A summary of the proposed staging and the total dwelling yield able to be supported by each stage is shown in Table 7.1

Table 7.1: Staging summary

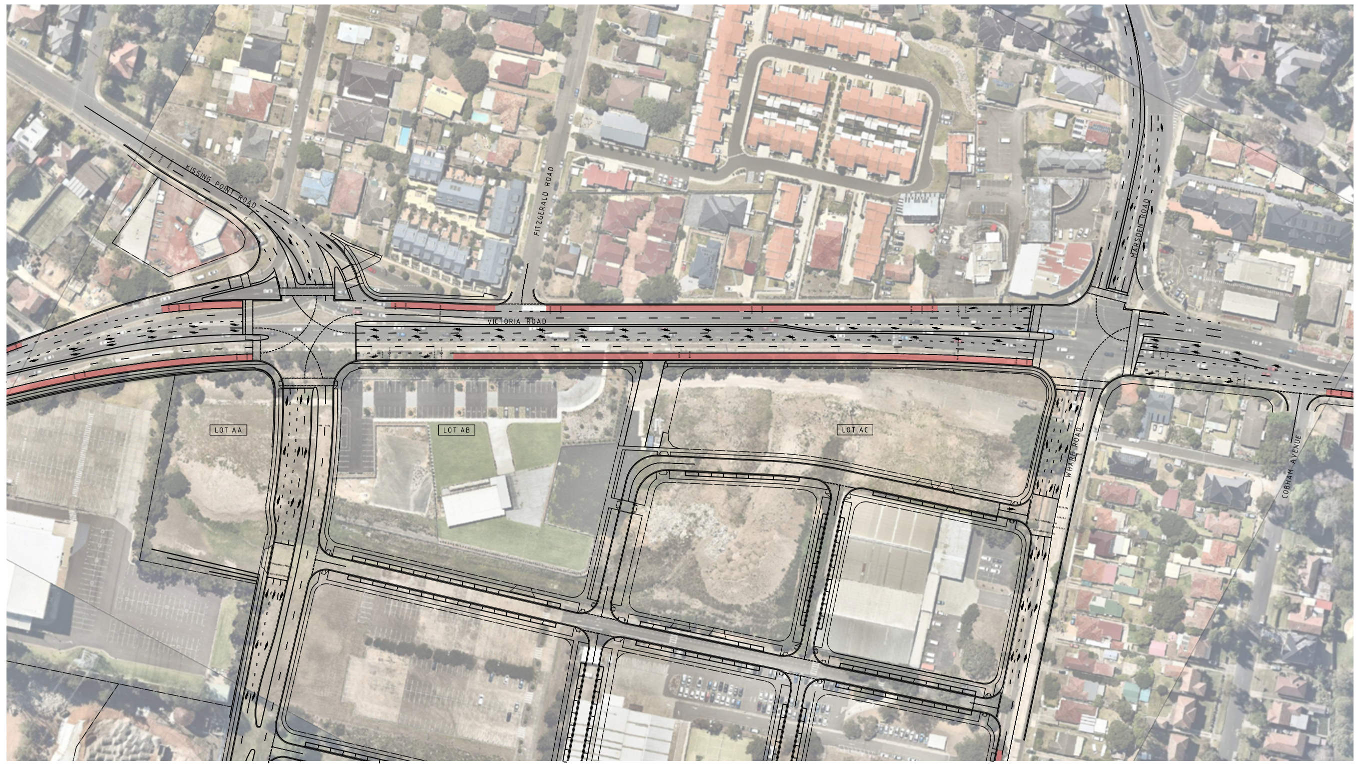
Stage	Delivered at (dwellings)	Yield supported (dwellings)
Existing network	N/A	1,100
Stage 1A	1,100	1,800
Stage 1B	1,800	3,200
Stage 1C	3,200	6,700
Stage 2	6,700	11,000

Figure 7.3 to 7.5 set out the staging of identified road infrastructure recommendations for the Melrose Park precinct. Intersection designs and pedestrian crossing facilities will be subject to further refinement at the detailed desgn stage. It is noted that all traffic modelling presented in this TMAP assumes full one-stage pedestrian crossings on all legs of Victoria Road intersections with Kissing Point Road and Wharf Road.

Figure 7.3 : Victoria Road Stage 1A upgrades (Northrop) - Required at approx 1,100 dwellings

Figure 7.4 : Victoria Road Stage 1B upgrades (Northrop) - Required at approx 1,800 dwellings

Figure 7.5 :Victoria Road Stage 1C upgrades (Northrop) - Required at approx 3,200 dwellings



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7.3 Implementation plan

The table below sets out a summary of the proposed transport infrastructure and services required to support the Melrose Park development. Detailed staging of these items is outlined in section 7.2

ID	Description	Responsibility	Background	Objective	Timing
Road network					
1	Internal road network	Proponents	The internal road network will be delivered in lockstep with the staged development of Melrose Park. It is proposed to develop internal roads progressively to provide access to core development areas as they come online.	2,5,6	Ongoing
2	Wharf Road intersection upgrade at Victoria Road	Proponents/ RMS	Proposed upgrade to the Victoria Road/Wharf Road intersection will improve access to and from Melrose Park whilst also improving efficiency for buses, freight and general traffic on Victoria Road.	2,4,5,6	Short term
3	Kissing Point Road - new access at Victoria Road	Proponents/ RMS	New left-in/left-out access into the precinct via the Victoria Road/Kissing Point Road intersection. This will be required in the initial stages of the development to allow for local access.	2,4,5,6	Short term
4	Intersection upgrades - As part of PLR Stage 2	TfNSW	Intersections along Hope Street will require adjustments as PLR stage 2 is delivered. This will result in newly signalised intersections at Hughes Avenue, NSR-2 and NSR-3/Waratah Street.	2,4,5,6	Medium term
5	Kissing Point Road - intersection upgrade at Victoria Road	Proponents/ RMS	Full upgrade of the Victoria Road/Kissing Point Road intersection. This will provide full access into and out of the Melrose Park precinct whilst also improving efficiency for buses, freight and general traffic on Victoria Road.	2,4,5,6	Medium term
6	Victoria Road upgrade between Wharf Road and Kissing Point Road	Proponents/ RMS	Widening of Victoria Road between Kissing Point Road and Wharf Road to allow for extended turning lanes and a continuous bus lane in each direction.	2,4,5,6	Medium term
Public transport network					
7	On-demand services	TfNSW	On-demand services to Macquarie Park are currently being trialled in the Melrose Park area. The possible expansion of these services to other hubs will reduce car reliance for Melrose Park residents and workers.	1,2,5,7	Short term
8	Local bus shuttle services	Proponents	The provision of bus shuttle services to promote integration with local bus and rail services at Meadowbank. Staged provision of buses to allow an ultimate Stage 1 (pre-bridge) headway of 5 minutes in the weekday peak period. 4 buses required to support up to 6,700 dwellings. Potential minor works and pedestrian crossing on Bank Street or at kiss and ride facility to support shuttle operations at Meadowbank station.	1,2,5,7	Short term
9	Bus service enhancements	TfNSW	The following improvements will provide efficient and sustainable travel options for residents and visitors of Melrose Park in the short to medium term: • Increased frequency on M52 to cater for both background growth and Melrose Park demand along Victoria Road to Parramatta and the Eastern City • Potential new service Top Ryde to Concord Hospital via a new bridge over Parramatta River • New and upgraded bus stops on Wharf Road to ensure a maximum 400m spacing and to provide increased waiting areas and passenger amenity	1,2,5,7	Short to medium term
10	Ferry services	TfNSW	Investigations into the following ferry service improvements are recommended: • Service improvements for F3 Parramatta River services to cater for future commuter ferry and tourist patronage demand • Investigate and consult with TfNSW and RMS on ferry shuttles between Olympic Park and Parramatta and a potential new wharf at Melrose Park	1,2,5,7	Short to medium term
11	New bridge across Parramatta River	Proponents/ TfNSW	A new bridge connecting Melrose Park and Wentworth Point will have a transformative impact on Melrose Park and the wider region. Rapid transport connections via bus or light rail will directly connect Melrose Park with jobs, services and key transport corridors at Rhodes and Sydney Olympic Park.	1,2,3,4,5, 7	Medium term
12	PLR Stage 2	TfNSW	A new light rail line will be provided connecting Melrose Park with Parramatta CBD and Olympic Park. At least two stops will be provided within Melrose Park to cater for central / northern and southern precinct access to the light rail corridor. The structure plans makes provision for a LRT corridor along Hope Street.	1,2,4,5,7	Medium term
13	Sydney Metro West	TfNSW	New metro line connecting Westmead, Parramatta CBD, Olympic Park, the T1 Northern rail line, Bays Precinct and Sydney CBD. This will be a key connection for Melrose Park residents who can access the line at Sydney Olympic Park via PLR Stage 2.	1,2,4,5,7	Medium term
14	Victoria Road bus improvements	TfNSW	As outlined in Future Transport 2056 - Improvements will include upgrading bus services and infrastructure on the Victoria Road corridor. Improvements will transform the Victoria Road Corridor into a more attractive place to live and work. Improvements would enhance access for Melrose Park residents traveling to Parramatta or the Eastern City. A potential indented bus bay to be investigated eastbound on Victoria Road east of Kissing Point Road.	1,2,4,5,7	Medium term
15	T1 Northern Line improvements	TfNSW	Investigations into capacity improvements for the T1 Northern Line are currently underway. TfNSW has indicated improvements will be necessary within the next 10 years. Improved services would enhance access for Melrose Park residents who could reach West Ryde/Meadowbank via bus or on-demand services before transferring to the T1 Northern Line	1,2,4,5,7	Medium term
16	T1 Western Line improvements	TfNSW	The T1 Western Line Rail Upgrade Program is recommended to be implemented in order to provide more capacity for Northern Line services	1,2,4,5,7	Medium term

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ID	Description	Responsibility	Background	Objective	Timing
Active transport network					
17	Walking and cycling infrastructure on internal network	Proponents	The internal road network within the Melrose Park precinct will include provision for safe, efficient and attractive walking and cycling trips, particularly to/from Melrose Park Primary School. A midblock crossing on Hope Street between Wharf Road and Waratah Street is recommended to be investigated to facilitate safe connections between the northern precinct and the school. This will encourage local trips to be undertaken via active modes whilst also enhancing access to nearby public transport services. A shared path will be provided on the western side of Wharf Road.	1,2,3,7	Ongoing
18	Enhanced local connections	Proponents/ CoP	Enhancements to active transport infrastructure linking Melrose Park Precinct to the surrounding activity areas through new connections via the internal road network to the Parramatta River foreshore shared path and to George Kendall Reserve	1,2,3,7	Short term
19	Cycle parking and end of trip facilities	Proponents	End of trips facilities and secure and visible cycle parking should be provided at all commercial centres and other major trip generators Adopt bicycle parking provision of: • 1 per dwelling + 1 visitor space per 10 dwellings • 1 per 150m² commercial GFA + 1 visitor space per 450m² commercial GFA • 1 per 250m²retail GFA + 1 visitor space per 100m² retail GFA	1,2,5,7	Short term
20	Implement and refine Parramatta Bike Plan 2017	Proponents/ CoP	• Fully separated cycleway for Hope Street providing a new high quality east-west connection between Melrose Park and Rydalmere • Painted lanes on Wharf Road connecting Hope Street cycleway to existing Parramatta Valley cycleway • New shared path connecting north-south through the Melrose Park precinct and connecting with the Parramatta Valley cycleway	1,2,3,7	Short to medium term
21	Shared mobility facilities	Proponents	Shared mobility pods to be provided within Melrose Park for bike share, as well as emerging forms of shared mobility such as electric mopeds.	1,5,7	Medium term
22	New bridge across Parramatta River	Proponents/ TfNSW	A new bridge connecting Melrose Park and Wentworth Point will include dedicated walking and cycling infrastructure. This will provide direct active transport connections between Melrose Park and key centres such as Rhodes and Sydney Olympic Park.	1,2,3,4,5, 7	Medium term
23	Walking and cycling facilities to be delivered as part of PLR Stage 2	TfNSW	Improved cycling and pedestrian facilities should be investigated during planning and delivery of PLR Stage 2 along the Hope Street and Waratah Street corridors.	1,2,3,7	Medium term
Policy					

24	Parking policy	CoP/ Proponents	• Consider maximum parking rates for Melrose Park in the long term with parking provision of:
			  • 0.73 spaces per dwelling (average based on currently assumed dwelling mix)
			  • 1 space per 30m² commercial GFA
			  • 1 space per 50m² retail GFA
			• Prioritise on-street car share within Melrose Park at a residential car share rate of 1 space per 40 dwellings
			• On-street parking to be provided within the internal road network and be designed to support the function for the street.
			• Provide real-time parking information along key access streets and the proposed town centre
			• Unbundling /decoupling parking from the sale of apartments, to deliver housing choice and efficient allocation of parking across the development.
			• Monitor on-street parking activity on the surrounding street network at Wharf Road, Hope Street and Hughes Avenue to minimise over flow parking from Melrose Park
				1,6,7	Ongoing

25	Demand management	Proponents	• Ensure that transport information is up to date and liaise with the local residential and business communities on transport issues • Aligning information at stops and streets with digital transport information provided through websites, apps and electronic information displays • Liaise with transport providers to resolve any impediments to their efficient service and promote regular improvements • Enabling significant investment in car share, providing accessible mobility choice to households without parking or who choose not to own a car • Introduce parking management and control measures e.g. parking charges, constraining parking supply, unbundled/decoupled off-street parking • Facilitate car-sharing to reduce the need for private car ownership • Provide shared work spaces and 'smart hubs' to facilitate flexible working arrangements and minimise the need for peak hour commute trips • Provide opal cards to initial residents of the precinct	1,2,6,7	Ongoing

8. KEY FINDINGS AND CONCLUSIONS

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8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Overview

The Melrose Park TMAP has examined a wide range of issues in a complex land use and transport planning environment given the strategic location of the precinct within Greater Parramatta Olympic Peninsula (GPOP). The TMAP has sought to address the following key issues:

- The need to achieve a high level of public transport use, cycling and walking in order to achieve the *Future Transport Strategy 2056* broad strategic planning objectives of improved integration of land use and transport planning
- A strong commitment to bring light rail into the precinct as part of PLR Stage 2 and anchored by future connections to PLR Stage 1 and Sydney Metro West at Sydney Olympic Park
- The need to balance transport and access expectations in an environment where the road network, particularly at key intersections surrounding the site, is already close to capacity
- A staged approach to parking provision that will balance the short term needs with the long term objectives for sustainable parking management within the precinct
- To cluster residential, commercial and retail development in such a way that a 'critical mass' of trip generation is established within public transport catchments from the earliest stages of development.

