Mamre Road Upgrade Stage 1- Concept Design, REF and Detailed Design

Traffic and Transport Assessment Report

Transport for NSW (TfNSW)

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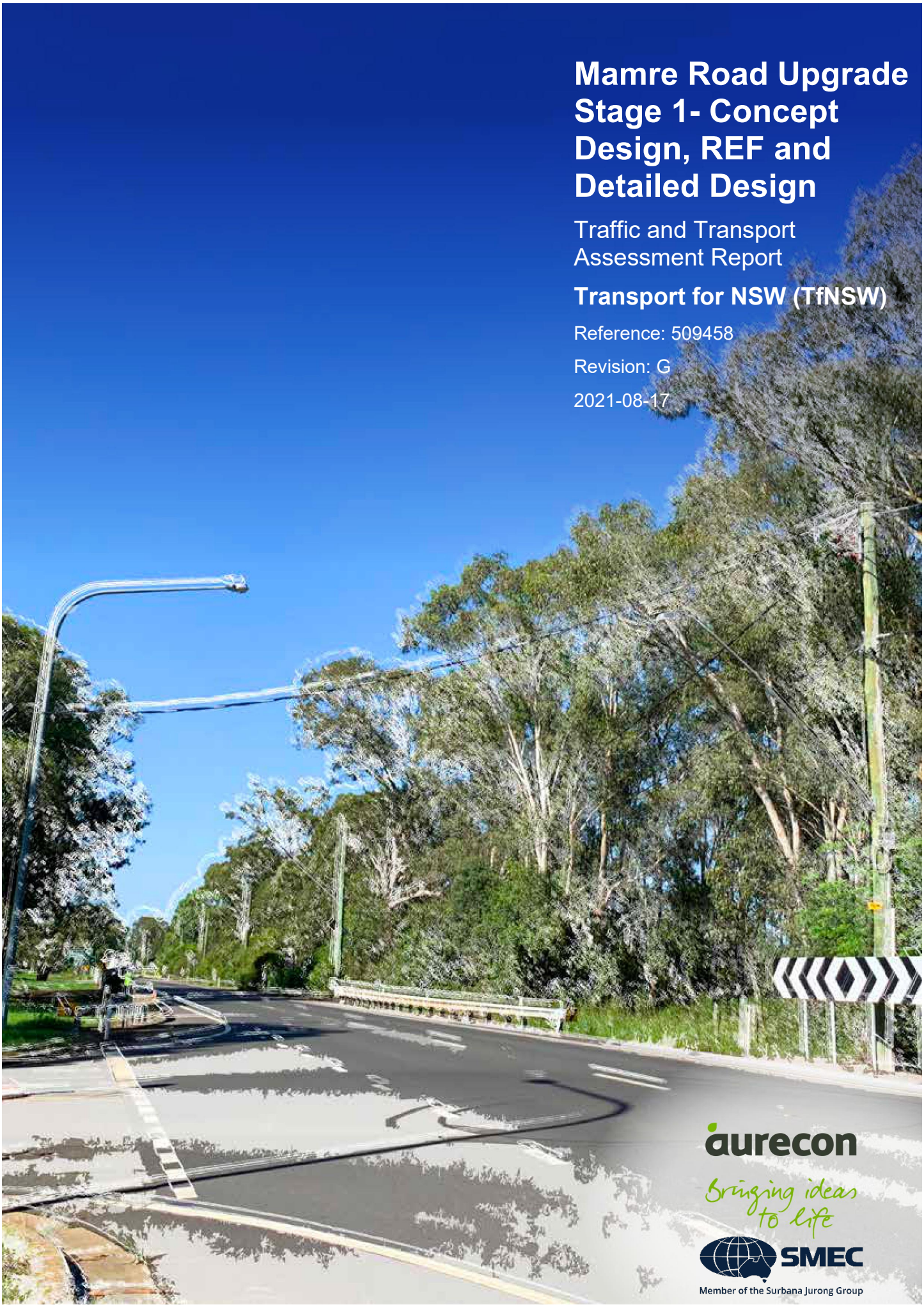

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Glossary and Abbreviations

Term	Explanation
AIMSUN Model	Traffic simulation-based software developed by AIMSUN. The software has the ability to analyse networks to varying levels of scale and detail.
Delay	The difference between travel time under free flow conditions and actual / measured travel time
DOS	Degree of Saturation
Link Density	Number of vehicles at the given length of the road
LOS	Level of Service
Modelling Guidelines	Roads and Maritime Services' Traffic Modelling Guideline, Version 1.0, February 2013
mm:ss	Minutes and seconds
NSW	New South Wales
Priority control	A control type for an intersection, which refers to Give-Way or STOP sign arrangements, as opposed to roundabout or traffic signal controls.
REF	Review of Environmental Factors
ROL	Road Occupancy Licence
SCATS signal data	SCATS stands for the Sydney Coordinated Adaptive Traffic System, which is a traffic signal system developed by Transport for NSW (TfNSW) formerly Roads and Maritime Services. SCATS signal data refers to data collected by traffic signals, including signal cycle times, traffic signal phases and traffic counts.
SMEC	SMEC Australia Pty Ltd
STFM	Sydney Strategic Traffic Forecasting Model
TfNSW	Transport for NSW
Traffic Flow	The number vehicles traveling section of road in one hour (Vehicles numbers /Hour)
Traffic Volumes	The number vehicles traveling section of road in the given unit of time (Vehicles numbers /Time Unit)
veh/hr	Vehicles per hour
VHT	Vehicle Hours Travelled
VKT	Vehicle Kilometres Travelled

1 Introduction

1.1 Proposal Overview

Transport for NSW (TfNSW) propose to upgrade about 3.8 kilometres of Mamre Road between the M4 Motorway, St Clair and Erskine Park Road, Erskine Park to a four-lane divided road (the proposal). The proposal is located within the City of Penrith local government area (LGA) in Sydney, New South Wales (NSW). Refer to Figure 1-1 Study Area Context below.

The proposal forms Stage 1 of the larger Mamre Road Upgrade Project, which is proposed to be delivered by TfNSW in two stages. Overall, the Mamre Road Upgrade Project would involve upgrades to a 10 kilometre long section of Mamre Road between the M4 Motorway, St Clair and Kerrs Road.

Mamre Road is a key transport corridor, which provides connections to the Western Sydney Employment Area and the proposed Western Sydney Aerotropolis. The proposal is required to support future economic and residential growth in Western Sydney by increasing the capacity of Mamre Road and improving road safety and movement between the M4 Motorway and Erskine Park Road.

Key features of the proposal would include:

- An upgrade of Mamre Road to a four-lane divided road with a wide central median that would allow for widening to six lanes in the future, if required
- Changes to intersections with Mamre Road including:
  - An upgrade to the existing signalised intersection at Banks Drive including a new western stub for access and a U-turn facility
  - A new signalised intersection at Solander Drive including a new western stub for access and a U-turn facility
  - A new signalised intersection at Luddenham Road with new turning lanes
  - An upgrade to the existing signalised intersection at Erskine Park Road with new turning lanes
  - Modified intersection arrangements (left in, left out only) at McIntyre Avenue and Mandalong Close
- A new shared path along the eastern side of Mamre Road and provision for a future shared path on the western side
- Reinstatement of bus stops near Banks Drive with provision for additional bus infrastructure in the future
- Changes to property access to Mamre House, Erskine Park Rural Fire Service and other private properties
- Drainage and flooding infrastructure upgrades including culvert crossings, water quality basins, grass swales and channel tail-out work
- New traffic control facilities including new traffic signals and relocation of existing electronic variable message signage
- Roadside furniture and street lighting
- Noise walls along the eastern side of Mamre Road at St Clair
- Utility relocations
- Establishment of temporary ancillary facilities to support construction including compound sites, stockpile and laydown locations, temporary access tracks, temporary waterway crossings and concrete batching plants.

Construction of the proposal is expected to start in 2022 and be completed in late 2025, subject to approval, funding and weather considerations. Construction of the proposal is planned to be carried out in two stages: early work and main construction work. Early work would involve utility relocations, site establishment activities, property adjustments and other low impact work required to facilitate construction.

Figure 1-1: Study area context

1.2 Purpose of This Report

The proposal is subject to environmental assessment under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), which requires TfNSW to prepare of a Review of Environmental Factors (REF) for the proposal. The purpose of this report is to document the traffic and transport analyses completed for the proposal to support the REF.

The report addresses the following aspects:

- Examination and general assessment of the traffic and transport patterns conditions for the existing corridor and connections
- Review of the previous traffic and transport studies and investigations
- Review of historic traffic volume and crash data for the proposal corridor
- Development, calibration and validation of a base year operational traffic model for the existing road configuration
- Conducting modelling to assess the current and future years' road network performance for the existing and proposed road configuration
- Determination of the impacts of the proposal for all road users during construction and operation, including property and local access, public transport, pedestrians, cyclists and vehicular traffic
- Recommendation of safeguards and mitigation measures to manage the identified impacts.

2 Methodology

2.1 Overview of Approach

The following steps and analyses have been completed as part of the traffic and transport assessment:

- Examination and general assessment of the traffic and transport patterns conditions for the existing traffic network in terms of:
  - Existing traffic volumes and patterns
  - Existing traffic network performance including site visit observations and analytical findings
  - Road safety and crash history
  - Public transport provisions
  - Heavy vehicles access and routing
  - Parking provisions and facilities for active transport users.
- Development of detailed Aimsun microsimulation traffic models to provide a set of AM and PM peaks commuter calibrated and validated traffic models to:
  - Assess the performance of the existing traffic network
  - Develop reliable traffic models to assess the impact of the proposed road upgrade and the impact of the forecast traffic volumes in the study area.
- Conducting modelling to assess the current and future years' road network performance for the existing and proposed road configuration via:
  - Estimation of the traffic volumes growth in the study area for the duration of construction, the opening year of the proposal (2026) and 10 years from the opening year (2036)
  - Inputting the traffic volumes forecast into traffic models
  - Assessing the impact of the proposed construction staging on the traffic network
  - Assessing the impact of the proposed road configuration during operation compared to future base case scenarios without the proposal under the forecast traffic volumes
- Analyse and document the impacts of the proposal for all road users during construction and operation, including potential impacts on property and local access, public transport, pedestrians, cyclists and vehicular traffic
- Summarise traffic and transport analyses and findings.
- Recommend safeguards and mitigation measures to manage the identified impacts.

In order to complete the required analyses in this report the following key data and resources have been utilised:

- Traffic volume surveys including:
  - Classified mid-block surveys (from 03/03/2020 to 09/03/2020)
  - Classified weekday peak periods intersection turning counts surveys (from 03/03/2020 to 05/03/2020)
  - Travel time surveys (from 03/03/2020 to 09/03/2020)
  - Traffic signal timing data (from 03/03/2020 to 09/03/2020)
- Sydney GMA Strategic Traffic Forecasting Model (STFM) outputs as updated based on Travel Zone Projections 2019 (TZP19) and Strategic Travel Model (STM) 3.8 provided by TfNSW

- Multiple project site visits between March 2020 and March 2021
- Intersection operation video footage collected between 03/03/2020 to 05/03/2020
- Crash history data for key roads in the area collected by TfNSW for five years between October 2014 and October 2019.
- Publicly available information for the following projects:
  - M12 Motorway
  - Sydney Metro Western Sydney Airport
  - Western Sydney Airport
  - M4 Roper Road Westbound On Ramp
  - M4 Smart Motorways
  - Western Sydney Employment Area
  - Altis Warehouse and Logistics Hub
  - Upper South Creek Advanced Water Recycling Centre.

In order to complete the required traffic modelling traffic analyses, Aimsun 20 Microsimulation modelling software was used for traffic model development. Throughout the traffic modelling and relevant analyses, the Roads and Maritime Services' Traffic Modelling Guideline, Version 1.0, February 2013 (modelling guidelines) has been applied.

2.2 Transport Policies and Plans

The proposal addresses the broader NSW Government objective set in the Premier's Priorities (NSW Department of Premier and Cabinet 2017):

- Delivering infrastructure: Key metropolitan: regional and local infrastructure to be delivered on time and on budget.
- The proposal supports or is recognised in strategic plans including:
  - *State Infrastructure Strategy 2018-2038* (SIS) (Infrastructure NSW, 2018)
  - *A Metropolis of Three Cities – the Greater Sydney Region Plan* (Greater Sydney Commission, 2018)
  - *Future Transport Strategy 2056* and *Greater Sydney Services and Infrastructure Plan* (NSW Government, 2018)
  - *Road Safety Plan 2021 – Towards Zero* (NSW Government, 2018)
  - *NSW Freight and Ports Plan 2018-2023* (TfNSW, 2018)
  - *Western Sydney Infrastructure Plan* (Roads and Maritime, 2016).

The proposal also fits with the *Smart Cities Plan* (Australian Government 2016) and *Western City District Plan* (Greater Sydney Commission, 2018).

2.3 Criteria Adopted

The definition of each reported network statistic and intersection performance criteria are as follows:

- The performance of an intersection can be measured by the average delay per vehicle which corresponds to a Level of Service (LOS) measure for the intersection
- Performance of an intersection is measured in accordance with the Austroads *Guide to Traffic Management-Part 3: Traffic Studies and Analysis* (2013). The guidelines recommend that for roundabouts and priority-controlled intersections, the LOS value is determined by the critical movement with the highest delay, whereas for a signalised intersection, LOS criteria are related to the average overall intersection delay measured in seconds per vehicle
- Intersection LOS were assessed using the standard set out by Transport for New South Wales *Level of Service criteria for intersections (Traffic Modelling Guidelines – Version 1 – February 2013)*, which are listed in Table 2-1.

Table 2-1: Modelling guidelines level of services for intersections

Level of Service	Average Delay per Vehicle (sec/vehicle)	Traffic Signal & Roundabout	Give Way & Stop Signs
A	<14	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	>70	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing

Travel Time: Represents average time required by a typical driver to travel between the two designated points in the designated route

Average delay per vehicle (seconds): This indicates average delay experienced by all vehicles in the network, regardless of the travel direction, vehicle type, vehicle destination, and routing patterns. In general, average delay is the amount of time it takes to traverse a given roadway segment minus the amount of time it would take to traverse that roadway segment at the posted speed limit (free flow conditions) if there were no interference.

Average network speed (km/h): Represents average network travel speed under the modelled scenario.

Vehicle Kilometres Travelled (VKT): Represents the measurement of the total kilometres travelled by all vehicles in the area for the entire modelling period. It is calculated by the number of vehicles multiplied by the kilometres travelled in the network area.

Vehicle Hours Travelled (VHT): Represents the measurement of the total time travelled by all vehicles in the area for the entire modelling period. It is calculated by the number of vehicles multiplied by the time travelled in the network area.

Total number of stops: Represents total number of stops in the network during the simulation period.

Unreleased vehicles (also known as latent demand): Represents the number of vehicles which did not manage to reach the network boundaries due to congestion at the network extremity.

2.4 Study Area

The study area for this report and context of the proposal are shown in Figure 2-1.

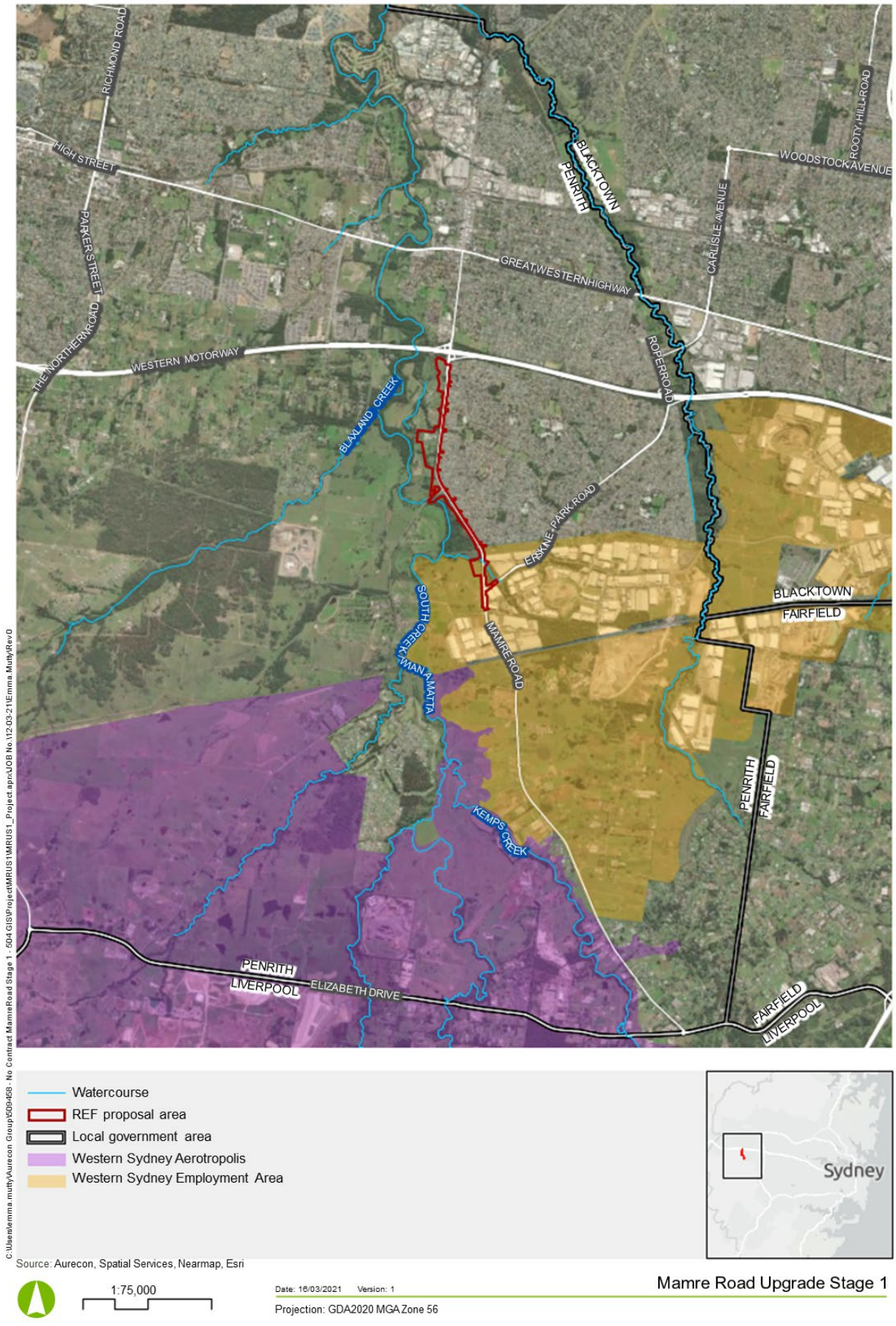


Figure 2-1: Location of the proposal

The study area for the purpose of Traffic and Transport assessment includes Mamre Road between the M4 Motorway, St Clair and James Erskine Drive, Erskine Park. The study area is also located partially within the Mamre West Precinct which is within the Western Sydney Employment Area. The M4 Motorway and James Erskine Drive are the closest intersections on Mamre Road to the north and south of the REF proposal area, respectively.

Mamre Road is a key transport corridor providing transport connections to the Western Sydney Aerotropolis, the Greater Penrith to Eastern Creek Urban Release Investigation Area, and the Western Sydney Employment Area. Mamre Road connects to the M4 Motorway to the north and James Erskine Drive to the south within the study area.

2.5 Detailed Modelling Method and Scenarios

2.5.1 Overall Traffic Modelling and Analyses Overview

In order to understand the impact of the proposal, the traffic modelling process outlined in Figure 2-2 below was adopted:

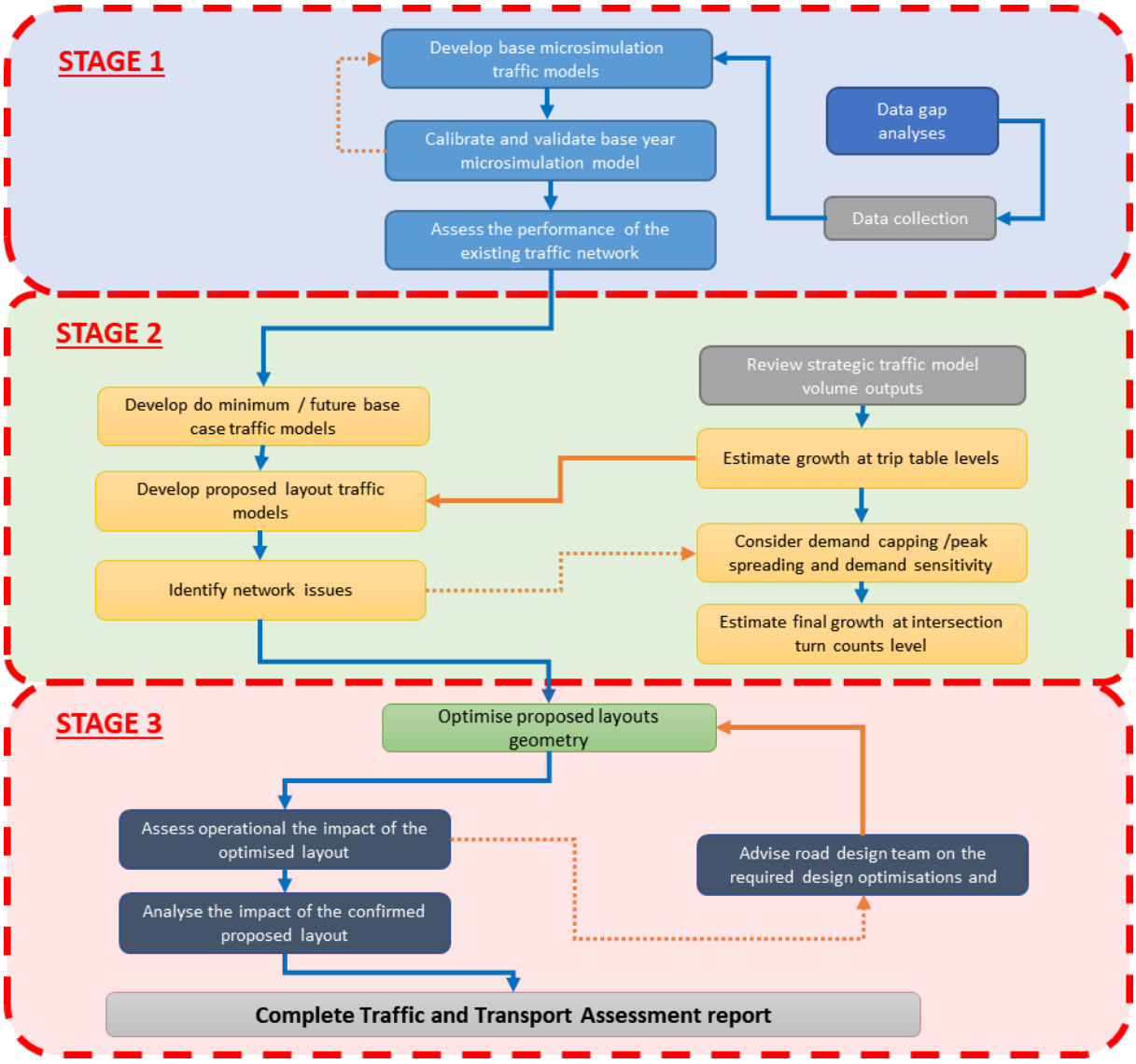


Figure 2-2: Traffic modelling and associated Analyses workflow

The traffic modelling for the proposal was completed in three stages as follows:

- **Stage 1 - Data Analyses, Base Year Model Development, Calibration and Validations:** During this stage, base year traffic models were developed, calibrated and validated. Details of the Base Aimsun microsimulation models' developments are set out in Appendix B of this report
- **Stage 2 – Future Year Demand Estimation, Develop Do Minimum and Proposed Design Modelling:** During this stage, the future year traffic growth was estimated. Also, during this stage, preliminary assessment of the proposed design traffic models was developed, the merits of demand capping/peak spreading was discussed, and final travel demand data was decided
- **Stage 3 – Design Option Traffic Analyses:** During this stage the proposed upgrade road layouts were analysed and modelled in Aimsun Microsimulation package. Key intersection deficiencies were communicated back to the road design team and intersection layouts were optimised and reassessed accordingly.

2.5.2 Traffic Modelling Network Coverage and Zone System

Six key intersections were modelled in Aimsun Next 20, as per the traffic modelling requirements for the proposal from TfNSW. These intersections are shown in Figure 2-3 below. The intersections included:

- M4 Motorway Westbound Ramp / Mamre Road (as signalised intersection)
- Banks Drive / Mamre Road (as signalised intersection)
- Solander Drive / Mamre Road (as signalised intersection)
- Luddenham Road / Mamre Road (as signalised intersection)
- McIntyre Ave / Mamre Road (as priority-controlled intersection)
- Mandalong Close / Mamre Road (as priority-controlled intersection)
- Erskine Park Road / Mamre Road (as signalised intersection)
- James Erskine Drive / Mamre Road (as signalised intersection).

The Aimsun model was coded with 11 traffic zones as shown in Figure 2-3.

While the intersections of M4 westbound ramp / Mamre Road and James Erskine Drive / Mamre Road are considered outside the scope of the road design for this proposal, these intersections were included in the 2020 Base Model and in all future design models. M4 westbound ramp / Mamre Road was included in all traffic analyses to reflect the existing downstream queue spill-back effect from this intersection, which affects existing traffic flow along Mamre Road, particularly at the Banks Drive intersection. Also, the intersection of James Erskine Drive / Mamre Road was included to ensure the effect of the proposed Altis Development (as part of Western Sydney Employment Area (WSEA)) on the western side of Mamre Road and the construction of the new western leg at this intersection is adequately captured. Additionally, inclusion of James Erskine Drive intersection in the traffic analysis allowed for more accurate performance assessment of the Erskine Park Road intersection with Mamre Road. This inclusion also enabled the traffic analysis to account for the platoon arrivals and queue interactions between the two closely spaced intersections of James Erskine Drive and Erskine Park Road with Mamre Road.

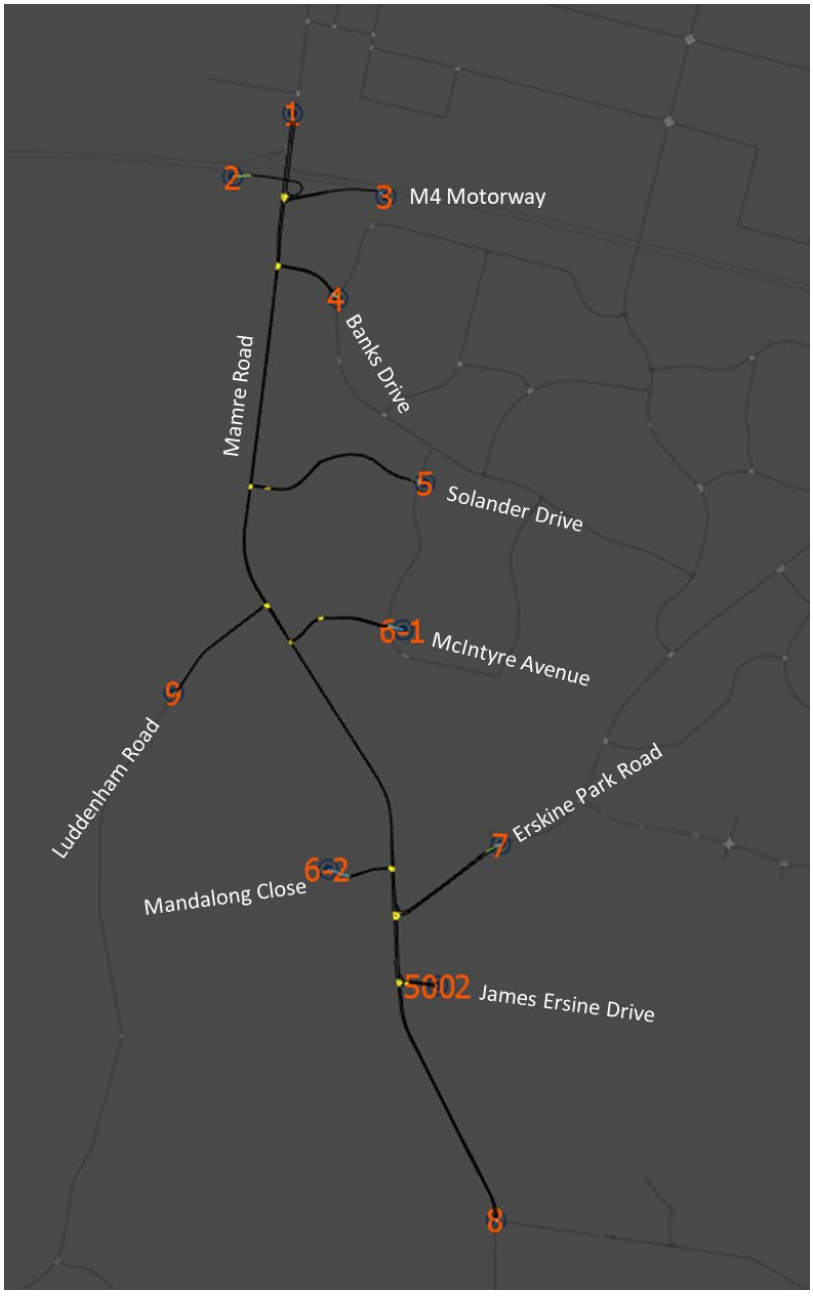


Figure 2-3: Key intersections and network modelled

2.5.3 Base Year Aimsun Model Calibration and Validation

The 2020 base year Aimsun model for the proposal was calibrated and validated according to the latest traffic modelling guidelines by TfNSW - (Traffic Modelling Guidelines – Version 1 – February 2013). A separate Aimsun Base Model Calibration and Validation Technical Note is attached in Appendix B of this report.

Base year models were developed for the year 2020 to set the calibrated benchmark models that can be used to assess the impact of the proposed future traffic growth and proposed design geometry for horizon design years.

The calibration results for the 2020 base year Aimsun model show that the model is meeting the recommended targets specified in the TfNSW Traffic Modelling Guidelines. As such, the model is deemed fit-for-purpose to be used for the objectives specified in the report.

2.5.4 Future Year Demand Assumptions

2026 and 2036 future year Aimsun models were developed for the purpose of assessing future year road network performance. Future year traffic demands were estimated based on Sydney GMA Strategic Traffic Forecasting Model (STFM) updated for Travel Zone Projections 2019 and Strategic Travel Model (STM version 3.8) provided by TfNSW.

The overall methodology for future year demand forecasting included the following main steps:

- Estimate a 'Delta Matrix' between the Base and Forecast Year of the Parent Strategic Transport Model. The Delta Matrix represents the nominal change in demand at a cell by cell level between the parent Strategic Transport Model's (STFM) base year demand matrix and the forecast year demand matrix.
- Overlay the base Aimsun microsimulation – calibrated trip tables with 'Delta Matrix' calculated in previous 1. This step involves three sub-steps:
  - Estimate / assume 'Growth Profile' that distributes the total 'Delta Matrix' across separate 15-minute matrices. This growth arrival was estimated based on the 2020 traffic arrival profile and calibrated traffic Aimsun models
  - Apply the profiled 'Delta Matrices' to each of the 15-minute base year demand matrices
  - Should any final cell value return negative values then adopt the relative growth (percentage growth) as forecast for the cell.

Total traffic demand trip table for each AM and PM peak periods are shown in shown in Table 2-2 and Table 2-3 below:

Table 2-2: AM Peak Trip: Demand Tables Summary

Scenario	Total Demand (2 Hours)	% Growth from 2020
2020 AM - Total Vehicle Demand	10,170	-
2026 AM – Base Case	11,904	17%
2026 AM – Proposal	12,321	21%
2036 AM – Base Case	14,479	42%
2036 AM - Proposal	14,897	46%

Table 2-3: PM Peak Trip: Demand Tables Summary

Scenario	Total Demand (2 Hours)	% Growth from 2020
2020 PM - Total Vehicle Demand	10,978	-
2026 PM – Base Case	12,287	21%
2026 PM – Proposal	12,393	22%
2036 PM – Base Case	15,227	50%
2036 PM - Proposal	15,536	53%

Intersection turning volumes showing traffic volume estimations for the future years of 2026 and 2036 are shown in Appendix A of this report. Please note the volumes shown Appendix A refer to unconstrained traffic volumes and represent traffic demand for each turning movements.

2.6 Other Key Assumptions and Limitations

In preparation of this Traffic and Transport Assessment report, the following additional assumptions and limitations were considered. The key assumptions and limitations include:

- Study Area Boundaries
- M4 Interchange Partial Upgrade Assumptions
- Other proposed developments
- COVID-19 virus pandemic

This section outlines the key assumptions and limitations applied in this report.

2.6.1 Study Area Boundaries

As discussed in Section 2.4 of this report, the traffic and transport analyses has mainly been completed in respect to the Mamre Road corridor between James Erskine Drive and M4 Motorway interchange. This is due to the assumption that the highest impact of the proposed road upgrade on traffic network operation is expected to be realised within the study area.

It should be noted that the impact of the proposed upgrade on the potential route choice in a larger context has also been accounted via application of the Sydney Strategic Transport Forecast Model (STFM). The impact of the route choice and its effect on the study area traffic volumes (and traffic volume growth as a result) have been reflected in the operational traffic analysis.

2.6.2 M4 Interchange Partial Upgrade Assumptions

Upon initial analysis, it became apparent that providing adequate capacity at M4 interchange plays a vital role in the stable operation of Mamre Road and the traffic models developed for the proposal.

Following preliminary traffic modelling of the forecast traffic volumes, it was realised that the current M4 interchange arrangement results in major congestion build-up throughout the study area. Preliminary analysis demonstrated that the major pinch point would form at the intersection of Mamre Road / M4 Motorway.

The reason for the congestion is due to the following:

- High right turn traffic volumes from Mamre Road to M4 Motorway westbound on-ramp (about 600 veh/hr in 2026 and 850 veh/hr in 2036) conflict with southbound through traffic on Mamre Road (about 2,100 veh/hr in 2026 and 2036)
- The right turn traffic from Mamre Road generates a long northbound queue and spills back towards Banks Drive intersection
- The extended queue on Mamre Road further blocks the southbound traffic from Banks Drive as well as the northbound traffic on Mamre Road
- The combined effect of the congestion at M4 interchange and Banks Drive creates significant reduction in overall network performance and high congestion along Mamre Road.

Figure 2-4 below shows snapshots of the worst-case peak period conditions for 2026 and 2036 future year traffic models.

2026 PM Peak (Worst case conditions for 2026 Models)

2036 AM Peak (Worst case conditions for 2036 Models)

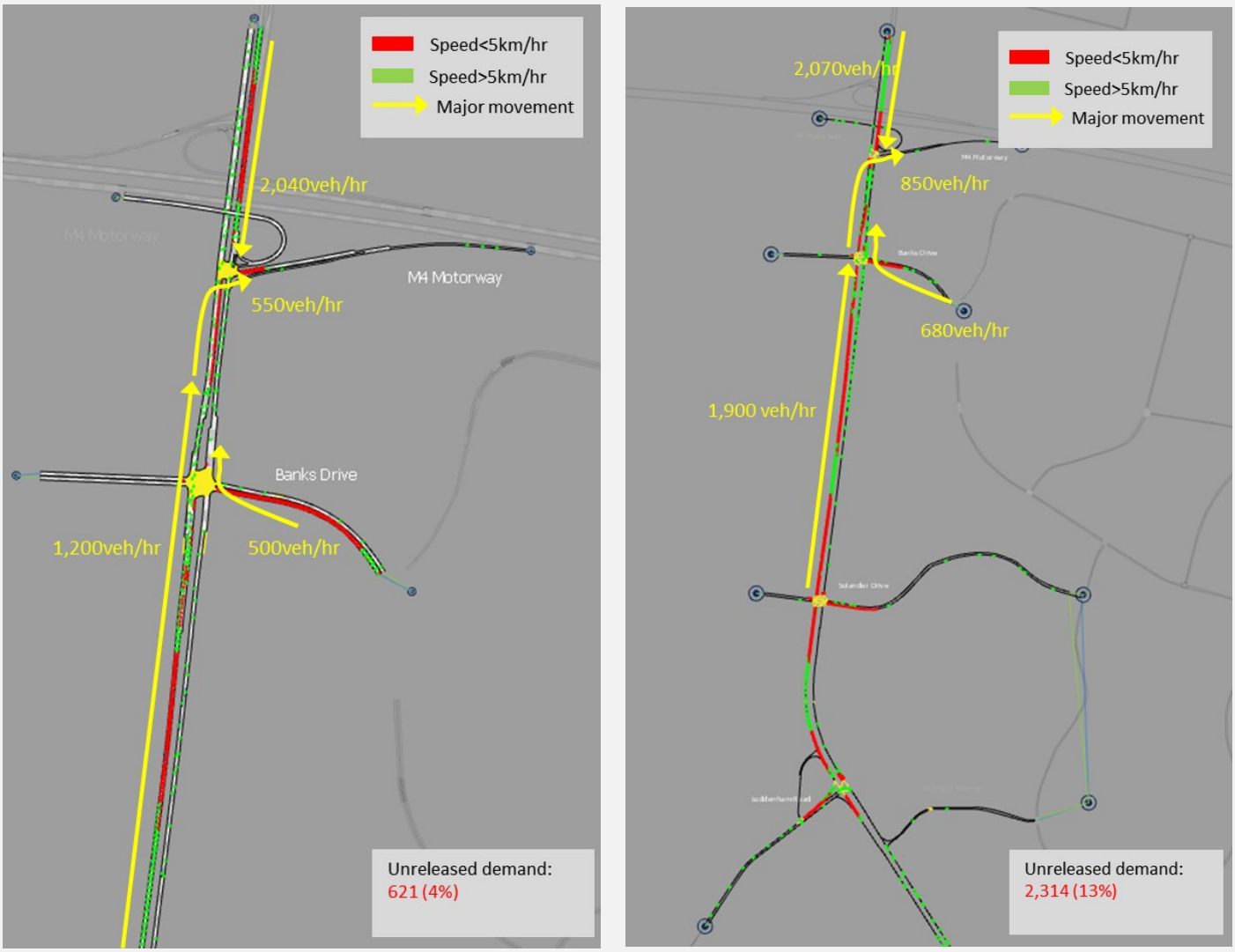


Figure 2-4: No M4 interchange upgrade scenario –Aimsun models snapshot

Upon review of the traffic models, it was concluded that the level of congestion under this scenario renders the traffic models unstable. This does not allow the traffic models to provide the required traffic data for the purpose of road geometry performance analysis or to assess the impact of the proposal.

As a result, a set of “Potential Future Upgrades” assumptions were identified for M4 interchange, and were applied to the traffic model to deal with the instability associated with the congestion at the M4 interchange and are not reflected in the road design for the proposal. The set of Potential Future Upgrade assumptions includes:

- A dual northbound right turn from Mamre Road onto M4 Motorway
- Three lanes northbound between Banks Drive intersection and M4 interchange with:
  - A third kerbside southbound lane that is about 185 metres long between M4 Interchange and Banks Drive intersection
  - Three northbound exit lanes on Mamre Road at Banks Drive intersection up to M4 interchange
- A third northbound kerbside approach lane that is about 120 metres south of Banks Drive intersection
- Removal of the bus lane/bus bay on Mamre Road either side of Banks Drive.

The Potential Future Upgrade has taken into consideration the upgrade of two lanes southbound at the M4 interchange bridge however due to the constraints and limitations associated with the M4 interchange upgrade has not been included.

Figure 2-5 below shows the assumed geometry for M4 Interchange upgrade scenario.

Figure 2-5: Future year M4 intersection Partial upgrade

The proposed “Potential Future Upgrades” were included in all future year traffic models including the “Proposal” and “Do Minimum” traffic models for 2026 and 2036 traffic demands. The inclusion of the proposed upgrade at M4 Motorway interchange enabled the following:

- Adequate traffic arrival from the M4 Motorway to the study area to ensure the intersections within the proposal are tested and designed for the intended traffic volumes as much as possible
- Reduced impact from the M4 interchange queue spill backs on Banks Drive intersection, which enabled traffic analysis of the proposed design for this intersection

2.6.3 Other Proposed Developments

Following discussions with TfNSW, it was understood that GHD were commissioned[1] to provide traffic modelling services to investigate the proposed Southern Link Road in Western Sydney, using the models to feed into a Benefit Cost Analysis of the Southern Link Road and a Multi-criteria analysis to assist in developing the Western Sydney Employment Area (WSEA) Road Network Plan. As advised by TfNSW, these models were developed to capture the most recent land use as outlined in Travel Zone Projections 2019 (TZP19) and Strategic Travel Model (STM) 3.8 as well as the land use proposals in Western Sydney Regions. As a result, the traffic volumes and traffic demand forecast by the above-mentioned strategic model was used as the primary source for traffic volumes forecast in the study area.

The land use in the area is changing rapidly and there are a number of strategic planning documents and proposals that have been accounted for in the traffic volume forecast, namely:

- Mamre West Precinct
- Mamre Road precinct and proposed inter-modal terminal
- Horsley Park and Cecil Park Structure Plan
- Western Sydney Airport and Aerotropolis in the Western Parkland City

Assumed major transport projects and infrastructure in the vicinity of the study area are shown in Table 2-4 below.

Table 2-4: Infrastructure assumptions in the forecast traffic models

Road network upgrade	Scope of works	2026	2036
Mamre Road – M4 Motorway to Erskine Park Road	Widening to 4 lanes	✓	✓
Mamre Road – Erskine Park Road to Kerrs Road	Widening to 4 lanes	-	✓
	Bridge over Sydney Water Pipeline	-	✓
	Devonshire Link Road	-	✓
	Kerrs Road to Elizabeth Drive remains 1 lane each way	-	-
Archbold Road – Great Western Highway to Lenore Drive	Widening to 4 lanes	✓	✓
	The interchange with east facing ramps only	✓	✓
Archbold Road – Lenore Drive to Old Wallgrove Road	Widening to 4 lanes	✓	✓
	Intersection with Old Wallgrove Road	✓	✓
Luddenham Road upgrade	2 lanes each way	-	✓

[1] Memorandum Trip Distribution Model, GHD, 4 December 2019.

Road network upgrade	Scope of works	2026	2036
Erskine Park Road – Coonawarra Drive to Lenore Drive	Widening to 4 lanes	✓	✓
M4 Roper Road westbound on ramp	New ramp (G-loop) at Roper Road and Erskine Park Road westbound on ramp at the M4 Motorway to allow traffic travelling in both directions from Roper Road and Erskine Park Road to head westbound on the M4 Motorway	✓	✓
West North South Link Road – Lenore Drive to Southern Link Road	New road link: 4 lanes	✓	✓
Southern Link Road – Mamre Road to Old Wallgrove Road	New road link: 4 lanes	✓	✓
Southern Link Road – Old Wallgrove Road to Wallgrove Road	New road link: 4 lanes	✓	✓
Wallgrove Road –Old Wallgrove Road and The Horsley Drive	Widening to 4 lanes	✓	✓
The Horsley Drive – M7 Motorway to Ferrers Road	2 eastbound lanes	✓	✓
M4 SMART Motorway upgrades	M7 to Erskine Park Road: Additional lane in each direction Widening around Archbold Road	✓	✓
Bringelly Road upgrade - Camden Valley Way to The Northern Road	2 lanes each way	✓	✓
The Northern Road upgrade	The Old Northern Road to Bradley Street: 2 lanes each way Bradley Street to Jamison Road: 3 lanes each way	✓	✓
M12 Motorway - M7 Motorway to Airport (un-tolled)	2 lanes each way	✓	✓
	Devonshire Link Road	-	✓
	M12 connection to Elizabeth Drive at the interchange with the M7 Motorway	-	✓
M12 Motorway - Airport to The Northern Road (un-tolled)	2 lanes each way	✓	✓
M7 Motorway capacity increase	Widening to 3 lanes each way	-	✓
South West Growth Centre (+ Devonshire Road widening)		-	✓
Elizabeth Drive - M7 Motorway to Devonshire Road	Widening to 2 lanes each way	-	✓
Elizabeth Drive - Devonshire Road The Northern Road	Widening to 2 lanes each way	-	✓
East west link road - The Northern Road/Littlefields Road to Luddenham Road	2 lanes each way	-	✓
Eastern Ring Road – Elizabeth Drive to The Northern Road	2 lanes each way	-	✓
Horsley Drive widening	Widening to 2 lanes in each way from the M7 Motorway to Cowpasture Road and convert the roundabout at Cowpasture Road to traffic lights	✓	✓
Outer Sydney Orbital (M12/The Northern Road to Appin Road)		-	-
Outer Sydney Orbital Airport to Richmond		-	-

2.6.4 COVID-19 Virus Pandemic

The transport data for the proposal was collected before the widespread restrictions to combat the COVID-19 virus pandemic were introduced in Australia in mid-March 2020, which resulted in atypical transport conditions. The first national spatial distancing announcement was on 13th March and Australia closed its borders to all non-citizens and non-residents on the 20th March 2020, following the data collection period of Tuesday 3rd March 2020 to Monday 9th March 2020. As a result, the data collected by the proposal is unlikely to be notably affected by the COVID-19 restricted and is considered representative of relatively normal traffic conditions.

3 Existing Road and Transport Conditions

3.1 Road Hierarchy

A summary of the function and characteristics of each road classification is provided below:

- Motorways (within study area: M4 Motorway; Adjacent roads: M7 Motorway, future M12 Motorway): Fully access-controlled roads with grade separation at intersections along their route. They have divided carriageways with high speed serving inter-region trips used for movement of freight.
- Arterial Roads (within study area: Mamre Road, Adjacent roads: Elizabeth Drive, The Northern Road): High-capacity urban roads that can be divided or undivided carriageways with lower speed limits that connect across regions. They provide access to other roads via signalised or roundabout intersections. They can be used by most classes of freight and commercial vehicles.
- Sub-arterial Roads (within study area: Luddenham Road, Erskine Park Road): Roads that provide connectivity between arterial roads typically carrying traffic between different parts within a region. Sub-arterial roads are generally expected to carry lower traffic volumes in line with their intended function of connecting arterial roads with collector roads.
- Collector Roads (within study area: McIntyre Avenue, Solander Drive, Banks Drive): Roads connect the higher-class arterial and sub-arterial roads to local roads and expected to provide connectivity within a locality, connecting local roads with sub-arterial roads.
- Local Roads (within study area: Mandalong Close): Provide direct access to local properties carrying local traffic only.

Figure 2-3 shows the location of the key roads within the study area.

Mamre Road connects Elizabeth Drive in the south with the Great Western Highway in the north. It is generally one lane in each direction with a posted speed limit of 80 km/h within the study area, with a northern section north from Mamre House entrance with a posted speed of 60km/h. The northern end of Mamre Road within the study area provides access to the M4 Motorway via an interchange that includes both east and west-facing ramps. In the longer-term, Mamre Road may be re-aligned and connected to Devonshire Road at Elizabeth Drive to provide a continuous north-south route between the Western Sydney Aerotropolis and the South West Growth Area (Roads and Maritime Services, 2019).

Luddenham Road links Elizabeth Drive to Mamre Road with priority-controlled seagull intersection with Mamre Road. It has a single lane of traffic in each direction and has a posted speed limit of 80 km/h. Erskine Park Road links Mamre Road to Roper Road. Erskine Park Road and Roper Road also provide access to the M4 Motorway via east facing ramps. Erskine Park Road has a sign-posted speed limit of 70 km/h. Erskine Park Road also provides access to the WSEA and other surrounding residential developments.

Banks Drive acts a collector road and connects Mamre Road to Erskine Park Road via Bennett Road. Banks Drive facilitates access for traffic between local roads in the St Clair area and Mamre Road.

Solander Drive and McIntyre Avenue also act as collector roads and facilitate access for traffic between local roads in the St Clair area and Mamre Road.

Mandalong Close is a local road and provides connectivity and access for properties along Mandalong Close to Mamre Road.

3.2 Existing Traffic Volumes and Patterns

Intersection turning count surveys and queue length surveys were conducted from Tuesday 03/03/2020 to Thursday 05/03/2020 at several intersections (shown in Figure 3-1):

- Mamre Road / M4 Motorway (westbound ramps)
- Mamre Road / Banks Drive
- Mamre Road / Solander Drive
- Mamre Road / Luddenham Road
- Mamre Road / Erskine Park Road
- Mamre Road / James Erskine Drive.

Mid-block traffic volume surveys were conducted from Tuesday 3rd March 2020 to Monday 9th March 2020.

Figure 3-1: Intersection turning counts, mid-block counts and queue length survey locations

Hourly total traffic volume profile based on the total mid-block volumes from traffic surveys at locations shown in Figure 3-1 above from Tuesday 3rd March 2020 to Monday 9th March 2020 was analysed and shown in Figure 3-2 below.

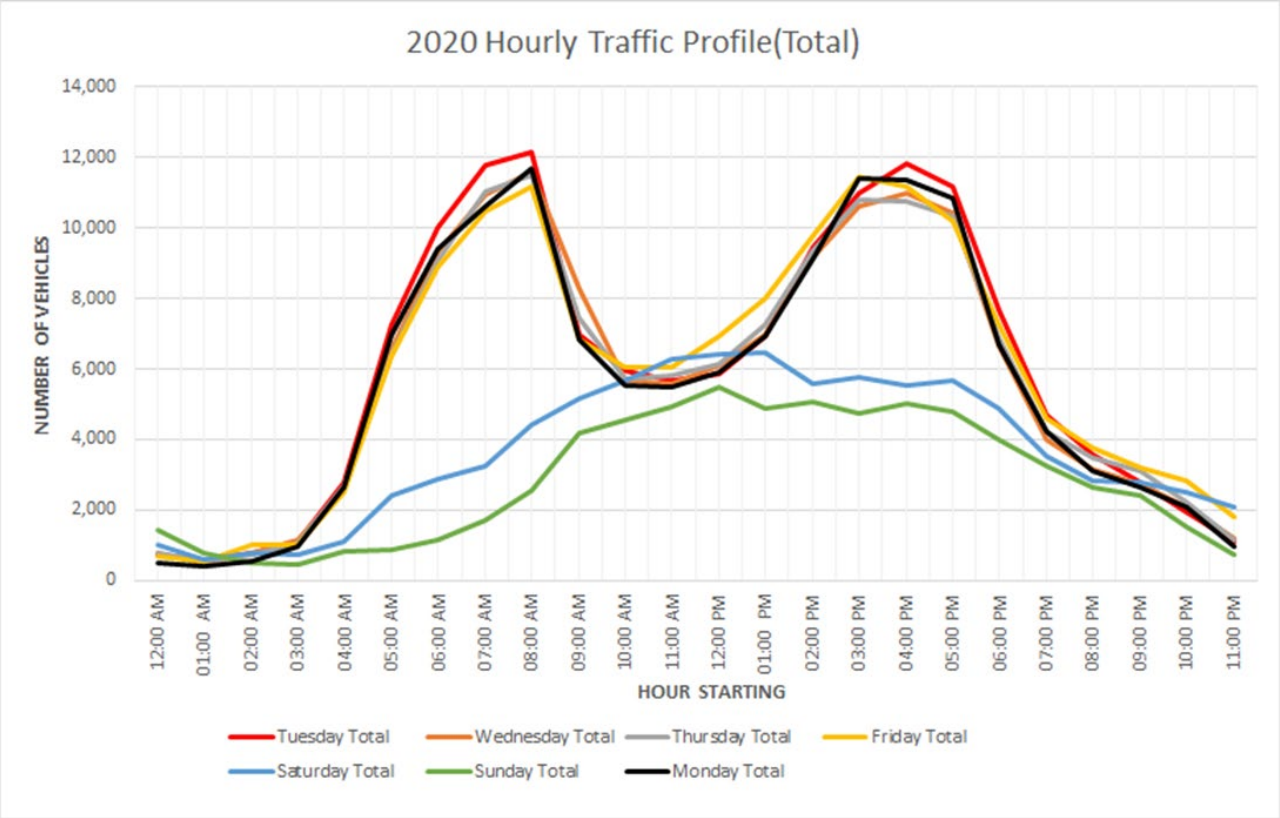


Figure 3-2: 2020 Hourly Traffic Profile (Total)

It can be seen from the above figure that the morning peak period can be identified as 5:00-9:00 AM and the afternoon peak period is identified as 2:00-6:00 PM.

Following multiple site visits of the study area , including site visits findings on the date for traffic surveys (on Wednesday 4th March 2020), it was observed that the Mamre Road intersections with Banks Drive and M4 interchange represents key congestion points in the study area and significantly impact the operation of Mamre Road in the study area. Therefore, further analyses were completed based on the detailed intersection turn counts for these two critical and high-volume intersections to obtain the critical peak two-hour peak periods within the AM and PM commuter peaks. Figure 3-3 and Figure 3-4 show the Wednesday 4th March 2020 total intersection turning volume data during 6:00-10:00 AM and 2:00-6:00 PM for the M4 westbound ramp and Banks Drive intersections with Mamre Road. Figure 3-3 and Figure 3-4 show total traffic volume between 7:00-9:00 AM during AM Peak and between 4:00-6:00 PM during PM Peak are at the highest for each peak period respectively. Therefore 7:00-9:00 AM during AM Peak and between 4:00-6:00 PM were selected for traffic analyses respectively. Please note these peak periods are also consistent with the Sydney Strategic Traffic Forecasting Model (STFM) AM and PM peak periods.

