Appendix I

Traffic and transport report

Traffic and Transport

Manns Road - West Gosford to Narara Concept Design and Environmental Assessment – Stage 1

80018005

Prepared for

Roads and Maritime Services / GHD

26 July 2018

Cardno

Contact Information

Cardno (NSW/ACT) Pty Ltd
ABN 95 001 145 035

Level 9 - The Forum
203 Pacific Highway
St Leonards 2065
Australia

www.cardno.com
Phone +61 2 9496 7700
Fax +61 2 9496 7748

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1 Introduction

This report details the traffic and transport implications of the proposal to upgrade a section of Manns Road, West Gosford, between Stockyard Place and Narara Creek Road. It is a supporting report for the project's Review of Environmental Factors (REF).

1.1 Background

1.1.1 Upgrade of Manns Road / Pacific Highway Route

Roads and Maritime Services (Roads and Maritime) Central Coast office, has engaged GHD to complete the concept design and environmental assessment for Stage 5 of the upgrade of Manns Road / Pacific Highway route between West Gosford and the M1 Pacific Motorway at Ourimbah. Stage 5 will upgrade Manns Road from Stockyard Place, West Gosford to Narara Creek Road, Narara. This project is immediately north of the recently completed upgrade of the major Central Coast Highway / Brisbane Water Drive / Manns Road intersection upgrade at West Gosford.

Stage 1 and Stage 2 of the Manns Road / Pacific Highway route are complete and operational, Stage 3A is under construction north of Lisarow and Stage 3B at Lisarow is close to completion of detailed design documentation. Stage 4 is well advanced at the concept design and environmental assessment stage.

1.1.2 Stage 5 – Manns Road from Stockyard Place, West Gosford to Narara Creek Road, Narara

The Stage 5 design project development will integrate with the already progressing Stage 4 concept design at Narara Creek Road. Roads and Maritime has indicted there is a strong possibility work will be advanced at that intersection as a stand-alone early works project.

The Stage 5 section of Manns Road covers a variety of adjacent land uses, including commercial, light industrial, remnant native vegetation, schools and residential. It is currently one lane in each direction with multiple access points, intersections and private business driveways, and long lengths of uncontrolled car parking on verges and adjacent areas. There are major public utility (mostly aerial electricity) installations adjacent to travel lanes.

A previous strategic concept design was by Roads and Maritime for the Stage 5 section covered a length of approximately 2.7 km. This strategic design is the basis of the current concept design, progressing for project development and environmental assessment, subject to detailed site investigations, flood modelling and traffic modelling. The design process will also incorporate risk management, value management, WH&S development, public utility consultations and community engagement.

The key features of the Manns Road upgrade developed to date include:

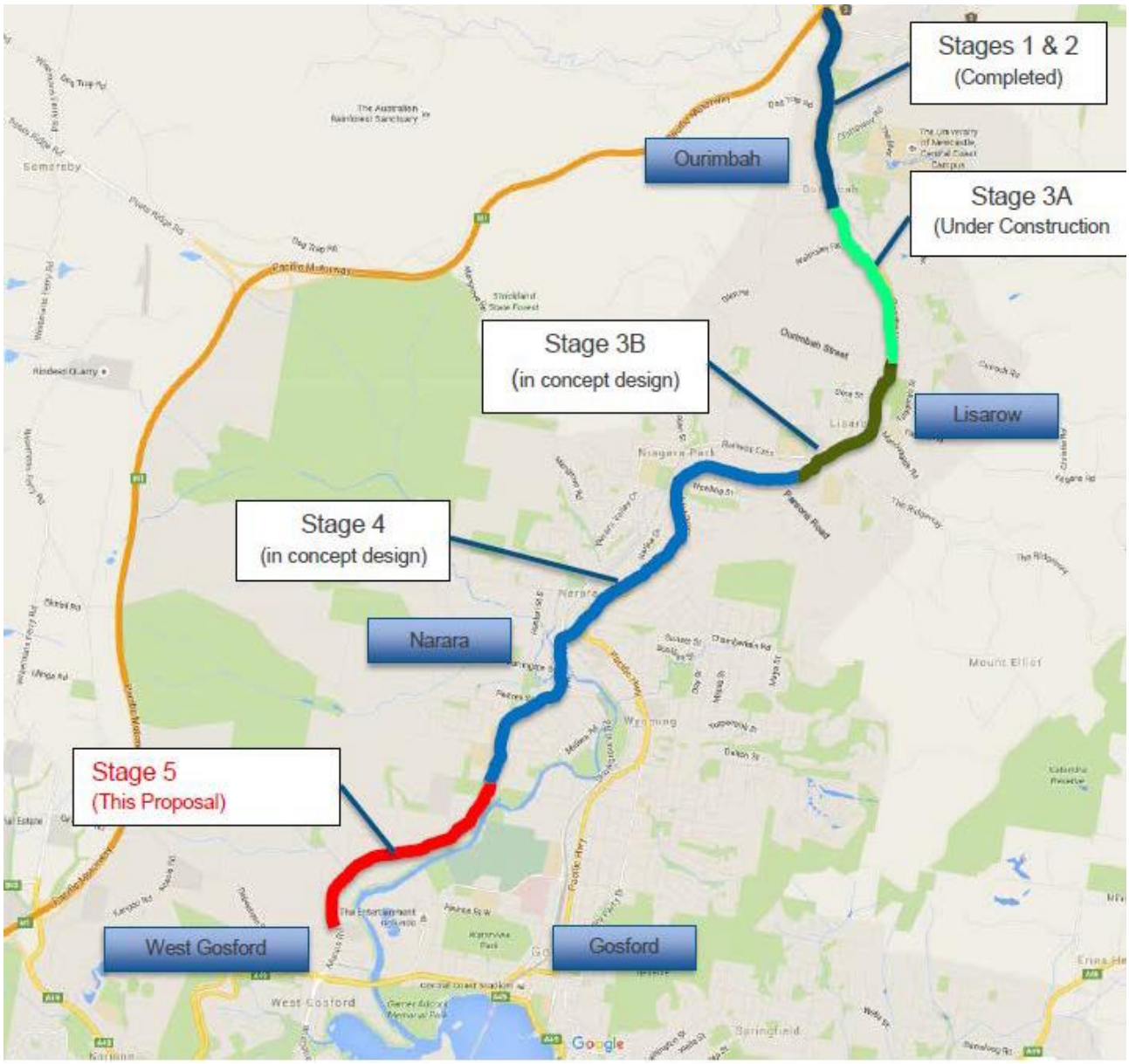
- Four traffic lanes on Manns Road, from Stockyard Place (two in each direction) to Narara Creek Road
- New and upgraded intersections, with traffic control signals (TCS), at Stockyard Place, Carnarvon Road, Merinee Road, Dell Road and Narara Creek Road
- Creation of a central median and restriction of access to left turns only at other intersections, provision of formal U-turn facilities at proposed upgraded TCS intersections at Carnarvon Road and Dell Road
- Replacement of the bridge over a tributary of Narara Creek approximately 500 m north of Stockyard Place
- Road widening – embankments and cuttings along Manns Road, including minor and major retaining walls in some locations to limit property acquisition
- Formalisation of drainage infrastructure and stormwater management
- Substantial relocations of multiple public utility assets on either side of, and across, Manns Road
- Standalone temporary intersection-only upgrades at Stockyard Place and Narara Creek Road.

1.2 Location and Context

The different stages of Manns Road improvements are shown in **Figure 1-1**.

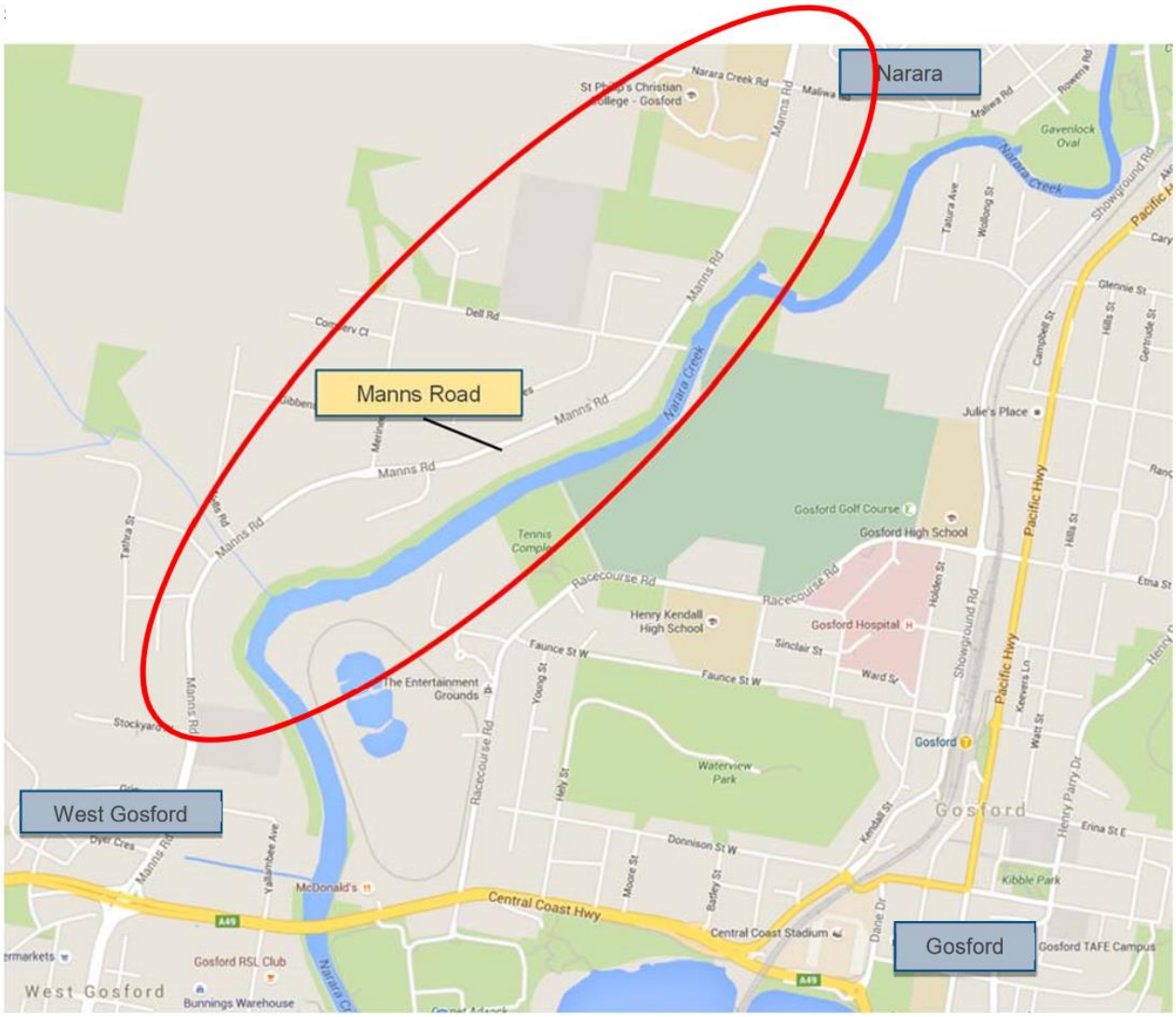
The location of the Stage 5 Manns Road upgrade between West Gosford and Narara is shown in **Figure 1-2**.

Figure 1-1 Manns Road Improvement Stages



Basemap Source: Google Maps

Figure 1-2 Site locality plan – Stage 5 of Manns Road / Pacific Highway route upgrade - Stockyard Place to Narara Creek Road



Basemap Source: Google Maps

The project's objectives as set out by the Roads and Maritime Professional Services Contract – Professional Services Scope and Requirements, prescribe that the upgrade should:

- Support economic growth and productivity by providing a road with capacity LoS D or better for 2036 forecast traffic volumes
- Upgrade the route for access of B-Doubles and other freight vehicles
- Improve access to and provide facilities for road based public transport
- Encourage active transport by providing appropriate facilities for walking and cycling.

The project also aims to minimise impact on the environment. The overall project goal is to achieve the best result for each of the above objectives, both in isolation and when considered together.

1.3 Scope and Purpose of this Report

A Review of Environmental Factors (REF) is an environmental assessment to support requirements of Part 5 of the *Environmental Planning and Assessment Act 1979*. An REF examines the magnitude and significance of the likely environmental impacts of a proposal, and documents the measures required to mitigate any adverse impacts to the environment. REFs assist the determining authority to decide whether an activity should be approved, taking into account all matters affecting or likely to affect the environment.

Specifically, Cardno has been engaged by GHD (on behalf of Roads and Maritime) to document the details of the traffic and transport implications from the proposal to upgrade the section of Manns Road, between Stockyard Place, West Gosford and Narara Creek Road, Narara.

Key areas examined in this report include:

- Understanding the exiting traffic and transport conditions in the study area
- Assessing the operational impacts of the proposal with future development in 2026 and 2036
- Assessing the impacts and benefits to pedestrians, cyclists and public transport operations
- Assessing the need to duplicate Manns Road between Stockyard Place and Narara Creek Road.

1.4 Report Structure

The report is comprised of the following sections:

- **Section 2 – Existing Traffic Conditions**: A description of the existing conditions at the Manns Road study corridor, including a range of survey data
- **Section 3 – Traffic Modelling**: An overview of the software and assumptions used for the traffic modelling assessment
- **Section 4 – Base Case Traffic Modelling Assessment**: Development of a base case (current) operational traffic model
- **Section 5 – Traffic Option Assessment**: Development of a future operational traffic model for Stage 1 upgrade of the stage 5 works
- **Section 6 – Summary of Findings and Recommendations**: Conclusion of proposal.

2 Existing Transport Conditions

2.1 Existing Manns Road Overview

2.1.1 Manns Road localised description

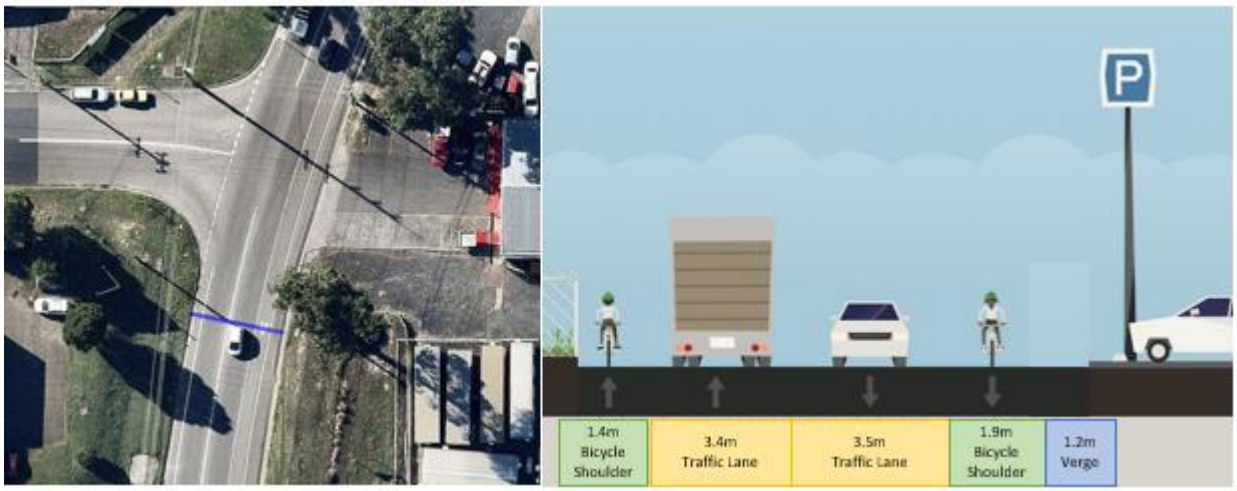
Manns Road is an arterial road in West Gosford, generally oriented in a north-south direction. Manns Road allows traffic to bypass the Gosford CBD for vehicles travelling between the Pacific Motorway and Gosford's northern suburbs. The local context of the Manns Road study corridor is shown in **Figure 2-1**.

Figure 2-1 Local context of Manns Road study corridor

Basemap Source: https://snazzymaps.com

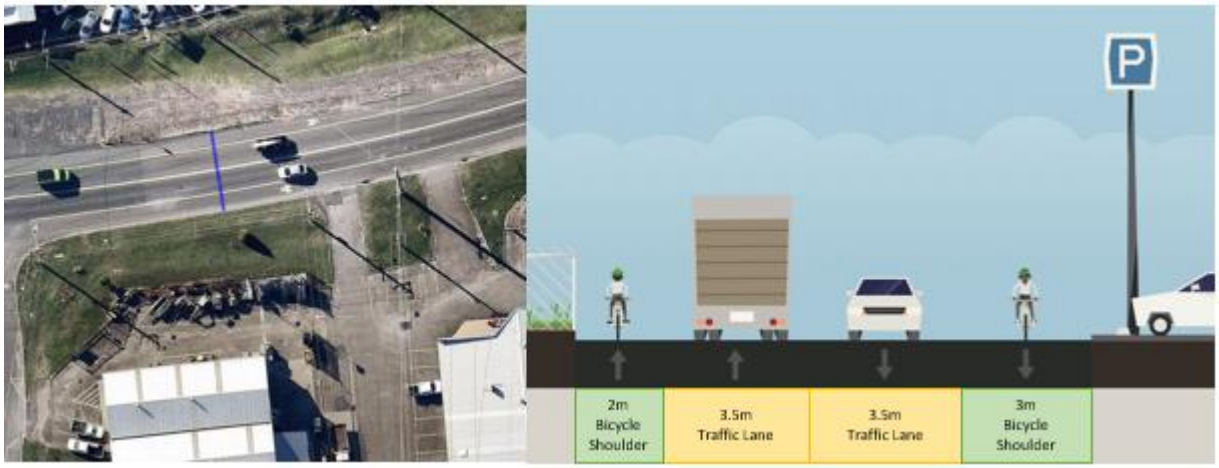
Manns Road is generally one traffic lane in each direction, with sealed shoulders which can function as bicycle lanes. Sample cross sections along the Manns Road near Carnavon Road, Dignity Crescent and Narara Creek Road are shown in **Figure 2-2**, **Figure 2-3** and **Figure 2-4** respectively. Along the study corridor, there are eight intersections, described in **Section 2.1.2**.

Figure 2-2 Indicative Manns Road Cross Section near Carnavon Road



Basemap Source: http://maps.au.nearmap.com/, https://streetmix.net/
Location: -33.420101, 151.319576

Figure 2-3 Indicative Manns Road Cross Section near Dignity Crescent



Basemap Source: http://maps.au.nearmap.com/, https://streetmix.net/
Location: -33.416760, 151.326770

Figure 2-4 Indicative Manns Road Cross Section near Narara Creek Road

Basemap Source: http://maps.au.nearmap.com/, https://streetmix.net/
Location: -33.408476, 151.336435

The speed limit of Manns Road is 60km/h. The localised speed limit conditions surrounding the study corridor are further described in **Section 2.1.3**.

Manns Road is classified as state road 349 road in the Roads and Maritime schedule of classified roads. The classified and regional roads surrounding the Manns Road study corridor are described in **Section 2.2**.

The land uses surrounding Manns Road are generally light industrial, and this is discussed in **Section 2.4**. Future population and workforce forecasts are detailed in **Section 2.5**.

A range of traffic data was collated for the project, as detailed in **Section 2.6**. Roads and Maritime has provided crash data along the Manns Road study corridor for the five years until November 2017, characteristics of these crashes are detailed in **Section 2.7**.

2.1.2 Intersections along Stage 5 Corridor

The Stage 5 study corridor between Stockyard Place and Narara Creek Road has eight intersections (inclusive of these named intersections). These intersections are described in **Table 2-1**, along with the indicative chainages from the concept drawing prepared by GHD[1].

Table 2-1 Reference Intersections on Manns Road Corridor

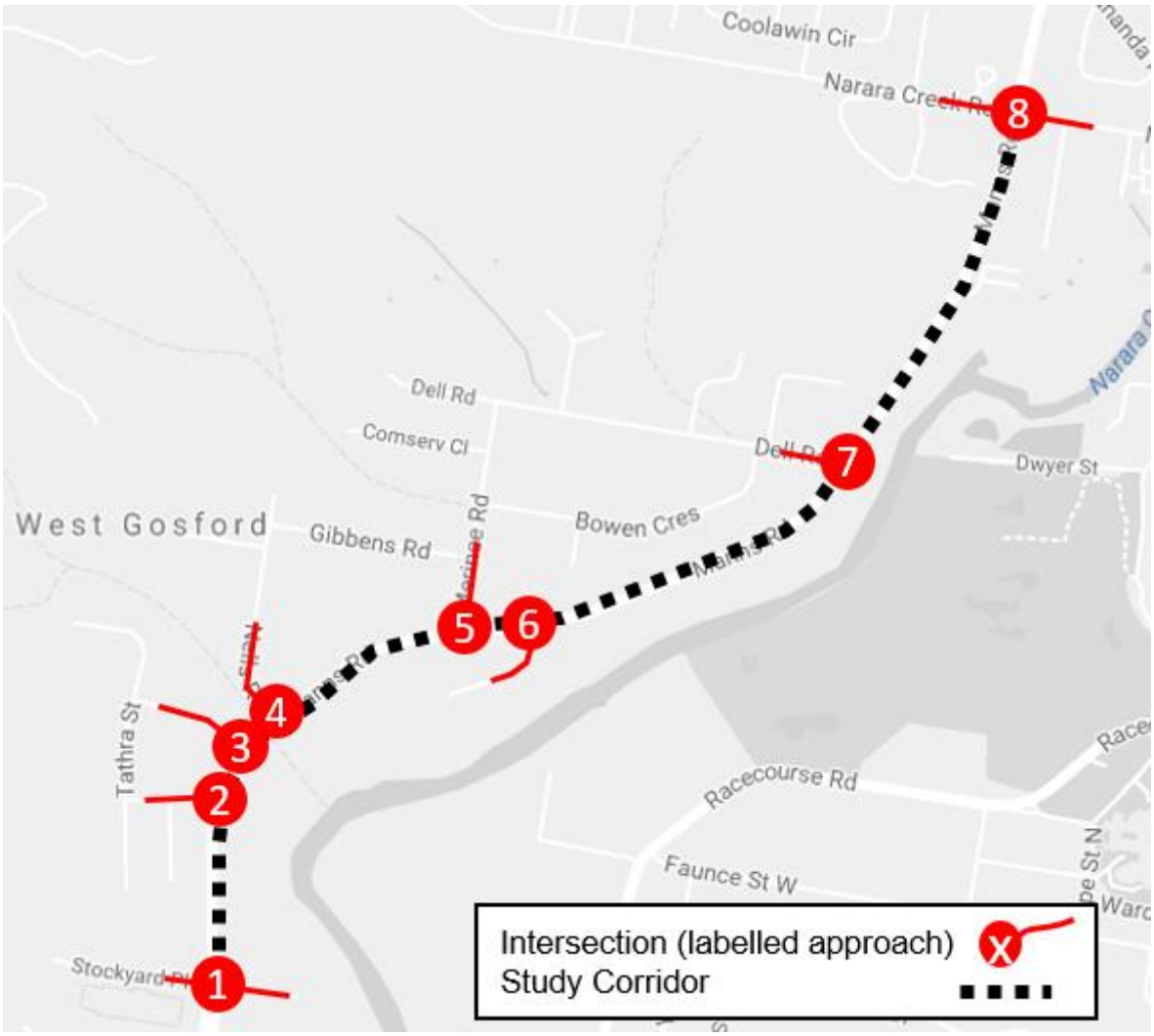
	Intersection	Indicative GHD Chainage (m)	Reference (from Stockyard Place) (m)	Distance from Previous Intersection (m)
1	Stockyard Place	500	0	
2	Carnavon Road	850	350	350
3	Yandinia Road	960	460	110
4	Nells Road	1,030	530	70
5	Merinee Road	1,460	960	430
6	Dignity Crescent	1,600	1,100	140
7	Dell Road	2,300	1,800	700
8	Narara Creek Road	3,080	2,580	780

The Manns Road corridor and the location of each intersection listed in **Table 2-1** are shown in **Figure 2-5**.

Table 2-2 details further the layout and characteristics of each intersection.

[1] 80% Concept Design RMS Registration Package DS2017/002307 dated April 2018

Figure 2-5 Study corridor intersections and approaches



Basemap Source: https://snazzymaps.com

Table 2-2 Intersections' Key Features

ID	1	2	3	4	5	6	7	8
Name	**Stockyard**	**Carnavon**	**Yandina**	**Nells**	**Merinee**	**Dignity**	**Dell**	**Narara Creek**
Distance Northbound from Stockyard	-	350m	460m	530m	960m	1,100m	1,800m	2,580m
Google Maps Link	Link	Link	Link	Link	Link	Link	Link	Link
Traffic Control	Signalised	Priority Control	Sign Controlled Giveway	Priority Control	Signalised	Priority Control	Sign Controlled Giveway	Signalised
Intersection Type	X	T	T	T	T	T	T	X
Through Traffic Lanes	2	1	1	1	1	1	1	1
Slip Turning Lanes	✓	✗	✗	✗	✓	✗	✓	✓

ID	1	2	3	4	5	6	7	8
5-Year Crash History[2]	1	4	3	3	4	4	2	5
Formal Parking in Vicinity	✗	✗	✗	✗	✗	✗	✗	✗
Pedestrian Path	✓	✗	✗	✗	Limited	✗	✗	Limited
Bicycle Shoulder/ Bicycle Lane	✓	✓	✓	✓	✓	✓	✓	✓
Shared Path	✓	✗	✗	✗	✗	✗	✗	✗
Median Separator	✓	✗	✗	✗	✓	✗	✗	✓

2.1.3 Speed Environment

The *Road Transport (Safety and Traffic Management) Act 1999* allows Roads and Maritime to set speed limits for roads in New South Wales. Speed limits reflect the road safety risk of a section of road, whilst also considering the needs of customers to reach their destination in a timely manner.

Key factors considered when establishing a speed limit include crash profile, road function, road use, roadside development, road characteristics, traffic mix, the presence of vulnerable road users, as well as conflict points such as intersections and driveways.

Generally, Manns Road has a posted speed limit of 60km/h along the length of the corridor. 60km/h speed limits are generally considered appropriate for:

- Significant urban undivided arterial roads (with direct driveway accesses)
- Divided roads with high volumes where the lanes are narrow (less than 3.0 metres), or
- Rural residential roads in villages with minimal development.

Manns Road can be classified as a significant urban undivided road, and so a 60km/h speed limit is considered appropriate, and is consistent with the *NSW speed zoning guidelines* (2011, Roads and Traffic Authority[3]).

Glenvale School locates the northern extent of the study corridor at Narara Creek Road. Around schools, temporal school zones with reduced speed limits of 40km/h are imposed during key drop off and pick up times. However, the school zone does not impede onto Manns Road. South of Narara Creek Road, there are no pedestrian facilities and therefore a school zone is not present and not appropriate given the site context.

