 Do Minimum scenario traffic modelling predicts a marginally worse level of performance for most intersections along the road corridor when compared to the 2021 Option Model scenario. Specifically, the modelling showed significant queueing along Minmi Road on the northern approach to the Cowper Road intersection.

6.2 2026 Option Model Traffic Performance

6.2.1 2026 Option Model Network Changes

The 2026 Option Model was developed in order to address deficiencies at key intersections / pinch points within the network.

6.2.2 Proposed Improvements for Year 2026

This section summarises the proposed improvements made to the 2026 network in order to cater for the increased 2026 traffic demand. Appendix C shows the intersection improvements made within the study are for the Year 2026. The improvements were:

Cowper Street / Kokera Street Intersection

- an additional lane (80m long) for the east to north movement;
- an additional eastbound lane on the Cowper Street departure as far as Brooks Street; and
- re-configure the eastbound kerb side lane to be a shared left and through lane.

Cowper Street / Nelson Street Intersection

- an additional departure lane in Cowper Street (E) as far as Murnin Street;
- extend the westbound short lane between Nelson Street and Newcastle Road; and
- one lane on the Nelson Street approach. This will reduce length of the pedestrian crossing. Vehicles
 existing the Wallsend Town centre can alternatively use the Cowper Street / Newcastle Road
 roundabout.

Cowper Street / Newcastle Road Intersection

 an additional short northbound lane (25m long) on the northbound approach of Newcastle Road and consequently an additional short lane (60m) on the exit side of Cowper Street (E).

Sandgate Road / Wilkinson Avenue / Tillie Street Intersection

extend the two-lane section on the Tillie Street approach by 70m.

Cowper Street / Cameron Street Intersection

- an additional southbound lane at the Minmi Road/Sandgate Road/Cowper Street/Cameron Street intersection; and
- an additional northbound short lane (65m) at the Longworth Avenue approach.

Minmi Road / Bunnings Intersection

- an additional departure lane northbound; and
- re-configure the northbound approach so that the kerb side lane is shared between through and left turning traffic.



Minmi Road / Maryland Drive Intersection

 re-configure the southbound left turn from priority control (give-way) to a slip lane configuration and introduce an additional traffic lane on the eastbound departure.

Minmi Road / McNaughton Avenue Intersection

- additional lane eastbound and westbound; and
- exclusive (60m) left turn lane on McNaughton Avenue.

Minmi Road / Woodford Street Intersection

- an additional northbound lane between Bell Street and Minmi Road;
- two left turn lanes on the westbound approach: one 50m lane and one full lane; and
- an additional southbound lane on Woodford Street south of the intersection.

Mid-block Road Capacity Improvements

- widen Minmi Road to two-lanes eastbound between Anna Place and Maryland Drive;
- widen Minmi Road to three-lanes eastbound between Maryland Drive and Fletcher Street;
- widen Minmi Road to two-lanes westbound between Bunnings and Macquarie Street and between Maryland Drive and Anna Place;
- widen Minmi Road to two-lanes eastbound between McInnes Street and McCarthy Street and between McCarthy Street and McInnes Street;
- widen Cowper street to two-lanes eastbound between Kokera Street and Nelson Street, between Newcastle Road and Union Street and between John Street and Minmi Road;
- widen Cowper Street to two-lanes westbound between Union Street and Newcastle Road;
- ban peak hour kerb side parking along Woodford Street between Minmi Road and Railway Street southbound and between Bell Street and Minmi Road northbound; and
- ban peak hour kerb side parking along Cowper Street between Lake Road and Kokera Street and between Nelson Street and Newcastle Road eastbound and between Newcastle Road and Nelson Street westbound and between Kokera Street and Lake Road westbound.

6.2.3 Intersection Analysis

The 2026 Option Model network performance was compared with the 2026 Do Minimum and the Base 2017 models network performance. Table 6.2 shows the comparison of the network performance across each scenario.

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Table 6.2:

2026 Option Model Intersection Performance – AM and PM Peak Periods

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Intersection	Intersection Control	LOS – AM (2017) (delay in seconds)	LOS – AM (2026 Do Minimum) (delay in seconds)	LOS – AM (2026 Option Model) (delay in seconds)	LOS – PM (2017) (delay in seconds)	LOS – PM (2026 Do Minimum) (delay in seconds)	LOS – PM (2026 Option Model) (delay in seconds)
Woodford Street / Newcastle Link Road / Cameron Park Drive		C (36)	D (49)	D (47)	C (42)	E (60)	D (48)
Woodford Street / Minmi Road	8	B (19)	C (40)	B (24)	B (19)	D (45)	B (26)
Brookfield Avenue / Minmi Road	GIVE	A (5)	C (40)	A (10)	A (5)	A (10)	A (9)
Minmi Road / Highland Way	GIVE	A (8)	A (11)	B (23)	A (7)	A (14)	B (17)
Minmi Road / Britannia Boulevard	$\overline{\mathbf{A}}$	A (6)	A (11)	A (12)	A (5)	A (15)	A (12)
Kurraka Drive / Minmi Road	$\overline{\mathbf{Q}}$	A (7)	D (45)	F (196)	A (4)	A (6)	A (6)
Awakabal Drive / Minmi Road / Bellbird Close	8	B (24)	C (36)	C (31)	B (18)	B (18)	B (19)
Maryland Drive / Minmi Road / Churnwood Drive		B (25)	C (36)	B (29)	B (27)	C (31)	C (32)
Minmi Road / Bottlebrush Boulevard	\heartsuit	A (10)	F (86)	A (6)	A (6)	A (12)	A (14)
Warkworth Street / Minmi Road	GIVE	B (18)	F (157)	F (101)	A (11)	A (13)	B (15)
Minmi Road / Summerhill Road	$\overline{\mathbf{v}}$	A (7)	F (94)	A (6)	A (12)	B (21)	D (45)
McNaughton Avenue / Minmi Road	GIVE	D (45)	F (80)	C (36)	B (27)	D (46)	B (22)
Maryland Drive / Minmi Road		B (17)	B (19)	B (28)	B (18)	B (21)	B (19)
Creek Road / Minmi Road / Macquarie Street	8	C (38)	C (31)	C (40)	B (28)	C (33)	D (44)
Minmi Road / Bunnings	Ø	A (15)	B (24)	B (22)	B (27)	D (54)	B (18)
Sandgate Road / Minmi Road		B (25)	B (29)	B (24)	B (29)	D (47)	C (31)
Cameron Street / Longworth Avenue / Cowper Street / Minmi Road		C (34)	C (35)	C (34)	C (39)	D (44)	C (40)
Sandgate Road / Tillie Street	GIVE	B (16)	С	С	C (34)	С	С
Tillie Street / Wilkinson Avenue	GIVE	B (26)	(32.4)	(35)	E (57)	(32)	(34)
Tillie Street / Douglas Street / Cameron Street	GIVE	C (40)	C (33)	C (33)	C (34)	B (18)	B (23)
Thomas Street / Walford Street		B (24)	C (33)	C (33)	A (14)	C (31)	B (25)
Longworth Avenue / Newcastle Road / Thomas Street	Ø	E (69)	E (62)	F (196)	B (27)	F (118)	F (111)
Newcastle Road / Cowper Street	GIVE	B (29)	E (60)	B (26)	B (27)	D (45)	F (84)
Kokera Street / Cowper Street		B (20)	D (54)	C (32)	B (17)	C (41)	C (36)
Metcalfe Street / Thomas Street		B (17)	B (20)	B (20)	B (22)	C (37	C (31)
Lake Road / Cowper Street	V	A (11)	F (76)	B (19)	E (59)	C (33)	B (22)
Lake Road / Thomas Street / Newcastle Link Road		D (49)	F (92)	E (65)	F (72)	E (64)	E (67)
Newcastle Link Road / Minmi Road	Ø	B (28)	D (45)	C (33)	E (61)	E (61)	C (36)
Nelson Street / Cowper Street	8	B (19)	D (57)	B (17)	B (18)	B (22)	A (15)



A detailed analysis shows that some intersections in the 2026 option models will fail with LoS F. A detailed analysis shows that this is due to selected failing movements which are very lightly trafficked. The failing movements at each intersection is identified below:

- Kurraka Drive/Minmi Road: the southbound to westbound right turn movement will experience 196 seconds delay in the AM peak. The volume of the right turning traffic is only 58 vehicles / hour. This is primarily a safety issue for this volume of traffic not being able to select gaps. Some of this traffic may decide instead to turn left and u-turn elsewhere, or the right turn may be banned in the future to address the safety issue; and
- Warkworth Street/Minmi Road: the southbound to westbound right turn movement will experience 101
 seconds delay in the AM peak. The volume of the right turning traffic is only 83 vehicles / hour This is
 primarily a safety issue for this volume of traffic not being able to select gaps. Some of this traffic may
 decide instead to turn left and u-turn elsewhere, or the right turn may be banned in the future to
 address the safety issue.

6.2.4 Travel Time Analysis

The 2026 Option Model travel time was compared to the 2026 Do Minimum and the Base 2017 model travel time, as shown in Figure 6.12 and Figure 6.15. the results generally show that the infrastructure upgrades in the Option Model (Do Something) result in overall lower travel times and more consistent speeds, although there are some localised exceptions where released traffic from an upgrade 'floods' a downstream pinch point.



Figure 6.12: 2026 Travel Time – Clockwise, AM Peak







Figure 6.14: 2026 Travel Time – Clockwise, PM Peak



Figure 6.15: 2026 Travel Time – Counter Clockwise, PM Peak

6.2.5 2026 Option Model Traffic Performance Summary

The 2026 Option Model shows an improvement in intersection performance across the study area when compared to the 2026 Do Minimum scenario. There is more consistent performance of the network and **'flattening out' of critical pinch points.** These capacity improvements resulted in general reductions in travel time across the study area.

7. 2036 NETWORK ASSESSMENT

7.1.1 Do Minimum Network Assumptions

The Do Minimum 2036 Model was developed using the 2026 Option Model road network and the traffic demand for the year 2036. The model was run to identify key pinch points within the network which would require upgrades.

7.1.2 2036 Link Traffic Volumes – AM and PM Peaks

The link/network volumes for the Do Minimum 2026 AM and PM peak period have been extracted from VISSIM as shown in Figure 7.1 and Figure 7.2.



Figure 7.1: Link Volumes - 2036 Do Minimum, AM



Figure 7.2: Link Volumes - 2036 Do Minimum, PM



7.1.3 Intersection Analysis

The 2036 Do Minimum AM and PM intersection traffic performance is compared against the 2017 and Option Model in Table 7.1. Most of the key intersections along Minmi Road, Newcastle Link Road and Thomas Street operate at LoS E-F with substantial delays for general traffic in 2036.

In the AM peak, significant delays and queue build-up for the general eastbound traffic is observed at:

- Woodford Street / Newcastle Link Road / Cameron Park Drive intersection as shown in Figure 7.3; and
- along Minmi Road at Minmi Road / Bottlebrush Boulevard, Warkworth Street / Minmi Road, Minmi Road / Summerhill Road and Minmi Road / McNaughton Avenue intersections as shown in Figure 7.4.









In the PM peak, significant delays and queue build-up for eastbound traffic is observed at:

- Lake Road / Thomas Street / Newcastle Link Road intersection as shown in Figure 7.5; and
- along Minmi Road at Minmi Road / Macquarie Street / Creek Road, Minmi Road / Bunnings and Sandgate Road / Minmi Road intersections as shown in Figure 7.6.



Figure 7.5: Queues at Lake / Thomas / Cowper– 2036 Do Minimum, PM Peak





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Table 7.1:2036 Do Minimum Intersection Performance – AM and PM Peak Periods									
Intersection	Intersection Control	LOS – AM (2017) (delay in seconds)	LOS – AM (2026 Option Model) (delay in	LOS – AM (2036 Do Minimum) (delay in	LOS – PM (2017) (delay in seconds)	LOS – PM (2026 Option Model) (delay in	LOS – PM (2036 Do Minimum) (delay in		
Woodford Street / Newcastle Link Road / Cameron Park Drive	8	C (36)	D (47)	E (58)	C (42)	D (48)	D (54)		
Woodford Street / Minmi Road		B (19)	B (24)	B (28)	B (19)	B (26)	D (55)		
Brookfield Avenue / Minmi Road	GIVE	A (5)	A (10)	D (51)	A (5)	A (9)	A (13)		
Minmi Road / Highland Way		A (8)	B (23)	C (35)	A (7)	B (17)	B (21)		
Minmi Road / Britannia Boulevard	Ŵ	A (6)	A (12)	B (19)	A (5)	A (12)	B (16)		
Kurraka Drive / Minmi Road	Ý	A (7)	F (196)	F (353)	A (4)	A (6)	A (6)		
Awakabal Drive / Minmi Road / Bellbird Close	8	B (24)	C (31)	C (33)	B (18)	B (19)	B (19)		
Maryland Drive / Minmi Road / Churnwood Drive		B (25)	B (29)	C (29)	B (27)	C (32)	C (32)		
Minmi Road / Bottlebrush Boulevard	Ŵ	A (10)	A (6)	A (11)	A (6)	A (14)	B (16)		
Warkworth Street / Minmi Road		B (18)	F (101)	F (217)	A (11)	B (15)	B (18)		
Minmi Road / Summerhill Road	Ý	A (7)	A (6)	C (38)	A (12)	D (45)	F (216)		
McNaughton Avenue / Minmi Road	GIVE	D (45)	C (36)	F (336)	B (27)	B (22)	E (59)		
Maryland Drive / Minmi Road		B (17)	B (28)	D (44)	B (18)	B (19)	B (23)		
Creek Road / Minmi Road / Macquarie Street		C (38)	C (40)	D (46)	B (28)	D (44)	D (51)		
Minmi Road / Bunnings	V	A (15)	B (22)	C (36)	B (27)	B (18)	F (89)		
Sandgate Road / Minmi Road		B (25)	B (24)	B (27)	B (29)	C (31)	D (51)		
Cameron Street / Longworth Avenue / Cowper Street / Minmi Road	8	С (34)	C (34)	C (43)	C (39)	C (40)	E (64)		
Sandgate Road / Tillie Street		B (16)	С	С	C (34)	С	С		
Tillie Street / Wilkinson Avenue	GIVE	B (26)	(35)	(35)	E (57)	(34)	(38)		
Tillie Street / Douglas Street / Cameron Street	GIVE	C (40)	C (33)	C (38)	C (34)	B (23)	C (31)		
Thomas Street / Walford Street		B (24)	C (33)	C (39)	A (14)	B (25)	C (40)		
Longworth Avenue / Newcastle Road / Thomas Street	V	E (69)	F (196)	F (149)	B (27)	F (111)	F (225)		
Newcastle Road / Cowper Street		B (29)	B (26)	F (113)	B (27)	F (84)	F (127)		
Kokera Street / Cowper Street	V	B (20)	C (32)	C (36)	B (17)	C (36)	C (78)		
Metcalfe Street / Thomas Street		B (17)	B (20)	B (21)	B (22)	C (31)	B (36)		
Lake Road / Cowper Street	V	A (11)	B (19)	B (20)	E (59)	B (22)	B (87)		
Lake Road / Thomas Street / Newcastle Link Road		D (49)	E (65)	E (67)	F (72)	E (67)	E (77)		
Newcastle Link Road / Minmi Road	V	B (28)	C (33)	D (50)	E (61)	C (36)	D (50)		
Nelson Street / Cowper Street		B (19)	B (17)	B (19)	B (18)	A (15)	B (36)		

7.1.4 Travel Times

Figure 7.7 and Figure 7.8 compare the 2036 Do Minimum AM peak clockwise and counter clockwise cumulative travel times with the 2017 Model and the 2026 Option Model. The 2036 Do Minimum Model in the AM peak (clockwise direction of travel) shows a progressive increase in travel time from Churnwood Road to the Bunnings intersection compared to the 2026 Option Model. In the counter-clockwise direction of travel, travel times steadily worsen from the Minmi Road intersection to the Lake Road intersection.



Figure 7.7: 2036 Do Minimum Travel Time – Clockwise, AM Peak



Figure 7.8: 2036 Do Minimum Travel Time – Counter Clockwise, AM Peak



Figure 7.9 and Figure 7.10 compare the 2036 Do Minimum PM peak clockwise and counter clockwise cumulative travel times with the existing 2017 and the 2026 Option Model ('Do Something') PM cumulative travel times. The comparison shows that during the PM peak (clockwise direction of travel) there is a sharp increase in travel times from the Bunnings intersection to Lake Road. In the PM peak (counter clockwise direction of travel), there is a steady increase in travel time between Churwood Drive and Cameron Park Drive.



Figure 7.9: 2036 Do Minimum Travel Time – Clockwise, PM Peak



Figure 7.10: 2036 Do Minimum Travel Time – Counter Clockwise, PM Peak

7.1.5 2036 Do Minimum Traffic Performance Summary

The 2036 Do Minimum scenario yielded a significant increase in travel times, reduced intersection performance with much longer queues when compared to the 2026 Option Model. The extent of planned development between 2026 and 2036 is a key contributor to the excessive queuing and delays, coupled with the limited access/egress routes available. Queues at the Minmi Road / Cowper Street / Cameron Street intersection were seen to extend to Macquarie Street in the model and average intersection delays at the Longworth Avenue / Newcastle Road / Thomas Street intersection increased from 110 seconds to 225 seconds.

7.2 2036 Option Model Traffic Performance

7.2.1 2036 Option Model Network Changes

The 2036 Option Model was developed, tested and optimised in order to address the key intersection pinch point deficiencies within the network.

7.2.2 Proposed Improvements for Year 2036

This section summarises the proposed improvements made to the 2036 network in order to cater for the increased 2036 traffic demand. Appendix D shows the intersection improvements identified as being required by 2036. The improvements were:

Cowper Street / Newcastle Road Intersection

- extend the additional short northbound traffic lane as far as Dangar Street; and
- extend the additional short departure lane in Cowper Street (E) to a full traffic lane.

Cowper Street / Cameron Street Intersection

• free-flow left turn lane from north to east traffic at the Minmi Road / Sandgate Road intersection.

Sandgate Road / Wilkinson Avenue / Tillie Street Intersection

 re-configure the short lane heading east to west on Sandgate Road to a full lane between Sandgate Road/Wilkinson Avenue/Tillie Street and Minmi Road/Sandgate Road.

Minmi Road / Bunnings Intersection

- introduce traffic signals with pedestrian crossings on all three approaches. The existing roundabout configuration will not service the 2036 traffic volumes as long queues were observed on all approaches especially on the Bunnings exit approach. Roundabouts generally work well when approach flows are balanced. However, future traffic flows are heavily imbalanced with much higher through movements. Traffic signals are required to reduce excessive traffic delays and associated queues;
- three through lanes and one dedicated right turn lane (35m long) on the southbound approach; and
- three through lanes on the northbound approach.

Minmi Road / Macquarie Street / Creek Road Intersection

- additional lane eastbound and westbound on Minmi Road; and
- ban peak hour kerb side parking at the Macquarie Street approach to provide two full lanes.

Minmi Road / Warkworth Street Intersection

- additional lane on Minmi Road eastbound;
- re-configure the westbound approach, so that the median lane is shared between through and right turn movements;
- an additional through lane on the Minmi Road westbound departure;
- an additional 50m left turn lane on Warkworth Street;
- other forms of intersection including the introduction of a roundabout will potentially reduce traffic delays on Warkworth Street. However, a roundabout in this location will potentially increase traffic



flows though Warkworth Street which is not designed to service high through traffic volumes. There are direct house frontages and increased through traffic in this street will impact residential amenity and local traffic safety.

Minmi Road / Kurraka Drive Intersection

- an additional lane on Minmi Road eastbound; and
- an additional 60m left turn short lane on Kurraka Drive.

Minmi Road / Britannia Boulevard Intersection

• an additional lane on Minmi Road eastbound.

Minmi Road / Highland Way Intersection

It is important to note that the following upgrade will only be required if the full level of development in the model area is realised. It may be preferable that this project not be further considered now, and the (roundabout) intersection is monitored into the future to determine if this configuration needs to be changed at that time. This change, if required, would be likely to require the following:

- re-configure the roundabout to a priority type (give-way) intersection. This is required to reduce delays
 for the eastbound and westbound Minmi Road movements by prioritising them over the minor legs of
 the intersection;
- an additional left turn lane on the Highland Way northbound approach; and
- an additional traffic lane on Minmi Road eastbound.

Minmi Road / Blue Gum Hills Road Intersection

- an additional traffic lane on Minmi Road eastbound;
- an additional free flow short left turn lane on Blue Gum Hills Road (south); and
- an additional westbound traffic lane on Minmi Road west of the intersection.

Minmi Road / Woodford Street Intersection

ban peak hour kerb side parking on Woodford Street southbound approach to provide two traffic lanes.

Mid-block Road Capacity Improvements

- widen Minmi Road to two-lanes eastbound between McCarthy Street and Awabakal Drive;
- widen Minmi Road to three-lanes eastbound between Fletcher Street and Sandgate Road;
- widen Minmi Road to three-lanes westbound between Sandgate Road and Maryland Drive;
- widen Minmi Road to two-lanes westbound between Summerhill Road and Bottlebrush Boulevard, between Bottlebrush Boulevard and Churnwood Drive, and between Blue Gum Hills Road and McInnes Street;
- widen Cowper Street to two-lanes each way between Union Street and John Street;
- ban peak hour kerb side parking on the Woodford Street Southbound to provide two lanes;
- ban peak hour kerb side parking along Woodford Street between Railway Street and Bell Street northbound; and
- ban peak hour kerb side parking on Sandgate Road between Minmi Road and Tillie Street.

7.2.3 Intersection Analysis

The 2036 Option Model network performance was compared with the 2036 Do Minimum and the Base 2017 models network performance. Table 7.2 shows how network performance for each scenario.