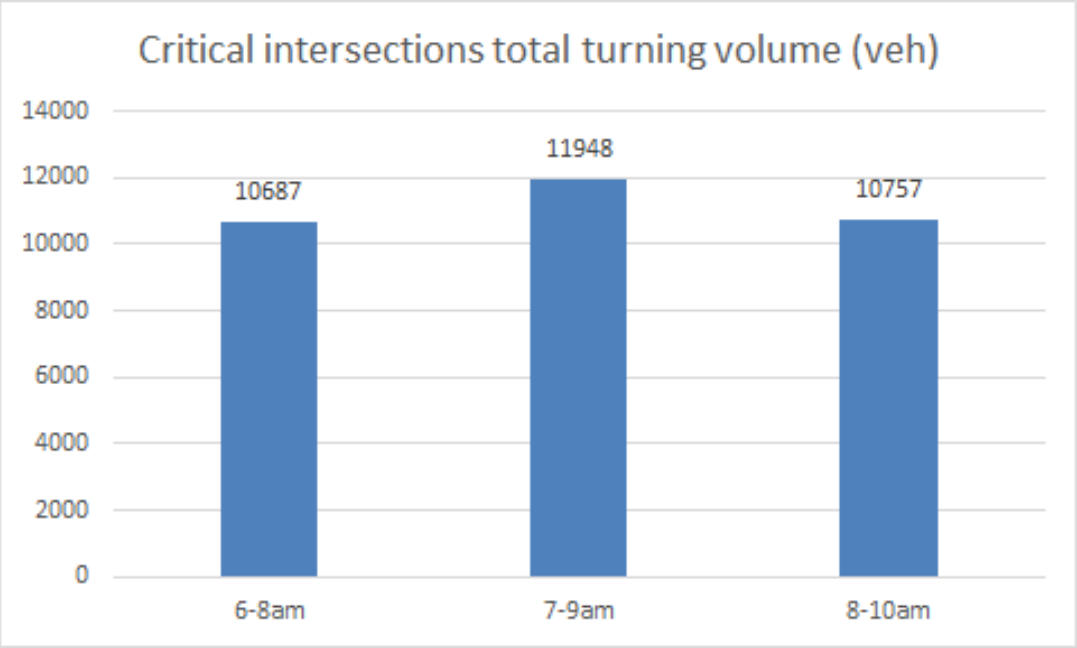


Figure 3-3: M4 interchange and Banks Drive intersection total turning volume during AM Peak

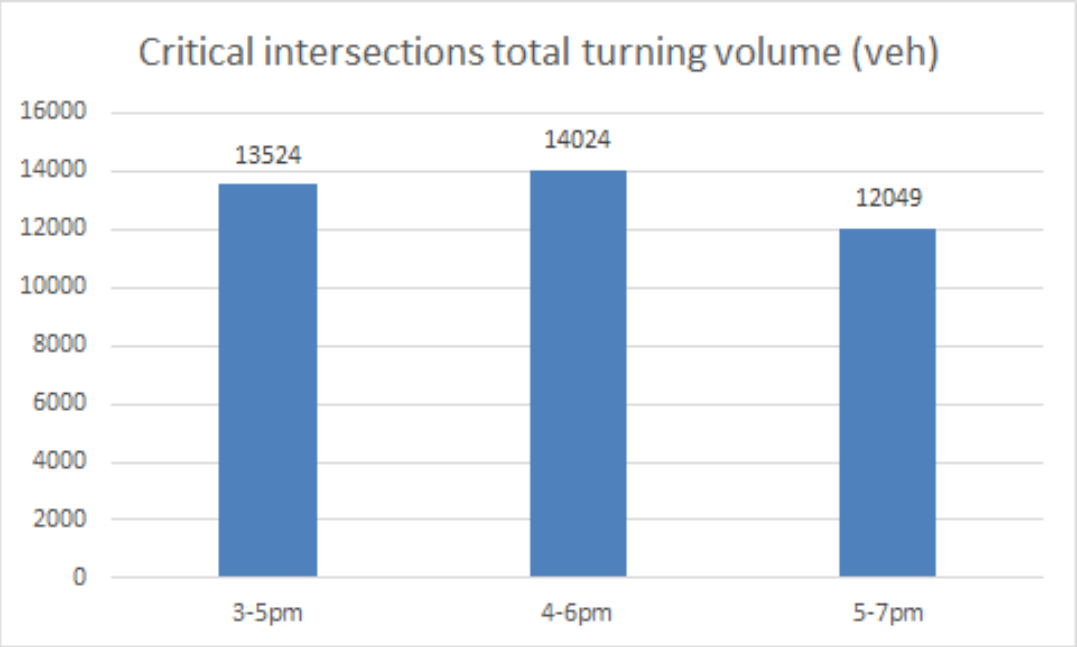


Figure 3-4: M4 interchange and Banks Drive intersection total turning volume during PM Peak

Figure 3-5 below shows the cumulative hourly total traffic profile across seven days from Tuesday 3rd March 2020 to Monday 9th March 2020.

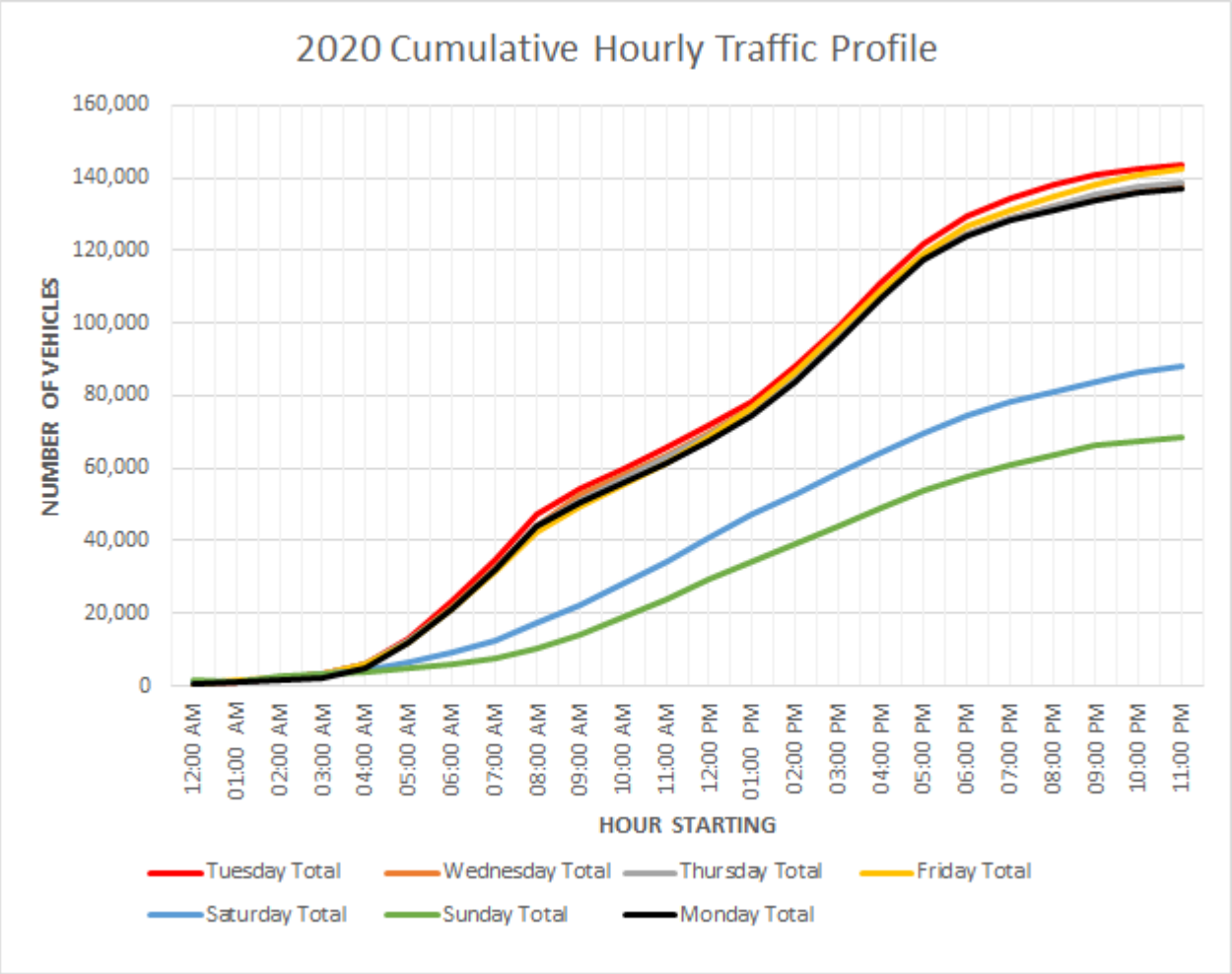


Figure 3-5: 2020 Cumulative Hourly Traffic Profile

It can be seen from the above figure that there are relatively consistent traffic volumes across all weekdays (Monday to Friday). The figure also shows that there are lower traffic volumes on the weekend (Saturday and Sunday) compared to weekdays with Sunday showing the lowest traffic volumes.

Figure 3-6 below shows the daily total and heavy vehicles volumes profile based on data collected during the mid-block surveys from Tuesday 3rd March 2020 to Monday 9th March 2020. The data shown in Figure 3-6 are based on the summation of all five midblock survey locations (midblock locations shown in Figure 3-1).

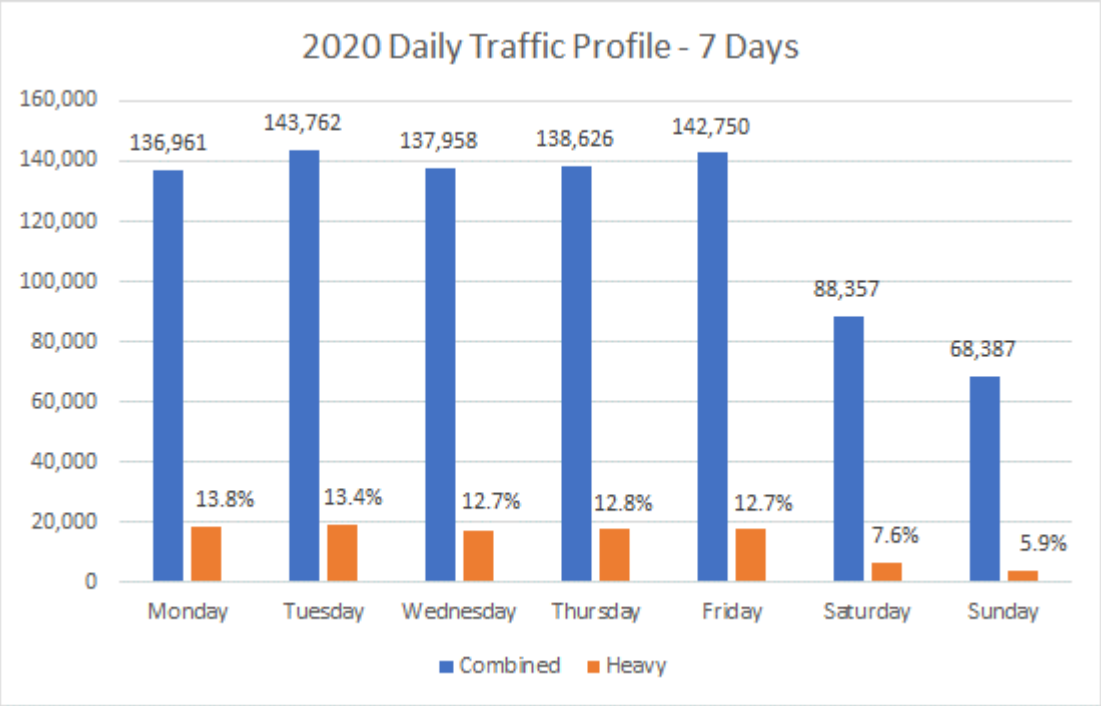


Figure 3-6: 2020 Daily Traffic Profile - 7 Days – Aggregated for all Midblock survey locations

It can be seen from the above figure that the overall traffic volume is relatively consistent across weekdays, with Tuesday showing the highest total daily traffic volume, however no significant difference between weekdays daily traffic volumes are noticeable. Figure 3-6 also show that weekend traffic in the study area is between 30 to 50 per cent lower than a typical weekday. Lowest total traffic volume is also observed on Sunday. Daily traffic volume data analyses indicate that the critical network condition is expected to occur during typical weekday.

Figure 3-6 also shows that the weekday daily traffic volumes include between 12.7 and 13.8 per cent heavy vehicles. The percentage of heavy vehicles during weekend is observed to be significantly lower than an average working day and to be between 7.6 and 5.9 of the total daily traffic volumes.

3.3 Existing Traffic Performance

In order to understand the existing traffic conditions in the study area, a series of site visits and traffic modelling have been completed for the existing traffic network. A summary of the site visit observations as well as traffic modelling findings are shown in this section of the report.

Figure 3-7 shows a schematic diagram of the existing lane configurations at each intersection within the study area.

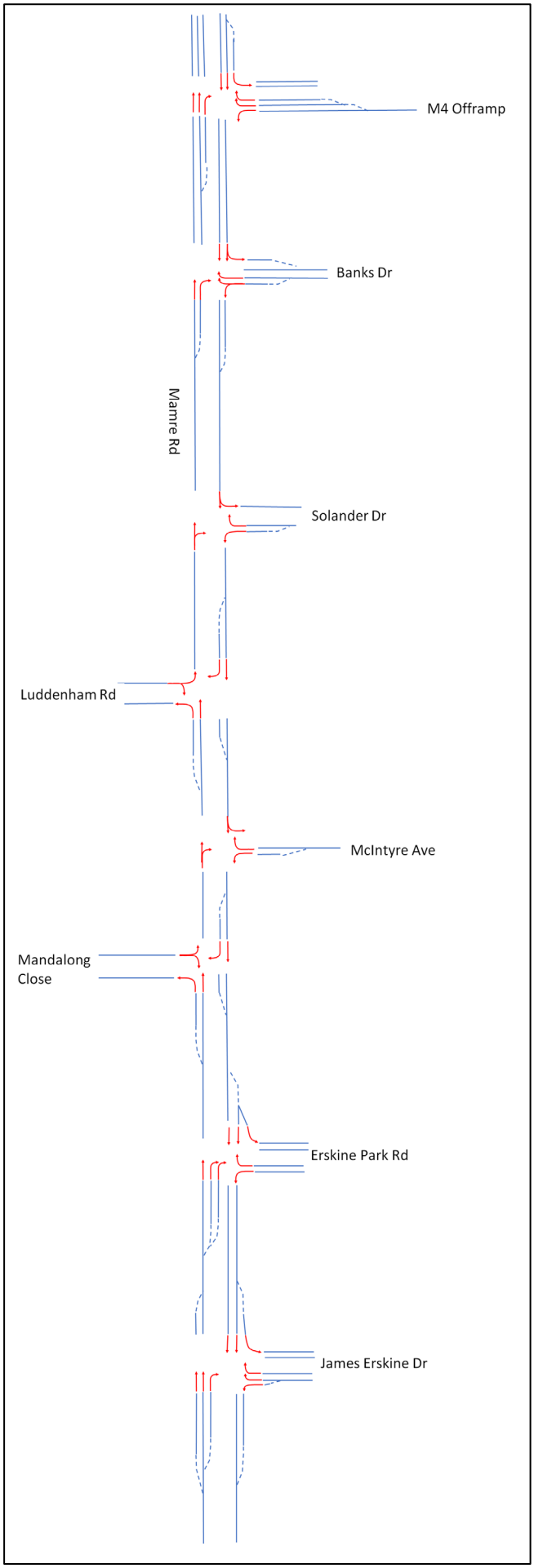


Figure 3-7: 2020 Base Year Existing Lane Configuration diagram

3.3.1 Site Visits Findings

In March 2020, multiple site visits were carried out along Mamre Road and at key intersections within the study area in order to fully understand current traffic conditions. Key findings are summarised below:

Typical AM Peak Traffic Conditions

Typical AM Peak traffic conditions at key intersections in the study area can be summarised as follows:

Mamre Road / Banks Drive Intersection

During AM Peak site visits:

- Long rolling queues were observed on Mamre Road northbound at Banks Drive intersection
- Long queues were observed for the right turn traffic out of Banks Drive
- Northbound through traffic on Mamre Road was observed to frequently experience green time loss due to congestion.

Figure 3-8 shows a snapshot of traffic conditions at this intersection.

Figure 3-8: 2020 AM Peak Banks Drive intersection
Source: Traffic counts survey video footage from TTM

Mamre Road / Solander Drive Intersection

During AM Peak site visits, a frequent rolling queue was observed northbound at the Solander Drive intersection as shown in Figure 3-9 and Figure 3-10. This queue was mainly an extension of the northbound queue from the Banks Drive intersection.

Figure 3-9: 2020 AM Peak Solander Drive intersection
Source: Traffic counts survey video footage from TTM

Figure 3-10: 2020 AM Peak Solander Drive intersection
Source: Traffic counts survey video footage from TTM

During the AM Peak, an occasional long rolling queue was also observed in the Mamre Road southbound lane near the Solander Drive intersection as shown in Figure 3-11. This was mainly due to the downstream signal at Erskine Park Road, which occasionally shows long rolling queues and results in impact to the southbound traffic on Mamre Road at Luddenham Road and Solander Drive intersections. Additionally, the performance of this section of Mamre Road seems to be susceptible to adverse weather conditions, which results in longer queue formations and slower travel speeds.

Figure 3-11: 2020 AM Peak Solander Drive intersection
Source: Traffic counts survey video footage from TTM

Also, during the AM Peak, excessive delay time (greater than three minutes) was frequently observed for right turn traffic from Solander Drive.

Mamre Road / Luddenham Road Intersection

During AM Peak site visits, infrequent long rolling queues were observed for northbound traffic along Mamre Road at the Luddenham Road intersection as shown in Figure 3-12. This was similar to the queues that were observed at the Solander Drive intersection.

Figure 3-12: 2020 AM Peak Luddenham Road intersection
Source: Traffic counts survey video footage from TTM

Also occasional extended rolling queue was observed for Mamre Road southbound traffic near the Luddenham Road intersection as shown in Figure 3-13. This was mainly due to the downstream signal at Erskine Park Road which occasionally creates long rolling queue and results in impact to the southbound traffic on Mamre Road up to this intersection.

Figure 3-13: 2020 AM Peak Luddenham Road intersection long southbound queue
Source: survey video footage from TTM

During AM Peak site visits, frequent excessive delay time (greater than one minute) was also observed at the Luddenham Road intersection for traffic turning right onto Mamre Road.

Mamre Road / Erskine Park Road intersection

During AM Peak site visits, the Erskine Park Road intersection did not show significant capacity issues with no major queue or congestion points. However, some infrequent and occasional southbound queues were observed for the northern approach. For the southbound section, the stationary queues were mainly contained within the two-lane section of the southbound approach, however occasional queue propagations out of this two-lane section showed shockwave formations and rolling queue extensions up to Solander Drive.

Summary of the AM Peak Site Visit Capacity Constraints

Figure 3-14 shows a summary of key capacity and congestion issues observed during site visits within the study area during the 2020 AM Peak period.

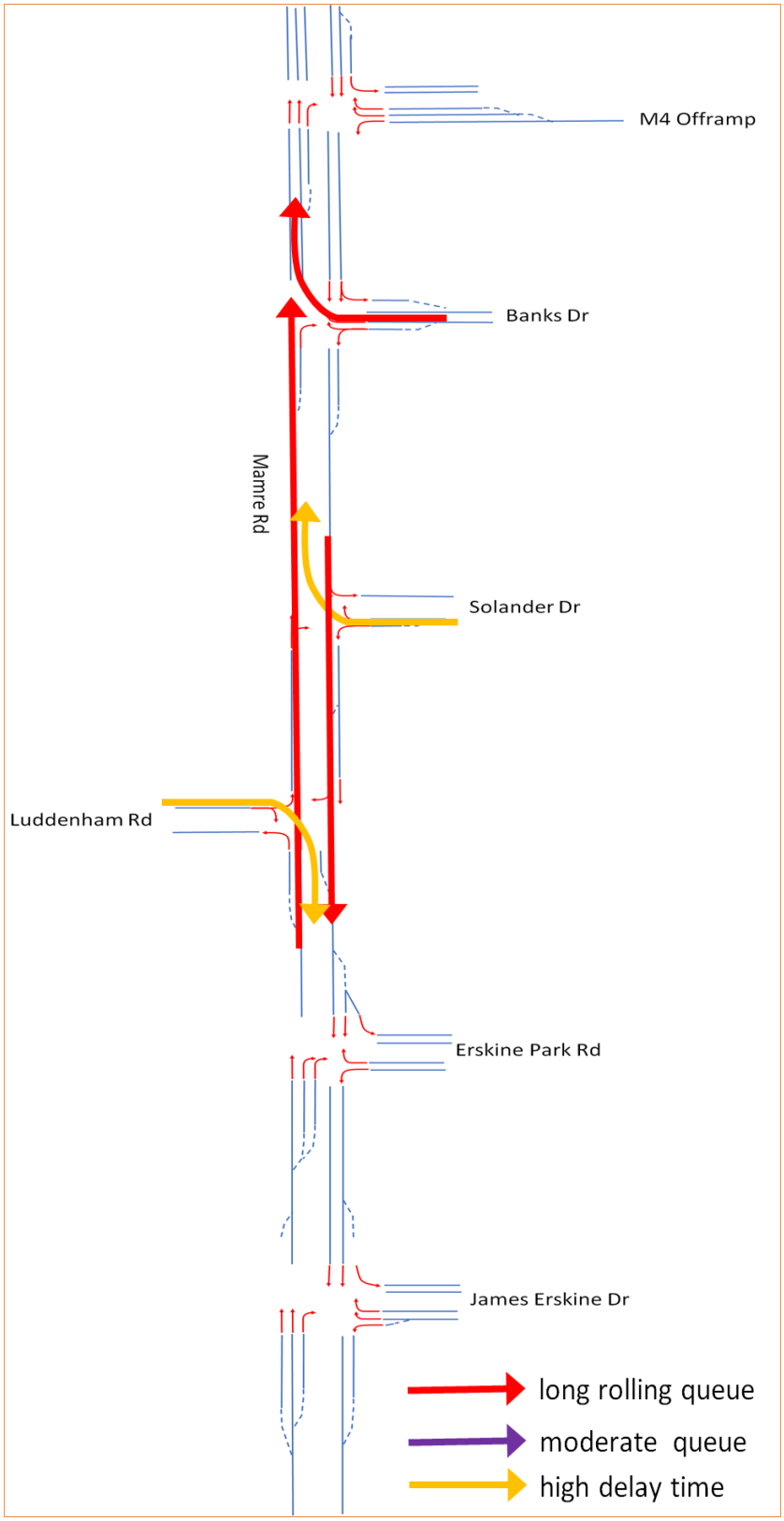


Figure 3-14: 2020 AM Peak key traffic issues within the study area

Typical PM Peak Traffic Conditions

Typical PM Peak traffic conditions at key intersections in the study area can be summarised as follows:

Mamre Road / Banks Drive Intersection

During PM Peak site visits, some long queues were observed on Banks Drive, as shown in Figure 3-15. However, the extent of the queue was generally less than those observed during the AM Peak.

Figure 3-15: 2020 PM Peak Banks Drive intersection
Source: Traffic counts survey video footage from TTM

Mamre Road / Solander Drive Intersection

During PM Peak site visits, excessive delay times (greater than three minutes) were frequently observed at Solander Drive for right turn traffic out of Solander Drive.

Mamre Road / Luddenham Road Intersection

During PM Peak site visits, infrequent long and extensive delay times (greater than two minutes) were observed for traffic from Luddenham Road, particularly for the right turn out traffic.

Infrequent long queues (about 20 vehicles long) were also observed for the right turn traffic from Mamre Road to Luddenham Road as shown in Figure 3-16.

Figure 3-16: 2020 PM Peak Luddenham Road intersection
Source: Traffic counts survey video footage from TTM

Mamre Road / Erskine Park Road Intersection

During PM Peak site visits, the Erskine Park Road intersection did not show significant capacity issues with no major queue or congestion points observed.

Summary of the PM Peak Site Visit Capacity Constraints

Figure 3-17 shows the summary of the key capacity and congestion issues observed during site visits within the study area during 2020 PM Peak period.

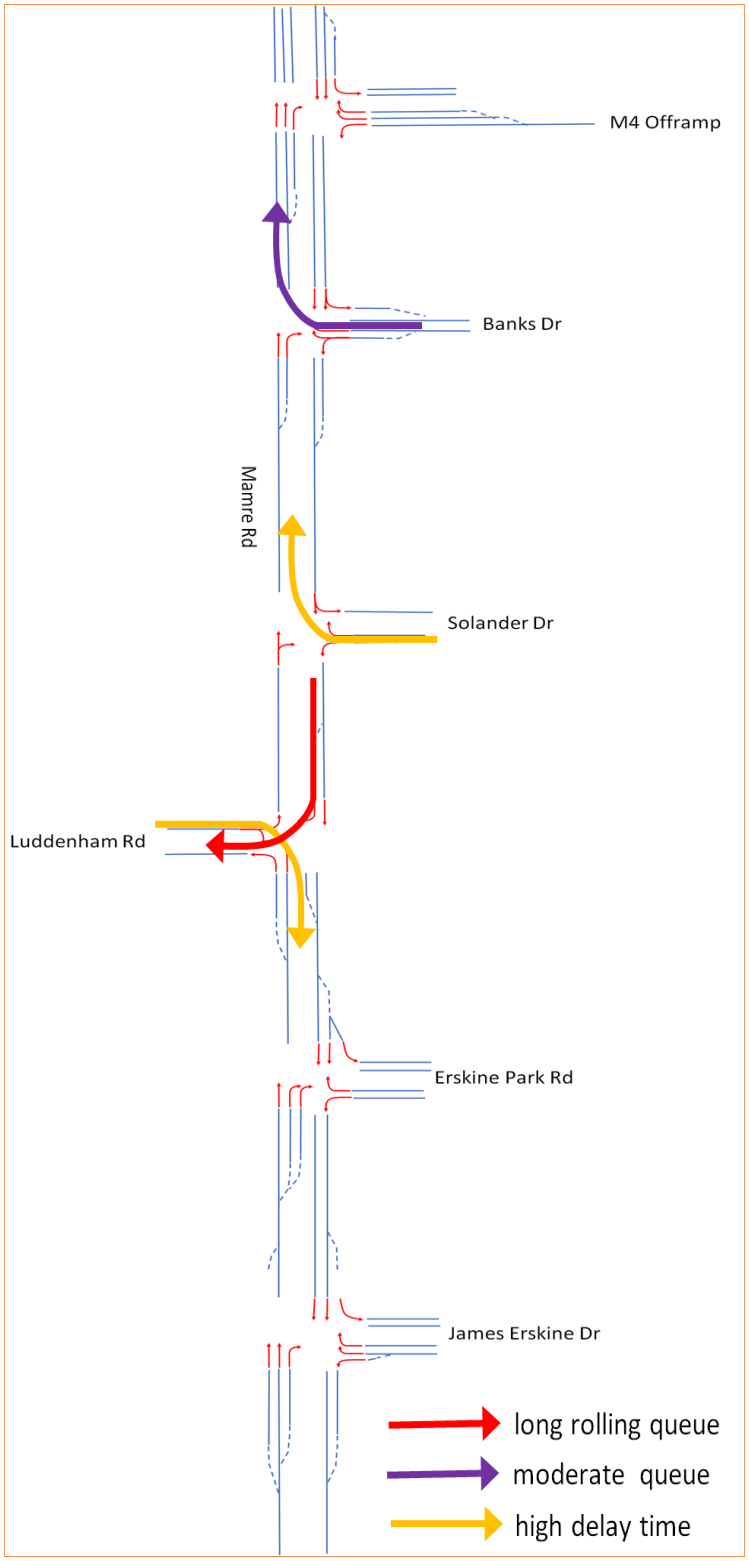


Figure 3-17: 2020 PM Peak key traffic issues within study area

3.3.2 Base Year Modelling Results

In order to assess existing road network performance, the traffic network was analysed for a 2020 Base Year scenario in terms of the following key performance indicators:

- Overall network statistics
- Key intersection level of service
- Key routes travel time analysis
- Overall network queueing and capacity analysis.

Overall network statistics analysis usually includes assessment of the following:

- Average delay per vehicle
- Average network speed
- Vehicle kilometre travel (VKT)
- Vehicle hour travel (VHT)
- Total number of stops
- Unreleased vehicles (also known as latent demand).

Table 3-1 lists the road network statistics for 2020 base model during AM and PM Peak periods.

Table 3-1: 2020 base model peak periods network statistics

	2020 AM Peak	2020 PM Peak
Average delay per vehicle (minutes: seconds)	00:54	01:04
Average network speed (km/hr)	39	34
Vehicle Kilometre Travel (VKT)	29,451	27,902
Vehicle Hour Travel (VHT)	750	810
Total Stops	2243	3652
Unreleased vehicles (number of vehicles)	117	30
% of demand unreleased	1.1%	0.3%
Total Demand (number of vehicles)	10,170	10,978

Intersection delay and associated level of service (LOS) were extracted from the 2020 base model for both AM and PM Peak periods. Table 3-2 outlines the LOS for key intersections within the study area for the 2020 Base Year scenario during the second hour of the peak period. Table 3-2 shows intersection LOS based on average delay for all intersection control types to allow for direct comparison with the intersection LOS during operation of the proposal. Detailed LOS analyses including approach LOS results are shown in Appendix C of this report.

Table 3-2: Key intersection LOS during 2020 peak period (2nd hour)

Intersection	2020 AM Peak (2nd hour)		2020 PM Peak (2nd hour)	
	Average Delay (sec)	LOS	Average Delay (sec)	LOS
M4 Motorway Westbound Ramp and Mamre Road	38	C	58	E
Banks Drive and Mamre Road	85	F	116	F
Solander Drive and Mamre Road	20	B	21	B
Luddenham Road and Mamre Road	9	A	11	A
Erskine Park Road and Mamre Road	50	D	47	D
James Erskine Drive and Mamre Road	15	B	17	B

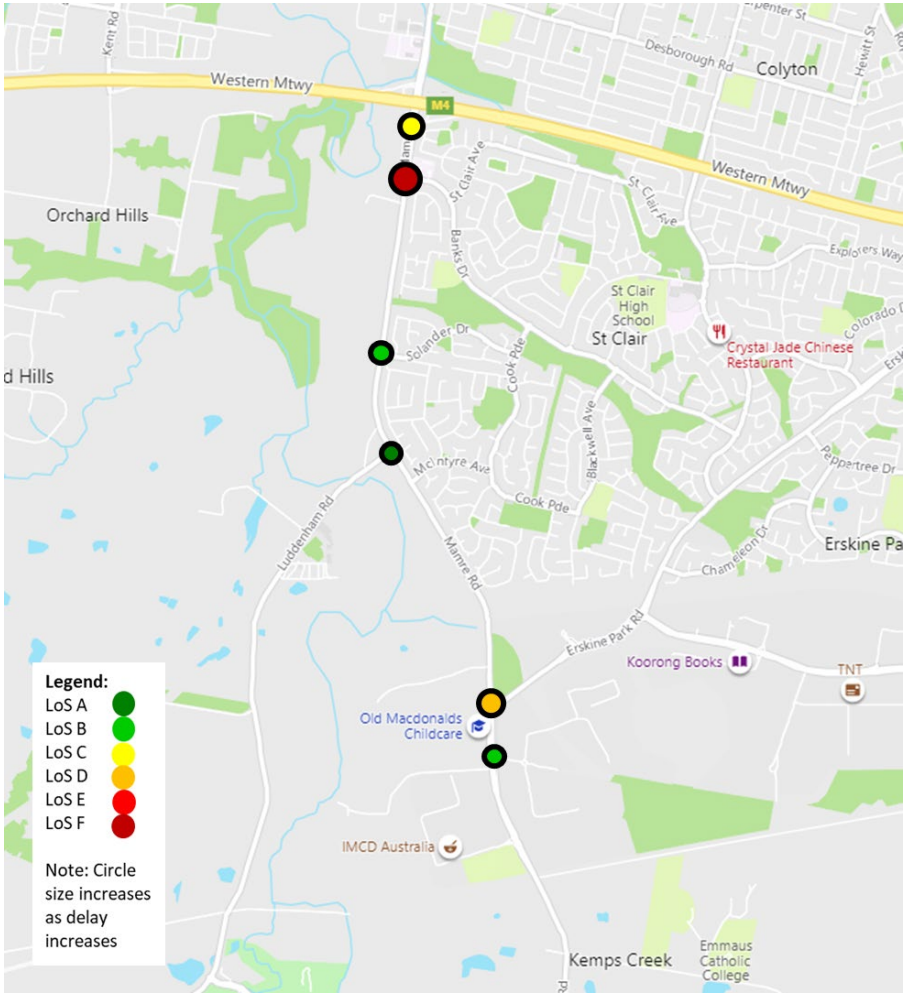


Figure 3-19: 2020 Base year AM Peak intersection LOS

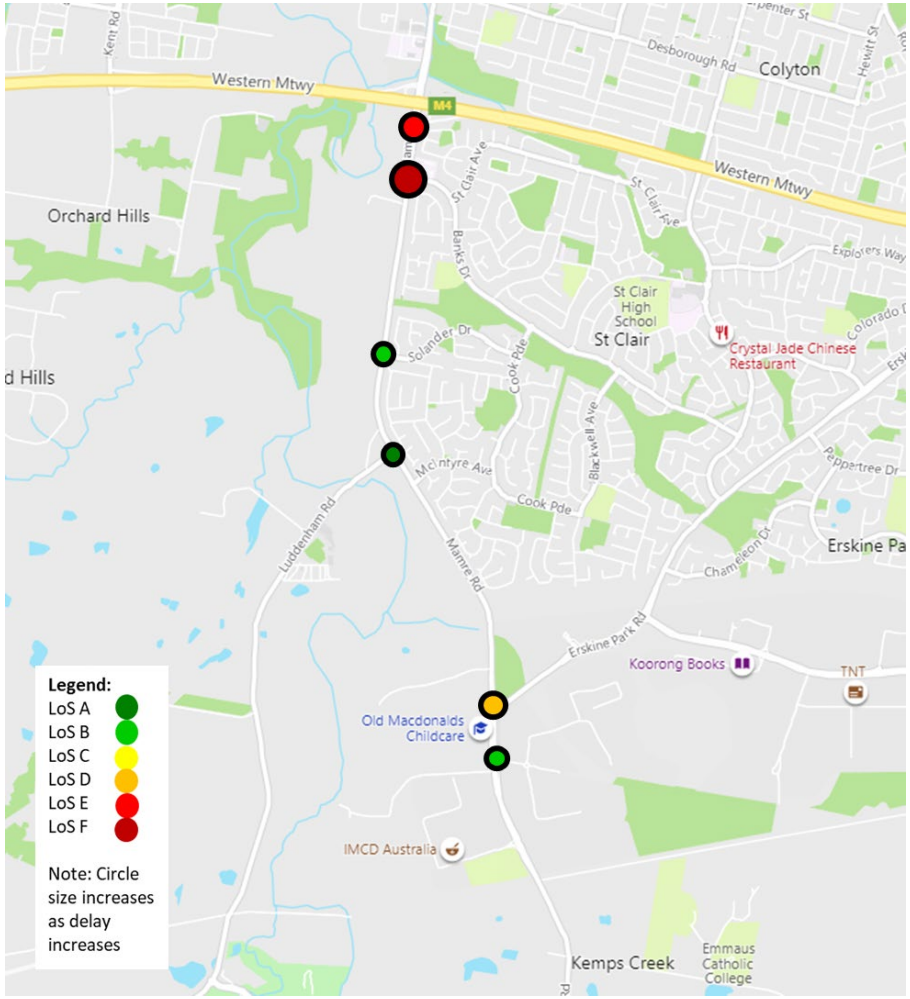


Figure 3-18: 2020 Base year PM Peak intersection LOS

3.4 Historical Crash Analysis

Analysis of crash history data was completed for key roads in the area using data collected by TfNSW for the five years from 2014 to 2019 focussed on the section of Mamre Road in the study area as shown in Figure 3-20.

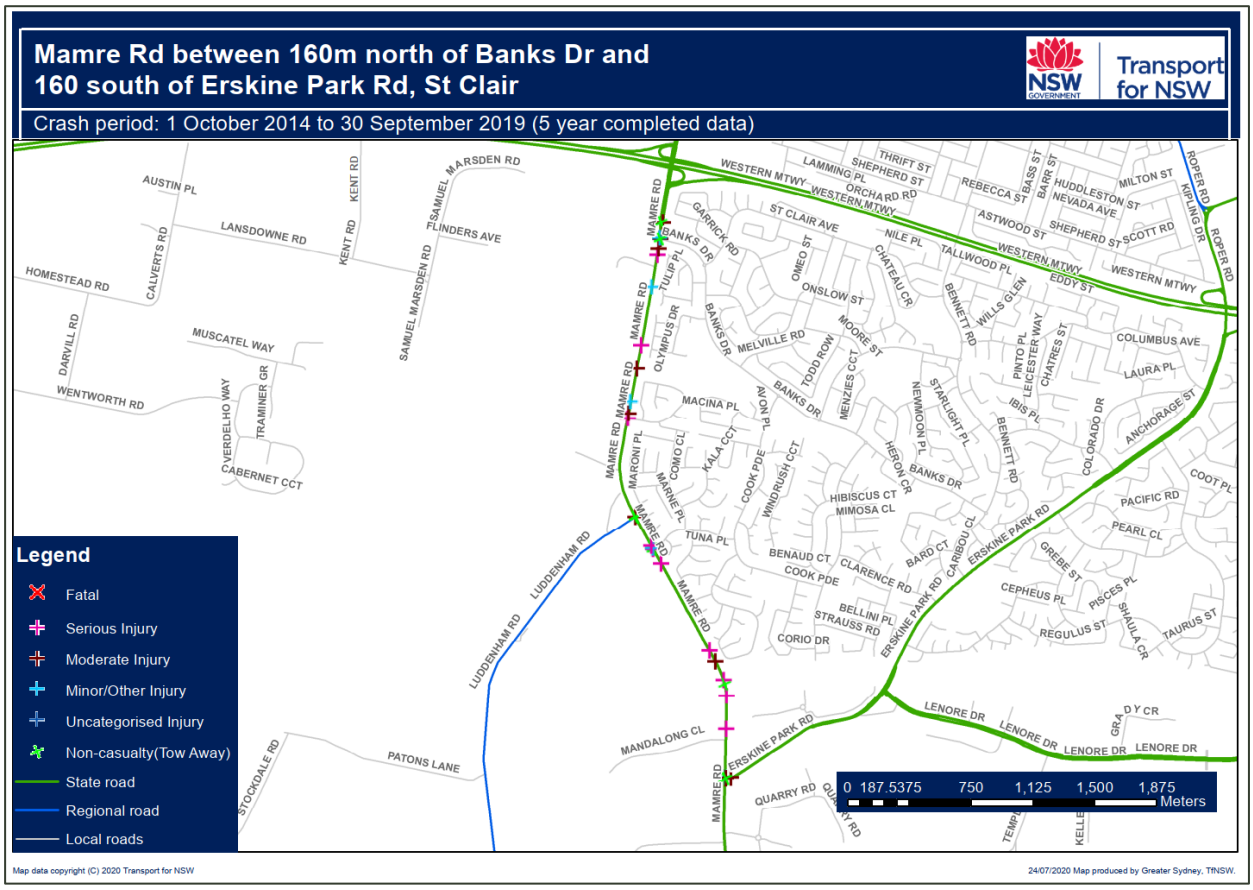


Figure 3-20: Crash analysis summary from 2014 to 2019 along Mamre Road

Source: https://roadsafety.transport.nsw.gov.au/statistics

As shown in Table 3-3, review of the crash data shows a total of 45 crashes occurred along Mamre Road within the study area in the five-year period. The following points provide a summary of the key findings:

- 45 crashes on Mamre Road from Banks Drive to Erskine Park Road
- Reported crashes resulted in 13 non-casualties, 6 minor injuries, 11 moderate injuries and 15 serious injuries.

Table 3-3 summarises crash statistics, classified by severity and road sections as well as the number of reported crashes by time of day.

Table 3-3: Summary of Crashes by Location and Severity in the Study Area

Section	Location	Casualty			Non-casualty (towaway)	Total
		Serious Injury	Moderate Injury	Minor/Other Injury		
1	Banks Drive to Solander Drive	3	5	4	3	15
2	Solander Drive to McIntyre Avenue	4	2	0	3	9
3	McIntyre Avenue to Erskine Park Road	8	4	2	7	21
Total		15	11	6	13	45

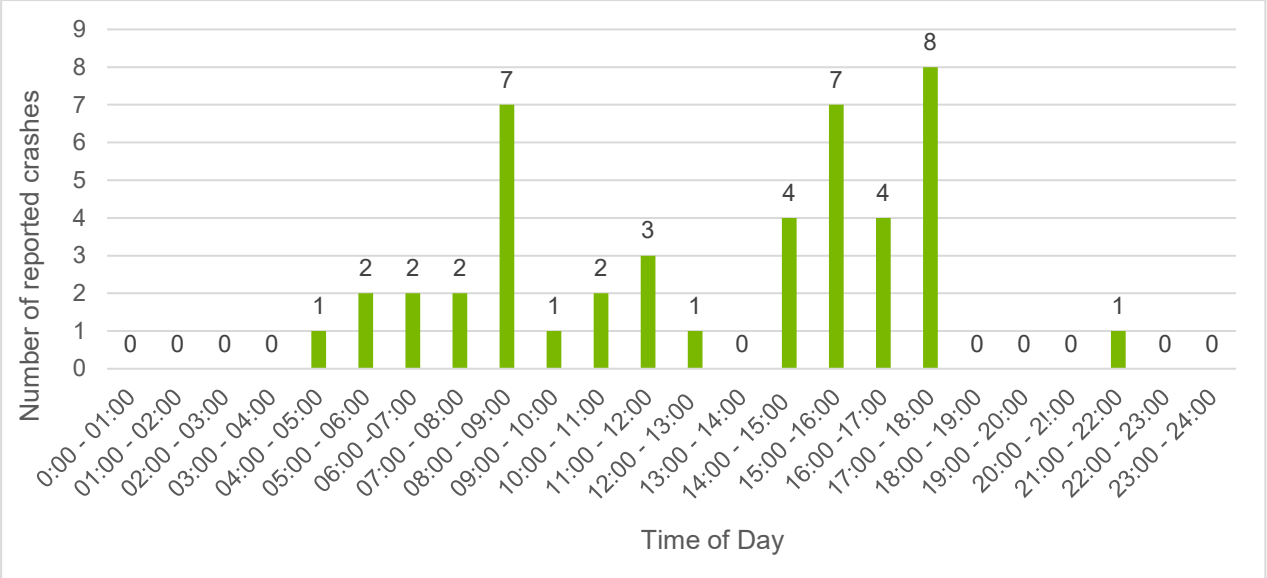


Figure 3-21: Number of Reported Crashes by Time of Day

Most injury crashes occurred during fine weather conditions. The most common time for crashes to occur was during the AM and PM Peak periods when traffic volumes are the highest. Only one crash was recorded between 6:00 PM and 5:00 AM in the morning.

Figure 3-22 presents the collision types occurring within the study area over the five-year period. The figure indicates that the most prevalent collision type was collisions involving vehicles travelling in the same direction, accounting for 56 per cent of the total crashes. The crashes for vehicles from the same direction mainly consist of rear end collisions. While it is not clearly stated in the data collected, these types of collisions are characteristically common on approaches to signalised intersections during peak periods where high numbers of 'stop and start' conditions observed. Also, the large crashes of this type along Mamre Road is an indication that traffic congestions may present a major safety issue. Fluctuations in average speed particularly during peak commute hours can create a 'start and stop' driving environment for motorists which increases the likelihood of rear end collisions during periods of congestion.

Further analyses of the crash data show that fifteen crashes at intersections were reported which account for 30 percent of the total crashes. Among these collisions, there were five crashes due to vehicles from opposing directions, and nine crashes that involved vehicles from adjacent directions.

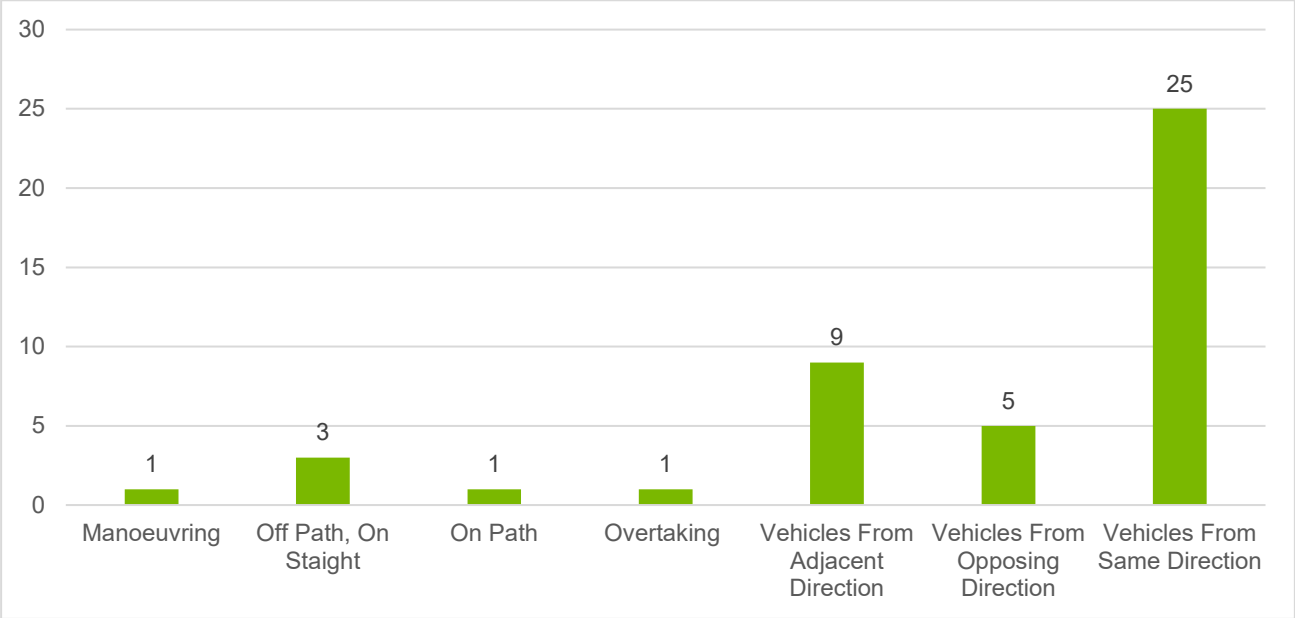


Figure 3-22: Summary of the number of crashes per type along Mamre Road between 2014 and 2019

Table 3-4 provides a summary of the number of fatalities, injuries and non-casualty crashes that have occurred and calculates the crash severity index for the study area. This measure uses a weighting system to give an indication of the severity of crashes at each intersection.

Table 3-4: Crash severity index

Description	Corridor length (km)	Fatal	Injury	Non-Casualty	Total	Crash severity Index
Mamre Road from Banks Drive to Erskine Park Road	3.8	0	32	13	45	1.71

The Mamre Road corridor has a crash severity index of 1.71, which is higher than both the Sydney Metropolitan Area and NSW state as a whole, which have average crash severity indexes of 1.22 and 1.24 respectively.

Review of the crash data and further analyses also show the following additional points:

- Crash types were similar to the mix of road users with 89 per cent of crashes involving cars, two per cent of crashes including cyclists or pedestrians and nine per cent of crashes including other road user types.
- Speeding was a contributing factor recorded in only two per cent of crashes
- 73 per cent of crashes occurred during daylight
- 76 per cent of crashes occurred in the 80km/h zone, and 24 per cent in the 60km/h zone of Mamre Road
- The crashes were fairly evenly distributed along this section of Mamre Road, with some concentration near the bend north of Erskine Park Road where there are no side roads.

In summary and given the projected traffic volumes growth and traffic congestion increase in the study area, it is likely that safety would continue to deteriorate along Mamre Road for all road users. Historical crash data analyses suggest that congestion is one of the key contributing factors for the most common crash type in the study area. Also, the concentration of crashes near intersections suggests that key intersections also experience capacity and safety deficiencies. Road safety along Mamre Road is of ongoing and substantial concern to TfNSW and the local community.

3.5 Heavy Vehicle Routes

Mamre Road and Erskine Park Road, along with other routes in the surrounding area such as Old Wallgrove Road, M4 Motorway, Great Western Highway and Elizabeth Drive are existing designated B-double routes.

Mamre Road and Erskine Park Road are TfNSW approved heavy vehicle routes for 19m B-double and 26m B-doubles that comply with the requirements contained in the Heavy Vehicle National Law (HVNL). They are also part of the road network that accommodates 4.6-metre-high vehicles. These heavy vehicle routes connect the highway and motorway network and local industries in Erskine Park.

Figure 3-23 shows the approved 26 metre B-double routes (over 50 tonnes) for Mamre Road and the surrounding area.

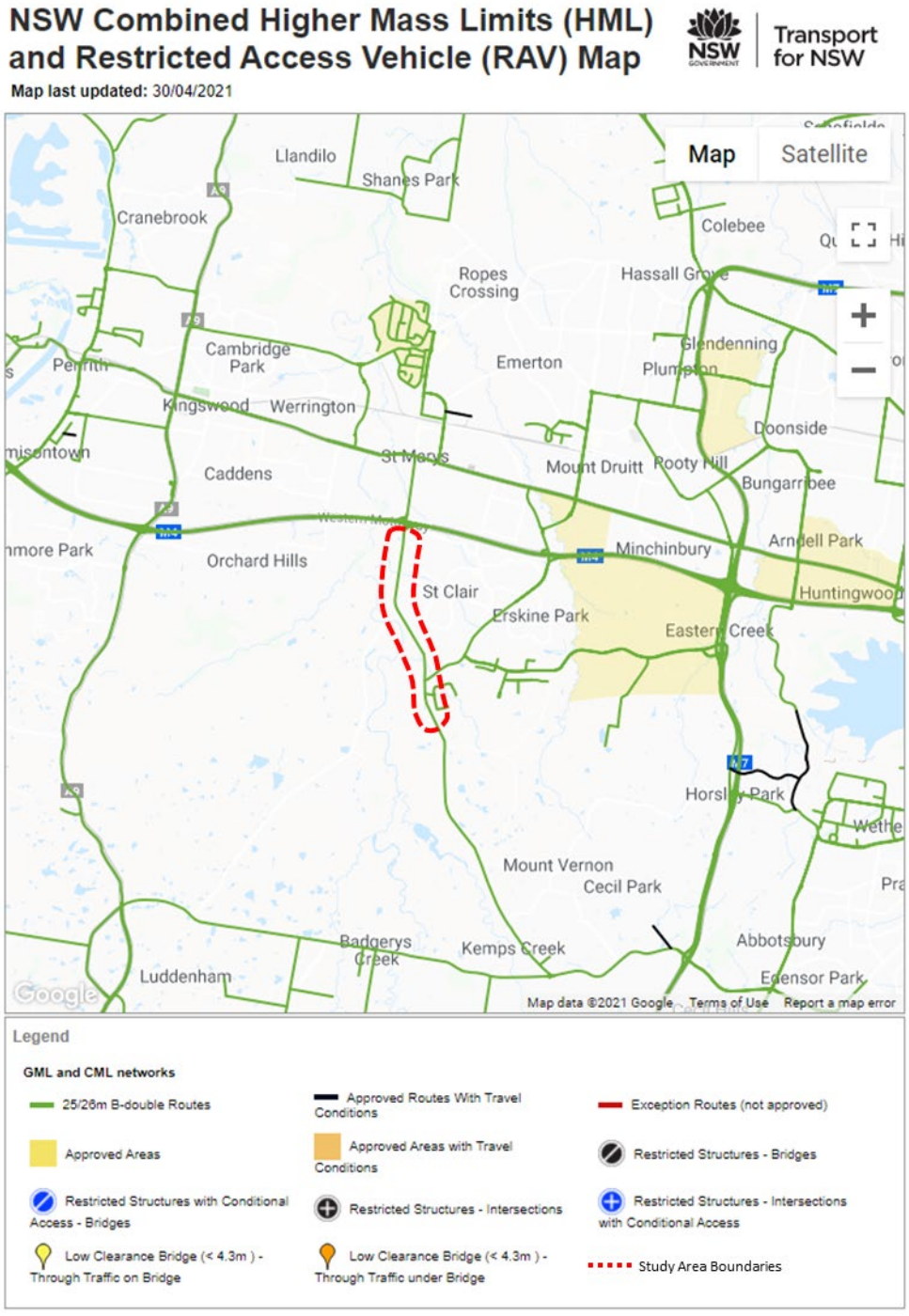


Figure 3-23: 26 m B-double Routes (over 50 tonnes)

3.6 Parking

The roads within the study area are main roads, collector roads and local roads. While there are unsealed gravel verge or widened grass verge areas, no formal on-street parking along the length of Mamre Road is provided. On-street parking along Mamre Road is formally prohibited through use of No Parking and No Stopping signs.

Parking provisions and restrictions vary for the various side roads:

- 'No Parking' restrictions are currently in place on Erskine Park Road.
- Mandalong Close contains an unsealed shoulder with no formal parking provisions. Due to the largely low-density nature of the surrounding land use, there is minimal or no demand for on-street parking, as the surrounding properties have ample space for off-street parking and are not intensively developed.
- McIntyre Avenue provides one lane in each direction and a full sealed shoulder for both directions, which is currently used by local residents for on-street parking. In addition, suitable parking provisions on private driveways is provided.
- Solander Drive provides a full sealed shoulder that is used for on-street parking. In addition, suitable parking provisions on private driveways is provided.
- Luddenham Road provides sections of sealed and unsealed shoulders, which can be used for on-street parking for infrequent road users. Due to the largely low-density nature of the surrounding land use, there is minimal or no demand for on-street parking, as the surrounding properties have ample space for off-street parking and are not intensively developed. Directly in front of the Rural Fire Service (RFS) site, the unsealed and grass verge has been seen to be used for infrequent parking at times. In addition, appropriate onsite parking facilities are provided for RFS workers.
- Within the study area No Parking restrictions are currently in place on Banks Drive for both directions of traffic.

3.7 Public Transport Provision

Car (driver and passenger) is the dominant mode of travel for people living and working within the study area, which account for about 80 per cent of all travel modes in vicinity of the study area. TfNSW Journey to work data show that train and bus public transport account for less than 10 per cent of the trips in the vicinity of the study area and only 5 per cent of travel consists of walking and/or cycling (source: TfNSW Journey to Work Data).

The bus routes in the study area include:

- #775 Mount Druitt to Penrith via Erskine Park and St Marys (36 services per day Monday to Friday)
- #776 Penrith to Mt Druitt (34 services per day Monday – Friday)
- #779 St Marys to Erskine Park Industrial area (four services in the peak direction per day Monday – Friday only)

In addition to the above bus services, there are several school bus services provided within the study area:

- #4647 (1 service per day Monday to Friday)
- #4036 (1 service per day Monday to Friday)
- #4115 (1 service per day Monday to Friday)
- #4002 (1 service per day Monday to Friday)
- #4566 (1 service per day Monday to Friday)
- #4642(1 service per day Monday to Friday)

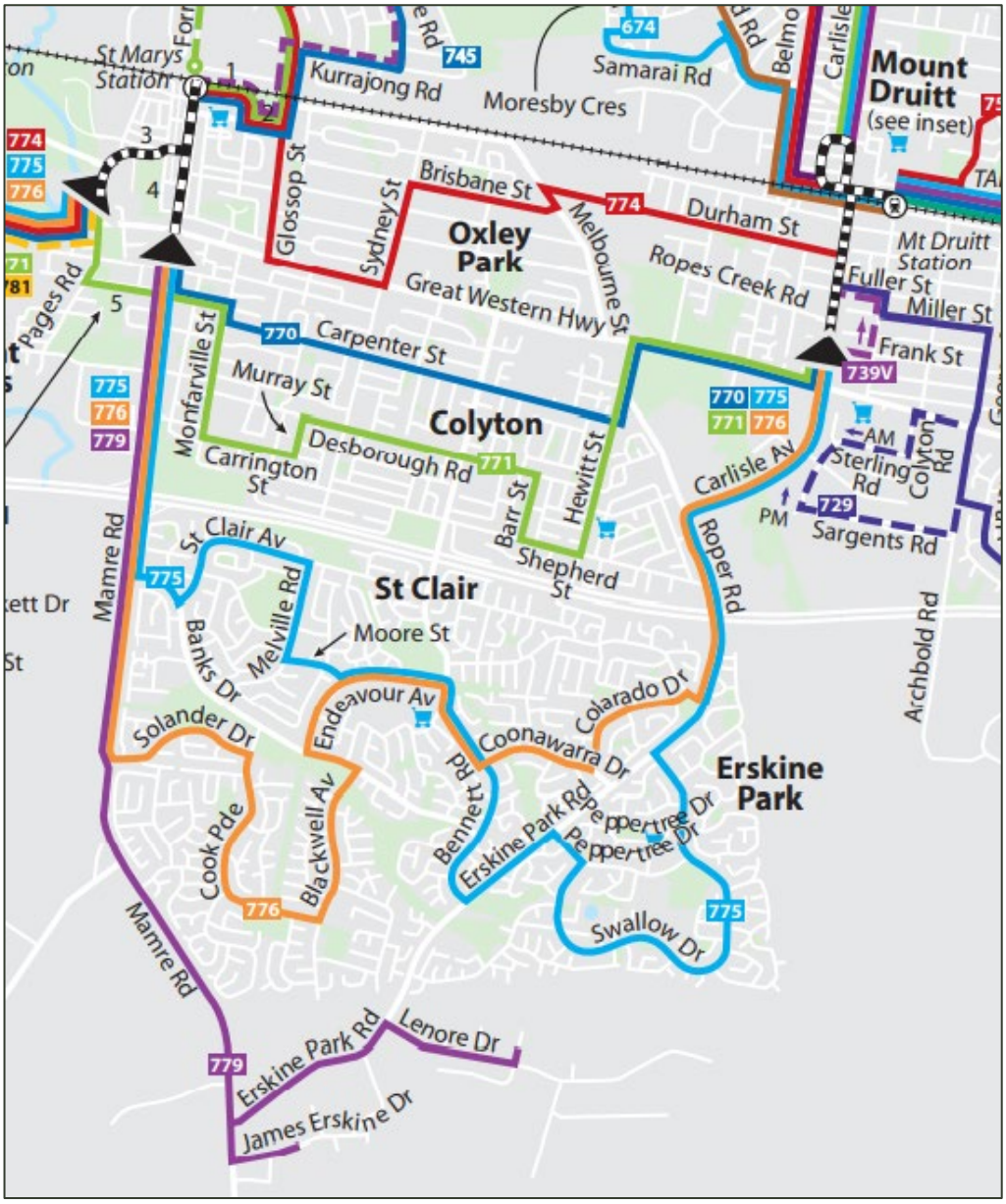
- #4050 (1 service per day Monday to Friday)
- #4514 (1 service per day Monday to Friday)
- #4563 (1 service per day Monday to Friday).

