

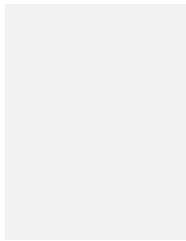
# Hillsborough Road Duplication, Concept Design and REF

Traffic and Transport Assessment Report

Incorporating



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# Transport for NSW

## Hillsborough Road Duplication, Concept and Design and REF

### Traffic and Transport Assessment Report

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## REVISIONS

Revision	Date	Description	Prepared by	Approved by
A	30 Aug 2022	First Draft for Client Review	KN, MW, MR	MR
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## Glossary and acronyms

Term	Definition
AADT	Annual Average Daily Traffic
ADT	Average Daily Traffic. The total volume of traffic (24 hours) passing a roadside observation point over a sampled one-week period, divided by the number of days per week
AWT	Average Weekday Traffic. The total volume of traffic (24 hours) passing a roadside observation point over a sampled five-weekday (Monday to Friday) period, divided by the number of days
ATC	Automatic traffic count
Avg.	Average
Capacity	The nominal maximum number of vehicles which has a reasonable expectation of passing over a given section of a lane or roadway in one direction during a given time period under prevailing roadway conditions
Carriageway	The portion of a roadway used by vehicles including shoulders and ancillary lanes
CD	Concept Design
Divided road	A road with a separate carriageway for each direction of travel created by placing a physical separation (e.g. median) between the opposing traffic directions
Heavy vehicles	A heavy vehicle is classified as a Class 3 vehicle (a two-axle truck) or larger, in line with the Austroads Vehicle Classification System
Hr	Hour
Local road	A road or street used primarily for access to properties in that road or street
Median	The central reservation which divides a carriageway for traffic travelling in opposite directions
Midblock	A general location on a road between two intersections
Min	minutes
NIBC	Newcastle Inner City Bypass
Off ramp	A ramp by which one exits a limited access highway/tunnel
On ramp	A ramp by which one enters a limited access highway/tunnel
Public transport	Includes train and bus
RMS	NSW Roads and Maritime Services, currently Transport for NSW (TfNSW)
Roundabout	An intersection where all traffic travels in one direction clockwise around a central island
Sec	Seconds
Transport	Transport for New South Wales
Veh	Vehicles

# 1 Introduction

## 1.1 Report purpose

Transport for NSW (TfNSW) is planning to upgrade the Hillsborough Road for about 1.8 kilometres from the Newcastle Inner City Bypass (NICB) roundabout west to a tie in point about 300 metres west of Crockett Street (the Proposal). The proposed upgrade includes duplication of the Hillsborough Road including the provision of associated shared paths and intersection upgrades. New traffic signals are proposed at Crockett Street intersection, Barker Avenue intersection and Chadwick Street intersection.

Hillsborough Road between Newcastle Inner City Bypass and Crockett Street is used by about 34,500 to 38,100 motorists every day (in 2021) and is subject to substantial traffic congestion during peak periods. The 1.8 kilometres section is currently constrained by two lanes undivided road (one lane in each direction).

The aim of the proposal is to improve network efficiency and road safety for local and regional road users along Hillsborough Road, Warners Bay. The road acts as the primary link between the urban centres of Charlestown and Warners Bay, as well as providing direct access to suburbs such as Hillsborough, Cardiff South and Lakelands.

This traffic and transport assessment aims to support the concept design and review of environmental factors (REF) for the proposal by assessing and reporting existing and future conditions.

## 1.2 Technical documents

The following is an overview of previous technical documents submitted to TfNSW.

- *Technical Advice – Traffic modelling and assessment on options, Arcadis, February 2022.* The technical report documents traffic modelling outcomes on strategic concept design options tested as part of the design challenge for the Hillsborough Road duplication project. Traffic modelling was undertaken for three U-turn options using VISSIM models. The base year model was updated for 2021 traffic conditions.
- *Technical Advice – Traffic modelling and assessment on 20% Concept Design, Arcadis, May 2022.* The technical report documents traffic modelling outcomes on the 20% concept design for the Hillsborough Road duplication project. Traffic modelling was undertaken for the new traffic signals at the Barker Avenue intersection and the provision of U-turn facilities on the Barker Avenue approach using VISSIM models.
- *Technical Advice – Traffic modelling and assessment on 80% Concept Design, Arcadis, June 2022.* The technical report documents traffic modelling outcomes on the 80% concept design.
- *Technical Note 4 – Base model development report, Arcadis, April 2018.* The technical report documents the base VISSIM model development, calibration and validation results. The base VISSIM model was calibrated and validated for 2017 traffic conditions and followed TfNSW *Traffic Modelling Guidelines, version 1, February 2013*.
- *Technical Note 5 – Future traffic growth, Arcadis, February 2018.* The technical report documents future traffic growth on the Hillsborough Road. Future traffic growth on Hillsborough Road was determined based on historical traffic counts, future population and employment growth and traffic forecasts from TfNSW Sydney Traffic Forecasting Model (STFM).



## 1.3 Report structure

This Traffic and Transport Assessment Report is structured into the following chapters:

- **Chapter 1: Introduction:** This chapter outlines the report purpose and previous technical documents submitted to TfNSW
- **Chapter 2: Existing conditions.** This chapter outlines the existing traffic and transport environment within the study area
- **Chapter 3: Traffic modelling methodology.** This chapter provides an overview of the traffic modelling and methodology adopted for traffic and transport assessment
- **Chapter 4: Future traffic conditions without the Proposal.** This chapter outlines traffic conditions on the Hillsborough Road for future years in 2027 and 2037. For modelling purpose, the proposal opening year is assumed to be 2027
- **Chapter 5: Traffic performance of the Proposal.** This chapter documents traffic performance of the proposal in 2027 and 2037 including intersection performance and travel time savings
- **Chapter 6: Management and mitigation measures.** This chapter outlines mitigation measures that have been developed to manage traffic and transport impacts
- **Chapter 7: Summary and conclusions.**

## 2 Existing conditions

This section outlines the existing traffic and transport environment within the study area.

### 2.1 Study area

Hillsborough Road is a major road corridor in the Lake Macquarie Local Government Area. Hillsborough Road carries significant regional and local traffic volumes, providing an important connection between Warner Bay, Cardiff and Newcastle Inner City Bypass.

Figure 2-1 highlights the extent of the proposal study area, which covers about 1.8-kilometres of Hillsborough Road from the Newcastle Inner City Bypass (NICB) roundabout west to a tie in point about 300 metres west of Crockett Street. The proposal area includes four key intersections on the Hillsborough Road with Crockett Street, Barker Avenue, Higham Road, and Chadwick Street:

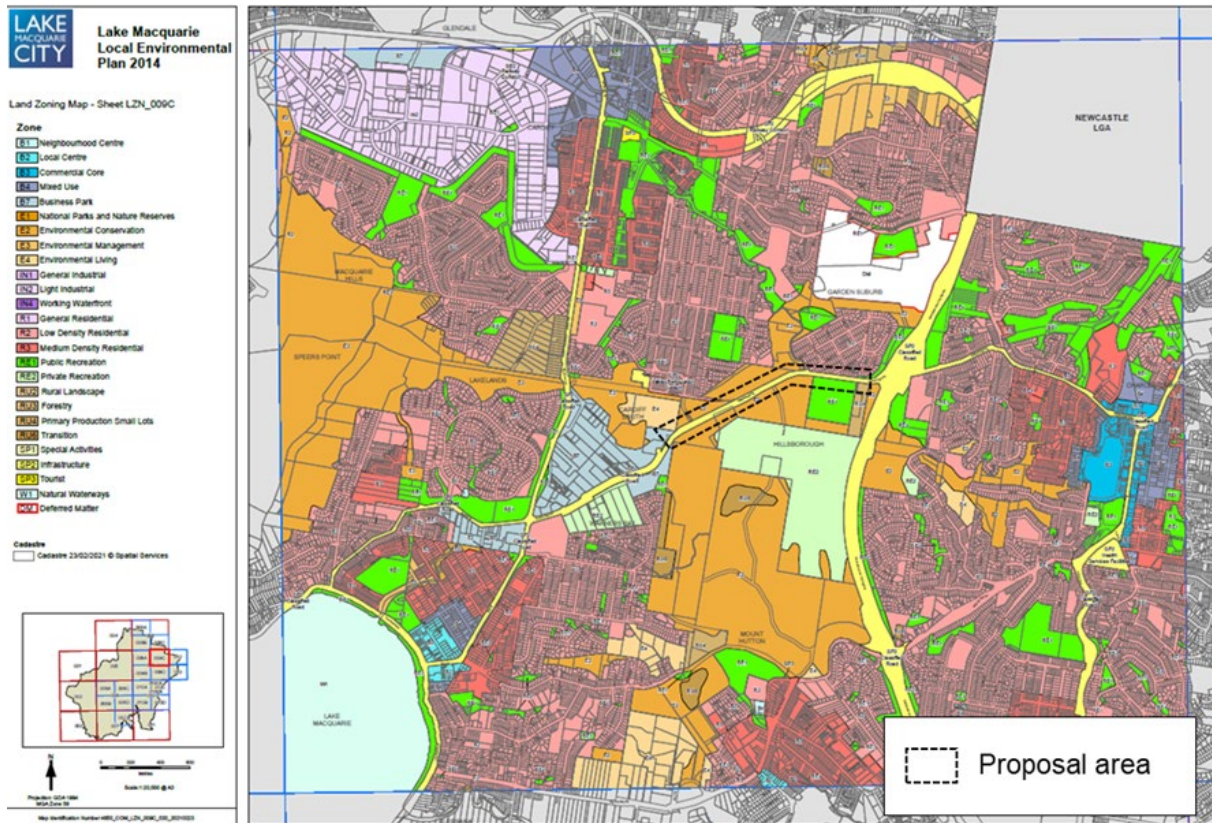
- Hillsborough Road / Crockett Street intersection is currently a seagull intersection. All movements are permitted with turning bays provided for both left and right turn in and out movements
- Hillsborough Road / Barker Avenue intersection is currently a seagull intersection. All movements are permitted with turning bays provided for both left and right turn in and out movements
- Hillsborough Road / Higham Road intersection is currently uncontrolled intersection allowing all movements
- Hillsborough Road / Chadwick Street intersection is currently priority controlled. All movements are permitted. Right turn in and out turning bays are provided on Hillsborough Road. Chadwick Street also aligns with the entrance to the CNCC Showground on the southern side of the road, a major access point during the weekend. Right turn from Hillsborough Road (eastbound) to CNCC Showground is banned.



Figure 2-1 Study area

## 2.2 Existing land use

The Hillsborough Road corridor and the surrounding areas have mixed land use types including the existing residential areas located north and south of the corridor and industrial and commercial areas located mainly east of Macquarie Road and King Street. Figure 2-2 shows the current Lake Macquarie Land Use zoning map and the Hillsborough Road corridor within the study area.



Source: Lake Macquarie Local Environmental Plan 2014, released 30 April 2021  
 ([https://eplanningprod.blob.core.windows.net/pdfmaps/4650\\_COM\\_LZN\\_009C\\_020\\_20210223.pdf](https://eplanningprod.blob.core.windows.net/pdfmaps/4650_COM_LZN_009C_020_20210223.pdf))

Figure 2-2 Land Use Map

## 2.3 Commuter mode share

The 2016 Census data shows the importance of cars for residents' travel mode to work in the proposal study area. Car trips accounted for about 96 per cent of commuter trips. The other modes of travel used by commuters within the study area are public transport (1 per cent) and active transport (2 per cent).

## 2.4 Road and speed environment

Hillsborough Road currently has a posted speed limit of 70 km/h between the western extent of the proposal and Barker Ave and a posted speed limit of 60 km/h between Barker Ave and the Newcastle Inner City Bypass. For school zone, 40 km/h speed limit is applied on the Hillsborough Road between Newcastle Inner City Bypass and Waratah Avenue between 8am and 9.30am in the AM peak and between 2.30pm and 4pm in the PM peak.