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Table 7.2:2036 Option Model Intersection Performance – AM and PM Peak Periods									
Intersection	Intersection Control	LOS – AM (2017) (delay in seconds)	LOS – AM (2036 Do Minimum) (delay in seconds)	LOS – AM (2036 Option Model) (delay in seconds)	LOS – PM (2017) (delay in seconds)	LOS – PM (2036 Do Minimum) (delay in seconds)	LOS – PM (2036 Option Model) (delay in seconds)		
Woodford Street / Newcastle Link Road / Cameron Park Drive	8	C (36)	E (58)	D (50)	C (42)	D (54)	D (47)		
Woodford Street / Minmi Road	8	B (19)	B (28)	C (30)	B (19)	D (55)	C (32)		
Brookfield Avenue / Minmi Road	GIVE	A (5)	D (51)	A (11)	A (5)	A (13)	A (11)		
Minmi Road / Highland Way	GIVE	A (8)	C (35)	A (13)	A (7)	B (21)	A (13)		
Minmi Road / Britannia Boulevard	<u></u>	A (6)	B (19)	A (10)	A (5)	B (16)	B (18)		
Kurraka Drive / Minmi Road	V	A (7)	F (353)	A (11)	A (4)	A (6)	A (6)		
Awakabal Drive / Minmi Road / Bellbird Close	8	B (24)	C (33)	C (38)	B (18)	B (19)	B (21)		
Maryland Drive / Minmi Road / Churnwood Drive		B (25)	C (29)	C (41)	B (27)	C (32)	C (38)		
Minmi Road / Bottlebrush Boulevard	$\overline{\mathbf{v}}$	A (10)	A (11)	A (8)	A (6)	B (16)	D (49)		
Warkworth Street / Minmi Road	GIVE	B (18)	F (217)	D (57)	A (11)	B (18)	C (41)		
Minmi Road / Summerhill Road	$\mathbf{\nabla}$	A (7)	C (38)	A (4)	A (12)	F (216)	B (16)		
McNaughton Avenue / Minmi Road	GIVE	D (45)	F (336)	C (41)	B (27)	E (59)	D (44)		
Maryland Drive / Minmi Road	_ 8 _	B (17)	D (44)	B (16)	B (18)	B (23)	B (27)		
Creek Road / Minmi Road / Macquarie Street		C (38)	D (46)	B (29)	B (28)	D (51)	C (38)		
Minmi Road / Bunnings	V 🚦	A (15)	C (36)	A (7)	B (27)	⊦ (89)	A (8)		
Sandgate Road / Minmi Road	GIVE	В (25)	В (27)	В (17)	В (29)	D (51)	В (21)		
Cameron Street / Longworth Avenue / Cowper Street / Minmi Road		C (34)	C (43)	C (34)	C (39)	E (64)	C (38)		
Sandgate Road / Tillie Street	GIVE	B (16)	С	В	C (34)	С	C (32)		
Tillie Street / Wilkinson Avenue	GIVE	B (26)	(35)	(29)	E (57)	(38)			
Tillie Street / Douglas Street / Cameron Street	GIVE	C (40)	C (38)	C (35)	C (34)	C (31)	C (23)		
Thomas Street / Walford Street	8	B (24)	C (39)	B (23)	A (14)	C (40)	B (37)		
Longworth Avenue / Newcastle Road / Thomas Street	$\mathbf{\nabla}$	E (69)	F (149)	A (14)	B (27)	F (225)	A (47)		
Newcastle Road / Cowper Street	GIVE	B (29)	F (113)	A (15)	B (27)	F (127)	A (19)		
Kokera Street / Cowper Street	V 🛯	B (20)	C (36)	C (35)	B (17)	C (78)	C (39)		
Metcalfe Street / Thomas Street	<u> </u>	B (17)	B (21)	B (23)	B (22)	B (36)	B (36)		
Lake Road / Cowper Street	V	A (11)	B (20)	A (15)	E (59)	B (87)	A (58)		
Lake Road / Thomas Street / Newcastle Link Road		D (49)	E (67)	E (59)	F (72)	E (77)	E (75)		
Newcastle Link Road / Minmi Road	<u> </u>	B (28)	D (50)	D (50)	E (61)	D (50)	D (38)		
Nelson Street / Cowper Street	8	В (19)	В (19)	В (16)	В (18)	В (36)	В (21)		

7.2.4 Travel Times

The 2036 Option Model travel time was compared to the 2036 Do Minimum and the Base 2017 travel times, as shown in Figure 7.11 to Figure 7.14 for the clockwise and counter clockwise directions. In general, the **upgrades introduced into the 2036 Option Model ('Do Something') significantly reduced travel times and** returned them to nearly year 2017 conditions.







Figure 7.12: 2036 Travel Time – Counter Clockwise, AM Peak









Figure 7.14: 2036 Travel Time – Counter Clockwise, PM Peak

7.2.5 2036 Option Model Traffic Performance Summary

The 2036 Option Model resulted in significant reductions in travel times and intersection performance when compared to the 2036 Do Minimum scenario. The proposed works are shown to substantially improve the performance of the Longworth Avenue / Newcastle Road / Thomas Street intersection with a reduction of average delay from 225 seconds to 47 seconds.

It is noted that there is a significant increase in average delay experienced at the Newcastle Link Road / Minmi Road intersection from 130 seconds to 416 seconds in the AM peak hour. This is due to the release of additional traffic volumes with the proposed infrastructure upgrades to into the Newcastle Link Road. This highlights a future issue with the need for Roads and Maritime to consider further upgrade needs for this corridor.

Overall though, the suite of upgrades proposed in 2021, 2026 and 2036 are likely to ensure that the study area network will operate at similar (but slightly worse) LoS compared to 2017 conditions in most parts of the network.

8. LINK ROAD OPTION ASSESSMENT

8.1 LINK ROAD OPTION (OPTION 1)

As shown in Figure 10.1 below, option 1 is envisaged to provide a connection between Minmi Road and Cowper Street by constructing a new link road between Minmi Road and Bulkara Street. The purpose of testing the link road option is to assess if any of the improvements suggested on Minmi Road for the 2036 Option Model scenario can be scaled back with this alternative route in place.



Figure 8.1: Link Road between Minmi Road and Bulkara Street

8.2 LINK ROAD OPTION: YEAR 2036 TRAFFIC PERFORMANCE

8.2.1 Link Road Option Network Changes

The Option 1 (year 2036) model was developed using the same VISSIM network as the Option Model 2036 scenario and the traffic demand volumes of 2036, in order to identify any intersections within the network which can be scaled back due to the impact of the direct link between Minmi Road and Cowper Street.

8.2.2 Intersection Analysis

The 2036 Option Model network performance was compared to the Option 1 (year 2036) models' network performance. Table 10.3 shows how the network performance for each scenario compares with one another.

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Table 8.1:

Option 1 (Year 2036) Intersection Performance – AM and PM Peak Periods

Intersection	Intersection Control	LOS – AM (2036 Option Model) (delay in seconds)	Option 1 – AM (2036) (delay in seconds)	LOS – PM (2036 Option Model) (delay in seconds)	Option 1 – PM (2036) (delay in seconds)
Woodford Street / Newcastle Link Road / Cameron Park Drive		D (50)	D (48)	D (47)	C (46)
Woodford Street / Minmi Road		C (30)	B (29)	C (32)	C (32)
Brookfield Avenue / Minmi Road	GIVE	A (11)	A (10)	A (11)	A (9)
Minmi Road / Highland Way	GIVE	A (13)	A (13)	A (13)	A (13)
Minmi Road / Britannia Boulevard	Ø	A (10)	A (9)	B (18)	B (17)
Kurraka Drive / Minmi Road	$\overline{\mathbf{A}}$	A (11)	A (12)	A (6)	A (5)
Awakabal Drive / Minmi Road / Bellbird Close		C (38)	C (37)	B (21)	B (20)
Maryland Drive / Minmi Road / Churnwood Drive		C (41)	C (38)	C (38)	C (37)
Minmi Road / Bottlebrush Boulevard	Ø	A (8)	A (8)	D (49)	D (43)
Warkworth Street / Minmi Road	GIVE	D (57)	F (121)	C (41)	C (31)
Minmi Road / Summerhill Road	A	A (4)	A (6)	B (16)	A (15)
McNaughton Avenue / Minmi Road	GIVE	C (41)	C (35)	D (44)	B (20
Maryland Drive / Minmi Road		B (16)	B (18)	B (27)	B (23)
Creek Road / Minmi Road / Macquarie Street		B (29)	X (30)	C (38)	D (44)
Minmi Road / Bunnings		A (7)	A (11)	A (8)	A (9)
Sandgate Road / Minmi Road	8	B (17)	B (18)	B (21)	B (24)
Cameron Street / Longworth Avenue / Cowper Street / Minmi Road		C (34)	C (30)	C (38)	C (31)
Sandgate Road / Tillie Street / Wilkinson Avenue		B (29)	C (32)	C (32)	C (36)
Tillie Street / Douglas Street / Cameron Street	GIVE	C (35)	C (30)	C (23)	B (20)
Thomas Street / Walford Street		B (23)	C (38)	B (37)	D (43)
Longworth Avenue / Newcastle Road / Thomas Street	Ø	A (14)	C (30)	A (47)	E (59)
Newcastle Road / Cowper Street	GIVE	A (15)	B (19)	A (19)	D (46)
Kokera Street / Cowper Street		C (35)	C (36)	C (39)	E (69)
Metcalfe Street / Thomas Street		B (23)	B (24)	B (36)	C (39)
Lake Road / Cowper Street	\bigotimes	A (15)	F (182)	A (58)	F (117)
Lake Road / Thomas Street / Newcastle Link Road		E (59)	F (74)	E (75)	F (84)
Newcastle Link Road / Minmi Road	\heartsuit	D (50)	F (461)	D (38)	F (94)
Nelson Street / Cowper Street		B (16)	B (16)	B (21)	C (34)

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Figure 8.2: Link Road Traffic Volume between Minmi Road and Bulkara Street

8.2.3 Travel Time Analysis

Figure 8.3 through Figure 8.6 compare the AM and PM peak clockwise and counter clockwise cumulative travel times between the 2036 Link Road Option and the 2036 Option Model.



Figure 8.3: 2036 Link Road Option Travel Time – Clockwise, AM Peak





Figure 8.4: 2036 Link Road Option Travel Time – Counter Clockwise, AM Peak



Figure 8.5: 2036 Link Road Option Travel Time – Clockwise, PM Peak



Figure 8.6: 2036 Link Road Option Travel Time – Counter Clockwise, PM Peak

There are very little differences in travel times on the core loop route being compared with the exception of the counter-clockwise direction in the AM peak which shows a worsening from Lake Street onwards.

8.2.4 Link Road Option Outcomes/Summary

The VISSIM modelling shows that the Link Road Option slightly reduces travel times through the study area and slightly improves intersection performance. However, the Link Road is found to significantly worsen the performance of the Warkworth Street / Minmi Road intersection in the AM peak and the Newcastle Road / Cowper Street intersection during the PM peak. The introduction of the proposed bypass will increase the AM peak right turn volumes from Minmi Road eastbound to Summerhill Road Southbound. The modelling shows that the queues of right turn traffic will extend back to the Warkworth Street intersection thereby restricting traffic flows from that road. In the PM peak, a significant number of trips travelling from Newcastle City Centre to Minmi would use the bypass route. These vehicles would use the Newcastle Road / Cowper Street intersection to access the bypass.
10. CYCLING AND FOOTPATH INFRASTRUCTURE

10.1 CYCLING FACILITIES

There are a variety of cycling infrastructure types within the Minmi Road development corridor and the broader study area. These include:

- On-Road Cycling Lanes allowing cyclists a defined space to travel alongside other vehicles. This
 improves the safety of the interaction of cyclists and other vehicles on the road, as cyclists are
 removed from the general traffic lanes. It also provides cyclists a defined path of travel through
 intersections, with heightened awareness of cyclist activity for motorists, highlighted by bright green
 paint. Key areas where on-road cycling lanes were used are:
 - sections of Minmi Road;
 - Thomas Street; and
 - Newcastle Link Road.
 - Cyclist-Only Paths off-road cycling opportunities linking other cycling infrastructure. These paths
 provide a safe and unobstructed passage of travel for cyclists, often to avoid high-scale conflicts with
 vehicles. Locations where cyclist only paths were used include:
 - between Newcastle Road and Thomas Street;
 - access to Newcastle Link Road from Lake Road; and
 - connecting Kempt Street across Newcastle Road.
 - Shared Paths creating a shared environment for low speed cycling and pedestrian activity. These
 paths are used in many intersections throughout the study area, in particular along Minmi Road. They
 are connected by a crossing, such as a pedestrian refuge or signalised crossing point. Shared paths
 are also used in conjunction with on-road cycling lanes at some intersections. Key intersections where
 shared paths are employed to improve the safety of cyclists crossing include:
 - Minmi Road / Bunnings Access;
 - Minmi Road / Macquarie Street;
 - Minmi Road / Maryland Drive / Creek Road;
 - Minmi Road / Summerhill Road;
 - Minmi Road / Bottlebrush Boulevard;
 - Minmi Road / Churnwood Drive;
 - Minmi Road / Awabakal Drive; and
 - Minmi Road / Kurraka Drive.
- On-Road Cycling –cycling is undertaken in the general traffic lanes. Generally, there is some form of bicycle-related infrastructure along these routes, however some sections of on-road cycling also exist on Kemp Street and Lake Road where no such infrastructure exists.

Generally, there is a high level of cycling infrastructure within the study area, encouraging cyclists along Thomas Street / Newcastle Road, Newcastle Link Road, Cowper Street, sections of Minmi Road and to and from the Wallsend Town Centre. However, this infrastructure is disconnected from the rest of the active transport network, with a lack of obvious cycling routes on Minmi Road between Maryland Drive and Summerhill Road and between Woodford Street and Brookfield Avenue. There is also a lack of connectivity between Cowper Street and Newcastle Road / Thomas Street.

The existing facilities and proposed improvements are shown in Figure 10.1.



Figure 10.1: Existing and Proposed Infrastructure

The proposed infrastructure along the sections of the Minmi Road corridor are:

- Missing Link 1: The existing section of roadway on Minmi Road between Brookfield Avenue and Blue Gum Hills Road requires cyclists to share the road with other vehicles, as shown in Figure 10.3. Cyclists share the carriageway with general traffic. The posted speed limit of this section of Minmi Road is 70 km/h, subjecting cyclists to conflicts with vehicles travelling at high speeds;
- Missing Link 2: On the southern side of Minmi Road between Brookfield Avenue and Britannia Boulevard there is a lack of connection between short sections of defined on-road cycling lanes. Construction is ongoing at this location;
- Missing Link 3: Another missing link is the northern side of Minmi Road between Maryland Drive (west) and Summerhill Road. The eastbound carriageway of the 340m section of Minmi Road is approximately 7m wide. Kerbside parking is provided for approximately 170m section of the road. The remaining 170m is wide enough to introduce formal bicycle facilities.



The missing links are identified in Figure 10.2.







Figure 10.3: Minmi Road too narrow for cycle lanes (Britannia Boulevard-Woodford Street)

As part of the 2013 Western Corridor Section 94 Contribution Plan, a cycleway was proposed connecting Britannia Boulevard and Woodford Street along Minmi Road. However, the road width throughout this section is relatively narrow and additional pavement may be required.

The CoN has also outlined upgrades to their current cycling network in the *Newcastle Cycling Strategy and Action Plan.* Improvements include:

- increasing the connectivity of cycling infrastructure along Minmi Road by providing an on-road cycling route along its entirety;
- providing off-road cycling facilities between Maryland Drive, at Churnwood Drive, and Minmi Cemetery access;
- creating an on-road cycling route from Ganney Road to Minmi Road, along Bousfield Street, Devon Street, Kenrick Street and Macquarie Street; and
- providing on-road cycling connectivity between Cowper Street and Newcastle Road via Murnin Street.

10.2 PEDESTRIAN FACILITIES

10.2.1 Current Infrastructure

The majority of footpaths along Minmi Road are shared paths. There is a lack of connectivity between sections of footpaths as shown in the example in Figure 10.4.



Figure 10.4: Shared Path Connects with Cycle Lane Only



Like the cycling facilities, the pedestrian network is more developed from Brookfield Avenue to Cowper Street. The following pedestrian facilities are provided along the Minmi Road corridor:

- shared path where pedestrian share the foot with cyclists;
- pedestrian crossing facilities at signalised intersections; and
- pedestrian refuge islands.

There is limited existing mid-block connectivity across Minmi Road. Pedestrian refuges are provided near Bottlebrush Boulevard, Warkworth Street and Summerhill Road. Connectivity between residential areas and community facilities, such as parks and community centres, is generally well catered for.

Generally, there is a footpath on at least one side of the road in suburban areas along the Minmi Road corridor. However, there are some sections of Minmi Road which do not have any formalised pedestrian infrastructure. Typically, footpaths on Minmi Road are located near intersections to provide increased safety at road crossings. Longer footpath sections along Minmi Road are found:

- between Cowper Street and Macquarie Street (shared path southern side only);
- between Creek Road and Maryland Drive (shared path northern side only);
- between Maryland Drive (at Churnwood Drive) to Kurraka Drive (shared path northern side only);
- Brittania Boulevard to Highland Way (mix of pedestrian footpath and shared path southern side only);
- in the vicinity of Brookfield Avenue (shared path northern side only); and
- between the Minmi Cemetery access and Woodford Street (mix of pedestrian footpath and shared path southern side only).

10.2.2 Missing Pedestrian Links

The following links along Minmi Road have been identified where no pedestrian facilities have been provided on either side of the road:

- Missing Link 1: McInnes Street to Brookfield Avenue;
- Missing Link 2: Between Britannia Blvd and Kurraka Drive;
- Missing Link 3: Churnwood Drive to Summerhill Road; and
- Missing Link 4: Summerhill Road to Maryland Drive.

These sections are shown in Figure 10.5.



Figure 10.5: Missing Pedestrian Links on Minmi Road

Missing Link 1: McInnes Street to Brookfield Avenue

A short section on Minmi Road, between McInnes Street in the west and Brookfield Avenue in the east, through a typically rural settings with limited driveway access directly onto Minmi Road.

Missing Link 2: Between Britannia Blvd and Kurraka Drive

This section of Minmi Road between Britannia Blvd and Kurraka Drive currently has no pedestrian facilities provided. There is a shared pedestrian path on the northern side of Minmi Road, just to the east of this missing link. There is also a shared pedestrian facility just to the west of the missing link.

Missing Link 3: Churnwood Drive to Summerhill Road

Between Churnwood Drive and Summerhill Road, the only opportunities to cross Minmi Road are the approaches to the Minmi Road / Bottlebrush Boulevard and Minmi Road / Summerhill Road roundabouts. In addition, there is approximately 45m of shared path on the west of Minmi Road at the Warkworth Street intersection. Any footpaths along this section are connected into residential areas along roads adjoined to Minmi Road, although the footpaths were abruptly discontinued on Minmi Road, as shown in Figure 10.6.



Figure 10.6: Footpath ends at driveway south of Minmi Road / Summerhill Road Roundabout

Missing Link 4: Summerhill Road to Maryland Drive.

The missing link from Churnwood Drive to Summerhill Road (Missing Link 3) extends into the Summerhill Road and Maryland Drive section (Missing Link 4).

The section of Minmi Road between Churnwood Drive and Maryland Drive has residential properties on both sides. Continuous pedestrian footpath and controlled crossing facilities are essential to enable pedestrian accessibility between the residential areas. The remainder of Minmi Road, to the east, offers a pedestrian link on at least one side of the road.

10.2.3 Pedestrian Connections

There are numerous pedestrian connections between streets and adjoining residential areas in the newly developed suburbs along either side of Minmi Road. These connections provide shorter trips for pedestrians, encouraging active transport over the use of private vehicles. Examples of pedestrian connections include:

- laneways between properties connecting streets;
- footpaths through bushland connecting residential areas;
- staircases providing connection between two areas of different grade;

- pathways to parks and community facilities;
- foot bridges across creeks; and
- crossing opportunities across Minmi Road.

Increased connectivity between Minmi Road, bus stops, shopping centres, parklands and community facilities will continue to encourage active transport and reduce reliance on private vehicle trips. Key pedestrian connections within the study area and locations where connectivity could be improved are shown in Figure 10.7.



Figure 10.7: Existing and Proposed New Pedestrian Connections

10.2.4 Minmi Road Footpaths (Churnwood Drive to Brittania Boulevard)

Additional pedestrian facilities should also be considered for connecting the existing retail developments near Brittania Boulevard and Churnwood Drive. The Fletcher Village retail precinct is located on the southern side of Minmi Road. With the current arrangement, pedestrians travelling between the residential areas near Britannia Boulevard and Bellbird Close, south of Minmi Road, have to cross Minmi Road twice to access the retail precinct. A continuous pedestrian path between Churnwood Drive and Britannia Boulevard, along the southern side of Minmi Road, would ensure that these pedestrians do not have to cross Minmi Road. Evidence of pedestrian use of bushland areas is visible from Bellbird Close to Minmi Road, and between Weller Street and Beech Close, as outlined in Figure 10.8.

Pedestrian connections to be considered are shown in Figure 10.8 and include:

- a shared path the southern side of Minmi Road between Churnwood Drive and Britannia Boulevard; and
- a pedestrian connection between Weller Street and Beech Close, through the existing bushland.



Figure 10.8: Minmi Road Pedestrian Infrastructure

11. INFRASTRUCTURE COSTS

11.1 METHODOLOGY

Costing analysis has been undertaken of all intersection and road upgrades in conjunction with CoN to determine the value of the suite of works. Pricing for each component was sourced from the Independent Pricing and Regulatory Tribunal (NSW) – Local Infrastructure Benchmark Costs (IPART) report (April 2015). **Each item's rate has been manually adjusted to reflect the to reflect the respective CPI Growth Index rate for** each horizon year (2021, 2026 & 2036). An additional factor of 20% has been applied to the final rates to cater for the location and congestion, as recommended by the IPART report. Further, a factor of 30% was also added to the final price to cater for any contingencies.

11.2 2021 Option Model Scenario Costing

The road and intersection upgrades detailed in Section 5.2.2 have been costed in accordance with the abovementioned methodology. The resultant cost estimate for each road and intersection upgrade is provided in Table 11.1.

	TOTAL
Intersection / Upgrade Type	(with 30% contingency)
Intersection Upgrades	
Cowper Street / Lake Road	\$2,477,011
Cowper Street / Newcastle Road	\$780,000
Sandgate Road / Wilkinson Avenue / Tillie Street	\$6,924,436
Cowper Street / Cameron Street / Sandgate Road / Minmi Road	\$2,488,871
Minmi Road / Awabakal Drive	\$2,361,527
Minmi Road / Highland Way	\$755,436
Minmi Road / Woodford Street	\$1,459,796
Road Widening Upgrades	
Awabakal Drive to Maryland Drive - Add lanes (1 to 2 lanes) - Minmi Road	\$3,844,346
Maryland Drive to Bottlebrush Boulevard (EB) - Add lanes (1 to 2 lanes) - Minmi Road	\$3,130,396
Bottlebrush Boulevard to Warkworth Street (EB) - Add lanes (1 to 2 lanes) - Minmi Road	\$1,922,173
Warkworth Street to Summerhill Road (EB) - Add lanes (1 to 2 lanes) - Minmi Road	\$4,173,861
Cameron Street to Newcastle Road (SB) - Add lanes (1 to 2 lanes) - Longworth Avenue	\$6,162,407
Land Acquisition Costs	-
TOTAL COST	\$36,480,260

Table 11.1: 2021 Option Model Scenario Costing Summary

11.3 2026 Option Model Scenario Costing

The road and intersection upgrades detailed in Section 6.2.2 have been costed in accordance with the abovementioned methodology. The resultant cost estimate for each road and intersection upgrade is provided in Table 11.2

Table 11.2:2026 Option Model Scenario Costing Summary

	TOTAL (with
Intersection / Upgrade Type	30%
Intersection Upgrades	contingency)
Cowper Street / Kokera Street	\$2,637,596
Cowper Street / Nelson Street	\$281,452
Cowper Street / Newcastle Road	\$360,259
Sandgate Road / Wilkinson Avenue / Tillie Street	\$960,690
Copwer Street / Cameron Street	\$2,151,078
Minmi Road / Maryland Drive	\$2,221,596
Minmi Road / McNaughton Avenue	\$337,743
Minmi Road / Woodford Street	\$1,460,863
Road Widening Upgrades	
Anna Place to Maryland Drive (EB) - Add lanes (1 to 2 lanes) - Minmi Road	\$1,688,713
McInnes Street to McCarthy Street (EB) - Add Ianes (1 to 2 Ianes) - Minmi Road	\$619,195
McCarthy Street to McInnes Street (WB) - Add Ianes (1 to 2 Ianes) - Minmi Road	\$619,195
Bunnings to Macquarie Street (WB) - Add lanes (1 to 2 lanes) - Minmi Road	\$7,925,693
Maryland Drive to Anna Place (WB) - Add lanes (1 to 2 lanes) - Minmi Road	\$3,182,286
Kokera Street to Nelson Street (EB) - Add lanes (1 to 2 lanes) - Cowper Street	\$1,200,863
John Street to Minmi Road (EB) - Add lanes (1 to 2 lanes) - Cowper Street	\$928,792
Union Street to Newcastle Road (WB) - Add lanes (1 to 2 lanes)- Cowper Street	\$365,888
Newcastle Road to John Street (NB) - Add lanes (1 to 2 lanes)- Longworth Avenue	\$816,211
Ban kerb side parking (EB) between Newcastle Road and Union Street - Copwer Street	\$6,500
Ban kerb side parking (EB) between Lake Road and Kokera Street and Nelson Street and Nelson Street	\$6,500
Ban kerb side parking (WB) between Newcastle Road and Nelson Street and Kokera Street and Lake Road - Copwer Street	\$6,500
Ban kerb side parking (SB) between Minmi Road and Railway Street - Woodford Street	\$13,000
Ban kerb side parking (NB) between Bell Street and Minmi Road - Woodford Street	\$6,500
Land Acquisition Costs	\$873,438
TOTAL COST	\$28,670,549

11.4 2036 Option Model Scenario Costing

The road and intersection upgrades detailed in Section 7.2.2 have been costed in accordance with the abovementioned methodology. The resultant cost estimate for each road and intersection upgrade is provided in Table 11.3.