8.2 Key findings

The key findings of the Melrose Park Precinct incorporating 11,000 dwellings in terms of transport infrastructure and services requirements are:

- Based on the nominated service levels for the road network, upgrades to Victoria Road intersections (Wharf Road and Kissing Point Road) will be required in order to efficiently service the Melrose Park precinct
- The road network analysis has identified that the remainder of the existing road network is able to cater for traffic generated by the proposed development, with no significant impacts compared to a future 'do minimum' scenario
- The public transport network for Melrose Park has been planned to cater for the full development without the need for light rail.
- Increased bus service frequencies on Victoria Road are required to support development and achieve mode share targets. Investigations have confirmed the required bus service levels are feasible
- A new bridge crossing (public and active transport only) across the Parramatta River linking Melrose Park to Wentworth Point is required by 2028 (approximately 6,700 dwellings) to enable connections from residential and employment areas to key public transport nodes
- New bus services between Top Ryde and Concord Hospital via Melrose Park are proposed to operate via the new bridge
- Shuttle services between Melrose Park and Meadowbank station are proposed to operate prior to the implementation of the new bridge. Proposed operations can be implemented without signifcant works or impacts
- Ferry user patronage demand from Melrose Park is likely to be small but may play an important role for discretionary trips. A new bridge across the Parramatta River will provide access to Sydney Olympic Park and proposed new ferry wharf at Rhodes East
- A light rail corridor is being proposed by TfNSW established through the core of the development. This would bring light rail services through the heart of Melrose Park with direct access to the proposed Sydney Metro West station at Olympic Park
- The introduction of PLR Stage 2 leads to a number of access implications along Boronia Street, Hope Street and Waratah Street which will need to be carefully managed
- The northern precinct structure plan maintains a corridor on Hope Street between Hughes Avenue and Waratah Street to enable the implementation of light rail. The southern precinct allows for light rail along Waratah Street.
- The entirety of the road works shall be delivered early with all upgrades delivered prior to the implementation of the new bridge over the Parramatta River. This plan ensures that infrastructure is in place to support the development and minimise wider network impacts.
- Key elements of Stage 1 - Prior to bridge (up to 6,700 dwellings:
  - Stage 1A, Stage 1B and Stage 1C road upgrades
  - Enhanced Victoria Road bus services to cater for background growth and Melrose Park demand
  - Shuttle services to Meadowbank Station
- Key elements of Stage 2 - After new bridge (more than 6,700 dwellings)
  - New high frequency services (bus or light rail) over the bridge
  - Continued enhanced Victoria Road bus services to cater for background growth and Melrose Park demand

8.3 Key conclusions

The key conclusions of the Melrose Park TMAP are:

- The scale of development envisaged for Melrose Park (11,000 dwellings) presents very significant, but manageable challenges for road and public transport infrastructure and services
- The package of transport infrastructure and services proposed and assessed in the TMAP is capable of accommodating the Melrose Park development yields (11,000 dwellings) and regional transport requirements as defined in *Future Transport Strategy 2056*
- Sydney Metro West will deliver significant benefits across the entire rail network for residents from Melrose Park with high capacity and more frequent services between Parramatta CBD, Sydney Olympic Park and Sydney CBD
- A new bridge crossing (public and active transport only) across the Parramatta River linking Melrose Park to Wentworth Point is required by 2028 (approximately 6,700 dwellings) to enable connections between multiple trip origins and destinations linking residential and employment areas to key public transport nodes
- Parramatta Light Rail Stage 2 will provide a direct link to and through the Parramatta CBD, and to the broader rail network, for the growing areas of Melrose Park, Wentworth Point, Sydney Olympic Park, North Parramatta and Westmead
- The public transport network needs for Melrose Park Precinct has been planned to match the type and scale of development without the need for light rail. The new bridge across Parramatta River linking Melrose Park and Wentworth Point will provide a key connection and will provide, a fast, direct, high frequency feeder bus services linking Melrose Park to Rhodes Station and future metro station at Sydney Olympic Park
- The signalised intersections within the study area are adequate and will operate at acceptable level of service with the improvements recommended. The TMAP analysis has shown LOS E or better for all the signalised intersections within the study area during the peak hours
- The additional traffic demands as a result of Melrose Park development on the surrounding local road network fall within acceptable capacity thresholds
- Parking provision in the early stages will need to balance the imperative of achieving as much development as early as possible (to contain travel within the area), while parking provision in the later stages will need to constrain parking supply as a means of reducing travel by private car
- The proposed 9,441 off-street parking spaces provided within Melrose Park is considered adequate to cater for the likely parking demand generated from the site at full build-out by 2036, which will be complemented by the public transport initiatives identified in the TMAP
- An integrated package of measures is required to be implemented over the next five to ten years as the development progresses, with the package containing a mix of policy and infrastructure and transport services measures
- The staging of the development will not cause any noticeable degradation of performance on the surrounding road network with the proposed integrated package of mitigation measures
- The staging of infrastructure and services is focused on ensuring high levels of accessibility in the short term. Road network upgrades and significant public transport service improvements are proposed in the early stages of the development.
- The measures presented within the TMAP need to be integrated comprehensively and consistently over the short, medium and long term if the mode split targets are to be achieved, and if the surrounding road network is to continue to function at an acceptable level of service.

APPENDIX A - MELROSE PARK PRECINCT MODEL (MPPM)

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Memorandum

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Subject	**MPPM Spreadsheet model**	**Project Name**	Melrose Park TMAP
Date	12 October 2018	**Project No.**	IA130100

1. Introduction

The purpose of the Melrose Park Precinct Model (MPPM) is to assist in understanding the impacts of proposed developments and the potential travel behaviour for trips to and from the precinct. The model provides forecasts for trip generation, trip distribution, mode choice and trip assignment to and from a development. This memorandum details the process of generating forecasts using the MPPM.

2. Step 1 – Zoning System

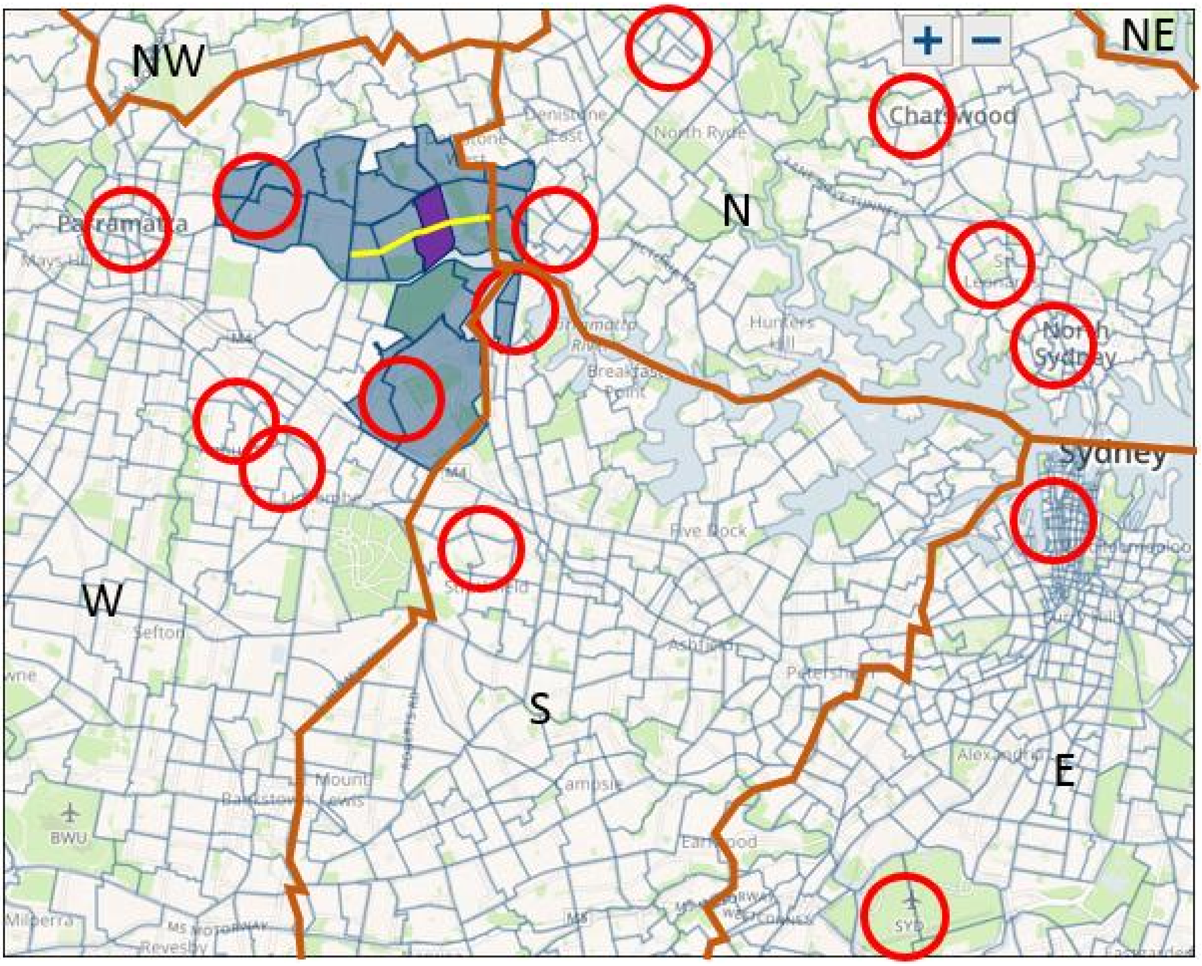
The first step is to define the zoning system. The zoning system forms the basis of the four-step analysis that is undertaken in the MPPM. MPPM uses Journey To Work (JTW) data from the 2011 census (the latest available at time of model development) for forecasting demand. As a result, JTW zones are used to define the geography of the model.

All JTW zones are defined into two types: internal and external. Internal zones comprise of the zone containing the development and its surrounding zones (the study area). If necessary, these zones can be further disaggregated to better reflect their public transit network connectivity. In the case of Melrose Park, travel zones between Victoria Road and the Paramatta River are all split into a North and a South zone because the North-South distance between Victoria Road and the Paramatta River is 2km. Therefore, residents in the Southern parts of these zones fall outside of the catchment of bus services running along Victoria Road.

External zones are divided into two types: employment centres, and wider external zones. These zones are created through the amalgamation of appropriate JTW travel zones. Employment centres represent the main places of employment for the residents of the internal zones (e.g. the CBD, Paramatta, Macquarie Park etc.). Employment centres are chosen to capture the majority of work trips which are made by the residents of the internal zones.

The figure above shows the zoning system used in the model. Internal zones are shaded blue, employment centre zones are indicatively shown by the red circles. Wider external zone boundaries are marked by the brown lines, which extend to cover the rest of Sydney (not shown above). Melrose Park is shaded purple. The yellow line marks the location of the split for the zones between Victoria Road and the Paramatta River, including the Melrose Park zone.

Figure 2.1: MPPM zoning system



All remaining travel zones are amalgamated into wider external zones. These zones represent large geographic areas (e.g. North West) and are comprised of many zones to which there are a low number of trips from the internal zones.

3. Step 2 – Demand development

Once the zoning system is developed, an origin-destination demand matrix (OD matrix) is created. JTW data provides the number of work trips which take place between every travel zone disaggregated by mode. MPPM uses the sum of all car and public transit trips; modes 1-5 in the JTW. Trips which report modes such as 'other' and 'mode not stated' (modes 6-9 in the JTW) are excluded from the analysis.

The sum of all car and public transit trips is amalgamated to provide OD demand for each OD pair using the zoning system defined in Step 1; with the exclusion of external to external zone pairs, as these do not influence the study area. This provides the base OD matrix for the year 2011.

Census projections are used to factor the base 2011 OD matrix in order to create the base study year matrix (2016) as well as future study year matrices (2026, 2036). The census provides population and employment projections for every JTW travel zone. These projections are split or amalgamated in the same manner as the JTW data to convert them into the MPPM zoning system. Using the reported

2011 employment and population, and the projected future population and employment in each zone, growth factors are derived. These are applied to the 2011 OD matrix to create the base and future year OD matrices.

Each OD pair is factored by two growth factors to arrive at the future OD value.

The population growth factor is simply the percentage by which the population in the origin zone has grown over time. Every origin zone has a growth factor which is applied to all trips originating from that zone.

The employment shift growth factor takes into consideration the fact that not all destination zones will grow at the same pace. First a distribution of trips from each origin zone is created using the 2011 OD matrix. This distribution is then factored by the relative growth in projected employment in each destination zone. This way, the fact that certain destinations, such as Paramatta, grow at a faster rate than others, such as the CBD, and will attract more trips in the future is accounted for. This new distribution of trips is then applied to the trips factored by the population growth factor to arrive at the future year number of trips for each OD pair.