Figure 2-3 shows the posted speed limits within the proposal study area.

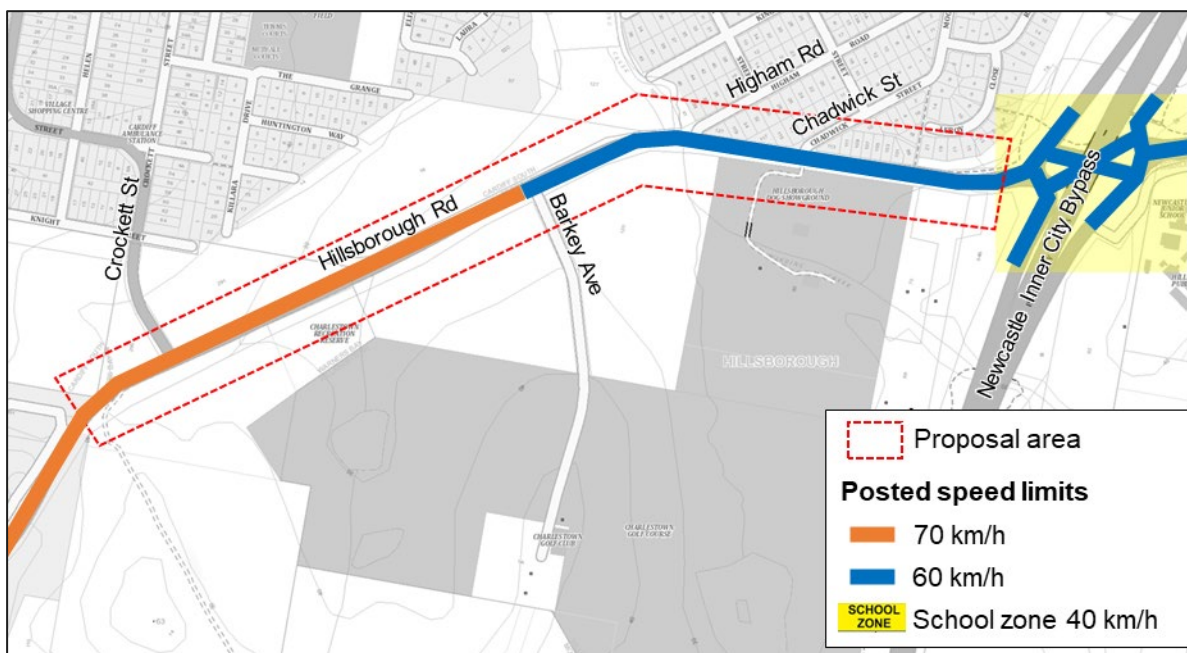


Figure 2-3 Existing posted speed limit on Hillsborough Road

## 2.5 Public transport

The proposal study area is serviced by two bus routes including routes 269 and 339. Figure 2-4 shows the existing bus routes and bus stop locations on the Hillsborough between Crockett Street and Newcastle Inner City Bypass.

During the AM peak two hours between 7am and 9am, there are about two services for each route, equivalent to about an hour for each bus. During the PM peak two hours between 4pm and 6pm, there are about two services for each route, equivalent to about an hour for each bus.

Currently, there are four bus stops on the Hillsborough between Crockett Street and Newcastle Inner City Bypass. Of these, three are bus bays and one is in-lane bus stop. There is no bus stop sign and bus bay at the stop on the westbound direction near Crockett Street.

In addition to the public buses, a number of School buses operate in the corridor servicing Biddabah Public School, St Mary's Primary School, Warners Bay Primary School, Warners Bay High School and Hillsborough Public School.

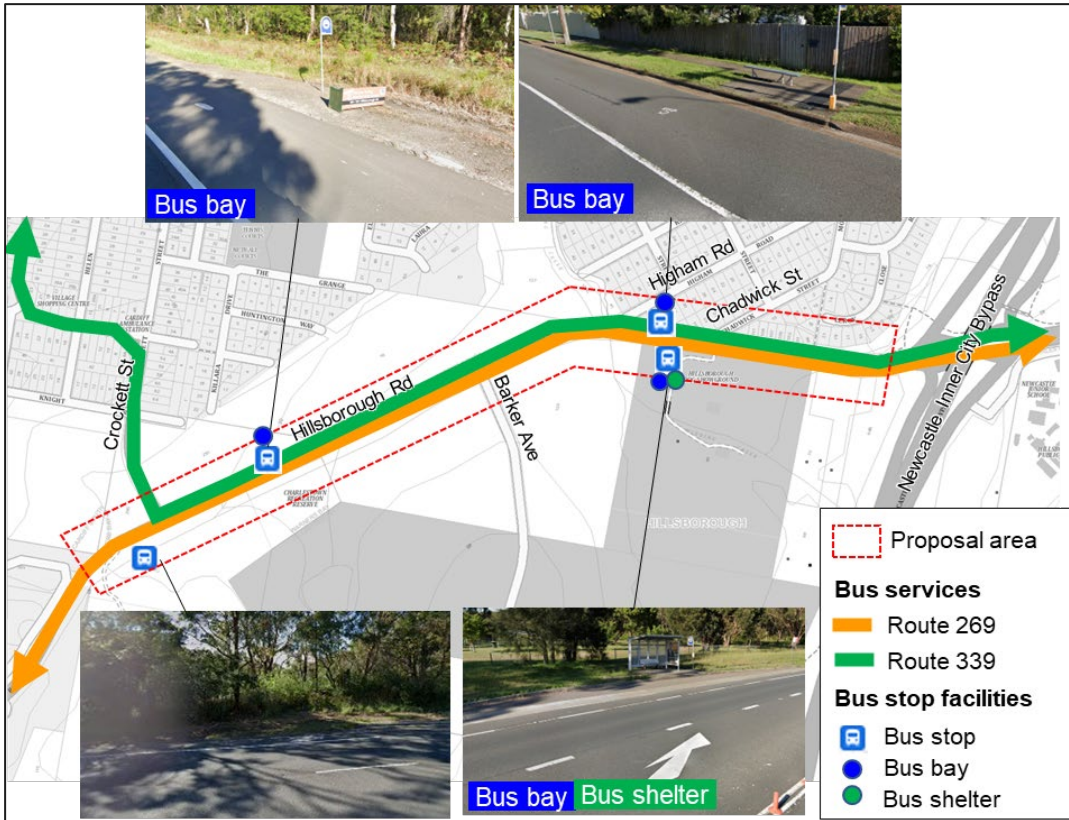


Figure 2-4 Bus services on Hillsborough Road between Crockett Street and Newcastle Inner City Bypass

## 2.6 Active transport

Currently, there is no formal footpath provided along Hillsborough Road between Crockett Street and Newcastle Inner City Bypass. One pedestrian refuge is provided near bus stops at Higham Road. Figure 2-5 shows the existing pedestrian facilities in the proposal study area.

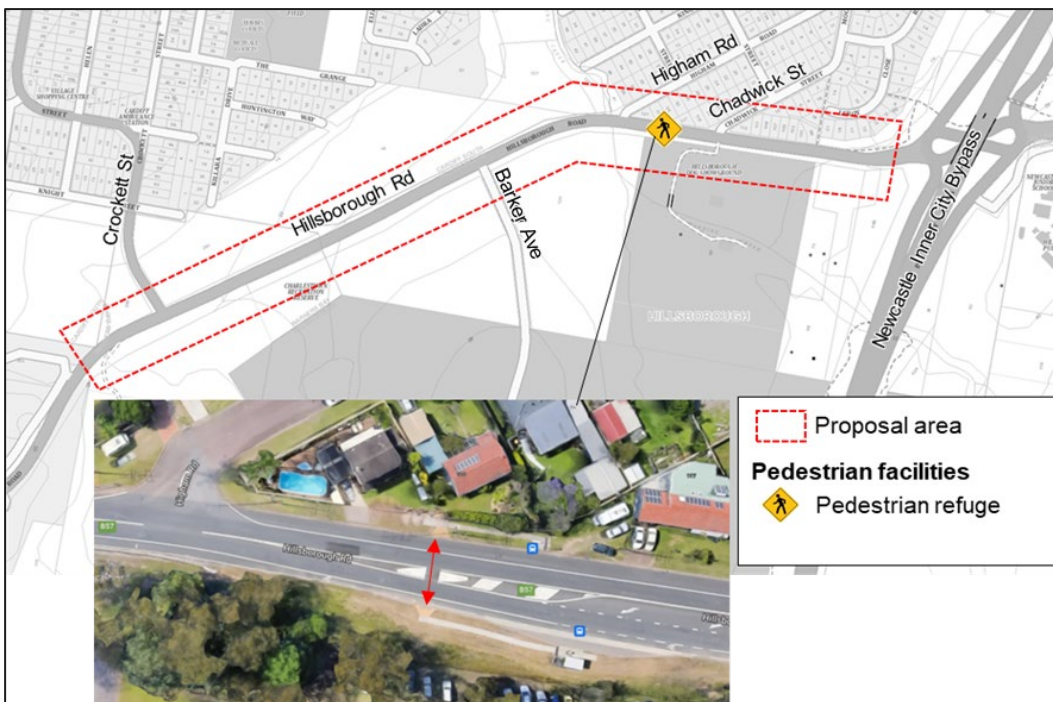


Figure 2-5 Existing pedestrian facilities on Hillsborough Road between Crockett Street and Newcastle Inner City Bypass

Currently, on-road bicycle lanes are provided along Hillsborough Road between Crockett Street and Newcastle Inner City Bypass either eastbound or westbound. The cyclists can cross Hillsborough Road at a pedestrian refuge near Higham Road. Figure 2-5 shows the existing cyclist facilities.

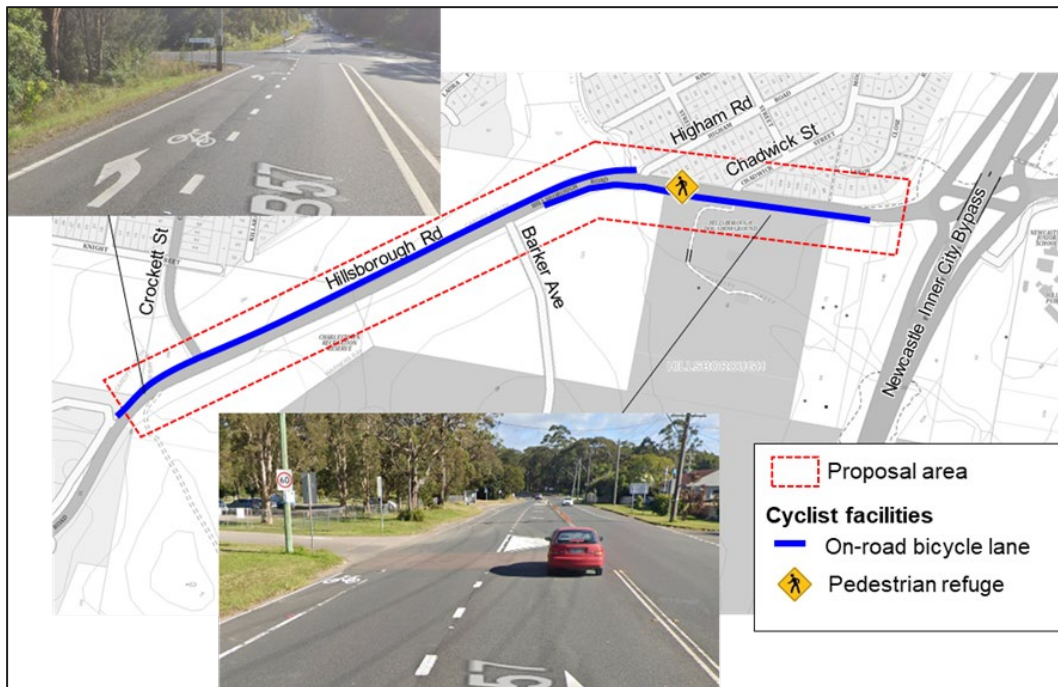


Figure 2-6 Existing cyclist facilities on Hillsborough Road between Crockett Street and Newcastle Inner City Bypass

## 2.7 Parking

Currently, there are small sections of on-street parking available on the Hillsborough Road east of Chadwick Street primarily associated with residential properties. Figure 2-7 shows on-street parking on the Hillsborough eastbound east of Chadwick Street.