Bus services within the study area (shown in Figure 3-24) have few services provided at low frequencies which operate long and circuitous routes primarily to provide local coverage. This reflects the low population density across the study area, which generates low demand for public transport trips. The existing bus routes tend to link residential and industrial areas with railway stations.

There are existing kerbside bus stops at the following locations:

- Mamre Road southbound north of Luddenham Road intersection
- Mamre Road southbound south of Solander Drive intersection
- Erskine Park Road east of Mamre Road eastbound and westbound
- Mamre Road south of Banks Drive northbound and southbound
- Banks Drive westbound prior to Mamre Road intersection

Along Mamre Road, bus stop signage is provided at kerbside bus stops.



(Source https://www.busways.com.au/sites/default/files/network-maps/2019-05-28/R1TimetableNetworkMapMay2019.pdf)

Figure 3-24: Local Bus Services

3.8 Facilities for Active Transport Users

Figure 3-25 shows existing active transport facilities along Mamre Road between the M4 Motorway and Erskine Park Road. Signalised pedestrian crossing facilities are available at the Erskine Park Road signalised intersection, Banks Drive signalised intersection and M4 Interchange ramps as shown in the figure below.

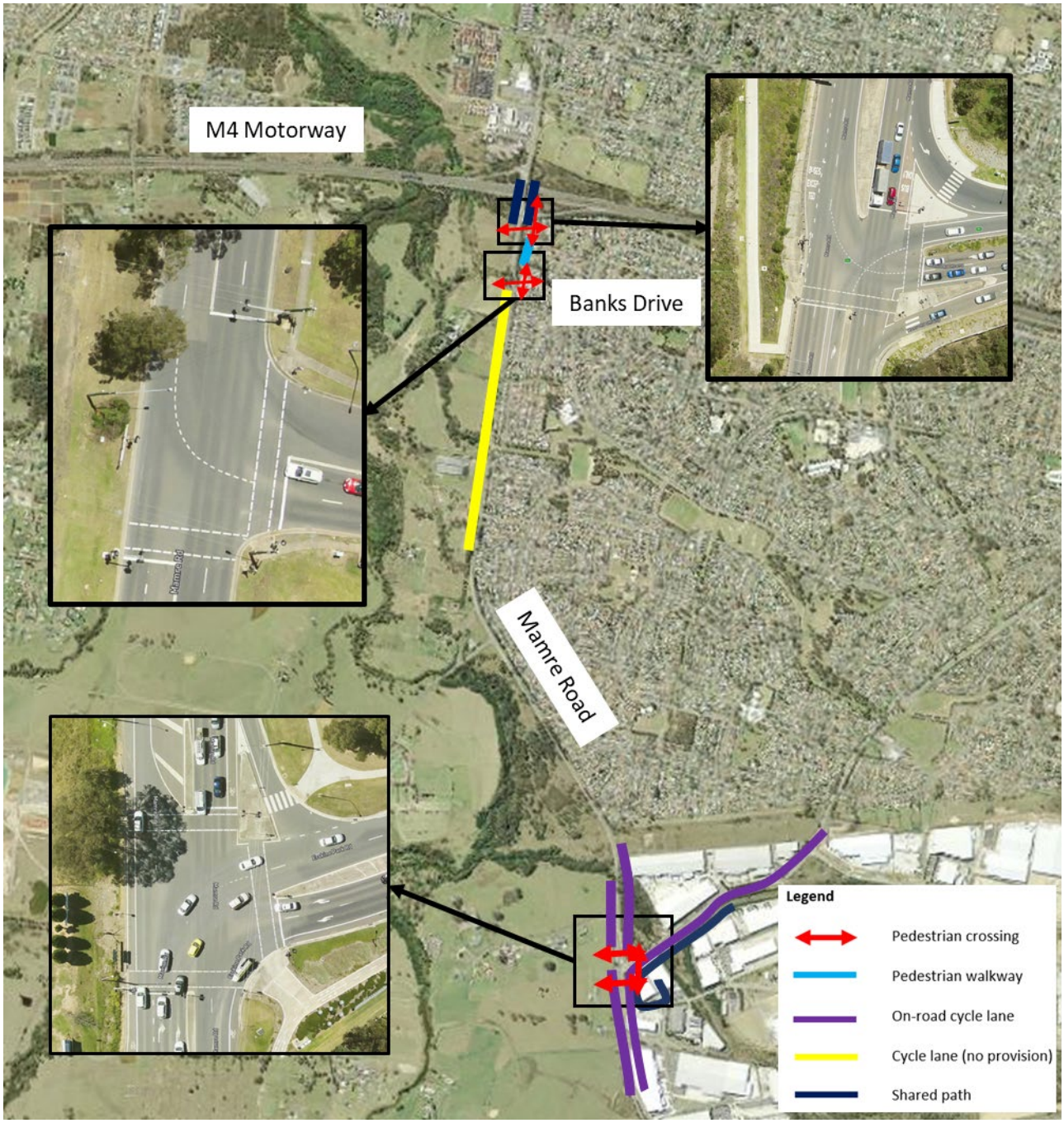


Figure 3-25: Existing Active Transport Facilities along Mamre Road between M4 Motorway and Erskine Park Road (Image Source: MetroMap)

Existing facilities for pedestrians and cyclists within the study area are limited. A designated pedestrian path is available along the section of Mamre Road between Banks Drive and M4 Interchange as well as a shared pedestrian / cycle path between Erskine Park Road and James Erskine Drive. There are designated on-road cycle lanes on Mamre Road between the southern extent of the study area and Mandalong Close as well as the section between Erskine Park Road and James Erskine Drive .

Figure 3-26 shows the difficulty level of existing cycling routes along Mamre Road and the roads in the vicinity of the proposal. Sections of Mamre Road are designated “hard difficulty” for cycling, with majority of the existing Mamre Road without designated on or off-road cyclist facilities.

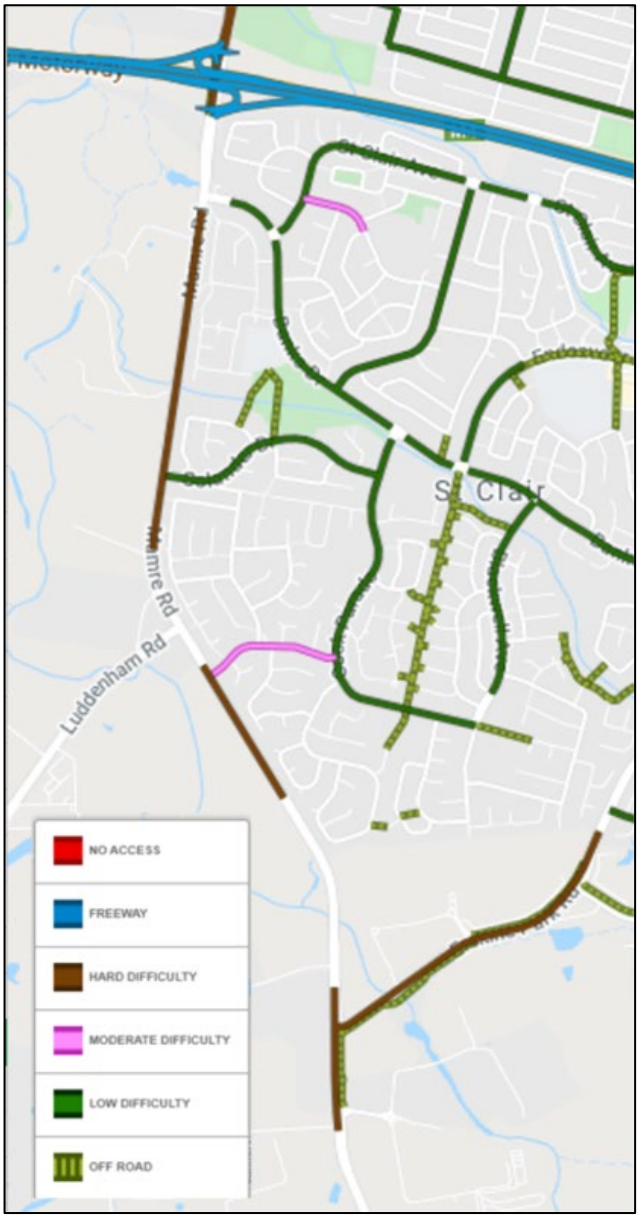


Figure 3-26: Existing Bicycle Network (source TfNSW - CyclewayFinder)

Figure 3-27 and Figure 3-28 show Strava heat map of pedestrian and cyclist activities along Mamre Road and surrounding area respectively.

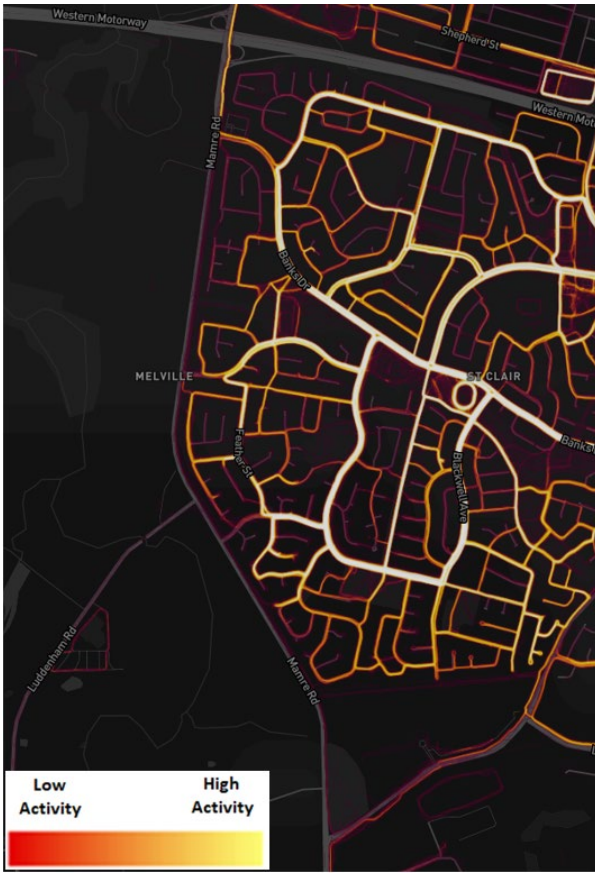


Figure 3-27: Pedestrian Activity Heatmap (Source: Strava)

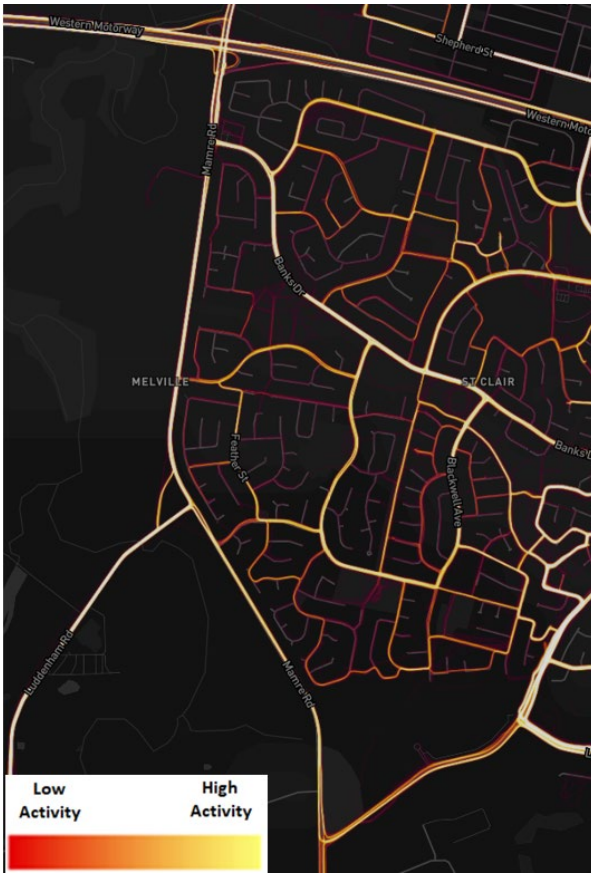


Figure 3-28: Cyclist Activity Heatmap (Source: Strava)

It is to be noted that the Strava heat maps are indicative and is based on users that log their journeys through the exercise tracker Strava.

As mentioned earlier, due to lack of pedestrian walkways, low pedestrian activity is shown in Strava heatmap along Mamre Road. However, some cyclist activities are shown along Mamre Road utilising the section of designated cycle lane south of Mandalong Close and then travelling on-road north of this location, where no designated cycle lane is available.

4 Proposed Road Upgrade

4.1 Proposed Mamre Road Upgrade

The proposal includes an upgrade of a 3.8 kilometre section of Mamre Road between Erskine Park Road and the M4 Motorway. The proposal would include widening Mamre Road to four lanes with two lanes in each direction and a wide central median along the length of the road that would allow for an additional lane in each direction, in the future. The proposal includes associated upgrades to existing intersections along Mamre Road including at:

- Erskine Park Road (upgrade of existing signalised intersection)
- Luddenham Road (upgrade from a seagull intersection to signalised intersection)
- Solander Drive (upgrade from priority-controlled intersection to signalised intersection and provision of a new fourth leg with a U-turn facility)
- Banks Drive (upgrade of existing signalised intersection and provision of a new fourth leg with a U-turn facility).

The following existing priority-controlled intersections would be adjusted to left-in, left-out only:

- Mandalong Close
- McIntyre Avenue.

The proposal's road geometry largely follows the horizontal alignment of the existing Mamre Road and provides adequate tie-ins to existing roads, where impacted by the proposal. The vertical alignment along Mamre Road would be raised in various locations in order to achieve suitable flood immunity requirements.

The proposed upgrade to Mamre Road would improve road safety and local access, and support connections to Elizabeth Drive and the M4 Motorway.

The construction activities for the proposal are proposed to be completed in three stages:

- Stage 1 - Mamre Road traffic would remain in the existing arrangement and the proposed northbound carriageway would be constructed offline behind safety barriers.
- Stage 2 - Mamre Road traffic would use the new northbound carriageway while the new proposed southbound carriageway would be constructed.
- Stage 3 - Mamre Road traffic would be configured to one lane in each direction using both the new northbound and southbound carriageways. The lanes closest to the median in both directions would be closed to allow safe working widths for final construction of the central median.

Table 4-1 summarises the proposed bus facilities at each intersection as part of the proposal.

Table 4-1: Summary of proposed bus facilities

Intersection with Mamre Road	Direction	Bus Bay Arrangement		Space Proofing for Bus Shelter in Footway
		Approach Side	Departure Side	
Erskine Park Road	Northbound	-	-	-
	Southbound	Provision for future bus priority lane (adjacent to high-entry angle left turn lane)	Indented bus bay	6.6 m footway in design. Providing 7.5 m footway will require steepening batter
	Eastbound	-	Existing bus stop location retained. Adjusted to new kerb line. Hardstand area is being provided.	Hardstand area will be provided adjacent to the 3 m shared path.

Intersection with Mamre Road	Direction	Bus Bay Arrangement		Space Proofing for Bus Shelter in Footway
		Approach Side	Departure Side	
	Westbound	Existing bus stop being relocated east by approximately 50m. Hardstand area is to be provided.	-	Hardstand area is to be provided adjacent to the existing footpath.
Solander Drive	Northbound	Provision for future bus priority lane (within left turn lane, to minimise impacts to the development)	Indented bus bay	7.5 m footway provided
	Southbound	Provision for future bus priority lane (within left turn lane, to minimise impacts to the development)	Indented bus bay	7.5 m footway provided
Banks Drive	Northbound	Provision for future bus priority lane (within left turn lane, to minimise impacts to the development)	Indented bus bay	7.5 m footway provided
	Southbound	Provision for future bus priority lane (within left turn lane, to minimise impacts to the development)	Indented bus bay	7.5 m footway provided
	Westbound	Existing bus stop being relocated about 30 m east to just outside the proposal area.	-	Hardstand area is to be provided adjacent to the existing footpath.

New bus bays would be provided on the departure side of Mamre Road at the Erskine Park Road, Solander Drive and Banks Drive intersections. For Erskine Park Road and Banks Drive, the existing bus stop infrastructure would be relocated as part of the proposal to the new location to provide similar to existing and catering for a bus stop level 3 requirement.

4.2 Proposed Geometry of Proposal

The geometry of the proposal used for traffic modelling and analyses are as the following.

4.2.1 Mamre Road / Banks Drive Intersection

Key road geometry upgrade features for this intersection as used in traffic analyses are shown in Figure 4-1:

- Two through lanes southbound and northbound on Mamre Road
- Three northbound departure lanes north of Banks Drive to account for assumptions undertaken for M4 interchange as outlined in section 2.6.2 of this report
- Dual right turn lanes on Banks Drive Eastern approach (two long lanes)
- New western approach (two lane each direction)
- Short right turn bay southbound turning into the new western leg.

The geometry shown in Figure 4-1 includes the proposed upgrades as part of the proposal as well as assumptions undertaken for M4 Interchange outlined in section 2.6.2.

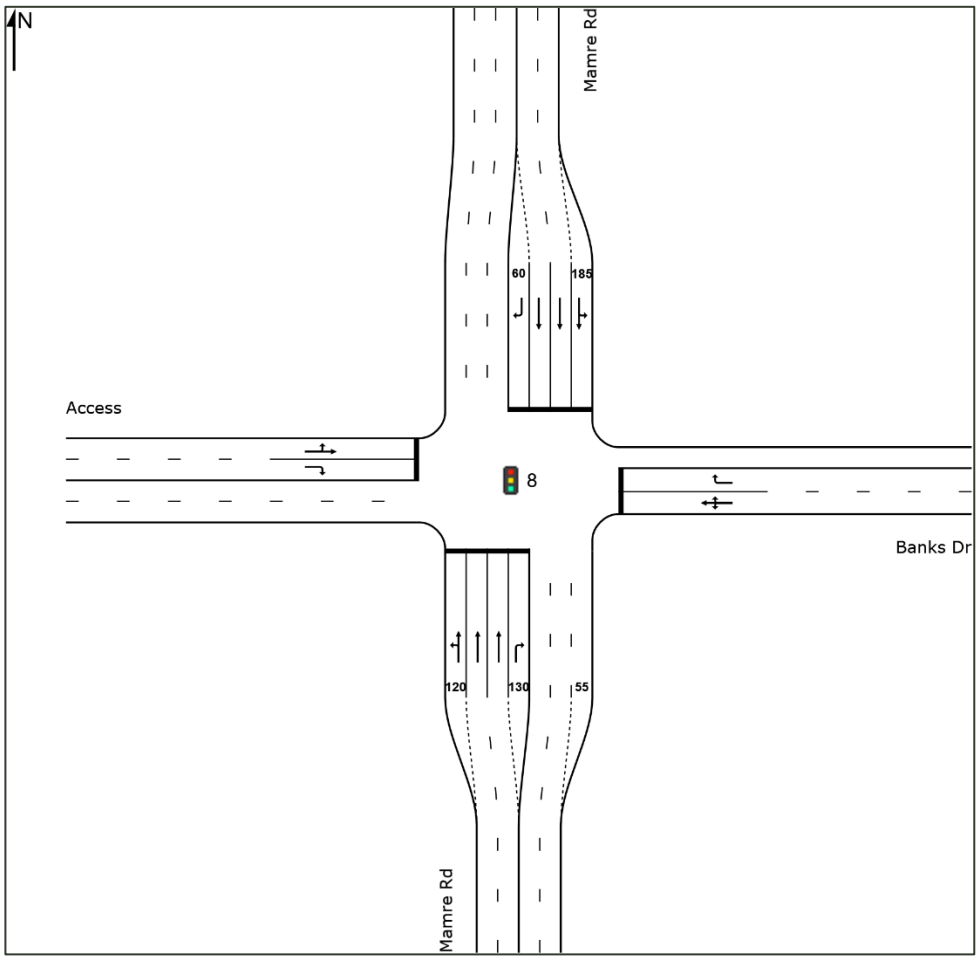


Figure 4-1: 2026 & 2036 Mamre Road & Banks Drive intersection

4.2.2 Mamre Road / Solander Drive Intersection

Key road geometry upgrade features for this intersection include (as shown in Figure 4-2):

- Converting the intersection into a fully signalised intersection
- Two southbound and northbound through lanes on Mamre Road
- Two approach lanes on Solander Drive
- New western access approach with two lanes on each direction.

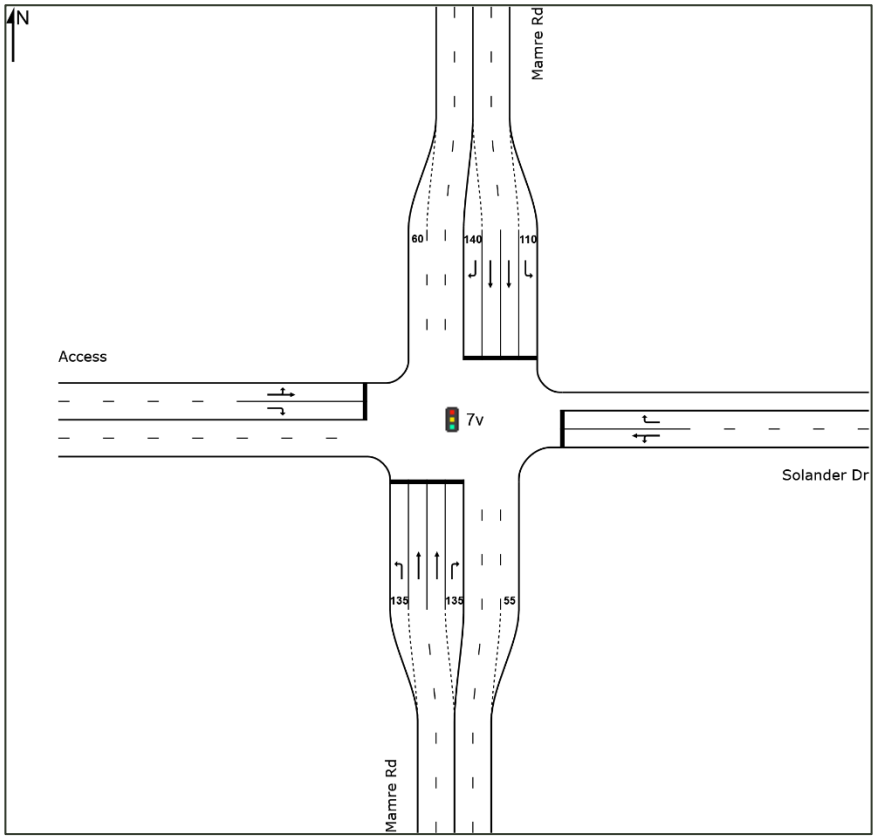


Figure 4-2: 2026 & 2036 Mamre Road & Solander Drive intersection

4.2.3 Luddenham Road and Mamre Road

During traffic analyses and as per discussions with TfNSW, it was understood Luddenham Road is planned to be upgraded to two lanes on each direction between the year 2026 and 2036. Please note that the Luddenham Road upgrade is part of the proposed road upgrades under this proposal and would be approved and delivered separately.

As advised by TfNSW and for the purpose of this report, it was assumed that Luddenham Road retains the existing midblock capacity in the 2026 scenarios and is upgraded by the 2036 scenarios to two lanes in each direction.

The road geometry upgrade features for this intersection include:

- Converting the intersection to a fully signalised intersection
- Dual southbound right turn lanes into Luddenham Road from Mamre Road (one departure lane in 2026 and two departure lanes in 2036)
- Providing additional left turn bay (dual left turn) from Luddenham Road to Mamre Road
- Providing additional right turn bay (dual right turn) from Luddenham Road to Mamre Road

Figure 4-3 below shows the summary of the proposed upgrades:

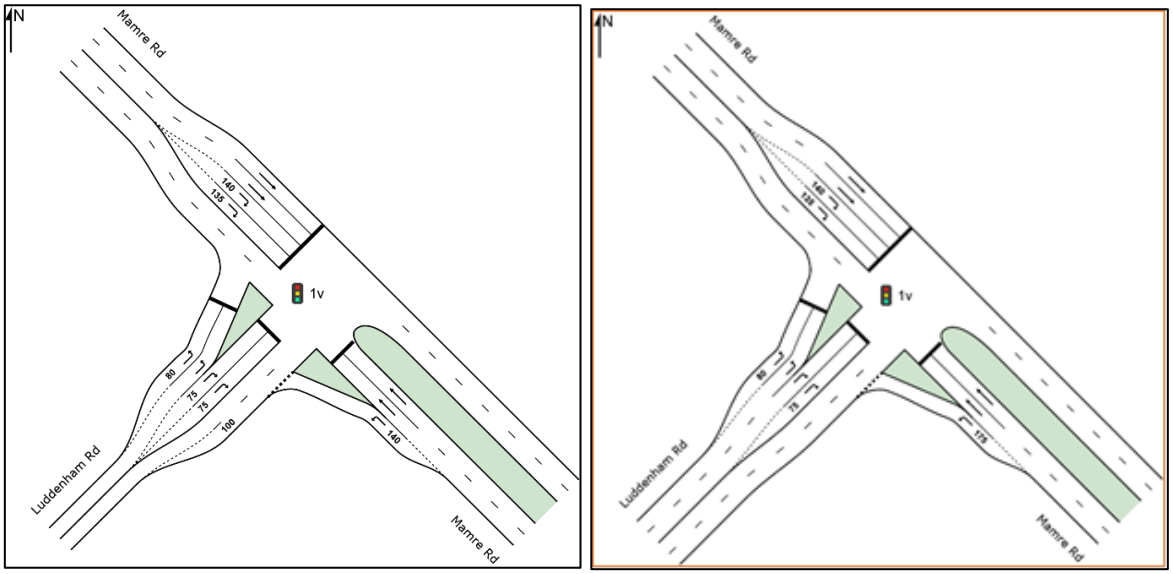


Figure 4-3: 2026 and 2036 Mamre Road & Luddenham Road intersection layouts

4.2.4 Mamre Road / Erskine Park Road Intersection

Key road geometry upgrade features for this intersection include (as shown in Figure 4-4):

- Two southbound and northbound through lanes on Mamre Road
- Dual right turn lanes and dual left turn lanes at stop line on Erskine Park Road eastern approach
- Left turn from northern approach becomes signal control on Mamre Road.

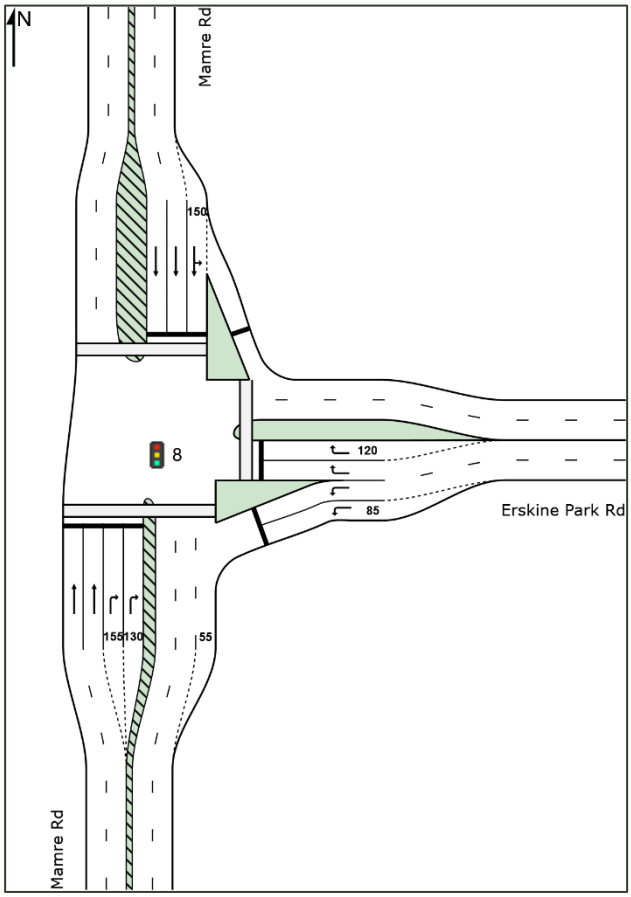


Figure 4-4: 2026 & 2036 Mamre Road & Erskine Park Road intersection

4.2.5 Mamre Road / James Erskine Drive Intersection

As outlined in section 2.5.2, the intersection of James Erskine Drive / Mamre Road is not part of this proposal. However, it was included in the traffic analyses to capture the expected effect of the proposed development (Altis Property Partners Development) on the western side of Mamre Road. Also, given the close proximity between James Erskine Drive and Erskine Park Road intersections with Mamre Road, this also allowed assessment of the performance of Erskine Park Road under expected traffic platoon arrivals and queue interactions with the James Erskine Drive intersection.

Key road geometry assumptions for this intersection was based on the technical note by Ason Group tilted "*Interim Layout of Mamre Road / James Erskine Drive Intersection Sensitivity Analysis – Technical Note - 28/06/2019 by Ason Group*" and included the following (as shown in Figure 4-5):

- Two southbound and northbound through lanes on Mamre Road
- Dual right turn lanes and single left turn lane at stop line on Mamre Road north and south approach
- Single right turn and slip lane left turn on James Erskine Drive
- New western approach with two through lane on each direction with similar geometry as James Erskine Drive approach.

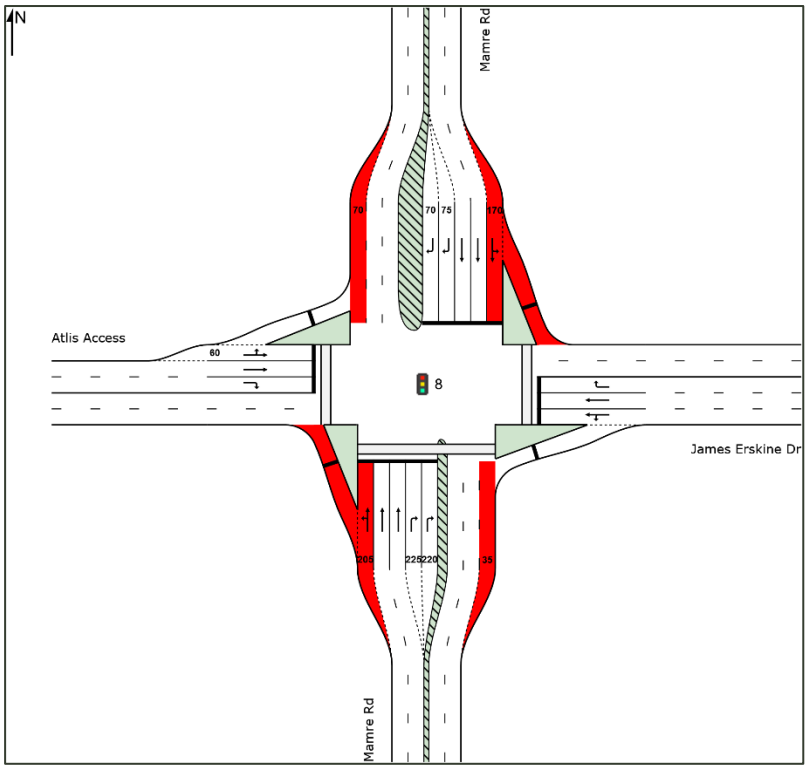


Figure 4-5: 2026 & 2036 Mamre Road & James Erskine Drive intersection

In order to compare intersection and midblock configurations, a set of schematic lane configurations to compare base year against 2036 proposed upgrade scenarios were developed. Figure 4-6 below shows the lane configuration comparisons.

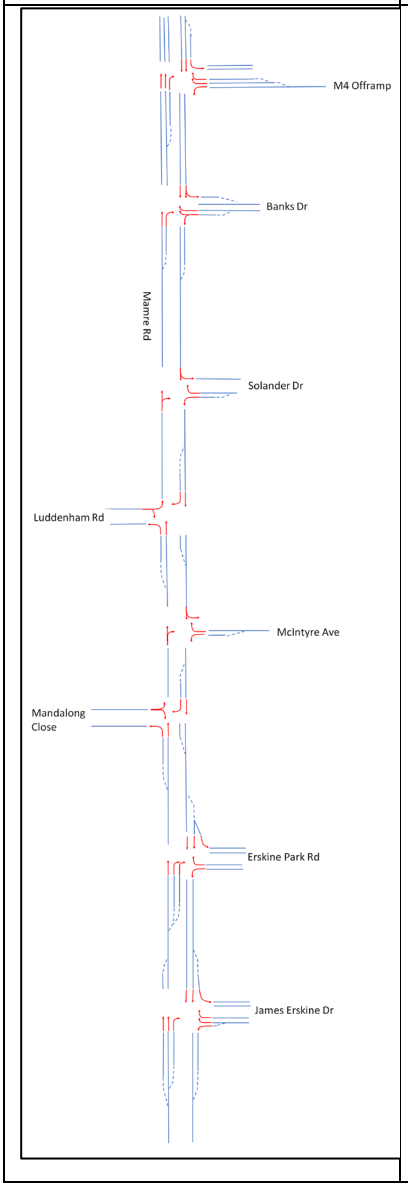
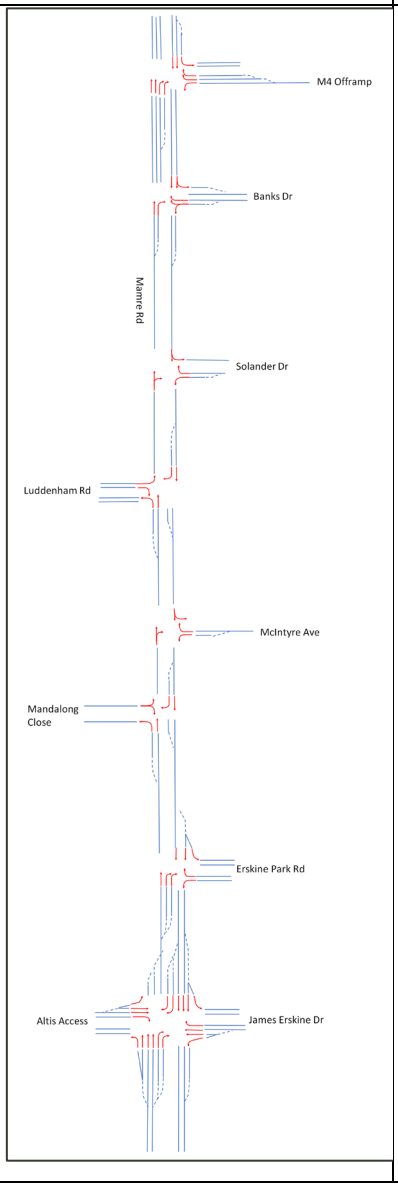
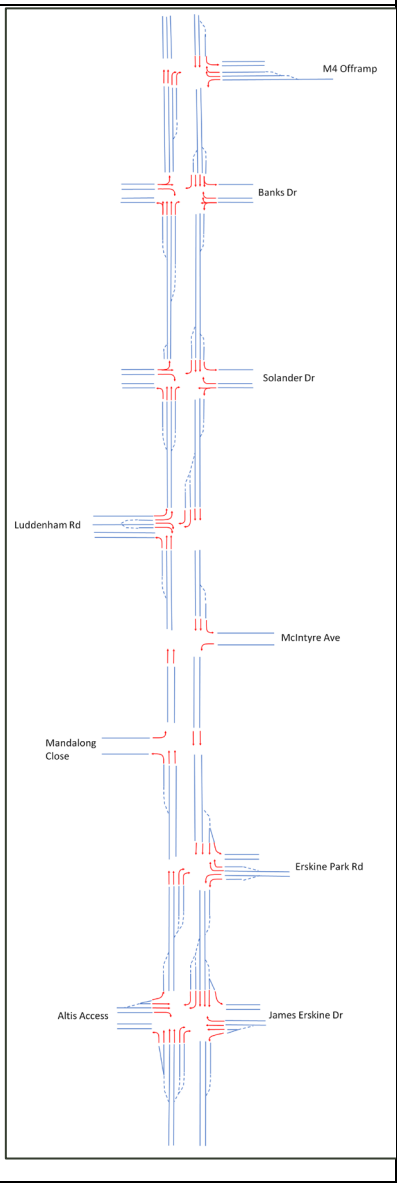
2020 Base Year Lane Diagram	Future year Base Case Lane Diagram (2036)	Future year Proposed Design Lane Diagram (2036)
		

Figure 4-6: 2036-year existing, future Base Case and proposed lane diagram

5 Impact Assessment

5.1 Construction Impacts

5.1.1 Impacts from Haulage Routes

The potential haulage routes for the proposal have been reviewed. Most material and equipment would be transported to and from the construction work zones via Mamre Road, Erskine Park Road, Elizabeth Drive and the M4 Motorway, which are existing routes approved for heavy vehicles including B-doubles. The contractor would minimise the use of local roads, where possible, to minimise impacts to the local community. The Kent Road interchange with the M4 Motorway is the haulage route to be used for vehicles that are not able to turn right out of the compound sites onto Mamre Road in Stage 1. See Figure 5-1 below showing the existing routes approved for heavy vehicles.

Construction of the proposal would increase heavy vehicle traffic along the potential haulage routes, especially along Mamre Road and near the main compound site proposed to the north of Solander Drive. Most heavy vehicles that access the site would be truck and dog or smaller in size. These trucks would be required to haul construction materials such as fill material, pavement materials, asphalt and concrete. Where possible, the reuse of excavated material within the corridor and on-site production would be prioritised to minimise the distances for transporting materials. However, it is noted that the proposal is predominantly in fill and would require large volumes of fill material to be imported.

It is estimated that construction of the proposal would require an average of 75 heavy vehicles per day, up to a maximum of 100 heavy vehicles per day, to travel to and from the proposal area. There may also be irregular movements of oversized vehicles. The volume of additional traffic generated by construction of the proposal on the surrounding main road network would be relatively small compared to the existing heavy vehicle volumes on the potential haulage routes. In addition, most haulage vehicle movements would be spaced throughout the day and occur within standard construction hours, including 7am to 6pm weekdays and 8am to 1pm on weekends. Therefore, any potential traffic impacts associated with haulage are expected to be minor.

Any potential impacts from use of haulage routes during construction would be managed in accordance with a Traffic Management Plan. The contractor would be required to develop the mass haul diagram and more detailed earthworks planning for the proposal and consider any associated road user delays. A Road Dilapidation Report would be prepared by a suitably qualified person for local roads proposed to be used by heavy vehicles, before the commencement of use of local roads during construction. Any damage to the local road network identified to be caused by construction vehicles for the proposal would be rectified by the contractor to be similar to the existing road condition or compensation would be paid to the relevant road authority.

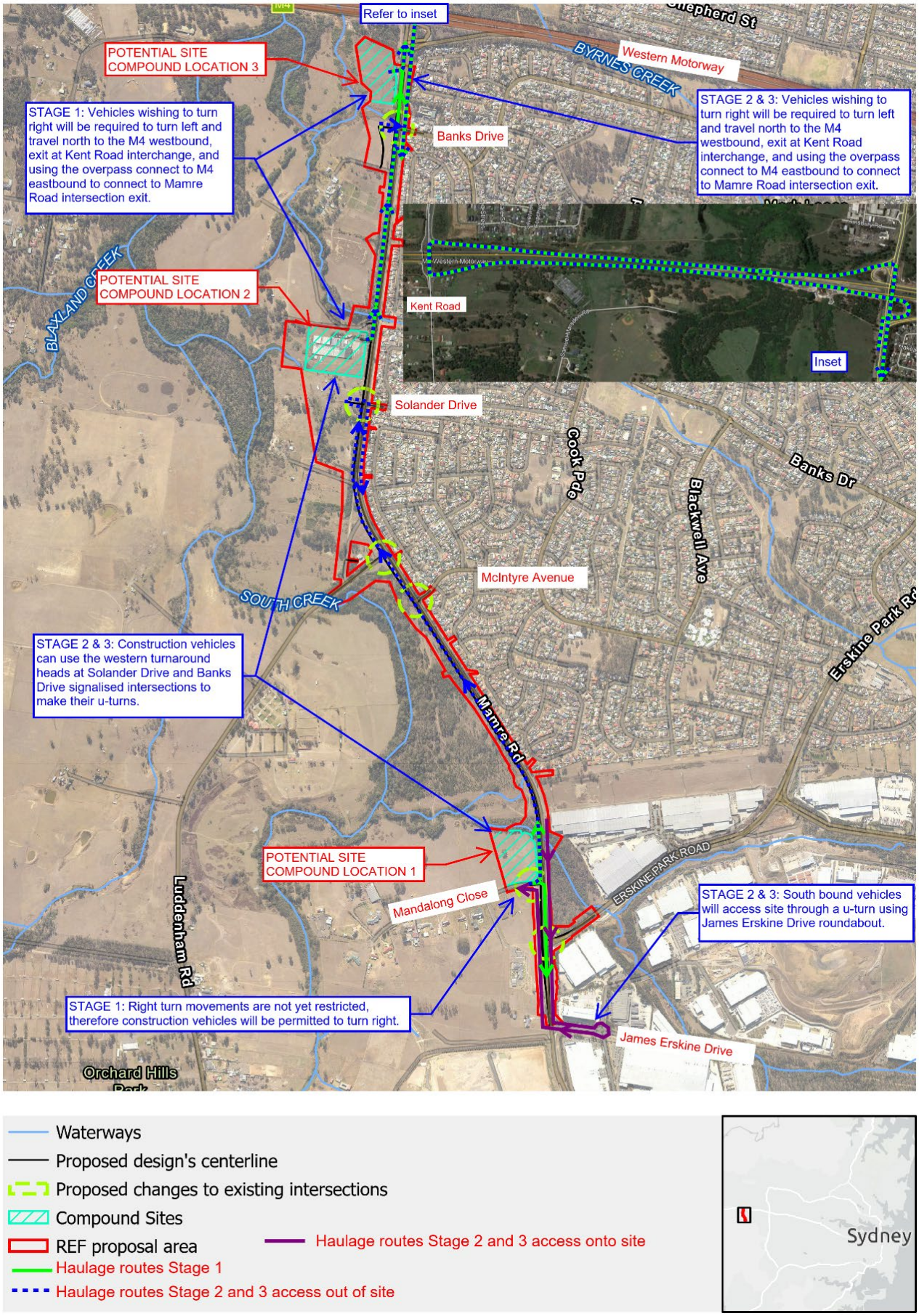


Figure 5-1: Existing Haulage Routes

5.1.2 Impacts from Site Access

Three potential compound sites have been identified for the proposal, which would be used for site offices, site amenities, to store equipment and machinery and to stockpile materials. The potential locations are:

- Location 1, Mandalong Close, located near the intersection with Mamre Road. Direct access from Mandalong Close.
- Location 2, located about 100 metres north of Solander Drive on the western side of Mamre Road. Direct access from Mamre Road
- Location 3, located at the northern end of the proposal near the intersection of the M4 Motorway Westbound Ramp and Mamre Road. Direct access from Mamre Road

Most heavy construction vehicles would likely access compound sites from Mamre Road via a left in-left out intersection. The proposed indicative locations for site access gates to the potential site compounds are likely to be located:

- On the northern side of Mandalong Close approximately 100m from the intersection of Mamre Road / Mandalong Close
- On the western side of Mamre Road approximately 250m north of the Solander Drive / Mamre Road intersection
- On the western side of Mamre Road approximately 250m north of Banks Drive / Mamre Road intersection.

However, these locations are indicative and would be refined during detailed design. There are other site access gates within the proposal area to access the construction activities behind barriers.

Construction site access and egress would be closely managed in order to ensure the safety of the construction workers and the community and minimise delays to road users. This would be managed through a designated site entry, vehicle movement plans and having appropriate site gate signage to allow motorists to easily identify site entry points. Typically, construction vehicles would need to enter and exit these gates under live traffic control whilst minimising impacts on the local road network and the local community. Any interruptions to traffic from this live traffic control is expected to be short in duration and minor.

The use of gates by construction vehicles may result in safety risks associated with vehicles turning into the gates colliding with other vehicles travelling along Mamre Road or pedestrians near the site compounds. This risk would be highest for the gates to the main compound site proposed at Mandalong Close due to high construction vehicle activity near potential pedestrian activity (including children) from the childcare centre on Mandalong Close. This risk would be minimised during refinement of the gate locations in consideration of appropriate acceleration and deceleration lanes for vehicular access as well as safe arrangements for pedestrians and/or cyclists near gates.

Given that it is assumed that construction areas would be essentially self-contained, construction facilities including concrete washout, laydown hardstand for materials and erosion and sedimentation controls should be provided within each isolated region to reduce unnecessary construction vehicle traffic. For movements of bulk materials, heavy vehicle haulage routes are required to have all-weather access points at entry/exit to the site, and traffic control plans would be developed to suit heavy vehicle movements and to minimise impacts to road users in these areas.

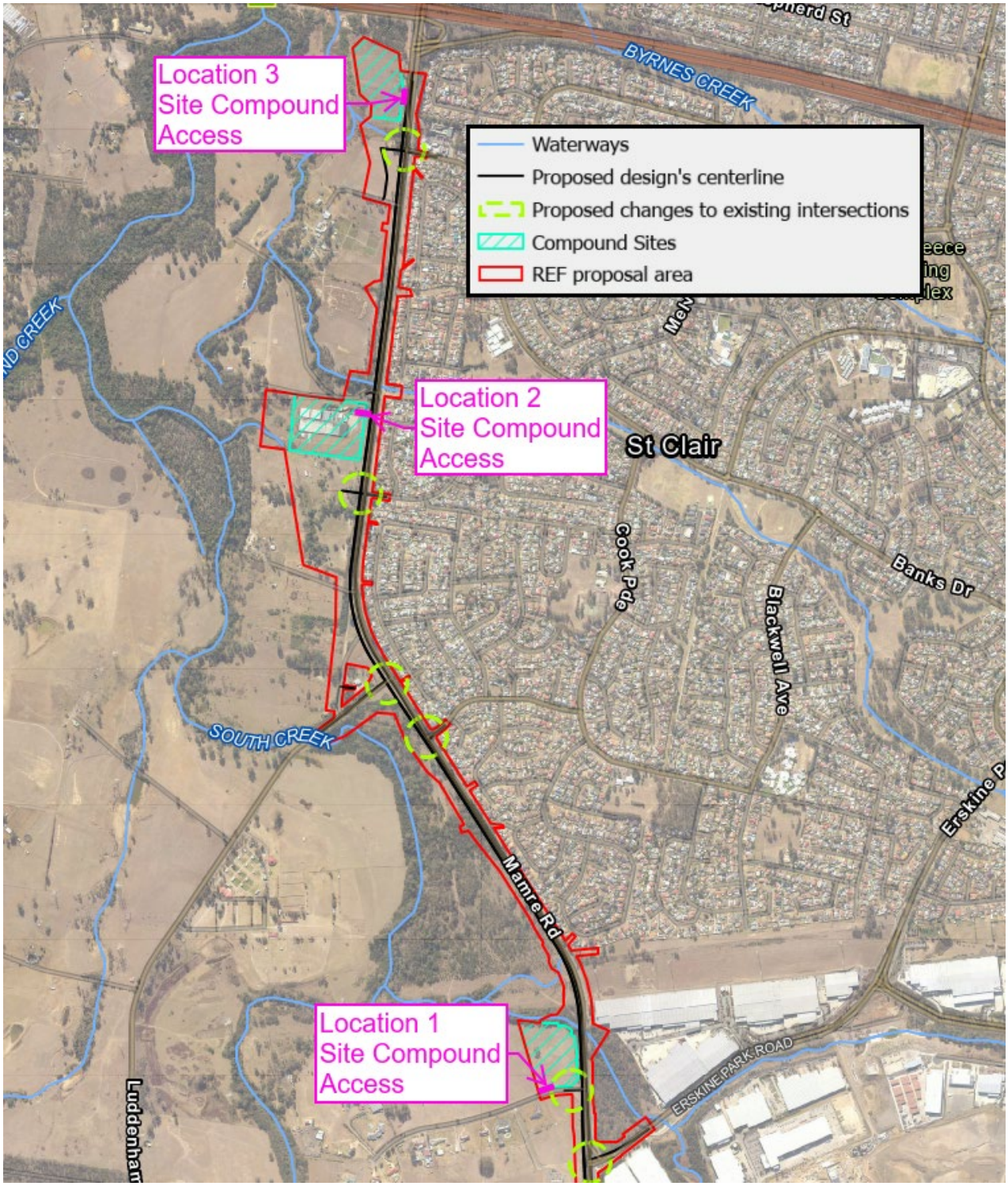


Figure 5-2: Indicative compound site accesses

5.1.3 Temporary Changes to the Road Network Associated with Construction

Traffic modelling was carried out for construction of the proposal to consider the impact of the temporary changes to the road network associated with construction including:

- New or modified intersections to allow entry and exit to construction zones
- Traffic management to allow for safe entry and exit to construction zones.

In addition to early work and preparations, a total of three major construction stages were identified as to having impact on the traffic network. During early work (also known as construction stage 0) it is expected all the activities would be completed behind barriers and no change to the traffic network capacity is expected.

During each major construction stage, where particular turning movements are expected to be restricted, traffic would be required to use an alternative route during the relevant construction stages. The details of the construction stages road access as part of the proposal are listed below in Table 5-1.

Table 5-1: Construction Stages Road Access & Alternative Routes

Stage	Location	Banned Movement/s	Alternative Route	Impact/s
Stage 1	-	No proposed banned movements. Similar as the current traffic network	No proposed alternative route required. Similar as the current traffic network	No change to existing.
Stage 2	McIntyre Avenue intersection	Right turn in from Mamre Road	Right turn in at Solander Drive intersection	About 31 veh/hr in the AM Peak and 55 veh/hr in the PM Peak would be affected. These road users are to travel about one kilometre north to turn right and use local roads to connect back to McIntyre Avenue, increasing their overall travel distance. The use of signalised Solander Drive intersection provides improved safety for road users, compared to the existing priority-controlled McIntyre Avenue intersection.
	McIntyre Avenue intersection	Right turn out from McIntyre Avenue	Right turn out from Banks Drive intersection	About 19 veh/hr in the AM Peak and 25 veh/hr in the PM Peak would be affected. These road users would be required to use local roads to travel about two kilometres north to turn right from Banks Drive intersection, increasing their overall travel distance. The use of signalised Banks Drive intersection provides improved safety for road users, compared to the existing priority-controlled McIntyre Avenue intersection.

Stage	Location	Banned Movement/s	Alternative Route	Impact/s
	Solander Drive intersection	Right turn out from Solander Drive	Right turn out from Banks Drive intersection	About 15 veh/hr in the AM Peak and 10 veh/hr in the PM Peak would be affected. These users would be required to use local roads to travel about one kilometre north to turn right from Banks Drive intersection, increasing their overall travel distance.
Stage 3	McIntyre Avenue intersection	Right turn in from Mamre Road	Right turn in at Solander Drive intersection	About 31 veh/hr in the AM Peak and 55 veh/hr in the PM Peak would be affected. These road users are to travel about one kilometre north to turn right and use local roads to connect back to McIntyre Avenue, increasing their overall travel distance. The use of signalised Solander Drive intersection provides improved safety for road users, compared to the existing priority-controlled McIntyre Avenue intersection.
	McIntyre Avenue intersection	Right turn out from McIntyre Avenue	Right turn out from Banks Drive intersection	About 9 veh/hr in the AM Peak and 11 veh/hr in the PM Peak would be affected. These road users would be required to use local roads to travel about two kilometres north to turn right from Banks Drive intersection, increasing their overall travel distance. The use of signalised Banks Drive intersection provides improved safety for road users, compared to the existing priority-controlled McIntyre Avenue intersection.
	Mandalong Close	Right turn in from Mamre Road	U turn back at James Erskine Drive and left turn in from Mamre Road	About 18 veh/hr in the AM Peak and 20 veh/hr in the PM Peak would be affected. These road users would be required to travel about 600 metres south to use the James Erskine Drive roundabout, increasing their overall travel distance. The use of signalised James Erskine Drive intersection provides improved safety for road users, compared to the existing priority-controlled Mandalong Close intersection.

Stage	Location	Banned Movement/s	Alternative Route	Impact/s
	Mandalong Close	Right turn out from Mandalong Road	Left turn out from Mandalong Road and U turn back from western approach at Solander Drive intersection	About 12 veh/hr in the AM Peak and 9 veh/hr in the PM Peak would be affected. These road users would be required to travel about two kilometres north to use the U-turn facility on the western leg of Solander Drive intersection, increasing their overall travel distance. The use of signalised Solander Drive intersection provides improved safety for road users, compared to the existing priority-controlled Mandalong Close intersection.

5.1.4 Other Construction Activities and Potential Road Disruptions

In addition to the aforementioned alternative routes, the following construction activities may potentially cause temporary delays to road users and would be managed through traffic management plans to minimise any potential impacts:

- Construction of transverse drainage – there are several transverse drainage crossings along the length of the proposal. The transverse drainage crossings will be constructed across Stages 1 and 2. As these are existing drainage networks, temporary drainage connections are likely to be required during construction. Temporary drainage connections are likely to be provided using temporary pipes (plastic or HDPE) an /or constructing one or two barrels at different stages (at locations where multiple barrels are proposed). These works are to be undertaken behind barriers to minimise impacts to road users. However, temporary drainage works and lifting of precast culvert units may require the use of live traffic control to allow for partial road closure which may cause short-term delays and increase travel time for road users.
- Installation of utility crossings – To minimise delays to road users, utilities are proposed to be constructed as part of Early Works. Utility crossings would be constructed via open trenching, where outside of the roadway and where feasible, and/or under-boring, where required to minimise the impact to road users locally. Open trenching for utility crossings would likely be carried out as nightworks with use of live traffic control to allow for partial road closures. This would allow setup of equipment, open trenching across Mamre Road, utilities to be laid and backfill and completion of pavement works. This would result in minor short-term delays and increase of travel time for road users. Furthermore, utility crossings have been grouped where possible to reduce the number of sites along Mamre Road and minimise the potential disruptions along the length of the proposal to road users.
- Changes to intersection and construction of a signalised intersection – Mandalong Close, McIntyre Avenue, Solander Drive and Luddenham Road intersections are currently priority-controlled intersections. During the construction stages, Mandalong Close and McIntyre Avenue would be converted to left-in and left-out only arrangements, resulting in increased travel time for road users due to the alternative routes discussed above. Solander Drive and Luddenham Road would be upgraded to signalised intersections in the ultimate proposal and are provided with temporary signals during construction (Solander Drive has temporary signals in Stage 2, and Luddenham Road has temporary signals during Stages 2 and 3). Some traffic movements would be restricted during construction stages and the use of the signalised intersections would result in increased travel time for road users who would need to travel to adjacent intersections as per the alternative route discussed above. Erskine Park Road and Banks Drive are existing signalised intersections, however, would also require temporary signals during construction due to construction works. In order to minimise delays to road users, the temporary signals would be installed on the night of the

traffic switch of construction stages under live traffic control to allow for partial road closure to place the traffic control signal posts. The temporary signals would provide a safer signalised environment for all road users at each site.