4. Step 3 – Benchmarking

The growth factors used in Step 2 cannot be applied to the development zone as the land use will be completely different than it currently is. Benchmarking is needed to develop an accurate representation for trip generation and trip distribution for this zone. Additionally, any other internal zones where significant change in land use has occurred or is planned to be happen must also be benchmarked.

In the MPPM benchmarking was applied to the development zones in Melrose Park, and the fast-growing zones at Olympic Park and Wentworth Point South.

Firstly, benchmark zones are specified. Benchmark zones of similar location, development level and public transit connectivity are chosen as they will provide the most accurate estimates for the trip generation and distribution for the zones which require benchmarking.

Benchmarking is used to provide an estimate for trip generation and trip distribution. Population and employment projections for other internal benchmark zones can be obtained from the census projections used in Step 2. For the development zones, projections for population and employment are extracted from the development documents.

A weighted average number of JTW trips out per population for the appropriate benchmark zones is calculated and applied to the projected population to obtain the projected total number of trips from the zone. These are then distributed by the weighted average distribution for the appropriate benchmark zones.

Once benchmarking is completed, final OD matrices for the base and future year are created. This completes the process of trip generation and distribution.

5. Step 4 – Public Transit Generalised Cost

The next step in the MPPM is to assign the trips from the final OD matrix. The MPPM uses a generalised cost binomial logit model to assign all trips for each OD pair to one of two modes: public transit (PT) or car.

To carry out the assignment, generalised cost for each OD pair for PT and car trips are computed. The generalised cost represents a representative average trip for each OD pair.

PT trips are divided into three types: Local to External (LE), External to Local (EL), and Local to Local (LL). LE trips take place between internal and external zones; EL trips the opposite, and LL trips occur between two internal zones. A representative average PT trip is then computed for each PT trip type.

LE trips are broken down into 3 legs. Leg 1 represents the walk to a local bus stop (or local light rail stop in light future light rail scenarios). Each internal zone is served by a local bus stop. All bus services which go through an internal zone stop at the local bus stop. Using GIS, a centroid is estimated for each travel zone based on its land use; i.e. accounting for dwelling density and green spaces. The centroid is taken as the origin of all trips from each zone to represent the average trip.

The distance from the centroid to the local bus stop via the road network is calculated using a GIS network of the area. The generalised cost is expressed in minutes. The formula for calculating Leg 1 costs is shown below:

$$Cost = Walk\ Distance\ x\ Walk\ Speed\ x\ Walk\ Factor$$

The cost of Leg 1 is computed by converting the distance to a walking time using an assumed average walking speed, and applying a factor reflecting the relative desirability of walking as a means of commute. The factor used in the MPPM is 1.5 reflecting the fact that walking is seen as a relatively undesirable means of commute.

Leg 2 represents the trip on a local bus to a gateway. A gateway is a train/ferry/metro/light rail stations inside or near the study area. A representation of bus services running through the study area is created. Each bus service is modelled to stop in each zone and at each gateway through which it passes. The travel times and frequencies are taken from the Transport for New South Wales (TfNSW) timetable for each local bus service. The cost for Leg 2 of the trip is calculated using the formula below:

$$Cost = Wait\ Factor\ x\ 0.5\ x\ \frac{60}{Frequency} + IVT\ Factor\ x\ IVT + Fare\ Factor\ x\ Fare + Mode\ Transfer\ Penalty$$

Where;

- Wait factor represents the disutility of waiting for a local bus service to arrive
- Frequency is the number of busses per hour
- In vehicle time (IVT) is the time taken for the trip
- IVT Factor represents the relative attractiveness of each mode of travel. It is different for busses, trains, light rai, ferry etc.

- Fare is calculated using Opal distance bands
- Fare factor converts the monetary value of the fare to a perceived minute cost
- Mode transfer penalty represents the perceived inconvenience in minutes of changing modes of travel at the end of Leg 2

Where zones are served by multiple overlapping services the frequency is the sum of all overlapping services per hour, since travellers would board the first available service.

The centroid of certain zones falls within 1km of a gateway. For these zones, Legs 1 and 2 are replaced by a single walking trip from the zone centroid to a gateway. The cost of the trip is calculated using the same methodology used in Leg 1.

Leg 3 refers to the trip from the gateway to the destination. It is divided in two parts. First, travellers use the rail/light rail/ferry/metro network to travel to a destination station. A destination station is the station which acts as the proxy for an external zone. Each external zone, both employment centre and wider external zone, is represented by a destination station. A representation of the rail/ferry network is created for Leg 3 using the TfNSW General Transit Feed Specification (GTFS). The formula for computing costs in Leg 3 is the same one used in Leg 2; with the exception of the mode transfer penalty, as it was already applied in Leg 2.

The second part of the Leg 3 trip is the trip from the destination station to the destination. Again, an average trip is created to represent the trips from the destination station to the final destination. For employment centres, this trip is a walking trip of various durations to account for the differing sizes of the employment centres. The cost of this part of the trip is computed using the same formula as in Leg 1. For wider external zones, another local bus trip is assumed to take place from the destination station to the destination. The costs of this trip are computed using the same formula as in Leg 2.

The final cost of a local to external public transit trip is calculated by the summation of the costs from all components of the three legs.

External to local trips are equivalent to LE trips but take place in the opposite direction. Since the only change is the order in which the trip is made, their costs are identical for equivalent EL-LE pairs.

Local to local trips also consist of three legs. Leg 1 is the walk to the local bus stop and is the same as in EL trips. Leg 2 consists of taking the local bus to a destination zone. The formula used is the same one as in Leg 2 of EL trips, with the only difference being that the trip is taken to another internal zone instead of a gateway. Finally, Leg 3 is another walking trip from the local bus in the destination zone to the centroid of the destination zone. The cost of this leg is calculated the same as Leg 1. If two zone centroids are within 1km of each other, or if two zones share the same local bus stop, a walking trip from one zone centroid to the other replaces Legs 1-3 of a LL trip.

The final cost of a local to local public transit trip is calculated by the summation of the costs from all components of the three legs.

An important note is that most zones are connected to multiple gateways via multiple local bus services. Each of these alternatives has a different generalised cost. For the purposes of public transit vs car mode choice, the generalised cost of a public transit trip is considered to be the lowest generalised cost of any of the possible public transit trips. Later, when the trips are assigned, they are assigned through a logit model so that trips are distributed via different gateways and via different local bus services.

6. Step 5 - Car Generalised Cost

Car generalised cost for each OD pair is computed via the following formula:

- $Cost = IVT + Fare\ Factor\ x\ \frac{(Distance\ x\ Car\ Operating\ Cost\ Per\ Km + Toll + Parking\ Cost)}{Car\ Occupancy}$

Where;

- IVT is in-vehicle time (travel time)
- Fare factor is used to convert monetary costs to perceived minute cost. It is the same factor used to convert fares into a perceived minute cost for public transit fares in Step 4

Car travel time, distances and tolls are all obtained from the Sydney Strategic Traffic Model (STM).

Car occupancy cost per km and car occupancy are globally assumed parameters. Parking costs are different for each external zone. Parking costs are chosen to reflect the scarcity of parking at each destination.

7. Step 6 – Mode Choice

A simple binomial choice model is used in the MPPM to calculate mode choice. Specifically, the following formula is sued to calculate the proportion of public transit trips:

$$PT\ Proportion = \frac{e^{-\beta\ x\ GC_{PT}}}{e^{-\beta\ x\ GC_{PT}} + e^{-\beta\ x\ (GC_{car} + ASC_{car})}}$$

Where;

- PT Proportion is public transit mode share
- GCpt is the public transit generalised cost calculated in step 4
- GCcar is the car generalised cost calculated in step 5
- ASCcar is the alternative specific constant for car
- β is the sensitivity parameter

The two parameters used in calibrating the model; the β and the ASCcar, are varied for different trip types. All trips are divided to fall into one of eight trip types. All origin zones are divided into two types – rail walk and rail non-walk, depending on whether the zone falls within the walking distance of a gateway station. Destination zones are divided into 4 types: CBD, other centre, rail walk and rail non-walk, where;

- CBD is the CBD
- Other centre refers to employment centres outside of the CBD
- Rail walk refers to destination zones which are within a walking catchment of a gateway station but are not employment centres

- Rail non-walk refers to destination zones which are not within a walking catchment of a gateway station

Trip types are the combinations of the origin and the destination types and are;

- Rail walk to CBD
- Rail walk to Other Centre
- Rail walk to Rail walk
- Rail walk to Rail non-walk
- Rail non-walk to CBD
- Rail non-walk to Other Centre
- Rail non-walk to Rail walk
- Rail non-walk to Rail non-walk

To ensure the most accurate representation of traveller's behaviour, a unique sensitivity and alternative specific constant for each of the eight trip types because the difference in costs is perceived differently depending on the trip type.

For example, the ASCcar for rail non-walk to rail non-walk trips is negative, indicating a preference for making these trips by car. This occurs because making such trips via public transit requires a minimum of two mode changes. While a mode transfer penalty is applied to each when computing generalised cost, the additional perceived inconvenience of having to change modes twice is not accounted for until the ASCcar parameter is applied. Conversely, the ASCcar for trips to the CBD is positive indicating a preference for public transit on such trips due to the additional perceived cost of spending additional time in congestion and difficulty finding parking at the destination.

The sensitivity parameter is also varied to reflect how strong some of these preferences are. It is lower for trip types where there is a clear preference for one mode over the other, such as the preference for public transit to the CBD or the car for non-walk to non-walk trips, and higher for trip types where there isn't a clear preference and the difference in general costs is the most important factor in mode choice.

Variation of the two parameters based on trip type allows for a better calibration of the model. The model is calibrated based on the 2011 JTW data. The shape of the logit curve represents a limitation for zone pairs where mode share is significantly skewed to either mode. While it would be very easy to replicate the 2011 mode choice using very high parameters, these parameters would not be realistic. Thus, the 2011 JTW mode shares are used a guide rather calibration targets.

The logit model is applied to each zone pair in the model to determine mode share to and from each individual zone. Demand values refer to JTW trips across the 24-hour period. These are converted into all trip purposes over a 3.5 Hr AM peak and then a 1 Hr AM peak using appropriate factors. The factors are derived by comparing the number of JTW trips assigning to the rail network to the total observed 3.5 Hr rail station entries. The 3.5 Hr rail station entries are sourced from the Rail Station Barrier Counts 2013 report authored for the Bureau of Transport Statistics and TfNSW.

8. Step 7 – Trip Assignment

The mode choice model provides forecasts for public transit trips between each zone pair. Multiple alternative paths exist for public transit trips, as they can be made via multiple gateways. Also, most gateways can be accessed via multiple local bus services. In the trip assignment stage, these trips are assigned to alternative paths through the modelled transit network.

First, the demand for each OD zone pair is distributed to all the possible gateways which can be used to complete each trip. This is done using a simplified version of the binomial choice used in determining mode choice. There is only one parameter in this model – the sensitivity parameter. The alternative specific cost parameter is not used as all of the trips are made using the same mode. The sensitivity parameter used here differs from the one used in the mode choice model. It is calibrated to create a reasonable distribution of trips to each gateway depending on their relative costs for each zone pair. The costs used in this assignment are the cost of making the entire trip via each gateway, not just the cost of leg 3, as the decision of which gateway to use is made at the beginning of the trip and not at the beginning of leg 3.

Next, the demand from each zone to a gateway (or to another internal zone for LL trips) is assigned to the appropriate bus services. Again, a simple binomial choice model is used, with the sensitivity parameter being the only factor. This is another internally calibrated factor based on a reasonable distribution in regards to relative costs of alternative routes which differs from sensitivity parameters used previously. Again, the costs used are for the whole trip made via each service, not just leg 2.

An allowance for park and ride is included at this stage. It is recognised that a certain proportion of public transit trips will be made via park and ride or kiss and ride instead of the local bus network, especially at gateways where significant parking provisions or on-street parking facilities exist such as Meadowbank or West Ryde. The park and ride factor reduces the demand on the local bus services leading to these gateways, while leaving the demand at the gateway unaffected.

Once the trips are assigned to each local bus service, statistics such as demand at gateways or bus on/off diagrams can be reported.

APPENDIX B - AIMSUN CALIBRATION REPORT

Melrose Park Transport Management and Accessibility Plan (TMAP)

Payce Property

Calibration and Validation Report

Rev B - Final

10 May 2018

Melrose Park Transport Management and Accessibility Plan (TMAP)

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Rev A	8/1/2018	Draft	C Arkell/A Minic	I Smith	I Smith
Rev B	10/5/2018	Final	C Arkell/A Minic	I Smith	I Smith

Contents

1. Introduction

1.1 The project

Jacobs have been commissioned by Payce Property to develop a Transport Management and Accessibility Plan (TMAP) for proposed development at Melrose Park. Currently comprised of primarily industrial development, the Melrose Park site presents significant opportunities for redevelopment and rezoning to increase population density.

The Melrose Park TMAP will be informed by operational traffic modelling undertaken using a hybrid mesoscopic and microscopic traffic model using the Aimsun software package. The *Melrose Park Hybrid Traffic Model* will provide a tool for the assessment the impacts of new proposed mixed-use development on travel times and traffic performance through the study area.

Hybrid mesoscopic and microscopic traffic modelling provides the ideal tool to assess the requirements of the surface transportation network, effects of congestion and identification of network constraints.

1.2 Model purpose

The purpose of the model is to provide a strategic assessment of the road-based transport infrastructure requirements to support proposed development at Melrose Park. The wider mesoscopic areas of the model are not for the purposes of detailed road design. The microsimulation area directly impacted by the proposed development will be more detailed in nature and may be used to inform road design activities.

1.3 Modelling process

The Sydney Strategic Travel Model (STM) has been used to provide initial travel demand and will also be used for future demand development.