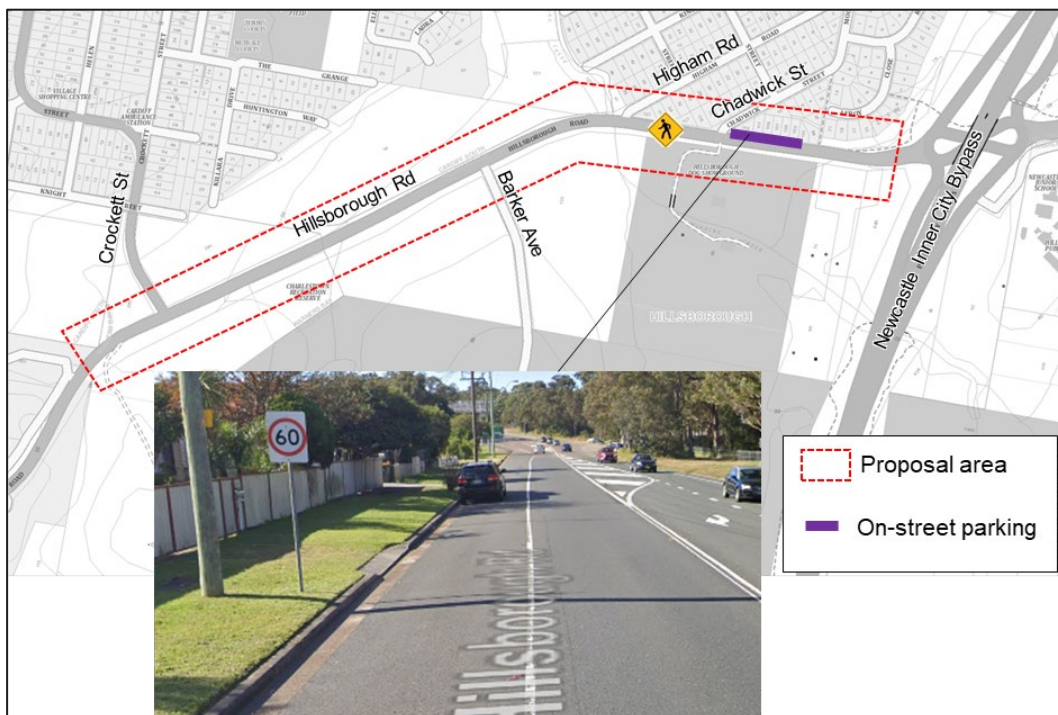


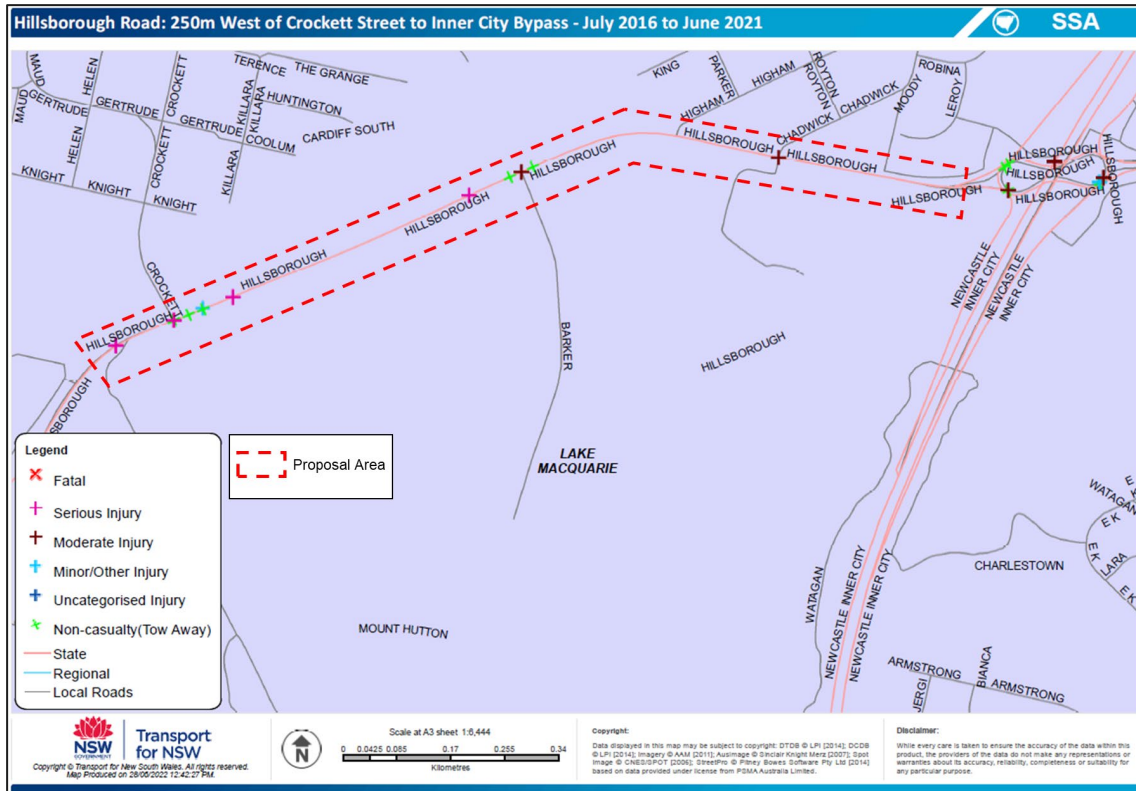
Figure 2-7 Existing parking on Hillsborough Road between Crockett Street and Newcastle Inner City Bypass

## 2.8 Heavy vehicles

Hillsborough Road is a designated B-double route for trucks up to 26 metres long and 4.6 metres in height. The heavy vehicles proportion on the Hillsborough Road between Crockett Street and Newcastle Inner City Bypass is about three to four per cent of total traffic on an average weekday.

## 2.9 Crash data

The five-year crash data between July 2016 to June 2021 on the Hillsborough Road was provided by TfNSW. Figure 2-8 shows the recorded crash location and severity on the Hillsborough Road between Crockett Street and Newcastle Inner City Bypass.



Source: Transport for NSW

Figure 2-8 Spatial distribution of crashes on Hillsborough Road between 2016 to 2021

Table 2-1 summarises five-year crash data recorded on the Hillsborough Road classified by location and crash severity (including fatal, injury and non-casualty).

Table 2-1 Recorded crashes on Hillsborough Road between 2016 and 2021

Road section	Period	Casualty				Non-casualty (towaway)	Total
		Fatal	Serious Injury	Moderate Injury	Minor/Other Injury		
Hillsborough Road between Crockett Street and Newcastle Inner City Bypass	Intersection	0	2	2	1	7	12
	Non-intersection	0	3	0	0	0	3
	Total	0	5	2	1	7	15
		<b>0</b>	<b>33%</b>	<b>13%</b>	<b>7%</b>	<b>47%</b>	<b>100%</b>

F:\10025887\2021 Concept Design (GHD) assessment\2. Calculation\4. Crash data analysis\Hillsborough\_Road\_Crash\_analysis.xlsx\REPORT

During the last five years, from 2016 to 2021, about 15 crashes were recorded on the Hillsborough Road between Crockett Street and Newcastle Inner City Bypass. About 80 per cent (12 crashes) were recorded at intersections.

Of the total 15 crashes recorded, no fatal crash was recorded. About eight crashes (53 per cent) were recorded as casualty crashes, with five crashes being serious injury, two being moderate injury, and one being minor/other injury. About seven non-casualty (tow-away) crashes were recorded, representing about 47 per cent of total crashes.

Figure 2-9 shows the frequency of each crash movement type. Common crash types on the Hillsborough Road included head-on crashes, which accounted for 40 per cent of the recorded crashes. Off-carriageway on straight crashes and rear-end crashes accounted for 20 per cent each. Other crash types include intersections from adjacent approaches and pedestrian crossing carriageways.

One pedestrian-related crash was recorded near the Chadwick Street intersection, indicating the need for pedestrian crossing.

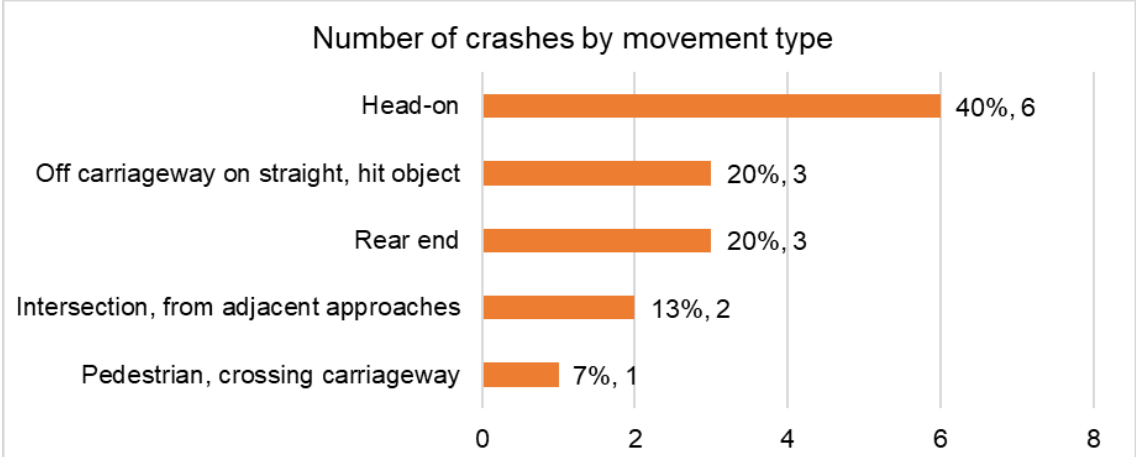


Figure 2-9 Number of crashes per movement type



## 2.10 Traffic volumes

Table 2-2 shows existing daily traffic volumes on Hillsborough Road in 2021. On an average weekday, Hillsborough Road between Crockett Street and Newcastle Inner City Bypass carried about 34,500 to 38,100 vehicles per day. The heavy vehicles proportion on Hillsborough Road is about three to four per cent of total traffic on an average weekday.

Table 2-2 Daily traffic volumes on Hillsborough Road in 2021

Hillsborough Road sections	Average weekday daily volumes (vehicles per day)		
	Total vehicles	Heavy vehicles	% Heavy vehicles
West of Crockett Street	38,100	1,210	3%
West of Higham Street	37,000	1,190	3%
West of Chadwick Street	34,500	1,310	4%

Table 2-3 shows weekday AM and PM peak hour traffic volumes on Hillsborough Road between Crockett Street and Newcastle Inner City Bypass in 2021. The AM peak hour represents between 8am and 9am and PM peak hour represents between 4pm and 5pm traffic conditions.

In the AM peak, Hillsborough Road carries higher traffic volumes in the eastbound direction. About 1,500 to 1,920 vehicles per hour were recorded in the eastbound direction. In the PM peak, higher traffic volumes were observed in the westbound direction. About 1,520 to 1,730 vehicles per hour were recorded in the westbound direction.

The current peak hour volumes of 1,730 to 1,920 vehicles per hour on Hillsborough Road reached to a single-lane capacity.