Table 11.3:2036 Option Model Scenario Costing Summary

Intersection / Upgrade Type	TOTAL (with 30% contingency)
Intersection Upgrades	
Cowper Street / Newcastle Road	\$571,915
Copwer Street / Cameron Street	\$3,740,170
Minmi Road / Bunnings	\$8,827,052
Minmi Road / Macquarie Street / Creek Road	\$4,957,288
Minmi Road / Warkworth Street	\$4,762,852
Minmi Road / Kurraka Drive	\$4,044,024
Minmi Road / Britannia Boulevard	\$2,870,788
Minmi Road / Highland Way	\$4,112,325
Minmi Road / Blue Gum Hills Road	\$4,762,852
Minmi Road / Woodford Street	\$6,500
Road Widening Upgrades	
McCarthy Street to Awabakal Drive (EB) - Add lanes (1 to 2 lanes) - Minmi Road	\$33,014,059
Fletcher Street to Sandgate Road (EB) - Add lanes (2 to 3 lanes) - Minmi Road	\$12,918,545
Sandgate Road to Maryland Drive (WB) - Add lanes (2 to 3 lanes) - Minmi Road	\$15,071,636
Summerhill Road to Bottlebrush Boulevard (WB) - Add lanes (1 to 2 lanes) - Minmi Road	\$6,602,812
Bottlebrush Boulevard to Churnwood Drive (WB) - Add lanes (1 to 2 lanes) - Minmi Road	\$5,023,879
Blue Gum Hills Road to McInnes Street (WB) - Add lanes (1 to 2 lanes) - Minmi Road	\$6,889,891
Union Street to John Street (EB) - Add lanes (1 to 2 lanes) - Cowper Street	\$1,682,102
John Street to Union Street (WB) - Add lanes (1 to 2 lanes) - Cowper Street	\$1,682,102
Railway Street to Newcastle Link Road (SB) - Add lanes (1 to 2 lanes) - Woodford Street	\$20,813,211
Ban peak hour kerb side parking on Minmi Road between Macquarie Street and Maryland Drive heading westbound	\$13,000
Ban peak hour kerb side parking on the southbound Woodford Street approach to provide for two traffic lanes	\$6,500
Ban peak hour kerb side parking between Railway Street and Bell Street (along Woodford Street) heading northbound	\$6,500
Ban peak hour kerb side parking on Sandgate Road between Minmi Road and Tillie Street	\$13,000
Land Acquisition Costs	\$10,140,000
TOTAL COST	\$152,533,002



11.5 PEDESTRIAN AND CYCLING INFRASTRUCTURE

11.5.1 Cycling Infrastructure

The cycling infrastructure detailed in Section 10.1 has been costed and provided in Table 11.4.

Table 11.4:Cycling Infrastructure Costs

Upgrade	TOTAL (with 10% contingency)
Blue Gum Hills Road to Brookfield Avenue (Northern side of Minmi Road)	\$380,737.85
Brookfield Avenue to Blue Gum Hills Road (Southern side of Minmi Road)	\$380,737.85
Britannia Boulevard to Brookfield Avenue	\$158,640.77
Maryland Drive to Summerhill Road	\$174,504.85
TOTAL COST	\$1,094,621

11.5.2 Pedestrian Infrastructure

The cycling infrastructure detailed in Section 10.2 has been costed and provided in Table 11.5Table 11.4.Table 11.5:Pedestrian Infrastructure Costs

	Year	TOTAL
Upgrade		(with 10% contingency)
Tallowood Crest to Jetty Parade	2021	\$ 489,555
Cottonwood Chase to Weller Street	2021	\$ 575,947
Beech Close to Weller Street	2021	\$ 590,345
Along Minmi Road (between Churnwood Drive & Bellbird Close)	2021	\$ 604,744
St Andrews Way to Styles Close	2026	\$ 393,551
Waterside Drive to Hebrides Road	2026	\$ 188,905
Waterside Drive to Tartan Place	2026	\$ 355,770
Waterside Drive to Plattsburg Parade	2026	\$ 289,654
Wedgetail Street to Crestview Street	2026	\$ 273,912
Wedgetail Street to Crestview Street	2026	\$ 550,972
Pebblestone Street to Kingfisher Drive	2026	\$ 428,184
Pebblestone Street to Kingfisher Drive	2026	\$ 333,731
Mowane Street to Awabakal Drive	2036	\$ 696,211
Minmi Road to Glendore Parade	2036	\$ 827,926
Minmi Road to Yapug Close	2036	\$ 470,413
TOTAL COST		\$7,069,819



12. CONCLUSIONS

The key findings of this traffic and transport study are as follows:

- a site visit showed that there was inadequate parking, cycling and pedestrian infrastructure throughout the study area;
- congestion was observed on the northern approach to the Minmi Road / Cowper Street intersection;
- the calibrated 2017 base model showed minor congestion at local intersections with the majority of the road network operating within acceptable performance parameters;
- a total of 4,580 trips are anticipated to be added to the road network through approved and planned developments within the study area;
- the anticipated traffic volumes in the 2021 future year scenarios shows the significant worsening of intersection performance (and travel times) across the study area;
- a suite of proposed upgrades in 2021 reduces vehicle travel times to slightly in excess of the 2017 base case performance;
- the 2026 future year scenario (Do Minimum) shows extensive queuing on the northern leg of the Minmi Road / Cowper Street / Cameron Street intersection;
- the 2026 suite of upgrades includes capacity improvements along Minmi Road and Cowper Street, specifically, on the section of Minmi Road between the Bunnings access and Cowper Street;
- the 2026 future year scenario (Do Minimum) shows extensive queuing on the northern leg of the Minmi Road / Cowper Street / Cameron Street intersection during the PM peak hour;
- the 2036 future year scenario (Do Minimum) shows southbound queues on Minmi Road between McNaughton Avenue and Maryland Drive during the AM peak hour;
- the 2036 future year scenario (Do Minimum) also shows extensive eastbound queues at the Newcastle Link Road / Lake road intersection during the PM peak;
- the potential link road between Minmi Road and Bulkara Street had a network-wide benefit and in anticipated to a reduction of travel times; however, the intersections in proximity to the entrances to the new link road was observed to experience increased congestion;
- the proposed suite of traffic infrastructure works to maintain an acceptable level of service across the study area is estimated to cost:
 - \$36,480,260 in 2021;
 - \$28,670,551 in 2026; and
 - \$152,533,002 in 2036; and
- additional footpaths are expected to cost \$7,069,819 by 2036 and additional cycling infrastructure is expected to cost \$1,096,621.

The study area's road network is approaching capacity now at it southern end with limited committed upgrades to address these issues. As there is very little route choice in the network, and because the network is at the exponential end of the relationship between traffic flow and delay, additional development traffic will generate the need for a large number of traffic upgrades, if current levels of service are desired to be maintained.

The suite of upgrades proposed in 2021, 2026 and 2036 is shown to provide intersection levels of service similar to, but slightly worse than those experienced in 2017. A significant number of upgrades are required at an overall costs in excess of \$226M to cater for an expected increase of over 50,000 vpd with expected development and an increase of 22,000 vpd of through traffic.

In addition to the above, if the proposed upgrades in the study area are implemented by 2036, then there are likely to be further capacity issues along the Newcastle Link Road corridor with its capacity being reached. This would consequently impact the ability for residents to access and egress the study area.



APPENDIX A

MODEL CALIBRATION AND VALIDATION TECHNICAL NOTE





Issue History

File Name	Prepared by	Reviewed by	Issued by	Date	Issued to
P2989.001T Western Corridor VISSIM Model Calibration and Validation	S. Hasan, E. Secondes	A. Ahmed	A. Ahmed	15/11/2017	Shannon Turkington Senior Urban Planner, Newcastle City Council E-mail: <u>sturkington@ncc.nsw.gov.au</u>

Western Corridor VISSIM Model Calibration and Validation

1. INTRODUCTION

1.1 BACKGROUND

Bitzios Consulting was engaged by The City of Newcastle (Council) to undertake a traffic and transport study of the Western Corridor area centred around Minmi, Fletcher, Maryland and Wallsend. It is understood that the Newcastle Western Corridor Urban Release Area is the most significant remaining residential land release within the Newcastle Local Government Area, and a significant residential growth of 64% has been anticipated from year 2011 to year 2036. It is essential to identify the transport infrastructure required to satisfy the future demand. This project has been proposed to take place in the following stages:

- Stage 1: Data collection / collation, existing situation analysis and base model;
- Stage 2: Future base year modelling;
- Stage 3: Option analysis for new link roads;
- Stage 4: Pedestrian and cycle network, strategic cost estimate and updating section 94; and
- Stage 5: Final Traffic and Transport Report and presentation of the report.

An existing condition VISSIM micro-simulation traffic model has been developed for the Western Corridor along Minmi Road, Woodford Street and Newcastle Link Road including surrounding roads. The model demonstrates the existing traffic conditions during a typical weekday morning and evening peak periods, and can be used to create future year models to assess traffic performance in the study area.

This Technical Note summarises the model development process and key assumptions as well as the calibration and validation of the base model.

1.2 LOCATION AND STUDY AREA

The extent of the study area was bounded by

- Newcastle Link Road; and
- Minmi Road.

The study area as mentioned above is shown overleaf in Figure 1.1.



SOURCE: Google Maps



1.3 INTERSECTIONS

Several key intersections which were assessed as part of the model are listed below and is shown in Figure 1.2 overleaf.

- 101 Woodford Street at Newcastle Link Road;
- 102 Woodford Street at Minmi Road;
- 103 Brookfield Avenue at Minmi Road;
- 104 Highland Way at Minmi Road;
- 105 Britannia Boulevard at Minmi Road;
- 106 Kurraka Drive at Minmi Road;
- 107 Awabakal Drive at Minmi Road;
- 108 Churnwood Drive at Minmi Road;
- 109 Bottlebrush Boulevard at Minmi Road;
- 110 Warkworth Street at Minmi Road;
- 111 Summerhill Road at Minmi Road;
- 112 McNaughton Avenue at Minmi Road;
- 113 Maryland Drive at Minmi Road;
- 114 Macquarie Street at Minmi Road;
- 115 Minmi Road at Bunnings Access;
- 116 Sandgate Road at Minmi Road;
- 117 Cowper Street at Minmi Road;
- 118 Tillie Street at Sandgate Road;
- 119 Tillie Street at Wilkinson Avenue;
- 120 Cameron Street at Tillie Street;
- 121 Walford Street at Thomas Street;
- 122 Newcastle Road at Longworth Avenue;
- 123 Newcastle Road at Cowper Street;
- 124 Cowper Street at Kokera Street (Shopping Centre Access);



- 125 Thomas Street at Metcalfe Street;
- 126 Cowper Street at Lake Road;
- 127 Lake Road at Newcastle Link Road;
- 128 Newcastle Link Road at Minmi Road (South); and
- 129 Cowper Street at Nelson Street.



Figure 1.2: Study Area and Modelled Intersections

2. DATA SOURCES

The process of developing the base VISSIM model for the study area involved creating the existing layout models from aerial images and validating the models against a range data including:

- intersection turn counts;
- travel time surveys;
- origin-destination surveys; and
- intersection diagnostic monitor data.

A significant portion of this data was provided by the Council however, surveys were conducted at several locations where data was not available.

2.1 INTERSECTION COUNTS

Intersection count data was provided by council for the following locations:

- 101 Woodford Street at Newcastle Link Road;
- 102 Woodford Street at Minmi Road;
- 103 Brookfield Avenue at Minmi Road;
- 104 Highland Way at Minmi Road;
- 105 Britannia Boulevard at Minmi Road;
- 106 Kurraka Drive at Minmi Road;
- 107 Awabakal Drive at Minmi Road;
- 108 Churnwood Drive at Minmi Road;
- 109 Bottlebrush Boulevard at Minmi Road;
- 110 Warkworth Street at Minmi Road;
- 111 Summerhill Road at Minmi Road;
- 112 McNaughton Avenue at Minmi Road;
- 113 Maryland Drive at Minmi Road;
- 114 Macquarie Street at Minmi Road;
- 115 Minmi Road at Bunnings Access;
- 116 Sandgate Road at Minmi Road; and
- 117 Cowper Street at Minmi Road.

Turn count surveys were undertaken at the following intersections to obtain model input data:

- 118 Tillie Street at Sandgate Road;
- 119 Tillie Street at Wilkinson Avenue;
- 120 Cameron Street at Tillie Street;
- 121 Walford Street at Thomas Street;
- 122 Newcastle Road at Longworth Avenue;
- 123 Newcastle Road at Cowper Street
- 124 Cowper Street at Kokera Street (Shopping Centre Access);
- 125 Thomas Street at Metcalfe Street;
- 126 Cowper Street at Lake Road;
- 127 Lake Road at Newcastle Link Road;
- 128 Newcastle Link Road at Minmi Road (South); and
- 129 Cowper Street at Nelson Street.

ΒП



2.2 TRAVEL TIME SURVEYS

Bitzios Consulting Commissioned travel time surveys to be conducted along Minmi Road and Newcastle Link Road. The surveys were conducted by TDC for the AM and PM peak periods. The route was separated into a number of sub sections in order to verify localised delays at various locations. The clockwise and counter-clockwise routes are shown in Figure 2.1



Figure 2.1: Travel Time Survey Routes and Sub-sections

2.3 ORIGIN-DESTINATION SURVEYS

Origin-destination surveys were undertaken by Matrix and considered the following 10 locations:

- Newcastle Link Road (West of Woodford Road);
- Minmi Road South (Sth of Newcastle Link Road);
- Lake Road (Sth of Newcastle Link Road);
- Walford Road (Sth of Thomas Street);
- Metcalfe Street (Sth of Thomas Street);
- Newcastle Road (East of Thomas Street);
- Cameron Street (East of Minmi Road);
- Minmi Road at Bunnings Access;
- Maryland Drive (Nth of Minmi Road);
- Maryland Drive West (Nth of Minmi Road); and
- Woodford Street (Nth of Minmi Road).

Figure 2.2 shows the origin-destination survey locations.





SOURCE: Google Maps

Figure 2.2: Origin Destination Survey Locations

2.4 INTERSECTION DIAGNOSTIC MONITOR DATA

Intersection diagnostic monitor (IDM) data was provided for the following signalised intersections:

- 101 Woodford Street at Newcastle Link Road;
- 102 Woodford Street at Minmi Road;
- 107 Awabakal Drive at Minmi Road;
- 108 Churnwood Drive at Minmi Road;
- 113 Maryland Drive at Minmi Road;
- 114 Macquarie Street at Minmi Road;
- 117 Cowper Street at Minmi Road;
- 121 Walford Street at Thomas Street;
- 125 Thomas Street at Metcalfe Street;
- 127 Lake Road at Newcastle Link Road; and
- 130 Newcastle Road at Douglas Street.



3. VISSIM BASE MODEL NETWORK DEVELOPMENT

3.1 MODEL NETWORK

The VISSIM model network was developed using VISSIM version 9 software. The network was coded using the layout observed in the latest available aerials, and was validated with the range of collected datasets. The "Links" in the model represent homogeneous sections of the road layout, including parameters such as posted speed, reduced speed areas, conflict points, signals etc., and were used to replicate the existing traffic operation in the model as shown in Figure 3.1.



Figure 3.1: Base Model Figure



3.2 ZONING SYSTEM

Vehicles input into the model were carried out using VISSIM's dynamic assignment method, using the trips from the OD matrices. These matrices were created form the intersection count volumes, carried out at various intersections along the study corridor as discussed in Section 2.1. The vehicles are inserted into the network via zones created in the VISSIM model. Overall 81 zones were created in the VISSIM model as shown in Figure 3.2 below.



Figure 3.2: VISSIM Travel Zones

3.2.1 Posted Speed

The posted speed in the VISSIM network was derived from site observations, and are as shown below in Figure 3.3 below.



Figure 3.3: Posted Speed Zones

It must be noted that during the site visit, a work zone of 40km/h was identified between Brookfield Avenue and Highland Way, and was therefore incorporated in the model.

3.3 PUBLIC TRANSPORT

Data for public transport services within the study area were obtained from the Transport NSW government website, and this data was utilised within the model. Bus routes were coded into the network as "Static Routes" as the path of these buses are predetermined along the corridor. The frequency of these buses was determined based on their actual arrival time at individual locations.

Bus stops in the model are required to demonstrate the impact on general traffic of buses stopping and starting. Both indented and on-street bus stops are present along the corridor, and have been coded accordingly in the VISSIM model. Figure 3.4 presents a 3D model screenshot of a bus operating in an indented bus stop along Newcastle Road within the study area.





Table 3.1 below details the Bus services within the study, and Figure 3.5 displays the routes graphically.

Route Number	Route Direction	Route Reference in Figure 3.5	Stops
222	Wallsend to Newcastle Via Lambton	cf	231, 222
231	Newcastle to Wallsend Via Jesmond	cf	231, 222
230	Newcastle to Wallsend Via North Lambton	cd	226, 267, 222, 235, 230
235	Newcastle to Wallsend Via Hamilton	cd	226, 267, 261, 235, 230
267	Wallsend to West Wallsend	he	260, 270, 261, 226, 267
160	Cessnock to Newcastle via Kurri Kurri, M15 Hunter Expressway, University of Newcastle and Mayfield	ae	260,270,261,
260	University of Newcastle to Minmi Via Wallsend Maryland & Fletcher	be	261, 226, 231
261	University of Newcastle to Minmi Via Wallsend Maryland	be	226, 230, 260, 267
270	University of Newcastle to Toronto West	he	260, 270, 267
226	Newcastle to Glendale	be	260, 270, 267
224	Wallsend to Newcastle Via Kotara	ch	224, 267, 270

Table 3.1:	Bus Services	within Study	/ Area





Figure 3.5: Bus Service Routes and Stops

3.4 TRAFFIC DEMANDS / MATRICES

Traffic count data was used to develop preliminary traffic demand matrices for the 2017 base models. The demands were developed for weekday AM and PM peak hours from traffic survey data. The base models include the following demand periods.

- 2017 AM Base Model
 - Warm-up period: 07:30 am to 08:00 am;
 - Peak period: 08:00 am to 09:00 am; and
 - Cool-down period: 09:00 am to 09:30 am.
- 2017 PM Base Model
 - Warm-up period: 04:00 pm to 04:30 pm;
 - Peak period: 04:30 pm to 05:30 pm; and
 - Cool-down period: 05:30 pm to 05:00 pm.

The 30-minute warm-up and cool-down matrices were created before and after the peak hours for each model, such that a more realistic level of traffic con the network prior to and proceeding from the peak periods can be observed. The use of 30-minute warm-up and cool-down periods is considered appropriate given the network consists of two (2) major road corridors with limited alternative routes.

As per the requirement of the NSW Government Transport Road and Maritime Services (RMS), separate matrices for light and heavy vehicles were created for input into the VISSIM model. Minor adjustments to the initial matrices were required throughout the calibration process so that intersection volumes reflected those surveyed. Stick diagrams of the traffic counts for each intersection in the model are shown in Attachment A.

3.4.1 Demand Profiling

To ensure that the correct number of vehicles are released into the network as per defined time slices, a demand profile was constructed. Temporal traffic profiles were developed for 15-minute periods based on the surveyed traffic data in the entirety of the network. The global traffic profiles across all sites for each peak period model is shown in Attachment B.



The AM and PM peak demand profiles are presented in Table 3.2 and Table 3.3.

Table 3.2:Weekday AM Peak Traffic Demand Profile

Magura	Weekday AM Peak			
MedSule	7.30am-7.45am	7.45am – 8.00am	8.00am – 8.15am	8:15am – 8.30am
Demand Profile	25%	25%	26%	24%

Table 3.3:Weekday PM Peak Traffic Demand Profile

Mogeuro	Weekday PM Peak			
INEASULE	4.30pm-4.45pm	4.45pm-5.00pm	5.00pm – 5.15pm	5.15pm – 5.30pm
Demand Profile	25%	24%	25%	26%

3.4.2 Traffic Composition

Traffic composition used in the model was based on the analysis of traffic mix across the entirety of the network. The traffic composition used in the model is summarised in Table 3.4.

Table 3.4:AM and PM Traffic Composition

Maacura	AM Peak		PM Peak	
Measure	Light	Heavy	Light	Heavy
Traffic Composition	96.7%	3.3%	96.4%	3.6%

3.4.3 Bus Dwell Time

A normal distribution has been assumed in VISSIM using the program setting for bus dwell time. A value of 20 seconds has been applied for each bus stop in each route.

3.4.4 VisVAP Signalling

The signal groups within the model are partially actuated and controlled by VisVAP program, incorporating the signal behaviours reflected in the IDMs. The signal behaviour varies in an-hour blocks, depending on the average, observed phase timing from the IDMs.

SCATS's .LX files were interrogated to calculate intersection offsets:

- Progression Plan (PP) and Link Plan (LP) 4 were adopted for the AM peak model; and
- Progression Plan (PP) and Link Plan (LP) 2 were adopted for the PM peak model.

4. BASE MODEL CALIBRATION AND VALIDATION

4.1 TURN COUNTS VALIDATION

The GEH statistic was used to measure how well the modelled flows matched the counts, taking into consideration the order of magnitude of the modelled flows and observed counts. The strength of the GEH calculation, as defined within the UK Design Manual for Roads and Bridges, is to compare both absolute and relative differences in flow volumes between data sets. This is an industry accepted approach to measure the quality of the model in Australia and many other countries.

To judge if the output matrices have been corrected in accordance to the RMS *Modelling Guidelines* is that GEH values of at least 85% of all links or turn modelled flows are less than or equal to 5.0. In addition, no GEH value is to be over 10.0 and minimum R² value of 0.9 for turning volumes is also required.

The VISSIM model was calibrated and validated to the GEH statistic and the Travel Time validation was targeted at $\pm 15\%$ for the modelled vs. observed travel time (as per RMS *Modelling Guidelines*).

4.2 GEH STATISTIC

The modelled traffic volumes were compared to the observed volumes using the GEH statistic, defined below:

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

Where, "M" is the modelled traffic volume and "C" is the observed traffic volume.

The GEH statistic decreases as the modelled volume approaches the observed volume. As an absolute value it ignores whether the modelled value is above or below the observed. This allows easy inspection and prioritisation of different variances relative to the size of the flow.

The results of this calibration process using the GEH statistic is summarised in Table 4.1 and detailed for each peak hour in Attachment C.