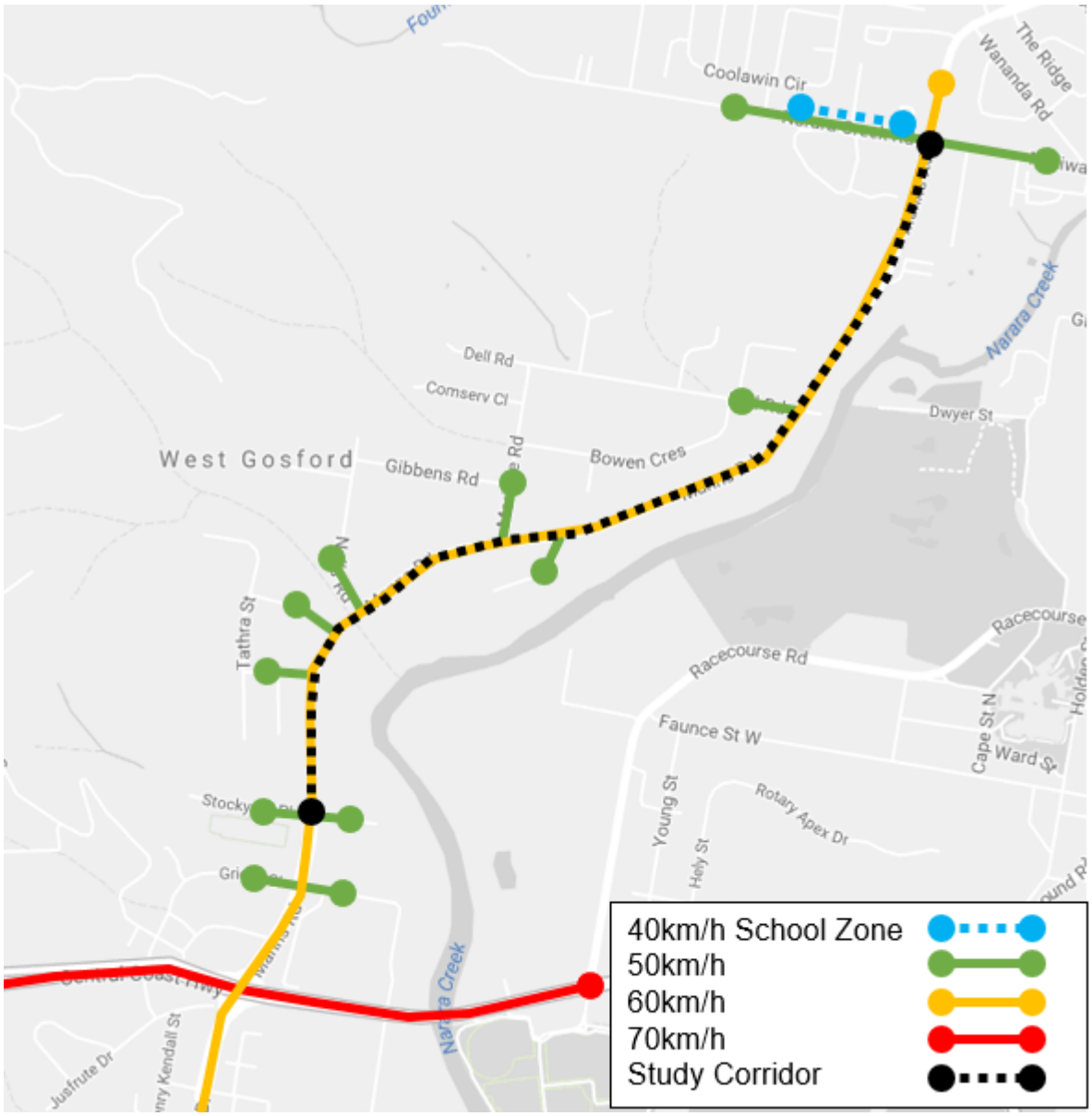
A diagram showing speed limits in the vicinity of the study corridor is shown in **Figure 2-6**. A desktop assessment of several side roads abutting Manns Road observed no reduced speed limit signs.

Figure 2-6 was presumed that the industrial area encompassing roads such as Dell Road, Merinee Road and Nells Road would be classified as a 'built up area[4]' within the NSW road rules. The speed zoning guidelines specify, '*statutory speed limits that apply in the absence of a sign posted speed limit in a built-up area. The default speed limit in a built up area is 50km/h*' (pg. 5). Section 25 (1) of the NSW Road Rules (2014) states, '*If a speed limit sign does not apply to a length of road and the length of road is not in a speed*

[2] Refer **Section 2.7** for more detailed crash data analysis
[3] http://roadsafety.transport.nsw.gov.au/downloads/nsw_sza.pdf, accessed 2 May 2018
[4] ***built-up area***, in relation to a length of road, means an area in which either of the following is present for a distance of at least 500 metres or, if the length of road is shorter than 500 metres, for the whole road: (a) buildings, not over 100 metres apart, on land next to the road, (b) street lights not over 100 metres apart. From https://legislation.nsw.gov.au/#/view/regulation/2014/758/dict1, accessed 2 May 2018

limited area, school zone or shared zone, the speed limit applying to a driver for the length of road is the default speed limit[5].'

Figure 2-6 Study Area Speed Limits



Basemap Source: https://snazzymaps.com

2.1.4 Parking

Manns Road is typically configured with one traffic lane in each direction and a bicycle shoulder lane. A desktop audit shows that near intersections, no stopping signs are in place; which prevent parking in those locations. The land uses along Manns Road (further described in **Section 2.4**) typically provide off-street parking, with the local access roads providing supplementary parking. Notwithstanding, the size of the verge results in some informal and opportunistic parking for some businesses west of Merinee Road as shown in **Figure 2-7**.

[5] https://www.legislation.nsw.gov.au/#/view/regulation/2014/758/part3/rule.25, accessed 2 May 2018

Figure 2-7 Verge parking west of Merinee Road (southern verge)

Source: http://maps.au.nearmap.com

2.2 Road Hierarchy

The primary roads in vicinity of the study corridor include:

- **Manns Road** – Manns Road is the focus of this study and carries approximately 20,000 vehicles per weekday. It is generally a single lane undivided road with a posted speed limit of 60km/h/ Manns Road provides a bypass of the Gosford CBD linking the Pacific Highway with Gosford's northern suburbs including Wyoming, Niagara Park and Wyoming.
- **Central Coast Highway** – The Central Coast Highway is the main road linking the Pacific Motorway with the broader Central Coast region. Immediately to the west of Manns Road, there is a steep gradient which links the developed areas on the coast, with the motorway on the plateau. To the east of Manns Road, the Central Coast highway passes along the southern extent of the Gosford CBD. The Central Coast Highway generally has a posted speed limit of 70km/h around the Manns Road corridor.
- **Racecourse Road** – Racecourse Road is a secondary Gosford CBD bypass road in addition to Manns Road. Should Manns Road be closed for any reason, Racecourse Road is the alternative route (in conjunction with Showground Road).
- **Brisbane Water Drive** – Brisbane Water Drive is an extension of Manns Road to the south beyond the Central Coast Highway. Brisbane Water Drive is the primary road linking to areas such as Woy Woy, Umina and Ettalong.

Roads and Maritime is required to maintain a schedule of classified roads under the *Roads Act 1993* s153 (4)[6]. A classified road is a road which Roads and Maritime is responsible for maintaining and funding. They are classed as either highways or state/main roads, and are generally recognised as key arterial links within the road transport network. Regional roads provide an intermediate function and are funded by Roads and Maritime, but maintained by Council. Local roads are maintained and funded by Council. The relationship between different road classes, funding and maintenance responsibility and selected study area roads are shown in **Table 2-3**.

[6] http://www.rms.nsw.gov.au/business-industry/partners-suppliers/lgr/documents/classified-roads-schedule.pdf

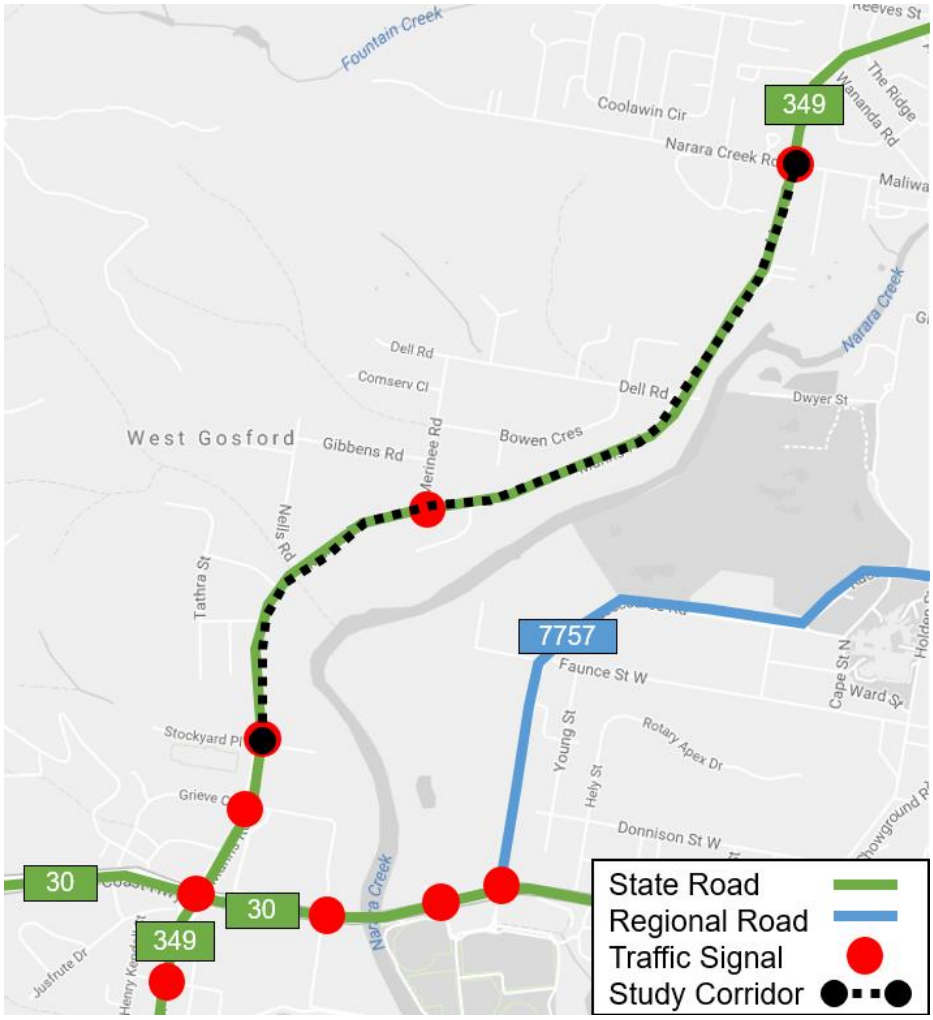
Table 2-3 Road Classification Local Context

Road Classification	Class	Funding	Maintenance	Study Area Roads (Classification Number)
Classified Road	Highway	Roads and Maritime	Roads and Maritime	Pacific Highway (10) Central Coast Highway (30)
	State Road/ Main Road	Roads and Maritime	Roads and Maritime	**Manns Road (349)** Henry Parry Drive (673)
Unclassified	Regional	Roads and Maritime	Council	Racecourse Road (7757)
	Local	Council	Council	All other roads

Manns Road is classified as state road 349 and is the study corridor. At the southern extent of the study corridor is the Central Coast Highway which is state road 30 and beyond the northern extent of the study corridor is the Pacific Highway is state road 10. Outside of the study corridor, but within an area of influence, part of Henry Parry Drive makes up state road 673 and part of Racecourse Road makes up regional route 7757.

Roads and Maritime also has planning control at all traffic signals, even if these are located on regional or local roads. A map illustrating classified and unclassified roads and traffic signals surrounding the study corridor is shown in **Figure 2-8**.

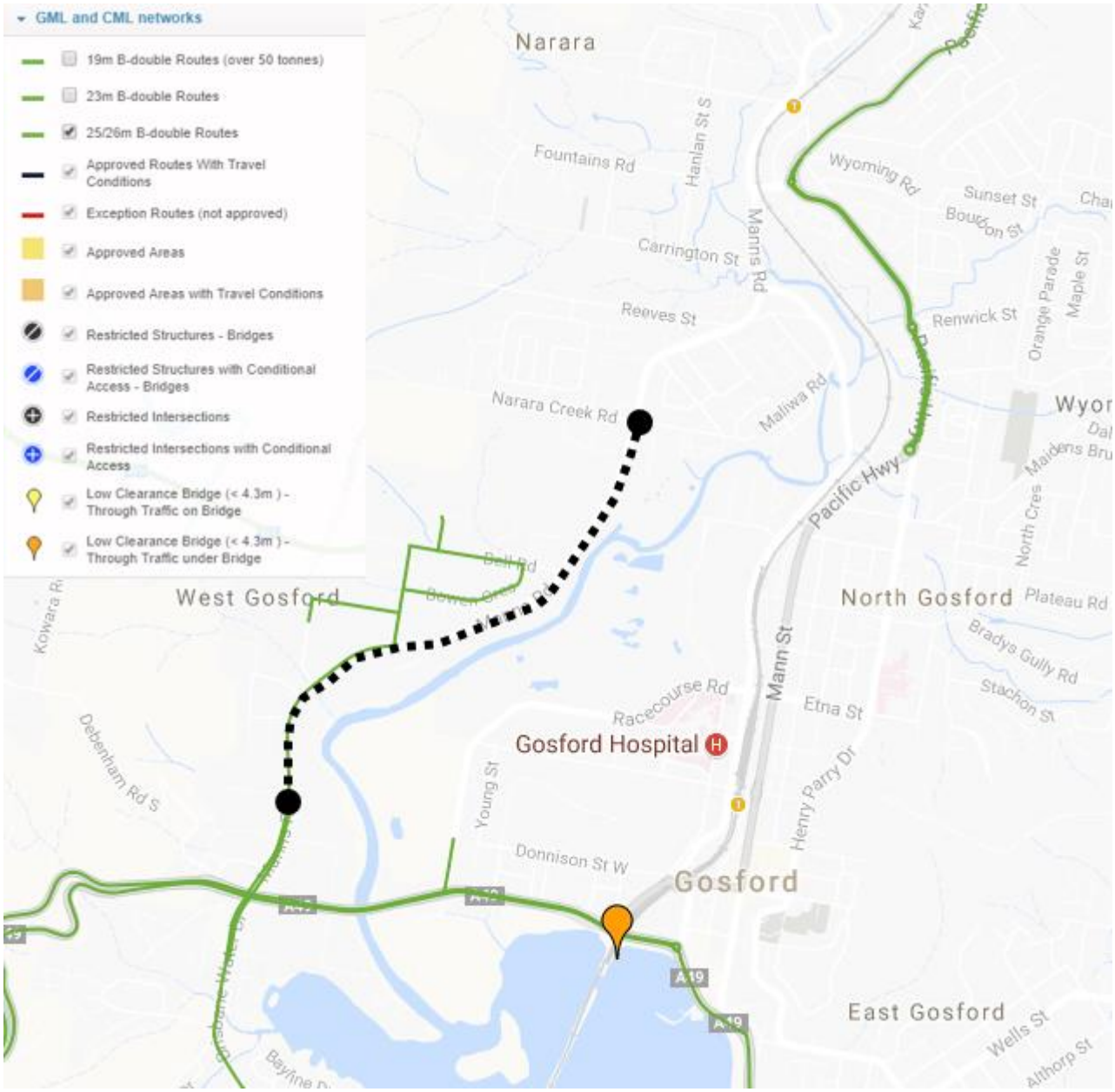
Figure 2-8 State/Regional Roads and traffic signals surrounding study corridor



Basemap Source: https://snazzymaps.com

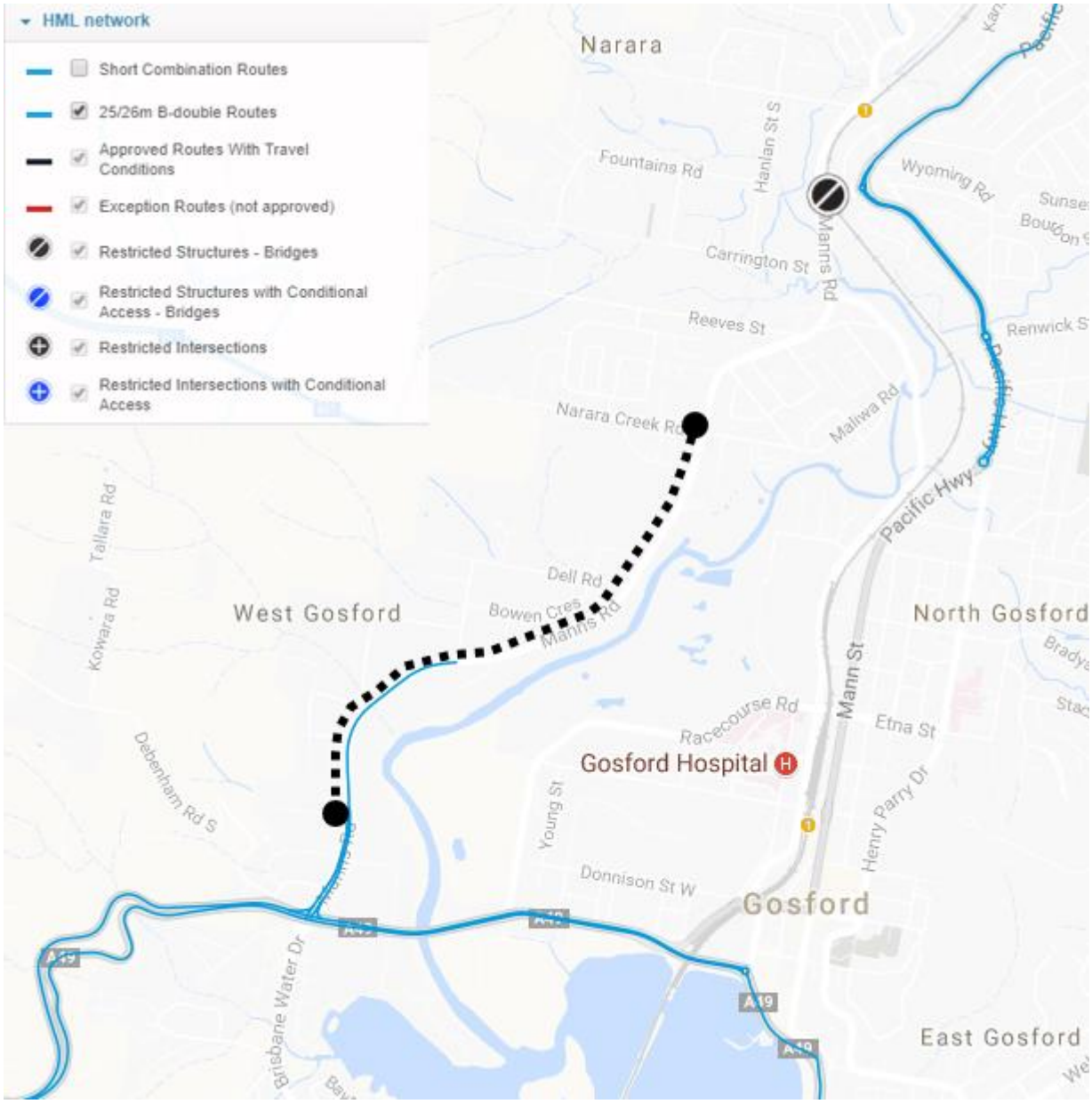
In addition to the state and regional road classification, Roads and Maritime maintains a number of maps which illustrate where heavy or oversized vehicles are permitted. These maps are reproduced in **Figure 2-9** to **Figure 2-11**.

Figure 2-9 General mass limit and concessional mass limit routes



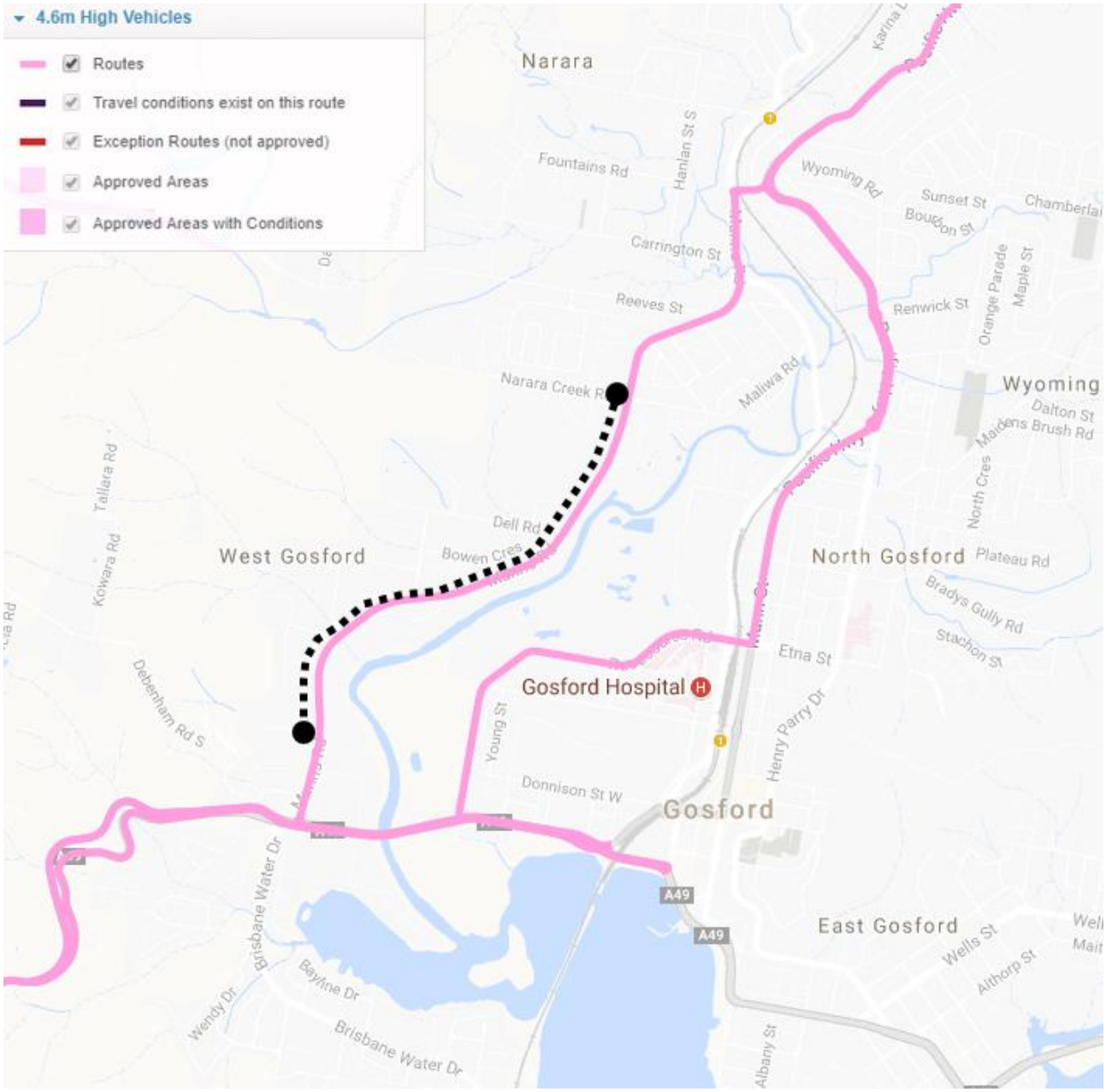
Basemap Source: http://www.rms.nsw.gov.au/business-industry/heavy-vehicles/maps/restricted-access-vehicles-map/map/index.html

Figure 2-10 Higher mass limit routes



Basemap Source: http://www.rms.nsw.gov.au/business-industry/heavy-vehicles/maps/restricted-access-vehicles-map/map/index.html

Figure 2-11 4.6-metre-high routes



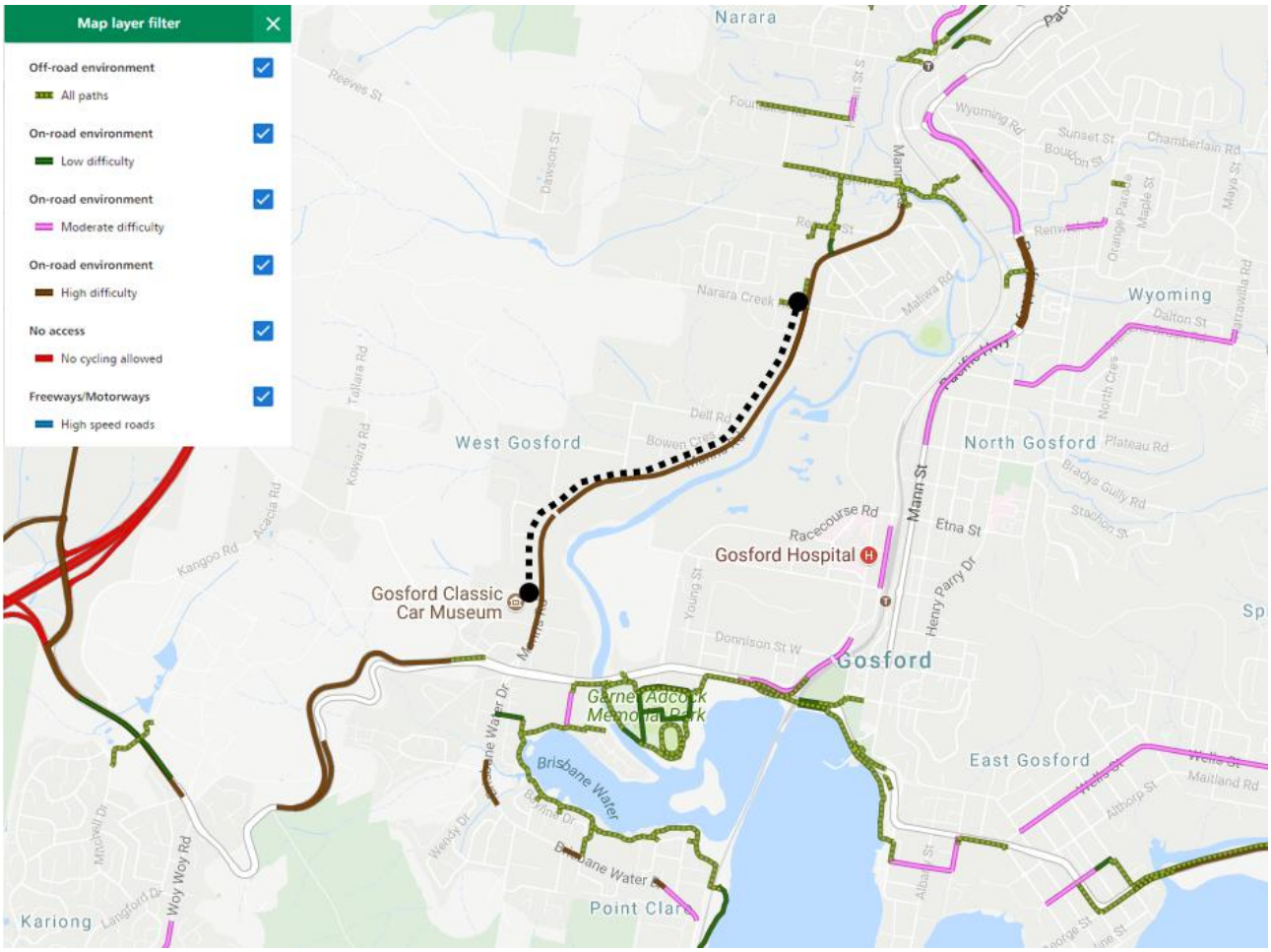
Basemap Source: http://www.rms.nsw.gov.au/business-industry/heavy-vehicles/maps/restricted-access-vehicles-map/map/index.html

2.2.2 Cycling and Pedestrian Infrastructure

As previously noted, Manns Road does have sealed shoulders which act as bicycle lanes. The Roads and Maritime cycleway finder identifies Manns Road as a 'high difficulty' on road route, and it is not well integrated at either end into a broader cycling network. Some of the shoulder characteristics were previously described in **Section 2.1.1**, with the Roads and Maritime cycleway map shown in **Figure 2-12**.

As was outlines in **Table 2-2**, there is presently sporadic pedestrian footpath infrastructure on Manns Road, which is focused around previously upgraded sections and signalised intersections. The characteristics and land uses on the Manns Road corridor are generally not favourable for walking.

Figure 2-12 Cycle Route Identification



Basemap Source: http://www.rms.nsw.gov.au/maps/cycleway_finder, accessed 16 July 2018

2.3 Public Transport

Manns Road has a limited number of bus routes which operate along the corridor. This is because, as outlined previously, Manns Road acts as a bypass for the Gosford CBD, and therefore, a route along Manns Road would bypass the major trip origin and destination land uses in the Gosford CBD. Essentially, the only people who would potentially benefit from a bus route on Manns Road would utilise the businesses along Manns Road, and those people who do an end-to-end trip from places like Narara (north of Gosford) to Woy Woy (south of Gosford). It is clear from the timing of the bus services shown that the services are aimed at employees of the industrial area. A typical weekday bus schedule for Manns Road is described below in **Table 2-4**. The bus services do not regularly operate on the weekend.