Table 2-3 AM and PM peak hour volumes in 2021

Hillsborough Road sections	AM peak one hour			PM peak one hour		
	EB	WB	Two-way	EB	WB	Two-way
West of Crockett Street	1,500	1,150	2,650	1,360	1,520	2,880
West of Higham Street	1,830	1,280	3,110	1,510	1,730	3,240
West of Chadwick Street	1,840	1,280	3,120	1,550	1,730	3,280
West of Newcastle Inner City Bypass	1,920	1,300	3,220	1,500	1,700	3,200

## 2.11 Intersection level of service

The existing traffic performance (delay and level of service) of four intersections on the Hillsborough Road with Crockett Street, Barker Avenue, Higham Road, and Chadwick Street were sourced from VISSIM model for weekday AM and PM peak hours.

The intersection level of service (LoS) is reported in accordance with TfNSW Traffic Modelling Guidelines. The guide recommends that level of service is determined by the critical movement with the highest delay for priority intersections such as roundabout and sign-controlled intersections. With these intersection controls (roundabout, Stop and Give Way sign controls), some movements may experience high levels of delay while others may experience a minimal delay.

Table 2-5 below shows TfNSW standard level of service (LoS) criteria for intersection operation.

The level of service criteria for a signalised intersection is related to the average intersection delay measured in seconds per vehicle.

Table 2-4 Level of service criteria for intersections

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way & Stop Signs
A	<15	Good operation	Good operation
B	15 to 28	Good with acceptable delays & spare capacity	Acceptable delays & spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays Roundabouts require other control mode	At capacity, requires other control mode
F	>71	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing

Source: Transport' Traffic Modelling Guidelines, Version 1.0, February 2013

Table 2-5 shows the existing level of service for Crockett Street, Barker Avenue, Higham Road, and Chadwick Street intersections in 2021 for AM and PM peak hour.

As per the Guide, delay and level of service for existing condition is shown for the critical movement with the highest delay for priority intersections such sign-controlled intersections.

Table 2-5 Existing level of service for key intersections in 2021

Intersection	Control type	AM		PM	
		Delay (sec)	LoS	Delay (sec)	LoS
Crockett Street / Hillsborough Road	Sign controlled	171	F	163	F
Barker Avenue / Hillsborough Road	Sign controlled	23	B	96	F
Higham Road / Hillsborough Road	Sign controlled	594	F	71	F
Chadwick Street / Hillsborough Road	Sign controlled	449	F	83	F

Source: VISSIM models, AM peak hour represents between 8am and 9am and PM peak hour represents between 4pm and 5pm.

Currently, all four intersections experience significant delays and poor level of service F either in AM or PM peak hour particularly for traffic exiting from Crockett Street, Barker Avenue, Higham Road and Chadwick Street. The high through traffic volumes in conjunction with a single lane on the

Hillsborough Road contributed substantial delays to these approach roads either in AM or PM peak. At Crockett Street intersection, traffic exiting from Crockett Street currently experiences delays between 2.9 minutes (AM peak) and 2.7 minutes (PM peak). Although traffic volumes at Barker Avenue are low, high level of delays are experienced by traffic exiting from Barker Avenue in PM peak (about 1.6 minutes). In AM peak, high eastbound through traffic on the Hillsborough Road in conjunction with a single lane contributed significant delays to traffic exiting either from Higham Road or Chadwick Street (delays between 7.5 minutes to 10 minutes). It is considered that this is unlikely to be consistently realised in reality as for regular occurring delays road users are likely to utilise alternate routes or travel outside of peak periods.

The existing condition (in 2021) delay and level of service results indicate the need to improve capacity at these four intersections.

Detailed intersection turning volumes, delay and level of service by approaches for existing condition in 2021 are included in **Appendix B**.

### 2.12 Travel time

The existing travel times are reported for the 2.3-kilometre section on the Hillsborough Road between Newcastle Inner City Bypass roundabout (point B on Figure 2-10) and Warners Bay commercial area (traffic signal approximately 350 metres east of Warners Bay roundabout, point A on Figure 2-10). The travel time data is reported for the longer distance than the proposal area (1.8 km) to capture upstream and downstream congestions.

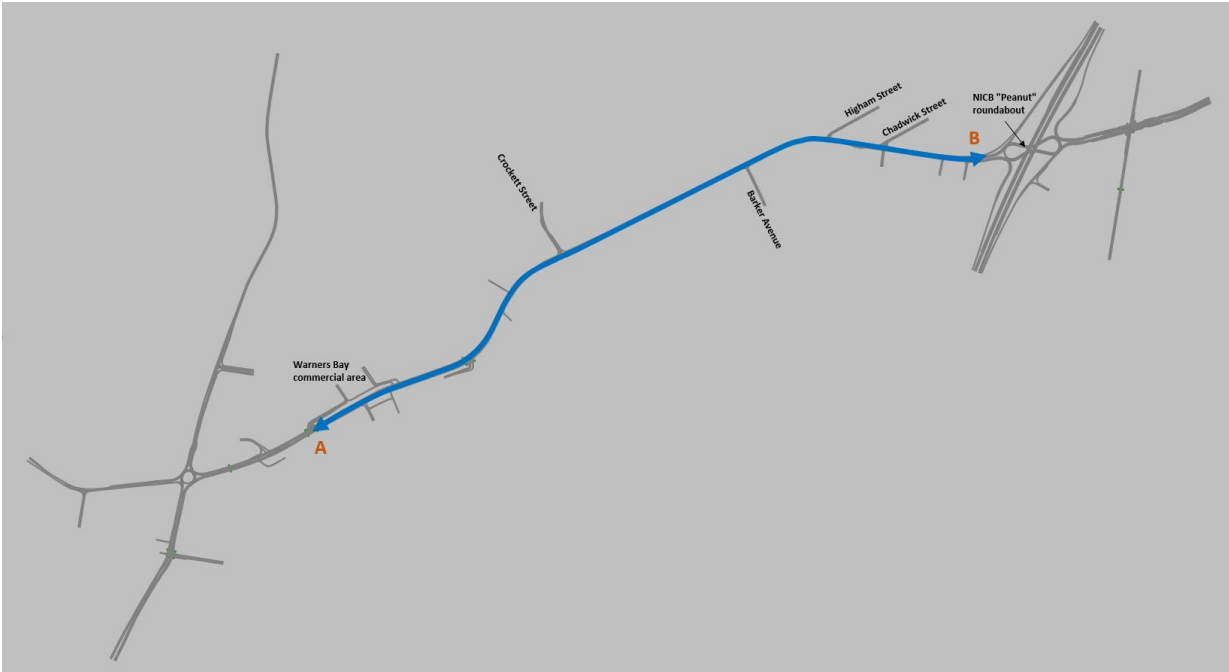


Figure 2-10 Travel time routes

Table 2-6 shows existing (in 2021) travel time and travel speed on the Hillsborough Road for eastbound and westbound directions in AM and PM peak hour. Table 2-6 also shows relative travel speed reduction compared to the posted speed on the Hillsborough Road.

Table 2-6 Existing travel time and travel speed on Hillsborough Road in 2021

Peak period	Direction	Average travel time (minutes)	Average travel speed (km/h)	% travel speed lower than posted speed
AM peak	Eastbound	7.5	18	70%
	Westbound	3.0	45	25%
PM peak	Eastbound	2.7	50	16%
	Westbound	3.1	45	26%

Source: VISSIM models, AM peak hour represents between 8am and 9am and PM peak hour represents between 4pm and 5pm.

Currently (in 2021), motorists took from 2.7 minutes to 7.5 minutes to travel about 2.3 kilometres section on the Hillsborough Road depending on the peak travel directions. In AM peak, motorist took about 7.5 minutes to travel on the Hillsborough Road primarily contributed by substantial eastbound through traffic volumes and two merge points before and after Crockett Street. The average travel speed on the Hillsborough Road during peak hour varies between 18 km/h and 50 km/h, being 16 per cent to 70 per cent lower than the posted speed. The data suggests, currently single lane on Hillsborough Road is at capacity in peak periods with low travel speeds between Crockett Street and Newcastle Inner City Bypass.

## 3 Traffic modelling methodology

This section provides an overview of the traffic modelling and analysis methodology that has been adopted for the traffic and transport assessment. The objective was to make the best use of available traffic count data and modelling software to determine the base and future conditions for the proposal and the surrounding local road network in terms of generating vehicle volumes and assessing the operational performance, both with and without the proposal.

### 3.1 VISSIM model

The modelling for the proposal was undertaken by using VISSIM microsimulation model developed previously for Hillsborough Road between Crockett Street, Chadwick Street, Barker Avenue and Higham Road roundabout during strategic design phase of the proposal. The model was developed using VISSIM software (version 2021). Figure 3-1 shows the broader VISSIM network developed for Hillsborough Road.

The VISSIM model was further updated for the proposal area between Crockett Street and Newcastle Inner City Bypass (shown as a red dotted line on Figure 3-1).

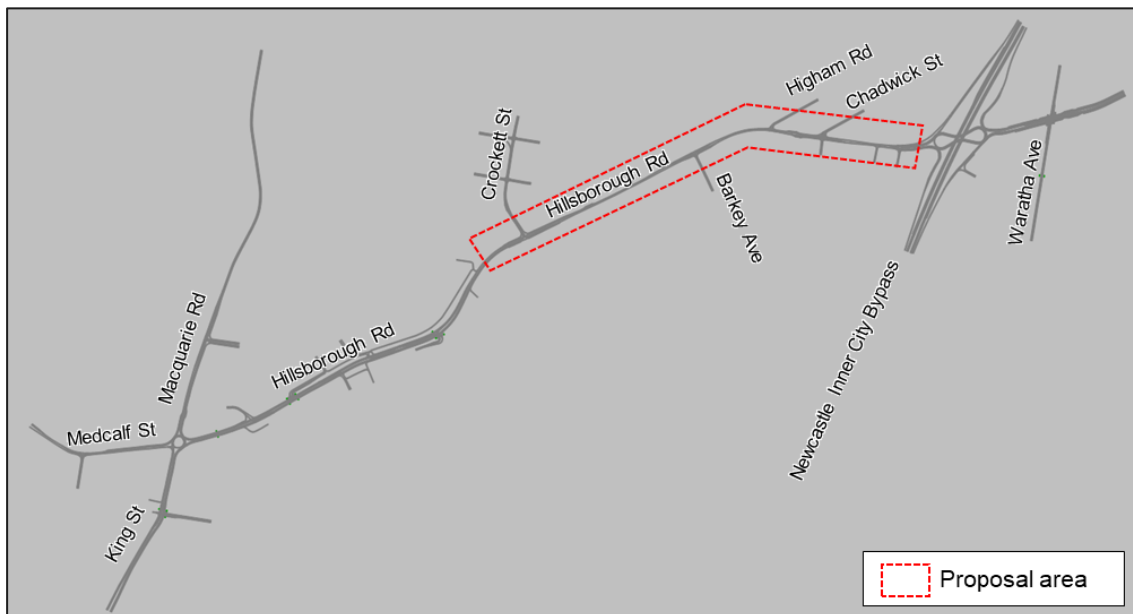


Figure 3-1 Update VISSIM model for Hillsborough Road between Crockett Street and Newcastle Inner City Bypass

The base year model was updated for 2021 traffic conditions and followed the Transport's *Traffic Modelling Guidelines, version 1, February 2013*.

The VISSIM model was developed for the AM two-hour peak period between 7am and 9am and for the PM two-hour peak period between 4pm and 6pm. A warm-up period (60 minutes) and a cool-down period (60 minutes) were added to each AM and PM peak period.

Future years VISSIM modelling was undertaken for 2027 and 2037.

#### 3.1.1 VISSIM model updates

During the strategic design phase, Arcadis developed a microsimulation traffic model for Hillsborough Road between Warners Bay roundabout (Hillsborough Road / Macquarie Road / King Street) and Newcastle Inner City Bypass roundabout using VISSIM software. The base year model represented 2018 traffic conditions and included improvements to the Newcastle Inner City Bypass / Hillsborough Road roundabout. The base 2018 model contained demand and was calibrated and validated as per traffic data collected in November 2017. The 2018 base model was reviewed and accepted by TfNSW.