- During the construction of the Banks Drive / Mamre Road intersection, a short-term closure of Banks Drive is proposed for about three to five days due to significant ground level differences. During this closure, all Mamre Road through traffic would be maintained using the Stage 2 staging configuration. The impact to traffic would be isolated to Banks Drive, with feasible detours for the local traffic. During this short-term closure, vehicles on Banks Drive will use Banks Drive and then Solander Drive to connect back to Mamre Road.

Generally short-term impacts would be minimised via:

- Implementing live traffic control to allow for partial road closures wherever required.
- Maintaining the roadway serviceability in terms of its width, design vehicle swept paths, vertical gradients and road surface condition to Austroads standards. Existing traffic lane widths would be maintained to 3.5 metre during construction to allow for a provision of a safety barrier system to be installed; a separation of 0.5 m between northbound/southbound traffic lanes would be maintained.
- The existing 1.2 metre wide shoulder for on-road cyclists on the western side of Mamre Road from the southern tie-in to Mandalong Close is retained in Stage 0 and Stage 1. In Stage 2, the construction of the shared user path on the western side of Mamre Road from Erskine Park Road to Mandalong Close would be completed. In all other locations, a 0.5-metre-wide shoulder has been provided throughout construction. Adequate signage would be installed to warn cyclists. From Stage 0 to Stage 3, it is assumed that cyclists would use the nominated alternative route through the local road network. Refer to Figure 5-13 below showing the alternative route.
- Installing, maintaining and monitoring advisory, direction and regulatory signage, line marking and, pavement markings that directs motorists over the safest and most convenient route during the construction staging
- 60km/hr speed limit would be applied on Mamre Road during the construction staging period, in the meantime, all side roads remain existing speed limits
- Managing construction vehicular traffic so that:
  - Plant and equipment would be scheduled to arrive outside of peak traffic flow periods obtained from traffic counts and identified during stakeholder engagement. Any lane closures need approval by Traffic Management Centre and Road Occupancy Licenses (ROLs) obtained
  - The start and finish of work shifts could be scheduled to occur outside of peak traffic periods (i.e. 05:00 – 07:00 and 14:00 – 16:00).

5.1.5 Impacts of Construction Staging on Traffic Performance

In order to assess the impact of the construction activities on the study area and traffic network performance, Aimsun microsimulation traffic models were utilised. The impact of the proposed construction activities was assessed for stages 1, 2, and 3. During early work (also known as construction stage 0) all the activities are expected to be completed behind the barriers and any traffic management required will be short in duration. Therefore, it was concluded that no noticeable impact from early works is expected on the traffic network.

The impact of the key proposed construction stages was generally assessed in terms of the following key traffic network performance indicators:

- Overall Network statistics
- Key intersection Level of Service and Delay Analyses
- Mamre Road Travel Time and Speed comparisons.

All comparisons were made against the existing traffic conditions (2020 base case scenario) as the performance benchmark. Also, all traffic analyses were completed for the same traffic network and coverage as the base year Aimsun model (as outlined in Section 2.5.2).

The construction staging traffic model was developed for the future year 2023. In general, and during AM and PM peak periods, background traffic is not expected to grow during construction periods due to the following key reasons:

- General traffic and in particular familiar drivers tend to avoid road construction zones and they tend to navigate via alternative routes.
- Consideration for construction workers to access the site as workplace outside the nominated AM and PM peak periods
- Recommendations have been made for heavy vehicles movements relating to construction activities to occur outside the nominated AM and PM peak periods

However, to account for possible traffic volumes increase as a result of construction activities during AM and PM peaks and to account for the worst case scenario it was assumed that the overall traffic for all vehicle types in the study would increase by 0.5 per cent per annum between the year 2020 and 2023.

Network Statistics

To assess and compare the proposed construction stages and their impacts, overall Network Statistics comparisons were made for each of the proposed stages against the Base Year traffic conditions.

Table 5-2 and Table 5-3 show the overall network statistics comparison for 2 hour AM Peak and 2 hour PM Peak for existing base case and 2023 construction staging scenarios respectively.

Table 5-2: Network Statistics AM Peak (7-9am)

All Vehicles	2020 Base Case	Construction Stage 1	Construction Stage 2	Construction Stage 3
Average delay per vehicle (minutes: seconds)	00:54	01:02	01:08	01:22
Average network speed (km/h)	39	34	35	33
Vehicle Kilometre Travel (VKT)	29,451	29,346	29,487	29,784
Vehicle Hour Travel (VHT)	750	867	852	943
Unreleased vehicles (number / %)	117 (1.1%)	184 (1.7%)	150 (1.4%)	113 (1.1%)
Total Demand (number of vehicles)	10,502	10,641	10,664	10,640

Table 5-3: Network Statistics PM Peak (4-6pm)

All Vehicles	2020 Base Case	Construction Stage 1	Construction Stage 2	Construction Stage 3
Average delay per vehicle (minutes: seconds)	01:04	01:06	01:10	01:20
Average network speed (km/h)	34	32	33	30
Vehicle Kilometre Travel (VKT)	27,902	28,199	28,482	29,364
Vehicle Hour Travel (VHT)	810	878	848	984

All Vehicles	2020 Base Case	Construction Stage 1	Construction Stage 2	Construction Stage 3
Unreleased vehicles (number / %)	30 (0.3%)	46 (0.4%)	55 (0.5%)	14 (0.1%)
Total Demand (number of vehicles)	10,868	11,084	11,067	11,084

The following findings can be noted from Table 5-2 and Table 5-3:

- Average delay per vehicle shows increase for all construction stages with construction stage 3 showing the highest average increase per vehicle.
- Average network speed shows reduction for all construction scenarios. This is mainly due to the impact of a reduced posted speed limit (60km/hr on Mamre Road) during each construction stage.
- Construction stage 1 and 2 show relatively minor impact on the overall network statistics and the highest impact from these two stages are expected to be observed during AM peak.
- Both AM and PM Peak network statistics results show that construction stage 3 has the highest impact on the traffic network performance during both AM and PM Peak traffic conditions. This stage is expected to increase the average delay per vehicle by up to 52 per cent (or additional 28 seconds per vehicle) when compared to the existing conditions. This is due to the signalisation of Solander Drive intersection (with new western leg opening) together with the signalisation of Luddenham Road intersection, which is expected to introduce some additional delays and stops for traffic along Mamre Road in both directions.

Key Intersection Level of Service

Table 5-4 and Table 5-5 show the average delay and LOS predicted at key intersections within the study area are summarised below for the 2020 base and three construction staging scenarios. The results have been presented for the second hour in each modelled peak period. This is because higher congestion build-ups were observed towards the last hour in each modelled period, therefore the second hour represented more critical analytical periods. Also, LOS calculations are provided below based on the average intersection delay for all movements for all intersections regardless of the control type. This allows for a like for like comparison for each intersection's performance between different stages of work, regardless of the proposed control type.

Table 5-4: Level of Service AM (2nd hour)

No.	Intersection	2020 Base		2023 Construction Stage 1		2023 Construction Stage 2		2023 Construction Stage 3	
		Average Delay	LOS	Average Delay	LOS	Average Delay	LOS	Average Delay	LOS
1	M4-Mamre Road	**38**	C	**39**	C	**38**	C	**38**	C
2	Banks Drive-Mamre Road	**85**	F	**91**	F	**114**	F	**122**	F
3	Solander Drive-Mamre Road	**20**	B	**16**	B	**12**	A	**47**	D
4	Luddenham Road-Mamre Road	**9**	A	**27**	B	**12**	A	**29**	C
5	Erskine Park Road-Mamre Road	**50**	D	**50**	D	**47**	D	**34**	C
6	James Erskine Drive-Mamre Road	**15**	B	**15**	B	**15**	B	**16**	B

Table 5-5: Level of Service PM (2nd hour)

No.	Intersection	2020 Base		2023 Construction Stage 1		2023 Construction Stage 2		2023 Construction Stage 3	
		Average Delay	LOS	Average Delay	LOS	Average Delay	LOS	Average Delay	LOS
1	M4-Mamre Road	58	E	61	E	56	E	62	E
2	Banks Drive-Mamre Road	116	F	120	F	106	F	105	F
3	Solander Drive-Mamre Road	21	B	15	B	10	A	41	C
4	Luddenham Road-Mamre Road	11	A	17	B	13	A	53	D
5	Erskine Park Road-Mamre Road	47	D	35	C	32	C	32	C
6	James Erskine Drive-Mamre Road	17	B	16	B	16	B	17	B

AM and PM Peak key findings from the traffic modelling are summarised below:

- During AM peak:
  - Banks Drive intersection shows LOS F for base case as well as all construction staging scenarios during AM Peak. During construction stage 2, due to the outbound right turn movement removal at Solander Drive and McIntyre Avenue and redirecting of this traffic via Banks Drive (about 60 vehicles per hour) some additional pressure at Banks Drive intersection is expected. In addition, during Stage 2 and Stage 3, Mamre Road northbound traffic is expected to receive less interruptions as a result of the banned right turn movement into McIntyre Avenue and installation of a new dedicated right turn bay at Solander Drive intersection. This in turn is expected to increase the rate of uninterrupted traffic arrival towards Banks Drive intersection and increase the pressure at this intersection. Also, in Stage 2 and Stage 3, the additional short 60 metre northbound kerbside lane provides extra capacity to the Mamre Road northbound approach at Banks Drive intersection.
  - Solander Drive intersection shows good level of service (LOS B) during Stage 1 and 2. During Stage 3 , this intersection shows degraded level of service (LOS D) which is mainly due to the signalisation of this intersection . In addition, the opening of new western approach at Solander Drive intersection is expected to moderately reduce the overall intersection capacity. This is due to the fact that introduction of additional legs increases number of signal phases and consequently leaves less available green times to be allocated to the Mamre Road though traffic.
  - Luddenham Road intersection shows good Level of Service (LOS C or better) during all construction staging scenarios.
  - Erskine Park Road intersection maintains current level of service. This is mainly due to combined effect of the change in traffic arrival patterns as a result of geometry change as well as signal timing optimisation for this intersection

- During PM traffic models:
  - Similar to the AM Peak conditions, Banks Drive intersection shows LOS F for the base case as well as all construction staging scenarios. During construction stage 2 and due to the outbound right turn movement removal at Solander Drive and McIntyre Avenue and redirecting of this traffic via Banks Drive (about 70 vehicles per hour), additional pressure at the Banks Drive intersection is expected. In addition, in stage 2 and stage 3, Mamre Road northbound traffic is expected to receive less interruptions as a result of the right turn movement ban into McIntyre Ave and installation of a new dedicated right turn bay at Solander Drive intersection. This is expected to increase the rate of traffic arrival towards Banks Drive intersection and increase the pressure at this intersection. Also, in stage 2 and stage 3 the additional short 60 metre northbound kerbside lane provides extra capacity to the Mamre Road northbound approach at Banks Drive intersection.
  - Solander Drive intersection shows a good Level of Service for all modelled stages (LOS C or better). During stage 3 and when compared to the existing conditions, the signalisation of Solander Drive intersection (with new western leg opening) is expected to introduce some additional delays and stops for traffic along Mamre Road in both directions. This in turn increases the overall intersection delay for stage 3 construction layout.
  - Luddenham Road intersection shows good Level of Service (LOS B or better) during the base case and construction stages 1 and 2. In Stage 3, signalisation of this intersection however is expected to result in higher delays (LOS D).
  - Erskine Park Road intersection performance shows acceptable Level of Service (LOS D) during base case and LOS C across all construction staging scenarios. During construction stage models, this is mainly due to combined effect of the change in traffic arrival patterns as a result of geometry change as well as signal timing optimisation for this intersection. The traffic modelling shows some level of signal phase timing optimisation would be required for this intersection across all construction staging scenarios to allow the maintenance of acceptable intersection level of service.

Travel Time & Speed

In order to understand the impact of the proposed construction stages, travel time analyses has been completed for Mamre Road between James Erskine Drive and the M4 interchange for both directions. Figure 5-3 below shows key routes applied for travel time and travel speed analyses.

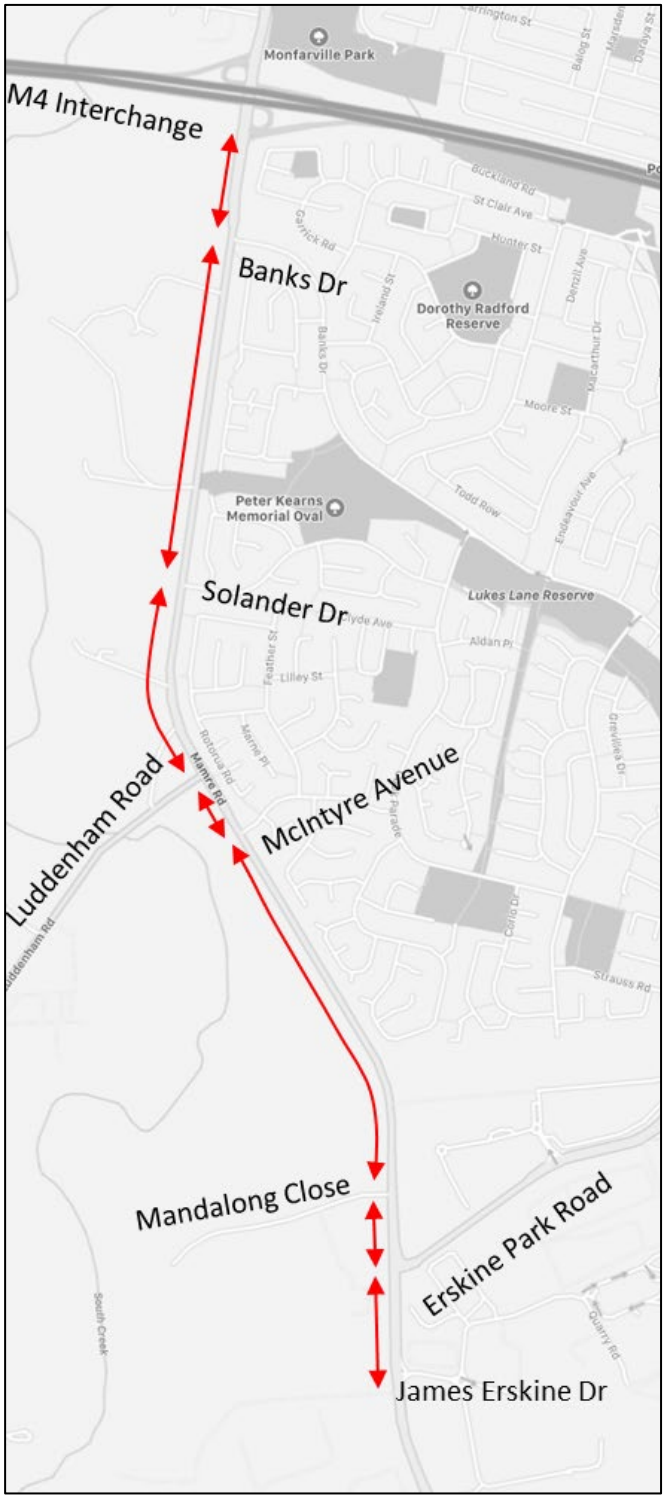


Figure 5-3: Key Travel Time Routes

The key objective of measuring travel time and speed on these routes is to quantify the impacts of the potential construction staging scenarios on Mamre Road and compare to the existing conditions. The results of the travel time and travel speed analysis are shown in Figure 5-4 to Figure 5-10.

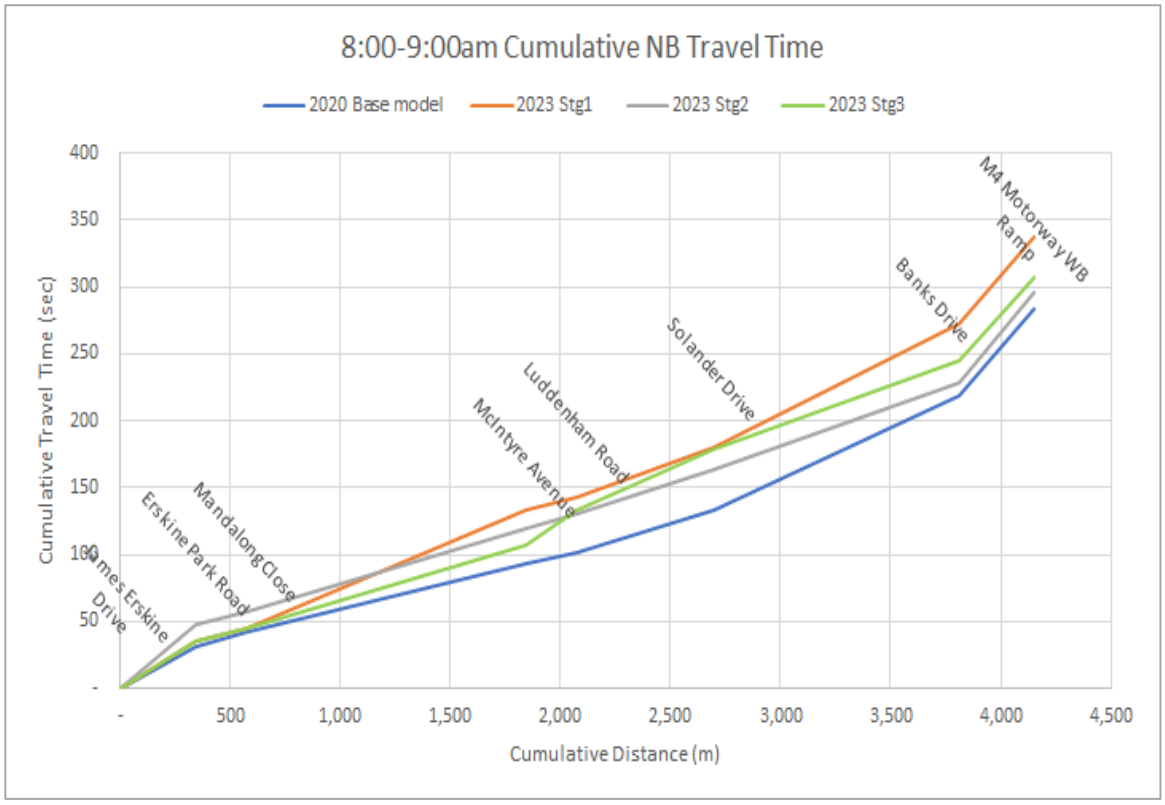


Figure 5-4: Northbound -James Erskine Drive to M4 ramp Travel Time (AM Peak 2nd hour) (sec)

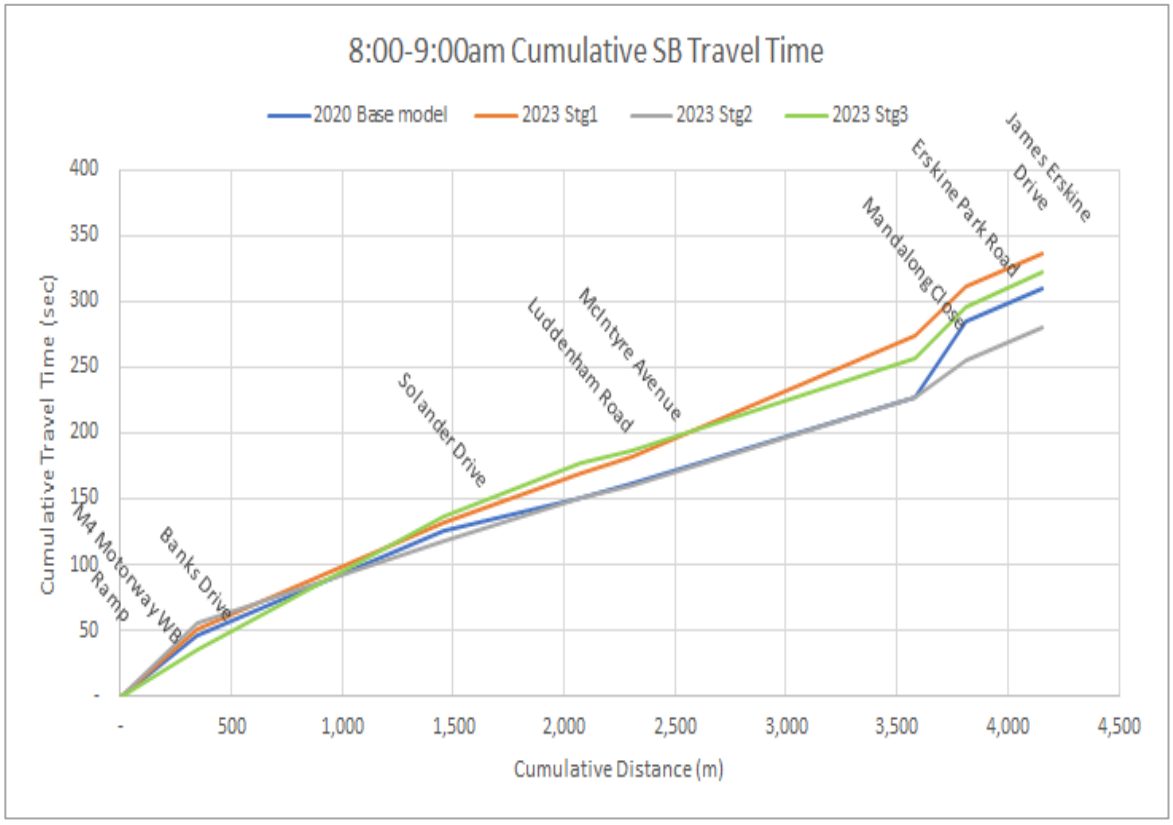


Figure 5-5: Southbound -M4 ramp to James Erskine Drive Travel Time (AM Peak 2nd hour) (sec)

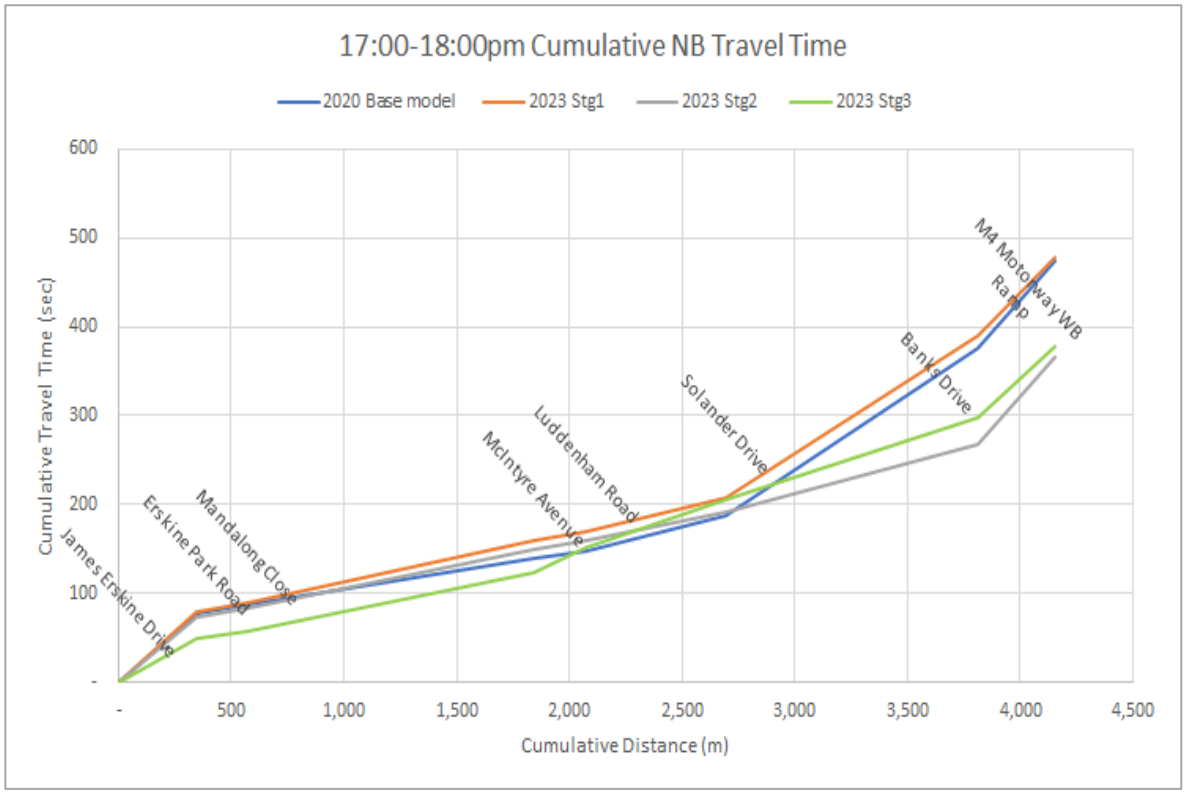


Figure 5-6: Northbound - James Erskine Drive to M4 ramp Travel Time (PM Peak 2nd hour) (sec)

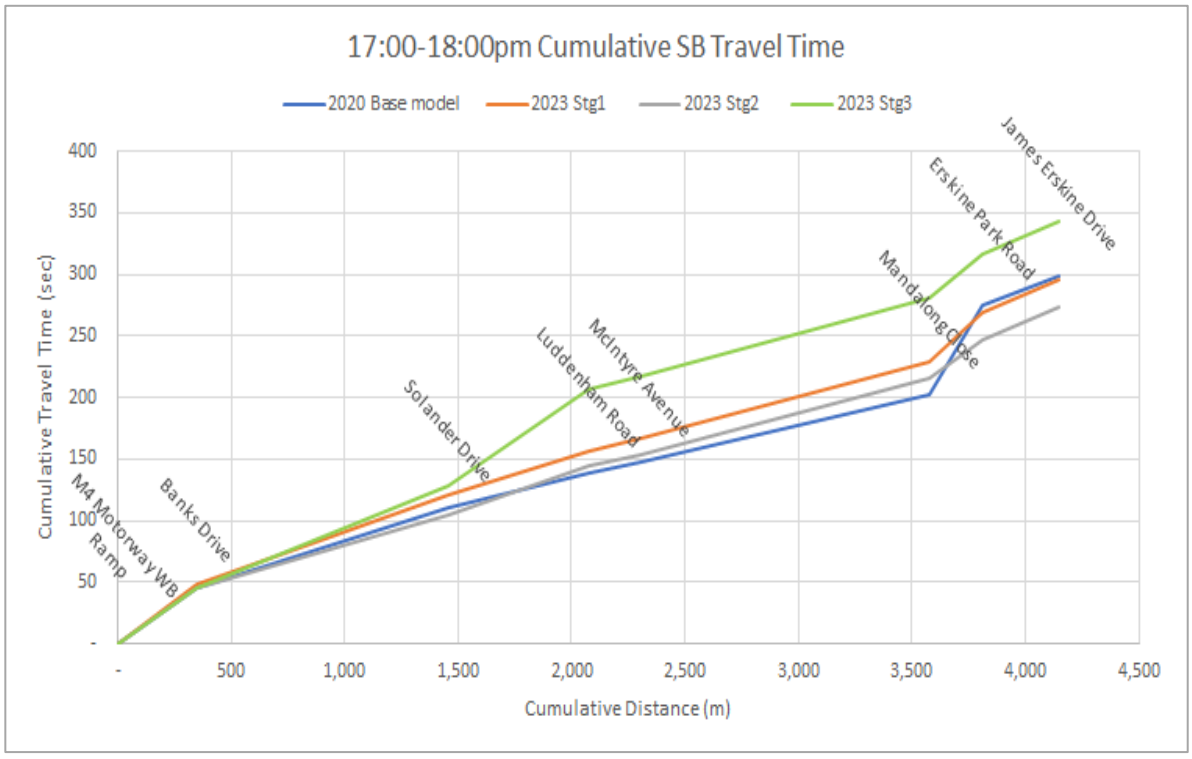


Figure 5-7: Southbound -M4 ramp to James Erskine Drive Travel Time (PM Peak 2nd hour) (sec)

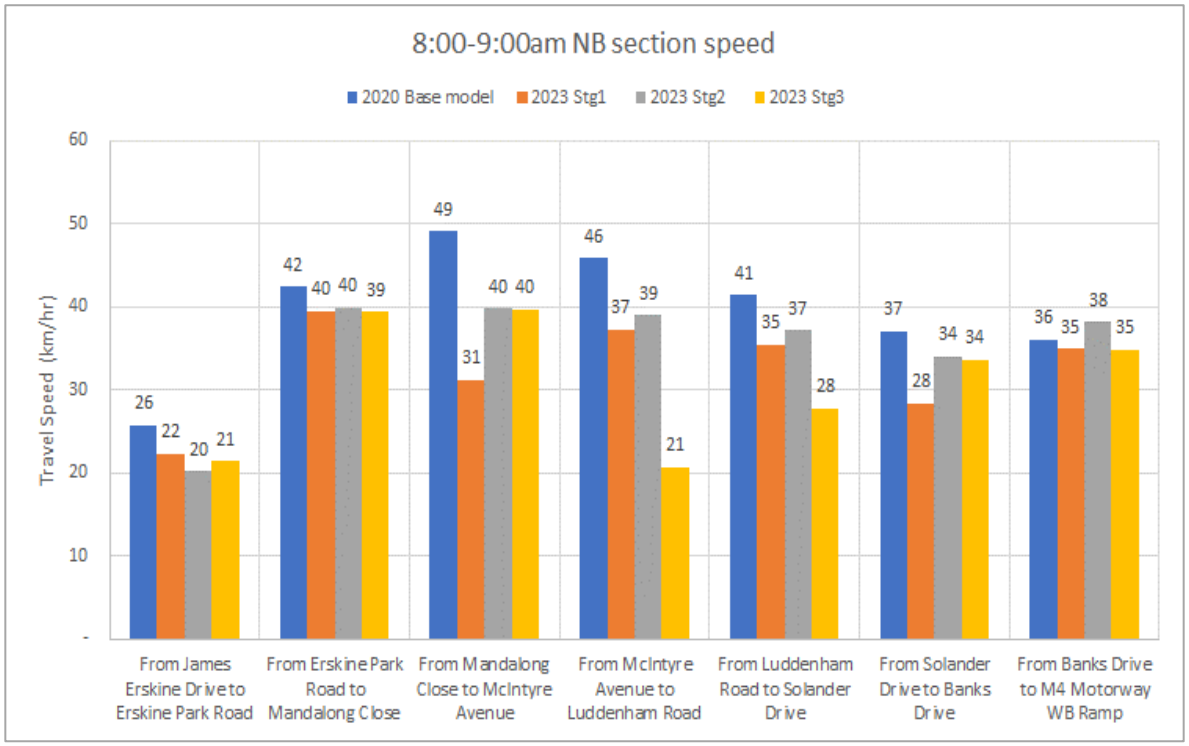


Figure 5-8: Northbound Section Travel Speed (km/hr) (AM Peak 2nd hour)

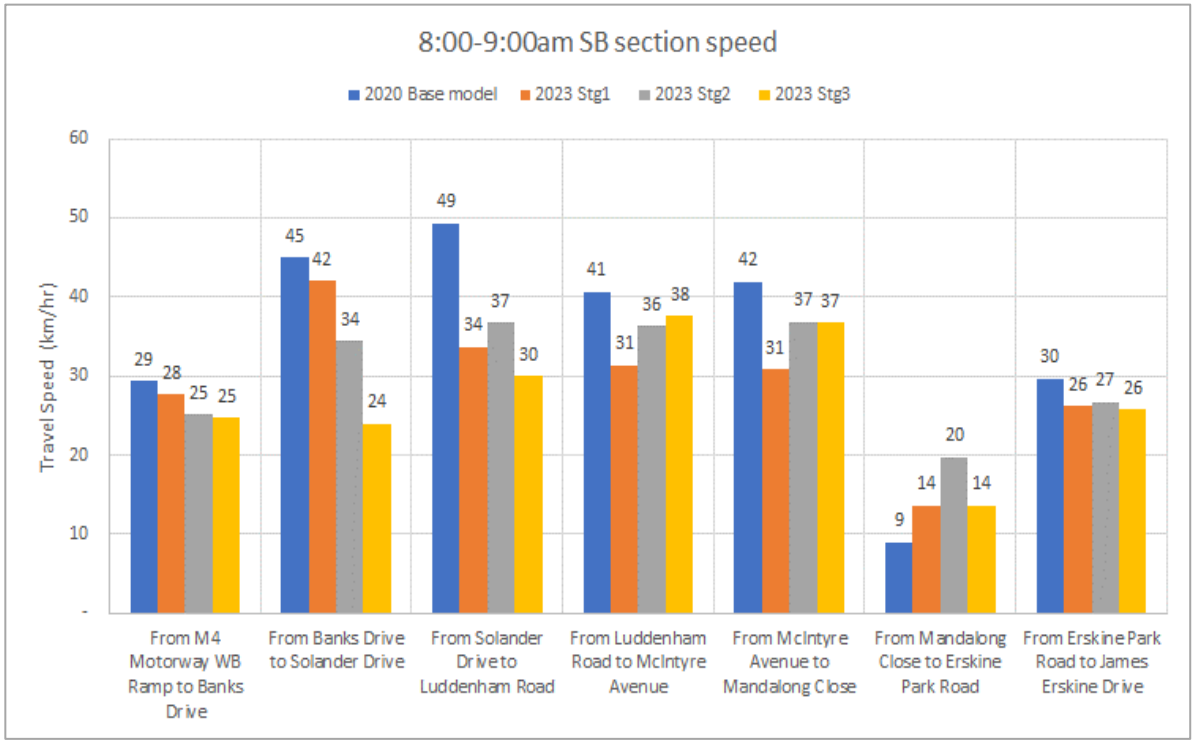


Figure 5-9: Southbound Section Travel Speed (km/hr) (AM Peak 2nd hour)

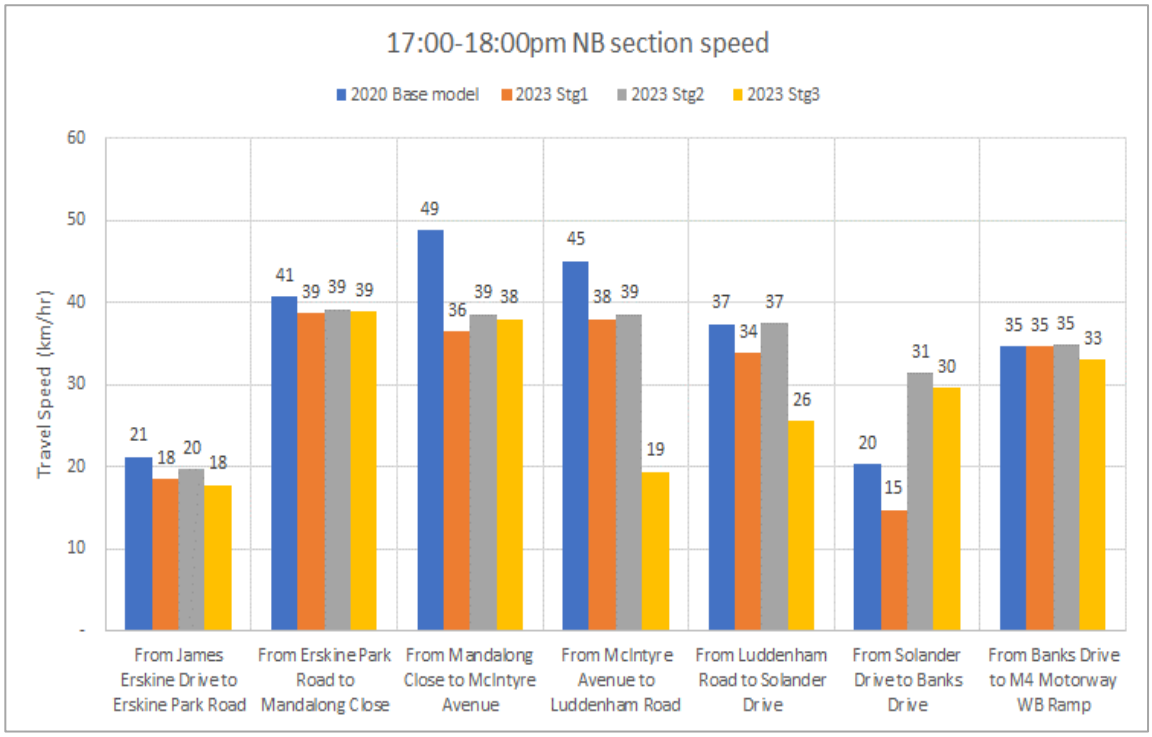


Figure 5-10: Northbound Section Travel Speed (km/hr) (PM Peak 2nd hour)

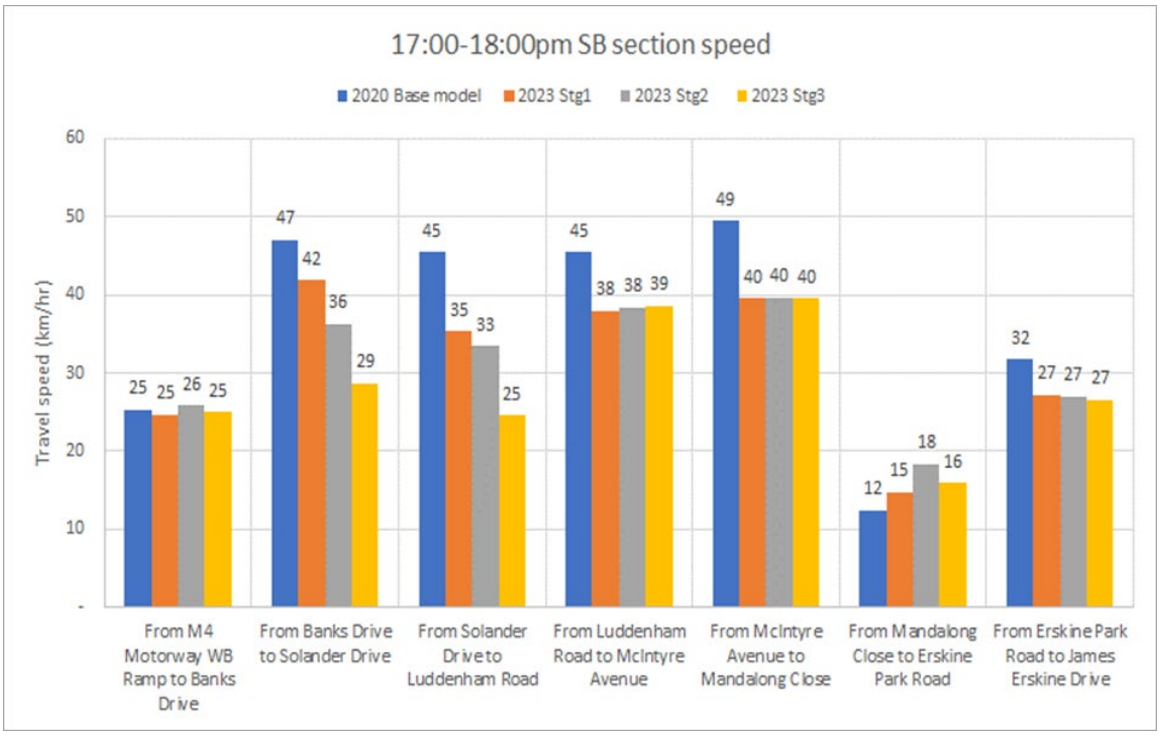


Figure 5-11 Southbound Section Travel Speed (km/hr) (PM Peak 2nd hour)

Key travel time and speed findings are summarised below based on the traffic analysis and modelling results:

- In general, all three construction stages travel time are longer (slower travelling speed) compared to 2020 base case. This is mainly due to the impact of the posted speed limit reductions to 60 km/hr along Mamre Road.
- Banks Drive intersection northbound has 60 metre short kerbside lane (with shared left turn and though movement) in place in Stage 2 and Stage 3 which provided extra northbound through movement capacity. As a result, the northbound travel time during Stage 2 and Stage 3 is generally shorter (faster travelling speed) compared to Stage 1.
- Signalisation of Solander Drive intersection and Luddenham Road intersection in Stage 3 can potentially further reduce the travel speed during both AM and PM Peak for both directions on Mamre Road.

Summary of the Construction Staging Traffic Performance

In order to assess the impact of the construction activities on the study area and traffic network performance, the impact of each proposed construction stage was assessed in terms of the key performance indicators. In summary, the following are the key observations from the traffic modelling and associated analysis:

- **Construction Stage 1** is expected to have minimal impact on overall network performance as well as local intersections due to minimal geometry change along Mamre Road corridor. Travel time and travel speed are expected to be comparable the 2020 base case conditions.
- **Construction Stage 2** is expected to have similar performance as those in stage 1. However, during 2023 AM Peak, Banks Drive intersection is expected to experience slightly higher delay, while during 2023 PM Peak, Banks Drive intersection is expected to have slightly lower delay and better performance.
- **Construction Stage 3** is expected to show moderate increase in delay at Solander Drive intersection and Luddenham Road intersection during both 2023 AM and PM Peak. This is primarily due to the signalisation of the Solander Drive intersection (existing priority controlled). The signalisation of the Solander Drive intersection (with new western leg opening) together with the signalisation of Luddenham Road intersection is expected to introduce some additional delay and stops for traffic along Mamre Road in both directions. During Stage 3, the Banks Drive intersection is expected to have similar performance as those in the base case and Stage 2.

5.1.6 Impacts on Road Safety

Generally, construction of the proposal has the potential in the following areas to impact road safety, if adequate controls are not implemented:

- Increased risk of loss of traction or control on temporary pavement surfaces;
- Increased risk of conflicts between general traffic and construction vehicles, particularly at construction site access and egress points;
- Reduced lane widths and increased proximity to barriers, increasing the risk of crashes;
- Increased risk of driver distraction around construction activities;
- Decreased visibility of temporary line marking and other traffic control measures.

The potential for road safety impacts during construction would be addressed through the development of a Construction Traffic Management Plan (CTMP) and all work would be undertaken by a competent contractor in accordance with the relevant industry standards and Work Health Safety regulations. Also, given the proposed speed reduction (from 80 km/hr to 60km/hr along Mamre Road during construction) it is expected that the impact on road safety would be limited during construction activities.

5.1.7 Impacts on Bus Services

Bus services within the study area are limited, with few services provided at low frequencies, that operate long and circuitous routes primarily to provide local coverage. The existing bus routes tend to link residential and industrial areas with railway stations. During construction, bus routes 775, 776, and 779 that operate along Mamre Road within the study area would be affected. The bus routes and service frequency include:

- #775 Mount Druitt to Penrith via Erskine Park and St Marys (36 services per day Monday to Friday)
- #776 Penrith to Mt Druitt (34 services per day Monday to Friday)
- #779 St Marys to Erskine Park Industrial area (4 services in the peak direction per day Monday to Friday).

The proposed changes to the bus stops and bus routes would be as follows:

- The two bus stops on Erskine Park Road and Banks Drive near Mamre Road would be relocated nearby during construction (refer to Figure 5-12 below). This would result in requiring some passengers to walk further, while other passengers may have a shorter distance to walk to their desired bus stop
- The two bus stops on Mamre Road near Banks Drive would be temporarily closed. During this period, commuters can use the nearby bus stops on Banks Drive westbound and eastbound approximately 90 meters and 150 meters from the Mamre Road bus stops respectively. The contractor would be required to maintain access at the Banks Drive intersection so commuters can walk to and from Mamre House. Two new bus stops would be constructed as part of the proposal on the departure side of Mamre Road intersection at Banks Drive to replace these bus stops.
- Bus routes 776 and 779, as well as school bus route 4115, would be amended so they avoid travelling through Mamre Road roadworks and instead use the local road network. The local road network already caters to similar size buses.
- Minor changes to bus timetables as a result of reductions in speed for buses when travelling through construction activity areas as a result of the reduced speed zone from 80km/h to 60km/h, resulting in longer travel times for users

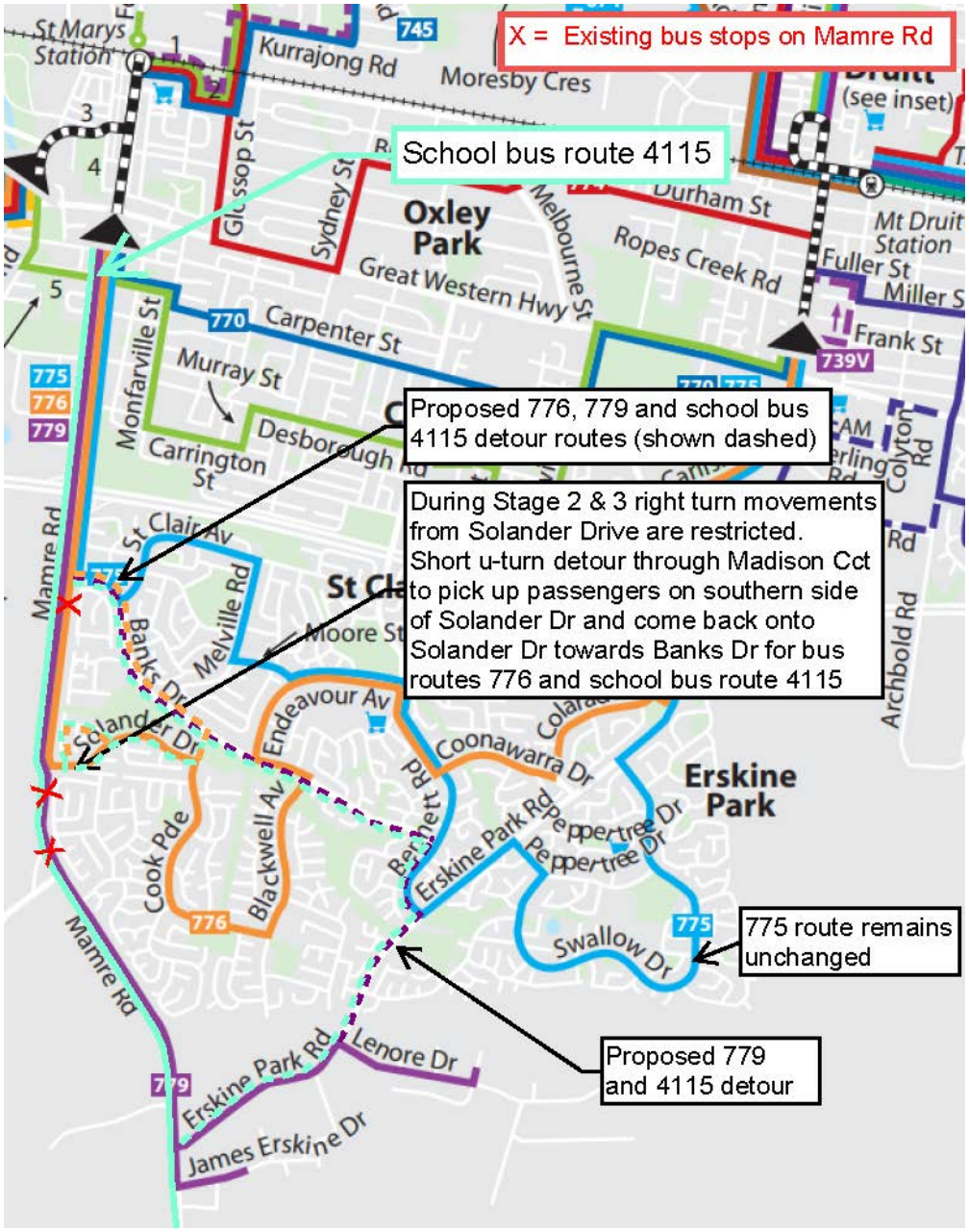


Figure 5-12: Proposed 776 and 779 bus alternative routes during construction

Table 5-6 below summarises the bus stop locations and changes for commuters during each of the construction stages.

Table 5-6: Bus stop locations and changes for commuters during construction

Location	Existing Facilities	Early Works	Stage 1	Stage 2	Stage 3
Mamre Road to the north of the bus stop on departure side of Mamre Road southbound near Banks Drive intersection	Footpath on the eastern side	As per existing	As per existing	Commuters would be able to move behind barriers to access bus stop	Commuters to utilise constructed shared path to access new bus stops
South of the Erskine Park Road intersection	Shared path on the eastern side	As per existing	Contractor to maintain access to shared path and intersection crossings using gaps in the barriers	Commuters would be able to move behind barriers to access bus stop	Commuters to utilise constructed shared path to access new bus stops
Erskine Park Road on the departure side of Mamre Road intersection heading eastbound	Bus stop	As per existing	Bus stop temporarily relocated east to outside of construction works zone	Commuters to use new bus stop	Commuters to use new bus stop
Erskine Park Road on the approach side of Mamre Road intersection heading westbound	Bus stop	As per existing	As per existing	Bus stop temporarily relocated east to outside of construction works zone	Commuters to use new bus stop
Mamre Road Northbound just after Mamre House entrance	Bus stop	As per existing	Temporarily closed. Commuters to use alternate bus stop on Banks Drive	Commuters to use new bus stop	Commuters to use new bus stop
Mamre Road Southbound on the departure side of Banks Drive	Bus stop	As per existing	As per existing	Temporarily closed. Commuters to use temporarily relocated bus stop on Banks Drive	Commuters to use new bus stop
Banks Drive westbound	Bus stop	As per existing	As per existing	Bus stop temporarily relocated to outside project boundary	Commuters to use new bus stop

Location	Existing Facilities	Early Works	Stage 1	Stage 2	Stage 3
Mamre Road Southbound on the departure side of Solander Drive	Bus stop	As per existing	As per existing	Temporarily closed. Commuters to be picked up on the southern side of Solander Drive on the proposed detour route.	Commuters to use new bus stop.
Mamre Road Southbound near Luddenham Road	Bus stop	As per existing	As per existing	Temporarily closed. Commuters to be picked up on the southern side of Solander Drive on the proposed detour route.	Commuters to use new bus stop on Mamre Road to the south of Solander Drive.

5.1.8 Impacts on Pedestrians and Cyclists

Except for the shared path on the eastern side of the road south of the Erskine Park Road intersection, there is very little existing provision for cyclist movement along Mamre Road. The shoulders along Mamre Road are mostly unsealed with vegetation growth, making it difficult for cyclists to safely use the existing Mamre Road as an access route.

During Stage 0 Early Works and Stage 1, a 1.2-metre-wide shoulder would be maintained from Erskine Park Road up to Mandalong Close for cyclists. Cyclists would use the existing shared path along eastern side of Mamre Road from James Erskine Drive to Erskine Park Road. The Contractor would maintain the crossing to the western side near the James Erskine Park Drive intersection.

During Stage 2, the shared path on the western side of Mamre Road from Erskine Park Road to Mandalong Close (constructed in Stage 1) would be open for cyclist and pedestrian use and would replace the existing cyclist 1.2 metre northbound shoulder connecting with James Erskine Drive. The existing shared path south of Erskine Park Road would require minor adjustments in order to allow tie into the new proposal works. The contractor would maintain safe connectivity to James Erskine Drive and Erskine Park Road shared path facilities during Stage 2 to cater for pedestrian and cyclist movements on the eastern side of Mamre Road.

During construction, the contractor would maintain access at the Banks Drive intersection so commuters can walk to and from Mamre House. Safety barriers would separate users from the construction zone during construction of the new path, the decommissioning of the old path and tie in works to provide safe passage during construction. At tie-in locations, any potential temporary disruptions (e.g. with final surfacing) would be managed to ensure users would be able to continue their journey.

Cyclists could also use an alternative route through the local road network, as per Figure 5-13 below. The proposed alternative routes for cyclists shown in Figure 5-13 are based on TfNSW's Principal Bicycle Network. These routes would result in additional distances travelled of about 1.4 kilometres for Option A and 3.8 kilometres for Option B, compared to travelling along Mamre Road.

Figure 5-13: Alternative Routes for Cyclists

5.1.9 Impacts on Property Access

The construction methodology for the proposal has been developed in consideration of the need to minimise the impact to local residents and businesses in the vicinity of the construction works.

Access to properties would be maintained, where feasible, unless an agreement with the relevant property owner is obtained. Where changed traffic conditions may restrict some existing turning movements in and out of property accesses, alternative detours may be provided. New temporary access arrangements would be in place prior to construction commencing in consultation with the property owners.

In particular, the following properties and businesses would remain open and trafficable throughout the construction phase:

- Erskine Park RFS, located on northern side of existing Luddenham Road - The proposal includes a new RFS property access gate and driveway to be constructed off Old Luddenham Road. Construction work for this revised access is planned to commence in Stage 1 prior to closure of the existing access and subsequent construction of the left turning lanes at new Luddenham Road Intersection.
- Mamre House, located on the western side of existing Mamre Road - The proposal includes a new access road connection to Mamre House via the new western stub at the Banks Drive intersection. Mamre House vehicle access would be maintained using temporary traffic arrangements during Stage 1 before the new access at the fourth leg of Banks Drive intersection has been constructed. The new Mamre House access is proposed to be made operational following the completion of Stage 2. The contractor would also need to maintain movements for pedestrians that need to cross through the site and make their way to the pedestrian crossing at Banks Drive.
- Mandalong Close residents and business owners. During Stage 1, a temporary side track would be constructed to the north-west of the Mandalong Close to provide access to the proposed ancillary site and also allow for less disruption in subsequent construction stages allowing the upgraded Mandalong Close to be constructed entirely offline from Stage 2 onwards.

Several local access gates to the Office of Strategic Lands property on the western side of Mamre Road would be closed at the commencement of Stage 0 works.

During construction, some of the local and collector roads on the eastern side of Mamre Road such as McIntyre Avenue, Solander Drive and Banks Drive would experience minor kerb adjustments adjustment of the kerb to the driveway of the private property on the north-east corner of the Solander Drive intersection. During construction, access would be maintained by the contractor at all times, where feasible, however local traffic is expected to experience some travel time delay associated with the change in traffic movements, change in traffic conditions, and introduction of temporary signals at some intersections.
A construction traffic management plan (CTMP) would be prepared and would outline all measures to manage potential property access impacts. This would include requirements for appropriate signage to businesses, local roads and residences to maintain access and minimise confusion for motorists.

5.1.10 Impacts on Parking

There is currently no parking permitted on Mamre Road. Parking along Mamre Road would continue to be prohibited during construction. This includes the use of the eastern side of Mamre Road as an informal parking area.

Localised on-street parking impacts during construction would include removal of some parking on side streets close to the intersections to allow for construction of the new intersection layouts.

The existing parking on the eastbound and westbound (approximately six parking spaces) side of Solander Drive near Mamre Road would be removed to provide space for the eastbound traffic lane. The removal of these parking spaces would result in residents and visitors having to utilise alternative parking on Solander Drive. As there is sufficient alternative parking on Solander Drive and within residential and commercial land, parking impacts are likely to be minimal. Minor driveway adjustments for the property on the eastbound side up to Madison Circuit may be required.

The existing parking (approximately two parking spaces) on the eastbound side of McIntyre Avenue would be removed to provide space for the eastbound traffic through lane and accommodate the intersection works.