GEH Criteria	AM (8:00 to 9:00)	PM (16:30 to 17:30)
<5.0	100%	100%
<10.0	100%	100%
<15.00	100%	100%

 Table 4.1:
 Summary of Turn Count Calibration GEH Statistics

As can be seen in the Table above, both peak hour models show that 100% of the turn counts have a GEH statistic below 5.0. Therefore, it is concluded the models have turn count volumes that are within the GEH requirement and the models are considered appropriate.

Plots are included in Figure 4.1 and Figure 4.2 overleaf which include GEH = 5 tolerance limits, R² value which are > 0.9 and the linear equation of slope.

Western Corridor VISSIM Model Calibration and Validation







Figure 4.2: Validation Volume Plot – PM Peak Period (1630-1730)

4.3 MODEL STABILITY

4.3.1 Stability Testing

Model stability between runs/seed values is particularly important in microsimulation models and is demonstrate using a variety of network performance measures. The following network performance measures have been adopted to demonstrate model stability:

- Cumulative travel time across all vehicles (vehicle-hour travelled); and
- Total number of vehicles in the model.

Model outputs for each of the two measures are presented at 15-minute interval in Figure 4.3 through to Error! Reference source not found. Figure 4.6 across the following five seeds modelled:

- Run 1: Seed 5;
- Run 2: Seed 10;
- Run 3: Seed 15;
- Run 4: Seed 20; and
- Run 5: Seed 25.



Figure 4.3: Weekday AM Peak Cumulative Travel Time









Figure 4.5: Weekday AM Peak Total Number of Vehicles in the Model





Figure 4.6: Weekday PM Peak Total Number of Vehicles in the Model

As evidenced by the above figures, the model behaviour across these two measures is quite consistent between seed runs. The models are therefore considered to be stable.

4.3.2 Median Seed

The median seed for each peak period has been identified by assessing the vehicle hours travelled (VHT) for each of the simulated runs. The weekday AM and PM peak median seeds are:

- Weekday AM Peak: Seed 5; and
- Weekday PM Peak: Seed 5.

All calibration and validation outputs reported are drawn from the median seed run.

4.4 TRAVEL TIME VALIDATION

Surveyed travel time data, described in Section 2.2, was used in the comparison of the modelled and surveyed travel times for the routes. This comparison is shown overleaf in Figure 4.7 to Figure 4.10, and contains an average of the surveyed and modelled travel times during both the AM and PM peak periods and its direction (i.e. clockwise and counter-clockwise). The results of this calibration process using the for the outlined sections and direction for each peak hour are provided in Attachment D.









Figure 4.8: AM Travel Time Validation (0800-0900) – Counter - Clockwise

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4.5 SIGNAL TIMING VALIDATION

4.5.1 Data Comparisons

SCATS data, obtained from Roads and Maritime Services, have been compared with modelled signal times. As per the RMS Modelling Guidelines, the following signal attributes were used in the comparison:

- Cycle Time: average modelled cycle time in one-hour period to be within 10 percent of observed average;
- *Green Time*: total of green time over each one-hour period to be within 10 percent of observed equivalent for each phase; and
- Call Frequency: call frequency if demand-dependent phases (including pedestrian phase calls) to be compared with observed data to ensure phase activation occurs to a similar level over each hour period.

A detailed comparison of modelled and observed Cycle Time, Phase Time and Offset for each intersection across the AM and PM Peak is presented in Attachment E.

4.5.2 Cycle / Phase Times Outside 10% of SCATS

Generally, the average cycle and phase times are within 10% of SCATS average phase times. There are some exceptions, which are clearly identified Table 4.2 and Table 4.3. The exceptions are mainly either minor or resulting due to differences in cycle time

AM Peak

Intersection (TCS)	Cycle / Phase	AM (08:00 – 09:00)				
		IDM				M/Hb - 100/0
		Average	+10%	-10%	VISSIIVI	WILIIII 10%?
Thomas Street / Metcalfe Street	D	31	34	28	39	No
Thomas Street / Walford Street	А	73	89	66	55	No
	С	30	33	27	49	No
Minmi Road / Cameron Street / Longworth Avenue / Cowper Street	СТ	134	147	121	120	No
	А	47	52	42	27	No
	D	16	18	14	24	No
	E	41	45	37	16	No
	F	28	31	25	37	No
	G	19	21	17	16	No
Newcastle Road / Douglas Street	А	71	78	64	52	No
	G	15	17	14	23	No
Minmi Road / Maryland Drive / Churnwood Drive	СТ	88	97	79	100	No
	А	50	55	45	55	No
	В	20	22	18	23	No
	С	19	21	17	22	No
Minmi Road / Awabakal Drive / Bellbird Close	А	36	40	32	17	No
	E	13	14	12	25	No
Newcastle Link Road / Lake Road / Thomas Street	А	34	37	31	28	No

Table 4.2: Cycle / Phase Times Outside of 10% of SCATS – AM Peak

PM Peak

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100	18 4	+.J).

Cycle / Phase Times Outside of 10% of SCATS – PM Peak

Intersection (TCS)	Cycle / Phase	PM (16:30 – 17:30)				
		IDM				
		Average	+10%	-10%	VISSIM	Within 10%?
Minmi Road / Cameron Street / Longworth Avenue / Cowper Street	СТ	160	176	144	120	No
	А	50	55	45	19	No
	D	16	18	14	32	No
	E	37	41	33	21	No
	G	22	24	20	13	No
Newcastle Road / Douglas Street	А	83	91	75	71	No
	E	18	20	16	29	No
Minmi Road / Macquarie Street / Creek Road	А	44	48	40	30	No
	D	24	26	22	36	No
Minmi Road / Maryland Drive / Churnwood Drive	А	31	34	28	18	No
	D	25	28	23	38	No
	СТ	61	67	55	70	No
Minmi Road / Maryland Drive	А	25	28	23	19	No
	С	16	18	14	29	No
Minmi Road / Awabakal Drive / Bellbird Close	А	27	30	24	18	No
	D	16	18	14	27	No
Newcastle Link Road / Lake Road / Thomas Street	СТ	154	169	139	120	No
	А	62	68	56	43	No
	D	29	32	26	24	No
	G	39	43	35	32	No
Newcastle Link Road / Lake Road / Thomas Street	CT	134	147	121	120	No
	А	37	41	33	28	No

4.5.3 Call Frequency

SCATS data was interrogated to find out which phases are called in most of the cycles. In order to simplify the VisVAP signal logic in VISSIM, it has been programmed in such a way that these phases called in every cycle in VISSIM.

Phases which are not called in most of the cycles, are programmed as demand dependent.



5. EXISTING TRAFFIC PERFORMANCE

The AM and PM peak models were run in VISSIM and there were several identified sections on the corridor that experienced queues, as detailed below.

5.1 **AM PEAK**

Figure 5.1 to Figure 5.8 below illustrate the eight (8) identified sections (as listed below) in the AM peak that experienced queueing of vehicles.

- Minmi Road towards Bunnings Access eastbound;
- Newcastle Link Road towards Minmi Road roundabout eastbound;
- Newcastle Link Road near Lake Road eastbound;
- Thomas Street towards Metcalfe Street eastbound;
- Newcastle Road / Thomas Street / Longworth Avenue roundabout northbound;
- Minmi Road towards Cowper Street / Cameron Street southbound;
- Minmi Road towards Macquarie Street eastbound; and
- Newcastle Link Road / Woodford Street / Cameron Park Drive Intersection northbound & southbound.

5.1.1 Minmi Road towards Bunnings Access – Eastbound



Figure 5.1: Minmi Road towards Bunnings Site Access - Eastbound Queue Length

5.1.2 Newcastle Link Road towards Minmi Road Roundabout – Eastbound





5.1.3 Newcastle Link Road near Lake Road – Eastbound



Figure 5.3: Newcastle Link Road near Lake Road – Eastbound Queue Length

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5.1.4 Thomas Street towards Metcalfe Street – Eastbound



Figure 5.4: Thomas Street towards Metcalfe Street – Eastbound Queue Length

5.1.5 Newcastle Road / Thomas Street / Longworth Avenue Roundabout – Northbound



Figure 5.5: Newcastle Road / Thomas Street / Longworth Avenue Roundabout – Northbound Queue Length
5.1.6 Minmi Road towards Cowper Street / Cameron Street – Southbound



Figure 5.6: Minmi Road towards Cowper Street / Cameron Street – Southbound Queue Length

5.1.7 Minmi Road towards Creek Road – Eastbound



Figure 5.7: Minmi Road towards Creek Road – Eastbound Queue Length

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5.1.8 Newcastle Link Road / Woodford Street / Cameron Park Drive Intersection – Northbound & Southbound



Figure 5.8: Newcastle Link Road / Woodford Street / Cameron Park Drive Intersection – Northbound & Southbound Queue Length

5.2 **PM PEAK**

Figure 5.9 to Figure 5.8Figure 5.13 below illustrate the five (5) identified sections (as listed below) in the PM peak that experienced queues.

- Newcastle Link Road towards Minmi Road roundabout eastbound & westbound;
- Lake Road near Newcastle Link Road northbound, southbound & westbound;
- Thomas Street / Metcalfe Street intersection southbound and westbound;
- Longworth Avenue towards Cowper Street / Cameron Street northbound; and
- Newcastle Link Road / Woodford Street / Cameron Park Drive northbound & southbound.
- 5.2.1 Newcastle Link Road towards Minmi Road Roundabout Eastbound & Westbound



Figure 5.9: Newcastle Link Road towards Minmi Road Roundabout – Eastbound & Westbound Queue Length

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Figure 5.10: Lake Road near Newcastle Link Road – Northbound, Southbound & Westbound Queue Length

5.2.3 Thomas Street / Metcalfe Street intersection – Southbound and Westbound



Figure 5.11: Thomas Street / Metcalfe Street intersection – Southbound and Westbound Queue Length

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5.2.4 Longworth Avenue towards Cowper Street / Cameron Street – Northbound



Figure 5.12: Longworth Avenue towards Cowper Street / Cameron Street – Northbound Queue Length

5.2.5 Newcastle Link Road / Woodford Street / Cameron Park Drive – Northbound & Southbound



Figure 5.13: Newcastle Link Road / Woodford Street / Cameron Park Drive – Northbound & Southbound Queue Length

6. CONCLUDING STATEMENT

In summary, the VISSIM models are deemed suitably calibrated and validated.

The models are considered fit for purpose of testing the benefits and impacts of the proposed upgrades in future year scenarios.

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ATTACHMENT A

AM AND PM PEAK STICK DIAGRAMS

Western Corridor Traffic and Transport Study Traffic Survey Data Analysis

AM Peak (0800-0900)

Section 1 of 2: Newcastle Link Road, Woodford Street and Minmi Road









AM Peak (0800-0900)

Section 2 of 2: Thomas Street, Newcastle Road, Cameron Street, Cowper Street and Lake Road



Legend	Ł
	Approaching Total
	Exiting Total

Western Corridor Traffic and Transport Study Traffic Survey Data Analysis

PM Peak (1630-1730)

Section 1 of 2: Newcastle Link Road, Woodford Street and Minmi Road





Legend Approaching Total

Exiting Total

Minmi Road Towards Section 2

Western Corridor Traffic and Transport Study Traffic Survey Data Analysis

PM Peak (1630-1730)



Section 2 of 2: Thomas Street, Newcastle Road, Cameron Street, Cowper Street and Lake Road

Walford Street

Lake Road

Legend Approaching Total Exiting Total

Sandgate Road

Wilkinson Street



Newcastle Road



ATTACHMENT B

PEAK DEMAND PROFILES

AM Period

Period	Dariad End	Cars Tota					
Start	Pendu Enu	Quartely	Hourly				
7:00	7:15	-					
7:15	7:30	975					
7:30	7:45	14,210					
7:45	8:00	14,815	30,000				
8:00	8:15	15,937	45,937				
8:15	8:30	15,862	60,824				
8:30	8:45	16,004	62,618				
8:45	9:00	15,270	63,073				
9:00	9:15	12,742	59,878				
9:15	9:30	11,794	55,810				
9:30	9:45	134	39,940				
9:45	10:00	-	24,670				

Trucks	s Total
Quartely	Hourly
-	
35	
492	
605	1,132
521	1,653
596	2,214
552	2,274
542	2,211
663	2,353
568	2,325
- 6	1,767
-	1,225

Cars

23%

25%

25%

25%

24%

20%

24% 25%

25%

25%

26% 25%

Trucks	
27%	AM Warmup
24%	
27%	
25%	AM Peak Hour
25%	
30%	AM Cool Down

PM Period

Period	Dariad End	Cars	Total
Start	Fellou Lliu	Quartely	Hourly
15:30	15:45	7,325	
15:45	16:00	7,424	
16:00	16:15	15,998	
16:15	16:30	16,293	47,040
16:30	16:45	16,564	56,279
16:45	17:00	16,381	65,236
17:00	17:15	16,577	65,815
17:15	17:30	17,201	66,723
17:30	17:45	16,655	66,814
17:45	18:00	15,178	65,611
18:00	18:15	6,248	55,282
18:15	18:00	5,718	43,799

Trucks	s Total
Quartely	Hourly
406	
327	
662	
619	2,014
643	2,251
628	2,552
613	2,503
639	2,523
650	2,530
570	2,472
155	2,014
176	1,551

25%	AM Warmup
25%	
25%	
24%	AM Peak Hour
25%	
26%	AM Cool Down





Total									
16,458	0.031656	0.252099	25						
16,458	0.036213	0.252099	25						
16,556	0.033341	0.2536	26						
15,812	0.034278	0.242203	24						
	0.033872								

Total	

17,207	0.037369	0.248491	25
17,009	0.036922	0.245632	24
17,190	0.03566	0.248245	25
17,840	0.035818	0.257632	26
	0.036442		



ATTACHMENT C

CALIBRATION SUMMARY

P2989 Western Corridor Traffic and Transport Study VISSIM Data Analysis

P2989	Wester	n Corridor Traffi	c and T	ransport Study									GEH Turn	Summary	0800-0900
AM Peak 0	10 7 (narysis) 800-0900												>5, <=10	0	0.00%
Time	ID	Intersection	Movement	From	То	Turn	Ohserved	Modelled	Abs. Diff	% Diff	GEH	Accent	<=o Delay (s)	240	Queue
1800	101	Woodford Street	Code 101-1	Woodford Street (N)	Newcastle Link Road (W)	R	110	119	(Mod - Obs) 9	(Mod - Obs) 8.2%	0.8	Y	49.0	D	(m) 9.9
		Newcastle Link Road	101-2		Cameron Park Drive (S)	Т	106	120	14	13.2%	1.3	Y	54.6	D	10.2
		Cameron Park Drive	101-3	Newcastle Link Road (E)	Woodford Street (N)	R	87 57	78 51	-9	-10.5%	1.00.8	Y Y	43.9 52.2	D	5.2 4.1
			101-5 101-6		Newcastle Link Road (W) Cameron Park Drive (S)	Т	1,289 155	1,271 151	-18 -4	-1.4% -2.6%	 ✓ 0.5 ✓ 0.3 	Y	36.0 25.7	C B	32.4
			101-7	Cameron Park Drive (S)	Newcastle Link Road (E)	R	176	181	5	2.8%	0.3	Ý	56.5	D	17.5
			101-8 101-9		Woodford Street (N) Newcastle Link Road (W)	T L	132 302	130 311	-2 9	-1.5% 3.0%	✓ 0.2✓ 0.5	Y Y	52.5 32.1	D C	10.9 18.0
			101-10	Newcastle Link Road (W)	Cameron Park Drive (S)	R	220	225	5	2.3%	0.3	Y	63.4	E	25.5
			101-11		Woodford Street (N)	L	1,742 79	97	-1 18	-0.1% 22.8%	✓ 0.0✓ 1.9	Y Y	28.8 18.7	B	35.9 3.0
	102	Woodford Street	102-2	All Woodford Street (N)	Woodford Street (S)	T	4,455 86	4,475 78	-8	-9.3%	• 0.9	Y	36.0 8.9	C A	15.0
	102	Minmi Road	102-3		Minmi Road (E)	L	125	141	16	12.8%	1.4	Ý	9.6	A	1.9
			102-4 102-6	Minmi Road (E)	Woodford Street (N) Woodford Street (S)	R L	149 249	162 287	13 38	8.7% 15.3%	1.02.3	Y Y	26.2 25.3	B	23.0 22.7
			102-7	Woodford Street (S)	Minmi Road (E)	R	236	267	31	13.1%	2.0	Y	18.3	В	8.2
			102-8	All	Woodford Street (N)		927	85 1,020	3	3.1%	V 0.3	Ŷ	18.9	B	9.6
	103	Brookfield Avenue Minmi Road	103-1 103-3	Brookfield Avenue (N)	Minmi Road (W) Minmi Road (E)	R	23	10 70	-13 14	-56.5% 21.5%	✓ 3.2✓ 1.6	Y	4.8 2.2	A A	0.0
			103-3	Minmi Road (E)	Brookfield Avenue (N)	R	17	31	14	82.4%	2.9	Ý	2.6	A	0.1
			103-5 103-11	Minmi Road (W)	Minmi Road (W) Minmi Road (E)	Т	370 362	445 437	75 75	20.3% 20.7%	✓ 3.7✓ 3.8	Y Y	0.2 1.3	A A	0.0 0.0
			103-12		Brookfield Avenue (N)	Ĺ	22	12	-10	-45.5%	2.4	Ŷ	0.9	A	0.0
	104	Minmi Road	104-5	All Minmi Road (E)	Minmi Road (W)	Т	421	476	55	13.1%	2.6	Y	0.9	A	0.0
		Highland Way	104-6	Highland Way (S)	Highland Way (S)	L	15 22	7	-8 1	-53.3%	2.4	Y	0.6	A	0.0
			104-7	nighlanu way (S)	Minmi Road (W)	L	7	0	-7	-4.3%	0.23.7	Ý	0.0	A	0.0
			104-10 104-11	Minmi Road (W)	Highland Way (S) Minmi Road (E)	R	3 430	0 518	-3 88	-100.0% 20.5%	 2.4 4.0 	Y	0.0	A A	0.0
			104-11	All		1	899	1,023	00	20.370	4.0	1	0.3	A	0.0
	105	Minmi Road Britannia Boulevarde	105-5 105-6	Minmi Road (E)	Minmi Road (W) Britannia Boulevarde (S)	T L	407 68	462 70	55 2	13.5% 2.9%	✓ 2.6✓ 0.2	Y Y	1.9 2.8	A A	0.0 0.0
			105-7	Britannia Boulevarde (S)	Minmi Road (E)	R	194	217	23	11.9%	1.6	Y	4.0	A	0.7
			105-9	Minmi Road (W)	Britannia Boulevarde (S)	R	47 18	9	-25 -9	-53.2% -50.0%	4.32.4	Y Y	3.8 2.1	A	0.7 2.7
			105-11	Δ1I	Minmi Road (E)	Т	446	535	89	20.0%	✓ 4.0	Y	5.2	A	2.7
	106	Kurraka Drive	106-1	Kurraka Drive (N)	Minmi Road (W)	R	30	28	-2	-6.7%	0.4	Y	3.0	A	0.5
		Minmi Road	106-3 106-4	Minmi Road (F)	Minmi Road (E) Kurraka Drive (N)	L R	83 43	62 35	-21 -8	-25.0% -18.6%	✓ 2.4✓ 1.3	Y Y	6.1 1.3	A A	0.5 0.0
			106-5		Minmi Road (W)	T	440	500	60	13.6%	2.8	Y	0.2	A	0.0
			106-11 106-12	iviinmi Road (VV)	Kurraka Drive (N)	L	639 29	729 21	90 -8	-27.6%	✓ 3.4✓ 1.6	Y Y	1.4 0.8	A	0.2
	107	Awabakal Drive	107-1	All Awabakal Drive (N)	Minmi Road (W)	R	1,264 105	1,375 98	-7	-6.7%	07	Y	1.2 43.4	A	0.2
	107	Minmi Road	107-2		Bellbird Close (S)	Т	0	0	0	#DIV/0!	0.0	Ý	0.0	A	18.4
		Bellbird Close	107-3 107-4	Minmi Road (E)	Minmi Road (E) Awabakal Drive (N)	L R	250 131	248 144	-2 13	-0.8% 9.9%	✓ 0.1✓ 1.1	Y Y	38.7 46.4	C D	18.7 11.8
			107-5		Minmi Road (W)	Т	394	436	42	10.7%	2.1	Y	7.2	A	4.5
			107-8	Bellbird Close (S)	Minmi Road (E)	R	3 11	13	5 2	18.2%	2.10.6	Y Y	0.1 77.6	F	4.0
			107-8 107-9		Awabakal Drive (N) Minmi Road (W)	T	1	0	-1 -1	-100.0%	 1.4 1.4 	Y	0.0	A A	0.6
			107-10	Minmi Road (W)	Bellbird Close (S)	R	1	0	-1	-100.0%	1.4	Ý	0.0	A	0.0
			107-11 107-12		Minmi Road (E) Awabakal Drive (N)	L	574 147	663 127	89 -20	15.5% -13.6%	✓ 3.6✓ 1.7	Y Y	23.1 10.1	B A	17.0 16.9
	100	Manyland Drivo	100 1	All Mapuland Drive (N)	Minmi Dood (M)	D	1,618	1,737	14	7 10/	10	V	23.8	B	9.4
	108	Minmi Road	108-1	iviai yialiu Drive (N)	Churnwood Drive (S)	T	38	41	-14	7.9%	0.5	Ϋ́	42.5 38.8	C	15.9
		Churnwood Drive	108-3 108-4	Minmi Road (F)	Minmi Road (E) Maryland Drive (N)	L	193 94	184 82	-9 -12	-4.7% -12.8%	✓ 0.7✓ 1.3	Y	25.6 42.6	B	6.5 5.5
			108-5		Minmi Road (W)	Т	343	367	24	7.0%	1.3	Y	16.5	В	6.7
			108-6 108-7	Churnwood Drive (S)	Churnwood Drive (S) Minmi Road (E)	L R	47 58	44 50	-3 -8	-6.4% -13.8%	✓ 0.4✓ 1.1	Y Y	13.7 34.0	A C	6.7 2.1
			108-8		Maryland Drive (N)	Т	60	63 25	3	5.0%	0.4	Y	27.1	В	2.4
			108-9	Minmi Road (W)	Churnwood Drive (S)	R	34 87	35 84	-3	-3.4%	✓ 0.2✓ 0.3	Y Y	23.0 44.5	D	6.1
			108-11 108-12		Minmi Road (E) Maryland Drive (N)	Т	641 159	690 138	49 -21	7.6% -13.2%	 1.9 1.7 	Y	17.9 22.0	B	16.5 16.7
			100-12	All			1942	1,953	-21	13.270	1.7	1	24.2	B	8.5
	109	Minmi Road Bottlebrush Boulevarde	109-5 109-6	Minmi Road (E)	Minmi Road (W) Bottlebrush Boulevarde (S)	T	441 43	459 43	18 0	4.1% 0.0%	✓ 0.8✓ 0.0	Y Y	2.8 1.4	A A	0.7 0.3
			109-7	Bottlebrush Boulevarde (S)	Minmi Road (E)	R	199	187	-12	-6.0%	0.9	Y	2.5	A	0.1
			109-9 109-10	Minmi Road (W)	Minmi Road (W) Bottlebrush Boulevarde (S)	R	46 28	41 29	-5 1	-10.9%	✓ 0.8✓ 0.2	Y Y	1.5 5.5	A A	0.1 9.7
			109-11		Minmi Road (E)	Т	882	901	19	2.2%	0.6	Y	9.1	A	9.7
	110	Warkworth Street	110-1	Warkworth Street (N)	Minmi Road (W)	R	74	76	2	2.7%	0 .2	Y	2.2	A	0.1
		Minmi Road	110-3 110-4	Minmi Road (F)	Minmi Road (E) Warkworth Street (N)	L	147 58	141 38	-6 -20	-4.1% -34.5%	 0.5 2 0 	Y	1.5 17.2	A B	0.0
			110-4		Minmi Road (W)	Т	410	425	15	3.7%	0.7	Y	0.8	A	0.0
			110-11 110-12	Minmi Road (W)	Minmi Road (E) Warkworth Street (N)	T	904 120	992 101	88 -19	9.7% -15.8%	2.91.8	Y Y	1.7 1.0	A A	0.1
				All			1713	1 773					1.8	Δ	0.1