Table 2-4 Bus Operations

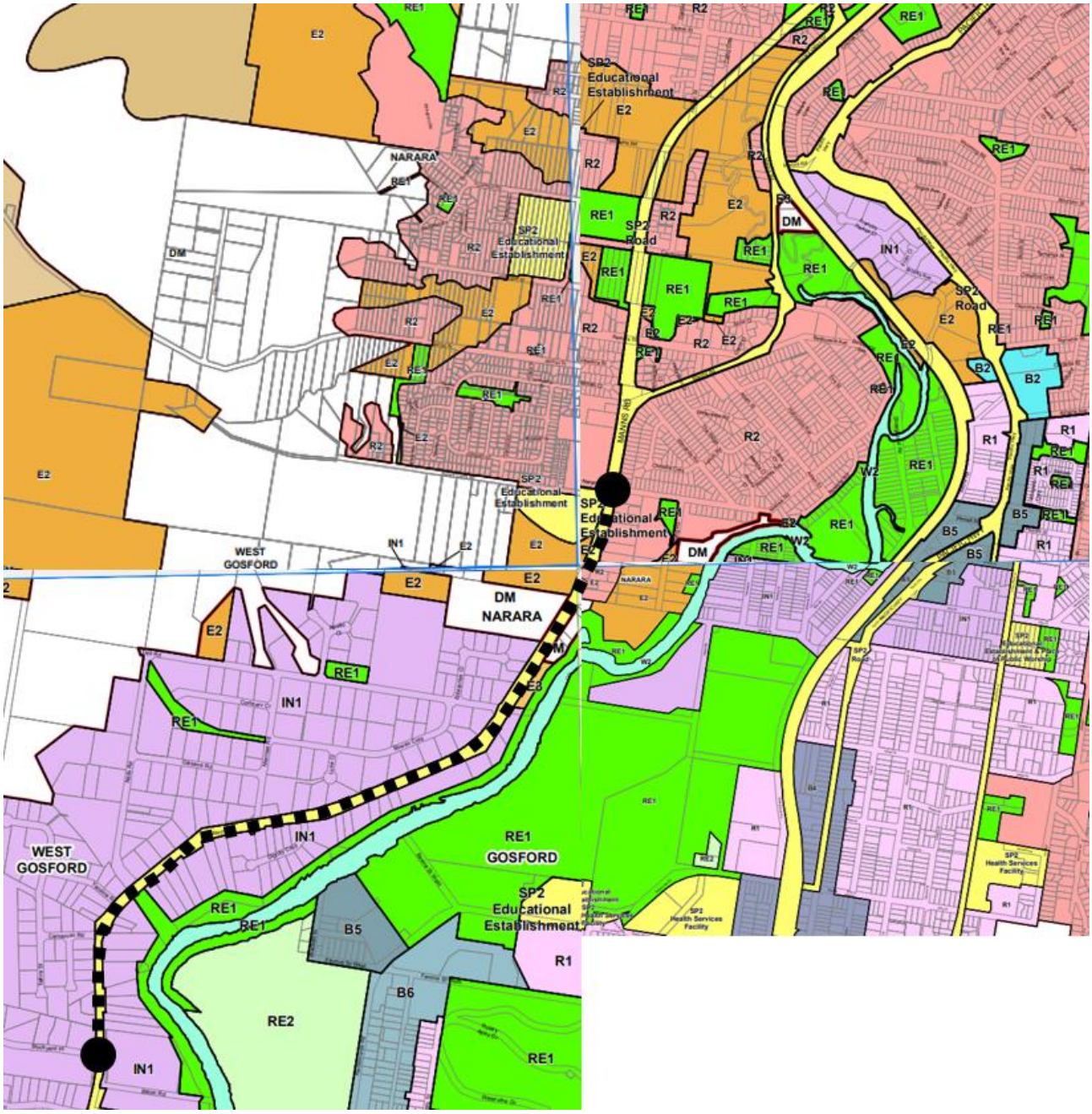
Route	Description	Direction	Services Per Day	First Service	Last Service
33	Somersby to Gosford via Industrial Estate and West Gosford	Northbound	5	4:00pm	5:30pm
55	Ettalong Beach to Gosford via Woy Woy and Umina Beach		6	6:15am	7:20am
33	Gosford to Somersby via West Gosford and Industrial Estate	Southbound	5	6:40am	9:00am
33/4	Gosford to Somersby Industrial Estate and Kariong (Loop Service)		5	5:30am	8:30am
70	Gosford to Ettalong Beach via Woy Woy, Point Clare and Tascott		2	3:45pm	4:00pm

Source: TripView iPhone app, accessed 10 July 2018

2.4 Surrounding Land Uses

The Manns Road study corridor has varying land uses and land use intensity along its length. Primarily, land use between the southern extent of the study corridor at Stockyard Place to Dell Road is industrial uses (IN1) on both sides of the road. North of Dell Road, land uses transition to general residential and educational (R2 and E2). Narara Creek is recognised as a conservation zone (RE1). The land use map surrounding the Manns Road corridor is shown in **Figure 2-13**.

Figure 2-13 Local Context Land Use



Basemap Source: Gosford Council LEP Land Use Map: 014B, 015A, 015CA, 015CB, available at https://www.legislation.nsw.gov.au/#/view/EPI/2014/42/maps

2.5 Future Growth

2.5.1 Population and Employment

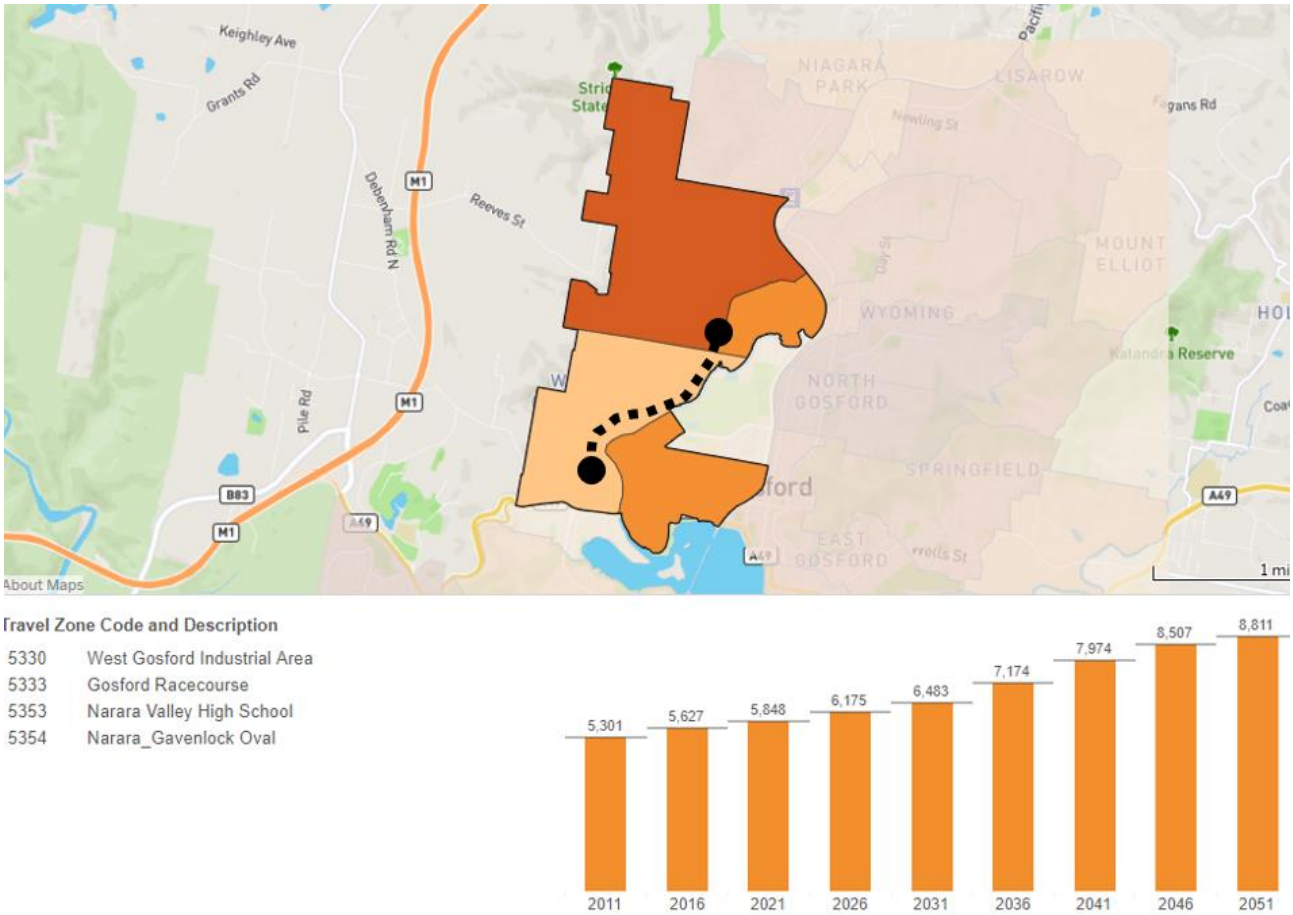
The Bureau of Transport Statistics (BTS) maintains a number of databases concerning future forecasts for population, workforce and other characteristics. To review population and workforce forecasts, it is necessary to define geographical boundaries. The following travel zones (and numbers) have been reviewed:

- 5330 – West Gosford Industrial Area
- 5333 – Gosford Racecourse
- 5353 – Narara Valley High School
- 5354 – Narara_Gavenlock Oval.

2.5.1.1 Population Projection

BTS estimates that in 2016, the population across the four travel zones was 5,627 residents. By 2026, the population for the four travel zones is expected to be 6,175 residents, an increase of 9.8% from 2016. The area of travel zones and a timescale projection of the population is shown in **Figure 2-14**. For the broader Gosford precinct, over the same time period, the population is forecast to increase from 166,964 to 179,358 representing 7.4% growth over the same period. Therefore, the residential population surrounding the Manns Road corridor is forecast to grow at a faster rate compared to the broader Gosford precinct.

Figure 2-14 Population Projection



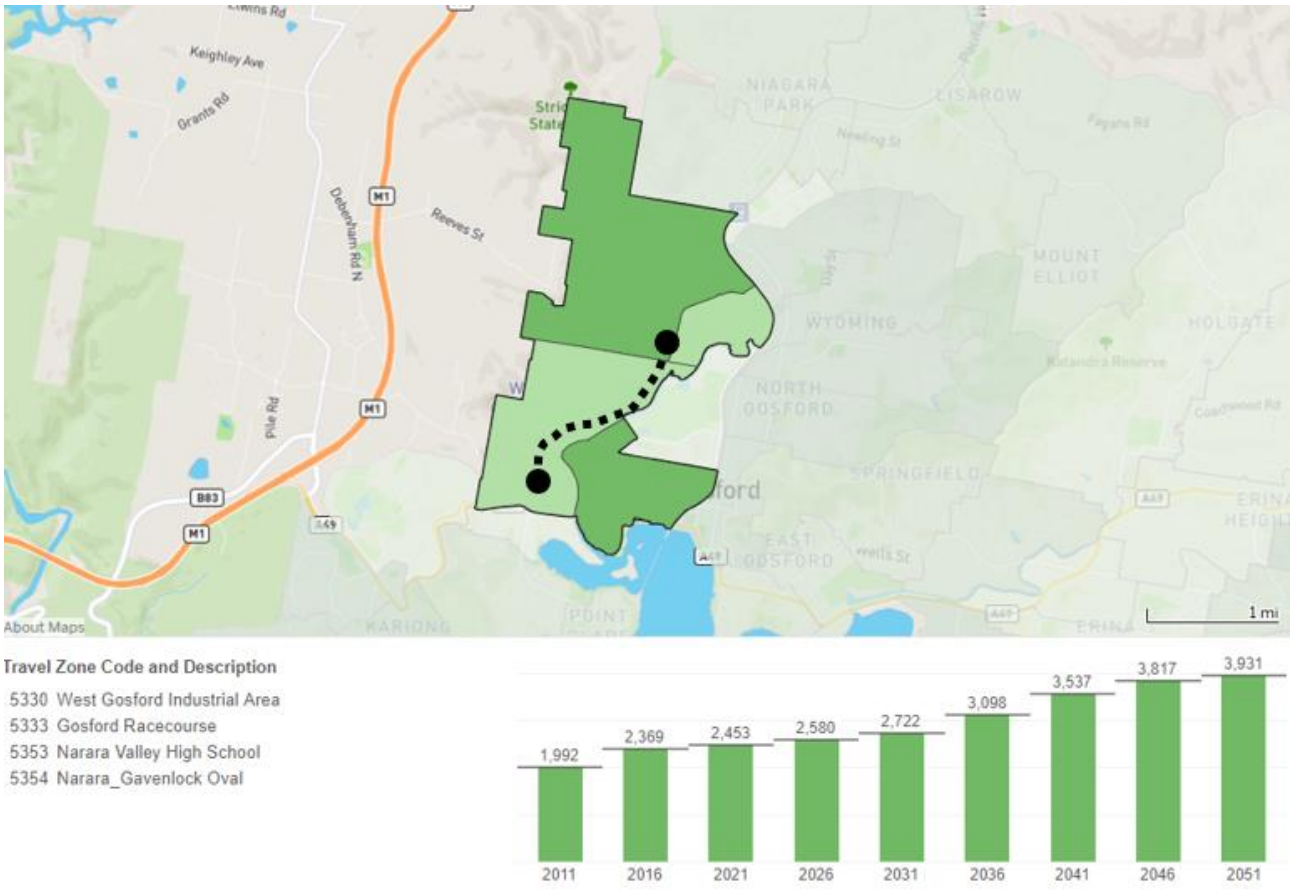
Base Source: https://www.transport.nsw.gov.au/data-and-research/forecasts-and-projections/population/land-use-planner-population, accessed 2 May 2018

2.5.1.2 Workforce Projection

BTS estimates that in 2016, the total workforce of the four travel zones was 2,369. By 2026, the workforce for the four travel zones is expected to be 2,580 workers, an increase of approximately 9% from 2016. The area of travel zones and a timescale projection of the workforce is shown in **Figure 2-15**. For the broader

Gosford precinct, over the same time period, the workforce is increasing from 76,703 to 79,935 representing approximately 4.2% growth over the same period. Therefore, the workforce surrounding the Manns Road corridor is forecast to grow at more than double the rate of the broader Gosford precinct.

Figure 2-15 Workforce Projection



Base Source: https://www.transport.nsw.gov.au/data-and-research/forecasts-and-projections/workforce/land-use-planner-workforce, accessed 2 May 2018

2.6 Existing Traffic Volumes and Patterns

A range of surveys were commissioned to support the Manns Road traffic and transport assessment report, these included:

- Automatic Tube Counts (i.e. to identify 24-hour traffic volumes on each road)
- Classified Intersection Counts (i.e. to identify peak hour turning volumes at intersections)
- Origin Destination Survey (i.e. to understand where traffic is coming from and going to)
- Travel Time Survey (i.e. to understand how long it takes to travel along each corridor).

These traffic surveys along Manns Road, were carried on Thursday 7 December and Saturday 9 December 2017.

2.6.1 Midblock Traffic Volumes

Seven day, 24-hour classified traffic counts identified the daily and peak hourly traffic variations at different locations in the road corridor, and any differences between weekday and weekend traffic volumes. Mid-block traffic surveys were compared to 2016 data provided by Roads and Maritime to identify any growth that occurred in the past two years.

The surveyed midblock locations on Manns Road, and the 2016/2017 results, are summarised in **Table 2-5**. Over the course of approximately 15 months, seven day traffic volumes along the Manns Road corridor grew between 5.5% (Site 4) and 8.8% (Site 2). These growth rates exceed the population and workforce forecasts previously discussed in **Section 2.5.1**. In many cases, the growth of traffic in 21 months has exceeded the 10 year BTS population and workforce growth forecasts.

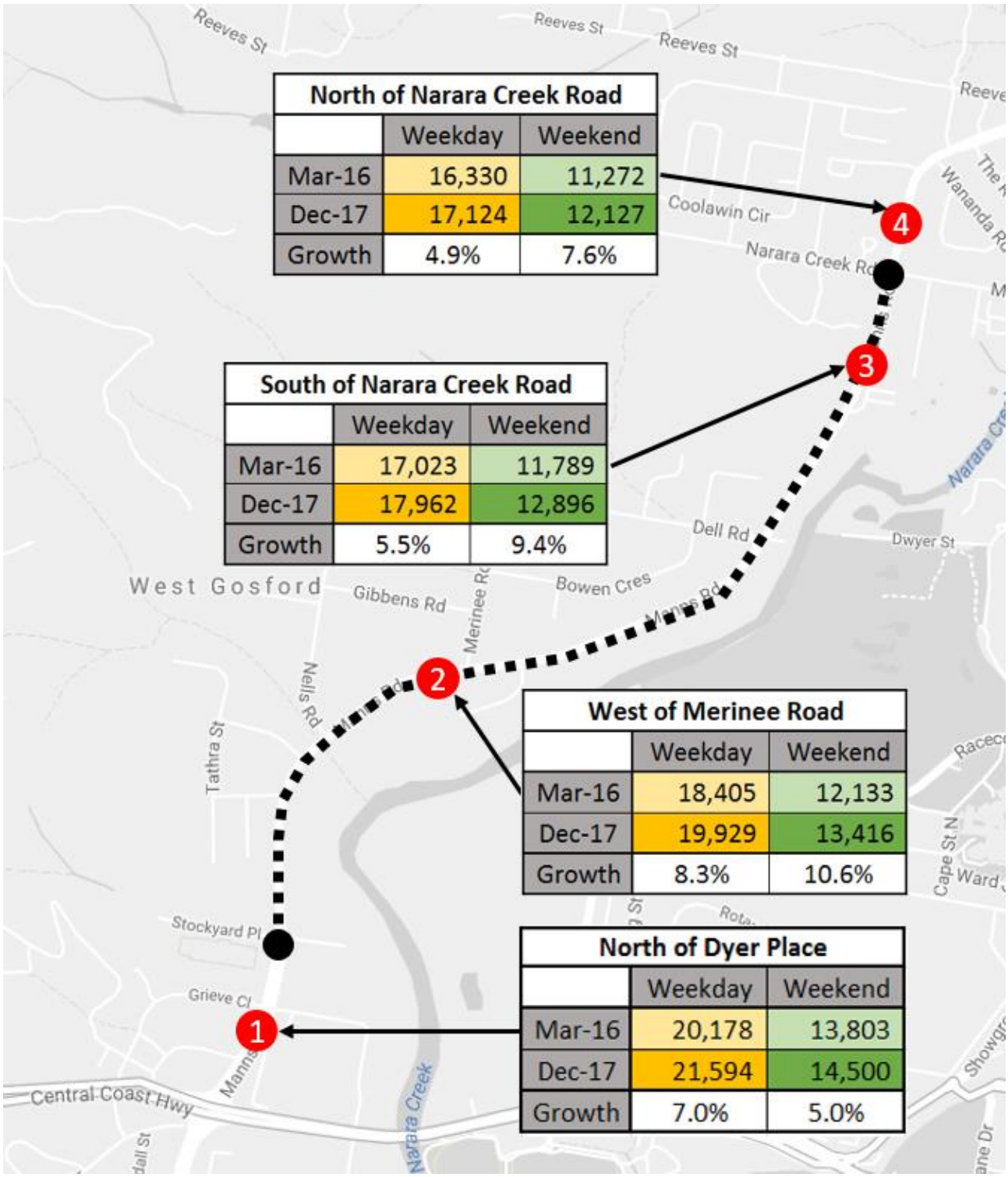
Table 2-5 Traffic Volumes at midblock locations – Manns Road corridor – 2016 and 2017

ID	Name	Time	Avg. 7 Days	Avg. Weekday	Avg. Weekend	Critical Day (Thursday)	% Traffic Change (Thurs vs Weekday)
1	North of Dyer Crescent	Mar 2016	18,356	20,178	13,803	20,506	1.6%
		Dec 2017	19,567	21,594	14,500	21,999	1.9%
		Difference	**+1,211 (+6.6%)**	**+1,416 (+7.0%)**	**+697 (+5.0%)**	**+1,493 (+7.3%)**	**+0.3%**
2	West of Merinee Road	Mar 2016	16,613	18,405	12,133	18,850	2.4%
		Dec 2017	18,068	19,929	13,416	20,407	2.4%
		Difference	**+1,455 (+8.8%)**	**+1,524 (+8.3%)**	**+1,283 (+10.6%)**	**+1,557 (+8.3%)**	**No change**
3	South of Narara Creek Road	Mar 2016	15,528	17,023	11,789	17,428	2.4%
		Dec 2017	16,515	17,962	12,896	18,457	2.8%
		Difference	**+987 (+6.4%)**	**+919 (+5.4%)**	**+1,107 (+9.4%)**	**+1,029 (+5.9%)**	**+0.4%**
4	North of Narara Creek Road	Mar 2016	14,885	16,330	11,272	16,614	1.7%
		Dec 2017	15,696	17,124	12,127	17,442	1.9%
		Difference	**+811 (+5.4%)**	**+794 (+4.9%)**	**+855 (+7.6%)**	**+828 (+5.0%)**	**+0.2%**

Source: 'Manns Road Upgrade, Stockyard Place, West Gosford to Narara Creek Road, Narara Traffic Survey Analysis' Revision A, dated 20 February 2018 - Table 1, Table 2, Table 3

The survey locations depicting daily traffic volumes are shown in **Figure 2-16**. Comparative traffic volume plots for the respective sites are shown in **Figure 2-17** to **Figure 2-20**.

Figure 2-16 Mid-block daily traffic volume on Manns Road



Basemap Source: https://snazzymaps.com

Figure 2-17 Comparative daily traffic volumes north of Dyer Crescent 2016-2017

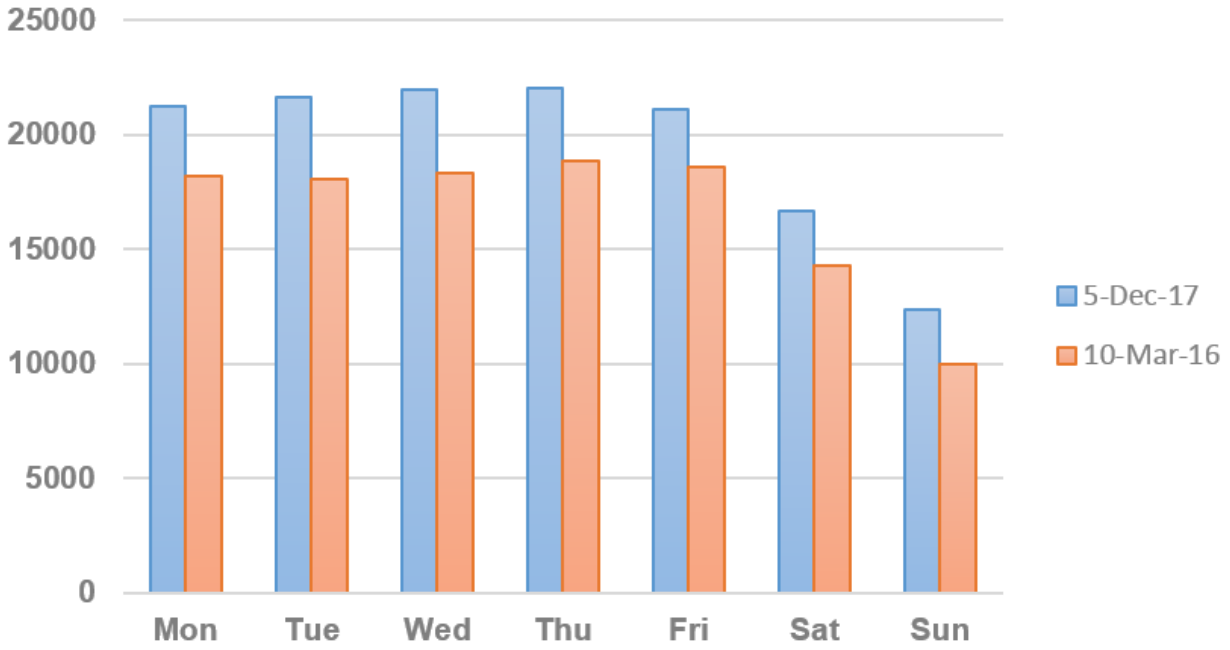


Figure 2-18 Comparative daily traffic volumes west of Merinee Road 2016-2017

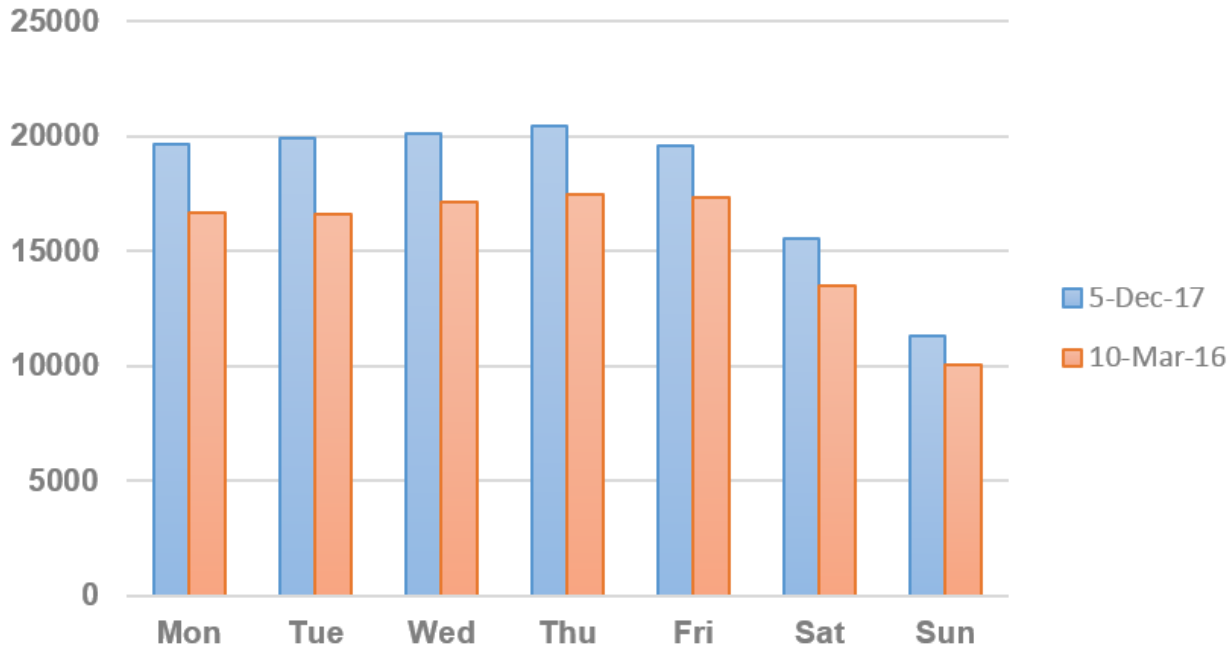


Figure 2-19 Comparative daily traffic volumes south of Narara Creek Road 2016-2017