For the concept design and REF purposes, the base 2021 model was developed based on the base 2018 model and the background traffic growth rate of 1.5 per cent per annum. The traffic demand in the VISSIM model was grown by six per cent between 2017 and 2021 (4 years). The background traffic growth rate of 1.5 per cent per annum is consistent with the future growth rate assumption used during the strategic phase investigation (Section 4.1).

### 3.1.2 Modelling assumptions

The following assumptions are used for traffic modelling and assessment:

- The base year VISSIM model represents 2021 traffic conditions
- The proposal refers to 80% concept design developed by GHD. At the time of undertaking traffic modelling for 80% concept design, future years were assumed to be 2024 and 2034. Following completion of 80% concept design, future years were amended to 2027 and 2037
- Proposal opening year is assumed to be 2027
- Traffic performance is assessed for opening year in 2027 and 10 years after opening in 2037
- The future base case 'Do Minimum network is essentially the "existing condition" network as per year 2021.

### 3.2 Relevant guidelines

The following guidelines were referenced in carrying out this assessment:

- *Transport Traffic Modelling Guideline*, version 1, February 2013
- *Transport Technical Direction (TTD 2017/001) Operational Modelling Reporting Structure*, May 2017.

### 3.3 Assessment criteria

The operation of the modelled road network provides an overview of the performance of the road network and is used to identify the impact of the proposal. This impact was assessed across the network and at intersection level:

- At a network level. This includes average travel speed, total distance travelled, and total time travelled within the modelled network
- At an intersection level. The performance of an intersection and its level of service (LoS) is determined by the average delay per vehicle. The performance criteria for intersections are shown in Table 2-4.

#### 3.3.1 Network performance criteria

Road network performance statistics are extracted from VISSIM traffic models for AM and PM peak periods, and the statistics used in this assessment are defined as follows:

- Total vehicle hours travelled in the study area (VHT)
- Total vehicle kilometres travelled across the study area (VKT)
- Average network travel speed – which is the average speed (kilometres per hour) of vehicles in the study area during the modelled periods
- Total stops – which is the cumulative total of every instance when a vehicle comes to a stop within the network. A stop is defined as a vehicle's speed dropping below five kilometres per hour until it accelerates to above ten kilometres per hour
- Latent demand – which is the total number of vehicles that cannot enter the model due to model constraints such as congestion.

## 4 Future traffic conditions without the Proposal

This section outlines the future traffic conditions without the proposal, including traffic growth rates and forecast traffic volumes in 2027 and 2037.

**Appendix A** includes growth rate assumption technical paper.

### 4.1 Future traffic growth

The future traffic growth on Hillsborough Road was estimated using TfNSW STFM data. The analysis suggested a linear growth rate of 1.5 per cent per annum between 2017 and 2044. The future traffic growth rate assumption on the Hillsborough Road was agreed with TfNSW during strategic phase investigation.

Table 4-1 shows future growth rates used in VISSIM traffic modelling. Future traffic growth on Hillsborough Road between Crockett Street and Newcastle Inner City Bypass is assumed to be 1.5 per cent per annum between 2021 and 2037.

Table 4-1 Future traffic growth rate in 2027 and 2037

Modelling year	Annual growth rate
2021 to 2027	1.5% p.a.
2027 to 2037	1.5% p.a.

### 4.2 Forecast traffic volumes

Traffic volumes on Hillsborough Road will continue to grow due to population and employment growth. The average weekday traffic volumes on Hillsborough Road between Crockett Street and Newcastle Inner City Bypass are predicted to grow from 34,500-38,100 vehicles per day in 2021 to 37,400-41,300 vehicles per day in 2027.

In 2037, traffic volumes on Hillsborough Road are predicted to increase to 42,300-46,700 vehicles per day, equivalent to about 130 per cent of 2021 traffic volumes. Table 4-2 shows predicted daily traffic volumes on Hillsborough Road in 2027 and 2037.

Table 4-2 Average weekday volumes on Hillsborough Road in 2027 and 2037

Hillsborough Road sections	Average weekday volumes (vehicles per day)		
	2021	2027	2037
West of Crockett Street	38,100	41,300	46,700
West of Higham Street	37,000	40,100	45,400
West of Chadwick Street	34,500	37,400	42,300

### 4.3 Consequences of inaction or delay

There is a significant need to address the constraints and issues associated with the existing Hillsborough Road configuration between Crockett Street and Newcastle Inner City Bypass to minimise avoidable costs to road users, provide an acceptable level of road transport infrastructure consistent to its classification as a movement corridor catering to both existing and future growth.

The traffic demand on Hillsborough Road is predicted to intensify (forecast to be approximately 1.5 per cent per annum) as a result of continuing population and employment growth in the Lake Macquarie local government area (LGA). The consequences of deferral, inaction or delay in upgrading this section of road, in association with this forecast growth, includes:

- Continued poor performance of Hillsborough Road, particularly at Crockett Street, Chadwick Street, Barker Avenue and Higham Road intersections under peak conditions. Over time, traffic congestion

will increase, and intersection performance will decrease due to failure to accommodate increased traffic growth

- A likely increase in the vehicle crash rate through deteriorating travel conditions
- Loss of opportunity to improve accessibility and efficiency for public and active transport
- Increased constructability challenges of working adjacent to higher traffic volumes.

As Crockett Street, Chadwick Street, Barker Avenue and Higham Road intersections already performs at poor level of service (LoS F) either AM or PM peak, the forecast growth in traffic demand in 2027 and 2037 will only serve to exacerbate the delay and congestion associated with these intersections.

Table 4-3 and Table 4-4 show predicted delay and level of service for Crockett Street, Barker Avenue, Higham Road and Chadwick Street intersections in 2027 and 2037 without the proposal.

Table 4-3 Level of service for key intersections without proposal in 2027

Intersection	Control type	AM		PM	
		Delay (sec)	LoS	Delay (sec)	LoS
Crockett Street / Hillsborough Road	Sign controlled	214	F	267	F
Barker Avenue / Hillsborough Road	Sign controlled	32	C	172	F
Higham Road / Hillsborough Road	Sign controlled	722	F	118	F
Chadwick Street / Hillsborough Road	Sign controlled	>800	F	325	F

Source: VISSIM models, AM peak hour represents between 8am and 9am and PM peak hour represents between 4pm and 5pm.

Table 4-4 Level of service for key intersections without proposal in 2037

Intersection	Control type	AM		PM	
		Delay (sec)	LoS	Delay (sec)	LoS
Crockett Street / Hillsborough Road	Sign controlled	217	F	540	F
Barker Avenue / Hillsborough Road	Sign controlled	53	D	337	F
Higham Road / Hillsborough Road	Sign controlled	>800	F	273	F
Chadwick Street / Hillsborough Road	Sign controlled	>800	F	470	F

Source: VISSIM models, AM peak hour represents between 8am and 9am and PM peak hour represents between 4pm and 5pm.

By 2037, traffic out of Crockett Street approach could incur delays between 3.6 minutes (AM peak) and 9 minutes (PM peak). Similarly, traffic out of Barker Avenue could incur delays more than 5 minutes in PM peak hour. In AM and PM peak hours, the residences on Higham Road and Chadwick Street could incur significant delays of more than 13 minutes.

It is considered that this is unlikely to be consistently realised in reality as for regular occurring delays road users are likely to utilise alternate routes or travel outside of peak periods. The level of service results in 2027 and 2037 indicates the need to improve capacity at these four intersections.

Detailed intersection turning volumes, delay and level of service by approaches without proposal in 2027 and 2037 AM and PM peak periods are included in **Appendix B**.



### 4.3.1 Impact to the broader road network

The single lane on the Hillsborough Road including current sign-controlled priority intersections with Crockett Street, Chadwick Street, Barker Avenue and Higham Road would impact traffic performance of the broader road network (refer to Figure 3-1). The broader network also includes Warners Bay roundabout (Hillsborough Road / Macquarie Road / King Street) and Newcastle Inner City Bypass roundabout. Table 4-5 shows key network performance for the broader road network in 2021, 2027 and 2037 without the proposal.

Table 4-5 Future network performance in 2021, 2027 and 2037

Network statistics	Base case / Do minimum	
	AM peak one hour (8am – 9am)	PM peak one hour (4pm – 5pm)
<b>2021</b>		
Demand (vehicles)	7,969	8,439
Latent demand (vehicles)	615	550
% Unreleased demand	8%	7%
Total trip time (VHT)	790	725
Total trip length (VKT)	17,306	17,469
Average network speed (km/h)	22	24
Number of stops	78,180	65,689
<b>2027</b>		
Demand (vehicles)	8,263	9,594
Latent demand (vehicles)	1,727	1,307
% Unreleased demand	21%	14%
Total trip time (VHT)	1,257	1,018
Total trip length (VKT)	17,286	20,080
Average network speed (km/h)	14	20
Number of stops	111,302	98,088
<b>2037</b>		
Demand (vehicles)	10,378	12,035
Latent demand (vehicles)	3,409	5,457
% Unreleased demand	33%	45%
Total trip time (VHT)	1,640	2,298
Total trip length (VKT)	21,945	25,456
Average network speed (km/h)	13	11
Number of stops	184,701	230,005

Between 2021 and 2037, total vehicle hours travelled (VHT) increased by 108 per cent in the AM peak and 217 per cent in the PM peak. In contrast, vehicle kilometres travelled (VKT) only increased by 27 per cent and 46 per cent, respectively. Such scenarios in which travel time greatly outstrips growth in travel distance indicate a highly congested network for the base case (without proposal).

In 2027 and 2037, latent demands increased significantly between 14% and 45% indicate a highly congested network.

## 5 Traffic performance of the Proposal

This section documents traffic modelling and analysis of future conditions with the proposal.

### 5.1 The proposal

The proposal involves duplication of about 1.8 kilometres of Hillsborough Road from the Newcastle Inner City Bypass (NICB) roundabout west to a tie in point about 300 metres west of Crockett Street.

Key features of the proposal include:

- Two lanes each a minimum 3.3 metre wide each way with a solid central median barrier
- Posted speed of 60 kilometres per hour
- New traffic lights at the Chadwick Street intersection including pedestrian crossings
- Modification of Higham Road intersection
- New traffic lights at the Baker Avenue intersection including pedestrian crossing
- U-turn bay on Barker Avenue
- Access gates to be relocated beyond u-turn facility
- New traffic lights at the Crockett Street intersection including pedestrian crossings
- Provision for on road cyclists within shoulder in both directions
- Off road concrete shared path on the northern side tying into existing path
- Upgraded bus stop facilities on Hillsborough Road at Crockett Street intersection, Chadwick Street intersection and on Crockett Street. All bus stops are to have shelters with the exception of the southbound bus lay over on Crockett Street
- Culvert widening on Winding Creek both up stream and down stream of existing culvert structure
- Culvert widening and full replacement of existing culvert between Crockett Street and Baker Avenue
- New separated left in only entry and left out only exit for the CNCC Showgrounds located east (entry) and west (exit) of Chadwick Street intersection
- Maintained access to the Hillsborough Road fire trail opposite Crockett Street
- Left in / left out only access from existing business fronting Hillsborough Road, east of the CNCC Showgrounds.
- Left in / left out only access to residences on Hillsborough Road, east of CNCC Showgrounds
- Relocation of utilities including, telecommunications, water, power, street lighting and minor adjustments to sewer infrastructure
- New as well as upgraded street lighting on Hillsborough Road
- Reinforced concrete retaining walls including facing panels
- Site preparation works, including establishing ancillary facilities, vegetation clearing, site fencing, temporary drainage measures, and implementation of environmental management measures

Temporary construction facilities, including site compounds and stockpile sites at The former Whalan's Nursery site– Hillsborough Road, and at vacant commercial buildings within the Warners Bay Commercial Centre – Accessed by northern commercial access road of Hillsborough Road.