II. Symmetriked I.S. Numerical existion T B B B B B C B C B C F I I A C B C F I A C C F I A C C F I A C C F I A C <thc< th=""> <thc< th=""> C <th< th=""><th>Time</th><th>ID</th><th>Intersection</th><th>Movement Code</th><th>From</th><th>То</th><th>Turn</th><th>Observed</th><th>Modelled</th><th>Abs. Diff (Mod - Obs)</th><th>% Diff (Mod - Obs)</th><th>GEH</th><th>Accept</th><th>Delay (s)</th><th>LoS</th><th>Queue (m)</th></th<></thc<></thc<>	Time	ID	Intersection	Movement Code	From	То	Turn	Observed	Modelled	Abs. Diff (Mod - Obs)	% Diff (Mod - Obs)	GEH	Accept	Delay (s)	LoS	Queue (m)
Summa Hised 110 I10 I10 I10		111	Minmi Road	111-5	Minmi Road (E)	Minmi Road (W)	Т	457	456	-1	-0.2%	0.0	Y	1.8	А	0.0
Image Description Description Perform			Summerhill Road	111-6	Current arthill Dated (C)	Summerhill Road (S)	L	55	59	4	7.3%	0.5	Y	1.7	A	0.0
Image Image Same Part Same P				111-7	Summernill Road (S)	Minmi Road (E) Minmi Road (W)	R I	50 19	51	-14	-73.7%	✓ 0.1✓ 4.0	Y Y	1.0 1.1	A	0.0
Image: Problem in the second				111-10	Minmi Road (W)	Summerhill Road (S)	R	29	29	0	0.0%	0.0	Ý	6.5	A	7.1
12 Accuration Answer 111: 112 Accuration Answer 111: 112 111: 112 112 112 112 112 112 112 112 112 112 112 112 112 112 112 112 113 <th></th> <th></th> <th></th> <th>111-11</th> <th>A II</th> <th>Minmi Road (E)</th> <th>Т</th> <th>1,041</th> <th>1,106</th> <th>65</th> <th>6.2%</th> <th>2.0</th> <th>Y</th> <th>6.4</th> <th>A</th> <th>7.1</th>				111-11	A II	Minmi Road (E)	Т	1,041	1,106	65	6.2%	2.0	Y	6.4	A	7.1
Drum Radi 11.0 Characterization of the section of the		112	McNaughton Avenue	112-1	McNaughton Avenue (N)	Minmi Road (W)	R	2	1,706	8	400.0%	3.3	Y	4.0 11.6	A	1.4
International sector Internati			Minmi Road	112-2		McNaughton Avenue (S)	Т	0	0	0	#DIV/0!	0.0	Y	0.0	А	1.2
11.9 Control (C) Control (C) <thcontrol (c)<="" th=""> <thco< th=""><th></th><th></th><th></th><th>112-3 112 4</th><th>Minmi Road (F)</th><th>Minmi Road (E)</th><th>L P</th><th>119 70</th><th>115 67</th><th>-4</th><th>-3.4%</th><th>0.4</th><th>Y</th><th>10.8 44.2</th><th>A</th><th>1.8 11 7</th></thco<></thcontrol>				112-3 112 4	Minmi Road (F)	Minmi Road (E)	L P	119 70	115 67	-4	-3.4%	0.4	Y	10.8 44.2	A	1.8 11 7
Image: second				112-4		Minmi Road (W)	Т	527	513	-14	-2.7%	0.4	Ý	5.5	A	6.7
100 Mongram Assurg 20 Mongram Assurg 20 Mongram Assurg 20 Fer (Hard) 30 Fe S 1 6 5 7 0 0 0 0 <th></th> <th></th> <th></th> <th>112-6</th> <th></th> <th>McNaughton Avenue (S)</th> <th>L</th> <th>7</th> <th>8</th> <th>1</th> <th>14.3%</th> <th>0.4</th> <th>Y</th> <th>0.5</th> <th>A</th> <th>6.7</th>				112-6		McNaughton Avenue (S)	L	7	8	1	14.3%	0.4	Y	0.5	A	6.7
Image: book of the strength of the stre				112-7 112-8	McNaughton Avenue (S)	Minmi Road (E) McNaughton Avenue (N)	R	1	6	5	500.0% #DIV/0I	✓ 2.7	Y	20.9	B	0.2
International state Internatinternational state International sta				112-9		Minmi Road (W)	L	9	0	-9	-100.0%	✓ 4.2	Ý	0.0	A	0.0
Image: second				112-10	Minmi Road (W)	McNaughton Avenue (S)	R	4	0	-4	-100.0%	2.8	Y	0.0	A	0.0
Ins Argent Date Ins Ins <th< th=""><th></th><th></th><th></th><th>112-11</th><th></th><th>Minmi Road (E) McNaughton Avenue (N)</th><th></th><th>1,172</th><th>1,159 37</th><th>-13 21</th><th>-1.1% 131.3%</th><th>✓ 0.4✓ 4.1</th><th>Y Y</th><th>0.5 0.6</th><th>A A</th><th>0.0</th></th<>				112-11		Minmi Road (E) McNaughton Avenue (N)		1,172	1,159 37	-13 21	-1.1% 131.3%	✓ 0.4✓ 4.1	Y Y	0.5 0.6	A A	0.0
T15 Digger One T151 Margine Shee (b) Mitrin Road (b) F 30 63 32 115, b 53 7 43, b 7 43, b <t< th=""><th></th><th></th><th></th><th></th><th>All</th><th>Montadghton / Vondo (N)</th><th></th><th>1,927</th><th>1,915</th><th></th><th></th><th></th><th></th><th>4.1</th><th>A</th><th>2.3</th></t<>					All	Montadghton / Vondo (N)		1,927	1,915					4.1	A	2.3
Instruction 13.3.4 bit Mark Roug (1) margane (1) <thmargane (1<="" td=""><th></th><td>113</td><td>Maryland Drive</td><td>113-1</td><td>Maryland Drive (N)</td><td>Minmi Road (W)</td><td>R</td><td>30</td><td>63 524</td><td>33</td><td>110.0%</td><td> 4.8 2.5 </td><td>Y</td><td>46.0</td><td>D</td><td>4.7</td></thmargane>		113	Maryland Drive	113-1	Maryland Drive (N)	Minmi Road (W)	R	30	63 524	33	110.0%	 4.8 2.5 	Y	46.0	D	4.7
Image: Image:<			IVIII II II KUdu	113-4	Minmi Road (E)	Maryland Drive (N)	R	199	164	-03	-17.6%	2.6	Ý	20.4 56.2	D	12.0
Image:				113-5		Minmi Road (W)	Т	559	516	-43	-7.7%	1.9	Y	3.6	А	1.0
International Control Data Compositional (*) C Casto Casto <thcasto< th=""> Casto Casto<</thcasto<>				113-11	Minmi Road (W)	Minmi Road (E)	Т	1,233	1,171	-62 16	-5.0%	 1.8 2.4 	Y	13.2	A	14.0
114 Creck Road 1 114 Clock Mad 2 (A) Mum Road 3 Mul (Sould S) F T <tht< th=""> <tht< th=""> T <</tht<></tht<>				113-12	All		L	2,642	2,468	10	114.370	3 .4	T	16.4	B	8.2
Image: Similar Similara Similara Similar Similar Similar Similar Similar Similar Simila		114	Creek Road	114-1	Creek Road (N)	Minmi Road (W)	R	20	47	27	135.0%	4.7	Y	51.1	D	5.2
International 114.4 Interact (%) Const Read (%) T 54 48 -6 -11.18 Ones V 41.2 D <thd< th=""> D D</thd<>			Minmi Road Macquarie Street	114-2		Macquarie Street (S) Minmi Road (F)		43	14 24	-3 -19	-17.6%	✓ 0.8✓ 3.3	Y Y	40.2 33.3	C	5.2 5.1
Image Image Image Mining Road (W) T 384 460 90 21 91 90 70 83.6 90 90 70				114-4	Minmi Road (E)	Creek Road (N)	R	54	48	-6	-11.1%	0.8	Ý	44.2	D	10.5
Image Image Macquarte Streter(S) M				114-5		Minmi Road (W)	Т	384	465	81	21.1%	3.9	Y	18.4	В	10.7
Image: Section of the sectin of the section of the section				114-6 114-7	Macquarie Street (S)	Macquarie Street (S) Minmi Road (F)	R	68 162	90 160	-2	32.4% -1.1%	✓ 2.5✓ 0.1	Y Y	17.6 68.4	F	9.0 26.4
Image Image Manue Road (M) I Image State				114-8		Creek Road (N)	Т	25	33	8	32.0%	0.11.5	Ý	54.7	D	26.4
International (n) watz, all static (n) watz, all static (n) with mask (n) with (n)				114-9		Minmi Road (W)	L	161	120	-41	-25.5%	3.5	Y	39.6	С	26.4
Image: biology of the strength of the s				114-10 114-11	Minmi Road (W)	Macquarie Street (S) Minmi Road (F)	R T	1.211	1,162	-27 -49	-12.4%	✓ 1.9✓ 1.4	Y Y	47.0 40.5	D C	67.8 67.0
Intern Road Intern Road (E) Minni Road (E) Minni Road (E) S49 563 14 2.06 Y 4.7 A 16 Burnings 115-5 Burnings (S) L 91 107 16 17.6K 5.6 Y 1.0 A 1.6 115-7 Burnings (S) Minni Road (W) L 4.1 38 -3 -7.3K 0.6 Y 4.4 A 0.2 115-0 Minni Road (W) Burnings (S) R 4.7 A 4.65 115-11 Minni Road (W) Burnings (S) R 1.322 45 -7.3K 0.6 Y 4.4 A 6.26 116 Sandgate Road (M) Minni Road (W) Minni Road (W) L 1.12 10.0035 0.4 Y 0.0 A 0.0 116 Sandgate Road (M) Minni Road (W) L 1.12 10.035 0.8 Y 0.0 A 0.0 A 0.0 A 0.0				114-12		Creek Road (N)	L	94	104	10	10.6%	1.0	Ý	28.0	B	64.9
No. Barnings 115.6 115.7 115.9 Barnings (S) mmin Road (D) 115.10 Barning (S) mmin Road (D) 115.10 L 91 107 16 17.6 5 9.7.1% 9.05 91.6 9.05 V 3.4 0.2 9.05 115.0 Barning (S) Minim Road (W) L 4.1 38 3 -7.3% 9.05 V 4.4 A 0.2 115.10 Minim Road (E) L 4.1 38 -3.7.3% 9.12 V 11.4 A 66.5 116.0 Bardgate Road (E) Minim Road (E) L 11.2 0 12.1 100.0% 4.9 V 0.0 A 0.0 116 Sardgate Road (E) Minim Road (W) T 5.17 5.17 0.00 V 2.5 V 0.0 A 0.00 116.1 Minim Road (W) Minim Road (W) T 5.77 51.7 0.0 0.00 V 2.4 0.5 116.1 Minim Road (W) Minim Road (W) T 52.5 2.3		115	Minmi Road	115-5	All Minmi Road (E)	Minmi Road (W)	Т	2,456 549	2,457	14	2.6%	0.6	Y	37.6 4.7	C A	27.0
Image is a probability of the strength is probability of the strengt		110	Bunnings	115-6		Bunnings (S)	L	91	107	16	17.6%	0.01.6	Ý	1.0	A	1.6
Instruction Minmi Road (W) L 4.4 4.8 5.3 7.26% 9.15 Y 1.4.4 A 0.6.2 115-10 Minmi Road (W) Minmi Road (E) T 1.3.12 4.4 3.3 1.5 Y 1.4.4 A 6.63.6 116 Sandgate Road (N) Minmi Road (E) L 1.15 0.15 Y 1.4.4 A 6.63.6 116 Sandgate Road (R) Minmi Road (E) L 1.15 1.15 1.0 9.0% 2.4 Y 1.0 A 0.66 A 0.00 116 Sandgate Road (R) Minmi Road (W) L 1.1 2.1 0 9.0% 2.5 Y 0.3 A 0.0 116.6 Sandgate Road (R) Minmi Road (W) T 5.7 1.0 0.00% 2.0 Y 1.2 A 0.0 116.12 A 0.1 Comper Street (S) Comper Street (S) Comper Street (S) 1.0 2.000 1.1 <th></th> <td></td> <td></td> <td>115-7</td> <td>Bunnings (S)</td> <td>Minmi Road (E)</td> <td>R</td> <td>70</td> <td>65</td> <td>-5</td> <td>-7.1%</td> <td>0.6</td> <td>Y</td> <td>3.7</td> <td>A</td> <td>0.2</td>				115-7	Bunnings (S)	Minmi Road (E)	R	70	65	-5	-7.1%	0.6	Y	3.7	A	0.2
Image of the second o				115-9 115-10	Minmi Road (W)	Minmi Road (W) Bunnings (S)	L R	4 I 49	38	-3 -16	-7.3% -32.7%	✓ 0.5✓ 2.5	Y Y	4.4 14.4	A A	0.2 68.6
Info Sandgate Road Info Sandgate Road (N) Mirmi Road (E) L 12 0 -12 1000% Q Y Q				115-11		Minmi Road (E)	Т	1,357	1,312	-45	-3.3%	✓ 1.2	Ý	11.4	A	68.6
110 Softgale Road 110-5 Softgale Road (r) minim Road (L) T 6.2 6.32 4 0.0% 9.12 1 0.00 A 0.05 Minim Road (N) 116-6 Sandgale Road (S) L 111 21 10 0.09% 2.5 Y 0.3 A 0.00 116-10 Minim Road (W) Imma Road (R) L 4.2 37 5 -11.9% 0.8 Y 0.4 0.00 Y 2.49 B 2.7 116-11 Minim Road (W) Minim Road (W) L 2.962 -10 -7 7.3 A 0.5 117 Cameron Street (N) Minim Road (W) T 2.962 27 -7.3 A 0.5 117 Cameron Street (N) Minim Road (W) T 2.962 273 -16.07% 2.01 Y 494 D 16.1 Longworth Avenue 117.2 Comport Street (N) T 2.26 273 5.1 6.0% 2.0 Y 49 Y 47 A 9.25 16.0% <td< th=""><th></th><th>116</th><th>Sandrato Doad</th><th>116.2</th><th>All Sandrato Road (NI)</th><th>Minmi Dood (E)</th><th></th><th>2,157</th><th>2,118</th><th>10</th><th>100.0%</th><th></th><th>V</th><th>8.8</th><th>A</th><th>18.0</th></td<>		116	Sandrato Doad	116.2	All Sandrato Road (NI)	Minmi Dood (E)		2,157	2,118	10	100.0%		V	8.8	A	18.0
Index Index Sandgale Road (S) internal Road (M) L 11 1 1 1 1 1 1 1 1 0 90% 2 Y 0.03 A 0.00 116 Minmi Road (W) Minmi Road (E) T 57.1 57.1 0.005 2.00 Y 2.49 B 2.77 110 Cameron Street 117.1 Cameron Street 117.1 Cameron Street 117.2 2.000 - - 7.3 A 0.5 117 Cameron Street 117.1 Cameron Street (N) Minmi Road (W) R 2.20 52 1.60 3.00 Y 2.04 0.7 Y 4.94 0.0 Comport Netei 117.2 Comport Netei(E) L 43 4.7 4 9.3% 0.66 Y 1.17 A 0.7 Minmi Road (W) T 2.1 Y 4.91 0.01 Y 4.0 2.2 0.05 0.12 Y		110	Minmi road	116-5	Minmi Road (E)	Minmi Road (W)	Т	628	632	4	0.6%	0.2	Ý	0.6	A	0.0
Image: Image:<				116-6		Sandgate Road (S)	L	11	21	10	90.9%	2.5	Y	0.3	А	0.0
Image: Street Internet Node (r) Image: Nod				116-9 116-11	Sandgate Road (S) Minmi Road (W)	Minmi Road (W) Minmi Road (E)	L	42 517	37 517	-5	-11.9%	0.8	Y	0.7 24.9	A	0.0
Image: state in the state				116-12		Sandgate Road (N)	L	920	805	-115	-12.5%	✓ 0.0✓ 3.9	Ý	1.2	A	2.7
117 Cameron Street (N) Minmi Road (W) R 296 3.09 13 4.4% 0.1 Y 4.94 0 6 16 Longworth Avenue Cowper Street (S) T 325 273 552 -16.0% 3.0 Y 20.3 B 9.2 Cowper Street 117.3 Longworth Avenue (E) L 43 47 4 9.3% 0.06 Y 117.7 A 0.7 Minni Road 117.5 Longworth Avenue (E) Cameron Street (N) R 58 102 44 759% 0.49 Y 957 F 30.5 117.5 Minni Road (W) R 28 102 44 759% 0.1 Y 41.4 D 22.1 Y 104.11 F 34.5 117.6 Cowper Street (S) Longworth Avenue (E) R 4 2 2 50.5% 0.1 Y 110.4 D 2.3 Y 104.1 F 34.5 56.5% 0.1 Y 110.5 34.5 57.5 55.5 55.5		117	Company Charact	117 1	All	Mienel Deed (AA)		2130	2,062	10	4 40/			7.3	A	0.5
Compare Street 117.3 Longworth Avenue (E) Cameron Street (N) R 53 102 44 75% 0 0 11.7 A 0.7 Minmi Road 117.4 Longworth Avenue (E) Cameron Street (N) R 58 102 44 75.9% 0 9 95.7 F 30.5 Minmi Road 117.4 Longworth Avenue (E) Cameron Street (N) T 289 254 35 -1.1% 0 95.7 F 30.5 117.6 Cowper Street (S) Longworth Avenue (E) R 4 2 -2 50.0% 0 1 Y 10.4 F 34.5 117.7 Cowper Street (S) Longworth Avenue (E) R 4.8 2 -2 50.0% 0.1 Y 104.1 FC 34.5 117.7 Minmi Road (W) Cowper Street (N) Longworth Avenue (E) R 48 50 -18 26.5% 2.3 Y 59.9 E 55.5 55.5<		/	Cameron Street	117-2	Cameron Street (N)	Minmi Road (W) Cowper Street (S)	R T	296 325	309 273	-52	4.4%	✓ 0.7✓ 3.0	Y Y	49.4 20.3	D B	16.1 9.2
Minmi Road 117.4 Longworth Avenue (E) Cameron Street (N) R 58 102 44 75.9% 24.9 Y 95.7 F 30.5 117.5 Minmi Road 117.6 Cowper Street (S) L 289 254 -35 -12.1% Q Y 41.7 C 22.7 117.6 Cowper Street (S) Longworth Avenue (E) R 4 2 -2 -50.0% Q 12 Y 104.1 F 34.5 117.7 Cowper Street (S) Longworth Avenue (E) R 4 2 -2 -50.0% Q 1 Y 104.1 F 34.5 117.9 Minmi Road (W) Cowper Street (S) R 68 50 -18 -26.5% Q 2.3 Y 10.7 8 28 117.10 Minmi Road (W) Cowper Street (S) R 68 50 -18 -26.5% Q<2.8			Cowper Street	117-3		Longworth Avenue (E)	L	43	47	4	9.3%	0.6	Ý	11.7	A	0.7
Image: Section of the sectin of the section of the section of the section of the			Minmi Road	117-4	Longworth Avenue (E)	Cameron Street (N)	R	58	102	44	75.9%	✓ 4.9○ 2.1	Y	95.7 41.7	F	30.5
Image: second				117-5		Cowper Street (S)	L	16	254 42	-35	-12.1% 162.5%	✓ 2.1✓ 4.8	Y Y	41.7 51.4	D	22.7
Image: Section of the sectin of the section of the section of the section of the				117-7	Cowper Street (S)	Longworth Avenue (E)	R	4	2	-2	-50.0%	1.2	Y	104.1	F	34.5
Image: Section of the sectin of the section of the section of the section of the				117-8		Cameron Street (N)	Т	404 57	402	-2	-0.5%	0.1	Y	31.9	С	34.0
Introduct				117-10	Minmi Road (W)	Cowper Street (S)	R	68	50	-18	-26.5%	2.3	Ý	59.9	E	5.5
Image: Construction of the street of the				117-11		Longworth Avenue (E)	Т	438	498	60	13.7%	2.8	Y	16.7	В	38.0
118 Sandgate Road 118-5 Sandgate Road (E) Sandgate Road (W) T 4 0 -4 -100.0% © 2.8 Y 0.0 A 0.0 Tillie Street 118-6 118-6 Tillie Street (S) L 414 446 32 7.7% © 1.5 Y 0.6 A 0.0 118-7 Tillie Street (S) Sandgate Road (E) R 447 443 -4 -0.9% © 0.2 Y 0.5 A 0.0 118-9 Sandgate Road (W) Tillie Street (S) Sandgate Road (E) R 447 443 -4 -0.9% © 0.2 Y 0.5 A 0.0 118-10 Sandgate Road (W) Tillie Street (S) R 425 332 -93 -21.9% © 4.8 Y 15.9 B 17.5 Sandgate Road (W) Tillie Street (S) R 425 332 -93 -21.9% © 4.8 Y 15.9 B 17.5 118-11 118-10 Sandgate Road (E) T 475 444 -31 -6.5% 0.				11/-12	All	Cameron Street (N)	L	16	1/	1	6.3%	O .2	Y	15.5 33.7	B	37.7
Tillie Street 118-6 Tillie Street (S) Sandgate Road (E) R 444 446 32 7.7% © 1.5 Y 0.6 A 0.0 118-7 Tillie Street (S) Sandgate Road (E) R 447 443 -4 -0.9% © 0.2 Y 0.5 A 0.0 118-9 Sandgate Road (W) L 3 0 -3 -100.0% © 2.4 Y 0.0 A 0.0 118-9 Sandgate Road (W) Tillie Street (S) R 425 332 -93 -21.9% © 4.8 Y 15.9 B 17.5 118-10 Sandgate Road (E) T 495 477 -18 -3.6% © 0.8 Y 14.6 A 17.5 119 Tillie Street 119-2 Tillie Street (N) Tillie Street (S) T 475 444 -31 -6.5% © 1.4 Y 1.2 A 0.0 Wilkinson Avenue 119-3 Wilkinson Avenue (E) Tillie Street (N) R 9 21 12 133.3% 0.3.1 Y <th></th> <td>118</td> <td>Sandgate Road</td> <td>118-5</td> <td>Sandgate Road (E)</td> <td>Sandgate Road (W)</td> <td>Т</td> <td>4</td> <td>0</td> <td>-4</td> <td>-100.0%</td> <td>2.8</td> <td>Y</td> <td>0.0</td> <td>A</td> <td>0.0</td>		118	Sandgate Road	118-5	Sandgate Road (E)	Sandgate Road (W)	Т	4	0	-4	-100.0%	2.8	Y	0.0	A	0.0
118-7 1111111 Sandgate Road (L) R 447 443 -4 -0.7% 0.2 1 0.3 A 0.0 118-9 118-9 Sandgate Road (W) L 3 0 -3 -100.0% 2.4 Y 0.0 A 0.0 118-9 118-10 Sandgate Road (W) Tillie Street (S) R 425 332 -93 -21.9% 24.8 Y 15.9 B 17.5 118-10 Sandgate Road (E) T 495 477 -18 -3.6% 20.8 Y 14.6 A 17.5 118-10 Sandgate Road (E) T 495 477 -18 -3.6% 20.8 Y 14.6 A 17.5 119 Tillie Street 119-2 Tillie Street (S) T 475 444 -31 -6.5% 21.4 Y 1.2 A 0.0 119 Tillie Street 119-3 Tillie Street (S) T 475 444 -31 -6.5% 21.4 Y 1.2 A 0.0 <			Tillie Street	118-6 119-7	Tillio Stroot (S)	Tillie Street (S) Sandaato Road (E)	L	414	446	32	7.7%	 1.5 0.2 	Y	0.6	A	0.0
Image: Normal Stret Image: Normal Stret Stret Stret R 425 332 -93 -21.9% 48 Y 15.9 B 17.5 Image: Normal Stret Image: Normal St				118-9		Sandgate Road (W)	L	3	0	-4	-100.0%	2.4	Ý	0.0	A	0.0
Image: Constraint of the street of the street (N) Sandgate Road (E) T 495 477 -18 -3.6% ♀ 0.8 ♀ 14.6 A 17.5 Image: Constraint of the street of the st				118-10	Sandgate Road (W)	Tillie Street (S)	R	425	332	-93	-21.9%	4.8	Y	15.9	В	17.5
Image: Normal system Image: Normal system <th< th=""><th></th><th></th><th></th><th>118-11</th><th>All</th><th>Sandgate Road (E)</th><th>T</th><th>495</th><th>477</th><th>-18</th><th>-3.6%</th><th>0.8</th><th>Y</th><th>14.6</th><th>A</th><th>17.5 5.8</th></th<>				118-11	All	Sandgate Road (E)	T	495	477	-18	-3.6%	0.8	Y	14.6	A	17.5 5.8
Wilkinson Avenue 119-3 Wilkinson Avenue (E) L 371 335 -36 -9.7% Y 0.3 A 0.0 119-4 119-4 Wilkinson Avenue (E) Tillie Street (N) R 9 21 12 133.3% <3.1 Y 26.0 B 6.6 119-6 Tillie Street (S) L 339 309 -30 -8.8% <1.7 Y 11.5 A 6.5 119-7 Tillie Street (S) Wilkinson Avenue (E) R 315 316 1 0.3% <0.1 Y 9.9 A 6.2 119-8 Tillie Street (N) T 433 424 -9 -2.1% 0.4 Y 1.2 A 1.0		119	Tillie Street	119-2	Tillie Street (N)	Tillie Street (S)	Т	475	444	-31	-6.5%	1 .4	Y	1.2	A	0.0
119-4 Wilkinson Avenue (E) 110e Street (N) R 9 21 12 133.3% ♥ 3.1 Y 26.0 B 6.6 119-6 Tillie Street (S) L 339 309 -30 -8.8% ♥ 1.7 Y 11.5 A 6.5 119-7 Tillie Street (S) Wilkinson Avenue (E) R 315 316 1 0.3% ♥ 0.1 Y 9.9 A 6.2 119-8 Tillie Street (N) T 433 424 -9 -2.1% ♥ 0.4 Y 1.2 A 1.0			Wilkinson Avenue	119-3	Willingen Augens (E)	Wilkinson Avenue (E)	L	371	335	-36	-9.7%	1.92.1	Y	0.3	A	0.0
119-7 Tillie Street (S) Wilkinson Avenue (E) R 315 316 1 0.3% 0.1 Y 9.9 A 6.2 119-8 Tillie Street (N) T 433 424 -9 -2.1% 0.4 Y 1.2 A 1.0				119-4 119-6	WIIKINSON AVENUE (E)	Tillie Street (N) Tillie Street (S)	R	339	309	-30	-8.8%	✓ 3.1✓ 1.7	Y Y	26.0 11.5	A	6.6 6.5
119-8 Tillie Street (N) T 433 424 -9 -2.1% <a>O V 1.2 A 1.0				119-7	Tillie Street (S)	Wilkinson Avenue (E)	R	315	316	1	0.3%	0.1	Ý	9.9	A	6.2
				119-8	Δ11	Tillie Street (N)	Т	433	424	-9	-2.1%	0.4	Y	1.2	A	1.0