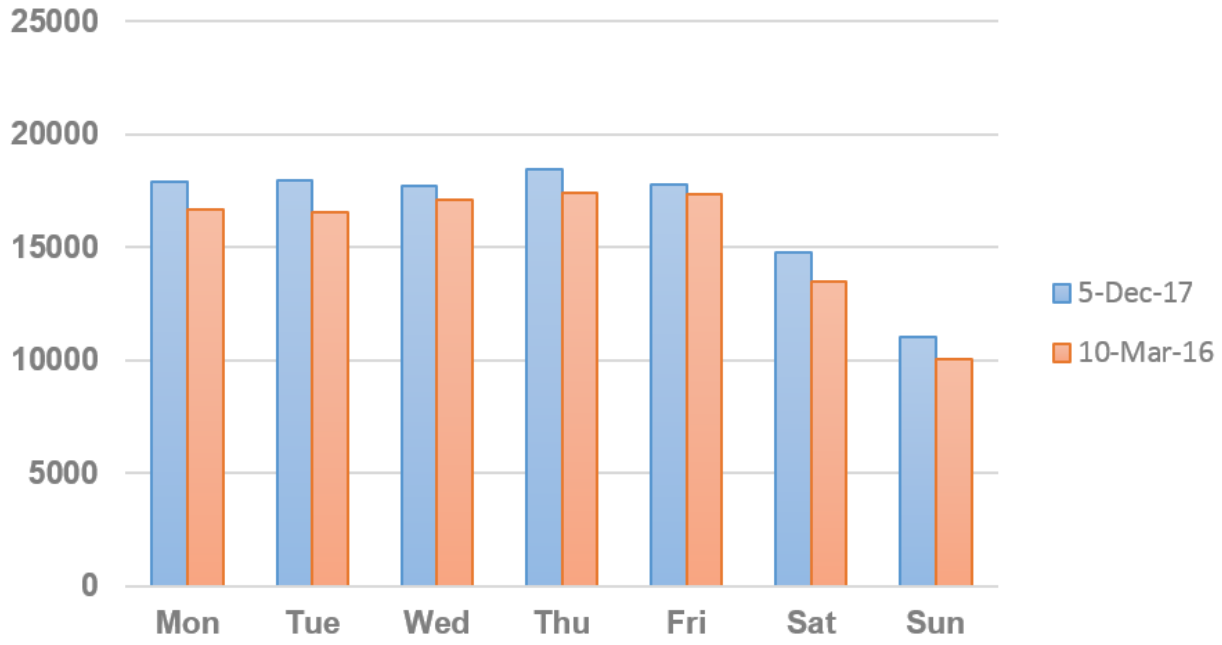
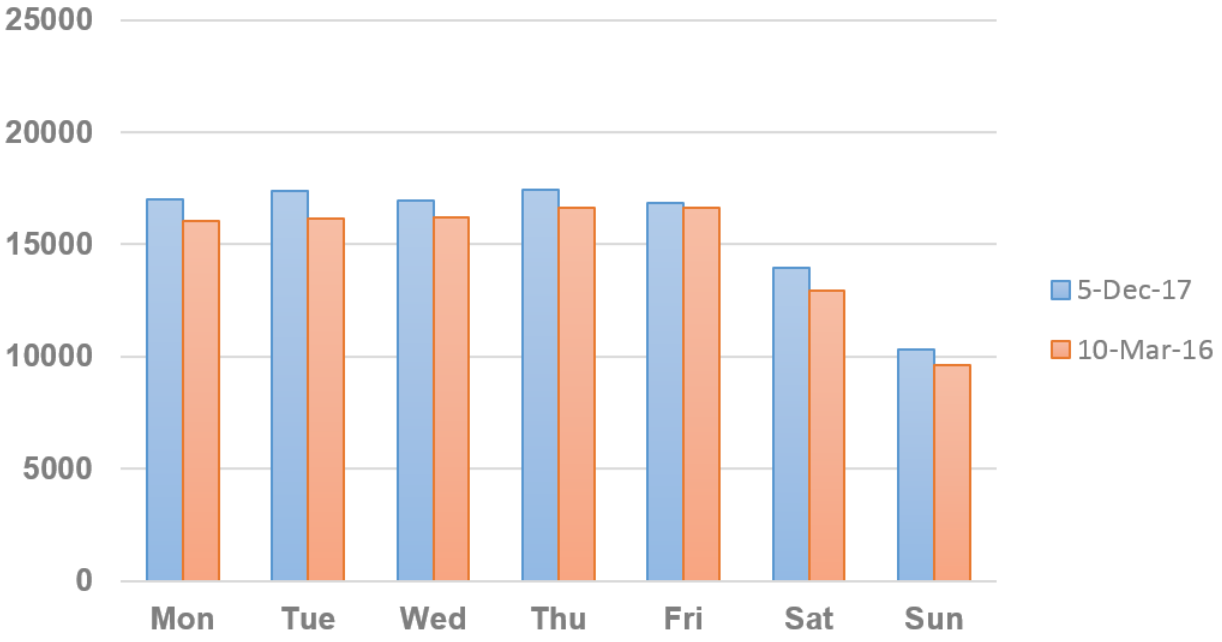


Figure 2-20 Comparative daily traffic volumes north of Narara Creek Road 2016-2017



The traffic data shows:

- The average difference in weekday volumes (between the 2016 and 2017 counts) was approximately 1,500 vehicles per day
- Traffic was recorded at its highest on the Thursday, approximately 1.9% to 2.8% higher than the average weekday traffic at all four locations surveyed in 2017
- The daily traffic volumes were relatively consistent for all weekdays (Monday to Friday) at all surveyed locations
- The daily traffic volumes vary significantly between all four locations surveyed with an average difference of 2,000 vehicles per day
- The daily traffic volumes consistently reduced heading north on Manns Road.
  - At north of Dyer Crescent, the average weekday volume was 21,594 vehicles per day in 2017

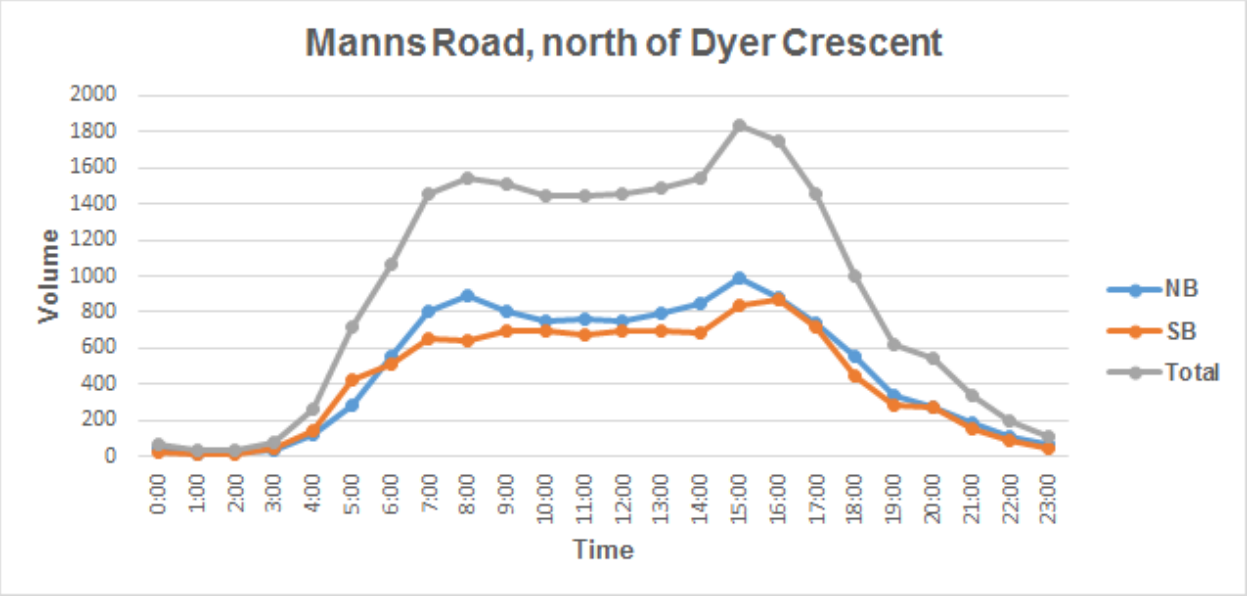
- North west of Merinee Road, the average weekday traffic volume was 19,929 (decreased by 1,665 from Dyer Crescent)
- Further north on Manns Road near Narara Creek Road, the average weekday traffic volumes were 17,962 and 17,124 respectively, decreasing by 1,967 and 838 respectively from the previous location.

2.6.2 Peak Hour Traffic Volumes

The 24-hour traffic volumes for all four surveyed locations were plotted for Thursday (highest weekday volume) by direction and two-way total volume. This information was used to establish vehicle travel patterns throughout the day and to identify the peak hour traffic periods.

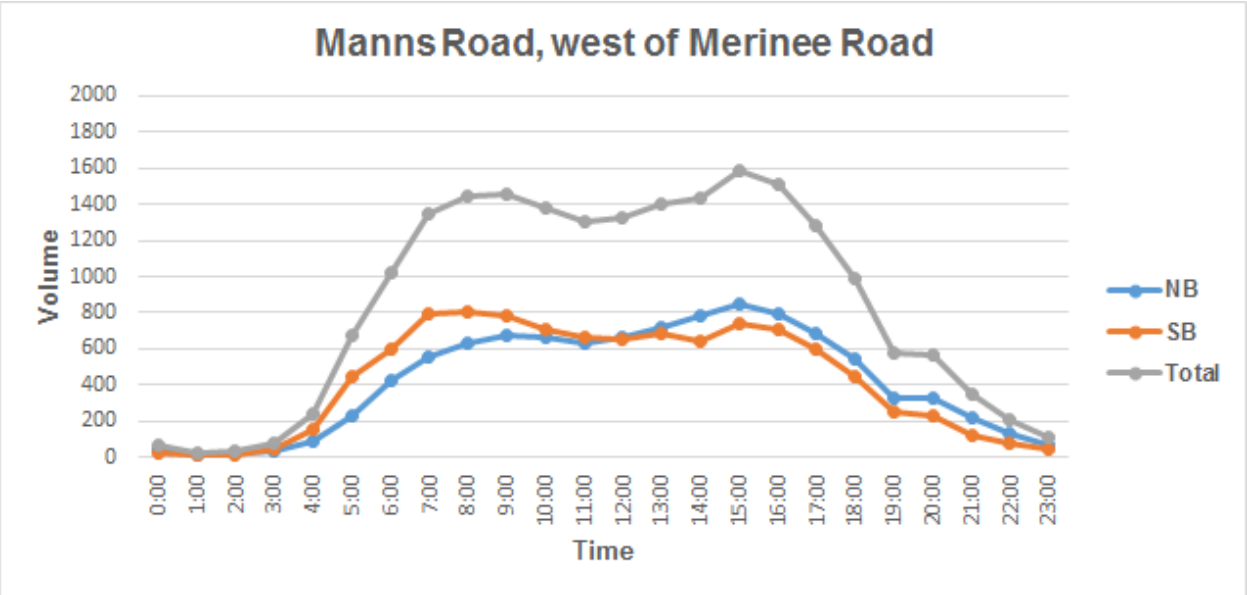
Figure 2-21 to **Figure 2-24** show the hourly traffic profiles for each of the locations.

Figure 2-21 24 Hour Traffic Profile – Manns Road north of Dyer Crescent



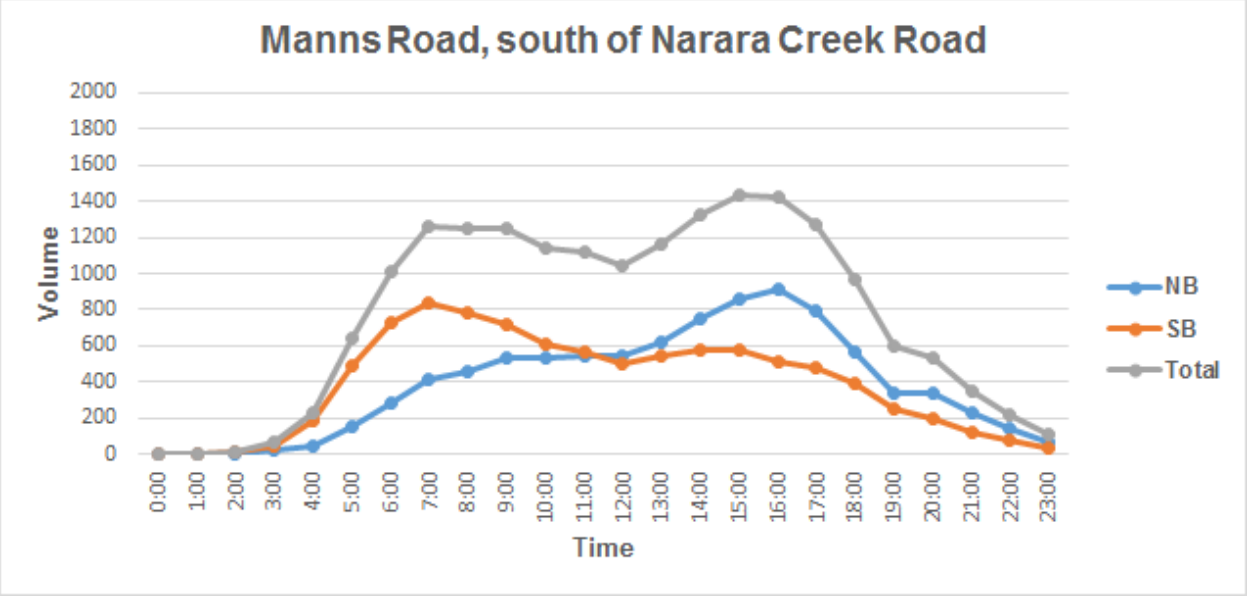
Source: Modified from 'Manns Road Upgrade, Stockyard Place, West Gosford to Narara Creek Road, Narara Traffic Survey Analysis' Revision A, dated 20 February 2018, Figure 6

Figure 2-22 24 Hour Traffic Profile – Manns Road west of Merinee Road



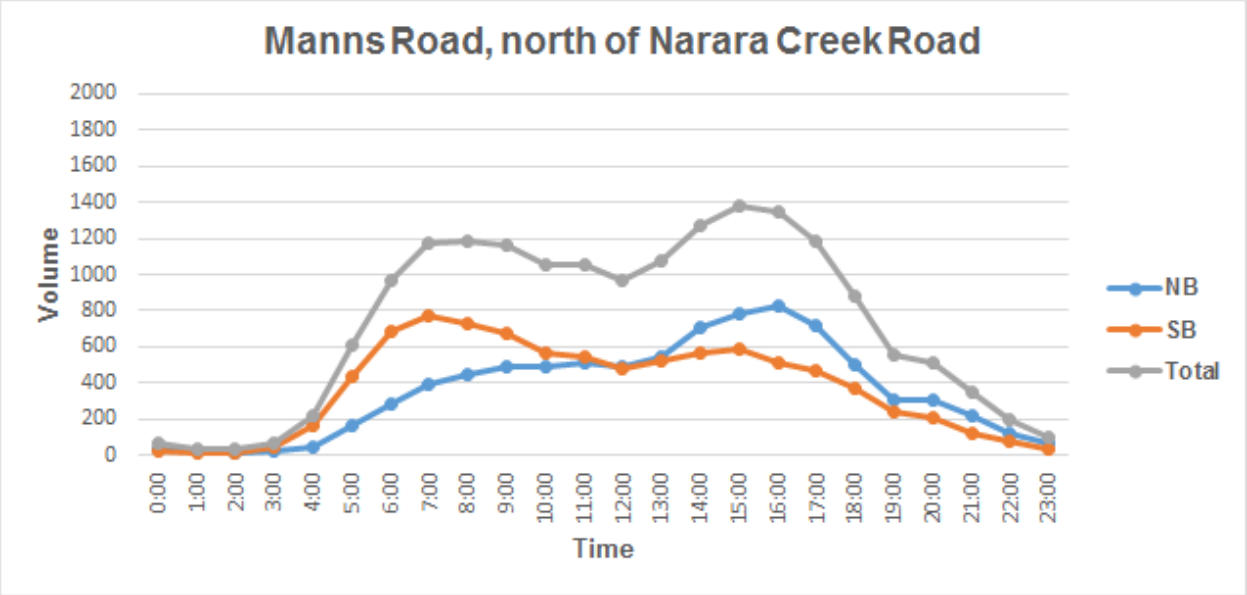
Source: Modified from 'Manns Road Upgrade, Stockyard Place, West Gosford to Narara Creek Road, Narara Traffic Survey Analysis' Revision A, dated 20 February 2018, Figure 7

Figure 2-23 24 Hour Traffic Profile – Manns Road south of Narara Creek Road



Source: Modified from 'Manns Road Upgrade, Stockyard Place, West Gosford to Narara Creek Road, Narara Traffic Survey Analysis' Revision A, dated 20 February 2018, Figure 8

Figure 2-24 24 Hour Traffic Profile – Manns Road north Narara Creek Road



Source: Modified from 'Manns Road Upgrade, Stockyard Place, West Gosford to Narara Creek Road, Narara Traffic Survey Analysis' Revision A, dated 20 February 2018, Figure 9

The 2017 hourly traffic volume analysis showed:

- The Manns Road corridor has a typical commuter/commercial pattern with highly pronounced morning and afternoon peak periods, this pattern is similar to the 2016 traffic data
- In general, the morning peak for the Manns Road corridor occurs between 8am and 9am and the evening peak occurs between 3:30pm and 4:30pm
- The traffic profiles for the northbound and southbound directions at both the Dyer Crescent and Merinee Road locations on Manns Road are similar with both AM and PM peaks relatively consistent
- The peak hour traffic profiles for Manns Road north and south of Narara Creek Road are also very similar, with the majority of traffic travelling southbound in the AM peak and northbound in the PM peak
- The catchment north of Dell Road is predominantly residential and the travel patterns in the peak hour resemble the outbound movements in the AM and inbound in the PM peak

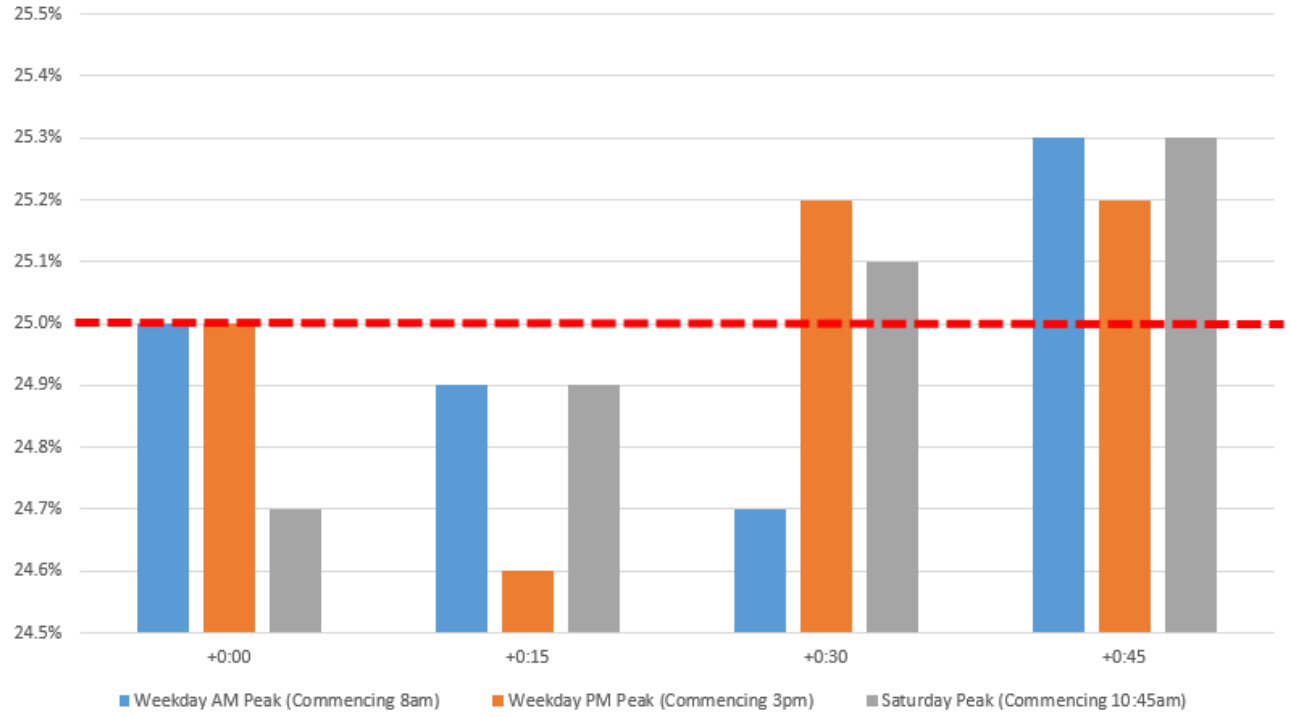
> The catchment south of Dell Road is predominately light industrial and automotive related so the peak travel pattern is different to the residential catchment peak (i.e. peak directions are reversed).

2.6.3 Peak Hour Traffic Distribution

Within a 'peak hour' period, there can be 'micro-peak' periods, which may also be referenced as a 'peak factor'. As an example, a peak hour for a road outside a school may identified within the 8am to 9am period, but if school commences at 9am, then a 'micro-peak' may be present between (for example), 8:30am and 9am.

The intersection count surveys identified the peak hour traffic period for each location. Within each peak hour, a 15-minute peak (i.e. peak factor) was also identified. The average peak hour traffic profile for all of the surveyed intersections was then calculated as shown in **Figure 2-25**. Based on the assessment, peak hour flows are constant. Based on a theoretical 1000 vehicles, a deviation of 0.4% from the 25% line represents, across the network, a 'micro-peak' of just 4 fewer/additional vehicles in any 15-minute period. This indicates there is no 'peak factor' within the network.

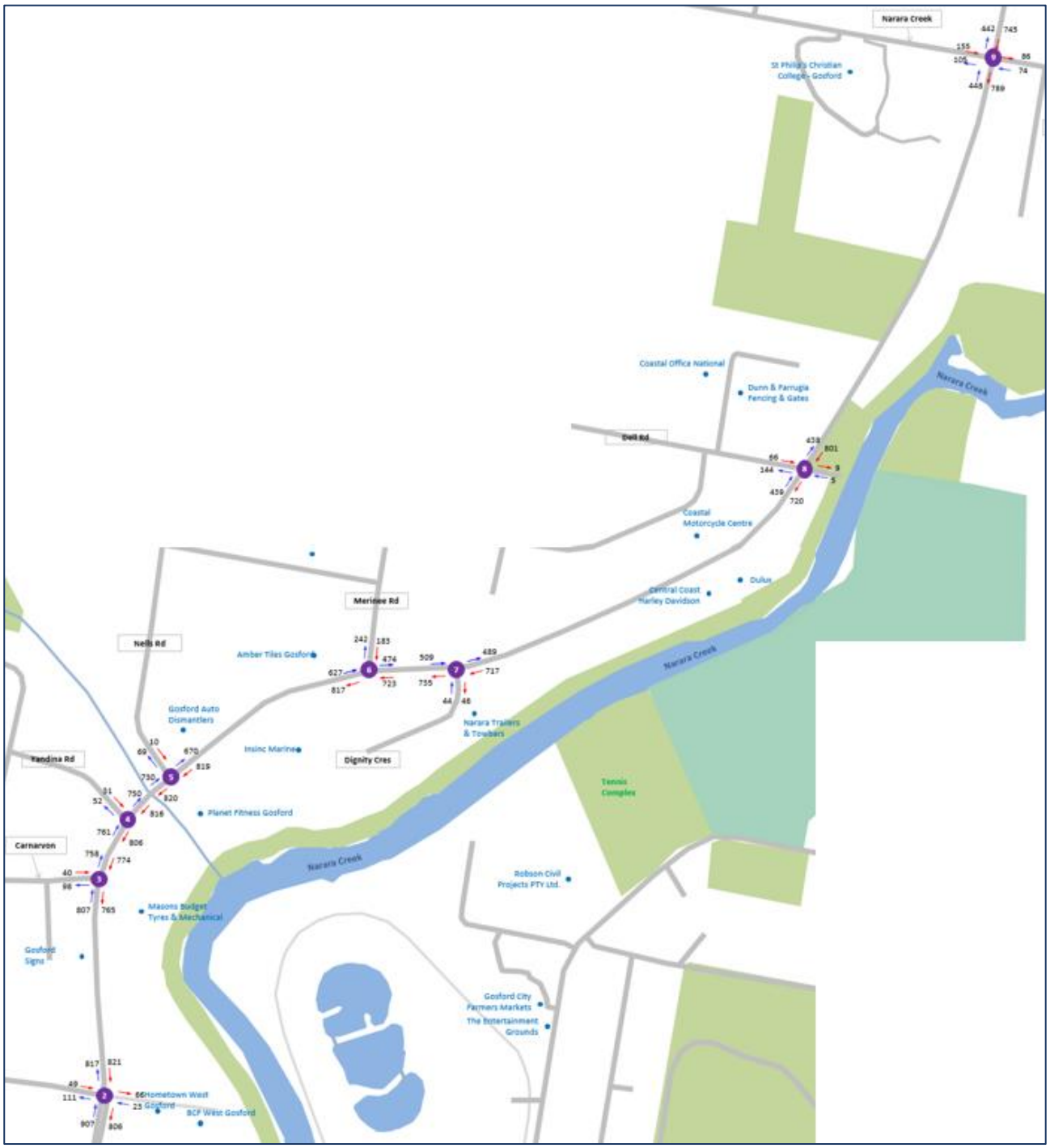
Figure 2-25 Peak Factor Assessment



2.6.4 Intersection turning volumes

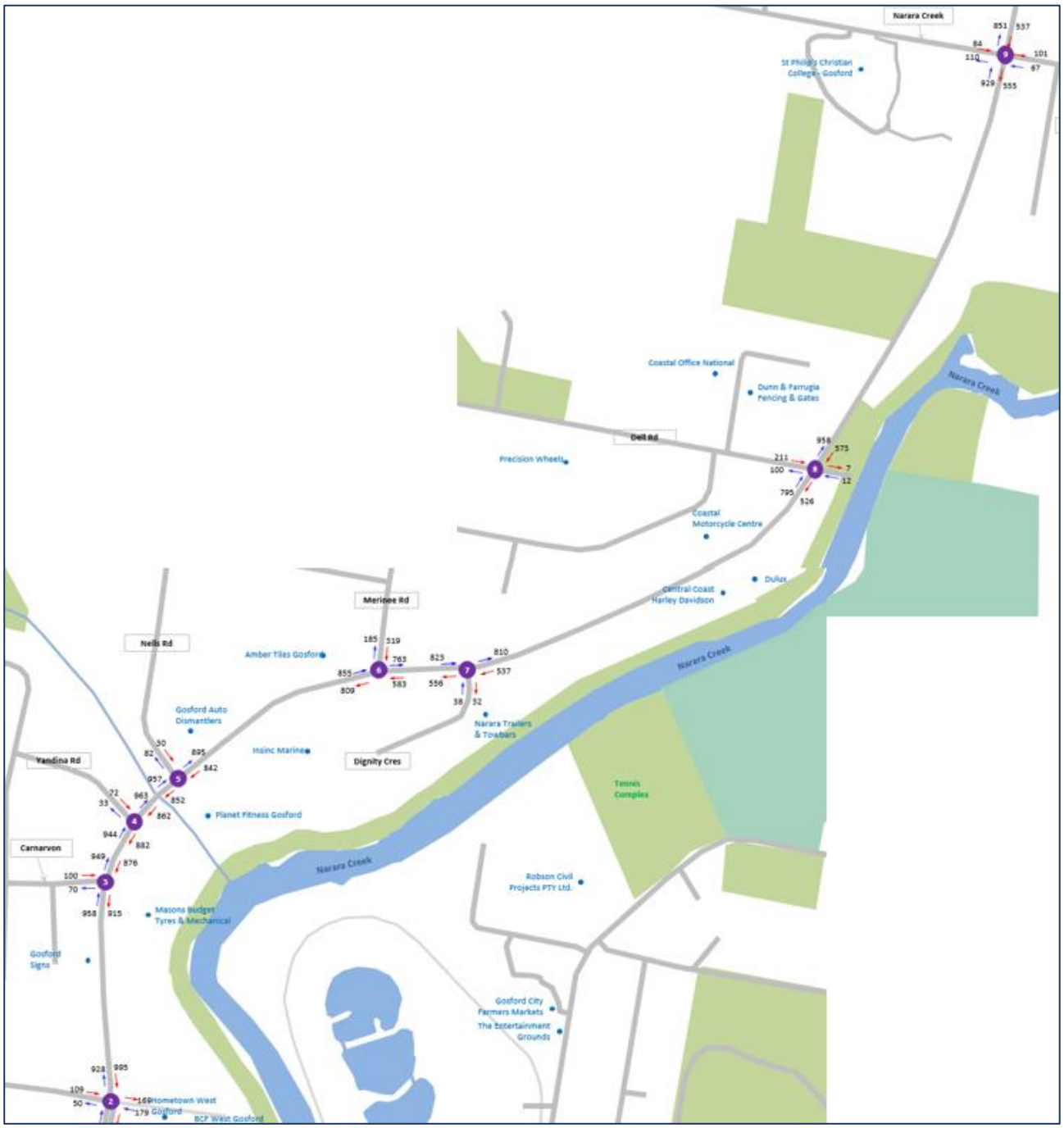
Overall network flows between Stockyard Place and Narara Creek Road are shown in **Figure 2-26** and **Figure 2-27**, for the peak hours commencing 8am and 3:30pm respectively. Detailed results of intersection flows are further discussed in **Section 3**.