5.1.11 Impacts on Emergency Services

Access would be maintained for emergency services during construction, where feasible. Access to the Erskine Park RFS site north of Luddenham Road would be maintained during construction, with a new access constructed off Old Luddenham Road prior to closure of the existing access.

With the existing Mamre Road being predominately one lane of traffic in each direction, the construction staging strategy proposes that the temporary traffic arrangements facilitate one lane of traffic in each direction throughout all construction activities as per the existing scenario.

In the existing scenario, vehicles may pull into the verge where feasible to allow emergency vehicles to pass. In construction stages 0 to 3, installation of barrier may impede vehicles from being able to pull into the verge. Barriers are proposed to be located on the western side of Mamre Road for Stage 0 and Stage 1, and on the eastern side for Stage 2. There are some locations on Mamre Road where there is a chevroned median, which could potentially be used if needed for vehicles to pull into while allowing emergency vehicles to pass.

In Stage 3, where there would be one lane in each direction due to barrier boards, vehicles could pull into the barrier boarded lanes in an emergency to allow emergency vehicles to pass.

The contractor would be required to inform the relevant authorities of any change to traffic conditions that would impact access prior to these works being undertaken.

The contractor would prepare a Traffic Management Plan to show how emergency vehicles could be managed during the short-term closure proposed at Banks Drive.

5.2 Operational Impacts

5.2.1 Impacts on Traffic Performance

Do Minimum Scenario Traffic Performance

Figure 5-14 below shows the 2026 & 2036 Base Case schematic lane configuration diagram at key intersections along Mamre Road. It can be noted that future base case network geometry is assumed to be consistent with 2020 Base Case, however, the James Erskine Drive intersection is assumed to be upgraded separately to the proposal and with new western leg (Altis Access). This is referred to as the 'Do Minimum' Scenario and does not include operation of the proposal.

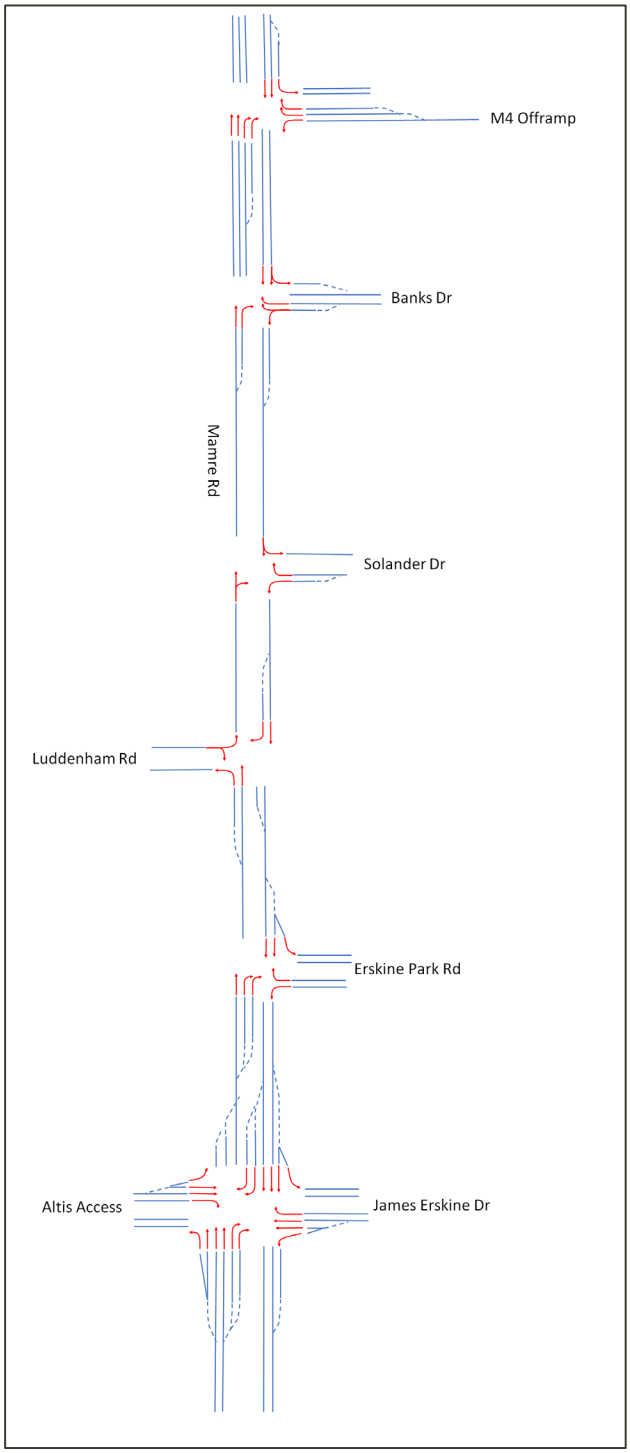


Figure 5-14: 2026 and 2036 Future Base year lane diagram

Future Year Base Case (Do Minimum) Modelling Results

2026 and 2036 future year Aimsun models were developed as future models for the purpose of assessing future year road network performance. Future year traffic demands were estimated based on Sydney GMA Strategic Traffic Forecasting Model (STFM) outputs as updated based on Travel Zone Projections 2019 (TZP19) and Strategic Travel Model (STM) 3.8 provided by TfNSW.

The result of the Do Minimum (without build) STFM model runs shows significant traffic network congestion for the study area and unstable future base year traffic models. This chapter summarises the findings of the Do Minimum (without build) traffic models based on the latest traffic volumes forecast models (STFM) for the Do Minimum models.

Table 5-7 lists the road network statistics for 2026 Base Case model during AM and PM Peak periods.

Table 5-7: 2026 Base Case model peak periods network statistics

	2026 AM Peak	2026 PM Peak
Average delay per vehicle (minutes: seconds)	02:14	01:37
Average network speed (km/hr)	19	22
Vehicle Kilometre Travel (VKT)	26,957	27,260
Vehicle Hour Travel (VHT)	1,401	1,234
Total Stops	2,989	3,389
Unreleased vehicles (number of vehicles)	866	51
% of demand unreleased	7.5%	0.5%
Total Demand (number of vehicles)	11,904	12,287

Intersection delay and associated LOS were extracted from the 2026 base model during both AM and PM Peak periods. LOS calculations have been provided based on the average intersection delay for all movements. Table 5-8 lists 2026 Base year key intersection LOS during peak period (2nd hour).

Table 5-8: Key intersection LOS during 2026 Base Case peak period (2nd hour)

Intersection	2026 Base AM Peak (2nd hour)		2026 Base PM Peak (2nd hour)	
	Delay (sec)	LOS	Delay (sec)	LOS
M4 Motorway Westbound Ramp and Mamre Road	108	F	49	D
Banks Drive and Mamre Road	171	F	89	F
Solander Drive and Mamre Road	228	F	184	F
Luddenham Road and Mamre Road	215	F	131	F
Erskine Park Road and Mamre Road	217	F	331	F
James Erskine Drive and Mamre Road	52	D	106	F

Figure 5-15 and Figure 5-16 show 2026 Base Case AM Peak and PM Peak 2nd hour key intersection performance within the study area respectively. Figure 5-17 and Figure 5-18 show 2026 Base Case AM Peak and PM Peak Aimsun traffic models snapshots respectively.

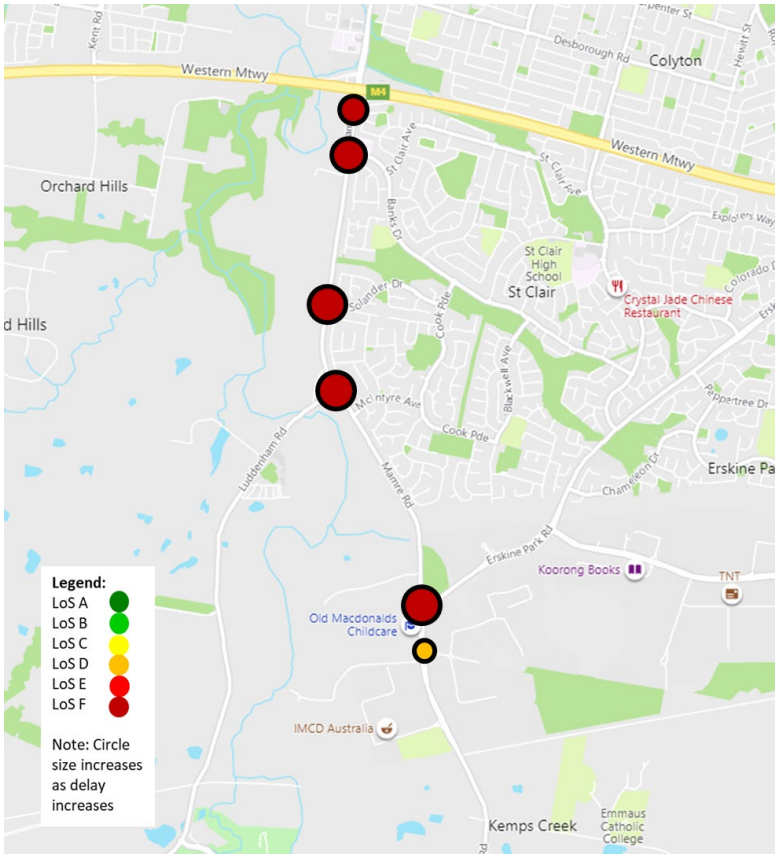


Figure 5-15: 2026 Base Case AM Peak (2nd hour) intersection LOS

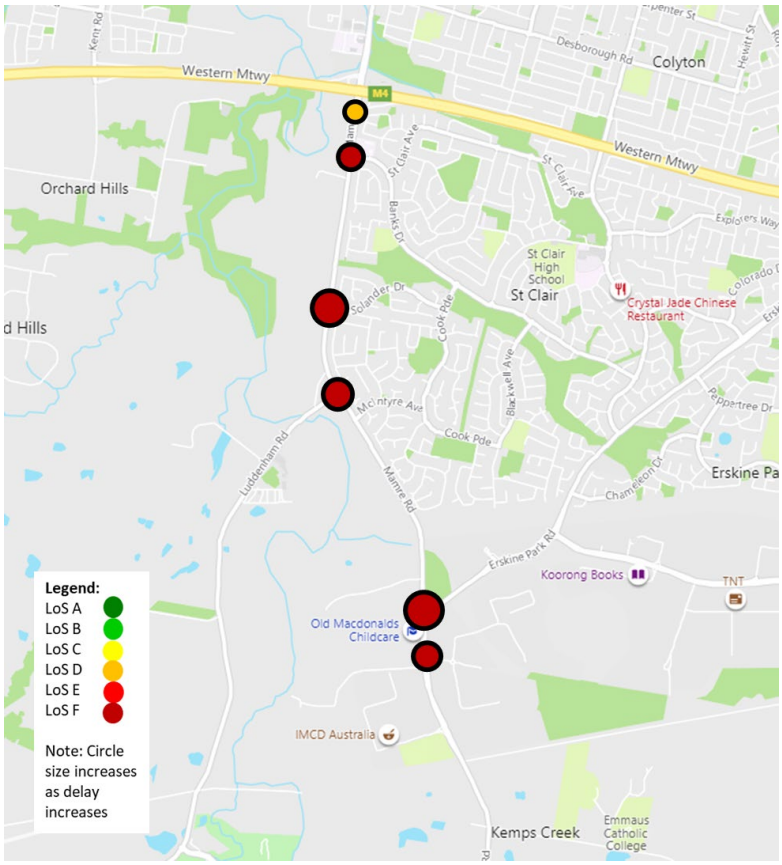


Figure 5-16: 2026 Base Case PM Peak (2nd hour) intersection LOS

Figure 5-17: 2026 Base Case AM Peak network congestion

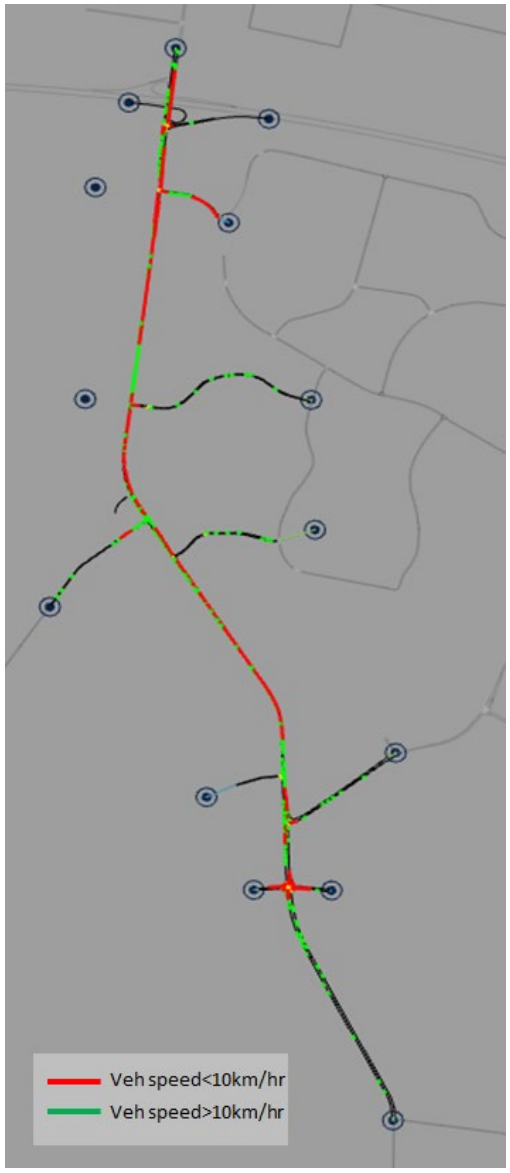


Figure 5-18: 2026 Base Case PM Peak network congestion

Figure 5-17 and Figure 5-18 show during 2026 peak periods that the Base Case network is highly congested with queuing on both Mamre Road mainline and side roads such as Banks Drive, Solander Drive, and Luddenham Road. Figure 5-17 and Figure 5-18 also show that during both peak periods most sections of Mamre Road between south of Luddenham Road and M4 interchange operate at speeds below 10 km/hr which substantially lower than the posted speed limits.

Table 5-9 lists the road network statistics for 2036 Base Case model during AM and PM Peak periods.

Table 5-9: 2036 Base Case model peak periods network statistics

	2036 AM Peak	2036 PM Peak
Average delay per vehicle (minutes: seconds)	03:05	03:32
Average network speed (km/hr)	16	13
Vehicle Kilometre Travel (VKT)	28,446	28,423
Vehicle Hour Travel (VHT)	1,826	2,110
Total Stops	4,065	4,008
Unreleased vehicles (number of vehicles)	3,108	2,927
% of demand unreleased	21.5%	21.4%
Total Demand (number of vehicles)	14,479	15,227

Intersection delay and associated level of service (LOS) were extracted from the 2036 base model during both AM and PM Peak periods. Please note LOS calculations have been provided based on the average intersection delay for all movements. Table 5-10 lists 2036 Base year key intersection level of service during peak period (2nd hour).

Table 5-10: Key intersection LOS during 2036 Base Case peak period (2nd hour)

Intersection	2036 Base AM Peak (2nd hour)		2036 Base PM Peak (2nd hour)	
	Delay (sec)	LOS	Delay (sec)	LOS
M4 Motorway Westbound Ramp and Mamre Road	116	F	145	F
Banks Drive and Mamre Road	223	F	118	F
Solander Drive and Mamre Road	227	F	280	F
Luddenham Road and Mamre Road	231	F	247	F
Erskine Park Road and Mamre Road	203	F	297	F
James Erskine Drive and Mamre Road	169	F	549	F

Figure 5-19 and Figure 5-20 shows 2036 Base Case AM Peak and PM Peak 2nd hour key intersection performance within the study area respectively. Figure 5-21 and Figure 5-22 show the 2036 Base Case AM Peak and PM Peak network congestion respectively.

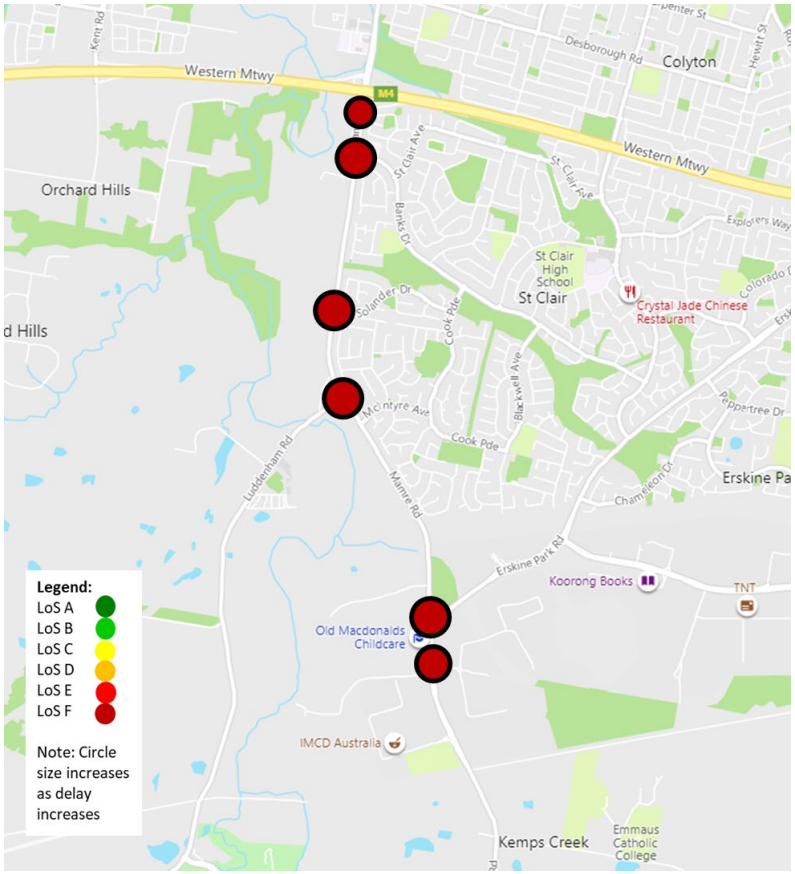


Figure 5-19: 2036 Base Case AM Peak (2nd hour) intersection LOS

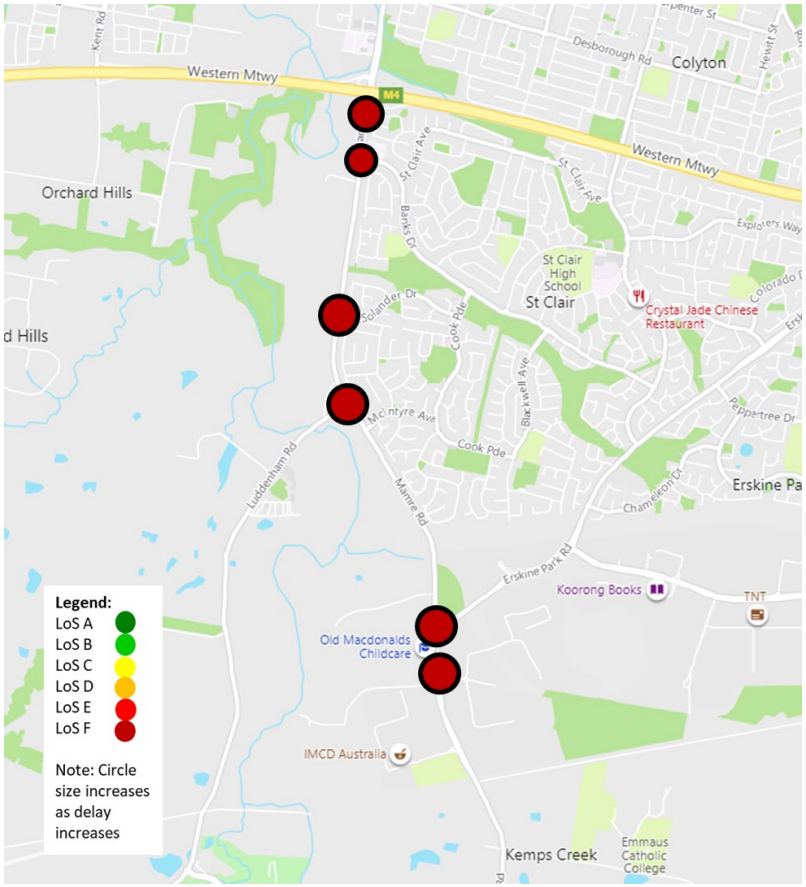


Figure 5-20: 2036 Base Case PM Peak (2nd hour) intersection LOS

Figure 5-21: 2036 Base Case AM Peak network congestion

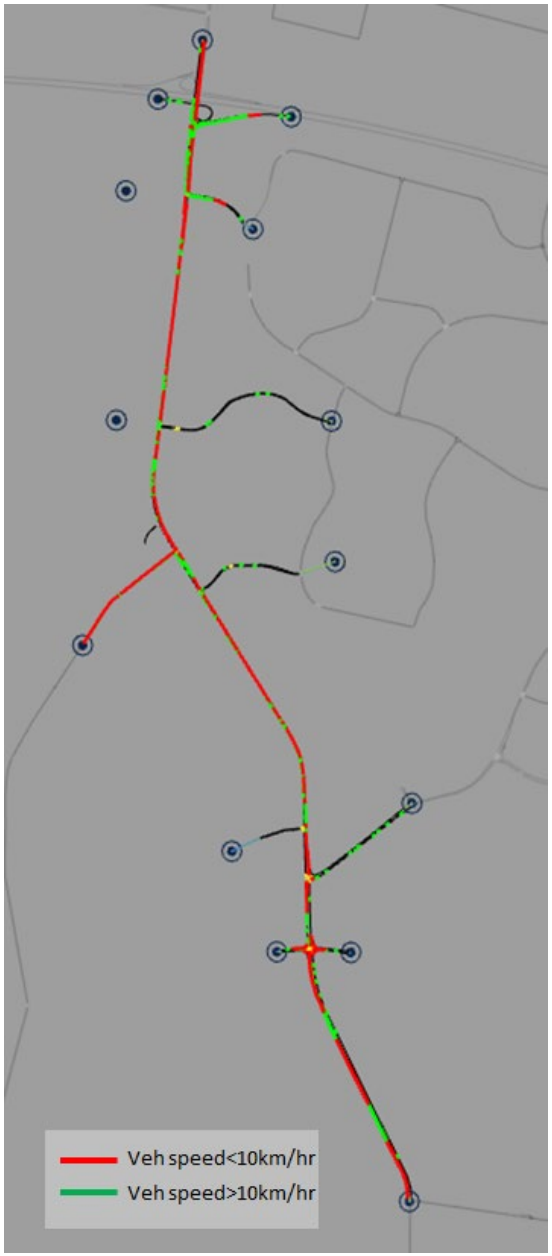


Figure 5-22: 2036 Base Case PM Peak network congestion

From Figure 5-21 and Figure 5-22, it can be noted that during 2036 peak periods, the network is extremely congested with significant queues on both Mamre Road mainline, and side roads such as Banks Drive and Luddenham Road. Figure 5-21 and Figure 5-22 show that during both peak periods the congestion build-ups along Mamre Road extends to the entire corridor and most sections on Mamre Road would show travel speed less than 10 km/hr which is substantially less than the posted speed limits. Traffic modelling results also indicate that the access from key roads; including Luddenham Road and Banks Drive, would also suffer long and extended congestions and delay times.

Future Year Proposal Scheme

In order to assess the impact of the proposed road design on the study and traffic network performance, Aimsun microsimulation traffic models were utilised. The impact of the proposed road geometry design assessed in terms of the following key performance indicators:

- Network statistics
- Key intersection Level of Service and Delay Analyses
- Mamre Road Travel Time and Speed.

Throughout the assessment, comparisons were also made against the Base Case (Do Minimum) scenarios to determine the impact of the proposal.

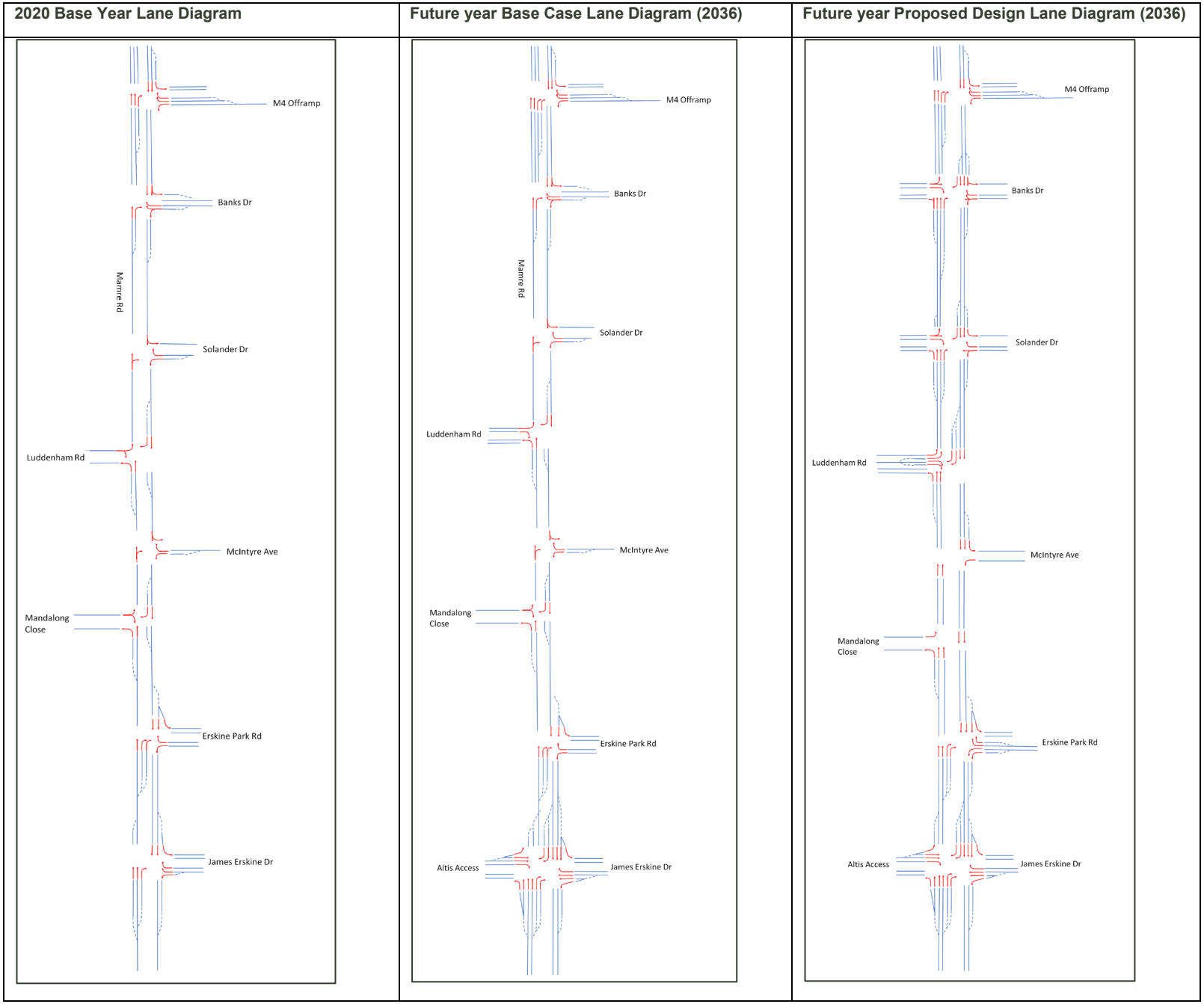


Figure 5-23: 2020 & future Base Case lane diagram comparison

Proposed Design Traffic Modelling Results

2026 and 2036 future year Proposed Design Aimsun modelling results and intersection LOS are summarised in this chapter.

In regard to the proposal's intersection performance analyses, LOS analyses have been completed for key signalised intersections in the study area. Since non-signalised intersections on Mamre Road are proposed to be left in – left out only arrangement, no LOS analyses have been provided for these intersections. The left in – left out arrangement includes the access to and from Mandalong Close and McIntyre Avenue. Traffic analyses did not show any noticeable delay for the left in and left out accesses in all scenarios for these intersections, therefore no LOS reporting results have been included in this report for the left-out movements at these intersections.

LOS analyses have been presented for the second hour in each modelled peak period. This is because higher congestion build-ups were observed towards the last hour in each modelled period, therefore the second hour represented more critical analytical periods.

Table 5-11 shows the summary of proposed design network statistics for the year 2026 during both AM and PM Peak periods.

Table 5-11: 2026 Proposed Design network statistics

	2026 Proposed Design AM Peak	2026 Proposed Design PM Peak
Average delay per vehicle (minutes: seconds)	00:49	01:18
Average network speed (km/hr)	39	34
Vehicle Kilometre Travel (VKT)	35,990	33,386
Vehicle Hour Travel (VHT)	924	978
Total Stops	1,188	2,444
Unreleased vehicles (number of vehicles)	266	0
% of demand unreleased	2.1%	0.0%
Total Demand (number of vehicles)	12,321	12,393

Intersection delay and associated LOS were extracted from the model during both AM and PM Peak periods. Table 5-12 lists 2026 Proposed Design key intersection level of service during peak period (2nd hour).

Table 5-12: Key intersection LOS during 2026 Proposed Design peak (2nd hour)

Intersection	2026 Proposed Design AM Peak		2026 Proposed Design PM Peak	
	Delay (sec)	LOS	Delay (sec)	LOS
M4 Motorway Westbound Ramp and Mamre Road	67	E	99	F
Banks Drive and Mamre Road	39	C	35	C
Solander Drive and Mamre Road	24	B	28	B
Luddenham Road and Mamre Road	18	B	24	B
Erskine Park Road and Mamre Road	24	B	24	B
James Erskine Drive and Mamre Road	34	C	42	C

Figure 5-24 and Figure 5-25 show 2026 Proposed Design AM & PM Peak 2nd hour key intersection performance within the study area respectively.

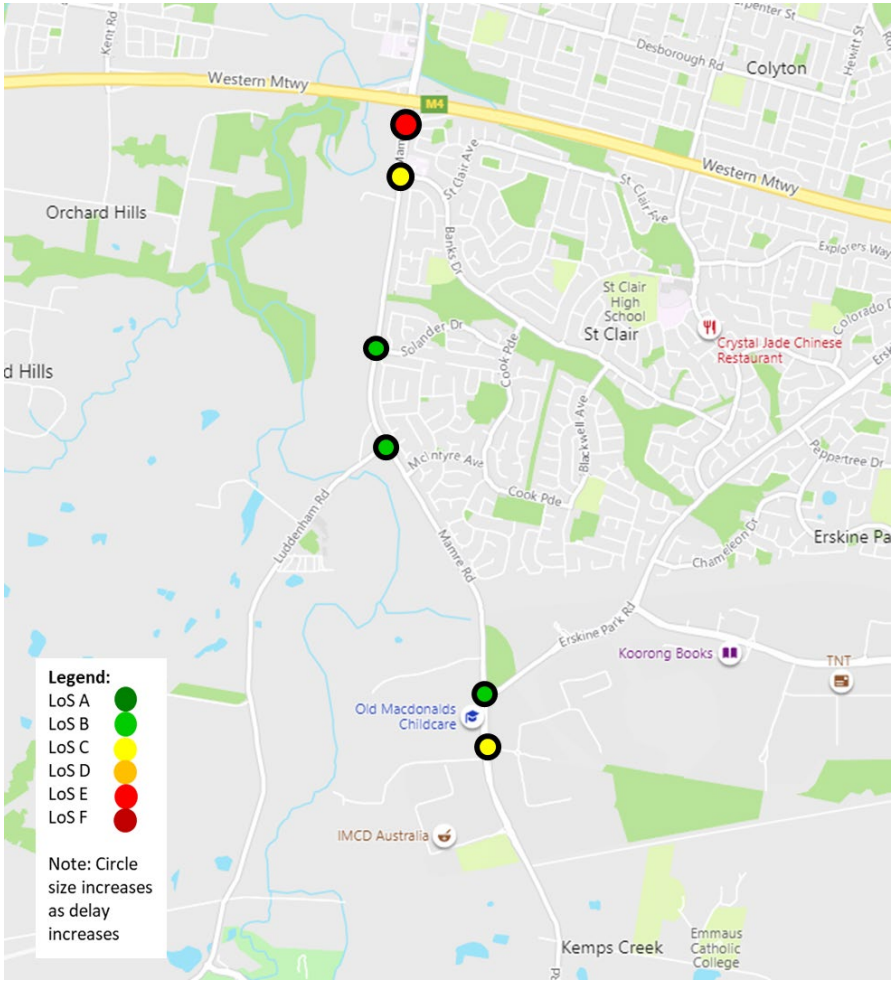


Figure 5-24: 2026 Proposed Design AM Peak (2nd hour) intersection LOS

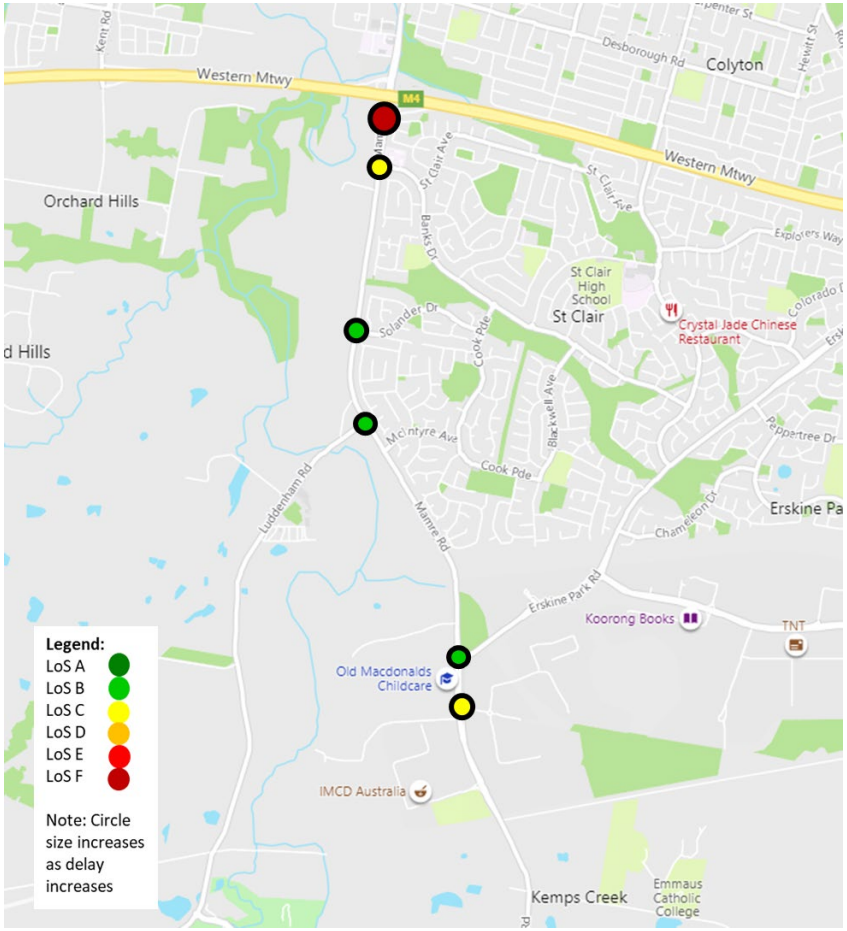


Figure 5-25: 2026 Proposed Design PM Peak (2nd hour) intersection LOS

Table 5-13 shows the summary of proposed design network statistics for the year 2036 during both AM and PM Peak periods.

Table 5-13: 2036 Proposed Design network statistics

	2036 Proposed Design AM Peak	2036 Proposed Design PM Peak
Average delay per vehicle (minutes: seconds)	00:58	01:19
Average network speed (km/hr)	36	34
Vehicle Kilometre Travel (VKT)	43,573	42,230
Vehicle Hour Travel (VHT)	1,214	1,245
Total Stops	3,044	2,816
Unreleased vehicles (number of vehicles)	257	644
% of demand unreleased	1.7%	4.2%
Total Demand (number of vehicles)	14,897	15,536

Intersection delay and associated level of service (LOS) were extracted from the model during both AM and PM Peak periods. Table 5-14 lists 2036 Proposed Design key intersection level of service during peak period (2nd hour).

Table 5-14: Key intersection LOS during 2036 Proposed Design AM and PM peaks (2nd hour)

Intersection	2036 Proposed Design AM Peak		2036 Proposed Design PM Peak	
	Delay (sec)	LOS	Delay (sec)	LOS
M4 Motorway Westbound Ramp and Mamre Road	69	E	101	F
Banks Drive and Mamre Road	48	D	37	C
Solander Drive and Mamre Road	25	B	25	B
Luddenham Road and Mamre Road	36	C	31	C
Erskine Park Road and Mamre Road	26	B	23	B
James Erskine Drive and Mamre Road	40	C	54	D

Figure 5-26 and Figure 5-27 show 2036 Proposed Design AM & PM Peak 2nd hour key intersection LOS within the study area, respectively.

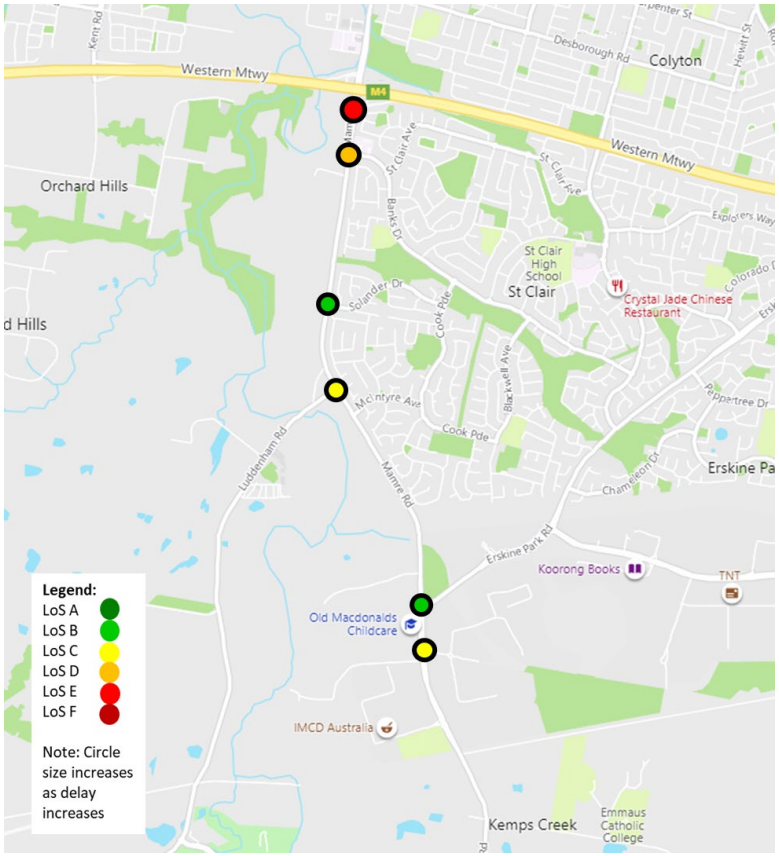


Figure 5-26: 2036 Proposed Design AM Peak intersection LOS

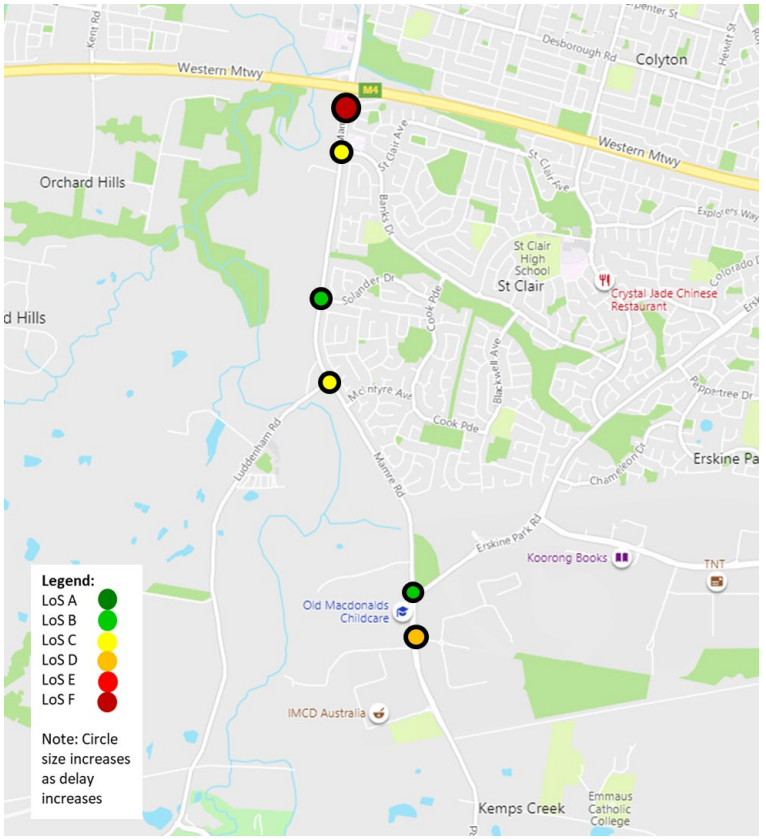


Figure 5-27: 2036 Proposed Design PM Peak intersection LOS

Based on the above modelling results, the following key points can be concluded:

- Key intersection and overall road network performance for the 2026 and 2036 AM and PM Peaks for proposal show major improvements when compared to the without the proposal (future Base case) traffic models
- Overall network statistics show that the proposal would cater for larger traffic demands and would also reduce the average delay per vehicles by up to 85 seconds in 2026 scenarios (up to 63 per cent) and up to 134 in 2036 scenarios (up to 69 per cent)
- Traffic modelling and intersection LOS shows by the year 2026, without the proposal, all key intersections in the study area would operate at LOS F/E with high intersection delay. Traffic modelling and traffic analyses shows the same intersections with the proposal would operate at LOS C or better by the year 2026 and intersection LOS D or better by the year 2036. This indicates that the proposal is able to adequately cater for the forecast traffic growth in the study area
- Intersection LOS analyses show that the M4 Motorway and Mamre Road intersection would remain as a low performance section of the traffic network with high delay and low LOS expected during all tested scenarios.

Travel time and speed along Mamre Road corridor was analysed in order to compare the impact of the proposed upgrade design against the Base Case. Figure 5-28 to Figure 5-35 show the travel time analyses during 2026 and 2036 AM and PM Peak (2nd hour) along Mamre Road for both directions.

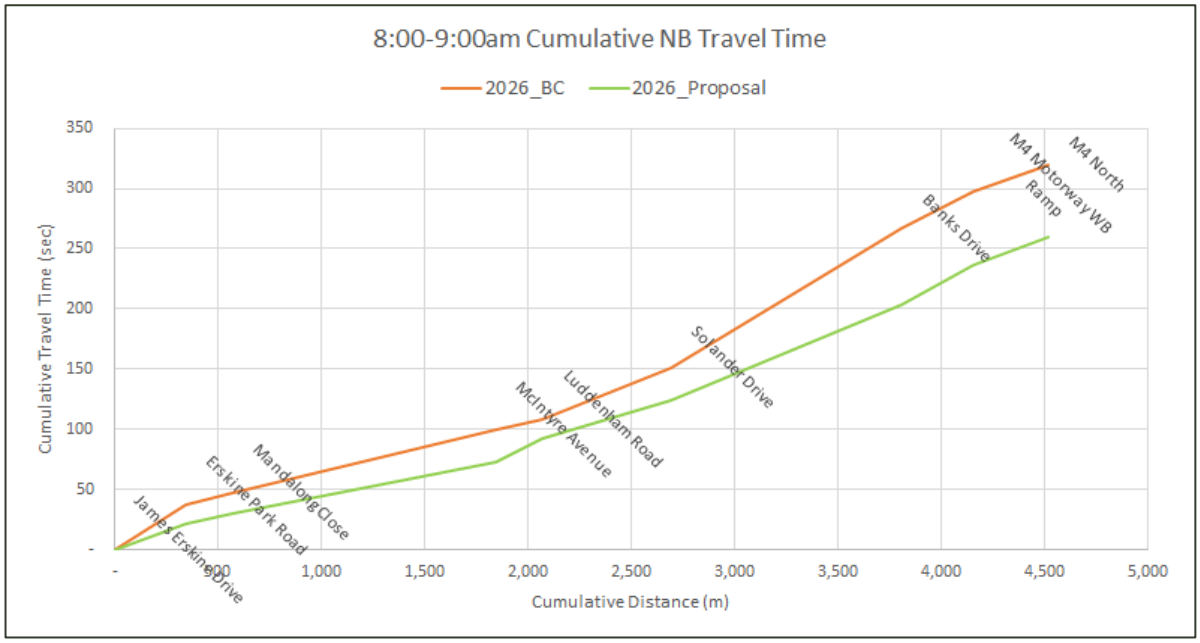


Figure 5-28: 2026 AM Peak 2nd hour Northbound travel time

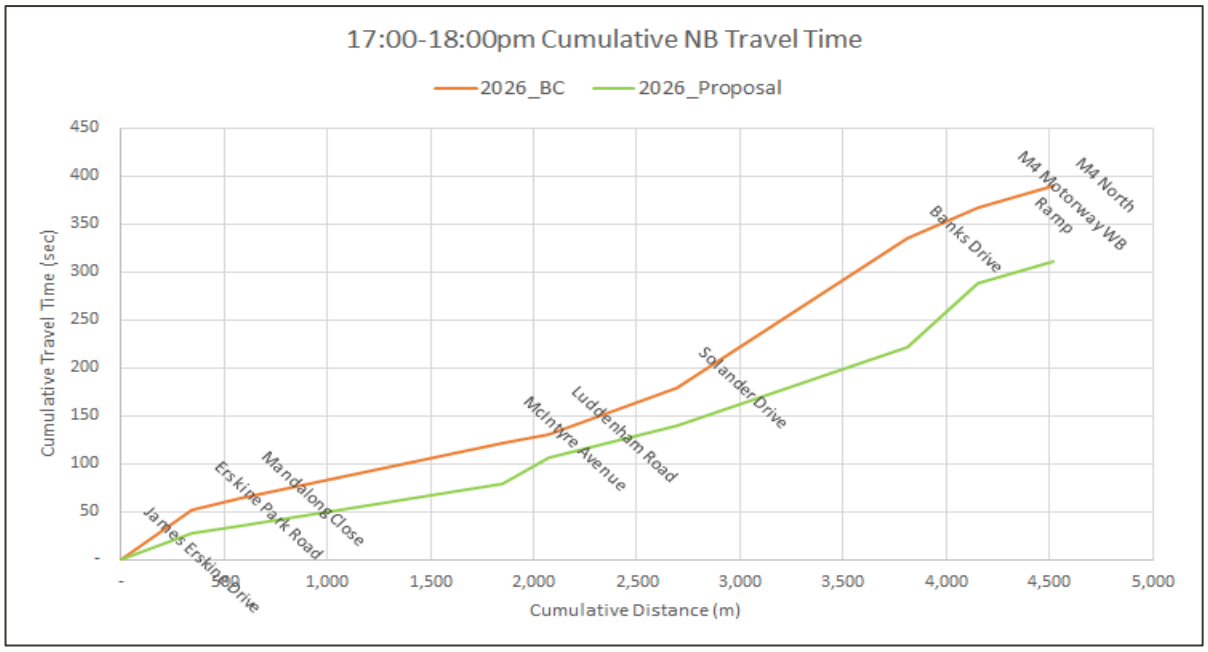


Figure 5-29: 2026 PM Peak 2nd hour Northbound travel time

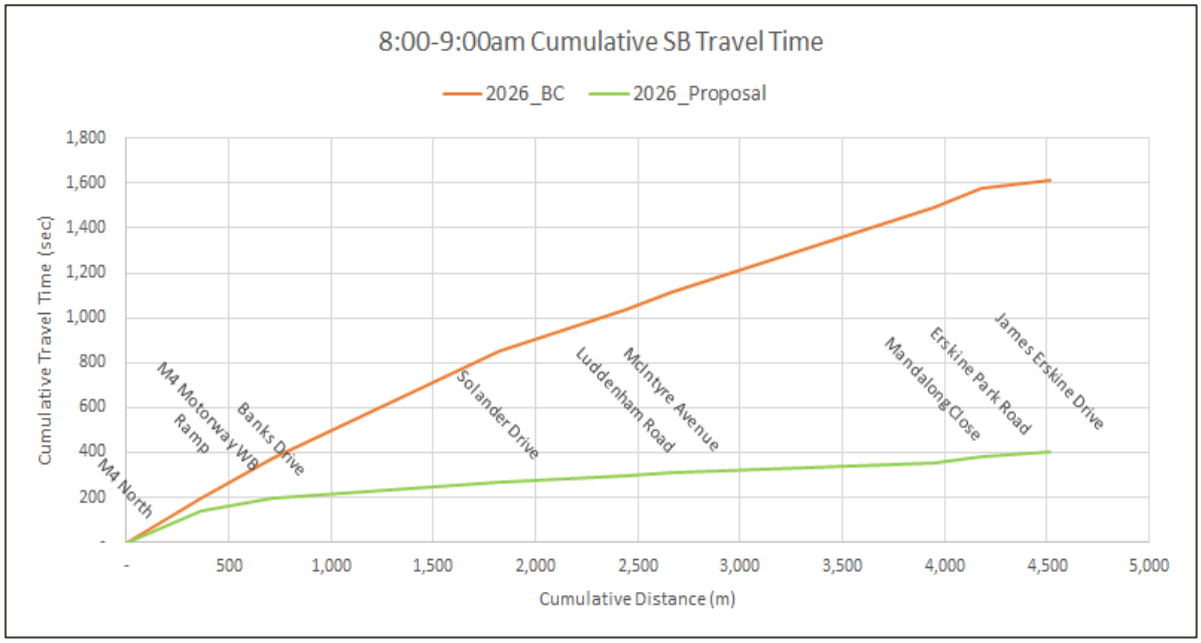


Figure 5-30: 2026 AM Peak 2nd hour Southbound travel time

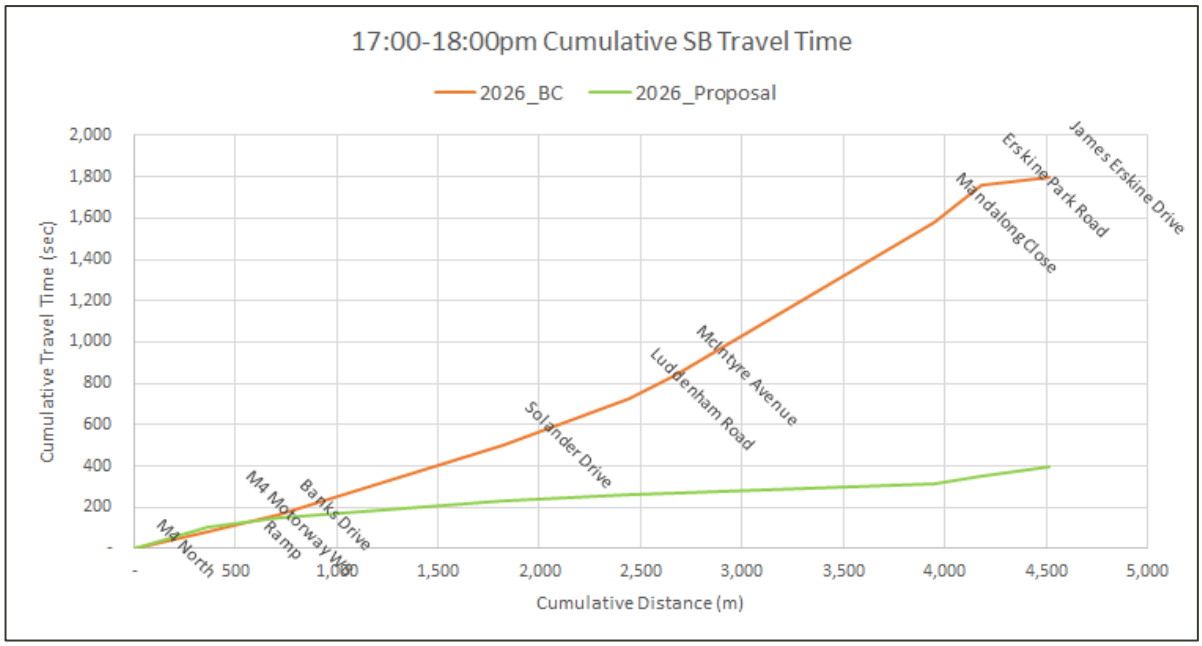


Figure 5-31: 2026 PM Peak 2nd hour Southbound travel time

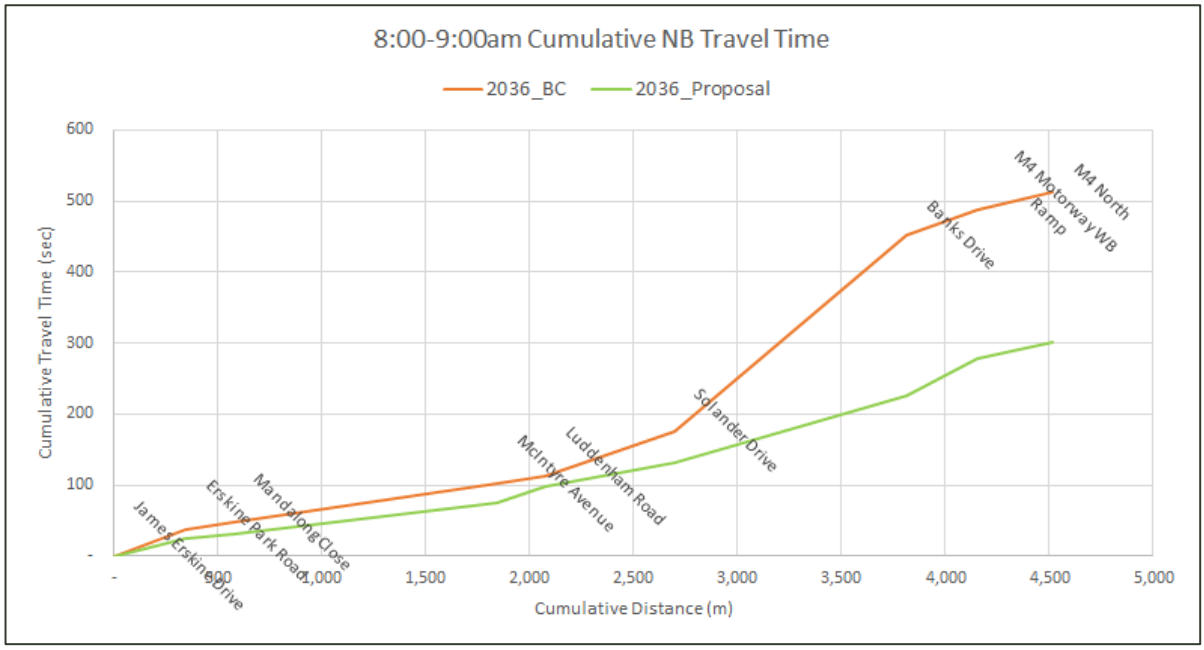


Figure 5-32: 2036 AM Peak 2nd hour Northbound travel time

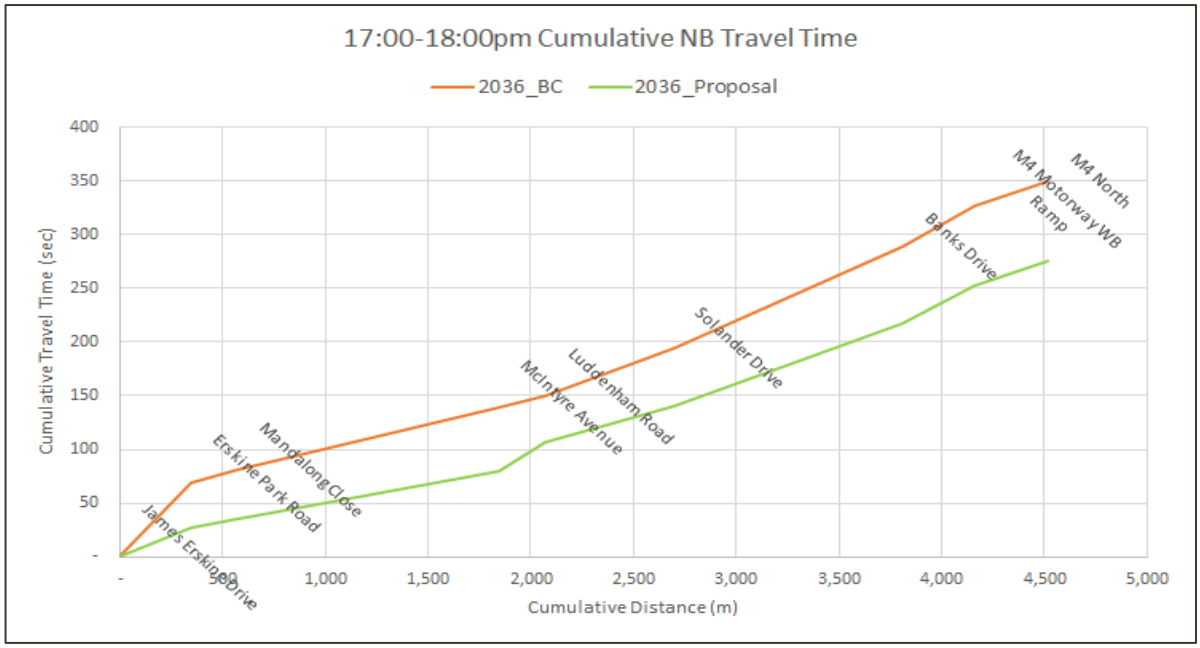


Figure 5-33: 2036 PM Peak 2nd hour Northbound travel time

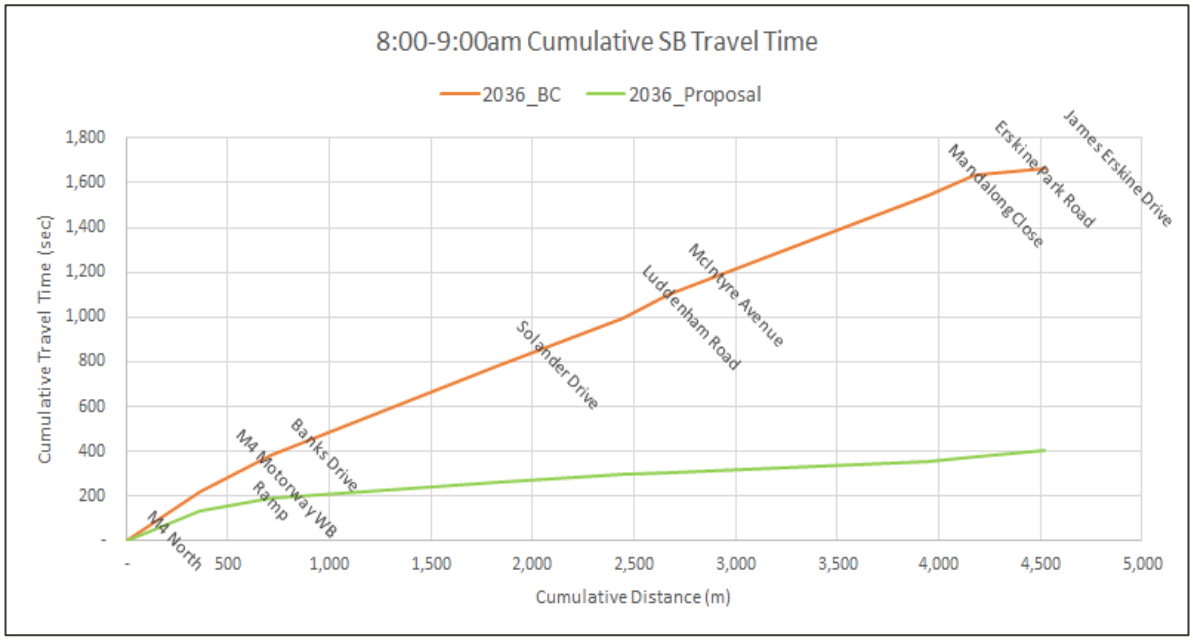


Figure 5-34: 2036 AM Peak 2nd hour Southbound travel time

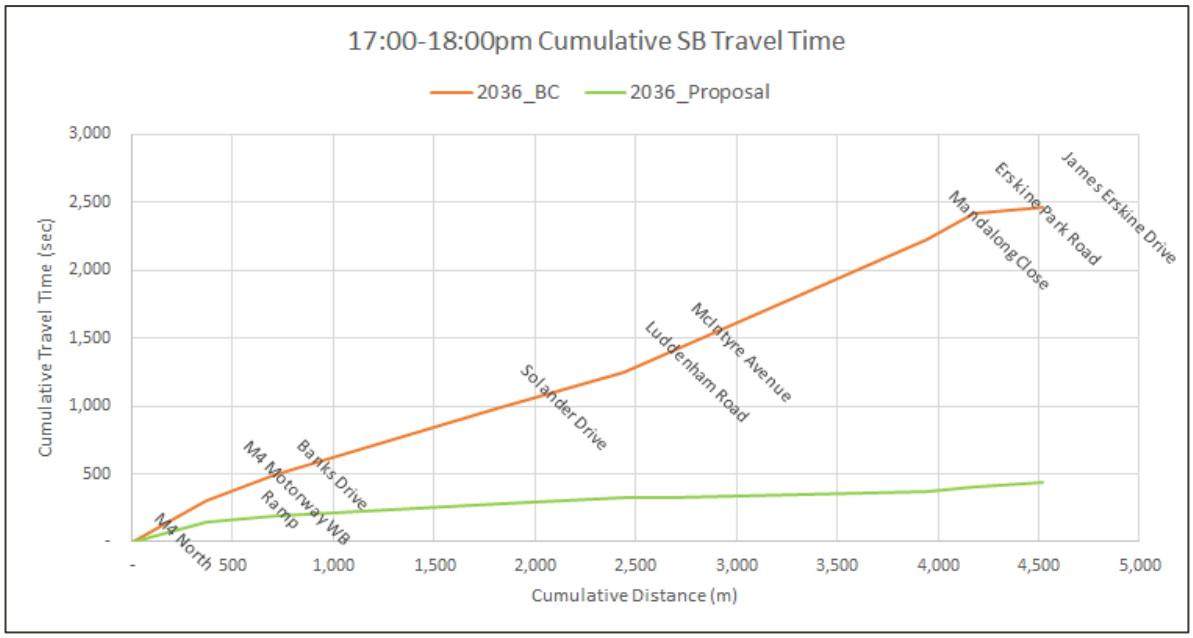


Figure 5-35: 2036 PM Peak 2nd hour Southbound travel time

Based on the above travel time analyses, key points were noted as below:

- The proposal provides major travel time benefits for both directions during both AM and PM Peak in all analysed future year scenarios
- The traffic network under the Base Case (without the proposal) conditions would operate at near gridlock conditions in both 2026 and 2036 scenarios, with travel times on the southbound direction of Mamre Road in the study area increasing up to 41 minutes. The same section with operation of the proposal shows less than 8 minutes of travel time.
- Travel time analyses for the northbound direction also show travel time savings of up to 3.5 minutes by the year 2036 with the proposal

Figure 5-36 to Figure 5-43 show travel speed comparisons during 2026 and 2036 AM and PM Peak (2nd hour) for road sections along Mamre Road for both directions.