The *Melrose Park Hybrid Model* has been developed using the Aimsun modelling platform (version 8.2.1) and has been calibrated and validated based on the principles outlined in the *Roads and Maritime Traffic Modelling Guidelines, 2013*, modified for the specific purposes of the model and specified in the *Melrose Park Traffic Model Scoping Report* (23 October 2017) prepared by Jacobs.

Mesoscopic modelling provides sufficient detail to determine the performance of the road network under proposed future land use scenarios and provides guidance on the need for further road infrastructure requirements. In addition, mesoscopic simulation allows for true dynamic equilibrium assignment where vehicles can select their optimal travel routes based on their previous travel experiences. This provides a confidence that the modelled pattern of traffic represents a realistic response to the delays and capacity constraints that would be experienced by traffic on a day-to-day basis.

Additionally, the model includes a microscopic simulation area in the immediate vicinity of the development site in order to better reflect detailed behaviour such as lane-changing and weaving which is best modelled using microscopic simulation.

1.4 Purpose of this report

This report is intended to document the development, calibration and validation of the *Melrose Park Hybrid Model*. It details the process undertaken to calibrate and validate the model and specifies the conformance of the model to relevant modelling guidelines for calibration and validation.

1.5 Assumptions and limitations

1.5.1 Assumptions

The calibration and validation of the *Melrose Park Hybrid Traffic Model* is based on a number of assumptions:

- Peak period private vehicle travel demands supplied from STM are representative of peak period travel demand
- Traffic count data is a true and accurate representation of existing traffic conditions
- Public transport data supplied by Transport for NSW is a true and accurate representation of existing services
- Signal timing data supplied by Roads and Maritime Services from 2017 is a true and accurate representation of existing traffic signal operation
- Travel time data is an acceptable representation of existing delays across the network.

1.5.2 Limitations

The calibration and validation of the *Melrose Park Hybrid Model* documented in this technical report is subject to the following limitations:

- Traffic analysis has been limited to the morning (6-10am) and evening peak (3-7pm) four-hour periods for a typical weekday
- The traffic model development has been limited to mesoscopic modelling of the study area, except for the specified area surrounding the Melrose Park proposed development which was simulated using microscopic modelling
- The zoning system within the model is limited to some subdivision of the Sydney Strategic Travel Model (STM) zone system (TZ11). This subdivision includes detailed zone disaggregation down to the level of local or collector roads.
- Traffic data, including counts, signal timings and travel time surveys were gathered from a number of sources. While every effort has been made to ensure continuity in these sources, some inconsistency in count data is expected which may have an impact on the calibration and validation process.

1.6 Report structure

This report is structured as follows:

- Section 2: *Model development* – Outlines the methodology used in the development of the model and illustrates all supplied transport data
- Section 3: *Demand matrix development* – Details the sources and development of traffic demand
- Section 4: *Model calibration* – Details the calibration procedures and results
- Section 5: *Model validation* – Details validation procedures and results
- Section 6: *Conclusions* – Outlines the conclusions of the calibration and validation process.

2. Model development

2.1 Overview

The *Melrose Park Hybrid Model* has been developed using the Aimsun (version 8.2.1) traffic modelling platform. Aimsun allows for the development of static and dynamic traffic models within a unified platform, performing traditional static macroscopic modelling using volume delay functions as well as more detailed dynamic mesoscopic and microscopic simulation modelling. Dynamic traffic models are useful in modelling congested or capacity-constrained conditions where traffic demand exceeds available capacity and traffic diverts to seek less congested alternative routes. These conditions result in queuing that builds up and dissipates over time and dynamic routing of traffic that is responsive to this build-up of delays.

The model is based on an initial road network and traffic demand supplied by Transport for NSW, converted from the Roads and Maritime Strategic Highway Assignment Model and refined for the study area. This model has been built within the Greater Metropolitan Sydney network as a sub-model.

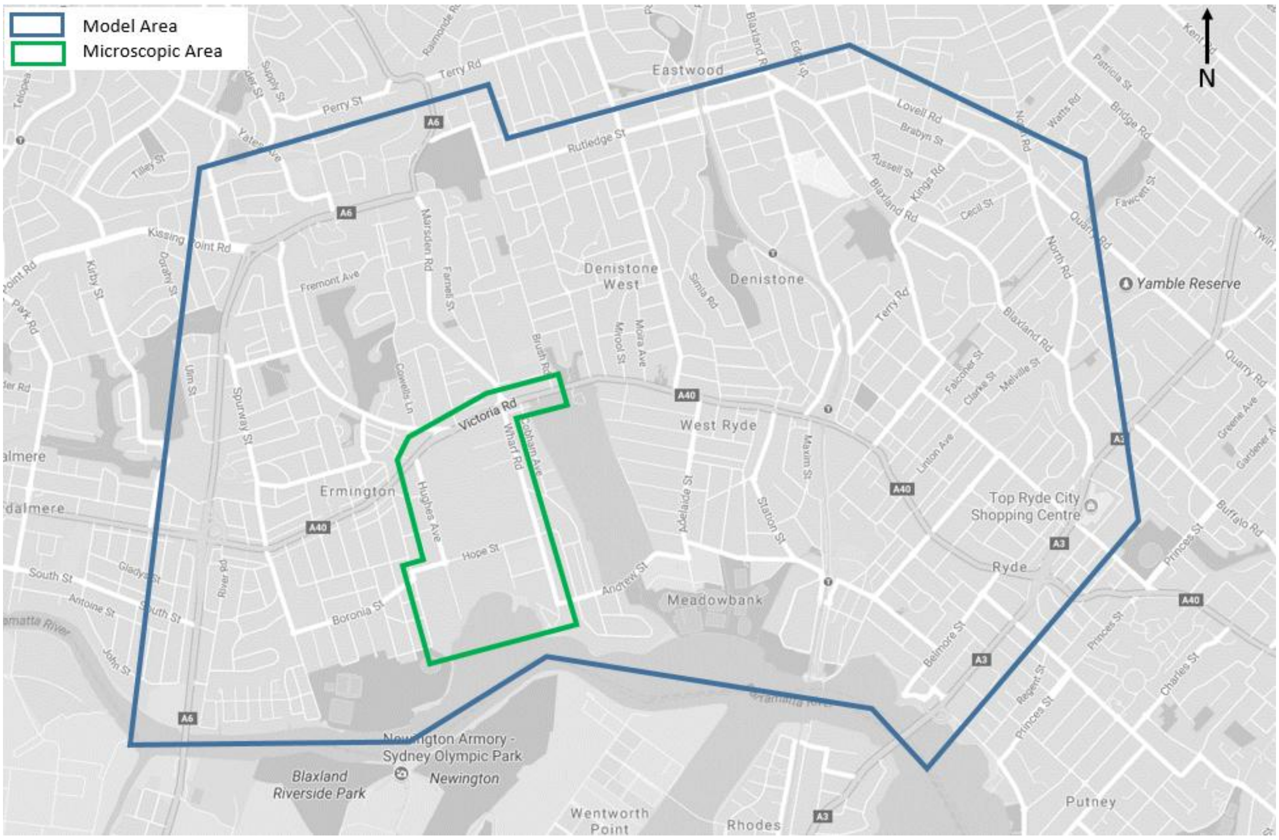
2.2 Model scope

2.2.1 Geographical coverage

A map of the model extents is provided in Figure 2.1. The model extends beyond the immediate area surrounding the proposed development to ensure that all traffic movements potentially related to development at Melrose Park are captured by the model.

Located in Sydney's North-West, Melrose Park is bounded by Victoria Road to the North, Archer's Creek to the East, the Parramatta River to the South and Hughes Avenue to the West.

Figure 2.1 : Aimsun model extents



2.2.2 Temporal coverage

The model covers the morning and evening peak periods from 6:00am to 10:00am and from 3:00pm to 7:00pm respectively. In addition to these simulation periods, a "warm-up" period of an additional 30 minutes has been specified to sufficiently load the network at the start of each analysis period. Results from the warm-up period are not included in the reported model statistics.

Traffic demand has been defined in 15-minute matrices, while signal control plans have been defined per-hour. Signal times were averaged per-hour as minimal phase time variance within the hour was observed for the majority of intersections within the modelled area. The accuracy that would be provided by the use of separate 15-minute signal plans would be minimal, particularly when considering traffic count data and traffic signal data are not from the same day. The profiles of 15-minute traffic counts would not correspond directly to the 15-minute profile of green time; furthermore, under future scenarios, fine-tuning of traffic signal settings at the 15-minute level is not practical.

2.2.3 Vehicle classes

The following four vehicle classes have been explicitly modelled:

- *Cars*: comprised of cars, taxis and light vans (all modelled as the same vehicle class), Austroads classes 1 and 2
- *Trucks*: comprised of small and large rigid trucks, Austroads classes 3, 4 and 5
- *Heavy trucks*: comprised of articulated semi-trailers and B-doubles, Austroads classes 6 and above
- *Buses*: modelled using fixed routes and timetables rather than demand matrices.

2.3 Road network

Key components of the existing road network in the study area are detailed in this section.

2.3.1 Victoria Road

Victoria Road is a state arterial road that provides access between Parramatta and the Anzac Bridge. Near the study area, the Victoria Road experiences moderate to high delays during the morning and evening peak periods, particularly near Kissing Point Road and Marsden Road. Clearways and bus lanes are in effect in both directions during peak periods. Several bus routes run along Victoria Road, including the M52 bus route. Parking is not permitted along Victoria Road, except near the West Ryde.

2.3.2 Silverwater Road

Silverwater Road is an arterial road that connects Dundas Valley to Lidcombe in a north-south direction. Some delays occur during the peak periods at Silverwater Road, south of Victoria Road. Near the study area, the posted speed limit is 80 km/hr and no parking is permitted along Silverwater Road.

2.3.3 Marsden Road

Marsden Road is a sub-arterial road that provides access between Carlingford and West Ryde. The posted speed limit is 60 km/hr and on-street parking is available on both sides of the road. The road generally operates with spare capacity, but experiences moderate delays near Victoria Road and between Morris Street and Stewart Street.

2.3.4 Wharf Road

Wharf Road is a collector road that connects Ermington to Melrose Park. The road experiences minor congestion at the intersection with Victoria Road. The posted speed limit is 50 km/hr and on-street parking is available along some sections of the road.

2.4 Zoning system

The model has a base centroid configuration corresponding with Transport for NSW's Transport Performance and Analytics (TPA) Travel Zones 2011 (TZ11). The TZ11Travel Zones cover large areas and hence have been disaggregated in order to provide sufficient detail and resolution in future scenarios. This disaggregation has been based on observed dwelling within each travel zone.

A summary of disaggregated centroids is shown in Table 2.1.

Table 2.1: Summary of centroid disaggregation

Travel Zone	Name	No. of disaggregated centroids
1113	Lottie Stewart Hospital	2
1118	Ermington	3
1121	Reckitt Benckiser	27
1123	George Kendall Riverside Reserve	4
1124	Ermington_River Rd and Lindsay Ave	2
1582	Marsden High School	2
1583	West Ryde Station_West	2
1585	West Ryde	2
1588	Melrose Park	4

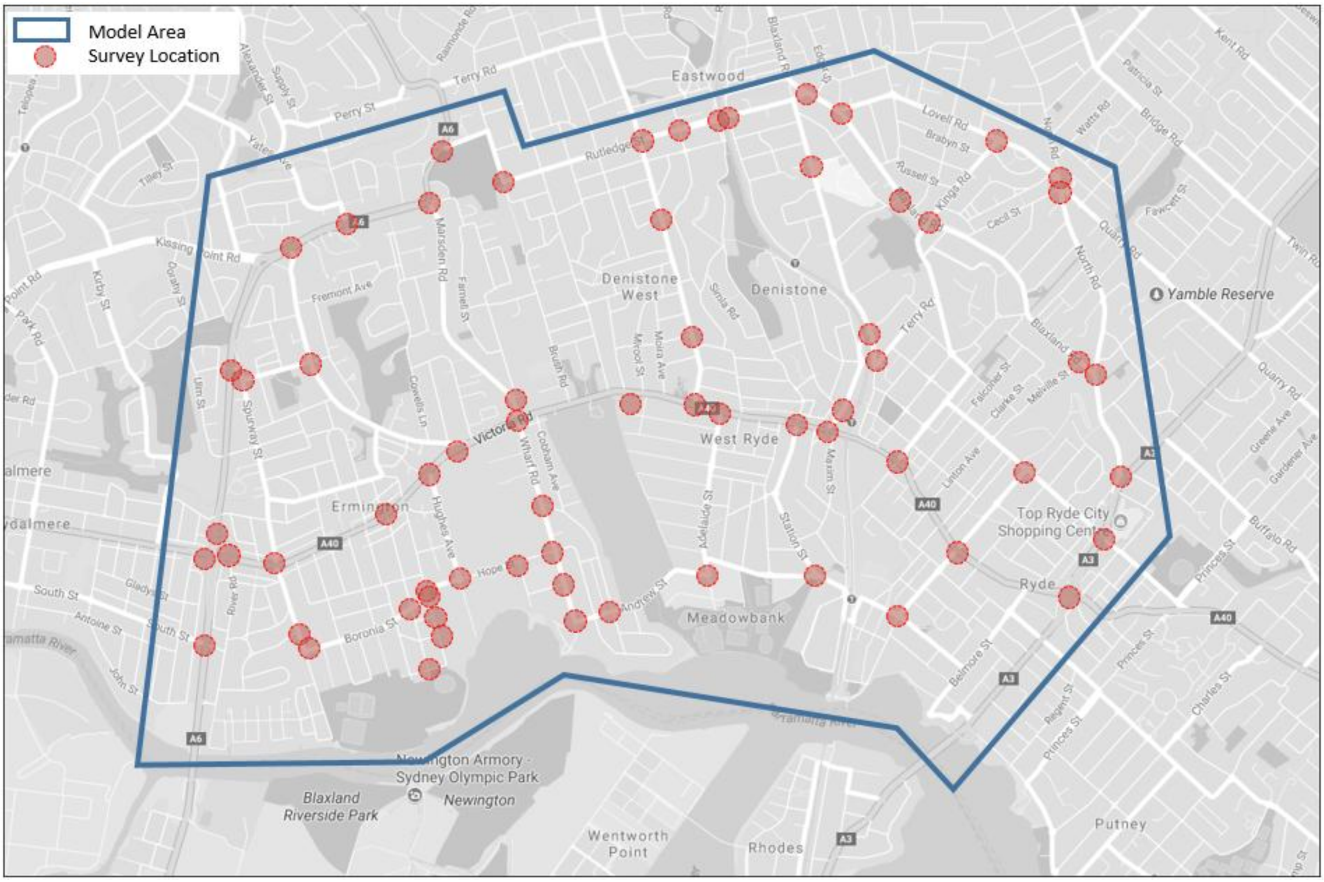
2.5 Model data

Traffic data used in the development of the model was collected from various sources. This section details the collection and analysis of this data.