Time	ID	Intersection	Movement Code	From	То	Turn	Observed	Modelled	Abs. Diff (Mod - Obs)	% Diff (Mod - Obs)	GEH	Accept	Delay (s)	LoS	Queue (m)
	120	Tillie Street	120-1	Tillie Street (N)	Cameron Street (W)	R	641	583	-58	-9.0%	2.3	Y	0.7	A	0.0
		Cameron Street	120-2	Douglas Street (S)	Tillie Street (N)	T	1/3	1/2	- I -1	-0.6% -0.8%	✓ 0.1✓ 0.1	Y Y	0.8 39.2	A C	0.0 4.9
			120-9	Comoron Street (M)	Cameron Street (W)	L	61 25	58	-3	-4.9%	0.4	Y	14.8	A	4.2
			120-10	Cameron Street (W)	Tillie Street (N)	L	629	615	-14	-2.2%	✓ 0.4✓ 0.6	Y Y	4.9 3.2	A	0.1
	121	Thomas Street	121-5	All Thomas Street (E)	Thomas Street (W/)	Т	1,657	1,582	84	7.0%	24	Y	5.4 27.2	A	1.9 29.4
	121	Walford Street	121-6		Walford Street (S)	L	118	122	4	3.4%	0.4	Ý	31.2	C	29.4
			121-7 121-9	Walford Street (S)	Thomas Street (E) Thomas Street (W)	R L	338 193	345 179	7 -14	2.1% -7.3%	✓ 0.4✓ 1.0	Y Y	53.2 37.9	D C	42.3 42.5
			121-10	Thomas Street (W)	Walford Street (S)	R	126	129	3	2.4%	0.3	Y	58.8	E	13.6
			2 -	All	momas Street (E)		3772	3,903	47	2.0%	V 1.1	Ŷ	23.3	B	20.7
	122	Longworth Avenue	122-1 122-2	Longworth Avenue (N)	Newcastle Road (W) Thomas Street (S)	R	5 150	1 194	-4 44	-80.0% 29.3%	 2.3 3.4 	Y Y	38.2 69.0	C	30.5 30.5
		Thomas Street	122-2		Newcastle Road (E)	Ĺ	252	282	30	11.9%	3.41.8	Ý	28.8	B	30.5
			122-4 122-5	Newcastle Road (E)	Longworth Avenue (N) Newcastle Road (W)	R T	140 143	174 209	34 66	24.3% 46.2%	✓ 2.7✓ 5.0	Y Y	8.9 7.7	A A	3.9 3.9
			122-6		Thomas Street (S)	L	1,020	972	-48	-4.7%	1.5	Y	0.6	A	0.0
			122-7 122-8	Thomas Street (S)	Newcastle Road (E) Longworth Avenue (N)	к Т	1,828 166	224	-15 58	-0.8% 34.9%	✓ 0.4✓ 4.2	Y Y	15.6 13.5	A	41.7 41.7
			122-9	Nowcastle Doad (M)	Newcastle Road (W)	L	24	42 95	18	75.0%	✓ 3.1✓ 5.0	Y	4.3 10.1	A	42.5
			122-10	Newcasile Road (W)	Newcastle Road (E)	T	167	217	40 50	29.9%	✓ 5.0✓ 3.6	Ý	13.2	A	5.0
			122-12	۵۱	Longworth Avenue (N)	L	7	16 4 229	9	128.6%	2.7	Y	13.8	A	5.3
	123	Newcastle Road	123-1	Newcastle Road (N)	Cowper Street (W)	R	6	8	2	33.3%	0.8	Y	17.0	B	2.2
		Cowper Street	123-2 123-3		Newcastle Road (S) Cowper Street (E)	T L	37 63	38 62	1 -1	2.7% -1.6%	✓ 0.2✓ 0.1	Y Y	28.5 11.4	B A	2.7 2.4
			123-4	Cowper Street (E)	Newcastle Road (N)	R	63	60	-3	-4.8%	0.4	Y	7.6	A	2.1
			123-5		Newcastle Road (S)	L	323 18	43	-64 25	-19.8% 138.9%	3.84.5	Ϋ́	3.9 1.5	A	0.7
			123-7 123-8	Newcastle Road (S)	Cowper Street (E)	R	10 37	16 53	6 16	60.0% 43.2%	 ✓ 1.7 ✓ 2.4 	Y	10.8 12.8	A A	0.5
			123-0		Cowper Street (W)	L	156	223	67	42.9%	2.44.9	Ý	2.5	A	0.9
			123-10 123-11	Cowper Street (W)	Newcastle Road (S) Cowper Street (F)	R T	182 566	222 549	40 -17	22.0% -3.0%	 2.8 0.7 	Y Y	3.4 3.1	A A	3.7 1.7
			123-12	A.U.	Newcastle Road (N)	Ĺ	41	43	2	4.9%	0.3	Ŷ	2.7	A	1.7
	124	Kokera Street	124-1	Kokera Street (N)	Cowper Street (W)	R	1502	1,353	-2	-1.3%	0 .2	Y	5.1 9.9	A	2.9
		Cowper Street	124-3 124-4	Cowner Street (F)	Cowper Street (E) Kokera Street (N)	L R	251 459	240 440	-11 -19	-4.4% -4.1%	 0.7 0.9 	Y	11.5 4 7	A A	3.2 1.1
			124-5		Cowper Street (W)	Т	265	313	48	18.1%	2.8	Ý	3.7	A	1.1
			124-11 124-12	Cowper Street (W)	Cowper Street (E) Kokera Street (N)	L	586 181	645 180	59 -1	10.1% -0.6%	✓ 2.4✓ 0.1	Y Y	19.7 12.1	A	24.9 24.9
	125	Metcalfe Street	125-1	All Metcalfe Street (N)	Thomas Street (W)	R	1897 105	1,971 102	-3	-2.9%	• 0.3	Y	11.3 58.8	A	8.1 29.7
	120	Thomas Street	125-2		Metcalfe Street (S)	T	306	316	10	3.3%	0.6	Ý	53.3	D	30.1
			125-3 125-4	Thomas Street (E)	Metcalfe Street (N)	R	22	49	0 29	0.0% 145.0%	✓ 0.0✓ 4.9	Y Y	46.3 59.9	E	29.4 4.5
			125-5		Thomas Street (W)	Т	1,192	1,253	61	5.1%	 1.7 1.2 	Y	9.6 9.5	A	15.9
			125-0	Metcalfe Street (S)	Thomas Street (E)	R	31	34	3	9.7%	0.5	Ý	63.8	E	21.9
			125-8 125-9		Metcalfe Street (N) Thomas Street (W)	Т	187 29	193 20	6 _9	3.2% -31.0%	✓ 0.4✓ 1.8	Y Y	52.9 44.5	D	22.1 21.7
			125-10	Thomas Street (W)	Metcalfe Street (S)	R	21	19	-2	-9.5%	0.4	Ý	38.6	C	1.0
			125-11 125-12		Thomas Street (E) Metcalfe Street (N)		1,854 45	2,024 44	1/0 -1	9.2% -2.2%	✓ 3.9✓ 0.1	Y Y	6.9 8.3	A A	21.8 0.6
	126	Lake Road	126-1	All Lake Road (N)	Cowper Street (W/)	P	3842	4,100	0	#DIV/0I		V	16.5	B	16.6
	120	Cowper Street	126-2		Lake Road (S)	Т	141	154	13	9.2%	○ 0.0○ 1.1	Ý	9.7	A	2.2
			126-3 126-4	Cowper Street (E)	Cowper Street (E) Lake Road (N)	L R	16 37	23 73	7 36	43.8% 99.9%	✓ 1.6✓ 4.9	Y Y	9.5 3.5	A A	2.2 0.0
			126-5		Cowper Street (W)	Т	3	0	-3	-100.0%	2.4	Y	0.0	A	0.0
			126-0	Lake Road (S)	Cowper Street (E)	R	428 720	395 792	-33 72	-7.0%	2.6	Ϋ́	6.9	A	0.0 4.5
			126-8 126-9		Lake Road (N)	Т	208 1	186 1	-22	-10.6% 0.0%	 1.6 0.0 	Y	4.0 0.2	A A	4.5 4.5
			126-10	Cowper Street (W)	Lake Road (S)	R	0	7	7	#DIV/0!	0.03.7	Ý	10.7	A	0.1
			126-11 126-12		Cowper Street (E) Lake Road (N)	T L	2 0	0	-2 0	-100.0% #DIV/0!	✓ 2.0✓ 0.0	Y Y	0.0 0.0	A A	0.1 0.1
	107	Laka Daad	107.1	All Lake Dood (N)	Nourcestle Link Dead (MA)	D	1,555	1,631	20	10.00/	20	V	5.4	A	1.7
	127	Thomas Street	127-1	Lake Road (N)	Lake Road (S)	R T	220	291	-29 13	-12.8% 4.7%	2.00.8	Ϋ́	53.1 51.2	D	27.6
		Newcastle Link Road	127-3 127-4	Thomas Street (F)	Thomas Street (E) Lake Road (N)	L R	65 60	65 55	0 -5	0.6% -8.3%	✓ 0.0✓ 0.7	Y Y	32.8 65.2	C	26.6 6.1
			127-5		Newcastle Link Road (W)	Т	785	801	16	2.0%	0.6	Y	75.2	F	39.3
			127-6	Lake Road (S)	Thomas Street (E)	R	576	603	32	4.7% 5.4%	✓ 1.1✓ 1.3	Y Y	32.6 62.2	E	43.8 36.7
			127-8		Lake Road (N)	Т	467	471	4	0.9%	0.2	Y	54.8 53.8	D	32.0
			127-9	Newcastle Link Road (W)	Lake Road (S)	R	302	314	12	4.0%	0.7	Ý	63.0	E	41.6
			127-11 127-12		Thomas Street (E) Lake Road (N)	T	1,275 416	1,302 448	27 32	2.1% 7.7%	✓ 0.8✓ 1.5	Y Y	33.6 19.5	C B	66.0 66.0
	100	Noursette List D	100.5			т Т	5,163	5,284		1.00/			48.1	D	37.1
	128	Minmi Road	128-5	Newcastie LITK KOAO (E)	Mewcastie Link Road (W) Minmi Road (S)	L	933 157	924 147	-9	-6.4%	0.30.8	Ϋ́	5.9 7.5	A	5.1 5.1
			128-7 128-9	Minmi Road (S)	Newcastle Link Road (E)	R	431 535	361 537	-70 2	-16.2% 0.4%	✓ 3.5✓ 0.1	Y	12.6 8.9	A A	9.7 10.8
			128-10	Newcastle Link Road (W)	Minmi Road (S)	R	388	414	26	6.7%	✓ 1.3	Y	27.4	В	245.3
			128-11	All	Newcastle Link Road (E)	Т	1,653 4097	1,632 4,015	-21 -82	-1.3%	0.5	Y	26.0 17.3	B	245.3

Time	ID	Intersection	Movement Code	From	То	Turn	Observed	Modelled	Abs. Diff (Mod - Obs)	% Diff (Mod - Obs)	GEH	Accept	Delay (s)	LoS	Queue (m)
	129	Nelson Street	129-1	Nelson Street (N)	Cowper Street (W)	R	320	359	39	12.2%	2.1	Y	42.9	С	33.8
		Cowper Street	129-3		Cowper Street (E)	L	122	130	8	6.6%	0 .7	Y	32.0	С	33.0
			129-4	Cowper Street (E)	Nelson Street (N)	R	111	148	37	33.3%	3.3	Y	32.6	С	11.0
			129-5		Cowper Street (W)	Т	358	353	-5	-1.4%	0.3	Y	10.9	А	10.6
			129-11	Cowper Street (W)	Cowper Street (E)	Т	646	686	40	6.2%	1.5	Y	9.1	А	14.3
			129-12		Nelson Street (N)	L	191	187	-4	-2.1%	0.3	Y	2.4	А	0.6
				All			1,748	1,863	115				18.7	В	17.2

P2989 Western Corridor Traffic and Transport Study VISSIM Data Analysis

P2989 VISSIM Da	Westeri Mata Analysis	n Corridor Traffi	c and T	ranspor	t Study									GEH Turn >10	Summary 0	1630-1730 0.00%
PM Peak 1	630-1730													>5, <=10	0	0.00%
Time	ID	Intersection	Aimsun	Movement	From	То	Turn	Observed	Modelled	Abs. Diff	% Diff	GEH	Accept	Delay (s)	LoS	Queue
1800	101	Woodford Street	Code	101-1	Woodford Street (N)	Newcastle Link Road (W)	R	91	94	3	3.3%	0.3	Y	45.1	D	6.8
		Newcastle Link Road Cameron Park Drive		101-2 101-3		Cameron Park Drive (S) Newcastle Link Road (E)	T L	148 78	168 57	20 -21	13.5% -26.9%	✓ 1.6✓ 2.6	Y Y	56.9 40.2	D C	16.2 3.5
				101-4 101-5	Newcastle Link Road (E)	Woodford Street (N)	R T	92 1.642	57 1 587	-35 -55	-38.0% -3.3%	✓ 4.1✓ 1.4	Y V	54.4 49.5	D	4.7 66 1
				101-6		Cameron Park Drive (S)	L	198	202	4	2.0%	0.3	Y	31.4	C	25.2
				101-7 101-8	Cameron Park Drive (S)	Newcastle Link Road (E) Woodford Street (N)	R T	166 96	195 81	29 -15	17.5% -15.6%	✓ 2.2✓ 1.6	Y Y	62.4 47.4	E D	21.4 6.2
				101-9 101-10	Newcastle Link Road (W)	Newcastle Link Road (W) Cameron Park Drive (S)	L R	262 401	271 396	9 -5	3.4% -1.2%	 ✓ 0.6 ✓ 0.3 	Y Y	25.9 73.3	B	11.6 56.2
				101-11		Newcastle Link Road (E)	T	1,795	1,745	-50	-2.8%	✓ 1.2✓ 1.0	Y	28.9	B	36.4
				101-12	All	woodford Street (N)	L	5,133	4,995	-22	-13.4%	1.8	Ŷ	41.9	C	2.3
	102	Woodford Street Minmi Road		102-2 102-3	Woodford Street (N)	Woodford Street (S) Minmi Road (E)	T L	87 164	92 163	5 -1	5.7% -0.6%	✓ 0.5✓ 0.1	Y Y	11.9 9.7	A A	1.5 2.3
				102-4 102-6	Minmi Road (E)	Woodford Street (N)	R	105 273	103 300	-2 27	-1.9% 9.9%	✓ 0.2✓ 1.6	Y	21.8 27.9	B	20.2 19.9
				102-7	Woodford Street (S)	Minmi Road (E)	R	272	236	-36	-13.2%	2.3	Y	15.4	B	5.9
				102-8	All	Woodford Street (N)		47 948	35 929	-12	-25.5%	✓ 1.9	Y	7.0	A B	0.2 8.3
	103	Brookfield Avenue Minmi Road		103-1 103-3	Brookfield Avenue (N)	Minmi Road (W) Minmi Road (E)	R	9 30	5 35	-4 5	-44.4% 16.7%	✓ 1.5✓ 0.9	Y Y	4.2 1.8	A A	0.0 0.0
				103-4	Minmi Road (E)	Brookfield Avenue (N)	R	66 2(0	46	-20	-30.3%	2.7	Y	2.9	A	0.1
				103-5	Minmi Road (W)	Minmi Road (W)	T	309 408	408 401	-7	-1.7%	1.90.3	Ý	0.2	A	0.0
				103-12	All	Brookfield Avenue (N)	L	28 910	11 904	-17	-60.7%	3.8	Y	0.8 0.7	A A	0.0
	104	Minmi Road Highland Way		104-5 104-6	Minmi Road (E)	Minmi Road (W) Highland Way (S)	T	413 23	456 24	43 1	10.4%	2.1	Y V	0.3	A	0.0
		ngnianu way		104-7	Highland Way (S)	Minmi Road (E)	R	11	24	10	4.3 <i>%</i> 90.9%	2.5	Y	7.0	A	0.0
				104-9 104-10	Minmi Road (W)	Minmi Road (W) Highland Way (S)	L R	8 10	0 11	-8 1	-100.0% 10.0%	✓ 4.0✓ 0.3	Y Y	0.0 3.7	A A	0.0 0.1
				104-11	All	Minmi Road (E)	Т	393 858	422 934	29	7.4%	✓ 1.4	Y	0.4	A	0.0
	105	Minmi Road		105-5	Minmi Road (E)	Minmi Road (W)	Т	426	464	38	8.9%	✓ 1.8✓ 1.2	Y	2.8	A	0.5
		Britannia Boulevarde		105-6 105-7	Britannia Boulevarde (S)	Minmi Road (E)	L R	185	202 112	-10	9.2% -8.2%	✓ 1.2✓ 0.9	Y Y	2.6 4.5	A A	0.5 0.4
				105-9 105-10	Minmi Road (W)	Minmi Road (W) Britannia Boulevarde (S)	L R	15 66	16 52	1 -14	6.7% -21.2%	✓ 0.3✓ 1.8	Y Y	2.0 2.7	A A	0.4 1.0
				105-11	A11	Minmi Road (E)	Т	387	392	5	1.3%	0.3	Y	3.3	A	1.0
	106	Kurraka Drive		106-1	Kurraka Drive (N)	Minmi Road (W)	R	25	27	2	8.0%	0.4	Y	3.6	A	0.2
		Minmi Road		106-3 106-4	Minmi Road (E)	Kurraka Drive (N)	R	52 69	46 71	-6 2	-11.5% 2.9%	✓ 0.9✓ 0.2	Y Y	3.6 1.4	A A	0.2 0.0
				106-5 106-11	Minmi Road (W)	Minmi Road (W) Minmi Road (E)	T T	590 457	645 473	55 16	9.3% 3.5%	✓ 2.2✓ 0.7	Y Y	0.2 1.4	A A	0.0 0.1
				106-12	۵۱	Kurraka Drive (N)	L	37	34	-3	-8.1%	0.5	Y	1.1	A	0.1
	107	Awabakal Drive		107-1	Awabakal Drive (N)	Minmi Road (W)	R	32	32	0	0.0% #DIV//01	0.0	Y	32.7	C	3.3
		Bellbird Close		107-2		Minmi Road (E)	L	88	78	-10	-11.4%	✓ 0.0✓ 1.1	Y	28.2	B	3.7
				107-4 107-5	Minmi Road (E)	Awabakal Drive (N) Minmi Road (W)	R T	129 629	137 671	8 42	6.2% 6.7%	✓ 0.7✓ 1.6	Y Y	63.1 8.1	E A	15.1 5.2
				107-6 107-7	Bellhird Close (S)	Bellbird Close (S) Minmi Road (E)	L R	14 10	16 0	2 -10	14.3% -100.0%	✓ 0.5✓ 4.5	Y Y	8.3 0.0	A A	5.2 0.2
				107-8		Awabakal Drive (N)	T	0	0	0	#DIV/0!		Y	0.0	A	0.2
				107-9	Minmi Road (W)	Bellbird Close (S)	R	1	8	-1	-100.0%	✓ 3.3✓ 1.4	Y Y	0.0	A	0.8
				107-11 107-12		Minmi Road (E) Awabakal Drive (N)	TL	495 22	491 31	-4 9	-0.8% 40.9%	✓ 0.2✓ 1.7	Y Y	15.1 6.8	B A	7.5 7.1
	108	Maryland Drive		108-1	All Maryland Drive (N)	Minmi Road (W)	R	1,421 124	1,464	31	25.0%	26	Y	17.5	B	4.2
	100	Minmi Road		108-2		Churnwood Drive (S)	T	39	44	5	12.8%	0.8	Y	29.6	C	8.6
		Chumwood Drive		108-3	Minmi Road (E)	Maryland Drive (N)	R	114	60 120	-17	-22.1% 5.3%	✓ 2.1✓ 0.6	Y Y	33.0	A C	6.3
				108-5 108-6		Minmi Road (W) Churnwood Drive (S)	T L	605 60	630 68	25 8	4.1% 13.3%	✓ 1.0✓ 1.0	Y Y	23.2 24.1	B B	15.5 15.6
				108-7 108-8	Churnwood Drive (S)	Minmi Road (E) Maryland Drive (N)	R T	107 95	96 95	-11 0	-10.3% 0.0%	 1.1 0.0 	Y	25.4 28.5	B	3.2 3.9
				108-9		Minmi Road (W)	L	33	36	3	9.1%	0.5	Y	18.5	B	0.9
				108-10 108-11	Minmi Road (W)	Churnwood Drive (S) Minmi Road (E)	R T	125 335	102 376	-23 41	-18.4% 12.2%	2.22.2	Y Y	31.6 29.0	C C	5.2 14.6
				108-12	All	Maryland Drive (N)	L	115 1829	94 1,887	-21	-18.3%	2.1	Y	26.4 26.2	B	14.8 8.2
	109	Minmi Road Bottlebrush Boulevarde		109-5 109-6	Minmi Road (E)	Minmi Road (W) Bottlebrush Boulevarde (S)	T	789 130	804 169	15 30	1.9% 21.6%	 ✓ 0.5 ✓ 2.4 	Y V	2.6 1.5	A	0.1
		Sottoprash Doulevalue		109-7	Bottlebrush Boulevarde (S)	Minmi Road (E)	R	87	93	6	6.9%	0.6	Y	5.3	A	0.2
				109-9	Minmi Road (W)	Bottlebrush Boulevarde (S)	R	22 29	24 30	2	9.1% 3.4%	✓ 0.4✓ 0.2	Y Y	2.1 1.3	A A	0.2
				109-11	All	Minmi Road (E)	T	409	500 1,620	91	22.2%	✓ 4.3	Y	<u>3.7</u> <u>2.9</u>	A	0.9
	110	Warkworth Street		110-1	Warkworth Street (N)	Minmi Road (W)	R	79	69 70	-10 8	-12.7%	✓ 1.2✓ 1.0	Y V	5.2 1.5	A	0.3
		MILLIN INUAU		110-3	Minmi Road (E)	Warkworth Street (N)	R	124	104	-20	-16.1%	1.0	Y	11.0	A	0.0
				110-5 110-11	Minmi Road (W)	Minmi Road (W) Minmi Road (E)	T T	823 421	900 483	77 62	9.4% 14.7%	✓ 2.6✓ 2.9	Y Y	2.4 0.8	A A	0.0 0.0
				110-12	All	Warkworth Street (N)	L	144 1653	105 1 731	-39	-27.1%	3.5	Y	1.2	A	0.0