Figure 2-26 Network Flow Diagram – Peak hour commencing 8am



Source: Matrix Data

Figure 2-27 Network Flow Diagram – Hour commencing 3:30pm



Source: Matrix Data

2.6.5 Travel Time Analysis

Corridor travel times were identified from analysis of TomTom data collected from commuters travelling along Manns Road corridor in 2016 and via travel time surveys in 2017. The data was segmented between the main intersection from Grieve Close (south of Stockyard Place) and Showground Road (north of Narara Creek Road) along Manns Road. The TomTom data was obtained for March 2016, the same month that the classified intersection counts were undertaken for all of the intersections along Manns Road. The travel time data was analysed for both weekdays and weekends. The travel time survey covered the section of Manns Road from Grieve Close to the Ridge.

In 2017, the travel time data was collected manually on Manns Road from Central Coast Highway to Showground Road, with GPS devices stationed in a car and a person driving the proposed travel time routes along Manns Road in the morning and evening peak hours. Travel times were recorded for a minimum of 35 runs for the northbound and southbound directions along the Manns Road study corridor.

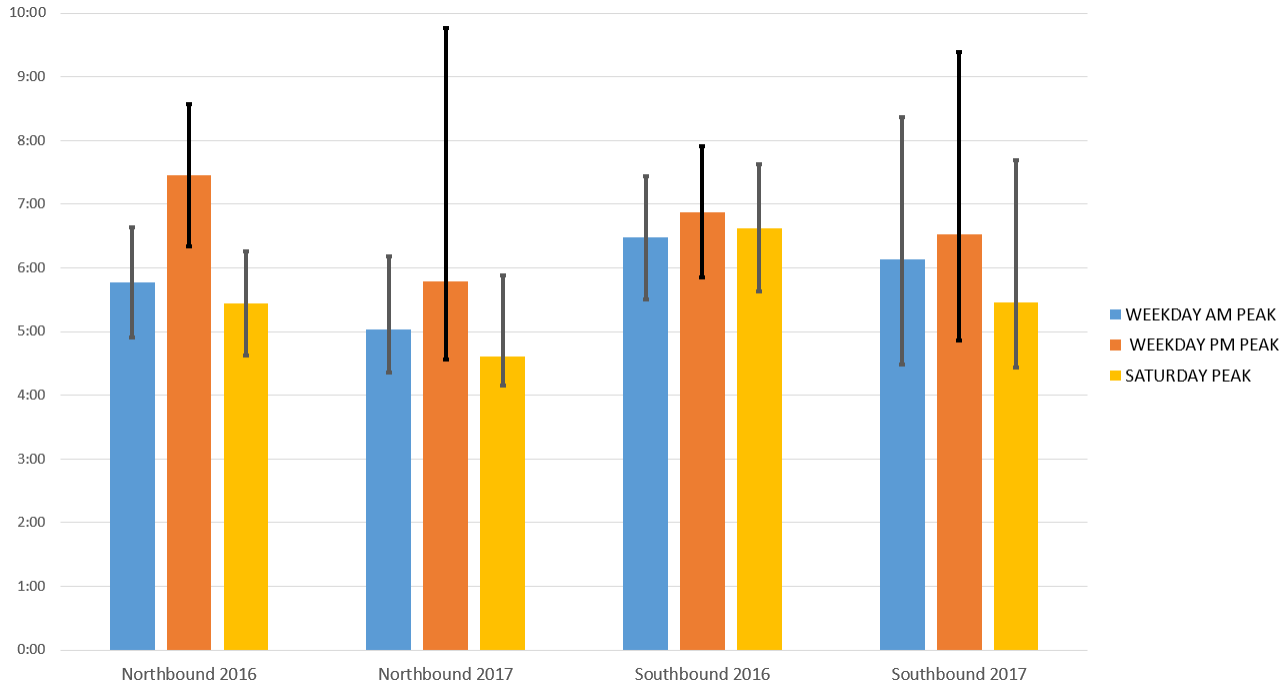
The travel times are shown in **Table 2-6**. A summary box and whisker chart showing the average, minimum and maximum times is shown in **Figure 2-28**.

Table 2-6 Travel times comparison along study corridor

Route	Average (mm:ss)	Max (mm:ss)	Min (mm:ss)
WEEKDAY AM PEAK			
Northbound 2016	5:47	6:39	4:55
Northbound 2017	5:02	6:11	4:22
Difference	**-0:45**	**-0:28**	**-0:33**
Southbound 2016	6:29	7:27	5:31
Southbound 2017	6:08	8:22	4:29
Difference	**-0:21**	**+0:55**	**-0:58**
WEEKDAY PM PEAK			
Northbound 2016	7:28	8:35	6:21
Northbound 2017	5:48	9:46	4:34
Difference	**-1:40**	**+1:11**	**-1:47**
Southbound 2016	6:53	7:55	5:51
Southbound 2017	6:32	9:24	4:52
Difference	**-0:21**	**+1:29**	**-0:59**
SATURDAY PEAK			
Northbound 2016	5:27	6:16	4:38
Northbound 2017	4:37	5:53	4:09
Difference	**-0:50**	**-0:23**	**-0:29**
Southbound 2016	6:38	7:38	5:38
Southbound 2017	5:28	7:42	4:26
Difference	**-1:10**	**+0:04**	**-1:08**

Source: 'Manns Road Upgrade, Stockyard Place, West Gosford to Narara Creek Road, Narara Traffic Survey Analysis' Revision A, dated 20 February 2018 - Table 4, Table 5, Table 6

Figure 2-28 Minimum, average and maximum travel times

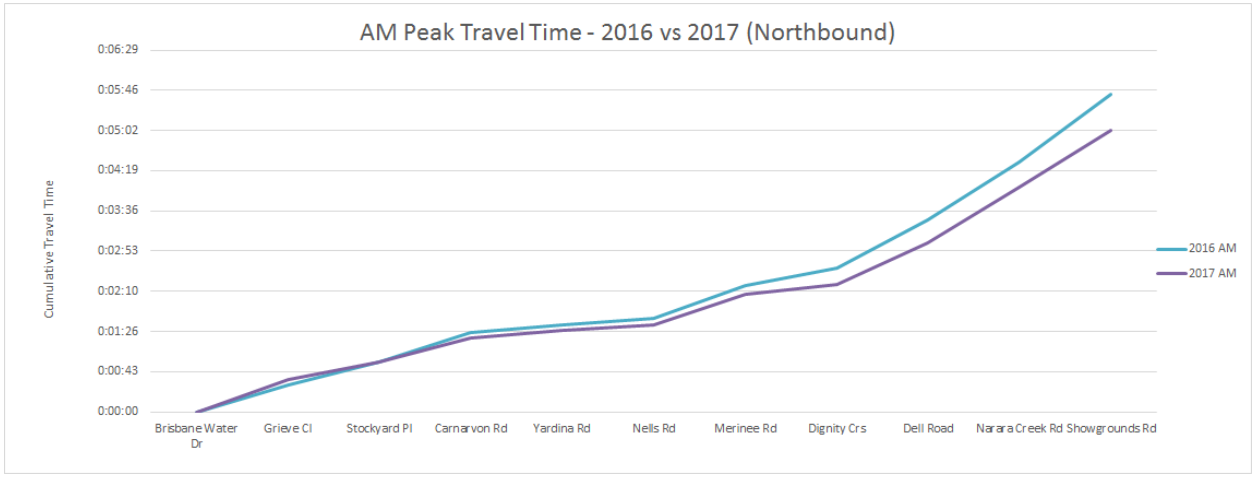


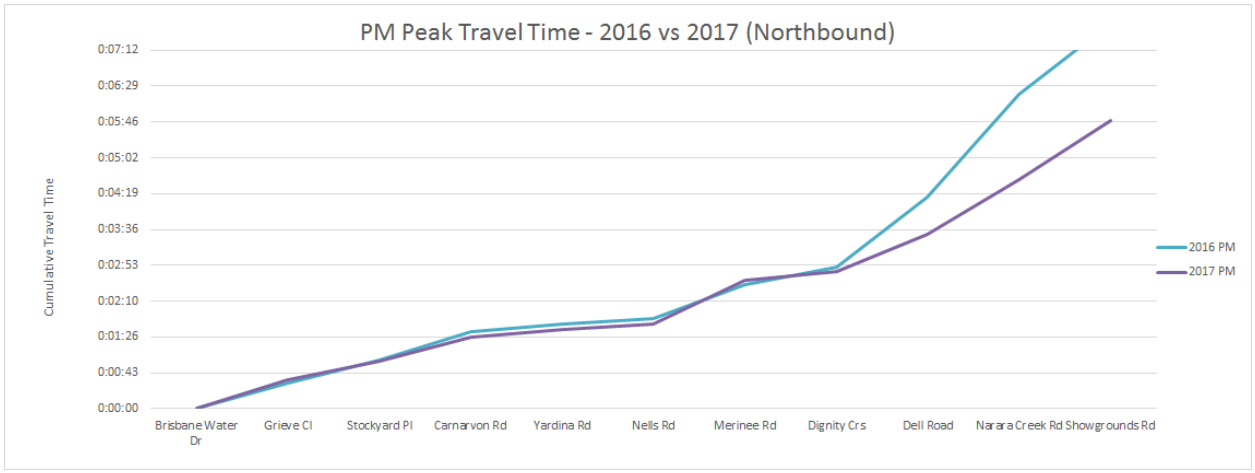
The average travel times recorded for 2017 are less than 2016 average travel times in all three peak periods despite the growth in traffic documented in **Section 2.6.1**.

The pattern of the travel time in 2017 is consistent with the previous year along the corridor. The 2017 PM peak has the highest maximum travel time recorded, however the 2017 average and minimum travel times are less than the 2016 recorded travel times in all peak periods.

Figure 2-29 and **Figure 2-30** illustrate the average travel time comparison plots for the northbound and southbound directions on Manns Road, respectively.

Figure 2-29 Observed Travel Time Northbound Direction





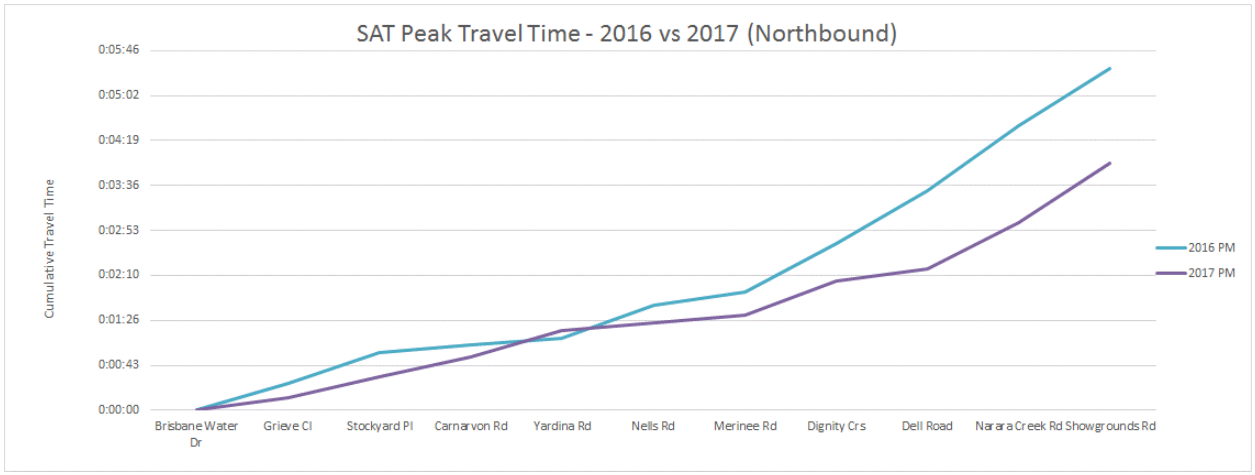
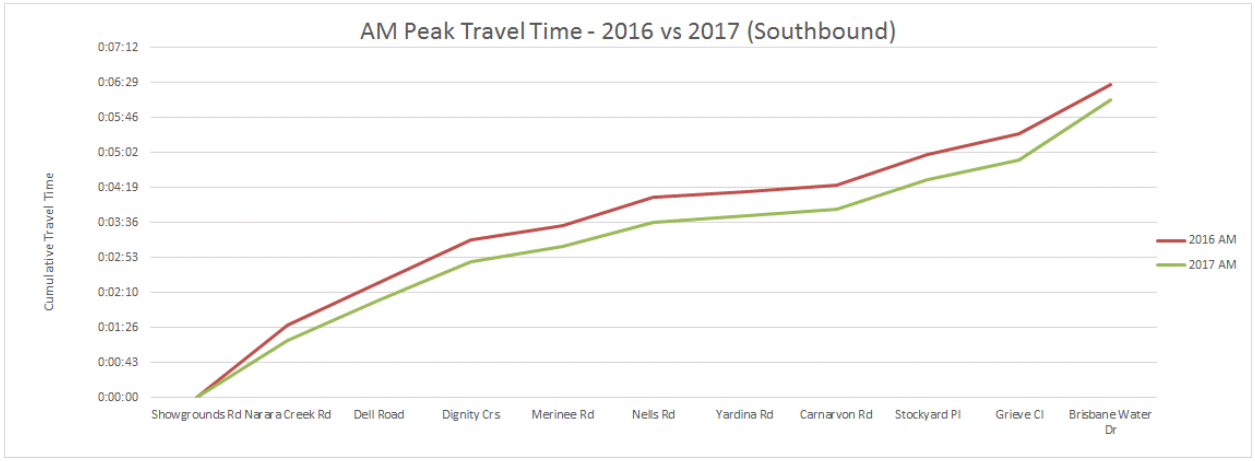
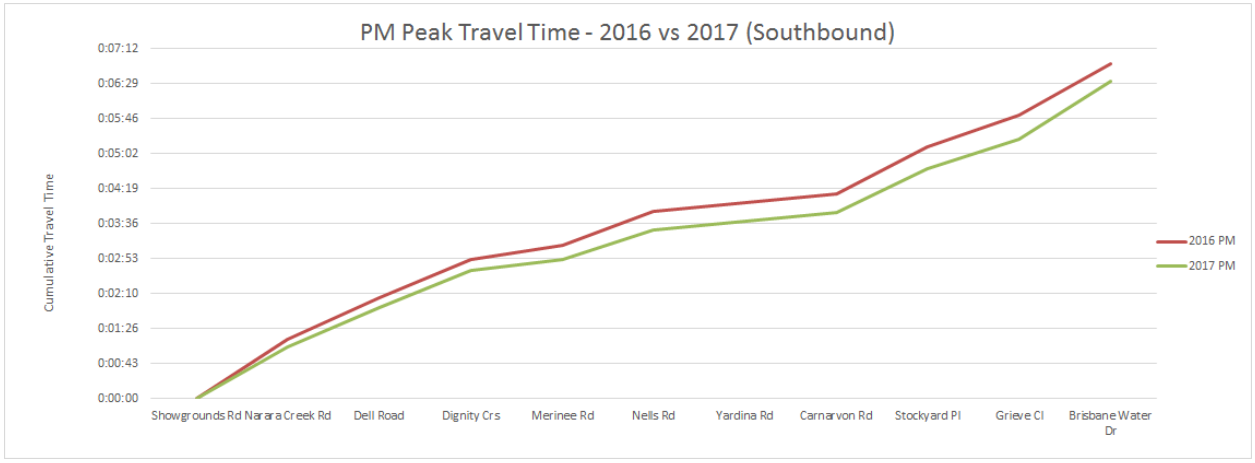
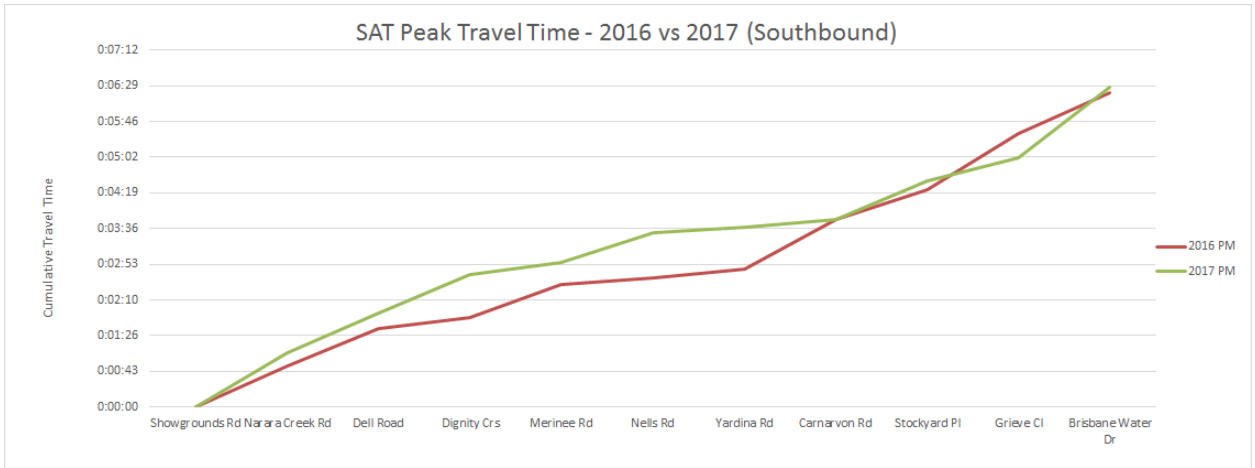


Figure 2-30 Observed Travel Time Southbound Direction







2.6.6 Traffic Survey Summary

The increase in the traffic between 2016 and 2017 on Manns Road on an average weekday is approximately 1,500 vehicles between Dyer Crescent and Merinee Road, and the increase in traffic volumes between Merinee Road and Narara Creek Road over the same period is approximately 940 vehicles. Similarly, north of Narara Creek Road, traffic volumes increased by approximately 800 vehicles from 2016 to 2017.

The growth of traffic between these three sections is approximately 8.2%, 5.5% and 4.8% respectively in the last 21 months, with an average increase in traffic volumes of approximately 6%. In most cases, this growth, experienced in less than two years, exceeds the BTS 10-year growth forecasts for residential and workforce populations between 2016 and 2026.

The hourly traffic profile over the 24-hour surveyed period indicates that the Manns Road corridor has a typical commuter/commercial pattern with pronounced morning and afternoon peak periods. This pattern is consistent across both the 2016 and 2017 traffic data.

A comparison of the 2017 travel time survey results against 2016 TomTom survey data estimated that the current 2017 travel time is less than in 2016, despite the increase in the traffic volume. This suggests that the traffic operation on Manns Road has improved from March 2016, with increases in the underlying traffic volumes. The travel time pattern remains consistent in all the three peak periods.

2.7 Crash Analysis

Roads and Maritime provided crash data for the most recent five-year period until 10 November 2017. Whilst 2017 data was incomplete, this dataset provides a robust and reliable data source for crash history. There were 71 reported crashes on Manns Road between Stockyard Place and the intersection of Manns Road and the Pacific Highway (approximately 1.55km north of Narara Creek Road).

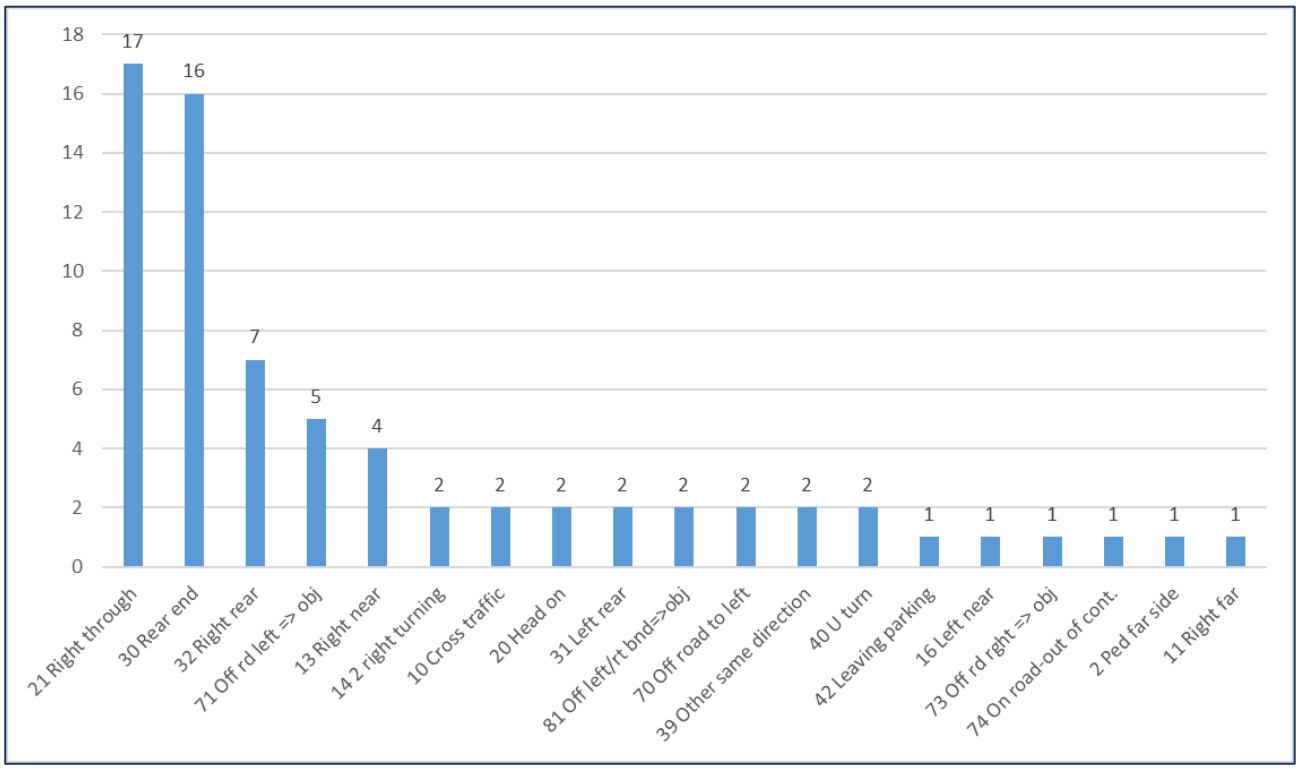
42 of the 71 recorded crashes occurred between Stockyard Place and Narara Creek Road (inclusive of intersections).

The most common crash types reported on the Manns Road study corridor include:

- Right through (RUM code 21) 17 crashes
- Rear end (RUM code 30) 16 crashes
- Right rear (RUM code 32) 7 crashes
- Off road left into object (RUM code 71) 5 crashes
- Right near (RUM code 13) 4 crashes

There five cost common crash types make up 49 of the 71 (69% of all crashes). A further 14 RUM codes have no more than two (2) crashes each. Crash types along Manns Road are shown in **Figure 2-31**.

Figure 2-31 Crash Type by RUM Code



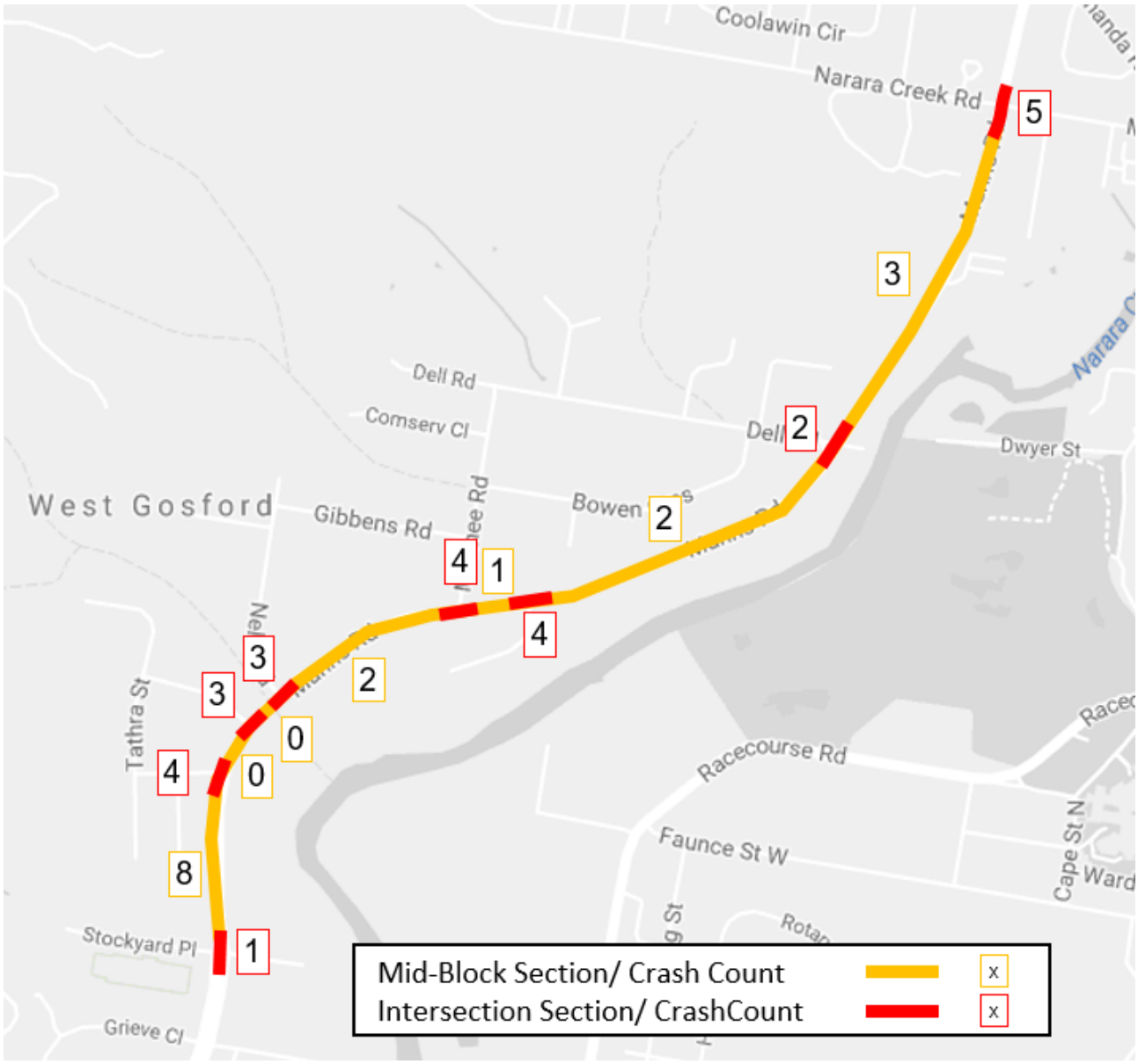
Source: Roads and Maritime Crash Data prepared 10 November 2017

Other characteristics of the Manns Road crashes include (for the full sample size of 71):

- 3 crashes involving vulnerable road users; 2 pedestrian crashes and 1 cyclist crash. A further 8 crashes involved motorbikes and 1 crash involved an emergency vehicle
- There were 0 fatalities, 11 serious injuries, 19 moderate injuries, 3 minor injuries, 4 uncategorised injuries and 34 non-casualties
- 4 crashes were deemed to have speed as a contributing factor, and 2 crashes were deemed to have fatigue as a contributing factor
- 57 crashes occurred with a dry road surface, 14 crashes occurred with a wet road surface (with 8 during rain and 6 during overcast conditions)
- 61 crashes occurred during daylight conditions, 6 crashes during darkness, 3 at dusk and 1 at dawn
- 62 crashes involved multi-vehicle accidents, 9 were single vehicle crashes
- 43 crashes occurred at intersections and 28 occurred at non-intersection locations
- 34 crashes occurred at T-intersections, 27 occurred on 2-way undivided roads, 2 at roundabouts and 1 on a divided road
- 12:00pm to 3:59pm was the period of the day with a significantly overrepresented crash rate. 25 crashes occurred during this 4-hour period (35% of total crashes despite representing just 17% of the hours in a day).