2.5.1 Turning movement counts

Classified turning movement surveys for 64 intersections were collected at 15 minute intervals during the morning and evening peak and do not identify rigid and articulated heavy vehicles separately. A summary of intersection turning movement counts within the study model area is shown in Figure 2.2. The intersection movements were collected on 1 August 2017.

Figure 2.2 : Intersection survey locations



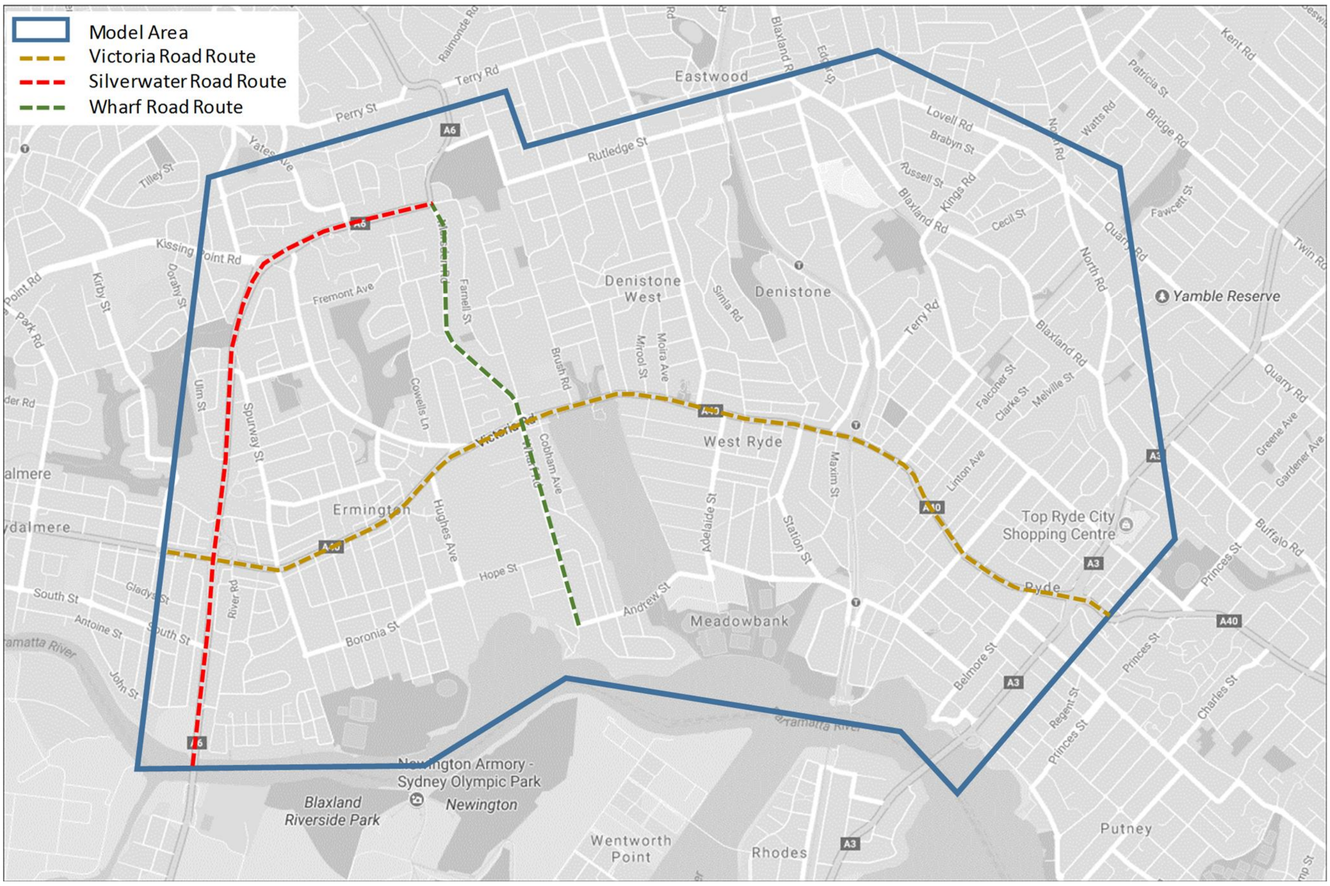
2.5.2 General traffic travel time data

General traffic travel time data was collected in August 2017 for three key routes in the study area using floating car travel time surveys:

- Victoria Road (between Silverwater Road and Devlin Street)
- Marsden Road (between Andrew Street and Silverwater Road)
- Silverwater Road (between Silverwater Bridge and Marsden Road)

These routes are shown in Figure 2.3.

Figure 2.3 : Travel time survey routes



2.6 Development of Real Data Sets

Real Data Sets (RDS) of target volumes were prepared for two purposes:

1) Target volumes against which model calibration is measured
2) Target volumes to guide the matrix adjustment processes

The RDS covers the full four hours of the morning and evening peak model periods. The RDS contains a total of 432 count movements for each hour.

2.6.1 Consistency checks and balancing

To provide a sound basis for calibration and demand adjustment, especially in view of the range of types and dates covered by the surveys, the counts have been checked and adjusted for consistency. This also provides an additional check that the counts have been processed and imported into the model correctly.

For each time interval, the counts have been propagated through the network to identify section volumes based on both upstream and downstream sources, and the turn or midblock counts which contribute to each.

Where a discrepancy is found between the propagated upstream and downstream sources, the contributing counts are adjusted accordingly.

Discrepancies have been adjusted for in cases where the GEH is greater than 2.0 or 50 vehicles per hour (whichever is larger) between adjacent intersections. As quoted in the *Roads and Maritime Traffic Modelling Guidelines version 1.0*, Transport for London (TfL) suggests that the accuracy of observed counts must be within +/- 50 pcu/hr or within a GEH of two. Adopting this method ensures that the larger counts remain within this range while providing good consistency between the lower volume counts.

2.7 Road network coding

2.7.1 Initial network coding

Coding of the road network was undertaken on the basis of updating Transport for NSW's latest Sydney GMA Aimsun network. In-filling of detail within the study area was undertaken on the basis of site observations, aerial photography and Google Streetview.

Additional time-dependent traffic management policies were coded in the network to reflect features such as school speed zones.

In locations where parking in a traffic lane is allowed across both peak periods, and aerial photographs indicate demand for this parking, the affected lane is not included as a trafficable lane in the model.

2.8 Public transport network coding

Coding of the public transport network was undertaken based on bus stop, bus route and bus timetable data from the Transport for NSW Operational Spatial Database (OSD). This database provides the location of bus stops, bus routes and stopping patterns as well as timetabled arrival times at each stop along each route.

A subset of the OSD was extracted that detailed the stops and routes for all public and school buses passing through the study area during the morning and evening peak periods. These bus stops were imported and bus routes created based on linking stops according to the shortest path between stops. Review and correction of imported routes was also undertaken to ensure that stops were imported in the correct locations and that routes operated along the correct paths.

2.9 Traffic signal settings

The traffic signal times have been derived from SCATS History file data which records the times for individual phases across the peak period. These phase times have been aggregated and imported into the models and manually adjusted to reflect a realistic representation of phase and cycle timings.

A limitation of the SCATS History files is that they do not record gap-out behaviour for diamond overlap phases. This behaviour occurs when there is an imbalance in right turns during a diamond phase, causing SCATS to call a short alternative phase to allow a leading right turn and through movement to run before the main through movement phase. The model flows and operation were observed and where it was determined that this gap-out feature was required to meet observed flows, a leading right turn phase was coded taking time from the recorded diamond phase.

Midblock pedestrian crossing in the study area also showed some variability in operation, with many being called inconsistently during the peak periods. A conservative assumption was made to model these pedestrian crossings as being called every cycle for the purposes of simplicity.

2.10 Behavioural settings

The following behavioural settings were used in the development of the model:

- Look-ahead distance variability: 40%
- Simulation step: 0.8 seconds
- Mesoscopic reaction time (all vehicles): 1.2 seconds
- Mesoscopic reaction time at traffic lights (all vehicles): 1.6 seconds
- Microscopic reaction time (all vehicles): 0.8 seconds
- Microscopic reaction time at traffic lights (all vehicles): 1.1 seconds
- Global arrivals: exponential distribution

The global jam density was set to 180 veh/km, which is the value used in the Sydney Aimsun model and suggested by the developers of Aimsun (TSS). Jam density is measured as number vehicles allowed per kilometre of road. Vehicles under mesoscopic simulation are modelled with instantaneous acceleration and deceleration; to better account for the impact of this behaviour in mesoscopic simulation, the jam density of road sections has been adjusted to more accurately represent delays in areas where driver merge and diverge behaviour is critical to the network, for example Victoria Road before Hermitage Road. The global jam density parameter has been retained for the majority of sections within the network, with the following exceptions:

  - Sections of Victoria Road westbound between Mellor Street and West Parade, where jam density is less than 180 veh/km due to a 'lane-drop' from 3 to 2 and a narrowing of the road corridor as vehicles travel under the rail bridge.
  - Sections of Victoria Road westbound on approach to Wharf Road/Marsden Road due to observed lane changing/weaving associated with the ending of the bus lane and vehicles preparing to turn right at Kissing Point Road.
  - The southernmost section of Church Street where downstream constraints on Concord Road outside of the model area reduce the southbound capacity of the section.

These changes to jam density closer replication of the observed capacity reductions through these parts of the road network.

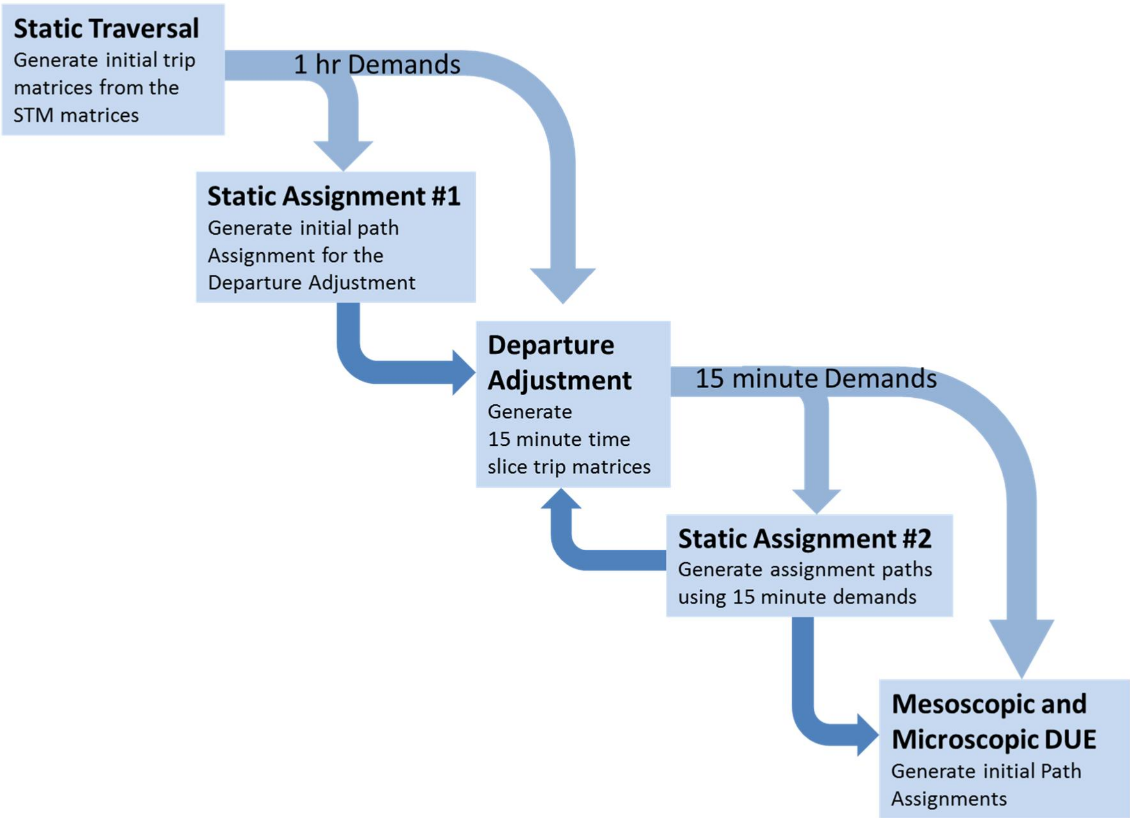
2.11 Traffic assignment and trip demand development

Aimsun allows for a combination of assignment types in combination with different vehicle simulation methods. The Melrose Park model has been developed using the following combinations of assignment and simulation techniques:

1) Static equilibrium assignment using static traffic model
2) Dynamic User Equilibrium (DUE) assignment using mesoscopic simulator
3) Dynamic User Equilibrium (DUE) assignment using hybrid mesoscopic/microscopic simulator

The process for assignment and trip demand is summarised in Figure 2.4.