Time	ID	Intersection	Aimsun Code	Movement Code	From	То	Turn	Observed	Modelled	Abs. Diff (Mod - Obs)	% Diff (Mod - Obs)	GEH	Accept	Delay (s)	LoS	Queue (m)
	111	Minmi Road	COUC	111-5	Minmi Road (E)	Minmi Road (W)	Т	934	975	41	4.4%	1.3	Y	3.4	А	0.3
		Summerhill Road		111-6		Summerhill Road (S)	L	27	28	1	3.7%	O .2	Y	1.5	А	0.2
				111-7	Summerhill Road (S)	Minmi Road (E)	R	32	36	4	12.5%	0.7	Y	11.7	A	0.7
				111-9	Minmi Road (W)	Summerhill Road (S)	R	20 15	11	-4	-26.7%	✓ 0.0✓ 1.1	Y	4.0 3.2	A	0.5
				111-11		Minmi Road (E)	Т	527	541	14	2.7%	0.6	Y	3.2	А	0.8
_	110	McNoughton Avenue		110.1	All	Minmi Dood (M)	D	1,563	1,619	2	66 70/	10	V	3.5	A	0.4
	112	Minmi Road		112-1	IVICIVAUGITION AVENUE (IV)	McNaughton Avenue (S)	R T	3	0	-1	-100.0%	✓ 1.0✓ 1.4	Y Y	0.0	A	0.3
				112-3		Minmi Road (E)	L	96	99	3	3.1%	0.3	Y	3.9	A	0.4
				112-4	Minmi Road (E)	McNaughton Avenue (N)	R	118	70	-48	-40.7%	5.0	Y	6.7	A	1.4
				112-5		Minmi Road (W) McNaughton Avenue (S)		1,044	1,064	20	1.9% 191.7%	✓ 0.6✓ 4.7	Y	1.4	A A	0.7
				112-7	McNaughton Avenue (S)	Minmi Road (E)	R	1	4	3	300.0%	✓ 1.9	Ý	26.1	В	0.1
				112-8		McNaughton Avenue (N)	Т	0	0	0	#DIV/0!	0.0	Y	0.0	А	0.1
				112-9	Minmi Dood (M)	Minmi Road (W)	L	4	0	-4	-100.0%	2.8	Y	0.0	A	0.0
				112-10		Minmi Road (E)	T	584	622	38	6.5%	1.41.5	Ý	0.0	A	0.0
				112-12		McNaughton Avenue (N)	L	24	20	-4	-16.7%	0.9	Y	0.6	A	0.0
	110	Manuland Driva		110.1	All Manuland Drive (N)	Minmi Dood (M)	D	1,888	1,919	2	0.00/	0.1	V	1.4	A	0.3
	113	Maryland Drive Minmi Road		113-1	Maryland Drive (N)	Minmi Road (W) Minmi Road (F)	R I	25 303	326	2	8.0% 7.6%	✓ 0.4✓ 1.3	Y Y	35.4 4.4	A	0.5
				113-4	Minmi Road (E)	Maryland Drive (N)	R	504	498	-6	-1.2%	0.3	Ý	38.2	C	20.0
				113-5		Minmi Road (W)	Т	1,133	1,102	-31	-2.7%	0.9	Y	14.0	А	16.6
				113-11	Minmi Road (W)	Minmi Road (E) Maryland Drive (N)		653 22	647	-6	-0.9% 18.2%	0.2	Y	12.0	A	6.2
				115-12	All		L	2,640	2,626	4	10.270	0.0		17.1	B	7.5
	114	Creek Road		114-1	Creek Road (N)	Minmi Road (W)	R	44	46	2	4.5%	0.3	Y	45.6	D	5.8
		Minmi Road		114-2		Macquarie Street (S)	T	23	26	3	13.0% 14.5%	✓ 0.6✓ 1.2	Y	30.0	C	5.7
		Macquarie Street		114-3	Minmi Road (F)	Creek Road (N)	R	02 17	53 19	-9	-14.5%	\bigcirc 1.2 \bigcirc 0.5	Y Y	54.2 65.1	F	5.6 30.8
				114-5		Minmi Road (W)	Т	1,113	1,104	-9	-0.8%	0.3	Y	27.0	B	30.9
				114-6		Macquarie Street (S)	L	48	51	3	6.3%	0.4	Y	23.8	В	30.5
				114-7 117-8	Macquarie Street (S)	Minmi Road (E) Creek Road (N)	R	46 5	39	-/	-15.2%	✓ 1.1	Y	45.2 47.4	D	20.7
				114-0		Minmi Road (W)	L	394	385	-9	-2.3%	0.5	Ý	32.0	C	20.7
				114-10	Minmi Road (W)	Macquarie Street (S)	R	212	198	-14	-6.6%	I .0	Y	39.5	С	19.8
				114-11		Minmi Road (E)	Т	606	689 27	83	13.7%	3.3	Y	17.8	B	18.8
				4- 2	All	CIEEK ROdu (IV)	L	2,599	2,651	0	27.070	V 1.4	ř	27.2	B	14.0
	115	Minmi Road		115-5	Minmi Road (E)	Minmi Road (W)	Т	1,141	1,121	-20	-1.8%	0.6	Y	13.5	А	20.0
		Bunnings		115-6	Puppings (S)	Bunnings (S) Minmi Bood (E)	L	108	111	3	2.8%	✓ 0.3✓ 1.2	Y	3.1	A	20.3
				115-7	burnings (S)	Minmi Road (W)	K L	70	90 67	-12	-11.0%	0.4	Y Y	20.3	B	3.9 3.9
				115-10	Minmi Road (W)	Bunnings (S)	R	39	35	-4	-10.3%	0.7	Y	4.3	A	3.6
				115-11	A 11	Minmi Road (E)	Т	711	735	24	3.4%	0.9	Y	6.7	A	3.6
_	116	Sandgate Road		116-3	Sandgate Road (N)	Minmi Road (E)	L	12	6	-6	-50.0%	2.0	Y	28.5	B	0.3
		Minmi road		116-5	Minmi Road (E)	Minmi Road (W)	T	1,159	1,183	24	2.1%	0.7	Y	1.5	Ā	0.0
				116-6	Conducto Decid (C)	Sandgate Road (S)	L	23	22	-1	-4.3%	0.2	Y	0.3	A	0.0
				116-9	Sanagate Road (S) Minmi Road (W)	Minmi Road (W) Minmi Road (F)	L T	59 431	49 336	-10	-16.9%	✓ 1.4✓ 4.9	Y	1.2	A B	0.0
				116-12		Sandgate Road (N)	L	332	392	60	18.1%	3.2	Y	0.9	A	0.1
				117.1	All			2016	2,081	15	7.40/			4.2	A	0.1
	11/	Cameron Street		117-1	Cameron Street (N)	IVIINMI ROAD (W) Cowper Street (S)	R	632 519	677	45 -40	-7.7%	✓ 1.8✓ 1.8	Y	24.2	D	35.4 22.6
		Cowper Street		117-3		Longworth Avenue (E)	L	79	108	29	36.7%	3.0	Y	18.5	B	1.8
		Minmi Road		117-4	Longworth Avenue (E)	Cameron Street (N)	R	58	86	28	48.3%	3.3	Y	94.9	F	22.7
				117-5 117-6		Minmi Road (W)	T	462 8	420	-42	-9.1% 250.0%	 2.0 4.7 	Y	36.6	С	30.9
				117-7	Cowper Street (S)	Longworth Avenue (E)	R	1	1	0	0.0%	0.0	Ý	90.5	F	41.6
				117-8		Cameron Street (N)	Т	361	322	-39	-10.8%	2.1	Y	48.7	D	41.2
				117-9	Minmi Dood (M)	Minmi Road (W)	L	80	108 05	28 25	35.0%	2.9	Y	17.1	B	3.1
				117-10	IVIIIIIII ROAU (VV)	Longworth Avenue (F)	R T	60 361	95 330	-31	-8.6%	✓ 4.0✓ 1.7	Y Y	20.1	B	22.2
				117-12		Cameron Street (N)	L	18	11	-7	-38.9%	1.8	Ý	12.7	A	21.8
	110	Sandaata Daad		110 5	All Sandanto Dead (E)	Sandasta Dead (MA	т	2,639	2,665	7	77.00/	20	V	38.7	С	23.1
	118	Tillie Street		118-5	Sanuyale Road (E)	Tillie Street (S)		1.128	2	-44	-3.9%	✓ 3.0✓ 1.3	Y Y	1.2	A	0.1
				118-7	Tillie Street (S)	Sandgate Road (E)	R	262	292	30	11.5%	✓ 1.8	Y	0.4	A	0.0
				118-9		Sandgate Road (W)	L	13	5	-8	-61.5%	2.7	Y	0.0	A	0.0
				118-10 118-11	Sandgate Road (W)	Lillie Street (S) Sandgate Road (E)	R	181 175	178	-3 45	-1.7% 25.7%	✓ 0.2✓ 3.2	Y	34.3	С	13.4
				110-11	All			1,768	1,781	40	23.170	J.2		5.6	A	4.5
	119	Tillie Street		119-2	Tillie Street (N)	Tillie Street (S)	T	1,168	1,090	-78	-6.7%	2.3	Y	2.5	А	0.0
		Wilkinson Avenue		119-3	Wilkinson Avenue (E)	Wilkinson Avenue (E)	L	160	172	12	7.5%	✓ 0.9▲ 1.0	Y	0.3	A	0.0
				119-4	whikinson Avenue (E)	Tillie Street (N)	R I	8 356	398	3 42	37.5% 11.8%	2.2	Y Y	57.0	E D	43.2
				119-7	Tillie Street (S)	Wilkinson Avenue (E)	R	170	184	14	8.2%	1.1	Ý	23.4	В	7.0
				119-8	A.II.	Tillie Street (N)	T	269	287	18	6.7%	✓ 1.1	Y	0.9	A	0.0
					All			2,131	2,142					13.2	A	15.5

Time	ID	Intersection	Aimsun	Movement	From	То	Turn	Observed	Modelled	Abs. Diff (Mod - Obs)	% Diff (Mod - Obs	GEH	Accept	Delay (s)	LoS	Queue
	120	Tillie Street	Code	120-1	Tillie Street (N)	Cameron Street (W)	R	1,318	1,246	-72	-5.5%	2.0	Y	1.4	А	0.0
		Douglas Street		120-2		Douglas Street (S)	T	215	243	28	13.0%	1.9	Y	1.4	A	0.0
		Cameron Street		120-8	Douglas Street (S)	Lillie Street (N) Cameron Street (W)		56 39	54 40	-2	-3.6% 2.6%	✓ 0.3✓ 0.2	Y Y	34.0 33.1	C C	3.9 3.6
				120-10	Cameron Street (W)	Douglas Street (S)	R	14	3	-11	-78.6%	3.8	Ý	18.3	B	0.0
				120-12	All	Tillie Street (N)	L	413	419	6	1.5%	0.3	Y	2.5	A	0.0
	121	Thomas Street		121-5	Thomas Street (E)	Thomas Street (W)	Т	1,724	1,728	4	0.2%	O .1	Y	10.4	A	12.5
		Walford Street		121-6	Walford Streat (C)	Walford Street (S)	L	118	124	6	5.1%	0.5	Y	13.1	A	12.2
				121-7	Wallold Street (S)	Thomas Street (W)	L	219	203	-3	-1.4%	✓ 0.2✓ 0.2	Ý	34.0	C	30.2 30.3
				121-10	Thomas Street (W)	Walford Street (S)	R	188	183	-5	-2.7%	0.4	Y	46.0	D	14.9
				121-11	All	Thomas Street (E)		1,323	1,357	34	2.6%	0.9	Y	2.2	A	1.1
	122	Longworth Avenue		122-1	Longworth Avenue (N)	Newcastle Road (W)	R	8	13	5	62.5%	I .5	Y	26.4	В	16.5
		Newcastle Road		122-2 122-3		Thomas Street (S) Newcastle Road (E)		332 266	281 237	-51 -29	-15.4%	✓ 2.9✓ 1.8	Y	26.0 14.2	B	16.5 16.5
				122-4	Newcastle Road (E)	Longworth Avenue (N)	R	210	240	30	14.3%	2.0	Ý	9.9	A	6.9
				122-5		Newcastle Road (W)	T	138	188	50 5	36.2%	✓ 3.9✓ 0.1	Y	11.4	A	6.9
				122-0	Thomas Street (S)	Newcastle Road (E)	R	1,273	1,277	4	0.3%	○ 0.1○ 0.1	Ý	16.3	B	31.4
				122-8		Longworth Avenue (N)	Т	326	279	-47	-14.4%	2.7	Y	18.9	В	31.4
				122-9	Newcastle Road (W)	Thomas Street (S)	R	49 63	109	25 46	51.0% 73.0%	✓ 3.2✓ 5.0	Y Y	5.0 13.4	A	32.3 3.0
				122-11		Newcastle Road (E)	Т	201	208	7	3.5%	0.5	Y	8.7	А	3.0
				122-12	All	Longworth Avenue (N)	L	13	29 4 296	16	123.1%	3.5	Y	9.2	A	3.2
	123	Newcastle Road		123-1	Newcastle Road (N)	Cowper Street (W)	R	16	17	1	6.3%	0.2	Y	19.6	B	2.0
		Cowper Street		123-2		Newcastle Road (S)	T	46	48	2	4.3%	0.3	Y	26.1 11.4	B	2.7
				123-3	Cowper Street (E)	Newcastle Road (N)	R	58	54	-4	-6.9%	0.2	Ý	5.9	A	3.0
				123-5		Cowper Street (W)	Т	623	612	-11	-1.8%	0.4	Y	3.0	A	1.8
				123-6 123-7	Newcastle Road (S)	Cowper Street (E)	R	4	20 4	4	400.0% #DIV/0!	4.62.8	Y Y	0.9 17.6	A B	0.3
				123-8		Newcastle Road (N)	Т	30	35	5	16.7%	0.9	Y	14.7	А	0.7
				123-9 123-10	Cowper Street (W)	Cowper Street (W) Newcastle Road (S)	L R	204	280 242	76 71	37.3%	✓ 4.9✓ 4.9	Y	20.5	B	14.0 10.1
				123-11		Cowper Street (E)	T	362	389	27	7.5%	1.4	Ý	5.2	A	5.4
				123-12	ΔII	Newcastle Road (N)	L	30 1579	28	-2	-6.7%	0.4	Y	7.2	A	5.4
	124	Kokera Street		124-1	Kokera Street (N)	Cowper Street (W)	R	197	187	-10	-5.1%	0.7	Y	6.3	A	0.9
		Cowper Street		124-3	Compor Street (E)	Cowper Street (E)	L	287	280 512	-7	-2.4%	0.4	Y	7.8	A	1.0
				124-4	Cowper Street (E)	Cowper Street (W)	T	400	513	45 56	11.3%	2.02.4	Ý	7.1	A	6.4
				124-11	Cowper Street (W)	Cowper Street (E)	Т	369	445	76	20.6%	3.8	Y	16.1	В	14.3
				124-12	All	Kokera Street (N)	L	2001	2,176	15	8.2%	V 1.1	Ŷ	9.4	A	5.7
	125	Metcalfe Street		125-1	Metcalfe Street (N)	Thomas Street (W)	R	91	81	-10	-11.0%	✓ 1.1	Y	125.2	F	74.9
		Thomas Street		125-2		Thomas Street (S)	L	278	236 19	-42 -5	-15.1%	✓ 2.6✓ 1.1	Y Y	97.4	F	74.8 74.6
				125-4	Thomas Street (E)	Metcalfe Street (N)	R	36	40	4	11.1%	0.6	Y	56.0	D	3.6
				125-5 125-6		Thomas Street (W) Metcalfe Street (S)		1,751 37	1,751 34	-3	0.0% -8.1%	✓ 0.0✓ 0.5	Y	8.8 5.1	A	21.9 0.2
				125-7	Metcalfe Street (S)	Thomas Street (E)	R	49	58	9	18.4%	1.2	Y	52.6	D	22.4
				125-8 125-9		Metcalfe Street (N) Thomas Street (W)		182 29	187 20	5 -9	2.7% -31.0%	✓ 0.4✓ 1.8	Y	50.4 43.1	D	22.5 22.1
				125-10	Thomas Street (W)	Metcalfe Street (S)	R	57	48	-9	-15.8%	1.2	Ý	71.4	F	5.8
				125-11 125-12		Thomas Street (E)	T	1,460	1,488	28	1.9% 3.4%	0.7	Y	8.9 13.3	A	20.6
				125-12	All		L	4023	3,992	1	5.470	0.2		22.0	B	28.7
	126	Lake Road		126-1	Lake Road (N)	Cowper Street (W)	R	0	0	0	#DIV/0!	0.0	Y	0.0	A	1.9
		Cowper Street		126-3		Cowper Street (E)	L	31	24	-7	-22.6%	✓ 1.5✓ 1.3	Ý	10.0	A	1.9
				126-4	Cowper Street (E)	Lake Road (N)	R	17	34	17	100.0%	3.4	Y	58.7	E	37.7
				126-6		Lake Road (S)	L	558	682	124	22.2%	✓ 0.7✓ 5.0	Ý	50.4 50.6	D	37.7
				126-7	Lake Road (S)	Cowper Street (E)	R	461	574	113	24.5%	5.0	Y	5.2	A	1.9
				126-8		Cowper Street (W)	L	254	252 5	-2	-0.8% 150.0%	✓ 0.1✓ 1.6	Y Y	3.9 0.4	A	1.9
				126-10	Cowper Street (W)	Lake Road (S)	R	2	13	11	550.0%	4.0	Y	55.3	D	0.1
				126-11 126-12		Cowper Street (E) Lake Road (N)		0	0	0	#DIV/0! #DIV/0!	✓ 0.0✓ 0.0	Y Y	0.0	A	0.1
	107	Lake Dand		107.1		Noussella La La Davida		1,463	1,742		11.101			28.1	В	10.4
	127	Lake Road Thomas Street		127-1	Lake Road (N)	Newcastle LINK Road (W) Lake Road (S)	R	463	423	-44 -40	-11.6%	✓ 2.3✓ 1.9	Y Y	94.3	F	162.6
		Newcastle Link Road		127-3		Thomas Street (E)	L	40	64	24	60.0%	3.3	Y	78.8	F	162.5
				127-4 127-5	i nomas Street (E)	Lake Road (N) Newcastle Link Road (W)	R T	58	61 1.195	-38	5.2% -3.1%	✓ 0.4✓ 1.1	Y Y	47.2 82.3	D	4.8 94.1
				127-6		Lake Road (S)	L	655	664	9	1.4%	0.4	Y	30.0	С	45.5
				127-7 127-8	Lake Road (S)	Thomas Street (E)	R T	472	441 547	-31 55	-6.6%	✓ 1.5✓ 2.4	Y	47.1 111.5	D	20.4
				127-0		Newcastle Link Road (W)	L	203	191	-12	-5.9%	0.9	Ý	116.5	F	89.3
				127-10	Newcastle Link Road (W)	Lake Road (S)	R	302	291	-11	-3.6%	0.6	Y	67.7	E	41.4
				127-11		Lake Road (N)		213	224	-1	-0.1% 5.2%	✓ 0.0✓ 0.7	Y Y	34.5 13.3	A	42.9
	400	Neurontelles		400.5	All		-	5,537	5,462	15	0.001			71.1	F	79.9
	128	Newcatle Link Road		128-5 128-6	ivewcastle Link Road (E)	Newcastle Link Road (W) Minmi Road (S)		266	236	-45 -30	-3.3%	✓ 1.2✓ 1.9	Y Y	60.1 61.0	E F	439.7 439.8
				128-7	Minmi Road (S)	Newcastle Link Road (E)	R	202	213	11	5.4%	0.8	Y	25.7	В	30.2
				128-9 128-10	Newcastle Link Road (W)	Newcastle Link Road (W) Minmi Road (S)	L R	570 670	559 695	-11 25	-1.9%	✓ 0.5✓ 1.0	Y Y	31.6 19.2	C B	32.2 40.2
				128-11		Newcastle Link Road (E)	T	1,196	1,299	103	8.6%	2.9	Y	15.9	В	40.2
								4279	4.332	53				35.0	C	146.3