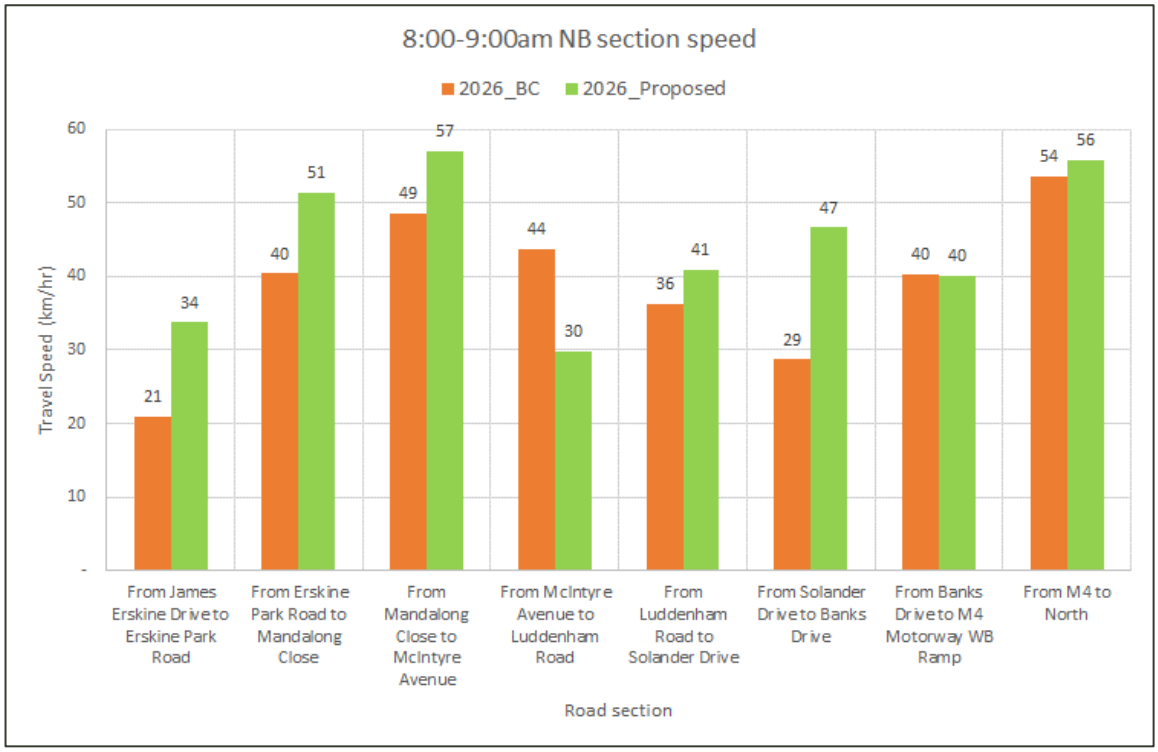


Figure 5-36: 2026 AM Peak 2nd hour Northbound section speed

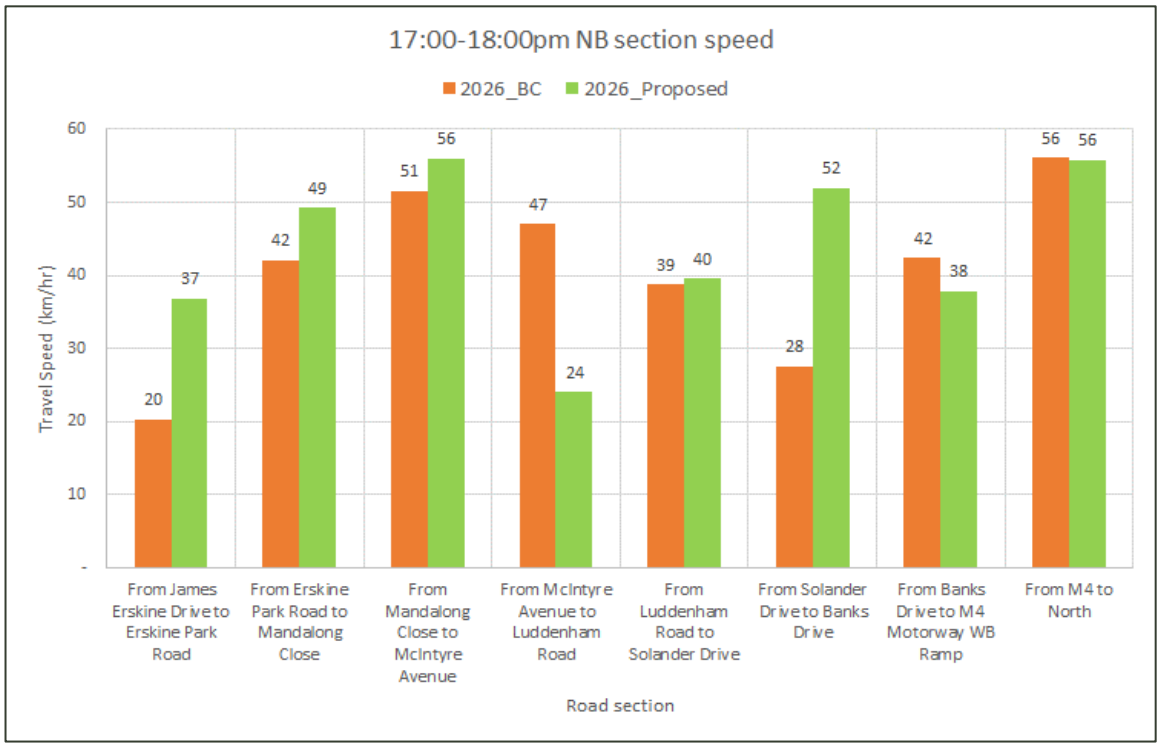


Figure 5-37: 2026 PM Peak 2nd hour Northbound section speed

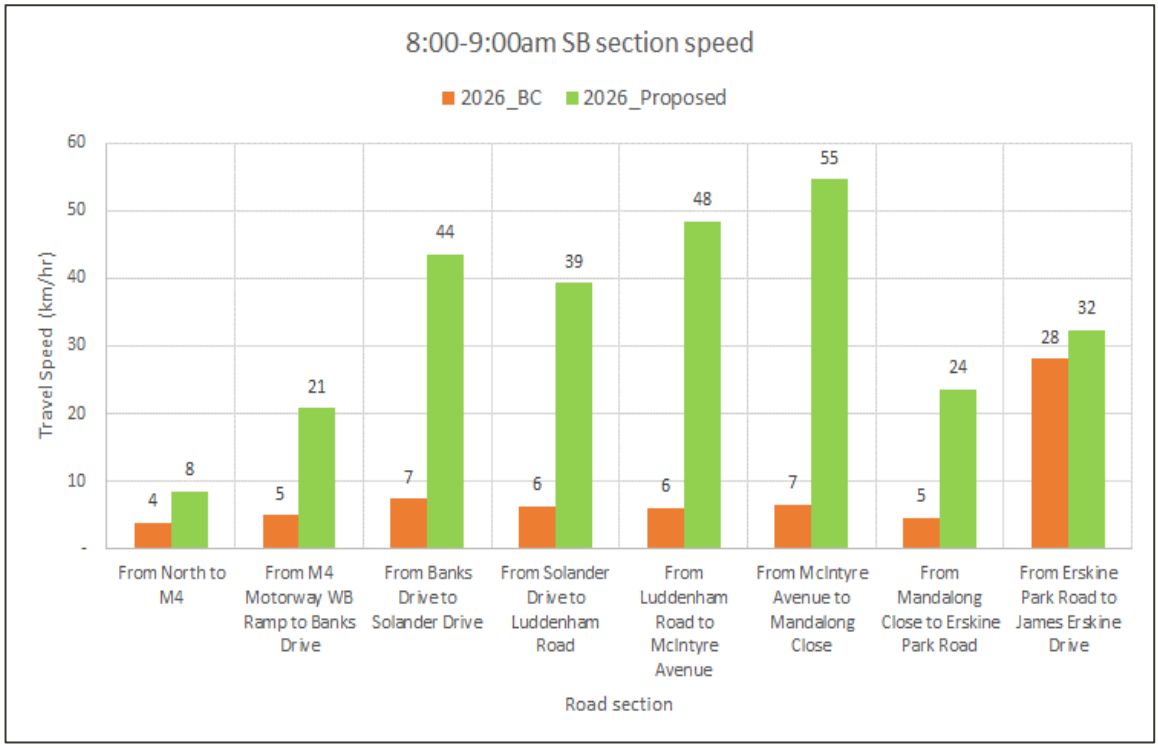


Figure 5-38: 2026 AM Peak 2nd hour Southbound section speed

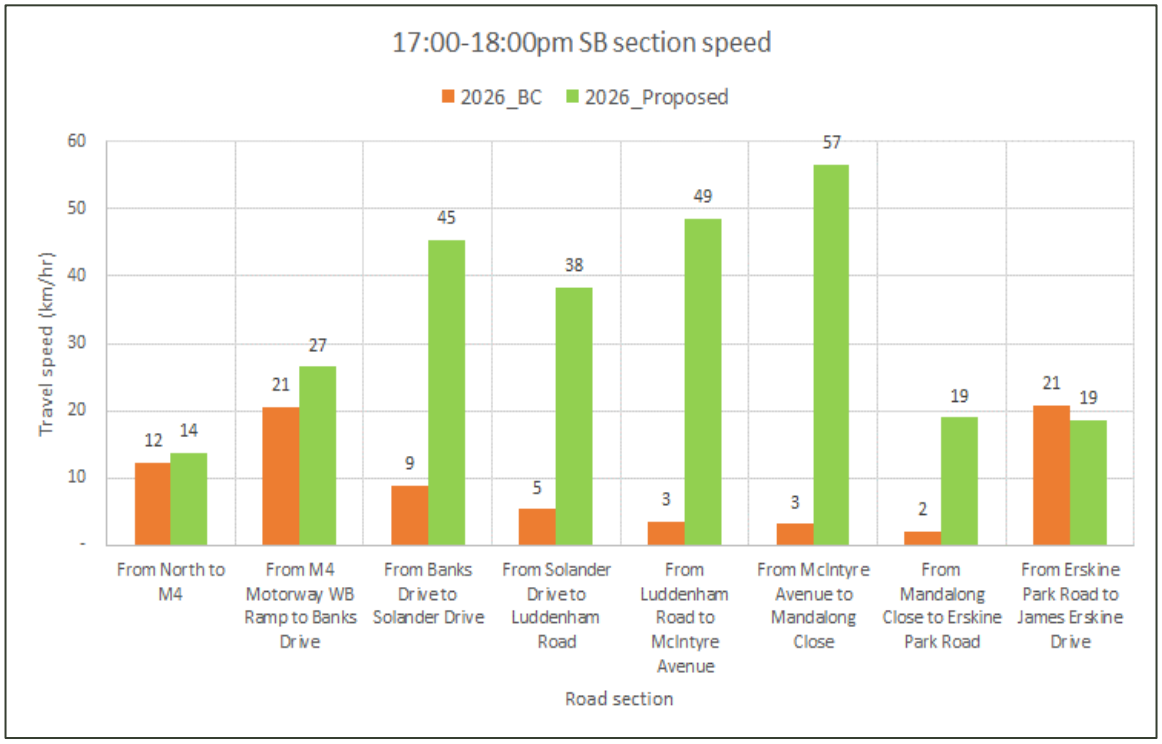


Figure 5-39: 2026 PM Peak 2nd hour Southbound section speed

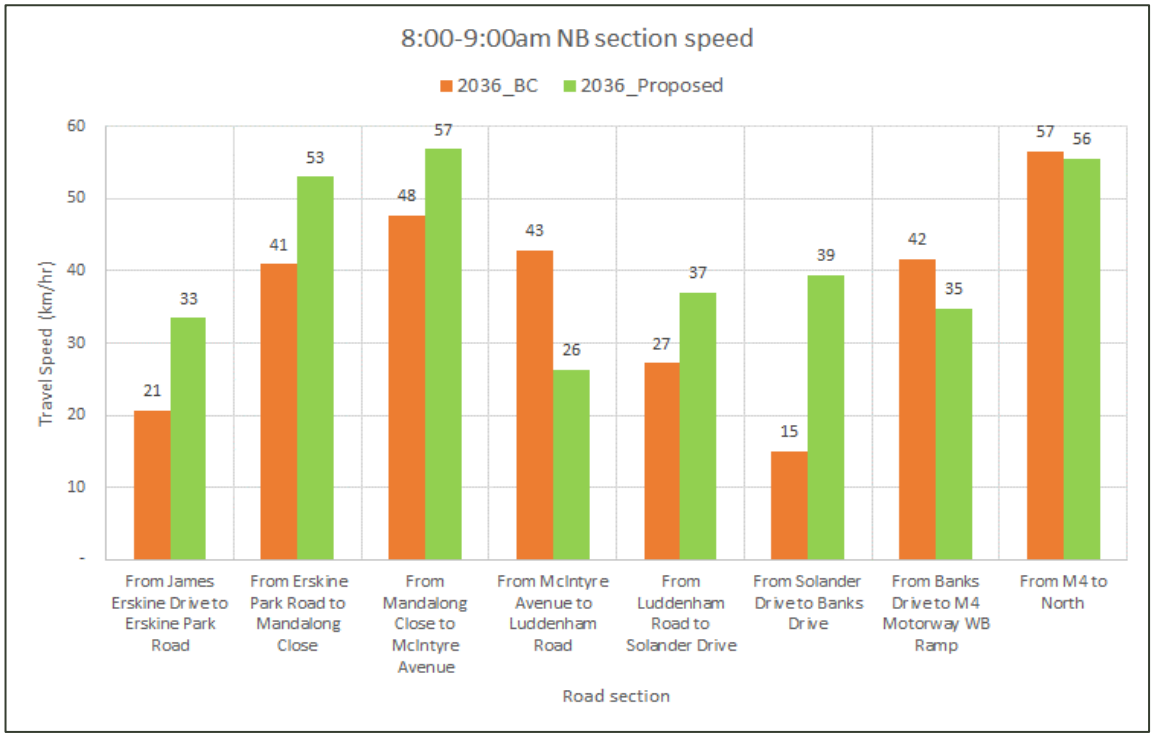


Figure 5-40: 2036 AM Peak 2nd hour Northbound section speed

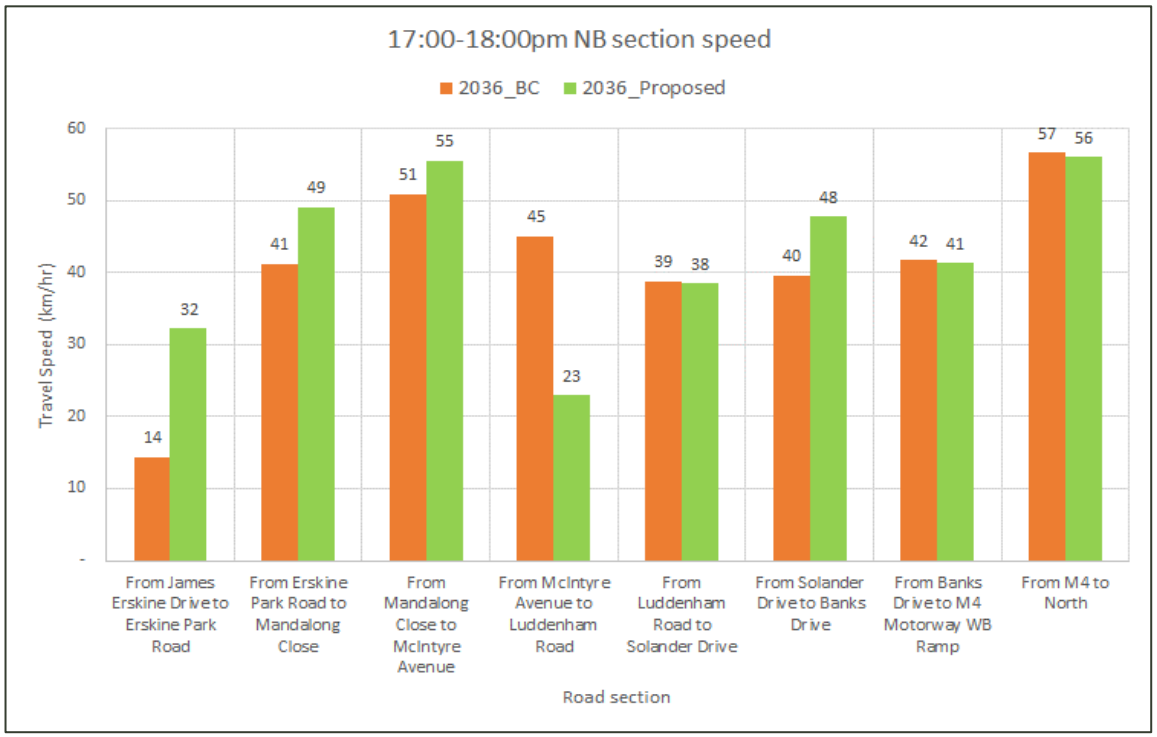


Figure 5-41: 2036 PM Peak 2nd hour Northbound section speed

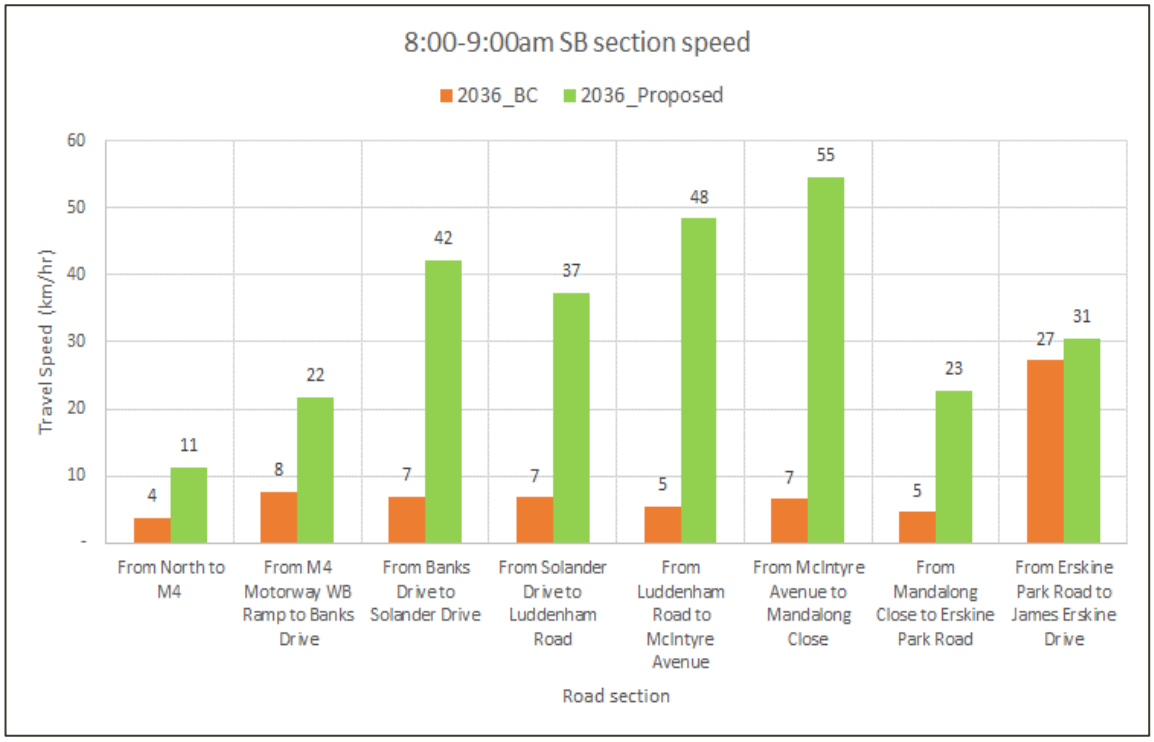


Figure 5-42: 2036 AM Peak 2nd hour Southbound section speed

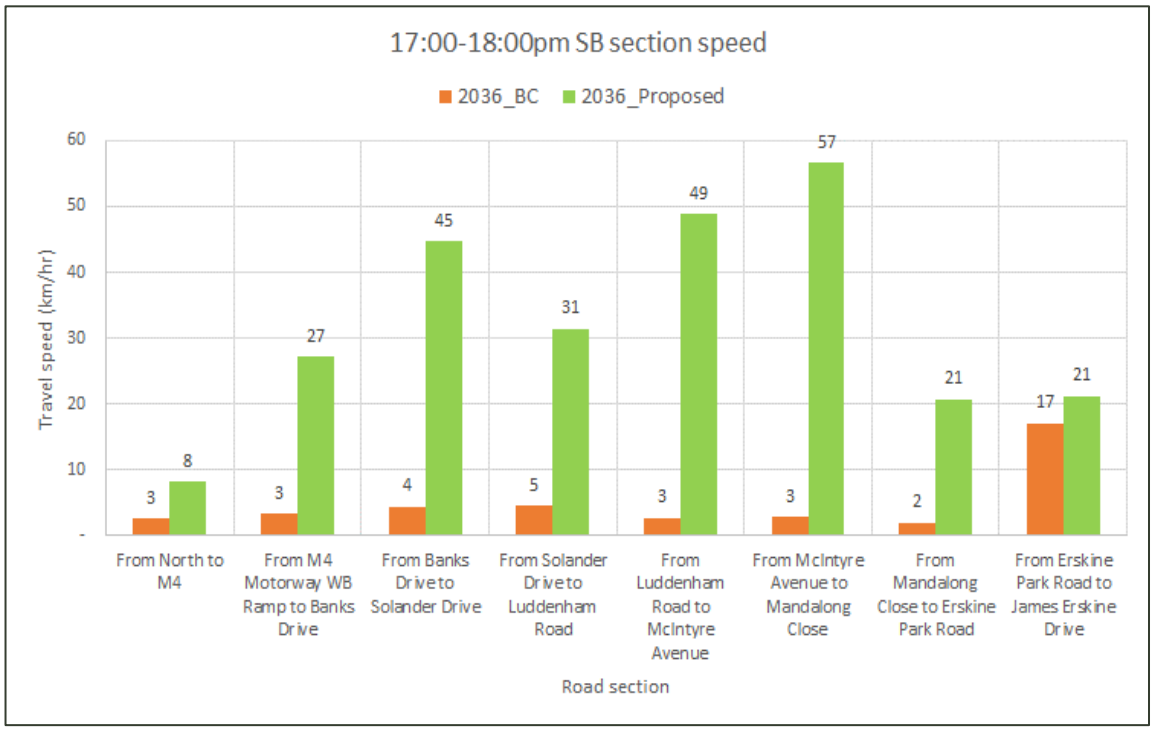


Figure 5-43: 2036 PM Peak 2nd hour Southbound section speed

Based on the above travel speed analyses, the following key points can be summarised:

- Proposed design provides faster travel speed for both directions during both AM and PM Peak under the modelled future year scenarios.
- Southbound travel speed shows significant improvements with operation of the proposal when compared to the future Base Case scenarios. For example, 2036 PM peak travel speed analyses for Mamre Road southbound shows under the Base Case conditions (without proposal scenario) the key sections for Mamre Road between Mandalong Close and M4 interchange would experience travel speeds between 2 and 4 km/hr. The same sections show travel speeds between 21 and 57 km/hr for the same peak period with operation of the proposal. This finding is consistent with travel time findings.
- The travel speed for most northbound sections is expected to be higher with operation of the proposal compared to the future base case. The only noticeable exception is observed between McIntyre Avenue to Luddenham Road. This section shows up to 24 km/hr higher travel speed under future Base Case scenario. This is mainly due to the uninterrupted through traffic at Luddenham Road intersection under the current priority intersection arrangements. During operation of the proposal, the introduction of the traffic signal control at the Luddenham Road intersection is expected to create stop-start conditions for northbound Mamre Road traffic movements. However, it is noted that the Luddenham Road intersection maintains acceptable intersection LOS (LOS D or better) in all future proposed design scenarios.

5.2.2 Impacts on Road Safety

The proposal is expected to result in the following impacts on road safety:

- The proposal would improve road safety by reducing opposing-lane overtaking of heavy vehicles and the associated risk of head-on crashes, due to the dual lanes in each direction and the divided carriageway with central median.
- Provision of a new separated shared user path for cyclists along the eastern side of Mamre Road may remove the risks associated with cycling on-road adjacent to general traffic.
- Provision of protected pedestrian crossings at the Luddenham Road and Solander Drive intersections is expected to reduce the number and severity of crashes involving pedestrians within the study area.
- The predicted reduction in congestion at key intersections along Mamre Road is expected to reduce the likelihood of vehicle crashes, especially rear-end type crashes under stop-start conditions.
- The reduction of delay time for turn movements to/from side roads and introduction of signalised traffic control is expected to reduce the potential for people to attempt unsafe turn manoeuvres to/from side roads and reduce crashes associated with turning vehicles.
- The introduction of traffic signals at the Luddenham Road and Solander Drive intersections may increase the number of rear end crashes at these locations due to vehicles slowing / coming to a stop on approach to the intersection.
- The change in sub-arterial, arterial and motorway vehicle kilometres travelled indicates that the proposal in conjunction with the M12 and M4 Smart motorway project would result in better access to higher order of road and in this case better access to the motorway network. In general, higher order of roads and particularly motorways are considered safer roads.

5.2.3 Impacts on Bus Services

The proposal would have minimal impact on existing bus routes and bus stops within the study area.

The two existing bus stops on Mamre Road near the Mamre House entrance would be replaced with the two new departure side bus stops at the Banks Drive intersection approximately 30 metres and 70 metres from the existing northbound and southbound bus stops respectively.

Future provision for bus priority lanes has been provided to allow buses to utilise the left turn lanes on approach to key intersections and bypass queued traffic in the through lanes. The current design allows for any vehicle to use this lane.

Buses would either:

- Stop at a red light in the left turn lane / short designated future bus priority lane
- Proceed through the intersection on a green signal directly into the indented departure-side bus bay.

The provision of a bus priority lane generally results in improved bus travel times due to the ability for buses to bypass queued general through traffic. This is also likely to result in an overall improvement to the traffic performance of intersections. The traffic control signals at Erskine Park Road, Solander Drive and Banks Drive do not currently allow for bus priority phasing and would have to be modified when the priority lanes are introduced, if required in the future.

The two existing kerbside bus stops on Erskine Park Road east of the intersection with Mamre Road would be relocated further away from the intersection to accommodate the upgrade works. The eastbound bus stop is relocated approximately 50 meters from its existing location with new shared path access providing safe and improved access facilities for commuters. The westbound bus stop is to be relocated away from the intersection approximately 45 meters to provide a more desirable exiting manoeuvre for bus services wishing to use the right turning lane to travel northbound on Mamre Road, noting the current location with the new proposal upgrade works would not be desirable. The relocated bus stops result in additional walking distance for commuters depending on where they are coming from, however provides a safer location for commuters, road users and bus services in their new locations.

5.2.4 Impacts on Freight Transport

Mamre Road and Erskine Park Road are TfNSW approved existing heavy vehicle routes for 19m B-double and 26m B-doubles. They are also part of the road network that accommodates 4.6-metre-high vehicles. These heavy vehicle routes connect the highway and motorway network and local industries in Erskine Park. The proposal is designed to be suitable for heavy vehicles, including B-Doubles at the Erskine Park Road intersection, 19-meter semi-trailer to Luddenham Road and turning movement provisions at the western stubs for Solander Drive and Banks Drive intersections.

As it was demonstrated in Sections 5.2.2 (Figure 5-27 to Figure 5-35), under Do Minimum (Base Case) conditions, significant congestion is likely to occur along Mamre Road. Under the Do Minimum scenario the travel speed along some key sections of Mamre Road may drop to 2 and 5 km/hr. In comparison, the scenarios with operation of the proposal show speeds between 19 and 57 km/hr for the same sections. Therefore, the proposal is expected to improve reliability and travel times for all vehicle classes including freight traffic travelling to and from the surrounding area via Mamre Road while also catering for the projected traffic volumes growth in the future. The proposal is expected to achieve this by providing additional traffic capacity and a higher standard of road. This would reduce vehicle operating costs for freight through a reduction in stop-start travel.

5.2.5 Impacts on Pedestrian and Cycling

The proposal includes provision of a three metre wide shared path on the eastern side of Mamre Road, as well as a shared path on the western side of Mamre Road from Erskine Park Road to Mandalong Close This would provide a safer alternative for pedestrians and cyclists compared to the existing high difficulty on-road cycle conditions and limited pedestrian paths on Mamre Road. This is

because the proposed shared user path would provide an off-road active transport corridor separated from vehicles, removing conflicts on-road and at crossing points. The introduction of the wide central median will prevent mid-block crossings; however, all intersections will provide crossing facilities. The proposed signalised intersections at Solander Drive and Luddenham Road would provide safe crossing facilities for both pedestrian and cyclists, compared to the lack of pedestrian crossing facilities at these existing priority-controlled intersections. Other intersections such as Erskine Park Road and Banks Drive would be upgraded to provide safe pedestrian signalised crossing facilities. In addition, 1.5-metre-wide footpaths between intersection pram ramps have been provided on the western side of Mamre Road to allow for improved pedestrian movements along Mamre Road and connection to the nearby bus stops.

Furthermore, the new shared path would provide connectivity to existing local routes and help connect major regional cycling facilities at The Northern Road, the M7 Motorway, Western Sydney Parklands and future M12 Motorway.

The shared path has been separated from the road in three key locations to improve the pedestrian and cyclist experience and allow for additional tree and planting cover and shading.

The proposal also includes space allocation for a future shared path along the western side of Mamre Road, where required.

5.2.6 Impacts on Property Access

In consultation with landowners, the proposal would remove direct access to Mamre Road for certain properties and provide an alternative access, where possible. This would include:

- Provision of revised access to the TransGrid tower north of Mandalong Close
- In consultation with Office of Strategic Lands, the existing driveway access to warehouse facility has been maintained south of Solander Drive.
- Relocation of the existing RFS driveway access to Old Luddenham Road, due to the widening on Luddenham Road. This new driveway would provide a safe entrance/exit to the facility removing conflict with the new dual left turn lanes of the proposal
- Revised access to Mamre House, where the main entrance would be removed from Mamre Road and relocated to the western leg of the Banks Drive intersection. A new two-lane driveway access would be provided from the Banks Drive intersection connecting to the internal driveway network. The existing secondary access to Mamre House, south of Banks Drive, would be reinstated on Mamre Road, with left in and left out only provisions.

All accesses on Mamre Road would be provided a left in and left out only arrangement, due to the new central median restricting right turn movements. The central median provides a divided carriageway resulting in improved road safety through separation. This would result in road users having to travel further to detour to make a U-turn. For residents and local businesses wishing to travel southbound, a U-turn could be carried out at Solander Drive western stub U-turn facility. For those travelling southbound wishing to turn into Mandalong Close, a detour via an existing roundabout on James Erskine Drive is required. Those wishing to use existing McIntyre Avenue and travel north would be expected to utilise the local network and connect to Banks Drive. For those travelling northbound wishing to turn right into McIntyre Avenue, they would be expected to utilise the Solander Drive western stub U-turn facility.

Additionally, provision of the western leg at the Banks Drive and Solander Drive intersections would provide improved access for potential parkland west of Mamre Road in the future.

The table below outlines the impacts to property accesses and the amended movements, where required.

Table 5-15: Property Accesses

Location	Description	Affected Property Access
Adjacent to Luddenham Road, joining Mamre Road (Old Luddenham Road), northbound	Direct access from Mamre Road to be removed. No alternative access to be provided. Existing access from Luddenham Road to remain.	1B/DP164099
Office of Strategic Lands north of Luddenham Road, northbound	Access to be removed. No alternative access to be provided.	2/DP529668
North of Solander Drive, northbound dual access: Office of Strategic Lands (Mamre House) Access to air quality monitoring station	Secondary Mamre House access amended to suit new road alignment. Additional access provided via Banks Drive stub. Access to the existing St Marys air quality monitoring station. New access has provided a like for like turning movement with the existing access (assumed 5.2 m passenger vehicle upon review of the existing turn path)	1/DP530579
Alternative access for RFS site at Luddenham Road	Access revised due to new arrangement at Luddenham Road and Mamre Road Intersection. Access will be via Old Luddenham via Luddenham Rd. Additional distance for access is approximately 140m.	23/DP1114968
Access to properties along Mandalong Close	Removal of the seagull interchange to a left-in left-out arrangement has impacted access to and from Mandalong Close. Individuals travelling southbound along Mamre Road would be required to use James Erskine Park roundabout to change direction to the northbound lane of Mamre Road. The additional travel distance required is approximately 1.5 km. Furthermore, individuals leaving Mandalong Close would be required to travel northbound to the U-turn stub facilities on either Banks Drive or Solander Drive to change direction on Mamre Road. The additional travel distance required is approximately 7 km.	201/1013539 202/1013539 203/1013539 204/1013539 205/1013539 206/1013539 207/1013539 208/1013539 209/1013539 210/1013539 211/1013539 212/1013539 213/1013539 214/1013539 215/1013539 216/1013539 90/752041
Access to properties along McIntyre Avenue	Removal of the T-Junction to a left-in left-out arrangement has impacted access to and from McIntyre Avenue. Individuals travelling northbound along Mamre Road would be required to use the U-turn stub facilities on either Banks Drive or Solander Drive to change direction on Mamre Road. Furthermore, individuals leaving McIntyre Close would be required to travel southbound to James Erskine Park roundabout to change direction to the northbound lane of Mamre Road. This additional distance travelled would be approximately 4 km. Alternatively, local streets can be used to change direction. Individuals may choose to use the local roads including Cook Parade or Blackwell Avenue to travel northbound from McIntyre Avenue.	Various

Diagrams below show the banned right turn movements from Mandalong Close and McIntyre Ave and proposed alternative routes.

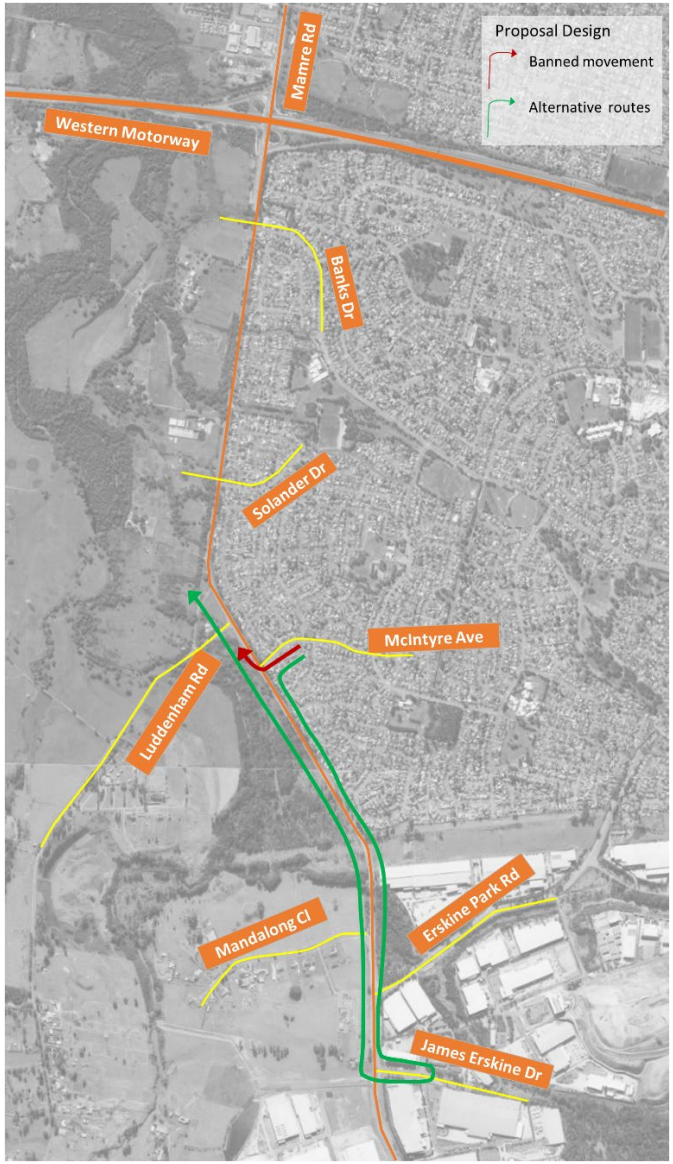


Figure 5-44: McIntyre Ave Right Turn Out banned movement and alternative route

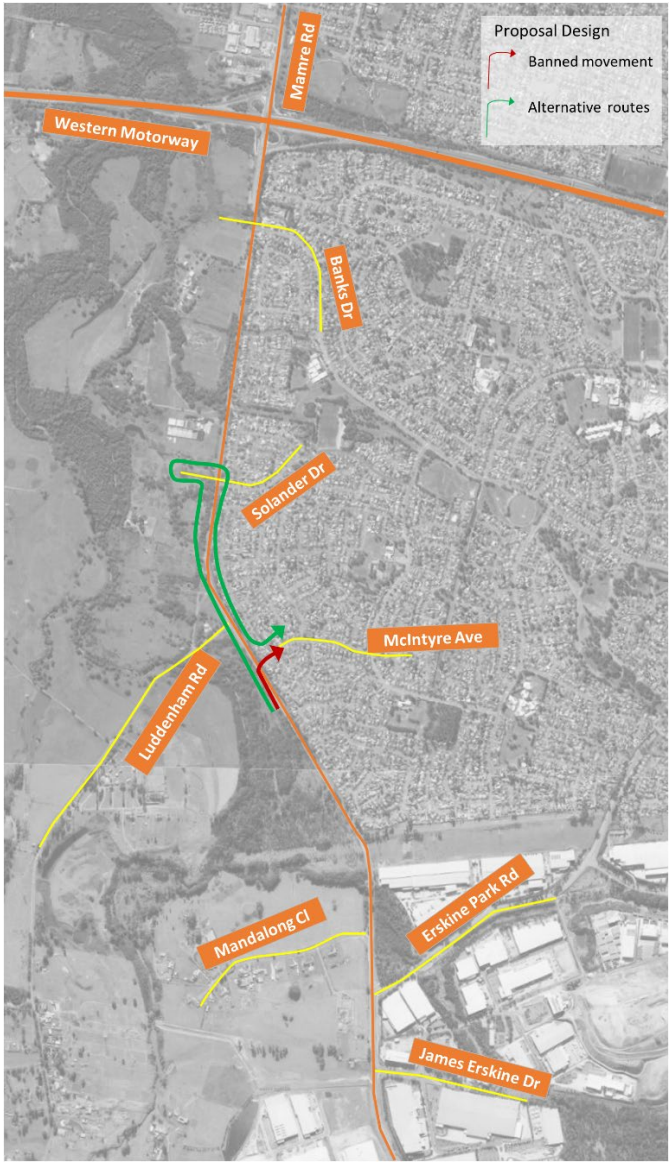


Figure 5-45: McIntyre Ave Right Turn In banned movement and alternative route

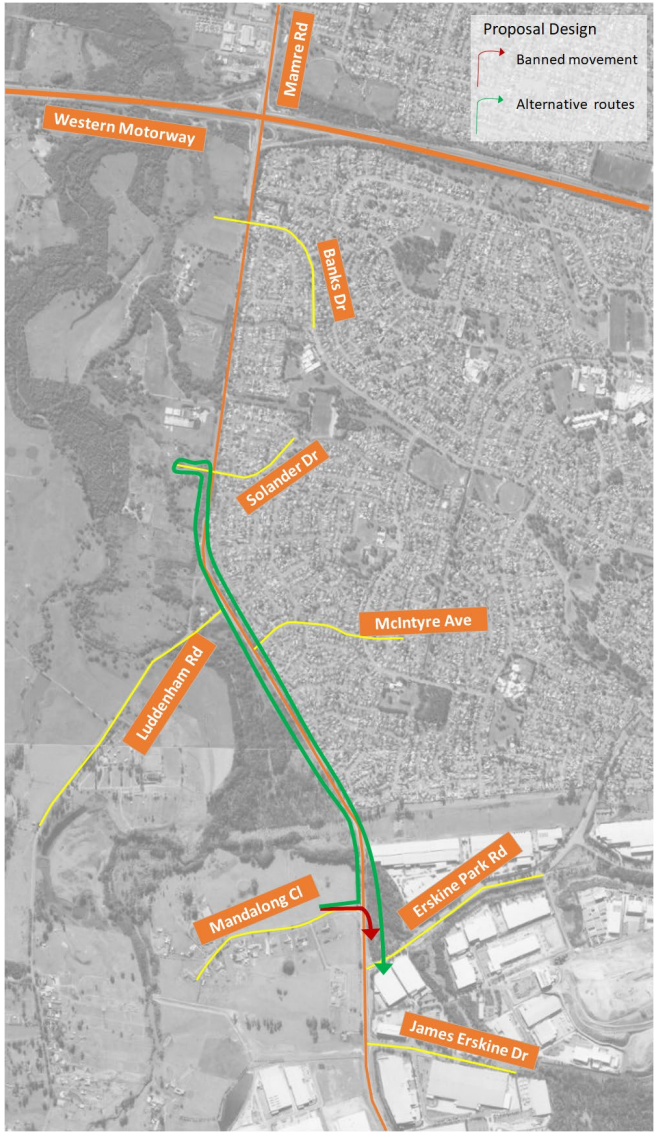


Figure 5-46: Mandalong Close Right Turn Out banned movement and alternative route

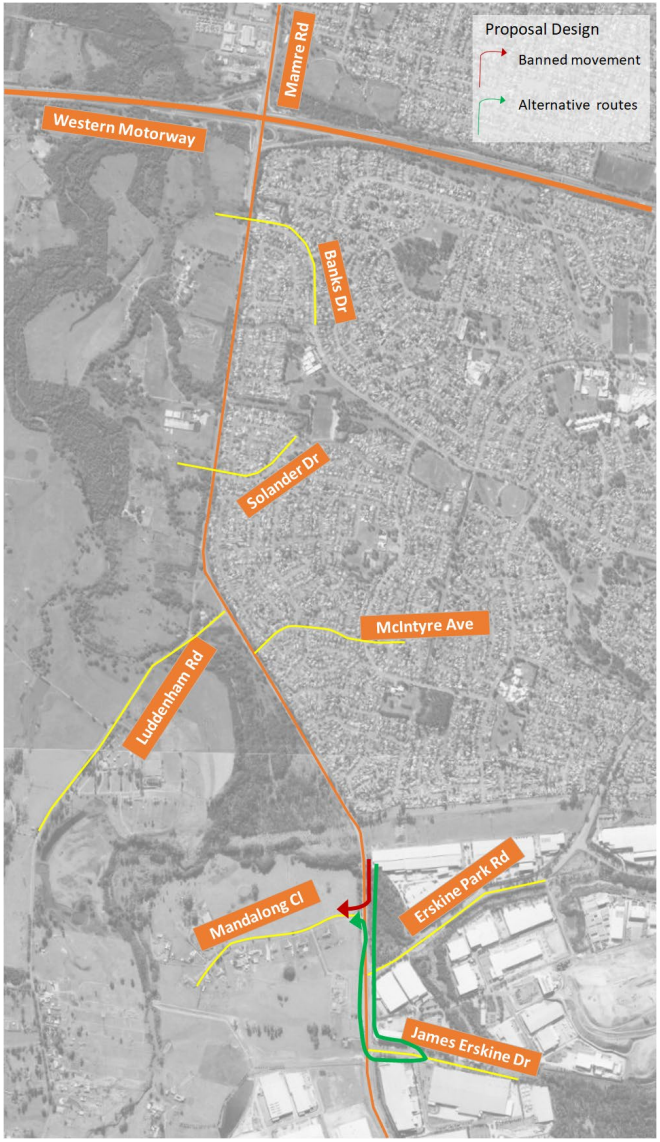


Figure 5-47: Mandalong Close Right Turn In banned movement and alternative route

5.2.7 Impacts on Parking

There is currently no parking permitted on Mamre Road. Parking along Mamre Road would continue to be prohibited during operation. This includes the use of the eastern side of Mamre Road as an informal parking area, as this area would become a shared path.

Localised on-street parking impacts during operation would include removal of some parking near signalised intersection on side streets close to the intersections to allow for the new intersection layout. This would occur at:

- The intersection of Mamre Road and Solander Drive. The existing parking on the eastbound and westbound (approximately six parking spaces) side of Solander Drive would be removed to provide space for the through traffic lane. This may impact parking spaces and also result in some minimal driveway adjustments for the property on the eastbound side up to Madison Circuit. The removal of these parking spaces would result in residents and visitors having to utilise alternative parking on Solander Drive. As there is sufficient alternative parking on Solander Drive and within residential and commercial land, parking impacts are likely to be minimal.
- The intersection of Mamre Road and McIntyre Avenue. The existing parking (approximately two parking spaces) on the eastbound side of McIntyre Avenue would be removed to provide space for the eastbound traffic through lane and accommodate the intersection works.

5.2.8 Impacts on Emergency Services

Emergency services access along Mamre Road would be maintained or improved. Additional lane capacity during operation of the proposal would result in improved travel time through the study area for emergency services. The proposal would improve congestion along Mamre Road, which would improve road safety, efficiency and access for emergency services when travelling on Mamre Road and when accessing local communities i.e. St Clair residential properties.

The proposal provides a divided carriageway for the length of the study area. In order to reduce impacts on emergency services for these changed conditions, at the local side streets, designated Emergency Vehicle Only access points would be provided within the central median to allow for U-turn movements.

5.3 Cumulative Impacts

The assessment of cumulative impacts considered other projects near Mamre Road that have sufficient scale, closeness and function to contribute to cumulative traffic and transport impacts with the proposal (refer to Table 5-16). This assessment excluded local residential developments or minor work on local roads that would not be of substantial scale to result in notable cumulative traffic impacts.

The cumulative operational traffic assessment in this section of the report was undertaken based on the latest land use information and traffic forecast models quantitatively. All the key projects have been accounted for in the traffic forecast assumptions for the future year traffic models. Therefore, the assessment of the proposal in this report has included the traffic growth and cumulative impact from the key projects in both local and larger area context, which has been presented in relevant sections of this report.

Based on the publicly available information cumulative construction impacts could not be assessed quantitatively, as the exact details of their construction methodology and staging were not publicly available at the time of undertaking this assessment For this reason, a worst-case qualitative assessment has be adopted whereby construction activities associated with nearby projects has been assumed to occur at the same time as construction of the proposal. This has allowed assessment of potential cumulative traffic impacts on the surrounding road network, including impacts on congestion, accessibility and potential road safety issues associated with additional heavy traffic on the road network.

The impacts of key projects and developments near the proposal area based on the publicly available information are outlined in Table 5-16.