Figure 2.4 : Assignment and trip demand process



The traffic demands were imported from the STM into Aimsun where it was assigned to the Greater Sydney Aimsun model using static assignment. A static traversal was undertaken to obtain the subarea trip matrices for the study area which were then disaggregated to a finer-grained centroid configuration to allow for modelling of the detailed road network.

The subarea matrices were then assigned to the study area road network as part of the first pass of the static assignment. The assignment results were reviewed to make sure that path assignment through the network was reasonable. The assignment paths were then used to undertake the departure adjustment.

The result of the departure adjustment was then reassigned using the static assignment. This was used to calibrate the initial flat traffic demand across the entire network and provide a starting point for mesoscopic simulation. Mesoscopic Dynamic User Equilibrium (DUE) was then used to fine-tune demand and generate the capacity constrained assignment for input to more detailed hybrid DUE simulation which contains the microsimulation area.

The following settings were used in the final DUE assignment parameters:

- Assignment cycle: 15 minutes
- Number of intervals: 1
- Maximum iterations: 30
- Stopping relative gap: 2%
- Attractiveness weight: 1.0
- User defined cost weight: 1.0
- Maximum paths from path assignment: 3 (the maximum number of assignment paths between any origin and destination pair taken from the static assignment input)
- Maximum paths per interval: 4 (the maximum number of assignment paths used by the DUE between any origin and destination pair)
- Assignment model: Gradient-based
- Path cost: Experienced

3. Demand matrix development

3.1 Traffic demand estimation methodology

Traffic demand estimation was undertaken using the Departure Adjustment method available in Aimsun. The following stages were used in the development of base traffic demand:

- Assignment of the Sydney GMA model and generation of morning and evening peak hour sub-area traversal matrices using static assignment
- Expansion of the single hour traversal matrices in the strategic model zone system to four hour total matrices in the higher-resolution Melrose Park zone system

Manual adjustment of 15-minute matrices to account for differences in static and dynamic assignment

Each of these stages is described in further detail below.

3.1.1 Static demand adjustment

The four-hour flat traffic demand for the sub-area traversal was adjusted to meet observed traffic flows throughout the network according to the hourly counts for each period using static departure adjustment. The departure adjustment procedure is an iterative matrix adjustment procedure that uses the paths and modelled travel time results from a static assignment to adjust the demand matrix and distribute trips in time so that their arrival profiles match observed flow profiles at count locations across the network. The demand adjustment was undertaken on the basis of turning movement counts outlined in Section 2.5.1.

3.1.2 Departure adjustment and slicing

The aim of this process is to adjust and time-slice an origin-destination matrix that considers static assignment travel times to allocate trips to the correct departure matrix in order to reach the desired location at the observed time under dynamic simulations. This resolves the time shift of long trips by considering static travel times in the adjustment. It should be emphasised that this process uses static modelled travel time, and hence dynamic factors such as congestion at signalised intersections are not considered.

The following are the parameters used in this project:

- Interval duration: 900 seconds (15 minutes)
- Matrix weight: 1

The interval duration is the general time duration used for the slicing calculation. The matrix weight provides a limit on the degree to which the original demand matrices can be adjusted, with 1 corresponding to no allowed change and 0 corresponding to complete liberty to change the original matrices.

The 15-minute traffic demands were then manually adjusted as needed for the finer tuning of the calibration in the mesoscopic model to match observed turn flows.

4. Model calibration

4.1 Overview

The calibration of the *Melrose Park Hybrid Model* has been undertaken with a view to meeting the targets for calibration provided in the *Roads and Maritime Traffic Modelling Guideline (2013)*. The calibration has been undertaken based on hourly turning movement counts over the four-hour AM and PM peak periods.

4.2 Calibration targets

The GEH statistic is used in the calibration of traffic models to compare the differences between modelled and observed traffic flows. The GEH statistic is defined as follows:

$$GEH = \sqrt{\frac{(V_{observed} - V_{modelled})^2}{(0.5 \times (V_{observed} + V_{modelled}))}}$$

Based on the calibration and validation guidelines presented in the *Roads and Maritime Traffic Modelling Guidelines, 2013* and the *Melrose Park Model Scoping Report* (23 October 2017) prepared by Jacobs, the following criteria has been adopted:

Whole model

- At least 80% of flow comparisons with GEH less than 5
- At least 95% of flow comparisons with GEH less than 10

Core/microsimulation area

- At least 85% of flow comparisons with GEH less than 5
- 100% of flow comparisons with GEH less than 10

In addition to GEH comparisons, regression analysis of observed versus modelled flows was also undertaken. The following criteria for regression analysis were adopted:

- R^2 greater than 0.95
- Slope between 0.95 and 1.05

The R^2 generally represents the closeness of fit of the observed data points to modelled data points and the slope of the trend line gives an indication of whether the model is general over-assigning (greater than 1) or under-assigning (less than 1) traffic across the network. A total of 432 individual turns were included in this analysis for each one-hour time period.

4.3 Model convergence

The *Melrose Park Hybrid Model* has been developed using dynamic user equilibrium (DUE) assignment. As the dynamic user equilibrium assignment is an iterative process, the relative gap between iterations is a measure of how close the assignment to the “optimal” network equilibrium.

Unlike static models, Aimsun’s dynamic user equilibrium measures the relative gap in the path costs for each path assignment cycle period (in this case 15 minutes) in the simulation. As later periods are dependent on the convergence of earlier time periods, later time periods require more iterations to converge. The relative gap reported for the convergence of the model is the mean relative gap for all time periods.

The hybrid DUE assignment was run using initial paths derived from both an initial static equilibrium assignment and a mesoscopic DUE assignment. A summary of the AM and PM peak hybrid DUE convergence for the model is shown in Figure 4.1 and Figure 4.2.

The hybrid DUE convergence shows that the models terminated at a mean relative gap of 2% after 19 and 23 iterations for the AM and PM peaks respectively. This relatively low variation in relative gap over the last 5 iterations gives confidence that the process has identified a stable equilibrium for the particular input parameters.

Figure 4.1: AM peak hybrid DUE convergence

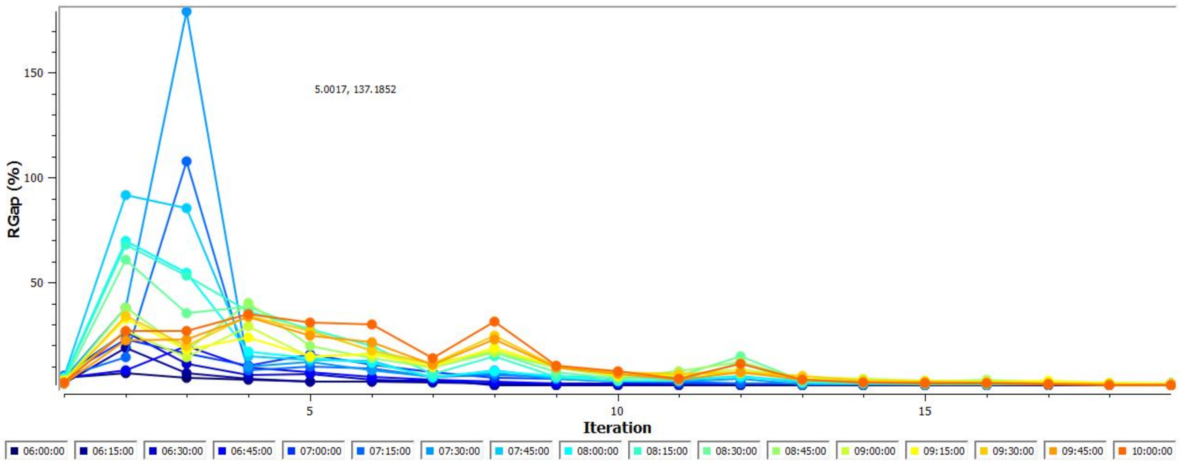
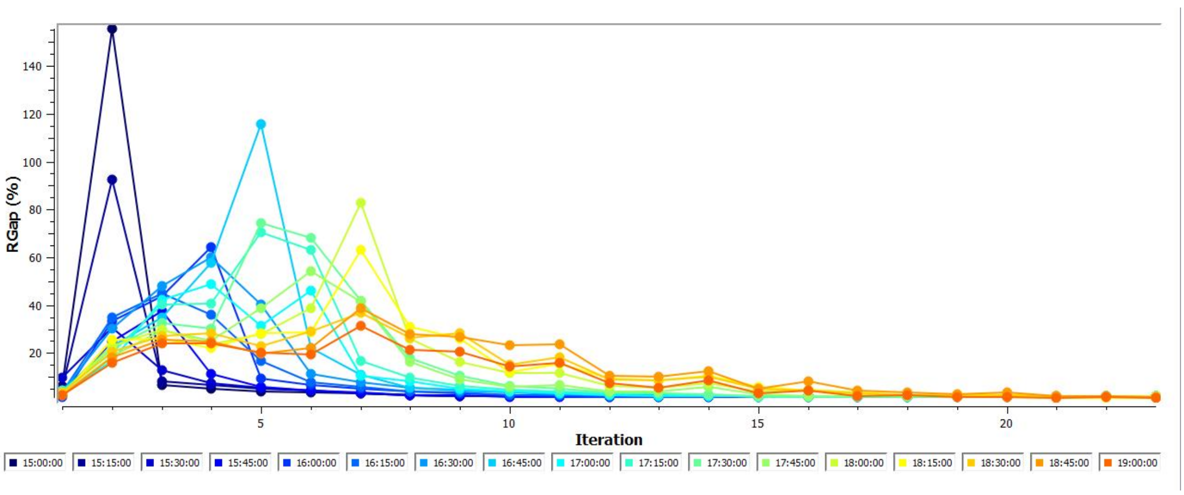


Figure 4.2: PM peak hybrid DUE convergence



4.4 Calibration results

4.4.1 Total traffic volume calibration statistics

A summary of the target count comparison statistics for the DUE assignment is provided in the following section.

Regression analysis

The following section summarises the regression analysis. Figure 4.3 and Figure 4.4 plot the observed traffic flows to the modelled traffic flows, while Table 4.1 provides a summary of the regression analysis statistics for the morning and evening peak by hour.

Figure 4.3: Morning peak modelled vs observed flows 6 – 10am

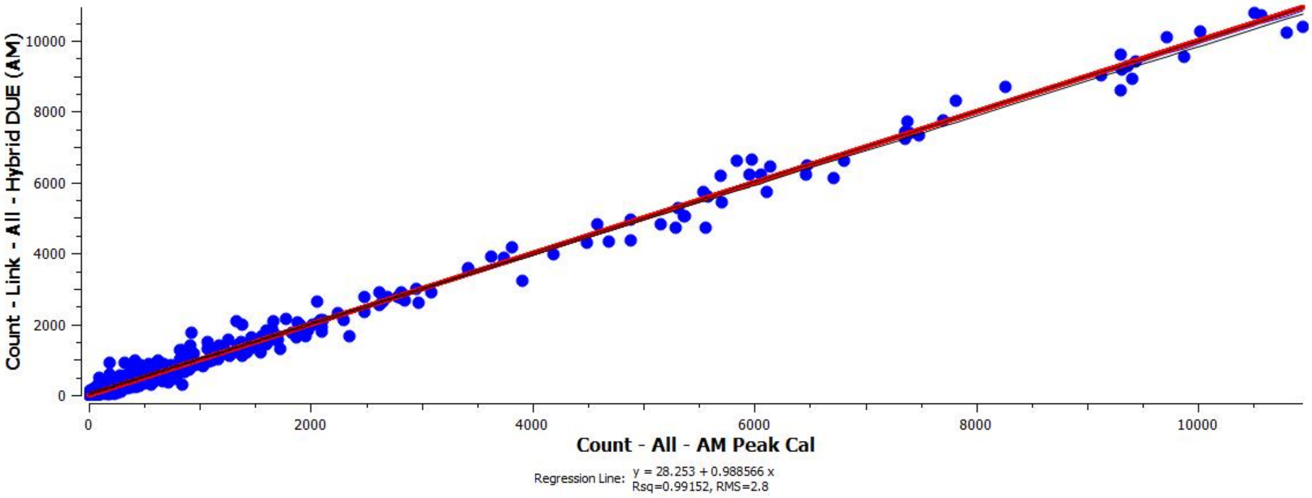


Figure 4.4: Evening peak modelled vs observed flows 3 – 7pm

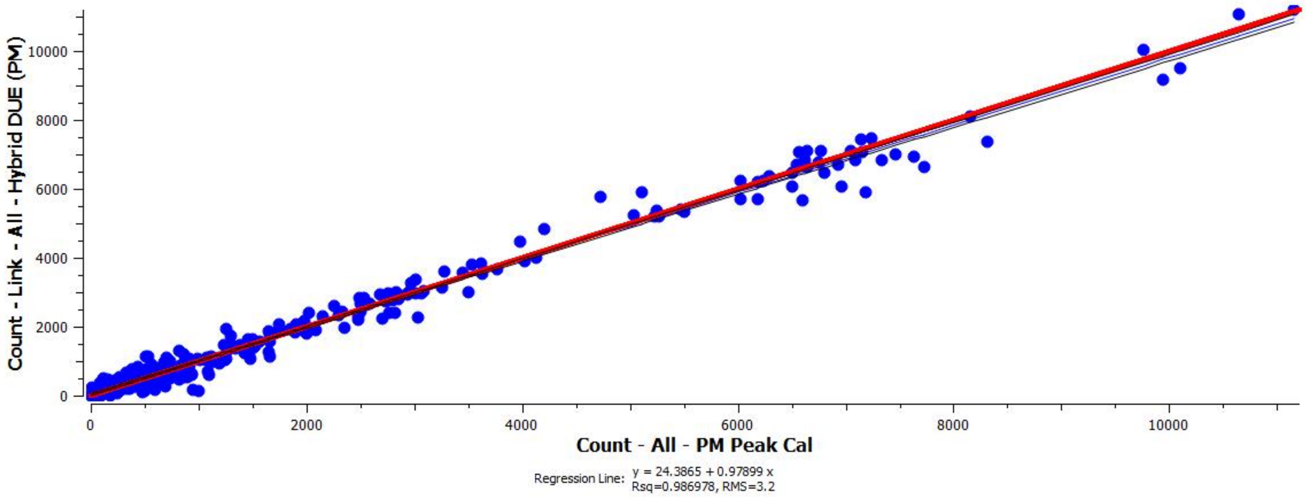


Table 4.1: Summary of model calibration – Regression analysis

Time period	R^2	Slope
6:00 AM to 7:00 AM	0.988	0.974
7:00 AM to 8:00 AM	0.990	0.981
8:00 AM to 9:00 AM	0.981	0.975
9:00 AM to 10:00 AM	0.982	1.014
Total morning peak – all hourly volumes	**0.992**	**0.989**
3:00 PM to 4:00 PM	0.973	0.950
4:00 PM to 5:00 PM	0.986	0.986
5:00 PM to 6:00 PM	0.986	0.989
6:00 PM to 7:00 PM	0.977	0.982
Total evening peak – all hourly volumes	**0.987**	**0.979**

Analysis of the regression parameters show that the targets of R^2 greater than 0.95 and slope between 0.95 and 1.05 are met in each hour.