Figure 2-32 separates crashes which occurred within approximately 30 metres (either side) of an intersection and midblock locations within the Manns Road study corridor.

Figure 2-32 Location of crashes within proximity to intersections



Basemap Source: https://snazzymaps.com, accessed 2 May 2018

Of the 42 crashes which occurred between Stockyard Place and Narara Creek Road, 26 occurred at intersections and 16 at mid-block locations. Locations with four or more crashes include:

- Manns Road Mid-block between Stockyard Place and Carnavon Place 8 crashes
- Intersection of Manns Road and Narara Creek Road 5 crashes
- Intersection of Manns Rad and Carnavon Place 4 crashes
- Intersection of Manns Road and Merinee Road 4 crashes
- Intersection of Manns Road and Dignity Crescent 4 crashes

For context and comparison, the intersection of Manns Road and Showground Road (north of the study corridor) recorded 12 crashes during the reported period.

3 Traffic Modelling

3.1 Modelling purpose and scenarios

A traffic model was developed to assess the performance of the existing road network with the study corridor and evaluate the proposed Stage 5 concept design for the future horizon years 2026 and 2036. The traffic model analysis includes current and future traffic volumes, queueing delays, travel time performances, and the operation of the side streets feeding into Manns Road.

The Stage 1 design considers the improvements to the intersections of Manns Road and Stockyard Place, and Manns Road and Narara Creek Road.

The scenarios considered for traffic modelling are the future horizon years, tested under two traffic growth scenarios; low growth traffic and high growth traffic.

3.1.1 Low Traffic Growth

For the low traffic growth scenario, historical traffic volumes along Manns Road corridor and surrounding roads were used to determine a trend in volume growth for Manns Road. The growth rates assumed for Manns Road in the low growth scenario are:

- AM Peak Hour: 1.85% per annum
- PM Peak Hour: 1.30% per annum
- SAT Peak Hour: 1.55% per annum

For the side roads, a growth rate of 0.55% per annum was assumed for traffic demands on Merinee Road and Stockyard Place.

3.1.2 High Traffic Growth

Conversely, for the high growth scenario, the Sydney Traffic Forecast Model (STFM) indicated a growth rate of 1.5% to 2.6% per annum for traffic along Manns Road for the horizon years 2026 and 2036. To study a worst-case future scenario, the traffic modelling assumed a growth rate of 2.4% per annum until 2026, and 2.6% per annum from 2026 to 2036, which was applied to all three peaks for the northbound/southbound demand on Manns Road.

For the side roads, mainly Merinee Road and Grieve Close, the traffic modelling assumed a capacity increase to meet the demand cap on the roads.

3.2 Key Inputs

The main information used for traffic modelling were the geometrical network, the traffic demand (derived from traffic surveys), traffic signal controls, speed limits and public transport lines.

3.3 Software

The traffic assessment used VISSIM micro-simulation modelling software (v10.05). This software models individual vehicle behaviour and interaction with the network and other road users. A microsimulation model is appropriate to assess a congested road network, as it can simulate dynamic queuing conditions visually in 2D and 3D.

3.4 Speed Environment

Regulatory speed signs can be spotted at different points along Manns Road. The speed limit on Manns Road is 60 km/h. A 60 km/h speed profile has been set for the network's entry points on Manns Road with a lower bound of 58 km/h, and an upper bound of 68 km/h. Where school zones exist, mainly on Narara Creek Road, a desired speed decision of 40 km/h was applied during the AM peak hour.

3.5 Key Modelling Assumptions

3.5.1 Road network

The traffic model covers the Manns Road Corridor from north of Showground Road to south of Central Coast Highway. The area of the model is shown in **Figure 3-1**.

Figure 3-1 Model study corridor

Source: Provided

3.5.2 Traffic Demand

Cardno commissioned traffic surveys though Matrix Traffic and Transport Data. These surveys included classified intersection counts by turning movements, and origin-destination surveys. The surveys were used to create the traffic demands for the traffic model based on peak hour profiles for each peak period.

These traffic surveys along Manns Road, were carried on Thursday 7 December and Saturday 9 December 2017.

From the profiles, the peak hours were identified as:

- Weekday:
  - AM Peak Hour: 08:15 to 09:15
  - PM Peak Hour: 15:30 to 16:30
- Weekend: 10:45 to 11:45.

3.5.3 Public Transport

Three bus routes run along Manns Roads. Bus Services 33 and 55 run from Brisbane Water Drive to Narara Creek Road/Maliwa Road and vice versa. Bus Service 36 run north of Narara Creek Road. All services have been included in the simulation.

3.5.4 Roads and Maritime SCATS data

There are five signalised intersections along the modelled Manns Road, and they are:

- Manns Road / Central Coast Highway (signalised TCS 1453, Subsystem 77)
- Manns Road / Grieve Close (signalised TCS 4522, Subsystem 85)
- Manns Road / Stockyard Place (signalised TCS 3471, Subsystem 56)
- Manns Road / Merinee Road (signalised TCS 4241, Subsystem 58)
- Manns Road / Narara Creek Road (signalised TCS 3758, Subsystem 81).

The received Intersection Diagnostic Monitor (IDM) data for these signals indicated that they work on different subsystems. Accordingly, the signals (except Manns Road / Central Coast Highway which was modelled as a fixed time signal) were modelled using the VISSIM add-on VISVAP, which enables vehicle actuation and overlapping of phases, with maximum phase times considered as the average running time over the peak hour. Offset between intersections was not reflected, considering that the intersections of Manns Road with Merinee Road and Narara Creek Road are far from any signal system.

3.5.5 Vehicle Types and Driving Behaviour

Reflective of the conducted surveys vehicle classifications, three vehicle types were modelled to traverse the network. Table 3-1 details the characteristics of the different vehicle types.

Table 3-1 Vehicle Types

Vehicle Type	Dimensions	Driving Behaviour
Car	3.75 m to 4.76 m	Urban (motorized)
HGV	10.22 m	Urban (motorized)
Bus	11.54 m	Urban (motorized)

In essence, all vehicle types, although having speed profiles, follow the same driving behaviour, inclusive of look ahead and look back distances, safety distances, and reactions to signal control.

3.6 Base Case Model Calibration and Validation

3.6.1 Calibration

For the base model (2017), network wide calibration was tested against RMS Modelling Guidelines for model calibration. The model GEH statistics indicate over 90% of intersections' GEH values are less than 5 in the Weekday AM, PM and Weekday SAT peak modelled periods. The comparison between the modelled flows and the survey flows are shown in **Table 3-2**.

Table 3-2 Base Model vs. Observed Turn Counts GEH Statistics

GEH Statistics	Weekdays AM	Weekday PM	Weekend
GEH less than 5	91%	90%	95%
GEH between 5 and 10	9%	10%	5%
Calibration	✓	✓	✓

The model calibration results indicate that an exceptional standard of model has been achieved for all time periods (AM, PM and Saturday) as all turning movement counts have a calculated GEH statistic of less than 5.

The main findings during the model calibration were:

- The GEH statistic is below 5 for 91, 90 and 95 per cent of the turning movements in all AM, PM and Saturday peak periods respectively.
- The GEH statistic is below 10 for 100 per cent of the turning movements in all AM, PM and Saturday peak periods.

3.6.2 Validation

The observed overall Manns Road journey travel times and their associated validation criteria in the AM, PM, and Saturday Peaks are detailed and compared with the average base model journey times in **Table 3-3**, **Table 3-4** and **Table 3-5**. The results indicate the modelled travel times are comparable to the observed travel time surveyed on site, and are within validation criteria limits as per RMS Modelling Guidelines.

Table 3-3 AM Peak Hour Travel Times Validation

Route	Observed (min:sec)					Modelled	Validated
	-1:00	-15%	Average	+15%	+1:00		
Northbound	04:21	04:33	05:21	06:09	06:21	05:30	✓
Southbound	05:39	05:39	06:39	07:39	07:39	06:22	✓

Table 3-4 PM Peak Hour Travel Times Validation

Route	Observed (min:sec)					Modelled	Validated
	-1:00	-15%	Average	+15%	+1:00		
Northbound	05:12	05:16	06:12	07:08	07:12	06:01	✓
Southbound	07:00	06:48	08:00	09:12	09:00	08:07	✓

Table 3-5 Saturday Peak Hour Travel Times Validation

Route	Observed (min:sec)					Modelled	Validated
	-1:00	-15%	Average	+15%	+1:00		
Northbound	05:01	05:07	06:01	06:55	07:01	05:24	✓
Southbound	06:46	06:36	07:46	08:56	08:46	06:51	✓

4 Base Case (Do-nothing) Traffic Modelling Assessment

4.1 Existing Operational Assessment

4.1.1 Existing Network Performance

The performance of a road network can be determined by evaluating the vehicle kilometres travelled (VKT), vehicle hours travelled (VHT), the average speed of vehicles through the model area and the unreleased latent demand. **Table 4-1** shows that in a typical peak hour on Manns Road, approximately 10,000km are travelled by all vehicles, at an average speed of approximately 32km/hr, approximately half the posted speed limit.

Table 4-1 Existing network performance

Existing Network Performance			
Peak Hour	**AM Peak**	**PM Peak**	**SAT Peak**
VKT (km)	9,900	10,756	9,961
VHT (hrs)	289	357	301
Average Speed (km/hr)	34	30	33
Latent Demand	0	1	0
% Latent Demand of All Demand	0%	0%	0%

Table 4-1 shows that approximately 9 per cent fewer kilometres are driven in a typical AM peak compared to a PM peak, and that an AM peak is more comparable to a Saturday peak than a PM peak.

4.1.2 Existing Mid-blocking Capacity

As presented in the *Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis (Section 5.2),* the mid-block traffic conditions associated with the various levels of service for urban arterial roads with interrupted flow conditions, are described in *HCM 2010* as follows:

- **LOS A** describes primarily free-flow operation. Vehicles are completely unimpeded in their ability to manoeuvre within the traffic stream. Control delay at the boundary intersections is minimal. The travel speed exceeds 85% of the base free-flow speed.
- **LOS B** describes reasonably unimpeded operation. The ability to manoeuvre within the traffic stream is only slightly restricted and control delay at the boundary intersections is not significant. The travel speed is between 67% and 85% of the base free-flow speed.
- **LOS C** describes stable operation. The ability to manoeuvre and change lanes at mid segment locations may be more restricted than at LOS B. Longer queues at the boundary intersections may contribute to lower travel speeds. The travel speed is between 50% and 67% of the base free-flow speed.
- **LOS D** indicates a less stable condition in which small increases in flow may cause substantial increases in delay and decreases in travel speed. This operation may be due to adverse signal progression, high volume, or inappropriate signal timing at the boundary intersections. The travel speed is between 40% and 50% of the base free-flow speed.
- **LOS E** is characterised by unstable operation and significant delay. Such operations may be due to some combination of adverse progression, high volume, and inappropriate signal timing at the boundary intersections. The travel speed is between 30% and 40% of the base free-flow speed.
- **LOS F** is characterised by flow at extremely low speed. Congestion is likely occurring at the boundary intersections, as indicated by high delay and extensive queuing. The travel speed is 30% or less of the base free-flow speed. **LOS F** is assigned to the subject direction of travel if the through movement at one or more boundary intersections has a volume-to-capacity ratio greater than 1.0.

The mid-block Level of Service thresholds for urban arterial roads with interrupted flow conditions are summarised below in **Table 4-2**.

Table 4-2 Level of Service Criteria for Automobile Mode on Urban Streets

LOS For Volume over Capacity ≤ 1	Percentage Difference	Travel Speed Threshold by Base Free-Flow Speed (km/h)					
		90	80	70	60	50	40
A	>80%	>72	>64	>56	>48	>40	>32
B	>67%	>60	>54	>47	>40	>34	>27
C	>50%	>45	>40	>35	>30	>25	>20
D	>40%	>36	>32	>28	>24	>20	>16
E	>30%	>27	>24	>21	>18	>15	>12
F	≤30%	≤27	≤24	≤21	≤18	≤15	≤12

The existing Level of Service for Manns Road at three locations in the worst peak hour is shown in **Table 4-3**.

Table 4-3 Existing Level of Service for Manns Road corridor – Worst Peak (PM Peak Hour)

Section	Travel Speed	Travel Speed/FFS	LOS
Stockyard - SB	17	28%	F
Stockyard - NB	52	87%	A
Merinee - WB	60	100%	A
Merinee - EB	60	100%	A
Narara Creek - SB	59	98%	A
Narara Creek - NB	43	72%	B

This indicates congestion at the southern end of Manns Road, where the travel speed, especially that during PM Peak, drops significantly due to the increased traffic volume in comparison to the available road capacity.

4.1.3 Existing Intersections Assessment

Intersection performance along the Manns Road study corridor was modelled. The performance of the existing road network is largely dependent on the operating performance of intersections which form critical capacity control points. The 'Level of Service' (LoS) is the standard measure used to assess the operational performance of the network and intersections. Level of Service is ranked from LoS A to LoS F, with LoS A representing the best performance and LoS F the worst. The assessment of intersection operation is based on criteria defined by Roads and Maritime in the *RTA Guide to Traffic Generating Development* 2002, and outlined in **Table 4-4**. The existing intersection assessment is presented in **Table 4-5** and shown illustratively in **Figure 4-1**.

Table 4-4 Level of Service Criteria for Intersections

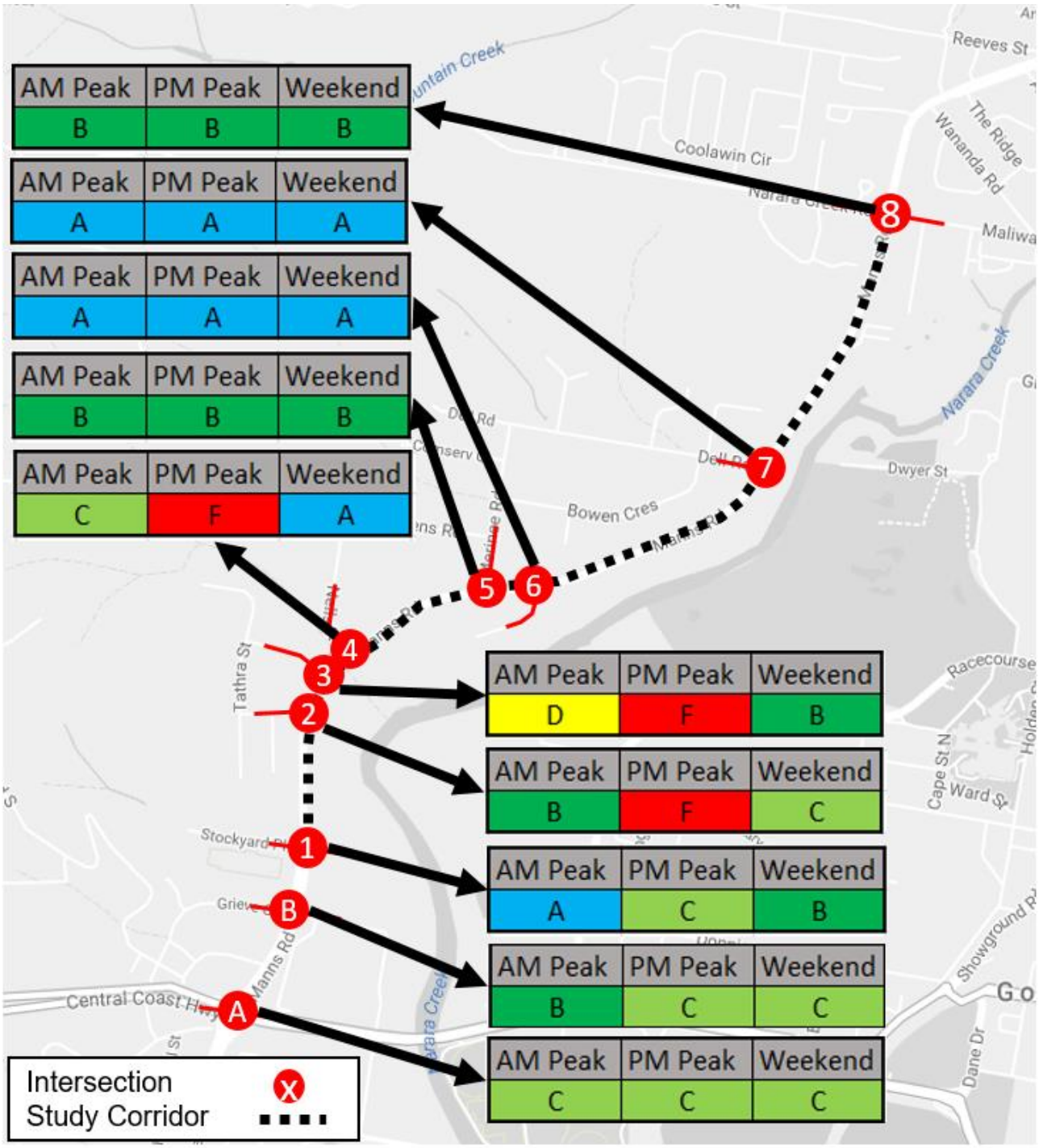
Level of Service (LoS)	Average Delay per Vehicle (sec)	Traffic Signals, Roundabouts	Give way, Stop Sign
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; incidents would cause excessive delays at signals. Roundabouts require other control modes	At capacity, requires other control mode
F	>70	Over capacity; unstable operation	Over capacity; unstable operation

Table 4-5 Existing Intersection Assessment(ID matches **Section 2.1.2**)

ID	Control	Intersection	AM		PM		Weekend	
			Delay	LOS	Delay	LOS	Delay	LOS
A	Signals	Manns Rd-Central Coast Hwy	**41**	**C**	**39**	**C**	**42**	**C**
B	Signals	Manns Rd-Grieve Cl	**28**	**B**	**36**	**C**	**33**	**C**
1	Signals	Manns Rd-Stockyard Pl	**14**	**A**	**31**	**C**	**25**	**B**
2	Priority	Manns Rd-Carnarvon Rd	**19**	**B**	**200**	**F**	**31**	**C**
3	Priority	Manns Rd-Yandina Rd	**55**	**D**	**97**	**F**	**18**	**B**
4	Priority	Manns Rd-Nells Rd	**40**	**C**	**81**	**F**	**6**	**A**
5	Signals	Manns Rd-Merinee Rd	**15**	**B**	**20**	**B**	**19**	**B**
6	Priority	Manns Rd-Dignity Cres	**11**	**A**	**10**	**A**	**11**	**A**
7	Priority	Manns Rd-Dell Rd	**9**	**A**	**9**	**A**	**4**	**A**
8	Signals	Manns Rd-Narara Creek Rd	**19**	**B**	**17**	**B**	**16**	**B**

Delay shown in seconds, and LOS based on output of delay compared to Table 4-4

Figure 4-1 Visualisation of existing intersection assessment



Basemap Source: https://snazzymaps.com, accessed 2 May 2018

The summary in **Table 4-5** shows that generally, the intersections at the northern and southern extents of the study corridor function well with LoS typically being C or better (A, B or C). The *RTA Guide to Traffic Generating Development 2002*, considers intersections to be operating well at LoS metrics of D or better (A, B, C or D).

Through the middle of the study corridor, there is some variance with three consecutive intersections operating at LoS F during the PM peak (intersections 2,3 and 4). In the AM peak, these intersections operate at LoS C, D and B respectively. Intersections along the route operate at LoS C or better during the weekend peak hour.

The intersections with LoS Fare poorly performing due to high proportions of vehicles turning right during high vehicular flow periods. The lack of acceleration lanes and the high proportions of heavy vehicles

originating from the industrial lands of West Gosford further contribute to the poor function of the intersections, especially during the PM peak period.

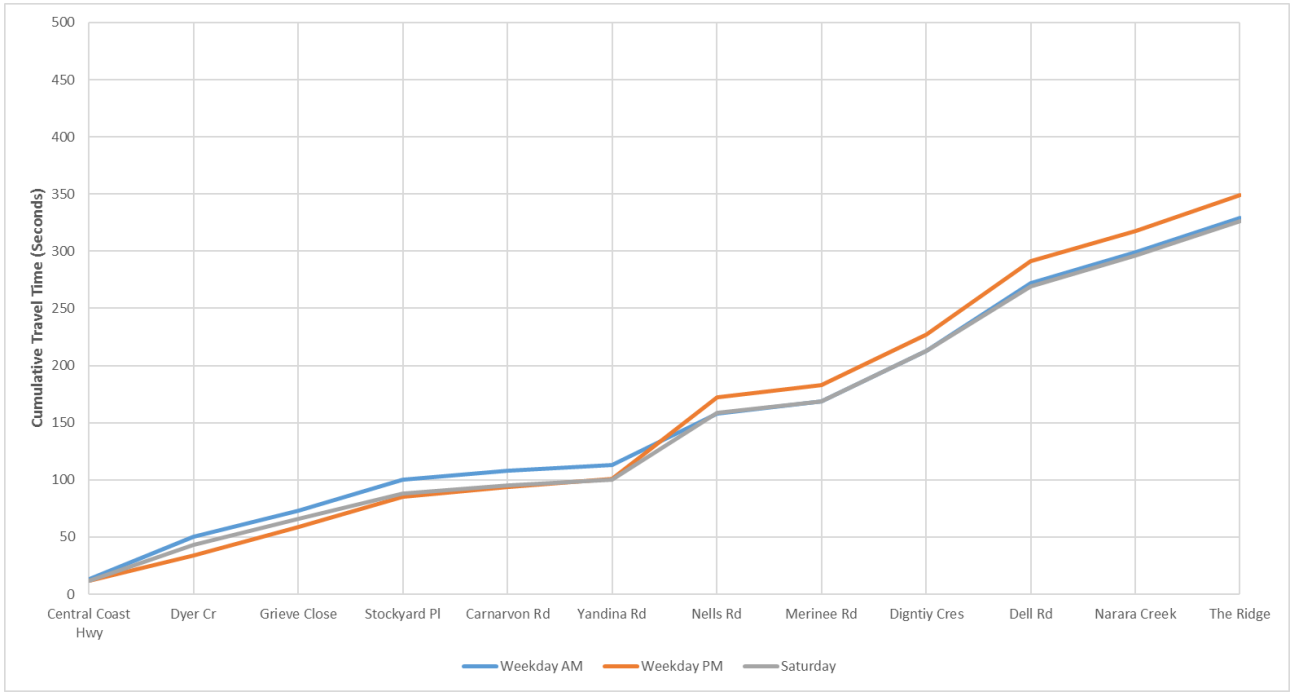
4.1.4 Existing Travel Time Performance

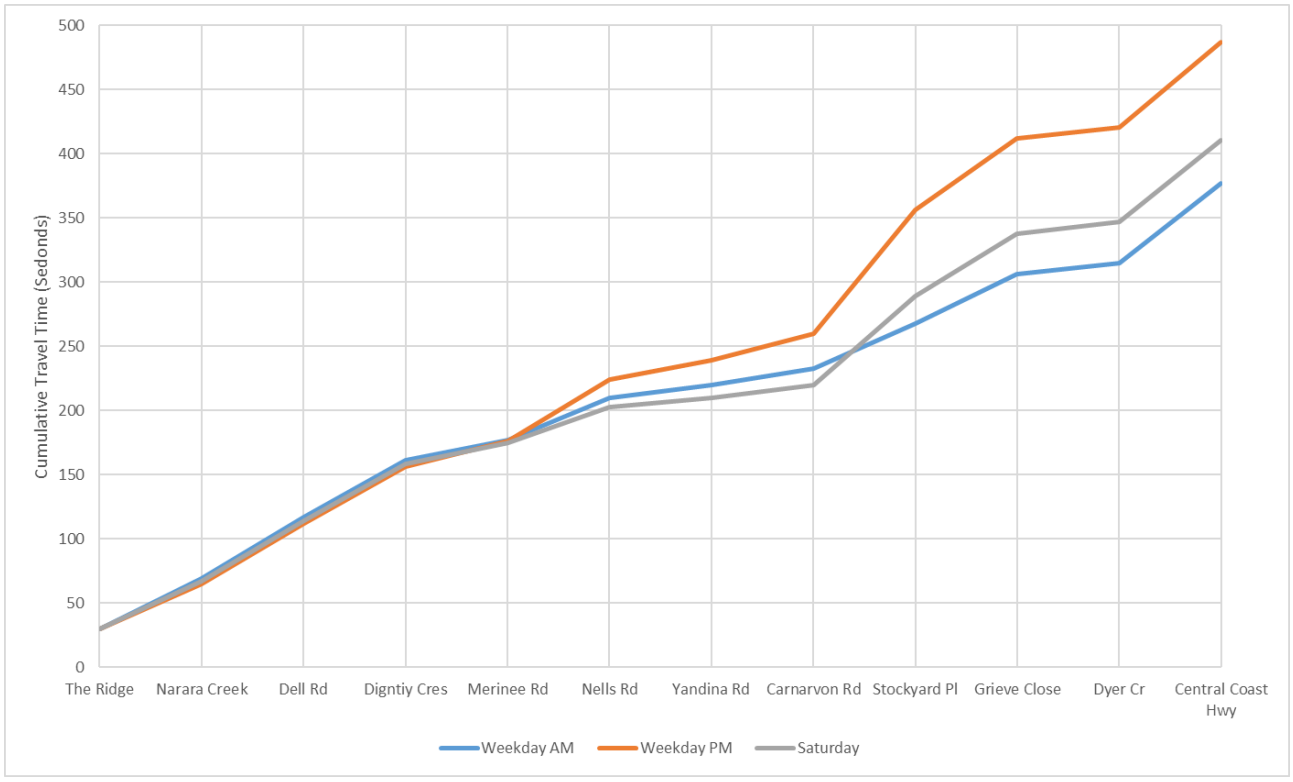
The model output estimates travel times for the study corridor. These modelled travel times can be compared to the surveys undertaken and previously described in **Section 2.6.5**. The modelled travel times by corridor segment are shown in **Table 4-6**. Modelled travel times along the study corridor are shown in **Figure 4-2**. The model data shows typical northbound journeys are approximately 5 to 6 minutes, whilst southbound journeys are approximately 6 to 8 minutes.

Table 4-6 Modelled section travel times

Direction	Travel Time Route Name	Modelled Travel Time (s)		
		AM	PM	Sat
Northbound	Central Coast Highway to Dyer Crescent	13	12	12
	Dyer Crescent to Grieve Close	37	22	31
	Grieve Close to Stockyard Place	23	25	23
	Stockyard Place to Carnarvon Road	27	26	22
	Carnarvon Road to Yandina Road	8	9	7
	Yandina Road to Nells Road	5	7	5
	Nells Road to Merinee Road	45	71	59
	Merinee Road to Dignity Crescent	11	11	10
	Dignity Crescent to Dell Road	44	44	44
	Dell Road to Narara Creek	59	64	56
	Narara Creek to the Ridge	27	27	27
	The Ridge to Showground Road	30	31	30
	Central Coast Hwy to Showground Road NB	**330**	**361**	**324**
Southbound	Showground Road to The Ridge	30	30	30
	The Ridge to Narara Creek	39	35	37
	Narara Creek to Dell Road	48	47	47
	Dell Road to Dignity Crescent	44	44	44
	Dignity Crescent to Merinee Road	16	20	17
	Merinee Road to Nells Road	33	48	28
	Nells Road to Yandina Road	10	15	7
	Yandina Road to Carnarvon Road	13	21	10
	Carnarvon Road to Stockyard Place	35	96	69
	Stockyard Place to Grieve Close	38	56	49
	Grieve Close to Dyer Crescent	9	9	9
	Dyer Crescent to Central Coast Highway	62	66	64
	Showground Road to Central Coast Highway SB	**382**	**487**	**411**

Figure 4-2 Modelled existing corridor travel times (scale in each chart has been standardised)





4.2 Future Base Case Operational Assessment

4.2.1 Future Network Performance

Future traffic scenarios were modelled for years 2026 and 2036 with the existing road network, these outputs are shown in **Table 4-7** and **Table 4-8** respectively, An illustration showing the change in VKT from current demand under the different scenarios is shown in **Figure 4-3**.