Table 5-16: Past, present, and future projects cumulative impacts

Project	Construction impacts	Operational impacts
M12 Motorway • A new dual-carriageway motorway to connect the M7 Motorway with the Western Sydney Airport and The Northern Road, which would pass over Mamre Road. • Construction expected 2022 – 2025.	The construction of the M12 Motorway is estimated to result in 1,560 additional construction related heavy vehicle movements per day which may affect performance of surrounding road network. This may result in cumulative traffic impacts with the heavy vehicle movements generated by the proposal. This would include on Elizabeth Drive, which is proposed to be a haulage route for both the M12 Motorway and the proposal. Mamre Road and Luddenham Road are mentioned in the M12 EIS as roads that would be used to access the construction site for the M12 Motorway. As such, construction vehicles travelling to and from the M12 Motorway may be affected by any changed traffic conditions along Mamre Road and Luddenham Road associated with construction of the proposal at the same time. The M12 Motorway project also proposed temporary road closures to Elizabeth Drive, Luddenham Road and other main roads in the area. This may result in traffic delays for vehicles travelling to and from the proposal during construction.	Cumulative operational impacts may include: • Improved intersection performance along the Elizabeth Drive corridor between The Northern Road and Mamre Road • Removal of most of the operational traffic associated with the new Western Sydney Airport from the local road network, including Mamre Road via providing Motorway to Motorway connections and reducing traffic on lower order roads including Mamre Road • Removal / reduction of some “rat running” from local roads by providing better level of service and reduce delay on higher order of roads and encouraging more utilisation of higher order roads.
Sydney Metro Western Sydney Airport • Construction and operation of a new metro railway around 23 kilometres in length between the existing Sydney Trains suburban rail network at St Marys in the north and the Western Sydney Aerotropolis Core precinct in the south, via Western Sydney airport. • Construction expected 2021 – 2026.	The Sydney Metro Western Sydney Airport project proposes to use the M4 Motorway, Mamre Road, Luddenham Road and Elizabeth Drive as haulage routes, which are also proposed to be used during construction of the proposal. The construction of the Sydney Metro Western Sydney Airport is expected to result in an additional 2,044 construction related vehicle movements during peak hours on the surrounding road network. This may result in cumulative impacts with heavy vehicles generated by construction of the proposal. In particular, the Sydney Metro Western Sydney Airport construction would result in approximately 50 additional vehicle per hour per peak on Mamre Road. The traffic assessment results undertaken for Sydney Metro Western Sydney Airport project indicates that Mamre Road would perform with acceptable LOS (LOS D) with these additional vehicle movements. Construction vehicles travelling to and from the Sydney Metro Western Sydney Airport construction site may also be affected by any changed traffic conditions along Mamre Road or Luddenham Road associated with construction of the Mamre Road Upgrade Stage 1 at the same time.	The proposal may result in cumulative benefits with the Sydney Metro Western Sydney Airport project, by providing improved access to the planned Luddenham station through the upgraded Luddenham intersection, This may encourage a mode shift to metro and bus public transport, which may reduce traffic demand growth on the road network. Vehicles travelling to and from the planned Luddenham station proposed as part of the Sydney Metro – Western Sydney Airport development may also lead to increased traffic using the upgraded Luddenham Road intersection. The upgrade of Mamre Road would have no negative impact on existing rail services and bus services could interchange with the planned Sydney Metro Western Sydney Airport.

Project	Construction impacts	Operational impacts
Western Sydney Airport • Construction of Western Sydney airport to provide additional aviation capacity in Sydney. • At the time of writing, construction was in progress, due for completion in 2026.	The main haulage route for the Western Sydney Airport construction is proposed to be via Elizabeth Drive, with other major roads in western Sydney such as the M4 Motorway also proposed to be used. Construction of the Western Sydney Airport would generate an estimated 202,500 tonnes of vegetation and construction materials waste, some of which will be transported via the surrounding road network including Mamre Road. Overall, the Western Sydney Airport is expected to generate 1,254 additional vehicle movements per day on the surrounding road network during the construction period. In addition to the usual heavy vehicle construction traffic there may be occasional over-dimensional vehicles to carry large plant and equipment. This additional construction traffic may result in cumulative traffic impacts with construction of the proposal, which is likely to use similar roads and occur at the same time.	Cumulative operational impacts may include: • An additional 103,000 additional vehicle trips to and from the airport each day by 2063, some of which may travel via the upgraded Mamre Road. However, traffic modelling for the Western Sydney Airport indicates that it would result in less than 200 additional vehicles per peak hour by direction on Mamre Road and that Mamre Road would have no impacts due to the additional vehicles. • Improved road access to the Western Sydney Airport for vehicles that would travel via Mamre Road, due to the increased road capacity and reduced congestion. • occasional over-dimensional vehicles to carry large plant and equipment to serve the airport and associated aerospace industries. • Airport activities will generate traffic on a 24-hour, 7 day per week basis because the new airport can operate without a night-time curfew. The NSW Government proposes to establish rapid bus services from the metropolitan centres of Penrith, Liverpool and Campbelltown to the Western Sydney Aerotropolis before it opens (TfNSW, 2018). The service frequencies for these buses would be determined based on the demand for travel to the airport. Some of these buses that would offer direct services to and from Western Sydney Airport may use Mamre Road as part of access into and out of the airport site. The proposal is expected to have positive impact on bus travel time as it is expected to improve travel time and journey reliability along Mamre Road between Erskine Park Road and Banks Drive. It has also included provision for bus priority lanes, if required in the future.
Altis Warehouse and Logistics Hub • Altis Property Partners propose to construct and operate a warehouse and logistics hub in Orchard Hills. • Construction beginning in 2021.	Cumulative construction impacts may include: • Potential for increased construction traffic on local roads from construction of the proposal occurring at the same time as the Altis Warehouse and Logistics Hub • Limited capacity at the James Erskine Drive intersection during the construction of the western leg, which may affect construction vehicles travelling to and from the proposal and/or result in cumulative traffic delays • Cumulative changes in access at intersections along Mamre Road, which may affect traffic conditions in the area	Operation of the Altis Warehouse and Logistics Hub would result in increased traffic travelling along Mamre Road to access the facility on a 24-hour, 7 day per week basis for warehousing and distribution activities. Approximately 550 veh/hr for each peak period is estimated to access Altis Warehouse and Logistics Hub. This traffic generated has been included in the travel modelling for the proposal. The modelling shows that all key intersection including James Erskine Drive are expected to operate at acceptable intersection LOS (LOS C and D). Vehicles accessing the Altis Warehouse and Logistics Hub would benefit from the improved travel times associated with increased capacity and reduced congestion along Mamre Road during operation of the proposal.

Project	Construction impacts	Operational impacts
Upper South Creek Advanced Water Recycling Centre • Sydney Water is planning to build and operate a wastewater treatment plant in Western Sydney. • Construction expected 2022 – 2025.	Cumulative traffic impacts could occur from increased construction traffic on the surrounding road network, due to construction of the proposal and the Upper South Creek Advanced Water Recycling Centre happening at the same time. Construction of the proposal may also potentially affect access for construction vehicles requiring to access the construction site for the Upper South Creek Advanced Water Recycling Centre, if they are required to use Mamre Road.	Delivery of process input materials such as chemicals and filter media and transportation of operational waste (including beneficial re-use of biosolids) may require additional heavy vehicles and hazardous goods to travel along Mamre Road. These vehicles would benefit from the improved travel times associated with increased capacity and reduced congestion along Mamre Road during operation of the proposal.
Mamre Road Precinct • The Mamre Road Precinct is within the Western Sydney Employment Area and was rezoned in June 2020 • The Precinct provides about 850 hectares of industrial land which could accommodate about 5,200 construction jobs and 17,000 ongoing jobs when fully developed. • For the purposes of cumulative impact assessment, it is assumed that the construction within the Mamre Road Precinct could coincide with the construction of the proposal.	Cumulative traffic impacts could occur from increased construction traffic on the surrounding road network, should construction within the Mamre Road Precinct happen at the same time as the construction of the proposal. Construction of the proposal may also potentially affect access for construction vehicles requiring to access construction sites within the Mamre Road Precinct, if they are required to use Mamre Road.	It is anticipated that the Mamre Road Precinct would generate additional vehicles including heavy vehicles that would regularly be required to access the industrial sites and warehouses within the Precinct once operational. These vehicles would benefit from the improved travel times associated with increased capacity and reduced congestion along Mamre Road during operation of the proposal.
M4 Roper Road Westbound On-ramp Project • The proposal is to construct a single lane, westbound on-ramp from Erskine Park Road northbound and Roper Road southbound to the M4 Motorway in a G-loop configuration providing access to the M4 Motorway westbound mainline in St Clair and Erskine Park • Construction expected to be complete in 2022	The proposed construction vehicle route to the M4 Roper Road project site would be via M4 westbound lane, M4 westbound off-ramp, Erskine Park Road northbound slow lane and Roper Road southbound slow lane. It is anticipated that the construction of the Roper Road Westbound On-ramp project would increase construction vehicle movements on these roads, including Erskine Park Road and the southern section Mamre Road and would affect the performance of surrounding road network.	It is anticipated that the proposed M4 Roper Road Westbound On-ramp project along with operation of the proposal would improve vehicle movements on the surrounding road network and provide better accessibility and connectivity to the surrounding area, including Erskine Park and St Clair. It is also anticipated that upon completion of the proposal, traffic on the surrounding road network would be re-distributed. Currently traffic use Mamre Road/M4 Motorway interchange into St Clair Avenue and Banks Drive to access the area on the east side of Erskine Park Road. This traffic is anticipated to use the proposed Roper Road On-ramp to access the area. This project is anticipated to reduce some traffic on local road network adjacent to Mamre Road as well as on Mamre Road. Additionally, this project is anticipated to reduce the pressure on northbound right turn from Mamre Road into M4 westbound by providing alternative route to access M4 westbound for traffic generating from St Clair area. This right turn movement from Mamre Road has been identified as one of the critical movements affecting the performance of Banks Drive in the study area. M4 Roper Road Westbound On-ramp can potentially improve the traffic condition along Mamre Road and Banks Drive.

6 Management of impacts

Table 6-1 provides a summary of the mitigation measures and environmental safeguards that are recommended for the proposal based on the assessment of potential traffic and transport impacts.

Table 6-1: Proposed safeguards and mitigation measures for potential traffic and transport impacts

Impact	Environmental safeguard	Responsibility	Timing
Traffic and Transport	A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the *Roads and Maritime Traffic Control at Work Sites Manual* (RTA, 2010) *and QA Specification G10 Control of Traffic* (Roads and Maritime, 2008). The TMP will include: • Confirmation of haulage routes • Measures to maintain access to local roads and properties. • Construction traffic control plans outlining site specific traffic control measures (including signage) to manage and regulate traffic movement. • Measures to maintain pedestrian and cyclist access. • Requirements and methods to consult and inform the local community of impacts on the local road network. • Access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads. • A response plan for any construction traffic incident. • Consideration of other developments that 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.	Contractor	Detailed design/pre-construction
Construction site access	Construction site access will be designed and implemented in consideration of: • Road design guidelines and turning paths for heavy vehicles • Appropriate sight distances and deceleration/acceleration lanes (where required near highly trafficked areas) to allow traffic to safely enter and exit • Conspicuous temporary regulatory, warning and guide signs • Use of accredited traffic controllers, where appropriate and/or other controls to separate, slow down or temporarily stop traffic for safe entry/exit. • Minimising use of local roads, where practical • Minimising the size of heavy vehicles that would use local roads to access construction zones • Safe arrangements for pedestrians and/or cyclists.	Contractor	Detailed design/ construction

Impact	Environmental safeguard	Responsibility	Timing
Temporary traffic arrangement	The temporary traffic arrangement for Mamre Road will be designed to provide at a minimum, where feasible and reasonable: • Single through lane per direction • Maintain traffic movements at intersections • Lanes widths of at least 3.5m • 0.5m shoulder.	Contractor	Detailed design
Traffic impacts	Further traffic modelling will be carried out during detailed design following confirmation of the construction methodology and traffic staging to confirm the potential for traffic impacts and identify whether any additional mitigation measures or traffic control measures would be required.	Contractor	Detailed design
Impact on bus stops or routes	If any potential direct impacts on bus stops or routes during construction are identified, TfNSW will consult with the relevant bus operator/s to identify alternate arrangements.	TfNSW	Pre-construction
Damage to local roads	A Road Dilapidation Report will be prepared by a suitably qualified person for local roads proposed to be used by heavy vehicles, before the commencement of use of the roads during construction. Any damage to the local road network identified to be caused by construction vehicles for the proposal will be remediated rectified by the contractor to be similar to the existing road condition or compensation will be paid to the relevant road authority.	TfNSW / Contractor	Pre-construction / Construction
Impacts on cycling	During detailed design, a cyclist detour strategy would be prepared and implemented to minimise any temporary impacts on cycling during construction. Community consultation will be carried out to understand the travel patterns of cyclists and inform the cyclists of any alternate access arrangements.	TfNSW / Contractor	Detailed design / pre-construction / Construction
Temporary access changes	Detours during temporary access changes will be implemented with directional signage along alternate routes, including advice to pedestrians and cyclists of any path closures.	Contractor	Construction
Traffic management measures	Any temporary traffic diversions, clearways and road closures will be implemented in accordance with Transport Management Centre (TMC) requirements.	Contractor	Construction
Property access	Property access will be maintained where feasible and reasonable and property owners (including Erskine Park Rural Fire Service and Mamre House) will be consulted before starting any work that may temporarily restrict or control access.	Contractor	Construction
Local road or shared path closures	Council will be consulted with prior to any local road or shared path closures to identify suitable mitigation measures such as detour routes.	Contractor	Construction
Parking	Off-road parking for construction vehicles will be provided within the compound sites and construction areas.	Contractor	Construction

Impact	Environmental safeguard	Responsibility	Timing
Cumulative traffic impacts	TfNSW and the contractor will coordinate with the project team for nearby projects (including M12 Motorway, Sydney Metro Western Sydney Airport, Western Sydney Airport, Altis Warehouse and Logistics Hub and Upper South Creek Advanced Water Recycling Centre) and the Transport Management Centre with regard to the proposed timing of any road and lane closures and identify alternate routes or additional safeguards and management measures, as required. This will include consideration of the timing of construction activities, proposed haulage routes and site access locations.	TfNSW and Contractor	Pre-construction / Construction

7 Conclusion

TfNSW proposes to upgrade about 3.8 kilometres of Mamre Road between the M4 Motorway, St Clair and Erskine Park Road, Erskine Park to a four-lane divided road. The proposal would include changes to intersections with Mamre Road, a new shared path along the eastern side of Mamre Road, reinstatement of bus stops near Banks Drive and changes to property access to Mamre House, Erskine Park Rural Fire Service and other private properties.

Mamre Road is a key transport corridor, which provides connections to the Western Sydney Employment Area and the proposed Western Sydney Aerotropolis. The proposal is required to support future economic and residential growth in Western Sydney by increasing the capacity of Mamre Road and improving road safety and movement between the M4 Motorway and Erskine Park Road.

The objectives of this traffic and transport assessment report were to:

- Review the previous traffic and transport studies and investigations commissioned by TfNSW.
- Review historical traffic crash data
- Review existing traffic conditions during AM and PM Peak (commuter peaks) and develop, calibrate and verify base year simulation traffic models for the existing condition.
- Develop future year model without the road upgrades associated with the proposal ('do minimum').
- Develop future year model with the road upgrades associated with the proposal ('with proposal').
- Assess the impact of the proposed road upgrade on the traffic and transport performance during construction of the project.
- Assess the impact of the proposed road upgrade on the traffic and transport performance during post project opening and forecast traffic volumes for the years 2026 and 2036.

A review of the existing traffic conditions without the proposal shows the following key network constraints:

- The Banks Drive intersection showed a low intersection LOS during peak periods. This is mainly due to the high traffic volumes turning right onto Mamre Road competing with the high northbound/southbound traffic volumes on Mamre Road. Also, during AM Peak conditions the performance of this intersection is further limited by the northbound right turn queue that spills back from M4 interchange.
- The Luddenham Road and Solander Drive intersections show low LOS for right turn traffic from these intersections. This is mainly due to the high traffic density on Mamre Road and lack of available safe gaps for traffic to complete the turning manoeuvres.
- The Erskine Park Road intersection shows near acceptable intersection LOS with some near capacity conditions (LOS D). This intersection also shows occasional southbound queue build-ups, which occasionally extends beyond Solander Drive intersection.

Construction of the proposal is expected to start in 2022 and be completed in late 2025, subject to approval, funding and weather considerations. The construction activities are proposed to be completed in three stages as the following:

- Stage 0 – Mamre Road traffic would remain in the existing arrangement and most utility work would be completed
- Stage 1 - Mamre Road traffic would remain in the existing arrangement and the proposed northbound carriageway would be constructed offline behind safety barriers.
- Stage 2 - Mamre Road traffic would use the new northbound carriageway while the new proposed southbound carriageway would be constructed.

- Stage 3 - Mamre Road traffic would be configured to one lane in each direction using both the new northbound and southbound carriageways. The median lanes in both directions would be closed to allow safe working widths for final construction of the central median.

These construction activities would create short-term delays or increase travel time for motorists. The traffic analyses show that the construction activities are expected to reduce vehicle travel speed in the study area between 6 and 15 per cent and increase average delay per vehicle between 3 and 52 per cent when compared to the exiting conditions.

These short-term impacts would be minimised via:

- Preparation of construction traffic management plans
- Management and restriction of the site access times to be outside of the commuter peak periods for both construction site workers (scheduled start and finish of work shifts) and plant/equipment related heavy vehicles and machinery movements. construction vehicular traffic
- Obtaining approval from TMC and ROLs for any lane closures and traffic diversions

In order to assess the impact of the construction activities on the study and traffic network performance, the impact of each of the proposed construction stage was assessed in terms of the key traffic network performance indicators. In summary, the following are the key observation from the traffic modelling:

- Construction Stage 1 is expected to have minimal impact on overall network performance as well as local intersections due to minimal geometry change along Mamre Road corridor. Travel time and travel speed are expected to be comparable the 2020 base case conditions.
- Construction Stage 2 is expected to have similar performance as stage 1. However, during 2023 AM Peak, Banks Drive intersection is expected to experience slightly higher delay, while during 2023 PM Peak , Banks Drive intersection is expected to have slightly lower delay and better performance when compared to the existing traffic conditions.
- Construction Stage 3 is expected to show moderate increase in delay at Solander Drive intersection and Luddenham Road intersection during both 2023 AM and PM Peak. This is primarily due to the signalisation of the Solander Drive intersection (existing priority controlled). The signalisation of the Solander Drive intersection (with new western leg opening) together with the signalisation of Luddenham Road intersection is expected to introduce some additional delay and stops for traffic along Mamre Road in both directions. During Stage 3, the Banks Drive intersection is expected to have similar performance as those in the base case and Stage 2.

In order to assess the performance of the proposed road upgrade, future year traffic demands were estimated based on Sydney GMA Strategic Traffic Forecasting Model (STFM) outputs as updated based on the Travel Zone Projections 2019 (TZP19) and Strategic Travel Model (STM) 3.8 provided by TfNSW.

Upon initial analysis, it became apparent that providing adequate capacity at the M4 interchange plays a vital role in accommodating the forecast traffic growth and developing stable operation of Mamre Road and relevant traffic models. Following discussions with TfNSW, a set of “Partial Future Upgrades” assumptions were identified for the M4 interchange. These upgrades are outside of this proposal and are flagged as potential future upgrades and will be approved and delivered separately to this proposal. The set of upgrade assumptions included an upgrade to a section of Mamre Road south of the M4 Motorway to three lanes, which extends up to 120 metres south of Banks Drive. In this arrangement, north of M4 interchange assumed similar capacity as the existing conditions. This set also assumed provision of northbound dual right turn lanes from Mamre Road onto M4 ramp.

The “Base Case” also known as “Do Minimum Scenario” future year base model was developed to assess the future performance of the road network in study area without operation of the proposal (the no-build scenario). Analysis of the traffic models under the no-build scenario showed the traffic network would face severe congestion due to the following:

- The sections of Mamre Road that are one-lane in each direction are not able to accommodate the forecast traffic volumes at mid-block levels.

- The Luddenham Road intersection would fail to accommodate for the traffic growth on Luddenham Road particularly beyond the year 2036.
- Given the high traffic volume forecast and traffic density along Mamre Road, the existing issue of long delays for traffic leaving Solander Drive and Luddenham Road would continue to worsen.
- The performance of the Banks Drive intersection would degrade significantly
- Overall network speed decreases by over 40 per cent by the year 2026 and over 60 per cent by the year 2036
- Overall network delay increases by over 100 per cent by the year 2026 and over 400 per cent by the year 2036
- By the year 2036, over one quarter of the peak period demand is not accommodated in the traffic network and are registered as unrealised or unmet demand.

The “with proposal” scenario assumes the proposal is built. The “with proposal” performance demonstrated noticeable improvements relative to the base case results, particularly in regard to the LOS at intersections. The summary of the traffic performance during operation of the proposal is as follows:

- All intersections along Mamre Road between Banks Drive and Erskine Park Road show LOS C or better under 2026 forecast traffic volumes. The same intersections for the Base Case scenarios show high intersection delay and LOS F.
- All intersections along Mamre Road between Banks Drive and Erskine Park Road show LOS D or better under 2036 forecast traffic volumes. The same intersections for the same year and under Base Case scenarios show high intersection delay and LOS F
- Traffic modelling demonstrates that the provision of two lanes along Mamre Road provides adequate mid-block capacity for the 2026 and 2036 forecast traffic volumes. This is demonstrated in the travel time analyses whereby the year 2036 and under the Base Case scenario, travel speeds along key sections of Mamre Road may drop to 2 and 5 km/hr. Under the proposed road design, the same sections show improved travel speeds between 19 and 57 km/hr
- By the year 2036 and despite the overall traffic volumes growth by about 30 per cent, traffic analysis shows that the proposal would successfully mitigate the impact from the forecast traffic growth by maintaining intersection level service to LOS D or better and maintaining overall network performance similar to the existing conditions .

Additionally, traffic modelling and relevant analyses show that the performance of southern section of M4 and Mamre Road interchange would remain one of the key congestion points in the traffic network and will not be able to adequately cater for the traffic forecast volumes.

8 Reference Documents and Guidelines

- *M12 Motorway – Environmental Impact Statement, 2019, Roads and Maritime Services (TfNSW)*
- *Strategic Phase SIDRA Modelling Report - MAMRE ROAD UPGRADE draft*
- *Guide to Traffic Generating Developments – RMS 2013*
- *Western Sydney Airport – Environmental Impact Statement, 2016, Department of Infrastructure and Regional Development*
- *Sydney Metro – Western Sydney Airport – Environmental Impact Statement, 2020, Sydney Metro*
- *Interim Layout of Mamre Road / James Erskine Drive Intersection Sensitivity Analysis – 2019 – AsonGroup on behalf of Atlis*
- *Traffic Control at Work Sites Technical Manual – TfNSW, 2020*
- *AustRoads Guide to Road Design Part 3 - 2021*
- *AustRoads Guide to Road Design Part 6 - 2020*
- *AustRoads Guide to Road Design Part 6A - 2021*

Appendices

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Bringing ideas to life

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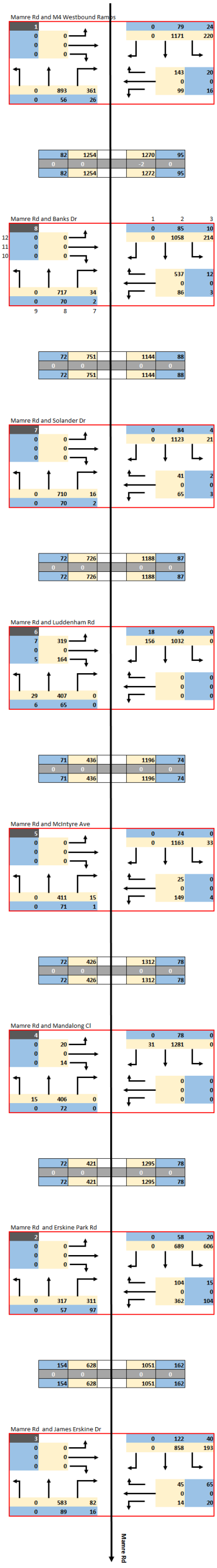
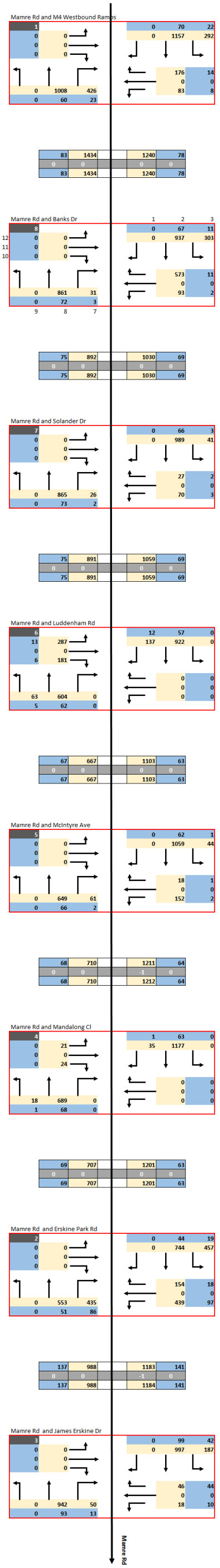
Appendix A
Intersection Flow Diagrams

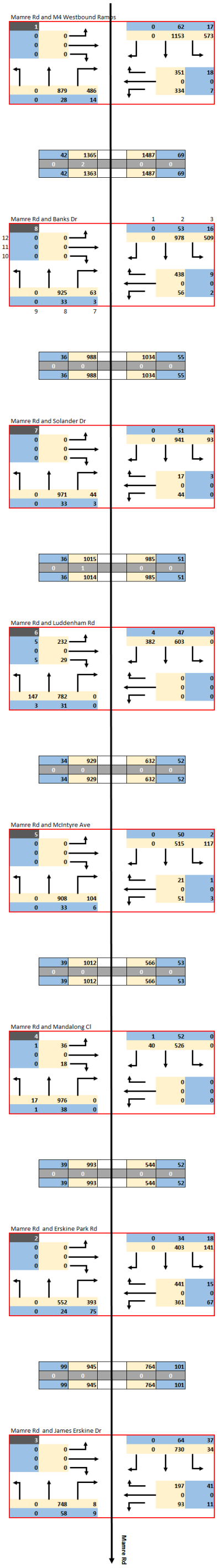
2020 AM Peak Stick Diagram (7-8am)



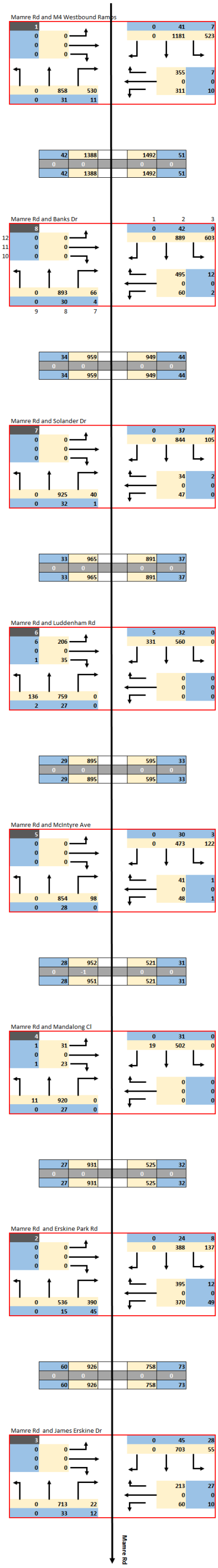
2020 AM Peak Stick Diagram (8-9am)



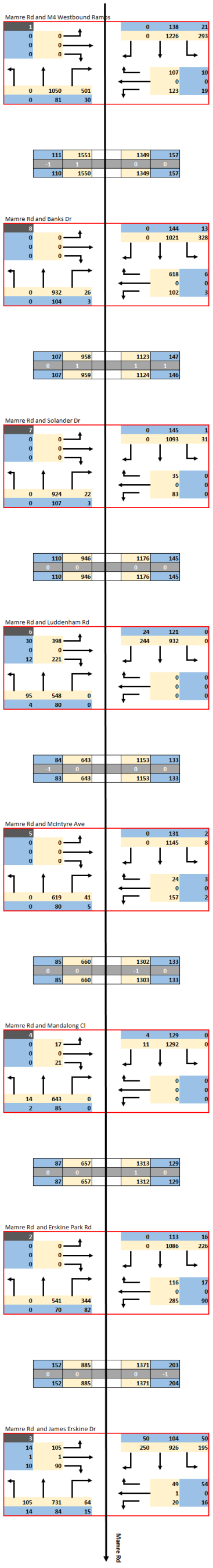
2020 PM Peak Stick Diagram (4-5pm)



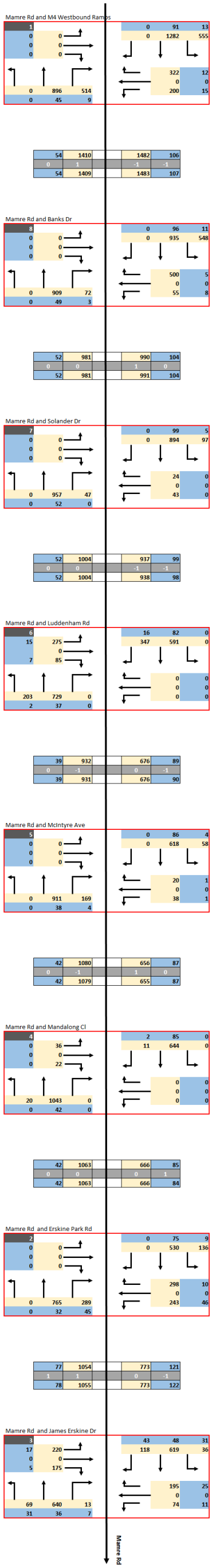
2020 PM Peak Stick Diagram (5-6pm)



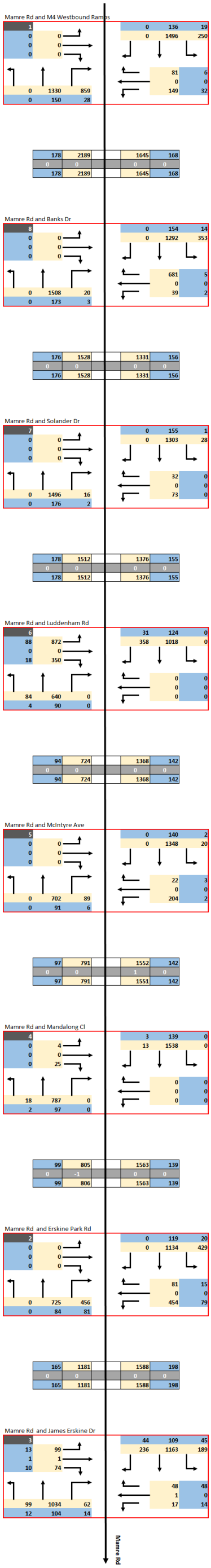
2026 BC AM Peak Stick Diagram (hourly average)



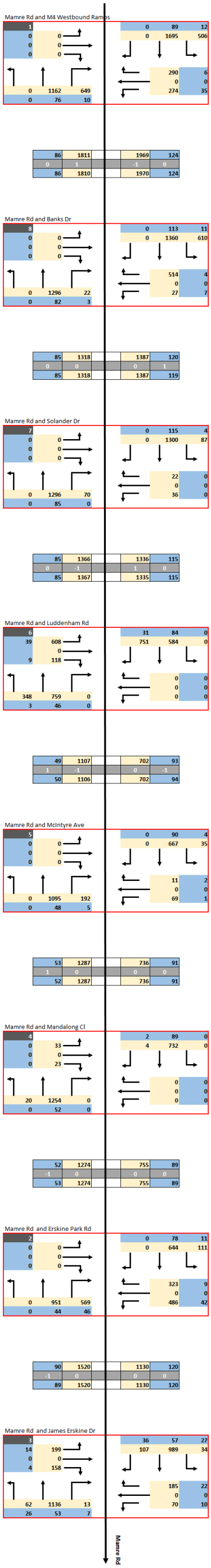
2026 BC PM Peak Stick Diagram (hourly average)



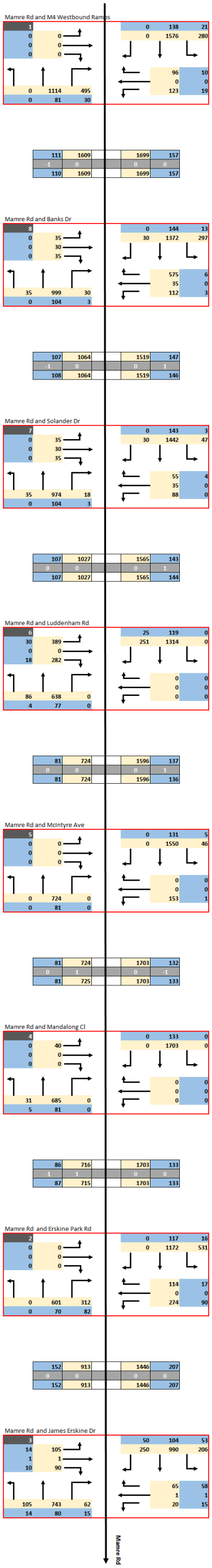
2036 BC AM Peak Stick Diagram (hourly average)



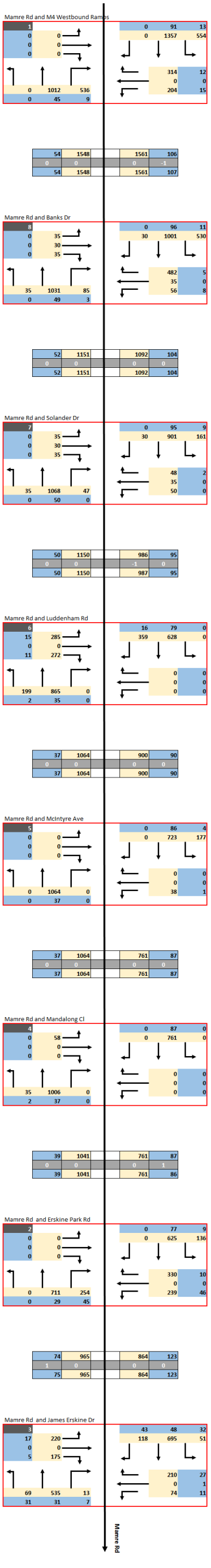
2036 BC PM Peak Stick Diagram (hourly average)



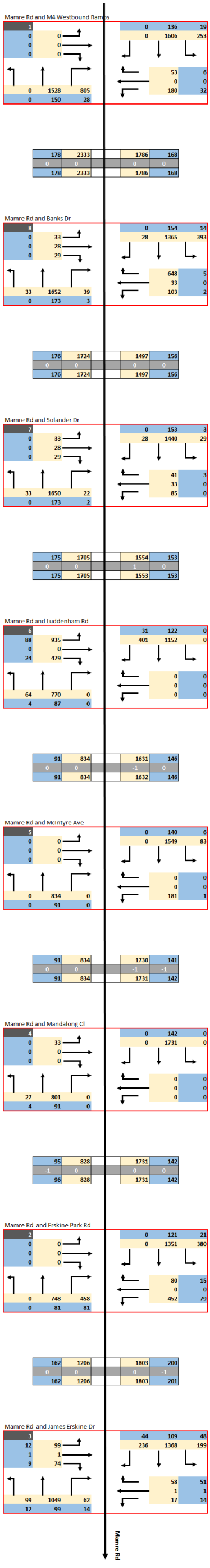
2026 Proposal AM Peak Stick Diagram (hourly average)



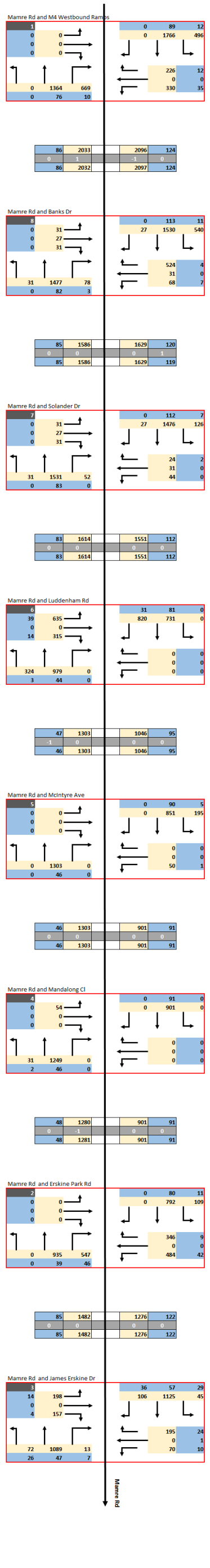
2026 Proposal PM Peak Stick Diagram (hourly average)



2036 Proposal AM Peak Stick Diagram (hourly average)



2036 Proposal PM Peak Stick Diagram (hourly average)



Appendix B

Mamre Road AIMSUN Base Model Calibration and Validation Technical Note

Mamre Road AIMSUN Base Model Calibration and Validation Technical Note

Scoping Paper No.		Date	**18 November 2020**
Title	**Mamre Road Upgrade Stage 1: Aimsun Model Calibration and Validation Technical Note**		
Reference	**509458**	Revision	**1**
Author	**Meysam Ahmadpour/ Michail Schwarz**	Reviewer	**Meysam Ahmadpour**

Introduction

Background

The NSW Government has started planning for a future upgrade of Mamre Road, between the M4 Motorway and Kerrs Road, to support economic and residential growth in this area. For the purpose of delivery, the upgrade has been split into two stages, Stage 1 between M4 Motorway and Erskine Park Road, and Stage 2 between Erskine Park and Kerrs Road.

Mamre Road is a key transport corridor passing through the Western Sydney Aerotropolis and the Greater Penrith to Eastern Creek Investigation Area, providing connections to the Western Sydney Employment Area. The Mamre Road upgrade is part of a plan to progressively upgrade arterial roads in Western Sydney to deliver a more efficient, reliable network that meets the future needs of the community and the economy. This includes the need to support Western Sydney Airport and the Western Sydney Aerotropolis.

Key Objectives

This Technical Note was prepared to discuss the development of a calibrated and validated Aimsun microsimulation model to inform Options development for Stage 1 of Mamre Road upgrades. The Aimsun model is to cover the length of the Mamre Road corridor between the M4 motorway and James Erskine Drive. This document covers the following key items:

- Input data
- Model extents and scope
- Modelling assumptions
- Calibration and validation results

Input data

Table 8-1 provides a summary of all input data used for the calibration and validation of the Aimsun model.

Table 8-1: Input Data Summary

Survey Type	Survey Location	Time Period	Survey Day(s)
Midblock Surveys	Mamre Road, between M4 Mwy & Banks Drive	24hrs	3/3/2020 to 9/3/2020
	Mamre Road, between Banks Drive & Solander Drive		
	Mamre Road, between Solander Drive & Luddenham Road		
	Mamre Road, between Luddenham Road & Erskine Park Road		
	Mamre Road, between Erskine Park Road & James Erskine Drive		
Intersection Surveys	Mamre Road & M4 Westbound Ramps	6:00-10:00am & 3:00-7:00pm	3/3/20 to 5/3/20
	Mamre Road & Banks Drive		
	Mamre Road & Solander Drive		
	Mamre Road & Luddenham Road		
	Mamre Road & McIntyre Ave		
	Mamre Road & Mandalong Close		
	Mamre Road & Erskine Park Road		
	Mamre Road & James Erskine Drive		
Travel Time Surveys	Mamre Road, between James Erskine Drive & Erskine Park Road	7:00-9:00am & 4:00-6:00pm	3/3/20 to 5/3/20
	Mamre Road, between Erskine Park Road & Mandalong Close		
	Mamre Road, between Mandalong Close & McIntyre Avenue		
	Mamre Road, between McIntyre Avenue & Luddenham Road		
	Mamre Road, between Luddenham Road & Solander Drive		
	Mamre Road, between Solander Drive & Banks Drive		
	Mamre Road, between Banks Drive & M4 Motorway WB Ramp		
TCS Signal Timing Data	TCS 3118 Mamre Road & M4 Westbound Ramps	24hr	3/3/20 to 5/3/20
	TCS 1175 Mamre Road & Banks Drive		
	TCS 4343 Mamre Road & Erskine Park Road		
	TCS 3909 Mamre Road & James Erskine Drive		

Model Assumptions

Software Version

Aimsun version 20 has been used for the purposes of base model development.

Model Scope

The Aimsun model has been coded with 8 intersections, and 11 traffic generating zones as shown in Figure 8-1. The model covers the section of Mamre Road between the M4 Motorway to the north, and James Erskine Drive to the south.

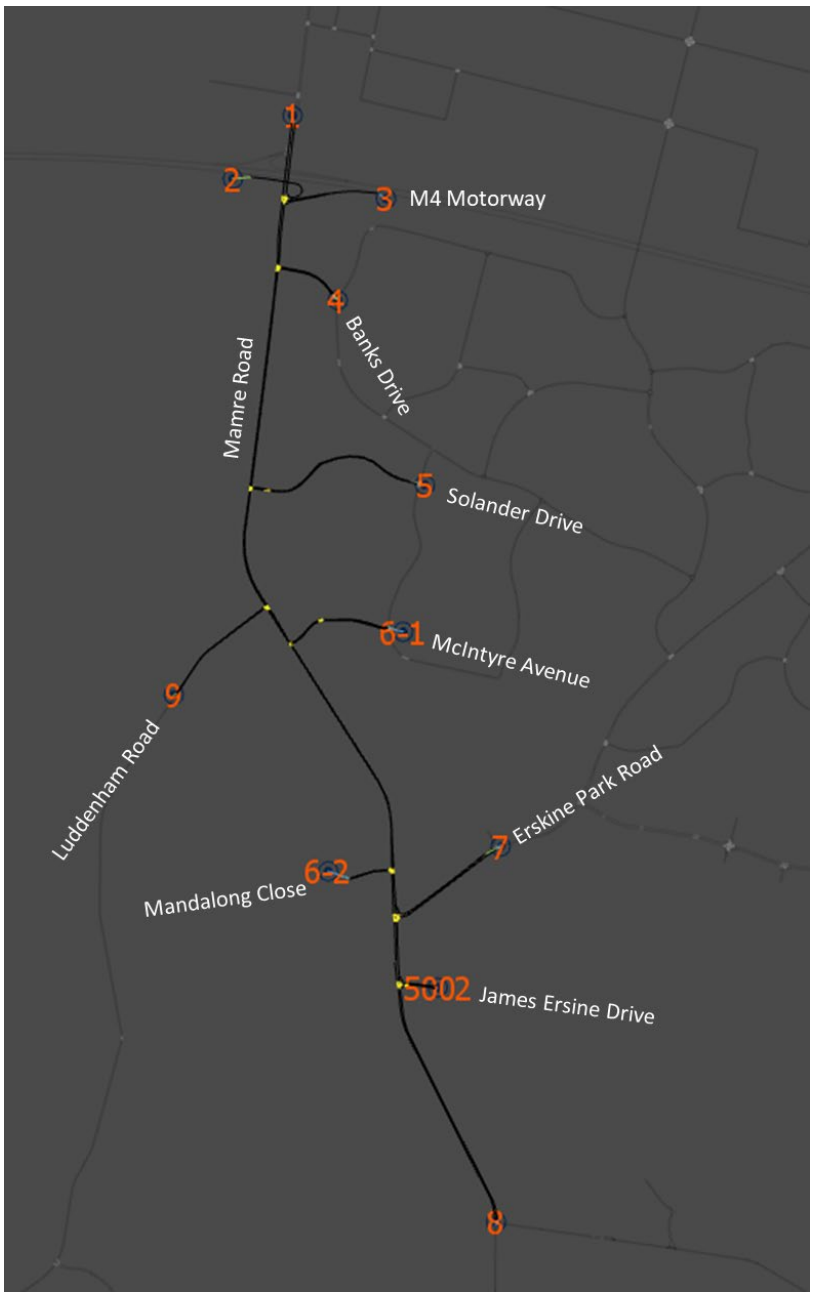


Figure 8-1: Modelled Road Network & Zone System

Modelled Time Periods

The modelling has been completed for one-hour peak periods (8:00-9:00am and 4:00-5:00pm). For the purposes of microsimulation modelling, the peak periods have been extended to cover two hours. Both peaks also include an additional 30-minute warmup period, to ensure realistic network saturation at the start of the analysis period. The following time periods have been selected for assessment:

- 6:30-9:00am (including 30min warmup)
- 3:30-6:00pm (including 30min warmup).

These time periods are both inclusive of the one-hour peaks used for the 20% design, and also align with the future demand matrices provided.

Assessment of the midblock surveys, for both the AM and PM 2-hour peak periods, is provided in Figure 8-2.

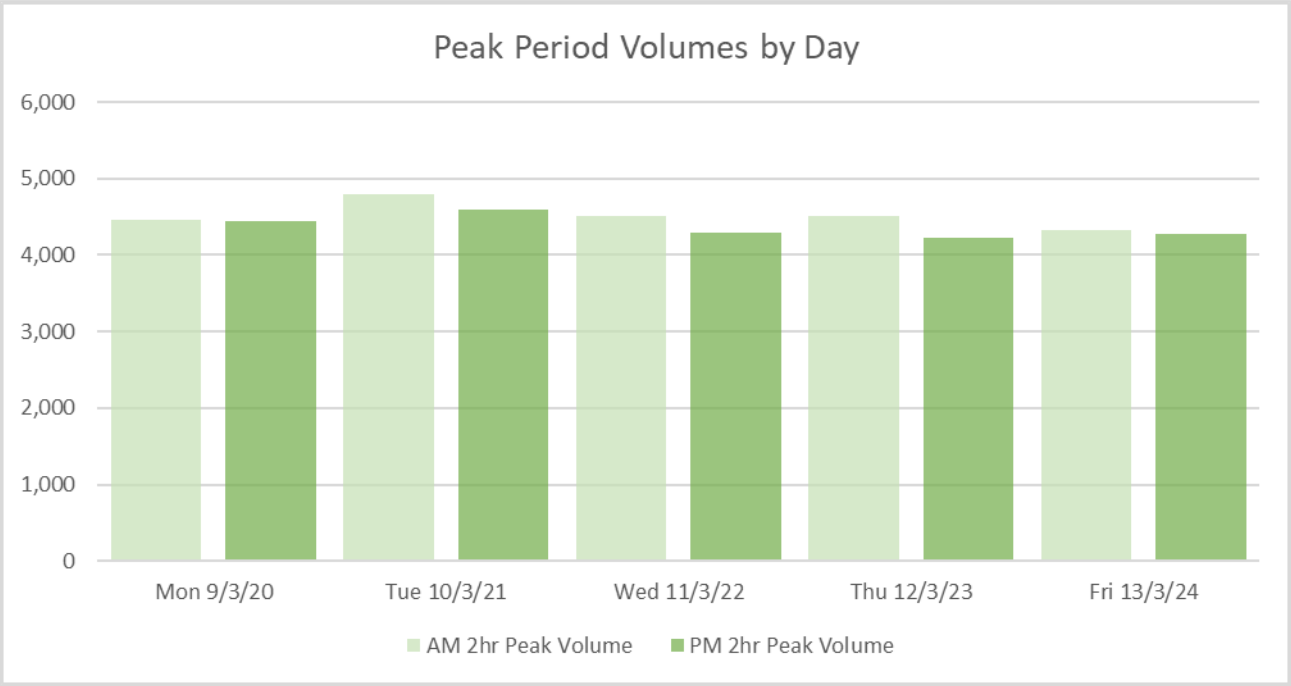


Figure 8-2: Peak Period Volume Fluctuation by Day

This assessment has shown relatively little fluctuation in corridor demand in either peak, across all surveyed weekdays. Intersection data from Wednesday the 11th March has been selected for the purpose of model calibration as this was found to be the median day for both the AM and PM Peak periods. This day also aligns with the previous SIDRA assessment undertaken as part of the 20% design.

Signal Phasing

SMEC analysed available SCATS signal data on 4th March 2020 for all signalised intersections within the network:

- Mamre Road/ M4 Westbound Ramps
- Mamre Road/ Banks Drive
- Mamre Road/ Erskine Park Road
- Mamre Road/ James Erskine Drive

All signals have been coded as fixed time, with phasing and timing consistent with the available SCATS data.

School Zones

No school zones were identified within the model boundary.

Modelled Demand

Modelled demand has been developed using outputs from the Sydney GMA Strategic Traffic Forecasting Model (STFM) updated for Land Use 2019 (LU 2019) to develop seed matrices. The seed matrices were adjusted using Aimsuns' static demand adjustment tool to produce a closer match to the survey data, with minor adjustments made to ensure all the calibration criteria could be met. The resulting 2-hour demand volumes are provided in Table 8-2.

Table 8-2 Total Model Demand

Time Period	Light Vehicles	Heavy Vehicles
7:00-9:00am	9,210	973
4:00-6:00pm	10,387	600

Total demand matrices were then profiled across 15-minute intervals, as per the profile observed in the survey data. Figure 8-3 and Figure 8-4 show the final demand profile, as well as the heavy vehicle percentages for each interval, for the AM and PM Peak s respectively.

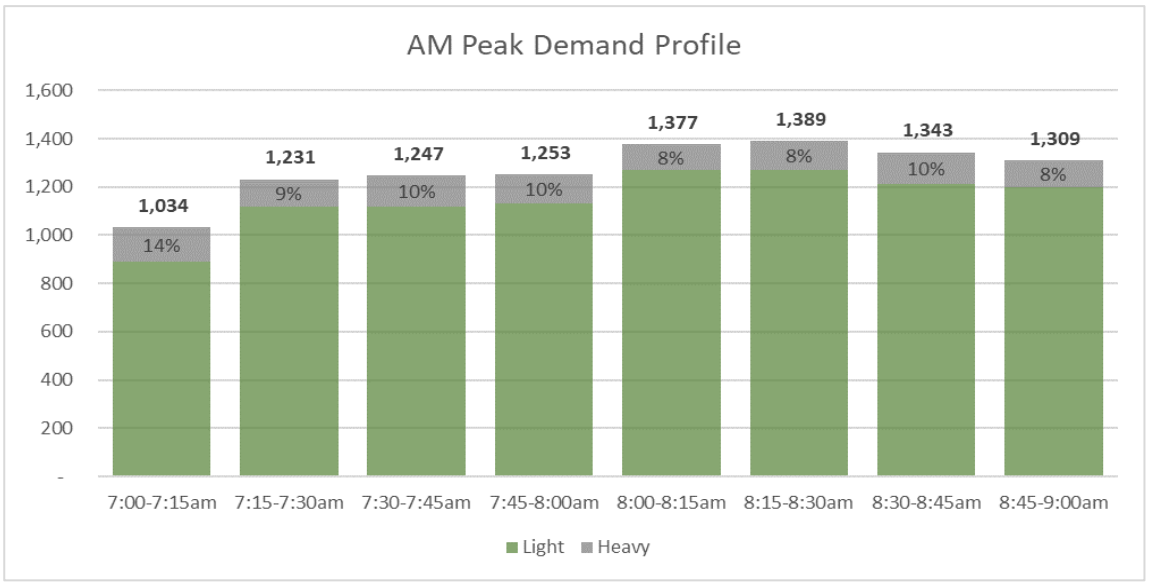


Figure 8-3: AM Peak Demand Profile

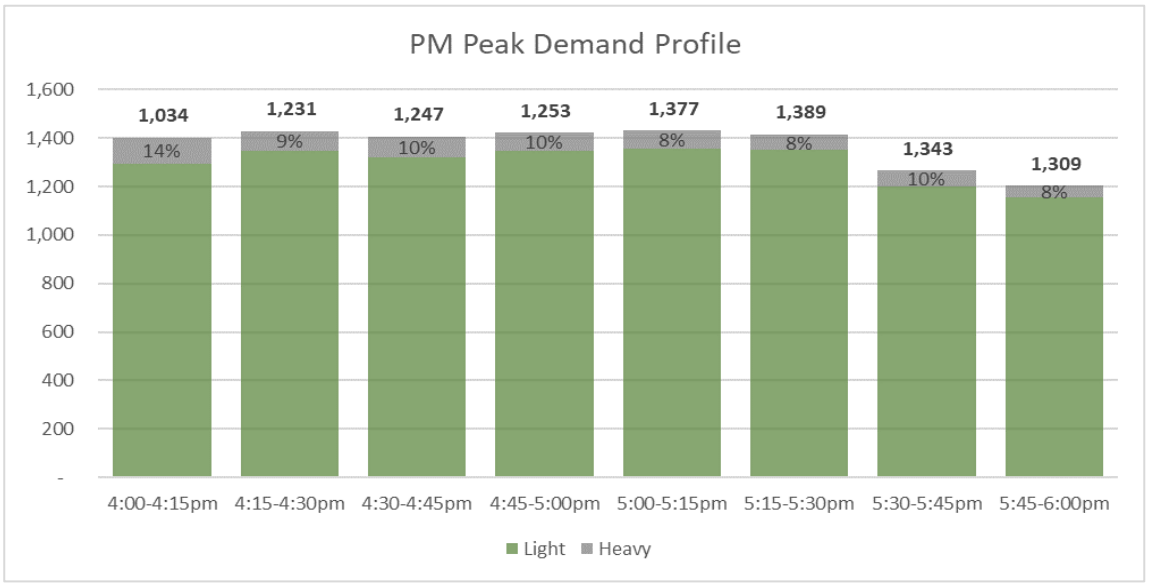


Figure 8-4: PM Peak Demand Profile

Public Transport

Three public transport lines were identified to traverse the corridor. These services were coded into the Aimsun model using the latest publicly available timetables. A summary of service frequency, by direction, in each peak, is provided in Table 8-3.

Table 8-3: Public Transport Service Summary

Service #	AM		PM	
	Northbound	Southbound	Northbound	Southbound
775	4	3	4	4
776	4	5	4	3
779	0	2	3	0
Total Number of Services:	18		18	

Figure 8-5 shows how each line traverses the modelled network.

Figure 8-5: Bus Routes

Calibration and Validation Targets

The Mamre Road Base model has been calibrated using available turn counts and travel time data, as per the *RMS Traffic Modelling Guidelines* (2013). Due to the size and scope of the model, all modelled intersections have been included as the model's core area and are hence calibrated to more stringent criteria. A summary of the calibration and validation criteria is provided in Table 8-4.

Table 8-4: Calibration and Validation targets

Topic	Criteria	RMS calibration and validation targets
Turns calibration	GEH < 5	85%
	GEH ≤ 10	100%
	GEH > 10	Requires explanation in reporting
	R^2	> 0.9
	Slope	Slope equation to be provided
Core Area Calibration	Flow < 99	To be within 10 vehicles of the observed value
	100 < Flow < 999	To be within 10% of the observed value
	1000 < Flow < 1999	To be within 100 vehicles of the observed value
	Flow > 2000	To be within 5% of the observed value
Travel Time Validation	Journey time average	Average modelled journey time to be within 15% or one minute (whichever is greater) of average observed journey time for full length of route. Each route should be cumulatively graphed by section.
	Section time average	Average modelled journey time to be within 15% of average observed journey time for individual sections.

Model Calibration and Validation

Model Stability

In accordance with the RMS Traffic Modelling Guidelines (2013), both the AM and PM Peak models have been run using 5 different seed values, listed below:

- 28
- 560
- 2849
- 7771
- 86524

Modelled Total Vehicle Kilometres Travelled (VKT) and Total Vehicle Hours Travelled (VHT) across all 5 seeds are provided in Figure 8-6 and Figure 8-7, for the AM and PM Peak models respectively. Both models show relatively good stability, with no major fluctuations for either metric across the various seed runs. Seed numbers 2849 and 28 have been identified as the median seed for the AM and PM Peak s respectively. Due to the high number of turn flows less than 100 vehicles per hour, required to be within 10 vehicles of the surveyed value to meet core area calibration criteria, further model calibration and validation has been performed using the median result from five seeds, as turn flows do show some minor fluctuations between different seed runs.