## 5.2 Intersection level of service improvement

New traffic signals are proposed at Crockett Street intersection, Barker Avenue intersection and Chadwick Street intersection. The traffic performance is analysed for the following four upgraded intersections in 2027 and 2037 including:

- Crockett Street (new traffic signals)
- Barker Avenue (new traffic signals)
- Higham Road (left out only)
- Chadwick Street (new traffic signals).

Table 5-1 and Table 5-2 show delay and level of service at four upgraded intersections in 2027 and 2037.

Table 5-1 Level of service for key intersections with proposal in 2027

Intersection	Control type	AM peak		PM peak	
		Delay (sec)	LoS	Delay (sec)	LoS
Crockett Street / Hillsborough Road	New traffic signals	16	B	20	B
Barker Avenue / Hillsborough Road	New traffic signals	15	B	12	A
Higham Road / Hillsborough Road	Left out only	16	B	12	A
Chadwick Street / Hillsborough Road	New traffic signals	12	A	8	A

Source: VISSIM models, AM peak hour represents between 8am and 9am and PM peak hour represents between 4pm and 5pm.

Table 5-2 Level of service for key intersections without proposal in 2037

Intersection	Control type	AM		PM	
		Delay (sec)	LoS	Delay (sec)	LoS
Crockett Street / Hillsborough Road	New traffic signals	20	B	23	B
Barker Avenue / Hillsborough Road	New traffic signals	17	B	14	A
Higham Road / Hillsborough Road	Left out only	30	B	17	B
Chadwick Street / Hillsborough Road	New traffic signals	16	B	10	A

Source: VISSIM models, AM peak hour represents between 8am and 9am and PM peak hour represents between 4pm and 5pm.

The new traffic signals at Crockett Street, Barker Avenue and Chadwick Street intersection would provide adequate capacity and an acceptable level of service B or better in 2027 and 2037.

Detailed intersection turning volumes, delay and level of service by approaches in 2027 and 2037 with the proposal are included in **Appendix B**.

### 5.3 Travel time savings

Travel time savings by the proposal were reported for the 2.3-kilometre section on the Hillsborough Road between Newcastle Inner City Bypass roundabout and Warners Bay commercial area (refer to previous Figure 2-10).

Table 5-3 and Table 5-4 show average travel times (minutes) for the base case (without proposal) and the project case (with proposal) in 2027 and 2037.

Table 5-3 Travel time savings on Hillsborough Road in 2027

Peak period	Direction	Average travel time (minutes)		
		Base case (without proposal)	Project case (with proposal)	Change/Savings
Weekday AM peak	Eastbound	8.3	3.5	-4.8
	Westbound	4.2	3.2	-1.0
Weekday PM peak	Eastbound	3.6	3.2	-0.4
	Westbound	4.7	3.9	-0.9

Table 5-4 Travel time savings on Hillsborough Road in 2037

Peak period	Direction	Average travel time (minutes)		
		Base case (without proposal)	Project case (with proposal)	Change/Savings
Weekday AM peak	Eastbound	10.8	3.6	-7.2
	Westbound	5.6	3.3	-2.3
Weekday PM peak	Eastbound	5.7	3.5	-2.2
	Westbound	8.0	4.7	-3.3

In 2027, the proposal would reduce journey time on the Hillsborough Road by up to 4.8 minutes during peak periods. In 2037, travel time savings by the proposal are estimated to be up to 7.2 minutes during peak periods.

## 5.4 Broader network performance improvement

Table 5-5 summarises network performance for the broader Hillsborough Road network in 2027 and 2037 base case (without proposal) and project case (with proposal).

Table 5-5 Future network performance with and without proposal in 2027 and 2037

Time Period	2027			2037		
	Base case (without proposal)	Project case (with proposal)	% change	Base case (without proposal)	Project case (with proposal)	% change
<b>AM peak one hour</b>						
Total trips (vehicles)	8,263	8,263		10,378	10,378	
Latent demand (vehicles)	1,727	554		3,409	1,600	
% Unreleased demand	21%	7%		33%	15%	
Total trip time (VHT)	1,257	736	-41%	1,640	954	-42%
Total trip length (VKT)	17,286	17,058	-1%	21,945	21,644	-1%
Average network speed (km/h)	14	23		13	23	
Stops	111,302	75,698	-32%	184,701	95,894	-48%
<b>PM peak one hour</b>						
Total trips (vehicles)	9,594	9,594		12,035	12,035	
Latent demand (vehicles)	1,307	822		5,457	2,173	
% Unreleased demand	14%	9%		45%	18%	
Total trip time (VHT)	1,018	869	-15%	2,298	1,296	-44%
Total trip length (VKT)	20,080	19,802	-1%	25,456	25,128	-1%
Average network speed (km/h)	20	23		11	19	
Stops	98,088	90,512	-8%	230,005	138,782	-40%

The network performance data show that the proposal would improve traffic performance of the broader Hillsborough Road network. The proposals would significantly reduce unreleased/ latent demand from 45 per cent under the base case (PM, without proposal) to 18 per cent under the project case (PM, with proposal). This indicates improved traffic throughput and accessibilities across the network.

In 2027, the proposal would reduce AM peak network travel time by up to 41 per cent and number of stops by up to 32 per cent. By 2037, the model shows network travel time reductions by up to 44 per cent (PM) and number of stops by up to 48 per cent (AM) during the peak period.

Overall, the proposal would increase lane capacity and improve intersection operation for vehicles traveling east-west along the Hillsborough Road. The proposed upgrade would address capacity issues along a key strategic network including intersections and improve local community accessibilities. The upgrade would improve access to local communities of Hillsborough and Cardiff.

## 5.5 Impact on other modes

### 5.5.1 Bus services

The proposal would not impact current bus routes. The proposal would improve bus travel time reliability due to reduced congestion and improved intersection performance.

The proposal also includes widening and relocating the bus stops to provide safer connectivity and access. These changes include:

- Two bus stops on Hillsborough Road near Crockett Street will be widened and relocated close to new traffic signals and upgraded pedestrian crossing facilities at Crockett Street
- Two bus stops on Hillsborough Road near Chadwick Street will be widened and relocated close to new traffic signals and upgraded pedestrian crossing facilities at Crockett Street.

### 5.5.2 Pedestrian and cyclist

The proposal includes providing share paths along Hillsborough Road eastbound between Crockett Street and Newcastle Inner City Bypass.

The proposal would increase and upgrade pedestrian crossing facilities along Hillsborough Road at three new traffic signals with Crockett Street, Barker Avenue and Chadwick Street including:

- Pedestrian crossing is provided on the western and northern approaches at Crockett St intersection
- Pedestrian crossing is provided on Hillsborough Road western approach at Barker Avenue intersection
- Pedestrian crossing is provided on all approaches at Chadwick Street intersection

These changes to the pedestrian network would improve connectivity, improve desire lines and provide safer access to bus stops.

## 6 Management and mitigation measures

### 6.1 Construction

During construction traffic impact on the Hillsborough Road is likely to increase depending on stages and locations. However, these impacts are expected to be minor and would not impact the operational performance of Hillsborough Road. The construction staging would maintain the existing traffic lane and accessibility on Hillsborough Road. Traffic management plans and construction staging would be progressively developed and refined during construction to facilitate the safe and efficient movement of traffic through and around the proposal area and to and from construction locations and ancillary facilities.

Measures to be implemented to manage potential traffic impacts during construction are:

- A Traffic Management Plan (TMP) will be prepared and implemented for traffic as part of the Construction Environmental Management Plan (CEMP) for the construction phase of the proposal. This will adhere to *Traffic Control at Worksites, Technical Manual, Issue No. 6, Transport, September 2020* and *QA Specification G10 Traffic Management (Transport, August 2020)*. This will include details on:
  - Measures to maintain access to properties and local roads
  - Site specific traffic control measures to manage and regulate traffic movement
  - Requirement and methods to consult and inform the local community of impacts on the local road network
  - Measures to maintain pedestrian and cyclist access
  - Access to ancillary sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads
  - A response plan for any construction road traffic incident
  - Consideration of other developments which may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic
  - Monitoring, review and amendment mechanisms.
- Traffic management plans would be prepared for the construction area and progressively updated as the works progress. The plans would be prepared and implemented by suitably qualified personnel
- Schedule partial and full road closures to avoid peak periods
- Undertake consultation with local and regional bus companies prior to and during construction
- Undertake consultation with emergency services prior to and during construction to confirm any diversions during construction and any operational road network changes
- Undertake consultation with property owners and occupiers regarding changes to access arrangements
- Undertake consultation with local Council regarding potential impacts to parking during the construction period.

## 6.2 Operation

Measures to manage potential traffic impacts and changes during operation include:

- Review incident management plan in the event the road may be temporarily closed due to scheduled maintenance or accident
- Consult with residents who may be affected by the temporary closure due to scheduled maintenance or accident.



## 7 Summary and conclusions

### 7.1 Overview

This report documents the traffic and transport assessment of the proposed Hillsborough Road upgrade from the Newcastle Inner City Bypass (NICB) roundabout west to a tie in point about 300 metres west of Crockett Street (the Proposal). This involves an assessment of the existing traffic conditions, future traffic growth analysis and modelling concept design for future years. During preparing this report, relevant documents associated with the proposal have been reviewed, and the potential traffic impacts on the study area road network have been assessed.

For traffic assessment purposes, traffic models were built using VISSIM software. Future traffic conditions on the Hillsborough Road were modelled for 2027 (opening year of the proposal) and 2037 (10 years after opening) for both morning (AM) and afternoon (PM) peak periods.

This traffic and transport assessment report has been prepared to support the concept design and review of environmental factors (REF) for the proposal.

### 7.2 Study area

Hillsborough Road is a major road corridor in the Lake Macquarie Local Government Area. Hillsborough Road carries significant regional and local traffic volumes, providing an important connection between Warner Bay, Cardiff and Newcastle Inner City Bypass.

The study area includes about 1.8-kilometres of Hillsborough Road from the Newcastle Inner City roundabout west to a tie in point about 300 metres west of Crockett Street. The study area includes four key intersections on the Hillsborough Road with Crockett Street, Barker Avenue, Higham Road, and Chadwick Street.

The 1.8 kilometres of Hillsborough Road is currently constrained by two lanes undivided road (one lane in each direction).

### 7.3 Existing traffic conditions

In 2021, Hillsborough Road between the Newcastle Inner City Bypass and Crockett Street carried about 34,500 to 38,100 vehicles per day. The heavy vehicles proportion on the Hillsborough Road was about three to four per cent of total traffic on an average weekday.

Hillsborough Road between the Newcastle Inner City Bypass and Crockett Street is one lane in each direction, with peak hour traffic volumes over the broader peak at theoretical capacity for a single lane.

Currently, four sign-controlled intersections on the Hillsborough Road with Crockett Street, Barker Avenue, Higham Road and Chadwick Street operate with poor Level of Service F either in the morning or afternoon peak hour.

### 7.4 Future traffic conditions without the Proposal

Between 2021 and 2037, traffic volumes on the Hillsborough Road are predicted to grow by 1.5 per cent per annum. The average weekday traffic volumes on the Hillsborough Road between the Newcastle Inner City Bypass and Crockett Street are predicted to grow from 34,500-38,100 vehicles per day in 2021 to 37,400-41,300 vehicles per day in 2027.

In 2037, traffic volumes on the Hillsborough Road are predicted to increase to 42,300-46,700 vehicles per day, equivalent to about 130 per cent of 2021 traffic volumes.