Table 4-7 2026 Network Performance Base Case

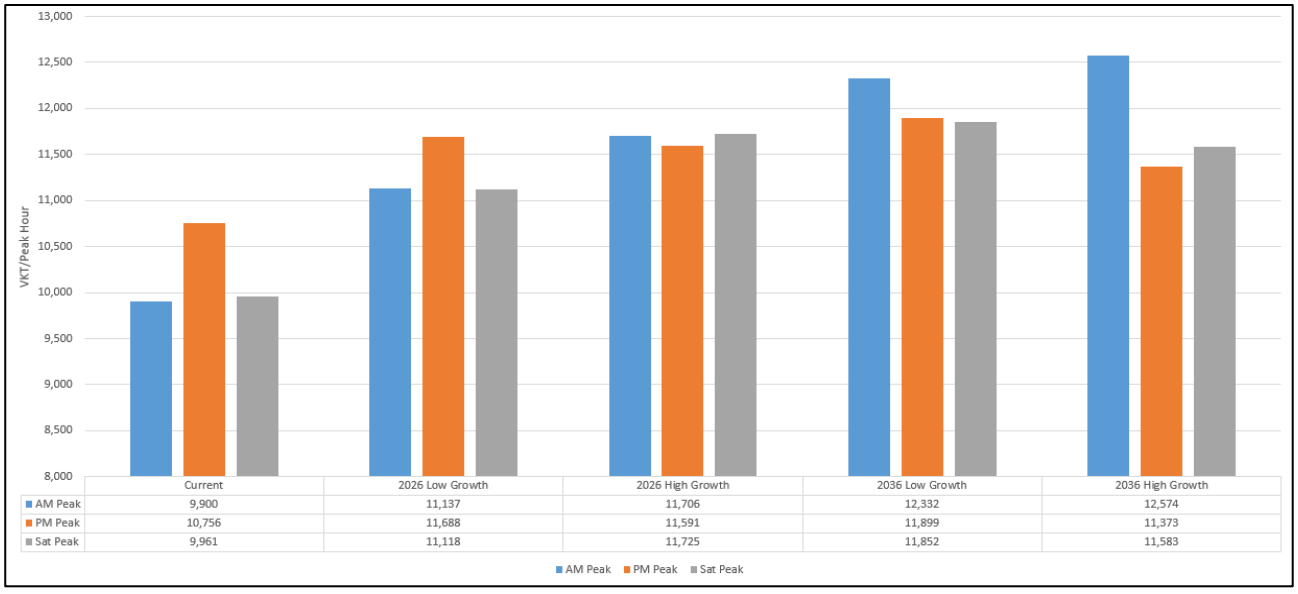
2026	Low Growth Scenario			High Growth Scenario		
	AM Peak	PM Peak	SAT Peak	AM Peak	PM Peak	SAT Peak
VKT (km)	11,137	11,688	11,118	11,706	11,591	11,725
VHT (hrs)	344	464	394	432	798	591
Average Speed (km/hr)	32	25	28	27	15	20
Latent Demand	1	23	34	0	313	143
% Latent Demand of All Demand	0%	0%	0%	0%	3%	2%

Table 4-8 2036 Network Performance Base Case

2036	Low Growth Scenario			High Growth Scenario		
	AM Peak	PM Peak	SAT Peak	AM Peak	PM Peak	SAT Peak
VKT (km)	12,332	11,899	11,852	12,574	11,373	11,583
VHT (hrs)	516	724	609	824	1,080	904
Average Speed (km/hr)	24	17	20	16	11	13
Latent Demand	121	437	424	1136	4603	3239
% Latent Demand of All Demand	1%	4%	5%	11%	38%	29%

In some instances, the VKT for low growth scenarios exceeds the VKT for high growth scenarios (2026 PM). This is attributable to agglomeration benefits arising from more intensive development in the vicinity of the study corridor.

Figure 4-3 Growth in VKT with base case



4.2.2 Base Case Mid-blocking Capacity

Table 4-9 shows the base case mid-block capacity at three locations on Manns Road in the future year scenarios. The table indicates overall worsening conditions at the location near Stockyard Place.

Table 4-9 Base Case Level of Service for Manns Road corridor – Worst Peak (PM Peak Hour)

Section	Travel Speed (km/h)				Travel Time / FFS				LOS			
	2026		2036		2026		2036		2026		2036	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Stockyard - SB	16	13	14	12	27%	22%	23%	20%	F	F	F	F
Stockyard - NB	21	15	14	14	35%	25%	23%	23%	E	F	F	F
Merinee - WB	54	7	10	5	90%	12%	17%	8%	A	F	F	F
Merinee - EB	60	60	60	60	100%	100%	100%	100%	A	A	A	A
Narara Creek - SB	53	40	49	7	88%	67%	82%	12%	A	B	A	F
Narara Creek - NB	34	31	32	25	57%	52%	53%	42%	C	C	C	D

4.2.3 Future Travel Time

Future travel times have been modelled for the low and high growth scenarios in the year 2026. **Table 4-10** shows the segment travel times along the study corridor in 2026.

Table 4-10 2026 modelled corridor travel times for low and high growth scenarios with base case

2026	Travel Time Route Name	Low Growth Modelled travel times – (s)			High Growth Modelled travel times – (s)		
		AM	PM	Sat	AM	PM	Sat
Northbound	Central Coast Highway to Dyer Crescent	14	12	13	14	67	12
	Dyer Crescent to Grieve Close	42	23	35	42	94	33
	Grieve Close to Stockyard Place	23	39	24	25	150	30
	Stockyard Place to Carnarvon Road	30	77	24	32	137	56
	Carnarvon Road to Yandina Road	8	21	10	8	26	25
	Yandina Road to Nells Road	5	17	10	6	20	22
	Nells Road to Merinee Road	48	110	101	56	120	127
	Merinee Road to Dignity Crescent	13	11	11	17	12	12
	Dignity Crescent to Dell Road	44	45	44	45	45	44
	Dell Road to Narara Creek	58	62	57	61	63	56
	Narara Creek to the Ridge	27	27	27	27	29	27
	The Ridge to Showground Road	31	31	30	30	36	31
	Central Coast Hwy to Showground Rod NB	**340**	**490**	**383**	**362**	**743**	**467**
Southbound	Showground Road to The Ridge	30	30	30	31	66	30
	The Ridge to Narara Creek	42	37	37	45	78	39
	Narara Creek to Dell Road	48	47	47	77	179	49
	Dell Road to Dignity Crescent	49	57	44	132	421	89
	Dignity Crescent to Merinee Road	20	38	17	35	108	41
	Merinee Road to Nells Road	47	99	34	83	168	103
	Nells Road to Yandina Road	13	21	8	18	30	21
	Yandina Road to Carnarvon Road	14	26	13	19	36	27
	Carnarvon Road to Stockyard Place	36	100	87	38	136	116
	Stockyard Place to Grieve Close	42	58	58	44	92	54
	Grieve Close to Dyer Crescent	9	9	9	9	9	9

	Dyer Crescent to Central Coast Highway	61	69	65	66	64	67
	Showground Road to Central Coast Highway SB	**415**	**588**	**449**	**603**	**970**	**637**

Table 4-10 shows that in most instances, end-to-end peak hour journey times will increase by a magnitude of up to approximately 200% with no infrastructure upgrades. In particular, southbound weekday PM trips are modelled to deteriorate in journey time from a current 8 minutes (487 seconds) to 16 minutes (970 seconds).

Future travel times were also modelled for the low and high growth scenarios in the year 2036. **0** shows the segment travel times along the study corridor. 2036 modelled corridor travel times for low and high growth scenarios with base case

2036	Travel Time Route Name	Low Growth			High Growth		
		AM	PM	Sat	AM	PM	Sat
Northbound	Central Coast Highway to Dyer Crescent	14	61	13	18	127	13
	Dyer Crescent to Grieve Close	37	88	34	56	161	35
	Grieve Close to Stockyard Place	23	152	49	29	170	71
	Stockyard Place to Carnarvon Road	32	144	114	43	143	131
	Carnarvon Road to Yandina Road	8	28	30	11	27	31
	Yandina Road to Nells Road	6	21	24	9	20	24
	Nells Road to Merinee Road	60	124	129	87	122	128
	Merinee Road to Dignity Crescent	17	13	13	21	12	12
	Dignity Crescent to Dell Road	45	45	44	80	45	46
	Dell Road to Narara Creek	60	62	57	194	70	82
	Narara Creek to the Ridge	29	27	27	149	38	77
	The Ridge to Showground Road	38	31	30	193	53	115
	Central Coast Hwy to Showground Rod NB	**365**	**751**	**550**	**802**	**894**	**720**
Southbound	Showground Road to The Ridge	43	37	30	142	247	175
	The Ridge to Narara Creek	61	52	39	125	244	177
	Narara Creek to Dell Road	97	91	53	186	450	287
	Dell Road to Dignity Crescent	151	251	95	204	470	291
	Dignity Crescent to Merinee Road	37	81	40	42	98	62
	Merinee Road to Nells Road	85	143	113	92	162	140
	Nells Road to Yandina Road	18	27	21	19	28	24
	Yandina Road to Carnarvon Road	18	32	28	19	33	32
	Carnarvon Road to Stockyard Place	37	121	122	39	132	131
	Stockyard Place to Grieve Close	43	77	67	49	89	59
	Grieve Close to Dyer Crescent	9	9	9	9	9	9
	Dyer Crescent to Central Coast Highway	68	66	63	65	63	69
	Showground Road to Central Coast Highway SB	**659**	**833**	**646**	**954**	**1,505**	**1,258**

The figures above indicate that the High Growth PM Peak scenario experiences the highest increase in journey times for both northbound and southbound directions, with travel times increasing up to 25 minutes for southbound direction. The consistent surge in travel time reflects the lack of capacity Manns Road is expected to face with the high growth assumptions for 2036, when the road experiences gridlock conditions for vehicles travelling southbound towards Central Coast Highway.

4.2.4 Future Intersection Base Case Scenario

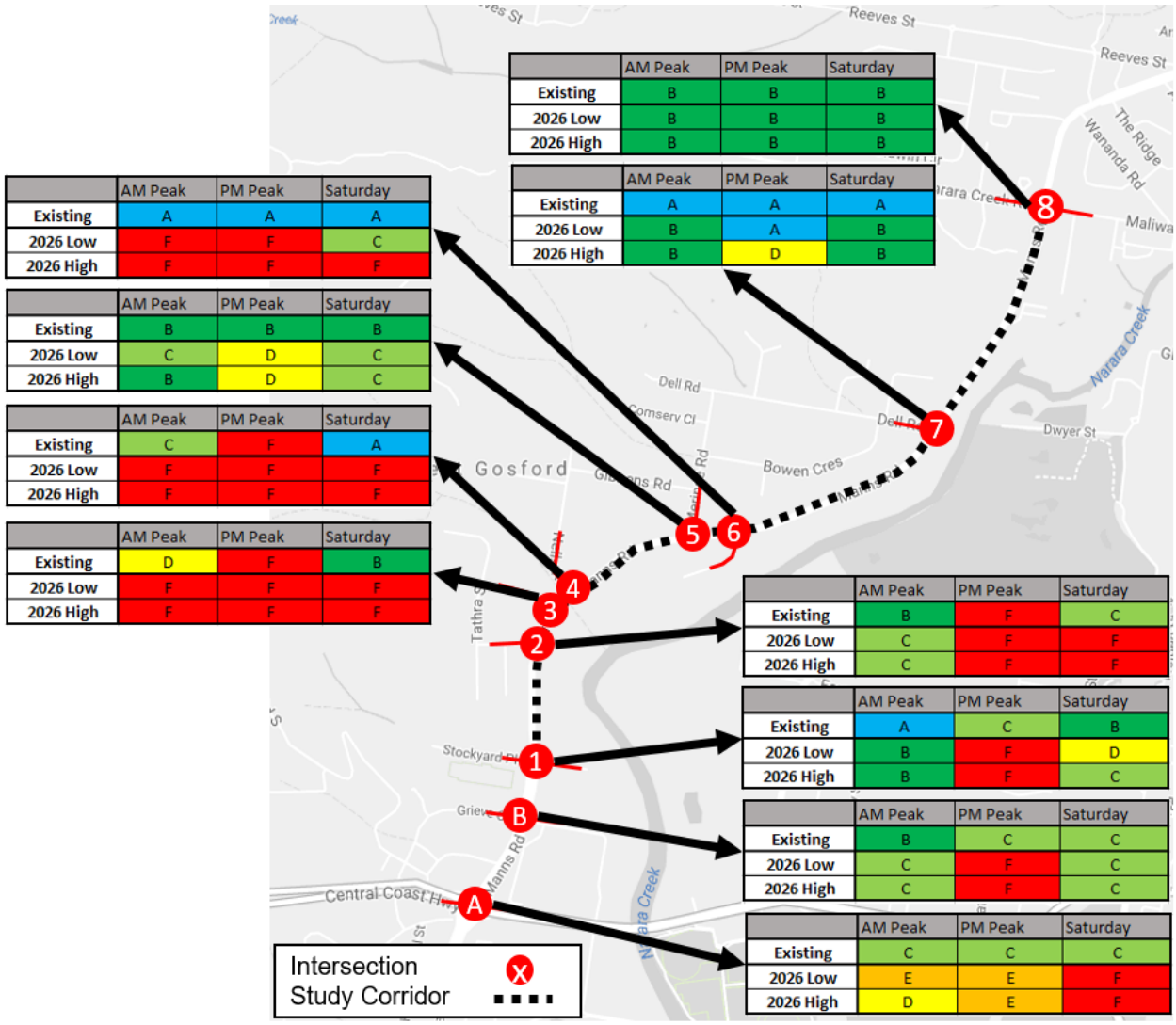
The future base-case scenario assessment is summarised in **Table 4-11**, quantifying how the road network would function with no further road upgrades in low growth and high growth scenarios. **Figure 4-4** and **Figure 4-5** show the future intersection operation with low and high growth scenarios with no road upgrade compared to existing conditions. It shows that the northern end of the corridor continues to function satisfactorily (LoS A, B, C or D), however, with no upgrade, the middle and southern extents of the corridor would function at unsatisfactory levels (LoS E or F). This deterioration is particularly prominent at priority intersections (as opposed to signalised intersections).

Table 4-11 Future intersection operation with no road upgrade

Year	Low Growth / High Growth	Scenario	Do Nothing								
		Peak	AM			PM			SAT		
		Criteria	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS
2026	Low Growth	Manns Road- Central Coast Highway (S)	43	NA	D	41	NA	C	58	NA	E
		Manns Road-Grieve Close (S)	31	NA	C	36	NA	C	36	NA	C
		Manns Road-Stockyard Place (S)	15	NA	B	39	NA	C	30	NA	C
		Manns Road-Carnarvon Road (P)	20	5	B	450	31	F	51	5	D
		Manns Road-Yandina Road (P)	113	6	F	403	22	F	20	4	B
		Manns Road-Nells Road (P)	324	7	F	193	24	F	26	7	B
		Manns Road-Merinee Rd (S)	18	NA	B	30	NA	C	22	NA	B
		Manns Road-Dignity Crescent (P)	31	5	C	27	7	B	16	2	B
		Manns Road-Dell Road (P)	15	1	B	7	1	A	28	1	B
		Manns Road-Narara Creek Road (S)	19	NA	B	16	NA	B	15	NA	B
	High Growth	Manns Road- Central Coast Highway (S)	45	NA	D	65	NA	E	97	NA	F
		Manns Road-Grieve Close (S)	34	NA	C	81	NA	F	40	NA	C
		Manns Road-Stockyard Place (S)	17	NA	B	96	NA	F	33	NA	C
		Manns Road-Carnarvon Road (P)	32	7	C	590	41	F	182	22	F
		Manns Road-Yandina Road (P)	386	11	F	669	36	F	133	17	F
		Manns Road-Nells Road (P)	406	13	F	390	36	F	174	26	F
		Manns Road-Merinee Rd (S)	28	NA	B	55	NA	D	35	NA	C
		Manns Road-Dignity Crescent (P)	263	22	F	260	42	F	170	13	F
		Manns Road-Dell Road (P)	24	7	B	50	20	D	21	1	B
		Manns Road-Narara Creek Road (S)	19	NA	B	25	NA	B	17	NA	B
2036	Low Growth	Manns Road- Central Coast Highway (S)	63	NA	E	61	NA	E	87	NA	F
		Manns Road-Grieve Close (S)	30	NA	C	72	NA	F	39	NA	C
		Manns Road-Stockyard Place (S)	15	NA	B	90	NA	F	47	NA	D
		Manns Road-Carnarvon Road (P)	31	7	C	473	41	F	124	27	F
		Manns Road-Yandina Road (P)	304	9	F	767	36	F	134	21	F
		Manns Road-Nells Road (P)	241	13	F	340	33	F	128	29	F
		Manns Road-Merinee Rd (S)	30	NA	C	49	NA	D	35	NA	C
		Manns Road-Dignity Crescent (P)	1030	30	F	273	33	F	29	12	C
		Manns Road-Dell Road (P)	25	9	B	14	7	A	18	2	B
		Manns Road-Narara Creek Road (S)	22	NA	B	20	NA	B	17	NA	B
		Manns Road- Central Coast Highway (S)	73	NA	F	114	NA	F	96	NA	F

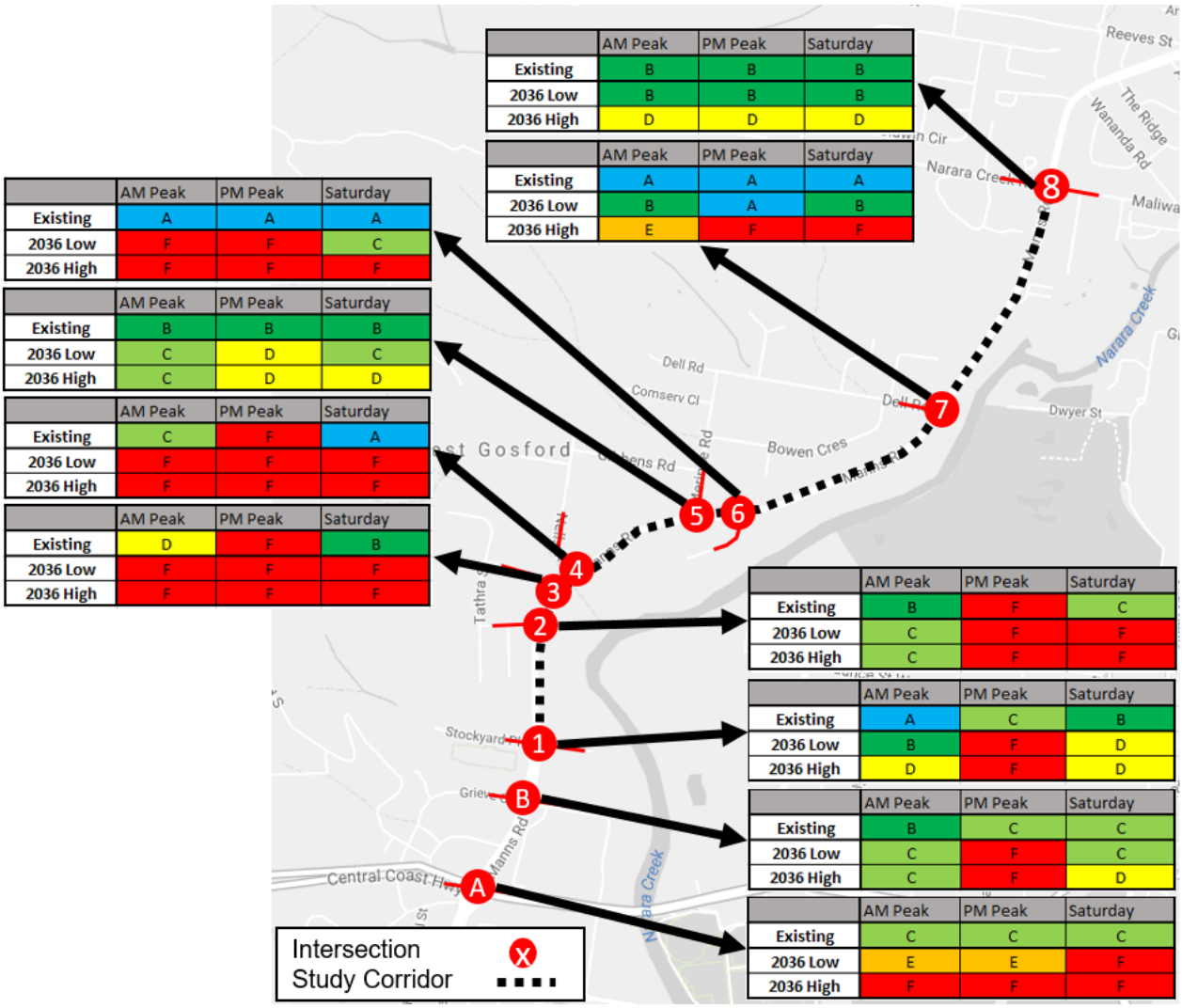
Year	Low Growth / High Growth	Scenario	Do Nothing								
		Peak	AM			PM			SAT		
		Criteria	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS
	High Growth	Manns Road-Grieve Close (S)	41	NA	C	95	NA	F	43	NA	D
		Manns Road-Stockyard Place (S)	20	NA	B	102	NA	F	56	NA	D
		Manns Road-Carnarvon Road (P)	36	8	C	599	42	F	157	30	F
		Manns Road-Yandina Road (P)	657	16	F	708	35	F	170	22	F
		Manns Road-Nells Road (P)	332	15	F	798	45	F	161	31	F
		Manns Road-Merinee Rd (S)	38	NA	C	53	NA	D	44	NA	D
		Manns Road-Dignity Crescent (P)	1,000	36	F	335	37	F	521	26	F
		Manns Road-Dell Road (P)	65	23	E	79	29	F	84	23	F
		Manns Road-Narara Creek Road (S)	47	NA	D	47	NA	D	47	NA	D

Figure 4-4 2026 Comparison of Levels of Service to Existing Conditions with Base Case



Basemap Source: https://snazzymaps.com

Figure 4-5 2036 Comparison of Levels of Service to Existing Conditions with Base Case



	AM Peak	PM Peak	Saturday
Existing	B	B	B
2036 Low	B	B	B
2036 High	D	D	D

	AM Peak	PM Peak	Saturday
Existing	A	A	A
2036 Low	B	A	B
2036 High	E	F	F

	AM Peak	PM Peak	Saturday
Existing	A	A	A
2036 Low	F	F	C
2036 High	F	F	F

	AM Peak	PM Peak	Saturday
Existing	B	B	B
2036 Low	C	D	C
2036 High	C	D	D

	AM Peak	PM Peak	Saturday
Existing	C	F	A
2036 Low	F	F	F
2036 High	F	F	F

	AM Peak	PM Peak	Saturday
Existing	D	F	B
2036 Low	F	F	F
2036 High	F	F	F

	AM Peak	PM Peak	Saturday
Existing	B	F	C
2036 Low	C	F	F
2036 High	C	F	F

	AM Peak	PM Peak	Saturday
Existing	A	C	B
2036 Low	B	F	D
2036 High	D	F	D

	AM Peak	PM Peak	Saturday
Existing	B	C	C
2036 Low	C	F	C
2036 High	C	F	D

	AM Peak	PM Peak	Saturday
Existing	C	C	C
2036 Low	E	E	F
2036 High	F	F	F

Basemap Source: https://snazzymaps.com

5 Traffic Option Assessment – Stage 1 Improvements

5.1 Stage 1 Upgrade

Roads and Maritime proposed an upgrade of Manns Road between Stockyard Place and Narara Creek Road to improve traffic flow and safety. The Stage 1 upgrade investigated and modelled in this study include:

- Intersection upgrades:
  - Stockyard Place / Manns Road
  - Narara Creek Road / Manns Road.

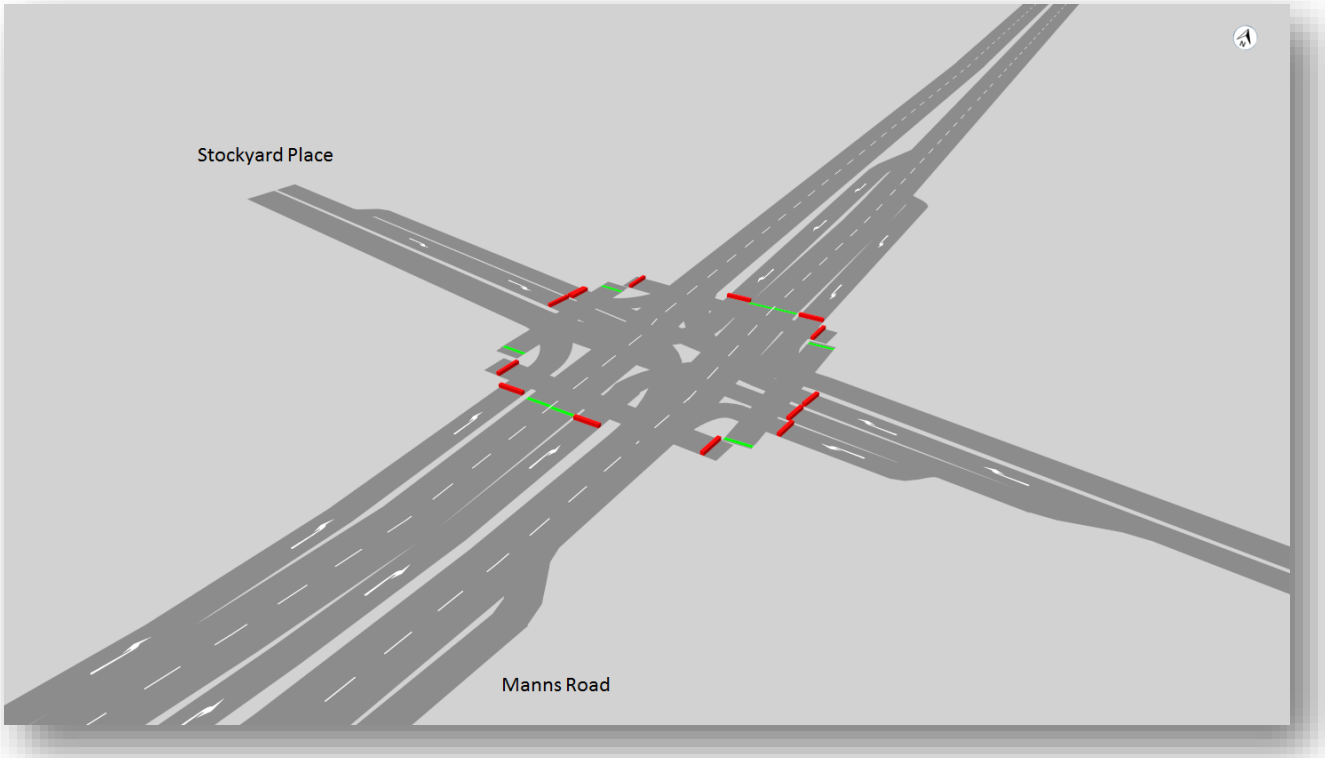
The features of the two intersection upgrades are described below.

Manns Road / Stockyard Place Intersection

- Manns Road to be two through lanes northbound and southbound
- Extending south right turn lane to 95m
- Additional southbound left turn short lane with 115m.

These upgrades were incorporated into the model and a snap shot of the modelled intersection layout (in Vissim) is presented in **Figure 5-1**.