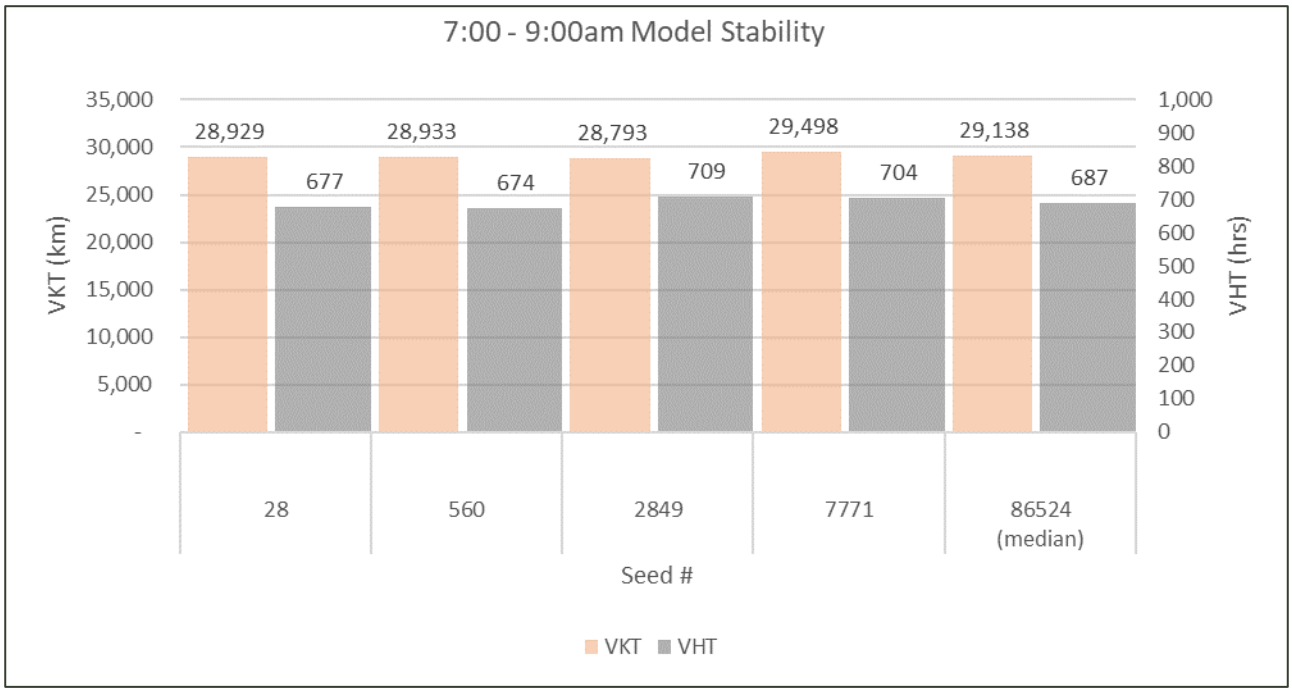


Figure 8-6: Modelled VKT & VHT, by Seed, AM Peak

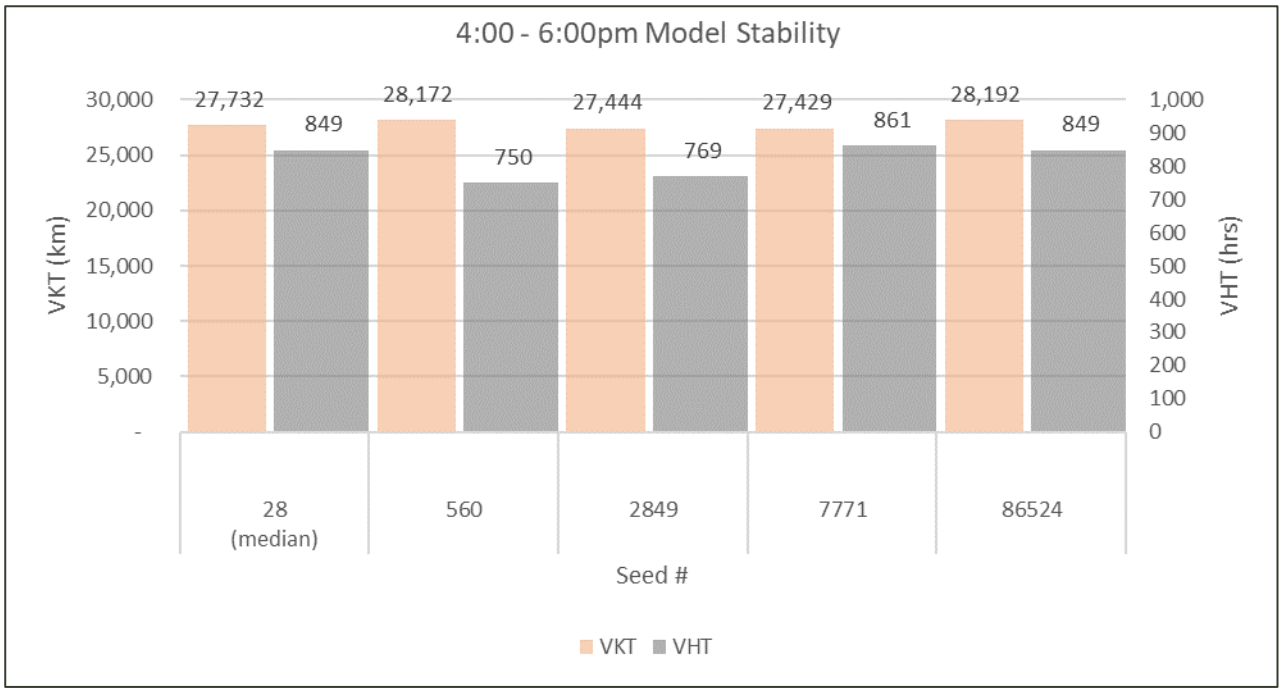


Figure 8-7: Modelled VKT & VHT, by Seed, PM Peak

Calibration Results

Table 8-5 provides a summary of the calibration results achieved by both the AM PM Peak models. These results show that the models have been sufficiently calibrated, with all turns recording a GEH of 5 or better. Slope values for each time period and vehicle type range between 0.97 and 1.04 showing that there was no systematic over or underestimation of corridor demand. R^2 values ranged between 0.96 and 1, also indicating good correlation between modelled and observed demand flows. Figure 8-8 to Figure 8-11 show modelled turn flows plotted against their corresponding observed values for both light and heavy vehicles, across all modelled one hour time periods.

Table 8-5: Median Seed Calibration Results, by Vehicle Type

Vehicle Type	Measure	AM Peak		PM Peak	
		7:00am - 8:00am	8:00am - 9:00am	4:00pm - 5:00pm	5:00pm - 6:00pm
Light Vehicles	GEH < 5	48/48 (100%)	48/48 (100%)	48/48 (100%)	48/48 (100%)
	GEH ≤ 10	48/48 (100%)	48/48 (100%)	48/48 (100%)	48/48 (100%)
	R^2	1.00	1.00	1.00	1.00
	Slope	0.98	1.01	1.01	0.97
Heavy Vehicles	GEH < 5	48/48 (100%)	48/48 (100%)	48/48 (100%)	48/48 (100%)
	GEH ≤ 10	48/48 (100%)	48/48 (100%)	48/48 (100%)	48/48 (100%)
	R^2	0.99	0.99	0.96	0.96
	Slope	1.04	1.00	1.00	1.04

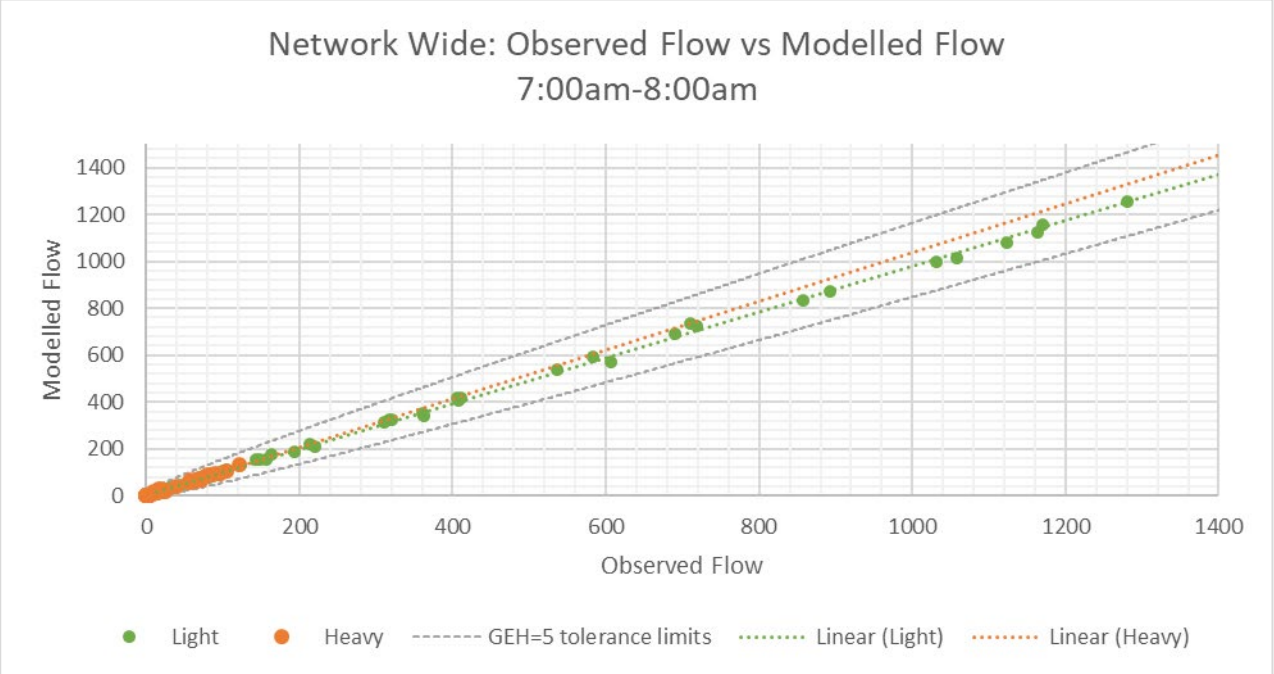


Figure 8-8: Modelled vs Observed Turn Flows, 7:00-8:00am

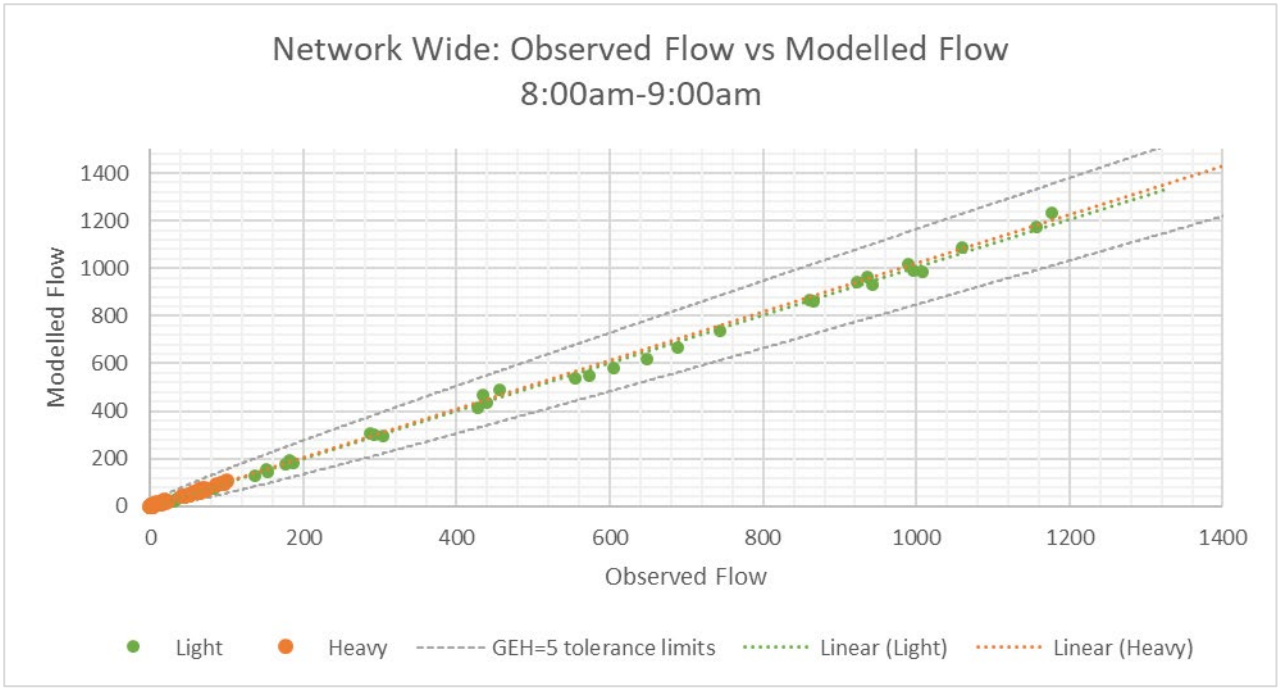


Figure 8-9: Modelled vs Observed Turn Flows, 8:00-9:00am

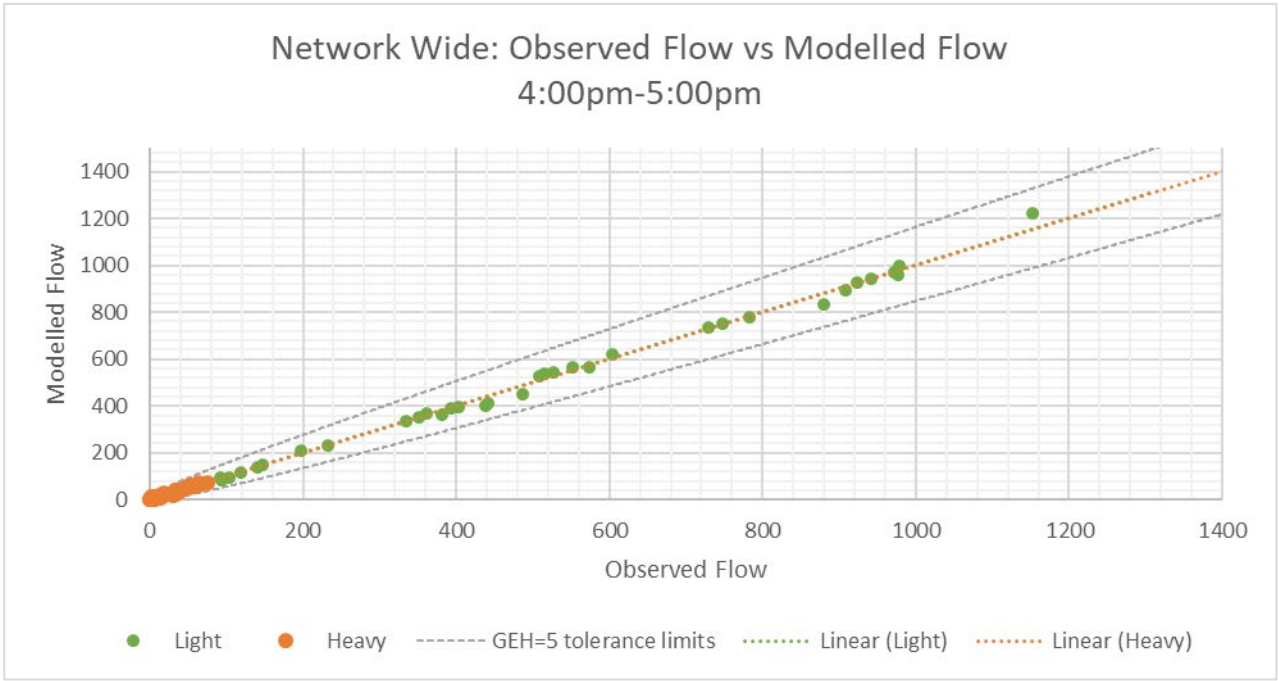


Figure 8-10: Modelled vs Observed Turn Flows, 4:00-5:00pm

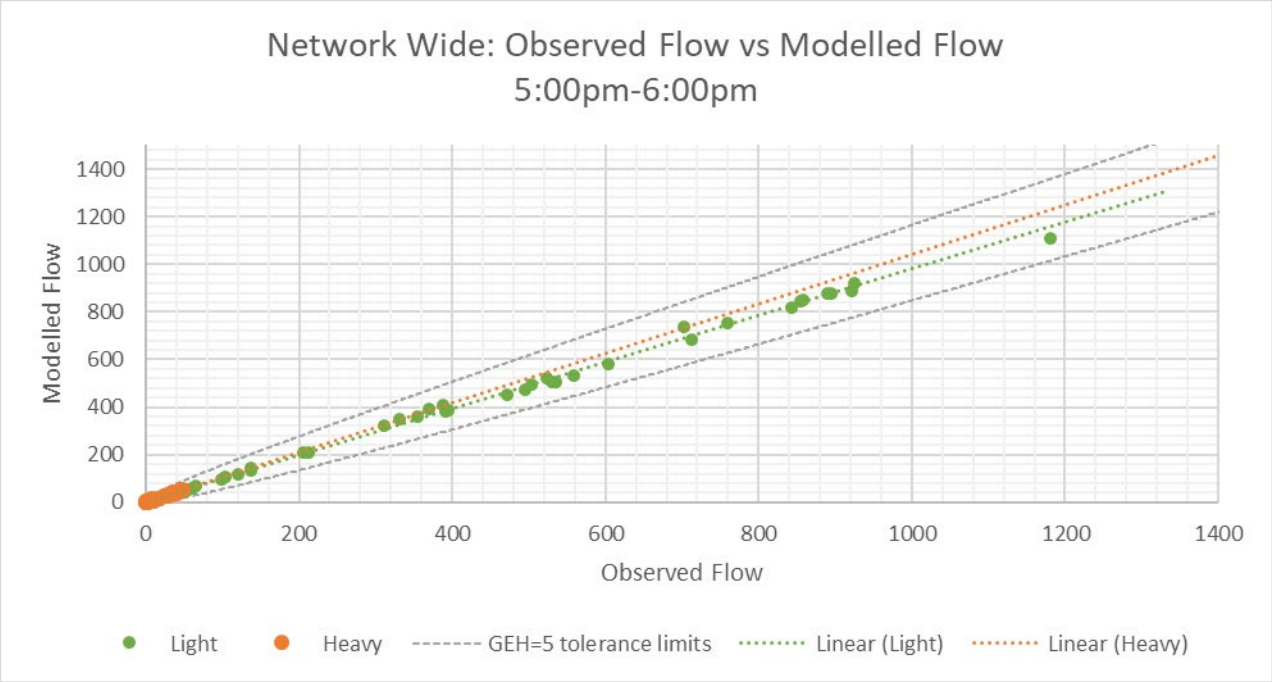


Figure 8-11: Modelled vs Observed Turn Flows, 5:00-6:00pm

Table 8-6 shows a summary of the core area calibration results achieved by both models. All core area criteria set out in this document have been achieved indicating a strong correlation between modelled and observed turn flows.

Table 8-6: Median Seed Core Area Calibration Results, by Vehicle Type

Vehicle Type	Measure	AM Peak		PM Peak	
		7:00am - 8:00am	8:00am - 9:00am	4:00pm - 5:00pm	5:00pm - 6:00pm
Light Vehicles	<100	18/18 (100%)	18/18 (100%)	16/16 (100%)	16/16 (100%)
	100-999	24/24 (100%)	26/26 (100%)	31/31 (100%)	31/31 (100%)
	1000-1999	6/6 (100%)	4/4 (100%)	1/1 (100%)	1/1 (100%)
	>2000	0/0 (100%)	0/0 (100%)	0/0 (100%)	0/0 (100%)
Heavy Vehicles	<100	46/46 (100%)	47/47 (100%)	48/48 (100%)	48/48 (100%)
	100-999	2/2 (100%)	1/1 (100%)	0/0 (100%)	0/0 (100%)
	1000-1999	0/0 (100%)	0/0 (100%)	0/0 (100%)	0/0 (100%)
	>2000	0/0 (100%)	0/0 (100%)	0/0 (100%)	0/0 (100%)

Validation Results

A comparison of the modelled and observed travel time on the Mamre Road Corridor is provided in Table 8-7. Travel times were recorded in both the northbound and southbound directions on Mamre Road, between James Erskine Drive to the south, and the M4 Motorway westbound ramps to the north. To remain consistent with the calibration assessment, modelled travel times presented are derived from the median result for each section, across 5 seed runs.

Table 8-7: Travel time Validation Results Summary

Route	Time Period	Survey Average	Modelled Median Result	Within 15% of Survey	Within Survey Min/Max
Mamre Road Northbound	7:00am - 8:00am	03:31	03:56	Yes	Yes
	8:00am - 9:00am	04:18	05:00	Yes	Yes
	4:00pm - 5:00pm	04:14	04:45	Yes	Yes
	5:00pm - 6:00pm	07:18	07:03	Yes	Yes
Mamre Road Southbound	7:00am - 8:00am	04:23	04:35	Yes	Yes
	8:00am - 9:00am	04:55	05:13	Yes	Yes
	4:00pm - 5:00pm	03:53	04:31	Yes	Yes
	5:00pm - 6:00pm	05:19	04:38	Yes	Yes

Modelled route travel times fall within 15% of the surveyed value in both directions, for all modelled time periods, meeting the validation target set out in Section 0 of this document.

Figure 8-12 to Figure 8-19 show a cumulative journey time comparison between the modelled and observed values in either direction, for all modelled time periods. Generally modelled journey times in the southbound direction are comparable to the surveyed value. In the northbound direction however, modelled are faster than what was observed in the survey data. Site observations have shown that, in both the AM and PM Peak periods, that a key driving factor in northbound congestion on the corridor is the high demand on the northbound right turn at the intersection of Mamre Road and the M4 motorway westbound ramps. The demand for this movement was observed to consistently exceed the available turn bay capacity, overflowing into adjacent lanes, and limiting the throughput of the northbound through movement. This in turn resulted in rolling queues impacting upstream intersections. This turn bay overflow was observed to also occur in the Aimsun model, however microsimulation modelling of highly oversaturated environments can lead to instability in model outputs, making it difficult to match the validation criteria as closely, while still meeting the turn counts calibration requirements.

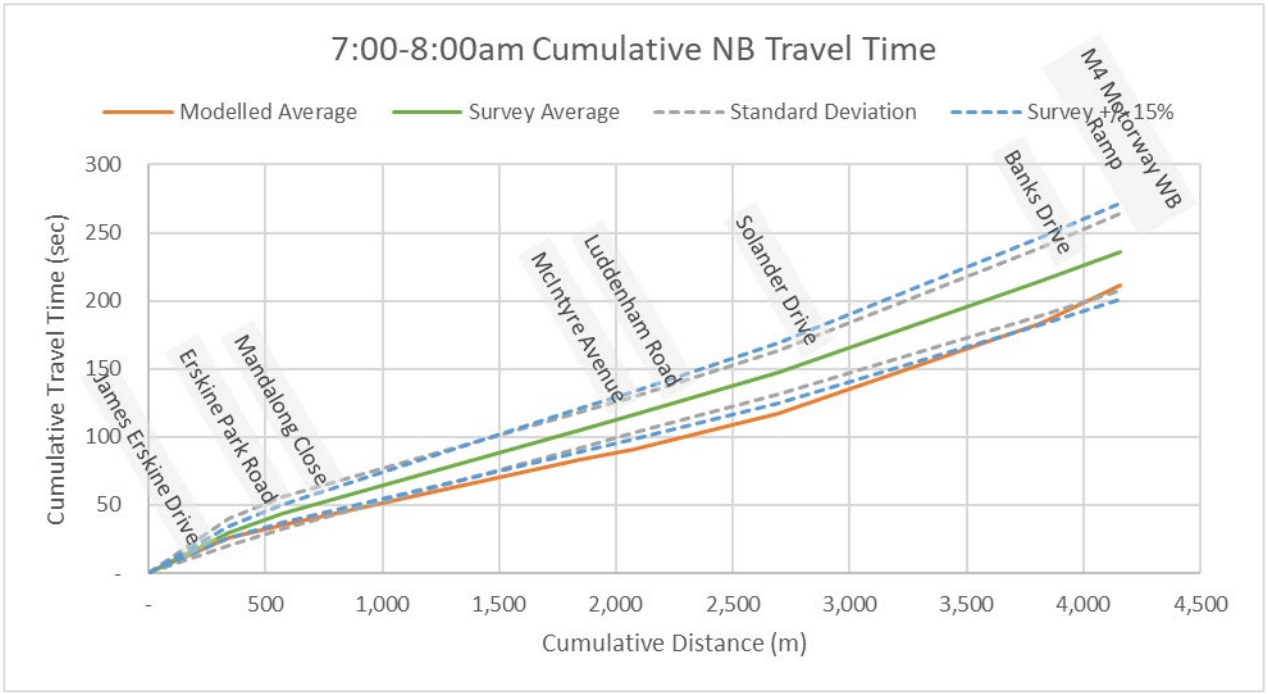


Figure 8-12: Mamre Road, Cumulative Northbound Travel Time, 7:00-8:00am

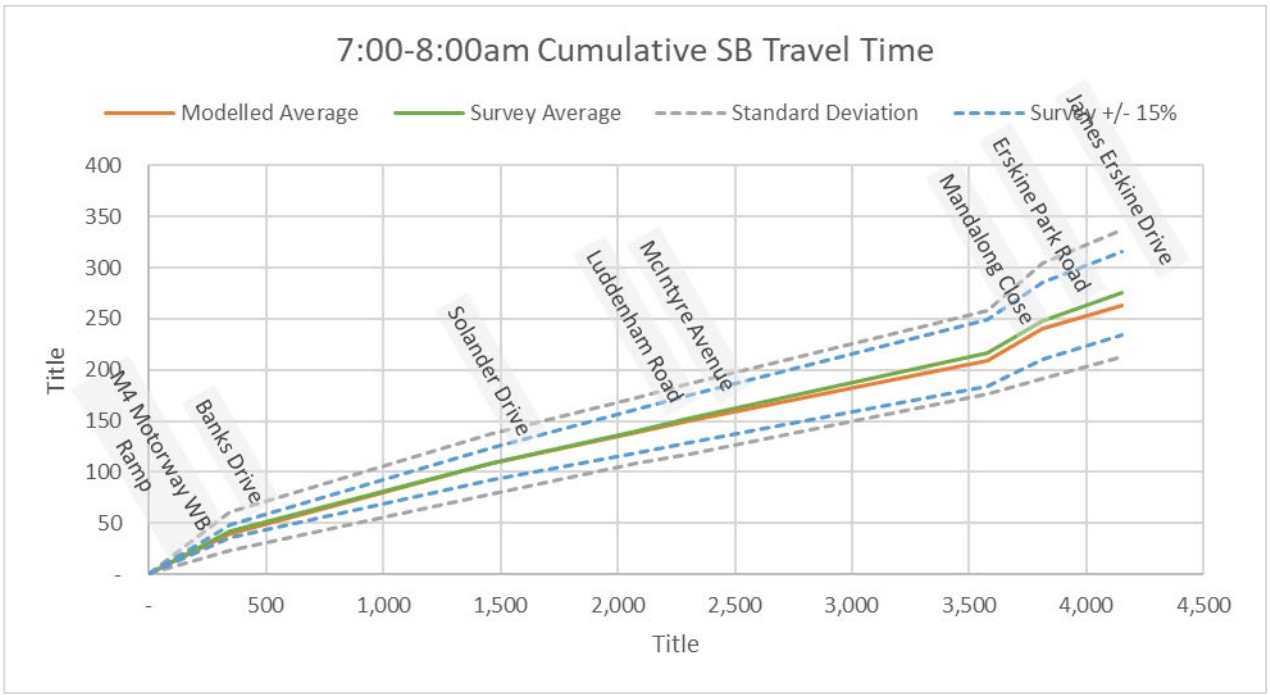


Figure 8-13: Mamre Road, Cumulative Southbound Travel Time, 7:00-8:00am

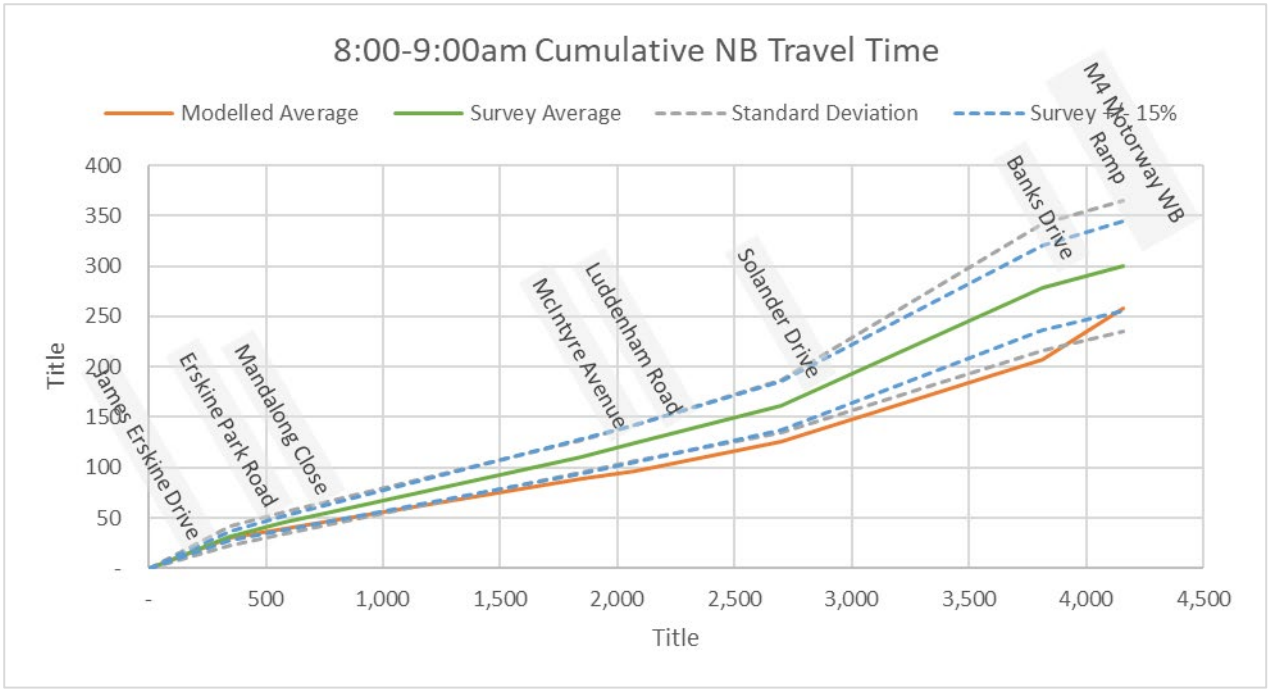


Figure 8-14: Mamre Road, Cumulative Northbound Travel Time, 8:00-9:00am

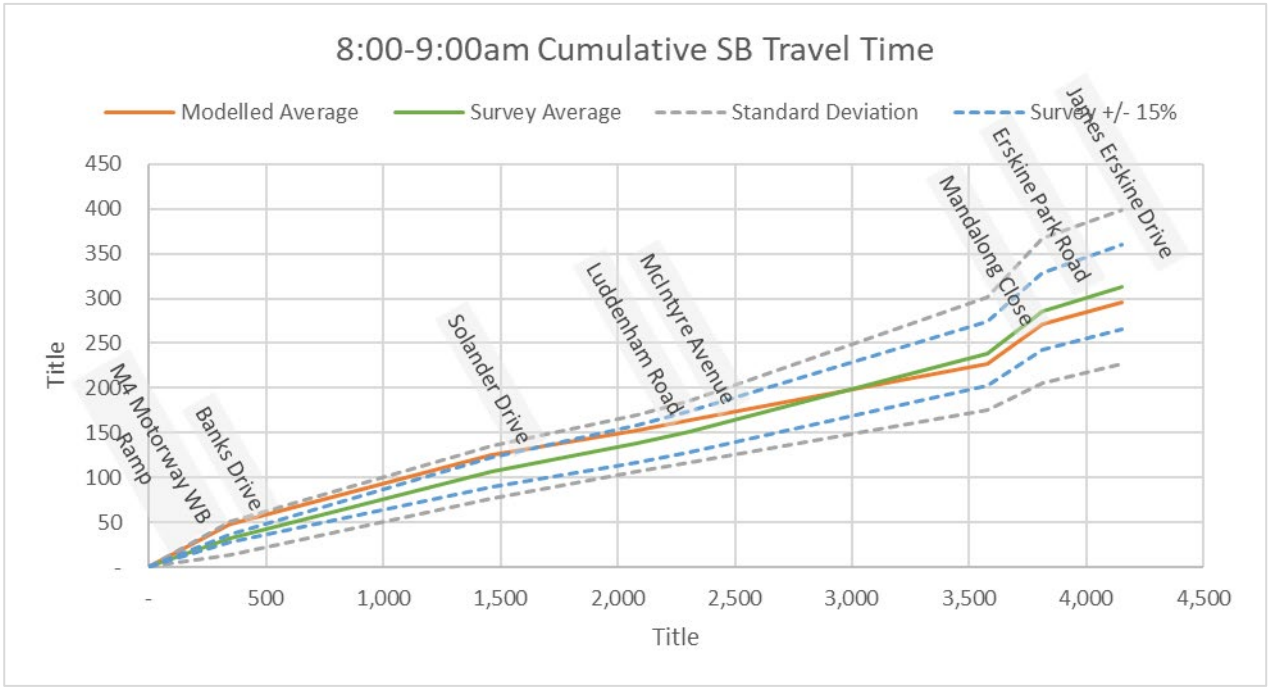


Figure 8-15: Mamre Road, Cumulative Southbound Travel Time, 8:00-9:00am

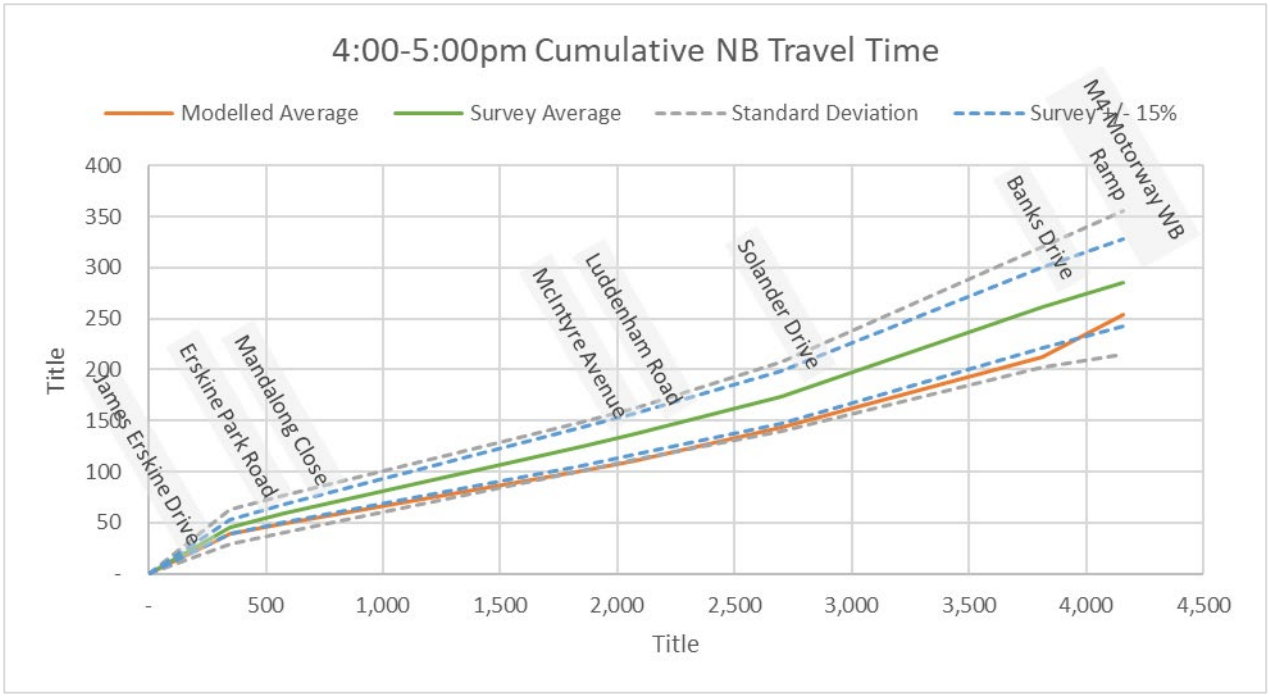


Figure 8-16: Mamre Road, Cumulative Northbound Travel Time, 4:00-5:00pm

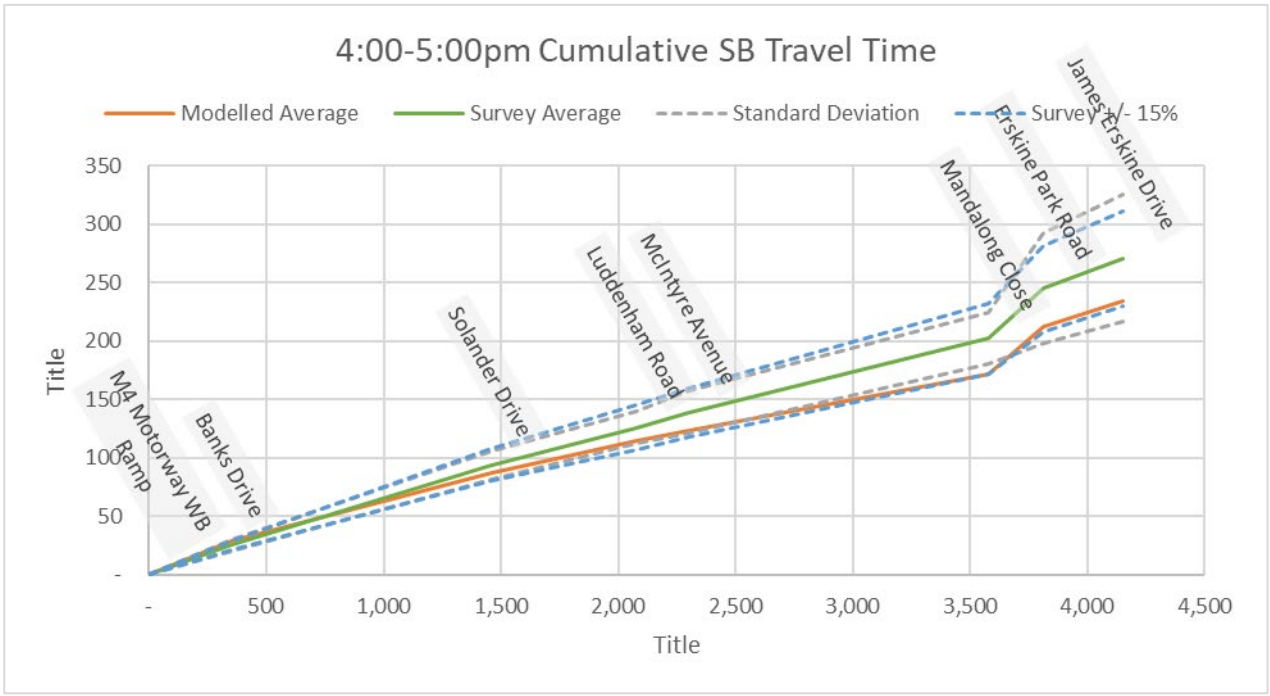


Figure 8-17: Mamre Road, Cumulative Southbound Travel Time, 4:00-5:00pm

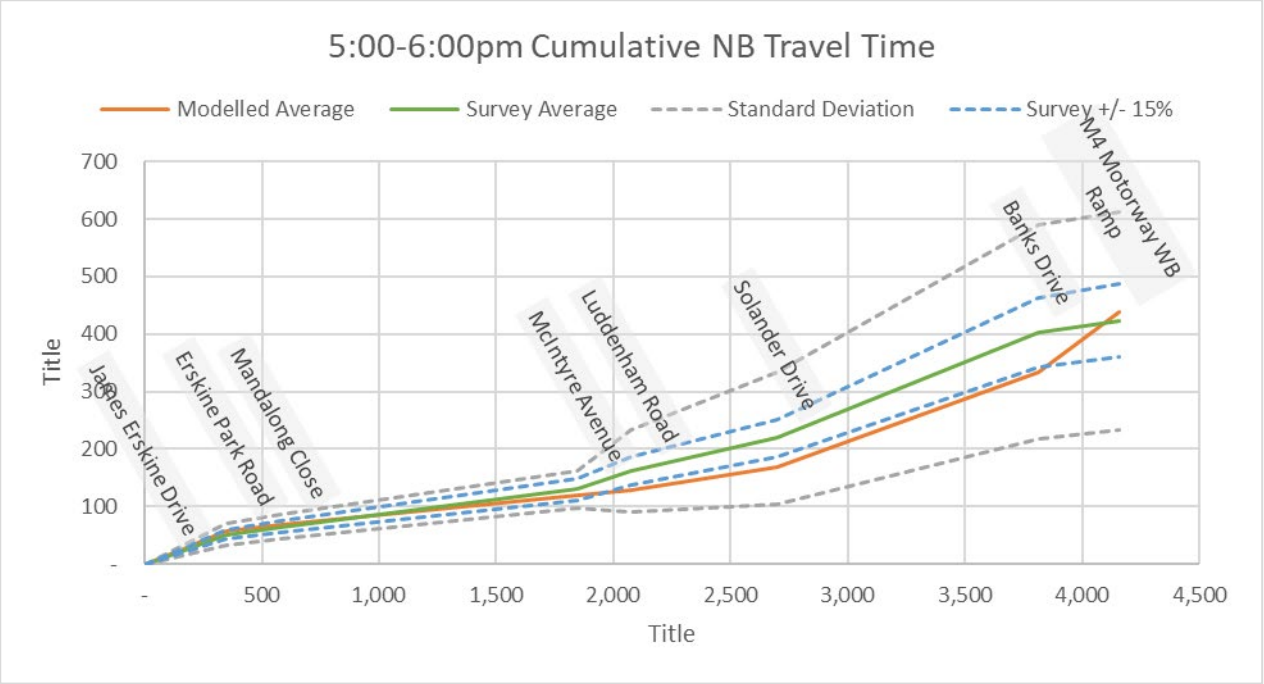


Figure 8-18: Mamre Road, Cumulative Northbound Travel Time, 5:00-6:00pm

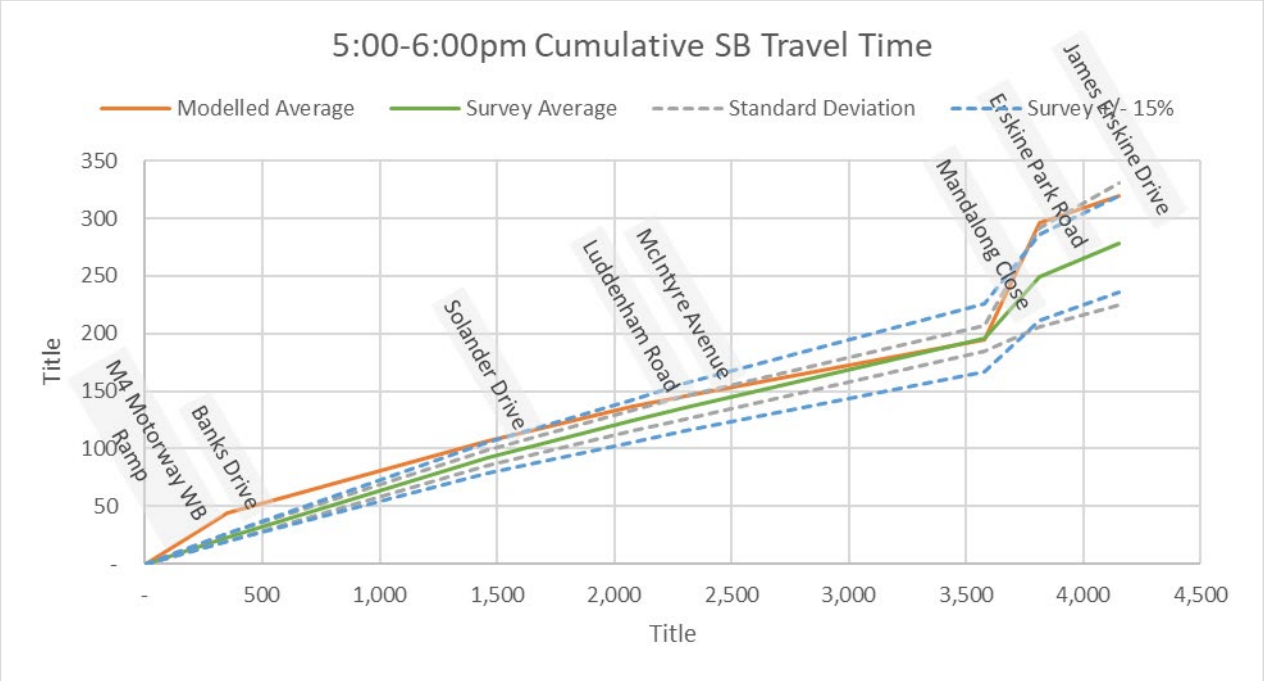


Figure 8-19: Mamre Road, Cumulative Southbound Travel Time, 5:00-6:00pm

Conclusion

Based on the information above, both models meet the calibration and validation criteria set out in Section 0 of this memo. Both models also show good stability across varying seed runs. This indicates that the models are likely a reasonable representation of existing traffic conditions on the Mamre Road corridor and are 'fit for purpose' for future year options assessment for the purpose of Mamre Road concept design.

Appendix C
Detailed Intersection LOS results (2020, 2026, 2036)

2020 Base Case Detailed Intersection LOS (2nd hour)

		2020 BC AM				2020 BC PM			
		2nd Hour				2nd Hour			
Intersection Name	Movement	Movement Volume	Movement Delay	Intersection Delay	Intersection LOS	Movement Volume	Movement Delay	Intersection Delay	Intersection LOS
M4_Mamre	M4_Mamre_NB_RT	1485	59	38	C	1411	111	58	E
M4_Mamre	M4_Mamre_SB_L	314	9			518	9		
M4_Mamre	M4_Mamre_SB_T	1254	24			1142	27		
M4_Mamre	M4_Mamre_WB_L	97	6			337	7		
M4_Mamre	M4_Mamre_WB_R	195	37			372	68		
Banks_Mamre	Banks_Mamre_NB_RTL	976	44	85	F	968	159	116	F
Banks_Mamre	Banks_Mamre_SB_RTL	1256	29			1150	31		
Banks_Mamre	Banks_Mamre_WB_RTL	646	256			566	213		
Banks_Mamre		0				0			
Solander_Mamre	Solander_Mamre_NB	981	13	20	B	998	22	21	B
Solander_Mamre	Solander_Mamre_SB	1136	26			977	19		
Solander_Mamre	Solander_Mamre_WB	103	25			90	30		
Solander_Mamre		0				0			
Luddenham_Mamre	Luddenham_Mamre_EB	523	27	9	A	259	38	11	A
Luddenham_Mamre	Luddenham_Mamre_NB	733	3			912	3		
Luddenham_Mamre	Luddenham_Mamre_SB	1160	5			917	11		
Luddenham_Mamre		0				0			
Luddenham_Mamre		0				0			
Erskine_Mamre	Erskine_Mamre_NB_RT	1124	27	50	D	962	48	47	D
Erskine_Mamre	Erskine_Mamre_SB_L	451	81			87	61		
Erskine_Mamre	Erskine_Mamre_SB_T	646	99			434	99		
Erskine_Mamre	Erskine_Mamre_WB	707	23			837	17		
Erskine_Mamre		0				0			
JamesErskine_Mamre	JamesErskine_Mamre_NB_RT	1096	10	15	B	755	11	17	B
JamesErskine_Mamre_	JamesErskine_Mamre_SB_L	223	10			82	7		
JamesErskine_Mamre_	JamesErskine_Mamre_SB_RT	1098	18			795	17		
JamesErskine_Mamre_	JamesErskine_Mamre_WB_L	32	10			65	9		
JamesErskine_Mamre_	JamesErskine_Mamre_WB_RT	89	42			233	38		
JamesErskine_Mamre_		0				0			
JamesErskine_Mamre_		0				0			
JamesErskine_Mamre_		0				0			

2026 and 2036 Base Case Detailed Intersection LOS (2nd hour)

		2026 BC_AM				2026 BC_PM				2036 BC_AM				2036 BC_PM			
		2nd Hour				2nd Hour				2nd Hour				2nd Hour			
Intersection Name	Movement	Movement Volume	Movement Delay	Intersection Delay	Intersection LOS	Movement Volume	Movement Delay	Intersection Delay	Intersection LOS	Movement Volume	Movement Delay	Intersection Delay	Intersection LOS	Movement Volume	Movement Delay	Intersection Delay	Intersection LOS
M4_Mamre	M4_Mamre_WB_R	117	41	108	F	314	56	49	D	93	38	116	F	296	61	145	F
M4_Mamre	M4_Mamre_WB_L	122	34			206	11			175	38			299	111		
M4_Mamre	M4_Mamre_NB_RT	1500	16			1463	16			1669	22			1529	26		
M4_Mamre	M4_Mamre_SB_T	1044	235			1332	84			1066	262			822	369		
M4_Mamre	M4_Mamre_SB_L	248	198			522	66			185	225			212	301		
Banks_Mamre	Banks_Mamre_WB_RTL	597	296	171	F	617	85	89	F	635	283	223	F	611	83	118	F
Banks_Mamre	Banks_Mamre_EB_RTL	0	-1			0	-1			0	-1			0	-1		
Banks_Mamre	Banks_Mamre_NB_RTL	1016	80			992	117			1079	235			983	46		
Banks_Mamre	Banks_Mamre_SB_RTL	1043	188			1323	70			1058	175			816	231		
Solander_Mamre	Solander_Mamre_WB_RTL	113	44	228	F	85	33	184	F	109	47	227	F	67	28	280	F
Solander_Mamre	Solander_Mamre_NB_RTL	999	27			1039	31			1050	54			1030	25		
Solander_Mamre	Solander_Mamre_EB_RTL	0	-1			0	-1			0	-1			0	-1		
Solander_Mamre	Solander_Mamre_SB_RTL	978	456			984	359			930	443			868	602		
Luddenham_Mamre	Luddenham_Mamre_NB_T	0	-1	215	F	0	-1	131	F	0	-1	231	F	0	-1	247	F
Luddenham_Mamre	Luddenham_Mamre_NB_L	842	3			982	4			804	6			988	4		
Luddenham_Mamre	Luddenham_Mamre_EB_R	0	-1			0	-1			0	-1			0	-1		
Luddenham_Mamre	Luddenham_Mamre_EB_L	484	571			381	125			505	579			498	598		
Luddenham_Mamre	Luddenham_Mamre_SB_RT	1028	222			942	266			973	235			853	323		
Erskine_Mamre	Erskine_Mamre_WB_R	0	-1	217	F	0	-1	331	F	0	-1	203	F	0	-1	297	F
Erskine_Mamre	Erskine_Mamre_WB_L	593	22			600	15			753	24			845	16		
Erskine_Mamre	Erskine_Mamre_NB_RT	1160	35			1104	38			1222	36			1260	66		
Erskine_Mamre	Erskine_Mamre_SB_T	604	651			447	1305			513	717			410	1474		
Erskine_Mamre	Erskine_Mamre_SB_L	154	641			84	1264			146	714			39	1439		
JamesErskine_Mamre	JamesErskine_Mamre_WB_RT	115	252	52	D	347	292	106	F	112	201	169	F	247	369	549	F
JamesErskine_Mamre_	JamesErskine_Mamre_WB_L	26	137			62	251			28	84			40	318		
JamesErskine_Mamre_	JamesErskine_Mamre_NB_RT	994	66			646	33			1064	365			913	1232		
JamesErskine_Mamre_	JamesErskine_Mamre_NB_L	118	26			100	34			82	279			69	1071		
JamesErskine_Mamre_	JamesErskine_Mamre_EB_RT	92	50			298	99			97	54			201	80		
JamesErskine_Mamre_	JamesErskine_Mamre_EB_L	120	43			136	379			104	42			110	363		
JamesErskine_Mamre_	JamesErskine_Mamre_SB_RT	1052	23			676	36			1197	23			890	48		
JamesErskine_Mamre_	JamesErskine_Mamre_SB_L	149	20			88	34			138	21			87	41		

2026 and 2036 Proposal Detailed Intersection LOS (2nd hour)

	2026 Proposal AM					2026 Proposal PM				2036 Proposal AM				2036 Proposal PM			
	2nd Hour					2nd Hour				2nd Hour				2nd Hour			
Intersection Name	Movement	Movement Volume	Movement Delay	Intersection Delay	Intersection LOS	Movement Volume	Movement Delay	Intersection Delay	Intersection LOS	Movement Volume	Movement Delay	Intersection Delay	Intersection LOS	Movement Volume	Movement Delay	Intersection Delay	Intersection LOS
M4_Mamre	M4_Mamre_WB_R	115	38	67	E	375	346	99	F	59	38	69	E	198	873	101	F
M4_Mamre	M4_Mamre_WB_L	123	14			225	29			208	16			373	29		
M4_Mamre	M4_Mamre_NB_RT	1839	15			1646	68			2618	45			2209	20		
M4_Mamre	M4_Mamre_SB_T	1634	123			1503	88			1660	107			1536	130		
M4_Mamre	M4_Mamre_SB_L	324	115			567	81			285	102			417	122		
Banks_Mamre	Banks_Mamre_WB_RTL	817	47	39	C	616	55	35	C	886	61	48	D	660	61	37	C
Banks_Mamre	Banks_Mamre_NB_RTL	1239	32			1262	28			1951	49			1726	32		
Banks_Mamre	Banks_Mamre_EB_RTL	96	65			99	70			99	68			94	68		
Banks_Mamre	Banks_Mamre_SB_RTL	1750	39			1732	30			1850	40			1918	31		
Solander_Mamre	Solander_Mamre_WB_RTL	183	53	24	B	157	115	28	B	160	45	25	B	119	66	25	B
Solander_Mamre	Solander_Mamre_NB_RTL	1280	15			1407	17			2085	19			1886	19		
Solander_Mamre	Solander_Mamre_EB_RTL	99	50			104	45			93	49			94	48		
Solander_Mamre	Solander_Mamre_SB_RTL	1570	27			1227	28			1572	29			1524	29		
Luddenham_Mamre	Luddenham_Mamre_NB_T	916	18	18	B	1141	29	24	B	1071	23	36	C	1243	30	31	C
Luddenham_Mamre	Luddenham_Mamre_NB_L	105	6			185	10			80	8			319	15		
Luddenham_Mamre	Luddenham_Mamre_EB_R	235	32			88	46			453	103			140	45		
Luddenham_Mamre	Luddenham_Mamre_EB_L	397	16			292	18			1041	43			674	20		
Luddenham_Mamre	Luddenham_Mamre_SB_RT	1621	17			1176	21			1609	21			1527	39		
Erskine_Mamre	Erskine_Mamre_WB_R	177	44	24	B	336	36	24	B	129	45	26	B	343	37	23	B
Erskine_Mamre	Erskine_Mamre_WB_L	389	26			285	14			605	28			525	14		
Erskine_Mamre	Erskine_Mamre_NB_RT	1305	15			1263	13			1599	18			1806	18		
Erskine_Mamre	Erskine_Mamre_SB_T	1134	31			753	41			1268	32			761	34		
Erskine_Mamre	Erskine_Mamre_SB_L	461	25			123	19			368	27			96	18		
JamesErskine_Mamre	JamesErskine_Mamre_WB_RT	121	329	34	C	306	82	42	C	106	130	40	C	246	59	54	D
JamesErskine_Mamre_	JamesErskine_Mamre_WB_L	27	42			62	29			23	40			71	33		
JamesErskine_Mamre_	JamesErskine_Mamre_NB_RT	1120	32			755	35			1447	68			1375	80		
JamesErskine_Mamre_	JamesErskine_Mamre_NB_L	123	14			97	8			107	23			92	23		
JamesErskine_Mamre_	JamesErskine_Mamre_EB_RT	105	56			192	29			95	57			161	34		
JamesErskine_Mamre_	JamesErskine_Mamre_EB_L	121	28			225	62			112	29			208	50		
JamesErskine_Mamre_	JamesErskine_Mamre_SB_RT	1430	15			922	41			1822	17			1229	33		
JamesErskine_Mamre_	JamesErskine_Mamre_SB_L	245	9			133	13			223	10			96	12		

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