Time	ID	Intersection	Aimsun Code	Movement Code	From	То	Turn	Observed	Modelled	Abs. Diff (Mod - Obs)	% Diff (Mod - Obs)	GEH	Accept	Delay (s)	LoS	Queue (m)
	129	Nelson Street		129-1	Nelson Street (N)	Cowper Street (W)	R	238	259	21	8.8%	1.3	Y	36.9	С	21.0
		Cowper Street		129-3		Cowper Street (E)	L	130	132	2	1.5%	O .2	Y	22.9	В	18.4
				129-4	Cowper Street (E)	Nelson Street (N)	R	148	192	44	29.7%	3.4	Y	34.4	С	24.9
				129-5		Cowper Street (W)	Т	668	756	88	13.2%	3.3	Y	14.5	А	24.9
				129-11	Cowper Street (W)	Cowper Street (E)	Т	423	530	107	25.3%	4.9	Y	8.7	А	8.6
				129-12		Nelson Street (N)	L	157	165	8	5.1%	0.6	Y	2.2	А	0.5
					All			1,764	2,034	270				17.3	В	16.4



Attachment D

VALIDATION SUMMARY

Travel Time Data Analysis AM Peak (0800 - 0900)

Clockwico	

Clockwise															
Sections	Number of Runs	Mean TT	+15%	-15%	Standard Deviation	95% Confidence Interval	Upper	Lower	Distance (Km)	Cumulative Distance (Km)	Cumulative Mean TT	Cumulative +15%	Cumulative -15%	Model	Cumulative Model
Bunnings	-	-	-	-	-	-	-	-	0.00	0.00	0:00:00	0:00:00	0:00:00		0:00:00
Cameron St	6	0:01:34	0:01:48	0:01:20	0:00:35	0:00:28	0:02:03	0:01:06	0.28	0.28	0:01:34	0:01:48	0:01:20	0:01:02	0:01:02
Newcastle Rd	5	0:02:24	0:02:46	0:02:02	0:01:59	0:01:44	0:04:08	0:00:40	0.53	0.81	0:03:58	0:04:34	0:03:23	0:01:41	0:02:44
Metcalfe St	5	0:00:52	0:01:00	0:00:44	0:00:19	0:00:16	0:01:08	0:00:36	0.65	1.46	0:04:50	0:05:34	0:04:07	0:01:03	0:03:47
Walford St	5	0:00:26	0:00:30	0:00:22	0:00:25	0:00:22	0:00:48	0:00:04	0.27	1.73	0:05:16	0:06:04	0:04:29	0:00:44	0:04:31
Lake Rd	6	0:01:15	0:01:26	0:01:04	0:00:17	0:00:14	0:01:29	0:01:01	0.30	2.03	0:06:31	0:07:30	0:05:33	0:01:36	0:06:07
Minmi Rd	6	0:03:46	0:04:20	0:03:12	0:00:12	0:00:09	0:03:55	0:03:37	4.34	6.37	0:10:17	0:11:50	0:08:45	0:03:51	0:09:58
Cameron Park Dr	6	0:02:09	0:02:28	0:01:50	0:00:55	0:00:44	0:02:53	0:01:25	1.73	8.10	0:12:26	0:14:18	0:10:34	0:02:18	0:12:16
Woodford St/Minmi Rd	6	0:02:59	0:03:25	0:02:32	0:00:47	0:00:38	0:03:36	0:02:21	2.03	10.13	0:15:25	0:17:44	0:13:06	0:02:20	0:14:36
Churnwood Dve	6	0:06:25	0:07:23	0:05:28	0:01:35	0:01:16	0:07:42	0:05:09	4.07	14.20	0:21:50	0:25:07	0:18:34	0:05:33	0:20:09
Maryland Dve	6	0:04:54	0:05:38	0:04:10	0:01:12	0:00:57	0:05:51	0:03:57	2.09	16.29	0:26:44	0:30:45	0:22:44	0:03:02	0:23:12
Bunnings	6	0:03:55	0:04:31	0:03:20	0:00:40	0:00:32	0:04:28	0:03:23	1.33	17.62	0:30:40	0:35:16	0:26:04	0:03:02	0:26:13

Model	Run
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8

Travel Time Data Analysis AM Peak (0800 - 0900)

Counter Clockwise															
Sections	Number of Runs	Mean TT	+15%	-15%	Standard Deviation	95% Confidence Interval	Upper	Lower	Distance (Km)	Cumulative Distance (Km)	Cumulative Mean TT	Cumulative +15%	Cumulative -15%	Model	Cumulative Model
Bunnings	-	-	-	-	-	-	-	-	0.00	0.00	0:00:00	0:00:00	0:00:00		0:00:00
Maryland Drive	5	0:02:16	0:02:36	0:01:55	0:00:41	0:00:36	0:02:51	0:01:40	1.33	1.33	0:02:16	0:02:36	0:01:55	0:01:48	0:01:48
Churnwood Drive	5	0:02:47	0:03:12	0:02:22	0:00:24	0:00:21	0:03:08	0:02:26	2.09	3.42	0:05:03	0:05:48	0:04:17	0:02:49	0:04:37
Woodford St/Minmi Rd	5	0:05:26	0:06:15	0:04:37	0:00:15	0:00:13	0:05:39	0:05:13	4.07	7.49	0:10:28	0:12:03	0:08:54	0:05:13	0:09:50
Cameron Park Dr	4	0:02:51	0:03:17	0:02:26	0:00:37	0:00:36	0:03:27	0:02:15	2.03	9.52	0:13:20	0:15:20	0:11:20	0:02:49	0:12:39
Minmi Road	4	0:03:26	0:03:56	0:02:55	0:02:04	0:02:01	0:05:27	0:01:24	1.73	11.25	0:16:45	0:19:16	0:14:14	0:02:42	0:15:21
Lake Rd	4	0:06:18	0:07:15	0:05:21	0:00:30	0:00:30	0:06:48	0:05:48	4.34	15.59	0:23:03	0:26:31	0:19:36	0:04:56	0:20:18
Walford St	4	0:01:09	0:01:19	0:00:58	0:00:28	0:00:27	0:01:36	0:00:41	0.30	15.89	0:24:12	0:27:49	0:20:34	0:00:27	0:20:44
Metcalfe St	4	0:01:11	0:01:22	0:01:01	0:00:19	0:00:19	0:01:30	0:00:52	0.27	16.16	0:25:23	0:29:11	0:21:34	0:00:40	0:21:24
Newcastle Rd	4	0:02:17	0:02:38	0:01:57	0:00:24	0:00:24	0:02:41	0:01:54	0.65	16.81	0:27:40	0:31:49	0:23:31	0:01:16	0:22:39
Cameron St	4	0:01:46	0:02:02	0:01:31	0:00:49	0:00:48	0:02:34	0:00:59	0.53	17.34	0:29:27	0:33:52	0:25:02	0:01:23	0:24:02
Bunnings	4	0:00:30	0:00:34	0:00:25	0:00:09	0:00:09	0:00:39	0:00:21	0.28	17.62	0:29:56	0:34:26	0:25:27	0:00:23	0:24:25

Model	Run
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Travel Time Data Analysis PM Peak (1630 - 1730)

Clockwise															
Sections	Number of Runs	Mean TT	+15%	-15%	Standard Deviation	95% Confidence Interval	Upper	Lower	Distance (Km)	Cumulative Distance (Km)	Cumulative Mean TT	Cumulative +15%	Cumulative -15%	Model	Cumulative Model
Bunnings	-	-	-	-	-	-	-	-	0.00	0.00	0:00:00	0:00:00	0:00:00		0:00:00
Cameron St	8	0:01:07	0:01:17	0:00:57	0:00:22	0:00:15	0:01:22	0:00:52	0.28	0.28	0:01:07	0:01:17	0:00:57	0:01:02	0:01:02
Newcastle Rd	8	0:01:18	0:01:30	0:01:07	0:00:20	0:00:14	0:01:32	0:01:05	0.53	0.81	0:02:26	0:02:47	0:02:04	0:01:28	0:02:30
Metcalfe St	8	0:00:57	0:01:06	0:00:49	0:00:21	0:00:15	0:01:12	0:00:43	0.65	1.46	0:03:23	0:03:53	0:02:52	0:01:19	0:03:48
Walford St	8	0:00:24	0:00:27	0:00:20	0:00:12	0:00:08	0:00:32	0:00:15	0.27	1.73	0:03:47	0:04:20	0:03:13	0:00:33	0:04:21
Lake Rd	8	0:01:42	0:01:57	0:01:27	0:00:47	0:00:33	0:02:14	0:01:09	0.30	2.03	0:05:28	0:06:18	0:04:39	0:01:19	0:05:40
Minmi Rd	6	0:07:16	0:08:21	0:06:10	0:01:09	0:00:56	0:08:11	0:06:20	4.34	6.37	0:12:44	0:14:39	0:10:49	0:05:51	0:11:31
Cameron Park Dr	6	0:02:05	0:02:24	0:01:46	0:00:48	0:00:38	0:02:43	0:01:27	1.73	8.10	0:14:49	0:17:02	0:12:36	0:02:47	0:14:18
Woodford St / Minmi Rd	6	0:02:26	0:02:48	0:02:04	0:00:23	0:00:18	0:02:44	0:02:08	2.03	10.13	0:17:15	0:19:50	0:14:40	0:02:10	0:16:28
Churnwood Dr	7	0:05:07	0:05:53	0:04:21	0:00:34	0:00:26	0:05:33	0:04:42	4.07	14.20	0:22:22	0:25:44	0:19:01	0:04:56	0:21:24
Maryland Dr	8	0:02:40	0:03:04	0:02:16	0:00:21	0:00:14	0:02:54	0:02:26	2.09	16.29	0:25:02	0:28:48	0:21:17	0:02:40	0:24:05
Bunnings	8	0:01:45	0:02:01	0:01:29	0:00:24	0:00:16	0:02:01	0:01:29	1.33	17.62	0:26:47	0:30:48	0:22:46	0:01:58	0:26:02

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Run 8

Travel Time Data Analysis PM Peak (1630 - 1730)

Counter Clockwise															
Sections	Number of Runs	Mean TT	+15%	-15%	Standard Deviation	95% Confidence Interval	Upper	Lower	Distance (Km)	Cumulative Distance (Km)	Cumulative Mean TT	Cumulative +15%	Cumulative -15%	Model	Cumulative Model
Bunnings	-	-	-	-	-	-	-	-	0.00	0.00	0:00:00	0:00:00	0:00:00		0:00:00
Maryland Drive	7	0:01:49	0:02:06	0:01:33	0:00:14	0:00:11	0:02:00	0:01:38	1.33	1.33	0:01:49	0:02:06	0:01:33	0:02:07	0:02:07
Churnwood Drive	7	0:02:43	0:03:08	0:02:19	0:00:16	0:00:12	0:02:55	0:02:32	2.09	3.42	0:04:32	0:05:13	0:03:52	0:03:13	0:05:20
Woodford St/Minmi Rd	9	0:05:01	0:05:46	0:04:16	0:00:20	0:00:13	0:05:14	0:04:48	4.07	7.49	0:09:33	0:10:59	0:08:07	0:04:47	0:10:06
Cameron Park Dr	9	0:03:18	0:03:48	0:02:49	0:00:55	0:00:36	0:03:54	0:02:43	2.03	9.52	0:12:52	0:14:47	0:10:56	0:02:21	0:12:27
Minmi Road	9	0:01:19	0:01:31	0:01:07	0:00:02	0:00:01	0:01:21	0:01:18	1.73	11.25	0:14:11	0:16:19	0:12:03	0:01:36	0:14:03
Lake Rd	8	0:03:47	0:04:21	0:03:13	0:00:18	0:00:12	0:04:00	0:03:35	4.34	15.59	0:17:58	0:20:40	0:15:17	0:04:11	0:18:15
Walford St	8	0:00:35	0:00:40	0:00:30	0:00:12	0:00:09	0:00:43	0:00:26	0.30	15.89	0:18:33	0:21:20	0:15:46	0:00:18	0:18:32
Metcalfe St	8	0:00:34	0:00:39	0:00:29	0:00:15	0:00:11	0:00:44	0:00:23	0.27	16.16	0:19:07	0:21:59	0:16:15	0:00:24	0:18:57
Newcastle Rd	7	0:01:06	0:01:16	0:00:56	0:00:23	0:00:17	0:01:23	0:00:49	0.65	16.81	0:20:13	0:23:14	0:17:11	0:01:11	0:20:08
Cameron St	7	0:02:10	0:02:30	0:01:51	0:00:23	0:00:17	0:02:27	0:01:53	0.53	17.34	0:22:23	0:25:44	0:19:01	0:01:50	0:21:58
Bunnings	7	0:00:27	0:00:31	0:00:23	0:00:08	0:00:06	0:00:33	0:00:21	0.28	17.62	0:22:49	0:26:15	0:19:24	0:00:34	0:22:32

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Attachment E

TRAFFIC SIGNAL TIME VALIDATION

Western Corridor Signal Time Comparison AM Peak

		AM (08:00 - 09:00)						
Intersection (TCS)	Cycle / Phase		IDM			Within		
(100)	T Hase	Avg.	10%	-10%	V13311VI	10%?		
	CT*	128	141	115	130	 Image: A start of the start of		
Thomas Steet /	А	82	90	74	76	~		
Metcalfe Street	D	31	34	28	39	×		
	E	15	17	14	15			
	CT*		0	0		\checkmark		
Woodford St /	А		0	0		\checkmark		
Minmi Rd	В		0	0		\checkmark		
	С		0	0		\checkmark		
	D		0	0		\checkmark		
Thomas Steet /	CT*	127	140	114	130	~		
Walford Street	A	73	80	66	55	×		
	В	24	26	22	26			
	С	30	33	27	49	×		
	CT*	134	147	121	120	×		
Minmi Rd /	A	47	52	42	27	×		
Cameron St /	D	16	18	14	24	×		
Longworth AV / Cowper St	E	41	45	37	16	×		
	F	28	31	25	37	×		
	G	19	21	17	16	×		
	CT*	131	144	118	120	✓		
Newcastle Road /	A	/1	/8	64	52	×		
Douglast St	D	26	29	23	26	V		
	E	19	21	1/	19	 ✓ 		
	G CT*	102	110	14	23	×		
Minmi Rd /		103	F2	93	100	×		
Macquarie St /	D A	47	31	42 25	40 27			
Creek Rd	E	20	37	25	27			
	CT*	29	08	20	100	¥		
Minmi Rd /	A	30	43	35	44	Ŷ		
Maryland Dr /	D	29	32	26	33	Ŷ		
Churnwood Dr	F	20	22	18	23	×		
	CT*	88	97	79	100	×		
Minimi Rd /	A	50	55	45	55			
Maryland Dr	B	20	22	18	23	×		
	C	19	21	17	22	X		
	CT*	88	97	79	90	v		
Minmi Rd /	A	36	40	32	17	X		
Awabakal Dr /	D	25	28	23	26	 Image: A start of the start of		
Bellbird Cl	E	13	14	12	25	×		
	F	21	23	19	22	~		
	CT*	128	141	115	120	 Image: A start of the start of		
Newcastle Link Rd	A	50	55	45	46	~		
/ Cameron Park Dr	D	27	30	24	25	 Image: A start of the start of		
/ Woodford St	E	22	24	20	22	~		
	G	30	33	27	28	~		
	CT*	129	142	116	130	 Image: A start of the start of		
	А	34	37	31	28	×		
Newcastle Link Rd	D	29	32	26	31	~		
St	E	30	33	27	33	~		
	G	17	19	15	18	~		
	B	20	22	18	20			

Note, CT* - Cycle time

Western Corridor Signal Time Comparison PM Peak

			PM (16:30 17:30)						
Intersection (TCS)	Cycle7 Phase		IDM		MISSIM	Within			
		Avg.	10%	-10%	VISSIM	10%?			
	CT*	129	142	116	120	~			
Thomas Stoot /	A	81	89	73	75	~			
Metcalfe Street	D	33	36	30	31	<			
	E	15	17	14	14	~			
	CT*		0	0		\checkmark			
Woodford St /	А		0	0		\checkmark			
Minmi Rd	В		0	0		\checkmark			
	С		0	0		\checkmark			
	D		0	0		\checkmark			
Thomas Steet /	CT*	129	142	116	120	 Image: A start of the start of			
Walford Street	А	76	84	68	69	~			
	В	24	26	22	24	~			
	С	29	32	26	30	✓			
	CT*	160	176	144	120	×			
Minmi Rd /	A	50	55	45	19	×			
Cameron St /	D	16	18	14	32	×			
Longworth Av /	E	37	41	33	21	×			
Cowper St	F	36	40	32	35	~			
	G	22	24	20	13	×			
	CT*	131	144	118	130	 Image: A second s			
Ne sette Dood /	A	83	91	75	71	×			
Newcastie Road / Douglast St	D	15	17	14	15	~			
Dougradie	E	18	20	16	29	×			
	G	15	17	14	15	V			
	CT*	93	102	84	90	~			
Minmi Rd / Macquaria St /	А	44	48	40	30	×			
Creek Rd	D	24	26	22	36	×			
	E	25	28	23	24	~			
	CT*	75	83	68	75	 Image: A start of the start of			
Minmi Rd / Manuland Dr /	A	31	34	28	18	×			
Churnwood Dr	D	25	28	23	38	×			
	E	19	21	17	19	~			
	CT*	61	67	55	70	×			
Minimi Rd /	A	25	28	23	19	×			
Maryland Dr	В	21	23	19	22	~			
	С	16	18	14	29	×			
	CT*	73	80	66	75	~			
Minmi Rd /	A	27	30	24	18	×			
Awabakal Dr /	D	16	18	14	27	×			
Bellbird Cl	E	13	14	12	13	✓			
	F	17	19	15	17	V			
	CT*	154	169	139	120	×			
Newcastle Link Rd	A	62	68	56	43	×			
/ Cameron Park Dr	D	29	32	26	24	×			
/ Woodford St	E	24	26	22	22	V			
	G	39	43	35	32	×			
	CT*	134	147	121	120	×			
	А	37	41	33	28	×			
Newcastle Link Ru	D	31	34	28	29	✓			
St	E	31	34	28	29	✓			
	G	21	23	19	20	\checkmark			
	В	14	15	13	14	\checkmark			

Note, CT* - Cycle time



APPENDIX B

2021 Upgrade Concepts





	Pesign	Drawn	Checked	
nsport Study	A.C	A.C	A.A Date	
ake Road Intersection -	Project Number	Sheet Number	15.05.2018 Issue	
ar 2021	P2989	1	001	
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em Corridor Traffic nsport Study	F.K	F.K	A.A Date	
/ Wilkinson Avenue	CONCEI Project Number	Sheet Number	13.08.2019 Issue	
n - Year 2021	P2989	1	001	



ern Corridor Traffic nsport Study	Design A.C	Drawn A.C	Checked A.A	
t / Cameron Street on - Year 2021	CONCEF Project Number	PT ONLY Sheet Number	Date 15.05.2018 Issue	
	P2989	1	001	



ern Corridor Traffic Insport Study	A.C	A.C	A.A
	CONCEPT ONLY		Date 15.05.2018
/ Awabakal Drive on - Year 2021	Project Number P2989	Sheet Number	Issue 001
	Prjet		
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P: (07) 5562-5377 W: www.bit/cosconsulting.com.au Brisbane Level 2, 428 Upper Edward Street, Spring Hill 4000. P: (07) 3831-4442 E: admin@bit/cosconsulting.com.au Studio 2013, 3 Gladstone Street, Newtown NSW 2042. P: (02) 9557 6202	Title Minmi Road / Hig Y		









	Design	Drawn	Checked	
ern Corridor Traffic ansport Study	F.K	F.K	A.A	
	CONCE	PT ONLY	Date 13.08.2019	
dford Street Intersection ear 2021	Project Number	Sheet Number	Issue	
	P2989	1	001	
	P2989	1	001	



APPENDIX C

2026 Upgrade Concepts





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BIT7IOS	Gold Coast Suite 26, 58 Riverwalk Avenue, Robina QLD 4226. P: (07) 5562-5377 W: www.bitziosconsulting.com.au Brisbane	lssue 001	REVISIONS Revisions/Descriptions	Drawn A.C	Date 22.12.2	ate .2017	0 Scale @ A3)	5	10	15	20	25	1:500	Project	P2989-Western Co and Transport
-consulting	Level 2, 426 Upper Edward Street, Spring Hill 4000. P: (07) 3831-4442 E: admin@bitziosconsulting.com.au Sydney														Title	COWPER STREET STREET INTERSEC
traffic engineering = transport planning	Studio 203, 3 Gladstone Street, Newtown NSW 2042. P: (02) 9557 6202															2020





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dio 20	3, 3 Gladstone S	Street,	Newtown	NSW 2042	
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			Proposed	Updates	to Net	work			
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ern Corridor Traffic nsport Study	F.K	F.K	A.A	
/ Wilkinson Avenue	CONCEI	PT ONLY	13.08.2019	
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ern Corridor Traffic ansport Study	Design A.C	Drawn A.C	Checked A.A	
nings Intersection - Year	CONCEP Project Number	PT ONLY Sheet Number 1	Date 15.05.2018 Issue	
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	Cold Coast Suite 26, 58 Riverwalk Avenue, Robina QLD 4226. P: (01) 5562-5377	Issue REVISIONS Revisions/Descriptions 001 CONCEPT DESIGN	Drawn Date A.A 07.05.2018	0 5 10 15 20 25	Project P2989-We
traffic engineering Transport planning	W: www.bitziosconsulting.com.au Brisbane Level 2, 428 Upper Edward Street, Spring Hill 4000. P: (07) 3831-4442 E: admin@bitziosconsulting.com.au Sydney Studio 203, 3 Gladstone Street, Newtown NSW 2042. P: (02) 9557 6202		Scale @ A3 LEGEND: Proposed	Updates to Network	500 and Title Minmi Road / Mi









Gold Coast Suite 26, 58 Riverwalk Avenue, Robina QLD 4226. P: (07) 5562-5377 W: www.bitziosconsulting.com.au VY, WW.DiadSconsuling.com.au Brisbane Level 2, 428 Upper Edward Street, Spring Hill 4000. P: (07) 3831-4442 E: admin@bitziosconsulting.com.au Sydney Studio 203, 3 Gladstone Street, Newtown NSW 2042. P: (02) 9557 6202

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P2989-Western Corridor Traffic and Transport Study	A.C	A.C	A.A	
	CONCE	PT ONLY	Date 15.05.2018	
ni Road / Wodford Street Intersection -	Project Number	Sheet Number	Issue	
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APPENDIX D

2036 Upgrade Concepts









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em Conidor Traffic	Design F K	Drawn F K	Checked	
nsport Study / Wilkinson Avenue n - Year 2036	Project Number	PT ONLY Sheet Number	Date 13.08.2019	
	P2989	1	001	





BITZIOS consulting	Gold Coast Suite 26 58 Riverwalk Avenue, Robina QLD 4226 P: (07) 5562-5377 W: www.bitziosconsulting.com.au Brisbane Level 2, 428 Upper Edward Street, Spring Hill 4000. P: (07) 3831-4442 E: admim@bitziosconsulting.com.au Sydney Studio 203, 3 Gladstone Street, Newtown NSW 2042.		REVISIONS Revisions/Descriptions CONCEPT DESIGN	Drawn F.K	Date 13.08.2019	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Project P2989-Weste and Tran
						LEGEND: Proposed Updates to Network	Title Minmi Road / Mac Road Intersec
trainc engineering a transport planning	P: (02) 9557 6202					· ·	





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Blue Gum Hills Road on - Year 2036 Project Number Sheet Number P2989 1 001	nsport Study	A.C	A.C	A.A Date	
P2989 1 001	Blue Gum Hills Road	Project Number	Sheet Number	15.05.2018	
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