The consequences of deferral, inaction or delay in upgrading this section of road, in association with this forecast growth, include:

- Continued poor performance of Hillsborough Road, particularly at Crockett Street, Chadwick Street, Barker Avenue and Higham Road intersections under peak conditions. Over time, traffic congestion

will increase, and intersection performance will decrease due to failure to accommodate increased traffic growth

- Between 2021 and 2037, total vehicle hours travelled (VHT) increased by 108 per cent in the AM peak and 217 per cent in the PM peak. In contrast, vehicle kilometres travelled (VKT) only increased by 40 per cent and 58 per cent, respectively. Such scenarios in which travel time greatly outstrips growth in travel distance indicate a highly congested network for the base case (without proposal)
- A likely increase in the vehicle crash rate through deteriorating travel conditions
- Loss of opportunity to improve accessibility and efficiency for public and active transport
- Incur ultimate cost escalations due to inflation and increased constructability challenges of working adjacent to higher traffic volumes.

## 7.5 Traffic performance of the Proposal

The proposal would improve intersection accessibility and level of service. The proposed new traffic signals at Crockett Steet, Barker Avenue and Chadwick Street intersection would provide adequate capacity and an acceptable level of service B or better in 2027 and 2037.

In 2027, the proposal would reduce journey time on the Hillsborough Road by up to 4.8 minutes during peak periods. In 2037, travel time savings by the proposal are estimated to be up to 7.2 minutes during peak periods.

Overall, the proposal would increase lane capacity and improve intersection operation for vehicles traveling east-west along the Hillsborough Road. The proposed upgrade would address capacity issues along a key strategic network including intersections and improve local community accessibilities. The upgrade would improve access to local communities of Hillsborough and Cardiff.

# APPENDIX A **Technical report on future traffic growth**

## Appendix A – Future Traffic Growth

### 1 Report Purpose

This Technical Note has been prepared to document future traffic on Hillsborough Road, between Warners Bay and Newcastle Inner City Bypass (broader project).

At the time of undertaking traffic modelling for strategic concept design, three future years models were developed including:

- Year 2024
- Year 2034
- Year 2044.

Future traffic growth on Hillsborough Road has been determined based on the following data sources:

- Historical traffic counts data on Hillsborough Road from last 5 years between 2010 and 2015
- Future population and employment growth within the project corridor
- Future traffic volumes and growth on Hillsborough Road sourced from Roads and Maritime's Sydney Traffic Forecasting Model (STFM, built in EMME software); and
- Traffic growth used in a previous study on Hillsborough Road undertaken by GHD in 2016 (*Hillsborough Road Traffic Modelling Treatment Options Assessment Report, GHD, April 2016*). The GHD's 2016 study used a linear growth rate of 1.5 per cent per annum on Hillsborough Road.

## 2 Historical Traffic Growth

Table 2-1 show historical traffic data on Hillsborough Road within the study area. Historical traffic data between 2010 and 2015 for Hillsborough Road were obtained from the nearest Roads and Maritime Count Station 05865 (Hillsborough Road east of Macquarie Road and 2015 count data (Hillsborough west of Crockett Street).

Table 2-1 Historical Traffic Data on Hillsborough Road

Road Sections	Average Weekday Daily Traffic (vehicles per day)		Growth per annum
	2010 <sup>(1)</sup>	2015 <sup>(2)</sup>	2010-2015 (5 years)
Hillsborough Road, East of Macquarie Road (Count Station 05865)	29,000		1.8%
Hillsborough Road, West of Crockett Street (M-5)		31,600	

Source: (1) Roads and Maritime, (2) 2015 traffic survey,

The historical data in Table 2-1 indicates that traffic volumes on the Hillsborough Road east of Warners Bay roundabout has increased from approximately 29,000 vehicles per day in 2010 to 31,600 vehicles per day in 2015.

The historical traffic data indicates that between 2010 and 2015 traffic on the Hillsborough Road east of Warners Bay roundabout has grown by about 1.8 per cent per annum.

### 3 Future Traffic Growth (STFM)

The future background traffic growth on the Hillsborough Road between Warners Bay and Newcastle Inner City Bypass has been estimated using TfNSW's Sydney Traffic Forecasting Model (STFM, built in EMME software). The STFM has used 2016 land use projections (LU2016V1.3).

The 2016 land use projection identified that population of Lake Macquarie LGA would grow by more than 27,000 from about 207,000 in 2016 to 234,000 in 2036. Employment would grow by more than 13,000 jobs from about 74,000 jobs in 2016 to 87,000 jobs in 2036.

The catchment area for population and employment growth within the Hillsborough Road study area is defined by five travel zones (TZ) as shown in Figure 3-1.

Table 3-1 shows projected population and employment growth for the Lake Macquarie LGA and Hillsborough Road catchment area separately between 2016 and 2036.

The population growth for the entire LGA is predicted to be 0.7 per cent per annum. The employment growth for the entire LGA is projected to be 0.9 per cent per annum. The growth projections within the Hillsborough Road catchment area is similar to the LGA growth being 0.4 per cent on population and 0.9 per cent on employment.

Table 3-1 Population and Employment Growth for within Catchment Area

Catchment	2016	2036	Growth per Annum 2016-2036 (20 years)
<b>Lake Macquarie LGA</b>			
Population	206,858	233,788	0.7%
Employment	73,934	87,126	0.9%
<b>Hillsborough Road Catchment Area (TZ: 6412, 6433, 6434, 6459, 6460)</b>			
Population	15,642	16,927	0.4%
Employment	6,098	7,173	0.9%

Source: TfNSW's 2016 Land Use Projection (LU2016V1.3)

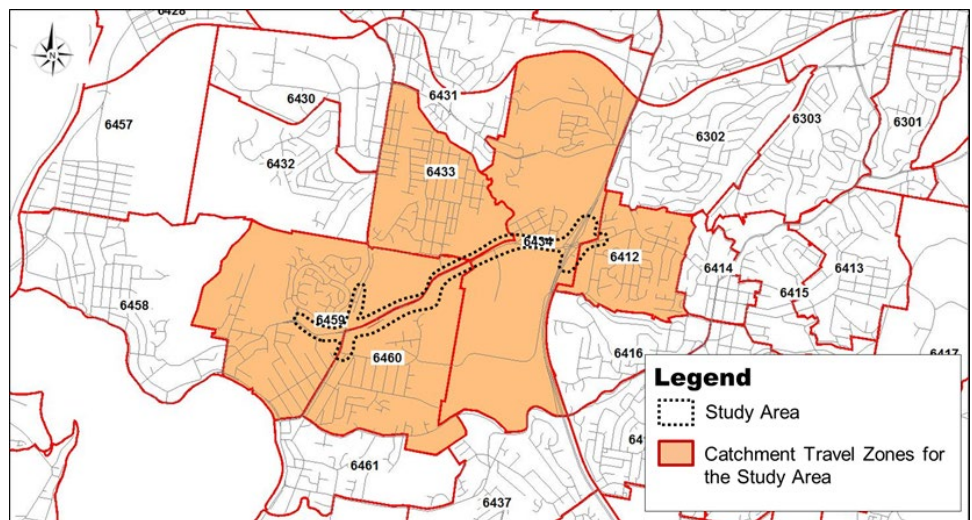


Figure 3-1 Catchment Area of Hillsborough Road Population and Employment Growth

The SFTM produces traffic volumes in two hours in AM peak and two hours in PM peak. In line with SFTM, traffic volumes for the study area network are reported for two hours for AM and PM respectively.

Table 3-2 and Table 3-3 shows predicted AM peak two hour (7AM to 9AM) and PM peak two hour (4PM to 6PM) traffic volumes within the study area for 2016 and 2036 sourced from TfNSW's SFTM.

Table 3-2 STMF's Forecast AM Peak 2 Hour (7AM to 9AM)

Road Sections	SFTM's Forecasts AM Peak 2 Hours (7-9AM)		Growth per Annum
	2016	2036	2016-2036 (20 years)
Hillsborough Road, East of Macquarie Road	3,901	4,975	1.4%
Hillsborough Road, East of Crockett Street	4,444	6,069	1.8%
Hillsborough Road, West of Watarah Street	3,219	4,120	1.4%
<b>Average</b>			<b>1.5%</b>

Table 3-3 STMF's Forecast PM Peak 2 Hour (4PM to 6PM)

Road Sections	SFTM's Forecasts PM Peak 2 Hours (4-6pm)		Growth per Annum
	2016	2036	2016-2036 (20 years)
Hillsborough Road, East of Macquarie Road	3,989	5,138	1.4%
Hillsborough Road, East of Crockett Street	4,571	6,241	1.8%
Hillsborough Road, West of Watarah Street	3,270	4,265	1.5%
<b>Average</b>			<b>1.6%</b>

Source: TfNSW's STFM (LU2016V1.3)

The STFM indicates that future traffic growth (between 2016 and 2036) on Hillsborough Road is about 1.4 to 1.8 per cent per annum depending on the sections. The STFM future growth is in line with the historical traffic growth of 1.8 per cent per annum.

On average, STFM suggested a growth rate of 1.5 to 1.6 per cent per annum on Hillsborough Road until 2036.

## 4 Conclusions

The growth rate analysis indicated that between 2010 and 2036, traffic growth on the Hillsborough Road varied between 1.4 per cent and 1.8 per cent per annum.

During the inception meeting, TfNSW project team advised Arcadis to use 1.5 per cent per annum growth rate on Hillsborough Road.

The agreed growth rate of 1.5 per cent per annum on Hillsborough Road is justified by the supporting analysis documented in this technical note.

Table 4-1 summarises proposed annual growth for 2024, 2034, and 2044.

*Table 4-1 Proposed Annual Growth Rate for the Study Area*

<b>Modelling Year</b>	<b>Proposed Annual Growth Rate for Traffic Modelling</b>
2017 to 2024	1.5% p.a.
2024 to 2034	1.5% p.a.
2034 to 2044	1.5% p.a.

Source: Arcadis' analysis



## **APPENDIX B Detailed intersection turning volumes, delay and level service in 2021, 2027 and 2037**

2021 Base Year

Intersection	AM peak	PM peak
Crockett Street / Hillsborough Road	<p style="text-align: center;">Crockett St</p> <p style="text-align: center;">Crockett St</p>	<p style="text-align: center;">Crockett St</p> <p style="text-align: center;">Crockett St</p>
Barker Avenue / Hillsborough Road	<p style="text-align: center;">Barker Ave</p>	<p style="text-align: center;">Barker Ave</p>
Higham Road / Hillsborough Road	<p style="text-align: center;">Higham St</p> <p style="text-align: center;">Higham St</p>	<p style="text-align: center;">Higham St</p> <p style="text-align: center;">Higham St</p>
Chadwick Street / Hillsborough Road	<p style="text-align: center;">Chadwick St</p> <p style="text-align: center;">CNCC Showground</p>	<p style="text-align: center;">Chadwick St</p> <p style="text-align: center;">CNCC Showground</p>

2027 Base Case

Intersection	AM peak	PM peak
Crockett Street / Hillsborough Road	<p style="text-align: center;">Crockett St</p> <p style="text-align: center;">Crockett St</p>	<p style="text-align: center;">Crockett St</p> <p style="text-align: center;">Crockett St</p>
Barker Avenue / Hillsborough Road	<p style="text-align: center;">Barker Ave</p> <p style="text-align: center;">Barker Ave</p>	<p style="text-align: center;">Barker Ave</p> <p style="text-align: center;">Barker Ave</p>
Higham Road / Hillsborough Road	<p style="text-align: center;">Higham St</p> <p style="text-align: center;">Higham St</p>	<p style="text-align: center;">Higham St</p> <p style="text-align: center;">Higham St</p>
Chadwick Street / Hillsborough Road	<p style="text-align: center;">Chadwick St</p> <p style="text-align: center;">CNCC Showground</p>	<p style="text-align: center;">Chadwick St</p> <p style="text-align: center;">CNCC Showground</p>