Figure 5-1 Stockyard Place / Manns Road Proposed Layout (Vissim)

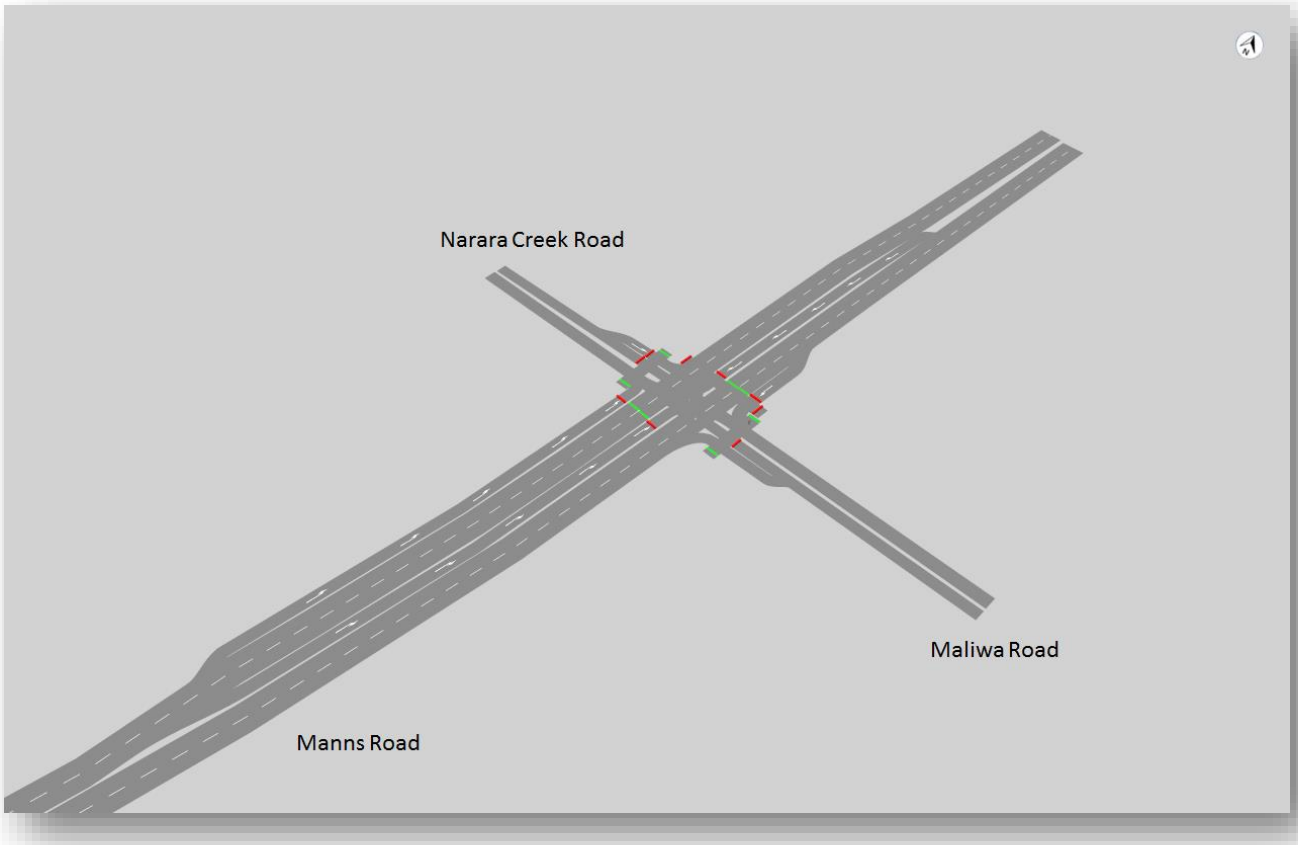


Manns Road / Narara Creek Road Intersection

- Manns Road to be two through lanes northbound and southbound
- Extend northbound left turn short lane (from 30m to 100m)
- Extend northbound right turn short lane (from 40m to 100m).

These upgrades were incorporated into the model and a snap shot of the modelled intersection layout (in Vissim) is presented in **Figure 5-6**.

Figure 5-2 Narara Creek Road / Manns Road Proposed Layout (Vissim)



5.2 Project Case Overall Network Performance

Table 5-1 to **Table 5-4** show the network performance metrics for future years with the proposed intersection upgrades in 2026 and 2036 respectively. The 2036 PM peak hour in the high growth scenario has the highest proportional increase, with an additional 34.9% VKT compared to the existing corresponding peak.

Table 5-1 2026 Network Performance with Project Upgrade – Low Growth

2026	Do-Nothing			Stage 1		
	AM Peak	PM Peak	SAT Peak	AM Peak	PM Peak	SAT Peak
VKT (km)	11,137	11,688	11,118	11,136	11,803	11,361
VHT (hrs)	344	464	394	350	372	377
Average Speed (km/hr)	32	25	28	32	32	30
Latent Demand	1	23	34	1	1	0
% Latent Demand of All Demand	0%	0%	0%	0%	0%	0%

Table 5-2 2026 Network Performance with Project Upgrade – High Growth

2026	Do-Nothing			Stage 1		
	AM Peak	PM Peak	SAT Peak	AM Peak	PM Peak	SAT Peak
VKT (km)	11,706	11,591	11,725	11,771	12,933	12,137
VHT (hrs)	432	798	591	394	491	552
Average Speed (km/hr)	27	15	20	30	26	22
Latent Demand	0	313	143	0	9	140

2026	Do-Nothing			Stage 1		
	AM Peak	PM Peak	SAT Peak	AM Peak	PM Peak	SAT Peak
% Latent Demand of All Demand	0%	3%	2%	0%	0%	2%

Table 5-3 2036 Network Performance with Project Upgrade – Low Growth

2036	Do-Nothing			Stage 1		
	AM Peak	PM Peak	SAT Peak	AM Peak	PM Peak	SAT Peak
VKT (km)	12,332	11,899	11,852	12,464	12,809	12,441
VHT (hrs)	516	724	609	484	464	489
Average Speed (km/hr)	24	17	20	26	28	26
Latent Demand	121	437	424	111	84	334
% Latent Demand of All Demand	1%	4%	5%	1%	1%	4%

Table 5-4 2036 Network Performance with Project Upgrade – High Growth

2036	Do-Nothing			Stage 1		
	AM Peak	PM Peak	SAT Peak	AM Peak	PM Peak	SAT Peak
VKT (km)	12,574	11,373	11,583	12,882	14,376	13,433
VHT (hrs)	824	1,080	904	787	729	679
Average Speed (km/hr)	16	11	13	17	20	20
Latent Demand	1136	4603	3239	751	2031	2342
% Latent Demand of All Demand	11%	38%	29%	7%	17%	21%

5.3 Project Case Mid-block Volume Capacity

The impacts of the improvements along Manns Road were assessed based on level of service criteria in Table 4-2 to determine when Manns Road would reach capacity (triggering Manns Road duplication).

The FFS (free flow speed) was assumed to be the posted speed limit (60km/h for Manns Road) and the average travel speeds extracted from the Vissim models.

The results of the mid-block analysis with future upgrades is shown in **Table 5-5** and **Table 5-6** for 2026 and 2036, respectively. The results indicate a significant improvement of the corridor capacity due to the improvements on Stockyard Place and Narara Creek intersections with Manns Road. The levels of service and travel time thresholds indicate acceptable vehicle speed along Manns Road for both low and high growth scenarios for 2026. For 2036, some sections of Manns Road deteriorate in the high growth scenario due to the increased demand beyond the capacity increases of Stage 1 upgrades, which signifies the need for duplicating Manns Road in the 2036.

Table 5-5 2026 Level of Service for Manns Road corridor – Worst Peak (PM Peak Hour)

Section	Travel Speed (km/h)				Travel Time / FFS				LOS			
	Base Case		Stage 1		Base Case		Stage 1		Base Case		Stage 1	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Stockyard - SB	16	13	59	43	27%	22%	98%	72%	F	F	A	B
Stockyard - NB	21	15	54	33	35%	25%	90%	55%	E	F	A	C
Merinee - WB	54	7	60	57	90%	12%	100%	95%	A	F	A	A
Merinee - EB	60	60	60	60	100%	100%	100%	100%	A	A	A	A
Narara Creek - SB	53	40	57	57	88%	67%	95%	95%	A	B	A	A
Narara Creek - NB	34	31	58	60	57%	52%	97%	100%	C	C	A	A

Table 5-6 2036 Level of Service for Manns Road corridor – Worst Peak (PM Peak Hour)

Section	Travel Speed (km/h)				Travel Time / FFS				LOS			
	Base Case		Stage 1		Base Case		Stage 1		Base Case		Stage 1	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Stockyard - SB	14	12	58	22	23%	20%	97%	37%	F	F	A	E
Stockyard - NB	14	14	51	37	23%	23%	85%	62%	F	F	A	C
Merinee - WB	10	5	60	17	17%	8%	100%	28%	F	F	A	F
Merinee - EB	60	60	60	60	100%	100%	100%	100%	A	A	A	A
Narara Creek - SB	49	7	58	38	82%	12%	97%	63%	A	F	A	C
Narara Creek - NB	32	25	59	59	53%	42%	98%	98%	C	D	A	A

5.4 Project Case Travel Speeds and Travel Time

The impact of the proposed intersection upgrades in 2026 and 2036 on travel times for each section were also modelled. The model result showed consistency with the results in Section 5.3, where the improvements along Manns Road on Stockyard Place and Narara Creek Road decrease travel times, significantly for the PM Peak Hour. Model results are presented in **Table 5-7** to **Table 5-10** respectively.

Table 5-7 2026 low growth modelled corridor travel times comparison between future base and stage 1 upgrade option

2026 / Low Growth	Travel Time Route Name	Base Model			Stage 1		
		AM	PM	Sat	AM	PM	Sat
Northbound	Central Coast Highway to Dyer Crescent	14	12	13	14	14	13
	Dyer Crescent to Grieve Close	42	23	35	47	56	35
	Grieve Close to Stockyard Place	23	39	24	23	21	28
	Stockyard Place to Carnarvon Road	30	77	24	31	29	24
	Carnarvon Road to Yandina Road	8	21	10	8	9	7
	Yandina Road to Nells Road	5	17	10	5	7	5
	Nells Road to Merinee Road	48	110	101	49	60	48
	Merinee Road to Dignity Crescent	13	11	11	13	11	11
	Dignity Crescent to Dell Road	44	45	44	44	44	44
	Dell Road to Narara Creek	58	62	57	65	64	62
	Narara Creek to the Ridge	27	27	27	30	32	31
	The Ridge to Showground Road	31	31	30	30	31	30
	Central Coast Hwy to Showground Rod NB	**340**	**490**	**383**	**358**	**379**	**336**
Southbound	Showground Road to The Ridge	30	30	30	30	30	30
	The Ridge to Narara Creek	42	37	37	44	39	40
	Narara Creek to Dell Road	48	47	47	54	50	51
	Dell Road to Dignity Crescent	49	57	44	49	44	44
	Dignity Crescent to Merinee Road	20	38	17	20	17	18
	Merinee Road to Nells Road	47	99	34	44	37	29
	Nells Road to Yandina Road	13	21	8	12	8	7
	Yandina Road to Carnarvon Road	14	26	13	15	9	8
	Carnarvon Road to Stockyard Place	36	100	87	35	48	81
	Stockyard Place to Grieve Close	42	58	58	45	61	53
	Grieve Close to Dyer Crescent	9	9	9	9	9	9
	Dyer Crescent to Central Coast Highway	61	69	65	67	65	67
	Showground Road to Central Coast Highway SB	**415**	**588**	**449**	**427**	**417**	**439**

Table 5-8 2026 high growth modelled corridor travel times comparison between future base and stage 1 upgrade option

2026 / High Growth	Travel Time Route Name	Base Model			Stage 1		
		AM	PM	Sat	AM	PM	Sat
Northbound	Central Coast Highway to Dyer Crescent	14	67	12	14	19	13
	Dyer Crescent to Grieve Close	42	94	33	49	71	34
	Grieve Close to Stockyard Place	25	150	30	22	26	34
	Stockyard Place to Carnarvon Road	32	137	56	32	52	50
	Carnarvon Road to Yandina Road	8	26	25	8	15	21
	Yandina Road to Nells Road	6	20	22	6	12	17
	Nells Road to Merinee Road	56	120	127	53	78	110
	Merinee Road to Dignity Crescent	17	12	12	15	12	12
	Dignity Crescent to Dell Road	45	45	44	44	44	44
	Dell Road to Narara Creek	61	63	56	64	68	59
	Narara Creek to the Ridge	27	29	27	30	32	31
	The Ridge to Showground Road	30	36	31	31	31	31
	Central Coast Hwy to Showground Rod NB	**362**	**743**	**467**	**367**	**467**	**450**
Southbound	Showground Road to The Ridge	31	66	30	30	30	30
	The Ridge to Narara Creek	45	78	39	44	39	41
	Narara Creek to Dell Road	77	179	49	57	51	52
	Dell Road to Dignity Crescent	132	421	89	66	44	46
	Dignity Crescent to Merinee Road	35	108	41	24	19	20
	Merinee Road to Nells Road	83	168	103	56	46	49
	Nells Road to Yandina Road	18	30	21	15	9	10
	Yandina Road to Carnarvon Road	19	36	27	16	9	10
	Carnarvon Road to Stockyard Place	38	136	116	34	51	99
	Stockyard Place to Grieve Close	44	92	54	49	67	60
	Grieve Close to Dyer Crescent	9	9	9	9	10	9
	Dyer Crescent to Central Coast Highway	66	64	67	74	68	69
	Showground Road to Central Coast Highway SB	**603**	**970**	**637**	**482**	**440**	**492**

Table 5-9 2036 low growth modelled corridor travel times comparison between future base and stage 1 upgrade option

2026 / Low Growth	Travel Time Route Name	Base Model			Stage 1		
		AM	PM	Sat	AM	PM	Sat
Northbound	Central Coast Highway to Dyer Crescent	14	61	13	14	16	14
	Dyer Crescent to Grieve Close	37	88	34	46	57	37
	Grieve Close to Stockyard Place	23	152	49	22	23	29
	Stockyard Place to Carnarvon Road	32	144	114	33	33	25
	Carnarvon Road to Yandina Road	8	28	30	8	9	7
	Yandina Road to Nells Road	6	21	24	6	8	6
	Nells Road to Merinee Road	60	124	129	63	65	56
	Merinee Road to Dignity Crescent	17	13	13	17	12	11
	Dignity Crescent to Dell Road	45	45	44	44	44	44
	Dell Road to Narara Creek	60	62	57	64	65	62
	Narara Creek to the Ridge	29	27	27	30	33	31
	The Ridge to Showground Road	38	31	30	31	32	31

	Central Coast Hwy to Showground Rod NB	**365**	**751**	**550**	**376**	**397**	**348**
Southbound	Showground Road to The Ridge	43	37	30	30	30	30
	The Ridge to Narara Creek	61	52	39	43	40	41
	Narara Creek to Dell Road	97	91	53	72	51	53
	Dell Road to Dignity Crescent	151	251	95	106	45	45
	Dignity Crescent to Merinee Road	37	81	40	32	18	18
	Merinee Road to Nells Road	85	143	113	71	42	39
	Nells Road to Yandina Road	18	27	21	16	8	10
	Yandina Road to Carnarvon Road	18	32	28	17	9	13
	Carnarvon Road to Stockyard Place	37	121	122	35	50	116
	Stockyard Place to Grieve Close	43	77	67	48	60	53
	Grieve Close to Dyer Crescent	9	9	9	10	9	9
	Dyer Crescent to Central Coast Highway	68	66	63	78	66	68
	Showground Road to Central Coast Highway SB	**659**	**833**	**646**	**563**	**427**	**499**

Table 5-10 2036 high growth modelled corridor travel times comparison between future base and stage 1 upgrade option

2036 / High Growth	Travel Time Route Name	Base Model			Stage 1		
		AM	PM	Sat	AM	PM	Sat
Northbound	Central Coast Highway to Dyer Crescent	18	127	13	19	88	14
	Dyer Crescent to Grieve Close	56	161	35	56	104	38
	Grieve Close to Stockyard Place	29	170	71	23	62	31
	Stockyard Place to Carnarvon Road	43	143	131	39	84	38
	Carnarvon Road to Yandina Road	11	27	31	11	19	15
	Yandina Road to Nells Road	9	20	24	10	14	12
	Nells Road to Merinee Road	87	122	128	86	84	84
	Merinee Road to Dignity Crescent	21	12	12	21	13	16
	Dignity Crescent to Dell Road	80	45	46	62	45	44
	Dell Road to Narara Creek	194	70	82	128	64	61
	Narara Creek to the Ridge	149	38	77	91	32	33
	The Ridge to Showground Road	193	53	115	106	31	31
	Central Coast Hwy to Showground Rod NB	**802**	**894**	**720**	**592**	**584**	**417**
Southbound	Showground Road to The Ridge	142	247	175	85	30	31
	The Ridge to Narara Creek	125	244	177	158	40	52
	Narara Creek to Dell Road	186	450	287	252	52	112
	Dell Road to Dignity Crescent	204	470	291	197	64	151
	Dignity Crescent to Merinee Road	42	98	62	40	28	38
	Merinee Road to Nells Road	92	162	140	84	65	85
	Nells Road to Yandina Road	19	28	24	17	11	15
	Yandina Road to Carnarvon Road	19	33	32	17	11	18
	Carnarvon Road to Stockyard Place	39	132	131	35	64	127
	Stockyard Place to Grieve Close	49	89	59	53	72	58
	Grieve Close to Dyer Crescent	9	9	9	9	10	9
	Dyer Crescent to Central Coast Highway	65	63	69	71	70	73
	Showground Road to Central Coast Highway SB	**954**	**1,505**	**1,258**	**958**	**515**	**737**

5.5 Project Case Intersection Performance

A comparison of traffic operation and Level of Service for the intersections along Manns Road, for the base case and the Stage 1 works, indicated a consistent improvement of intersection operations in the Stage 1 upgrade compared to the base case. The one exception is the High Growth weekend peak scenario for 2026, where the delays at the priority intersections north of Stockyard Place increase. This can be attributed to the increased throughput on Manns Road, which inherently decreases the gaps allowing vehicles on the side roads to exit onto Manns Road. Delays at priority intersections represent the worst movement delay and levels of service. **Table 5-11** and **Table 5-12** show this comparison for 2026 and 2036, respectively.

Table 5-11 2026 Intersection operation for base case and upgrade

Scenario	Build Scenario	Base Model									Stage 1								
	Year	AM			PM			SAT			AM			PM			SAT		
	Criteria	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS
Low Growth	Manns Road- Central Coast Highway (S)	43	NA	D	41	NA	C	58	NA	E	43	NA	D	40	NA	C	56	NA	D
	Manns Road-Grieve Close (S)	31	NA	C	36	NA	C	36	NA	C	34	NA	C	40	NA	C	35	NA	C
	Manns Road-Stockyard Place (S)	15	NA	B	39	NA	C	30	NA	C	17	NA	B	26	NA	B	38	NA	C
	Manns Road-Carnarvon Road (P)	20	5	B	450	31	F	51	5	D	22	5	B	226	3	F	11	1	A
	Manns Road-Yandina Road (P)	113	6	F	403	22	F	20	4	B	108	5	F	41	4	C	14	1	A
	Manns Road-Nells Road (P)	324	7	F	193	24	F	26	7	B	112	6	F	46	6	D	11	2	A
	Manns Road-Merinee Rd (S)	18	NA	B	30	NA	C	22	NA	B	17	NA	B	19	NA	B	14	NA	A
	Manns Road-Dignity Crescent (P)	31	5	C	27	7	B	16	2	B	20	5	B	17	2	B	14	2	A
	Manns Road-Dell Road (P)	15	1	B	7	1	A	28	1	B	16	1	B	7	1	A	11	1	A
	Manns Road-Narara Creek Road (S)	19	NA	B	16	NA	B	15	NA	B	24	NA	B	20	NA	B	19	NA	B
High Growth	Manns Road- Central Coast Highway (S)	45	NA	D	65	NA	E	97	NA	F	46	NA	D	51	NA	D	93	NA	F
	Manns Road-Grieve Close (S)	34	NA	C	81	NA	F	40	NA	C	36	NA	C	45	NA	D	40	NA	C
	Manns Road-Stockyard Place (S)	17	NA	B	96	NA	F	33	NA	C	18	NA	B	32	NA	C	39	NA	C
	Manns Road-Carnarvon Road (P)	32	7	C	590	41	F	182	22	F	24	5	B	67	7	E	85	10	F
	Manns Road-Yandina Road (P)	386	11	F	669	36	F	133	17	F	272	9	F	123	9	F	257	11	F
	Manns Road-Nells Road (P)	406	13	F	390	36	F	174	26	F	64	9	E	88	11	F	101	15	F
	Manns Road-Merinee Rd (S)	28	NA	B	55	NA	D	35	NA	C	21	NA	B	48	NA	D	22	NA	B
	Manns Road-Dignity Crescent (P)	263	22	F	260	42	F	170	13	F	86	10	F	121	3	F	113	3	F
	Manns Road-Dell Road (P)	24	7	B	50	20	D	21	1	B	28	2	B	47	2	D	26	1	B
	Manns Road-Narara Creek Road (S)	19	NA	B	25	NA	B	17	NA	B	24	NA	B	22	NA	B	17	NA	B

(S) represents a signalised intersection, whereas (P) represents Priority Intersections.

Table 5-12 2036 Intersection operation for base case and upgrade

Scenario	Build Scenario	Base Model									Stage 1								
	Year	AM			PM			SAT			AM			PM			SAT		
	Criteria	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS	Delay	Average Delay for Priority	LOS
Low Growth	Manns Road- Central Coast Highway (S)	63	NA	E	61	NA	E	87	NA	F	63	NA	E	52	NA	D	81	NA	F
	Manns Road-Grieve Close (S)	30	NA	C	72	NA	F	39	NA	C	34	NA	C	40	NA	C	37	NA	C
	Manns Road-Stockyard Place (S)	15	NA	B	90	NA	F	47	NA	D	18	NA	B	28	NA	B	47	NA	D
	Manns Road-Carnarvon Road (P)	31	7	C	473	41	F	124	27	F	28	6	B	43	4	D	59	5	E
	Manns Road-Yandina Road (P)	304	9	F	767	36	F	134	21	F	263	8	F	46	4	D	20	3	B
	Manns Road-Nells Road (P)	241	13	F	340	33	F	128	29	F	246	11	F	67	7	E	21	5	B
	Manns Road-Merinee Rd (S)	30	NA	C	49	NA	D	35	NA	C	28	NA	B	20	NA	B	15	NA	B
	Manns Road-Dignity Crescent (P)	1030	30	F	273	33	F	29	12	C	316	21	F	19	3	B	20	2	B
	Manns Road-Dell Road (P)	25	9	B	14	7	A	18	2	B	21	4	B	10	1	A	11	1	A
	Manns Road-Narara Creek Road (S)	22	NA	B	20	NA	B	17	NA	B	23	NA	B	21	NA	B	20	NA	B
High Growth	Manns Road- Central Coast Highway (S)	73	NA	F	114	NA	F	96	NA	F	74	NA	F	84	NA	F	90	NA	F
	Manns Road-Grieve Close (S)	41	NA	C	95	NA	F	43	NA	D	41	NA	C	59	NA	E	42	NA	C
	Manns Road-Stockyard Place (S)	20	NA	B	102	NA	F	56	NA	D	19	NA	B	54	NA	D	48	NA	D
	Manns Road-Carnarvon Road (P)	36	8	C	599	42	F	157	30	F	29	7	C	165	13	F	109	11	F
	Manns Road-Yandina Road (P)	657	16	F	708	35	F	170	22	F	503	14	F	325	17	F	61	9	E
	Manns Road-Nells Road (P)	332	15	F	798	45	F	161	31	F	483	15	F	372	19	F	46	16	D
	Manns Road-Merinee Rd (S)	38	NA	C	53	NA	D	44	NA	D	36	NA	C	26	NA	B	28	NA	B
	Manns Road-Dignity Crescent (P)	1000	36	F	335	37	F	521	26	F	981	33	F	43	8	D	656	19	F
	Manns Road-Dell Road (P)	65	23	E	79	29	F	84	23	F	62	20	E	21	2	F	79	12	F
	Manns Road-Narara Creek Road (S)	47	NA	D	47	NA	D	47	NA	D	91	NA	F	21	NA	B	25	NA	B

(S) represents a signalised intersection, whereas (P) represents Priority Intersections.

5.6 Turn-bay Storage

This study included an analysis of the turn bay storage lengths proposed as part of the Stage 1 intersection upgrades. The results indicate a sufficient queue space in comparison to the maximum queue length for the upgrade options under all growth and year scenarios. The modelling results for 2026 and 2036 low and high growth scenarios are presented in **Table 5-13**, **Table 5-14**, **Table 5-15** and **Table 5-16.** This modelling analysis is not for concept design, it is only a conceptual plan.

Table 5-13 Turn bay storage and queue lengths for improved intersection – 2026 Low Growth Scenario

2026 Low Growth	Approach	Turn	Concept Design (Stage 1) Turn Bay Length	95% Back of Queue Length	Difference (95% vs. Modelled)
Stockyard Place	North	Left	110	38	72
		Right	95	46	49
Narara Creek Road	North	Left	70	18	52
		Right	150	32	118
	South	Left	84	23	61
		Right	96	32	64

Table 5-14 Turn bay storage and queue lengths for improved intersection – 2026 High Growth Scenario

2026 High Growth	Approach	Turn	Concept Design (Stage 1) Turn Bay Length	95% Back of Queue Length	Difference (95% vs. Modelled)
Stockyard Place	North	Left	110	42	68
		Right	95	24	71
Narara Creek Road	North	Left	70	19	51
		Right	150	35	115
	South	Left	84	24	60
		Right	96	32	64

Table 5-15 Turn bay storage and queue lengths for improved intersection – 2036 Low Growth Scenario

2036 Low Growth	Approach	Turn	Concept Design (Stage 1) Turn Bay Length	95% Back of Queue Length	Difference (95% vs. Modelled)
Stockyard Place	North	Left	110	44	66
		Right	95	45	50
Narara Creek Road	North	Left	70	21	49
		Right	150	32	118
	South	Left	84	38	46
		Right	96	34	62

Table 5-16 Turn bay storage and queue lengths for improved intersection – 2036 High Growth Scenario

2036 High Growth	Approach	Turn	Concept Design (Stage 1) Turn Bay Length	95% Back of Queue Length	Difference (95% vs. Modelled)
Stockyard Place	North	Left	110	43	67
		Right	95	28	67
Narara Creek Road	North	Left	70	17	53
		Right	150	47	103
	South	Left	84	31	53
		Right	96	50	46

6 Summary of findings and recommendations

6.1 Existing Conditions

Existing conditions show that Manns Road functions as a major arterial route which primarily services Gosford's northern suburbs and a range of light industrial land uses in West Gosford. The road currently generally has one lane in each direction with no median separation and no pedestrian facilities.

Manns Road has a posted speed limit of 60km/h and has a history of 42 crashes between Stockyard Place and Narara Creek Road over the past five years.

Depending on the specific section of Manns Road, it carries approximately 20,000 vehicles per weekday and 13,000 vehicles per weekend day. The intersections along Manns Road at the northern and southern extents of the study corridor generally function satisfactorily. Through the middle of the study corridor, intersection functionality is poor, especially during weekday PM periods.

6.2 Consequence of "do nothing"

This study considered a 'do nothing' scenario, with modelling for the future years 2026 and 2036, for low and high growth scenarios based on a range of growth assumptions detailed in the report.

Under the do nothing scenario, the road function would deteriorate with growing traffic volumes and intersection delays would increase and average speeds would decrease. The time period which would be subject to the highest delays would be the weekday PM in the high growth scenario.

It is estimated that travel times would increase from the current maximum of 6 minutes to as high as 16 minutes by 2036. Most scenarios would result in travel times of less than 10 minutes, which still represents a moderate deterioration compared to the travel times experienced today.

6.3 The Project Case Operational Impacts

When the Stage 1 intersection upgrades on Manns Road are applied to the model the function of the road would substantially improve compared to the do nothing scenarios. In most cases, the road upgrade would lead to a reduction in travel times from the future do nothing scenarios, to travel times modestly above those experienced currently.

In the 2036 model year there is some variation around the modelling scenarios. Current travel times are approximately 6 minutes, increasing to 12 minutes with a do nothing scenario by 2036. With the intersection upgrades, the modelling suggests travel times of approximately 8 minutes.

As one such example, the high growth PM weekday scenario would appear 35% more VKT in a typical peak hour compared to today with the road upgrade.

Based on these findings, it is recommended that implementation of Stage 1 upgrade to Manns Road from Stockyard Place to Narara Creek Road begins after 2026, in line with the full corridor upgrade program.