Based on regression analysis, the model adequately meets the calibration criteria and is a good fit to the observed traffic volumes.

GEH statistics

Table 4.2 and Table 4.3 present a summary of the turn comparison between observed and modelled by GEH statistic. The results indicate the model achieves the adopted GEH criteria for the combined 4 hour periods in both the morning and evening peak periods. On an hour by hour basis, the whole model generally achieves the criteria. Some hourly periods achieve less than 80% for the GEH<5 criteria however no period is lower than 78%.

Similarly, for the core area, all periods achieve the required criteria with the exception of the first hour in both the AM and PM periods. This is not anticipated to affect the findings of the model considering the peak traffic flows occur in the middle 2 hours of the modelled period.

Table 4.2: Summary of turning movement comparisons (morning peak)

Measure	Target	Hour starting				
		All hours	6:00am	7:00am	8:00am	9:00am
Whole model						
GEH<5	80%	84%	78%	80%	78%	80%
GEH<10	95%	99%	99%	98%	95%	98%
Core area						
GEH<5	85%	91%	82%	88%	85%	85%
GEH<10	100%	100%	100%	100%	100%	99%

Table 4.3: Summary of turning movement comparisons (evening peak)

Measure	Target	Hour starting				
		All hours	3:00pm	4:00pm	5:00pm	6:00pm
Whole model						
GEH<5	80%	85%	80%	81%	80%	79%
GEH<10	95%	97%	97%	97%	98%	97%
Core area						
GEH<5	85%	91%	83%	85%	89%	85%
GEH<10	100%	100%	100%	100%	100%	100%

Locations where the GEH comparison statistics exceed 10 are summarised in Table 4.4

Table 4.4: Summary of turn locations exceeding GEH 10

	Location	Comment
AM	Right turn from West Parade into Rutledge Street eastbound	This is at the far north-eastern section of the model and is due to the inability of mesoscopic modelling to depict the delays of this priority turn caused by poor road geometry and sight lines. This causes the turn to be too attractive and hence the modelled volume exceeds the observed counts. This turn will not influence the findings of the modelling.
	Left turn from Bartlett Street into Kissing Point Road northbound	This turn is located in the far north-western section of the model. Some local roads in this area are not included in the model so turning movements are more concentrated at the Silverwater Road/Bartlett Street intersection. The discrepancies at this location are required in order for strategically important upstream and downstream flows on Silverwater Road to match observed counts.
	Left turn from Park Street into Devlin Street northbound	This turn is located at the far eastern section of the model. The zonal system and road networking coding in this area is fairly course and so this turn is used by trips which in reality would be accessing Devlin Street via the Top Ryde car-park exit ramp. Turn flows cannot be accurately met without detrimental impacts to calibration at the downstream Devlin Street/Blaxland Street intersection.
PM	Right turn from West Parade into Anthony Road westbound	These turns are out of/ into a local road in the West Ryde shopping village, 2km from the study area. The zonal system and road networking coding in this area is fairly course and turn flows cannot be accurately met without detrimental impacts to calibration at the nearby Victoria Road intersection.
	Left turn from Anthony Road into West Parade northbound	
	Right turn from Kings Road into Blaxland Road westbound	This turn is located in the far north-eastern section of the model. The zonal system and road networking coding in this area is fairly course and turn flows cannot be met without unrealistic fixed route choice constraints.

4.5 Calibration summary

Based on the model results, the model is considered to be satisfactorily calibrated for the purpose of the Melrose Park TMAP assessment.

5. Model validation

5.1 Overview

Validation of the *Melrose Park Hybrid Model* has been undertaken on the basis of general traffic travel times for routes identified in Sections 2.5.2. As recommended by the *Roads and Maritime Traffic Modelling Guide (2013)*, the target for validation of each route in each hour is for the modelled average travel time for the route to be within 15% or one minute of observed (whichever is larger).

5.2 Validation statistics

5.2.1 General traffic travel time validation results

The travel time validation for general traffic during the morning and evening peak periods are presented in Figure 5.1 to 5.24.

The majority of the travel time observations fall within the 15% upper and lower limits. Some of the modelled times sit outside of the 15% limits, but are still within one minute of the observed travel time.

The delays and travel times at the key areas of project influence along Victoria Road closely match the observed data. The main location where modelled travel times diverge from observed data is on Victoria Road, east of the study area and outside the key areas of influence of the Melrose Park development. At these locations some time periods in the model demonstrate travel times lower than observed data. This is generally due to delays from lane-changing, weaving and merging which cannot be fully captured by mesoscopic modelling. It is also noted that the observed data is highly variable at these locations, with significant differences between the upper and lower 95% confidence intervals.

In summary, these differences between modelled and observed travel times are expected based on the model assumptions and limitations, particularly in the mesoscopic model areas, and do not substantially affect the suitability of the model for assessing impacts of large scale land use changes.