2037 Base Case

Intersection	AM peak	PM peak
Crockett Street / Hillsborough Road	<p>Crockett St</p> <p>Northbound: 268 (up), 577 (down)</p> <p>Eastbound: 1,837 (left), 85 (up), 1,752 (right), 68 (left), 510 (right), 2,262 (right)</p> <p>Westbound: 1,410 (left), 183 (up), 1,342 (down), 1,525 (left)</p>	<p>Crockett St</p> <p>Northbound: 550 (up), 490 (down)</p> <p>Eastbound: 1,671 (left), 221 (up), 1,450 (right), 96 (left), 394 (right), 1,843 (right)</p> <p>Westbound: 1,867 (left), 329 (up), 1,771 (down), 2,100 (left)</p>
Barker Avenue / Hillsborough Road	<p>Barker Ave</p> <p>Northbound: 2,262 (left), 2,245 (right), 2,249 (right)</p> <p>Eastbound: 2,245 (left), 17 (up), 1,523 (right), 3 (left), 4 (right), 43 (right), 1,566 (right)</p> <p>Westbound: 1,525 (left), 7 (up), 60 (down)</p>	<p>Barker Ave</p> <p>Northbound: 1,843 (left), 1,834 (right), 1,857 (right)</p> <p>Eastbound: 1,834 (left), 9 (up), 2,079 (right), 21 (left), 23 (right), 40 (right), 2,119 (right)</p> <p>Westbound: 2,100 (left), 44 (up), 49 (down)</p>
Higham Road / Hillsborough Road	<p>Higham St</p> <p>Northbound: 34 (up), 34 (down)</p> <p>Eastbound: 2,249 (left), 30 (up), 2,219 (right), 1 (left), 33 (right), 2,252 (right)</p> <p>Westbound: 1,566 (left), 4 (up), 1,565 (down), 1,569 (left)</p>	<p>Higham St</p> <p>Northbound: 14 (up), 52 (down)</p> <p>Eastbound: 1,857 (left), 12 (up), 1,845 (right), 0 (left), 52 (right), 1,897 (right)</p> <p>Westbound: 2,119 (left), 3 (up), 2,119 (down), 2,122 (left)</p>
Chadwick Street / Hillsborough Road	<p>Chadwick St</p> <p>Northbound: 48 (up), 122 (down)</p> <p>Eastbound: 2,252 (left), 12 (up), 2,240 (right), 20 (left), 0 (right), 103 (right), 2,343 (right)</p> <p>Westbound: 1,569 (left), 0 (up), 0 (right), 0 (down), 36 (up), 1,549 (down), 0 (down), 1,585 (left)</p> <p>Southbound: 0 (up), 0 (down)</p>	<p>Chadwick St</p> <p>Northbound: 105 (up), 74 (down)</p> <p>Eastbound: 1,897 (left), 17 (up), 1,879 (right), 26 (left), 0 (right), 48 (right), 1,928 (right)</p> <p>Westbound: 2,122 (left), 0 (up), 0 (right), 0 (down), 88 (up), 2,096 (down), 0 (down), 2,184 (left)</p> <p>Southbound: 0 (up), 1 (down)</p>

**2027 Project Case (with proposal)**

Intersection	AM peak	PM peak
Crockett Street / Hillsborough Road	<p style="text-align: center;">Crockett St</p>	<p style="text-align: center;">Crockett St</p>
Barker Avenue / Hillsborough Road	<p style="text-align: center;">Barker Ave</p>	<p style="text-align: center;">Barker Ave</p>
Higham Road / Hillsborough Road	<p style="text-align: center;">Higham St</p>	<p style="text-align: center;">Higham St</p>
Chadwick Street / Hillsborough Road	<p style="text-align: center;">Chadwick St</p>	<p style="text-align: center;">Chadwick St</p>

**2037 Project Case (with proposal)**

Intersection	AM peak	PM peak
Crockett Street / Hillsborough Road	<p style="text-align: center;">Crockett St</p> <p style="text-align: center;">Crockett St</p>	<p style="text-align: center;">Crockett St</p> <p style="text-align: center;">Crockett St</p>
Barker Avenue / Hillsborough Road	<p style="text-align: center;">Barker Ave</p>	<p style="text-align: center;">Barker Ave</p>
Higham Road / Hillsborough Road	<p style="text-align: center;">Higham St</p> <p style="text-align: center;">Higham St</p>	<p style="text-align: center;">Higham St</p> <p style="text-align: center;">Higham St</p>
Chadwick Street / Hillsborough Road	<p style="text-align: center;">Chadwick St</p> <p style="text-align: center;">Chadwick St</p>	<p style="text-align: center;">Chadwick St</p> <p style="text-align: center;">Chadwick St</p>

Table 1 Level of service in 2021

Intersection	Control type	Approach	2021			
			AM peak		PM peak	
			Delays (seconds)	LoS	Delays (seconds)	LoS
Crockett Street / Hillsborough Road	Sign controlled	Crockett Street – North	171	F	163	F
		Hillsborough Rd – East	69	E	36	C
		Hillsborough Rd - West	12	A	3	A
		<b>Worst movement</b>	<b>171</b>	<b>F</b>	<b>163</b>	<b>F</b>
Barker Avenue / Hillsborough Road	Sign controlled	Hillsborough Rd – East	1	A	1	A
		Barker Avenue – South	15	B	96	F
		Hillsborough Rd - West	23	B	71	F
		<b>Worst movement</b>	<b>23</b>	<b>B</b>	<b>96</b>	<b>F</b>
Higham Road / Hillsborough Road	Sign controlled	Higham Road – North	594	F	71	F
		Hillsborough Rd – East	168	F	34	C
		Hillsborough Rd - West	2	A	1	A
		<b>Worst movement</b>	<b>594</b>	<b>F</b>	<b>71</b>	<b>F</b>
Chadwick Street / Hillsborough Road	Sign controlled	Chadwick Street – North	449	F	83	F
		Hillsborough Rd – East	279	F	61	E
		Hillsborough Rd - West	1	A	1	A
		<b>Worst movement</b>	<b>449</b>	<b>F</b>	<b>83</b>	<b>F</b>

Table 2 Level of service in 2027 Base case (without proposal)

Intersection	Control type	Approach	2027 Baes case (without proposal)			
			AM peak		PM peak	
			Delays (seconds)	LoS	Delays (seconds)	LoS
Crockett Street / Hillsborough Road	Sign controlled	Crockett Street – North	214	F	267	F
		Hillsborough Rd – East	73	F	60	E
		Hillsborough Rd - West	24	B	3	A
		<b>Worst movement</b>	<b>214</b>	<b>F</b>	<b>267</b>	<b>F</b>
Barker Avenue / Hillsborough Road	Sign controlled	Hillsborough Rd – East	1	A	1	A
		Barker Avenue – South	32	C	172	F
		Hillsborough Rd - West	26	B	126	F
		<b>Worst movement</b>	<b>32</b>	<b>C</b>	<b>172</b>	<b>F</b>
Higham Road / Hillsborough Road	Sign controlled	Higham Road – North	722	F	118	F
		Hillsborough Rd – East	180	F	55	D
		Hillsborough Rd - West	2	A	1	A
		<b>Worst movement</b>	<b>722</b>	<b>F</b>	<b>118</b>	<b>F</b>
Chadwick Street / Hillsborough Road	Sign controlled	Chadwick Street – North	>800	F	325	F
		Hillsborough Rd – East	369	F	125	F
		Hillsborough Rd - West	1	A	1	A
		<b>Worst movement</b>	<b>&gt;800</b>	<b>F</b>	<b>325</b>	<b>F</b>



Table 3 Level of service in 2037 Base case (without proposal)

Intersection	Control type	Approach	2037 Baes case (without proposal)			
			AM peak		PM peak	
			Delays (seconds)	LoS	Delays (seconds)	LoS
Crockett Street / Hillsborough Road	Sign controlled	Crockett Street – North	217	F	540	F
		Hillsborough Rd – East	77	F	96	F
		Hillsborough Rd - West	50	D	25	B
		<b>Worst movement</b>	<b>217</b>	<b>F</b>	<b>540</b>	<b>F</b>
Barker Avenue / Hillsborough Road	Sign controlled	Hillsborough Rd – East	4	A	5	A
		Barker Avenue – South	44	D	337	F
		Hillsborough Rd - West	53	D	128	F
		<b>Worst movement</b>	<b>53</b>	<b>D</b>	<b>337</b>	<b>F</b>
Higham Road / Hillsborough Road	Sign controlled	Higham Road – North	>800	F	273	F
		Hillsborough Rd – East	214	F	106	F
		Hillsborough Rd - West	2	A	1	A
		<b>Worst movement</b>	<b>&gt;800</b>	<b>F</b>	<b>273</b>	<b>F</b>
Chadwick Street / Hillsborough Road	Sign controlled	Chadwick Street – North	>800	F	470	F
		Hillsborough Rd – East	382	F	215	F
		Hillsborough Rd - West	1	A	2	A
		<b>Worst movement</b>	<b>&gt;800</b>	<b>F</b>	<b>470</b>	<b>F</b>

Table 4 Level of service in 2027 Project case (with proposal)

Intersection	Control type	Approach	2027 Project case (with proposal)			
			AM peak		PM peak	
			Delays (seconds)	LoS	Delays (seconds)	LoS
Crockett Street / Hillsborough Road	New traffic signals	Crockett Street – North	41	C	52	D
		Hillsborough Rd – East	11	A	16	B
		Hillsborough Rd - West	13	A	15	B
		<b>Average</b>	<b>16</b>	<b>B</b>	<b>20</b>	<b>B</b>
Barker Avenue / Hillsborough Road	New traffic signals	Hillsborough Rd – East	7	A	13	A
		Barker Avenue – South	30	C	53	D
		Hillsborough Rd – West Right Turn	35	C	48	C
		Hillsborough Rd – West Through	19	B	7	A
		<b>Average</b>	<b>15</b>	<b>B</b>	<b>12</b>	<b>A</b>
Higham Road / Hillsborough Road	Left out only	Higham Road – North	16	B	12	A
		Hillsborough Rd – East	-	-	-	-
		Hillsborough Rd - West	1	A	2	A
		<b>Worst movement</b>	<b>16</b>	<b>B</b>	<b>12</b>	<b>A</b>
Chadwick Street / Hillsborough Road	New traffic signals	Chadwick Street – North	58	E	57	D
		Hillsborough Rd – East Right Turn	24	B	25	B
		Hillsborough Rd – East Through	7	A	6	A
		Hillsborough Rd - West	12	A	8	A
		<b>Average</b>	<b>12</b>	<b>A</b>	<b>8</b>	<b>A</b>

Table 5 Level of service in 2037 Project case (with proposal)

Intersection	Control type	Approach	2037 Project case (with proposal)			
			AM peak		PM peak	
			Delays (seconds)	LoS	Delays (seconds)	LoS
Crockett Street / Hillsborough Road	New traffic signals	Crockett Street – North	43	C	52	D
		Hillsborough Rd – East	12	A	21	B
		Hillsborough Rd - West	19	B	16	B
		<b>Average</b>	<b>20</b>	<b>B</b>	<b>23</b>	<b>B</b>
Barker Avenue / Hillsborough Road	New traffic signals	Hillsborough Rd – East	8	A	18	B
		Barker Avenue – South	34	C	60	E
		Hillsborough Rd – West Right Turn	48	D	53	D
		Hillsborough Rd – West Through	22	B	8	A
		<b>Average</b>	<b>17</b>	<b>B</b>	<b>14</b>	<b>A</b>
Higham Road / Hillsborough Road	Left out only	Higham Road – North	30	B	17	B
		Hillsborough Rd – East	-	-	-	-
		Hillsborough Rd - West	2	A	2	A
		<b>Worst movement</b>	<b>30</b>	<b>B</b>	<b>17</b>	<b>B</b>
Chadwick Street / Hillsborough Road	New traffic signals	Chadwick Street – North	69	E	60	E
		Hillsborough Rd – East Right Turn	40	C	35	C
		Hillsborough Rd – East Through	8	A	7	A
		Hillsborough Rd - West	18	B	11	A
		<b>Average</b>	<b>16</b>	<b>B</b>	<b>10</b>	<b>A</b>