Figure 5.1 : Travel time validation - Victoria Road eastbound 7am-8am

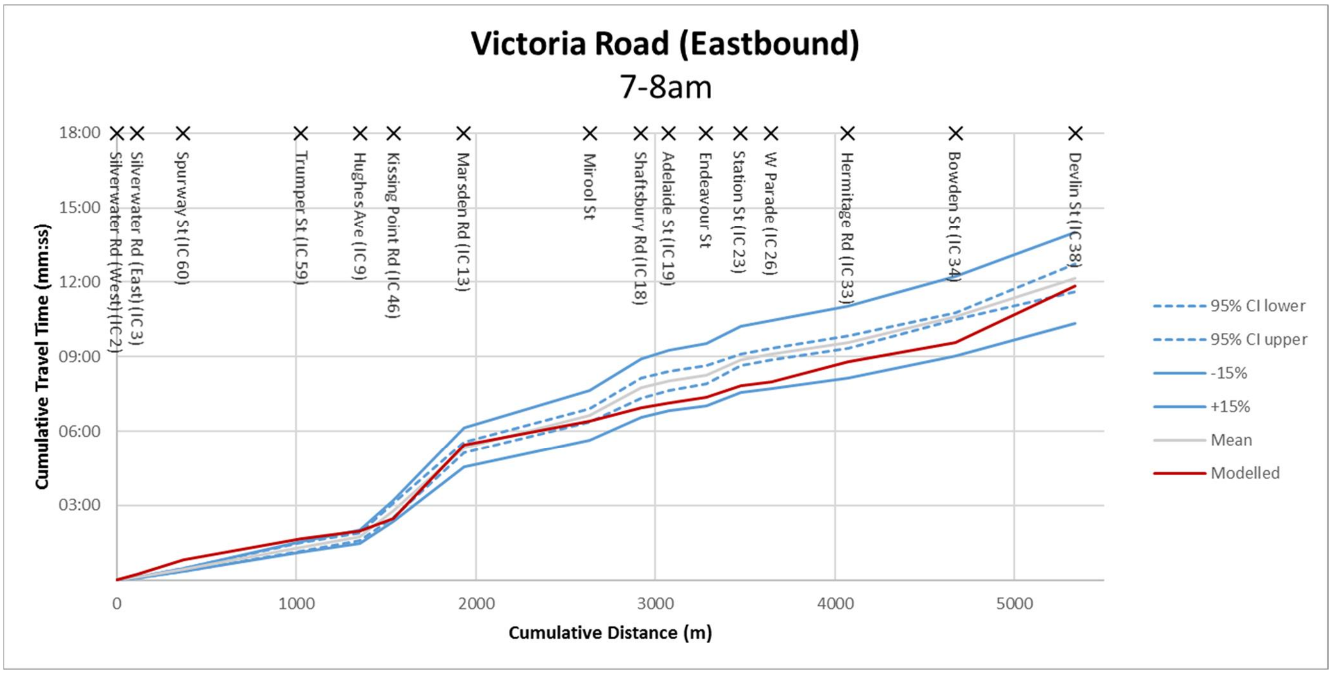


Figure 5.2 : Travel time validation - Victoria Road eastbound 8am-9am

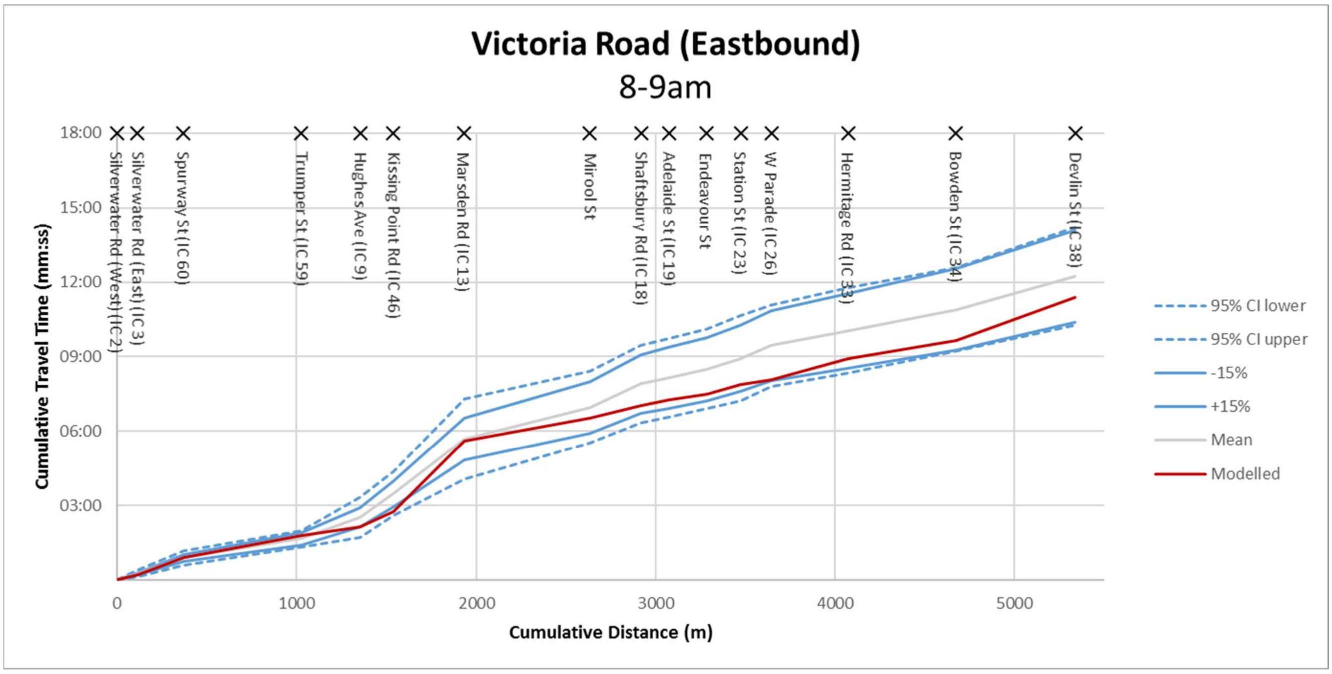


Figure 5.3 : Travel time validation - Victoria Road westbound 7am-8am

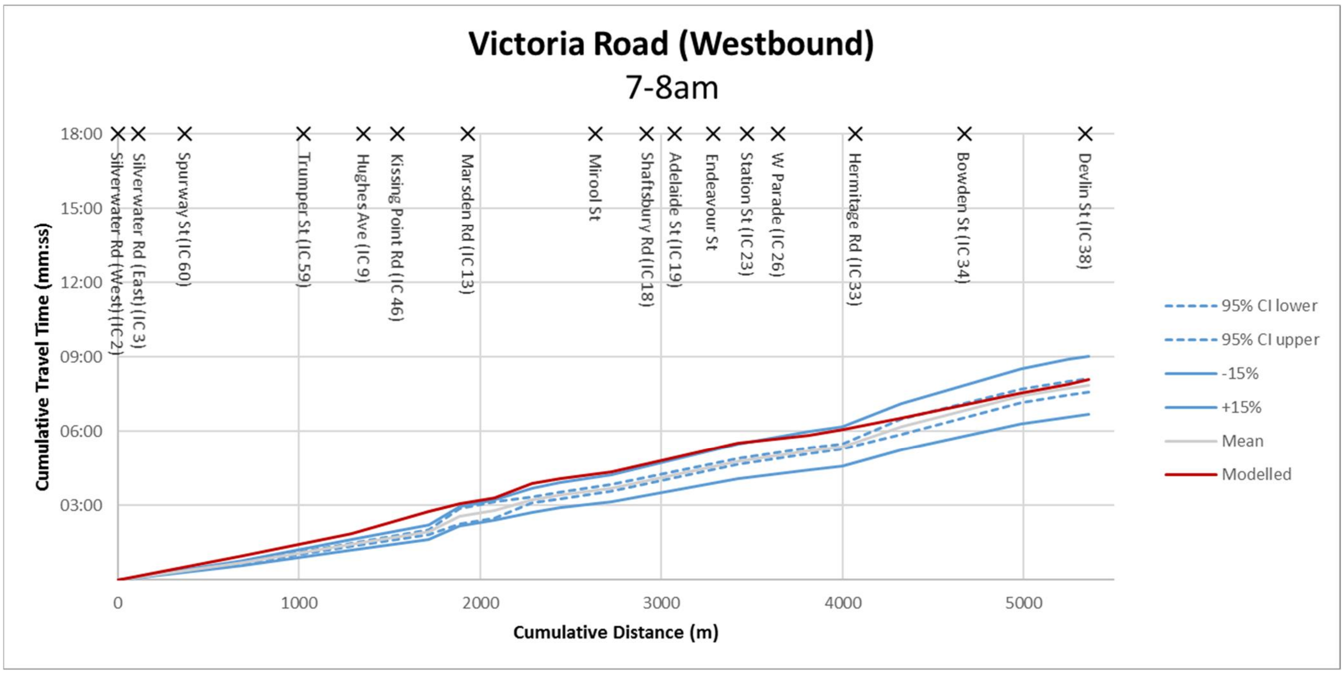


Figure 5.4 : Travel time validation - Victoria Road westbound 8am-9am

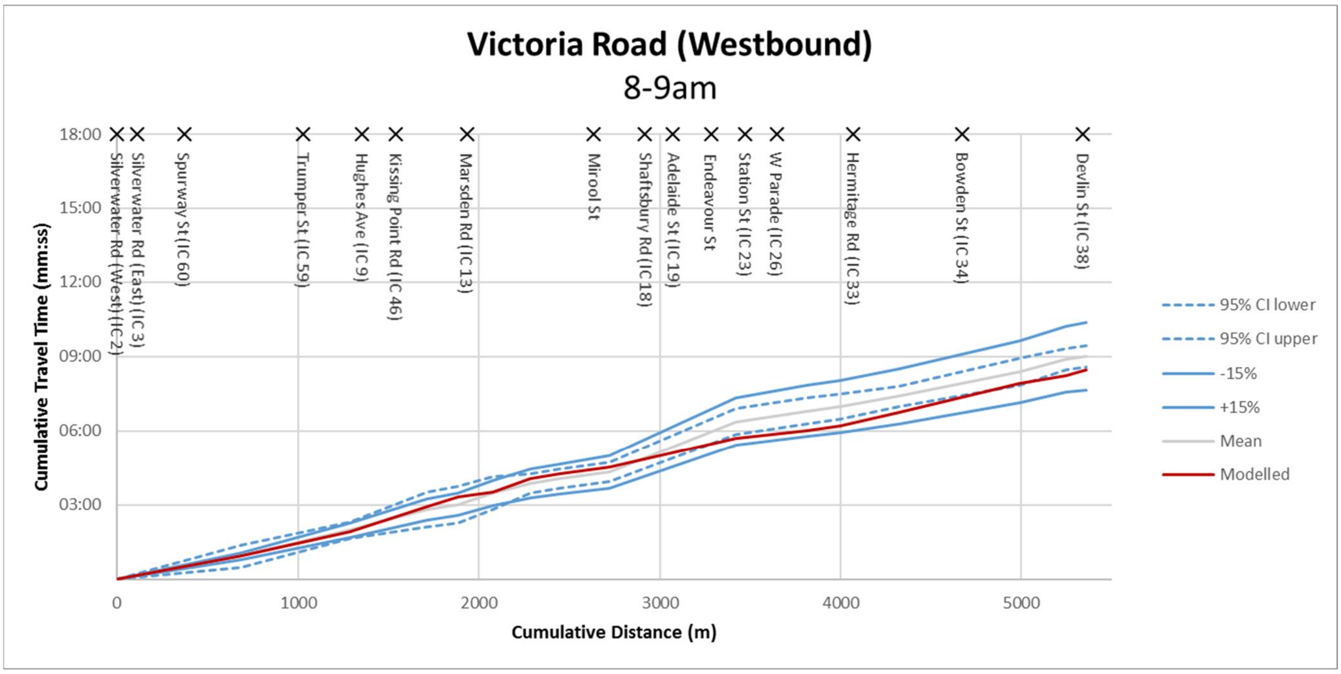


Figure 5.5 : Travel time validation - Victoria Road eastbound 4-5pm

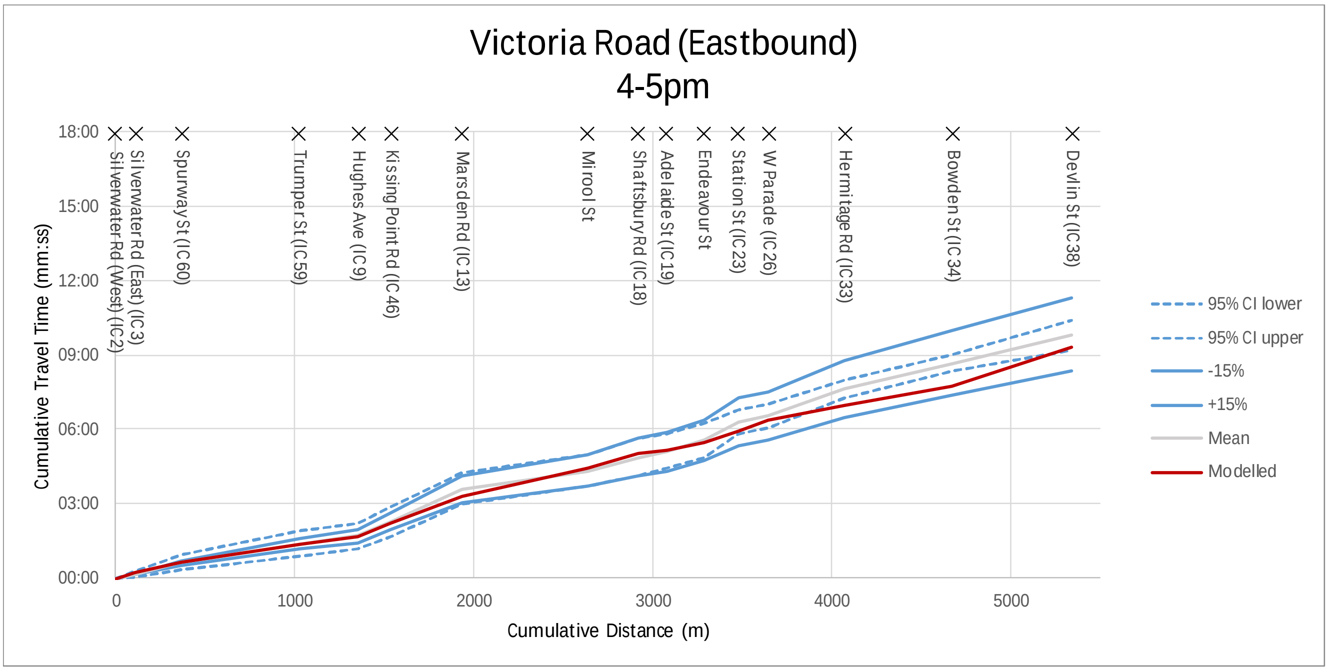


Figure 5.6 : Travel time validation - Victoria Road eastbound 5-6pm

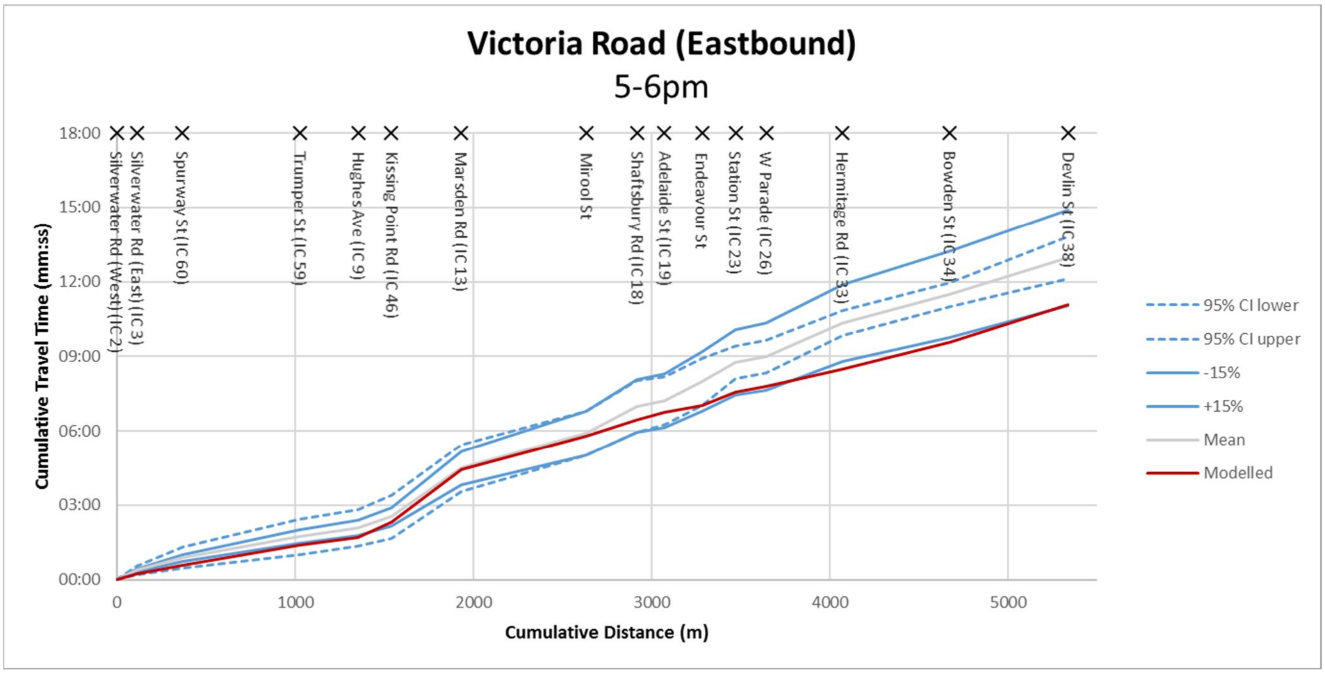


Figure 5.7 : Travel time validation - Victoria Road westbound 4-5pm

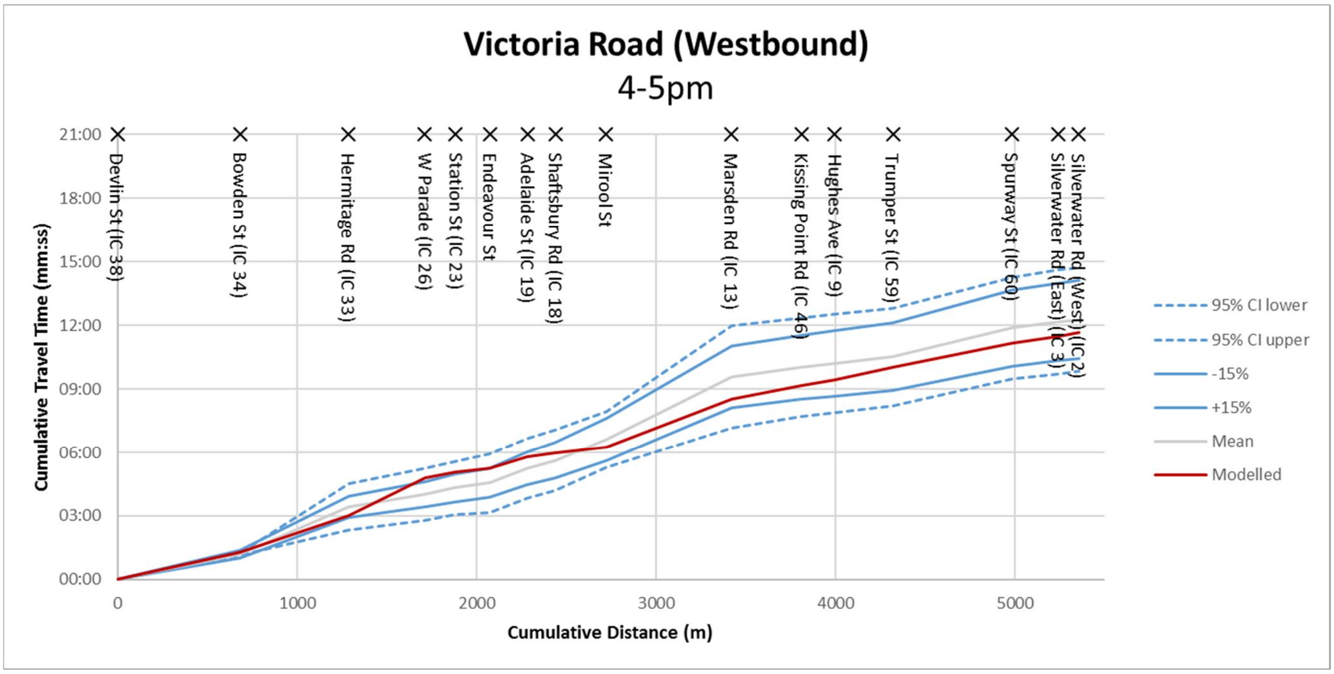


Figure 5.8 : Travel time validation - Victoria Road westbound 5-6pm

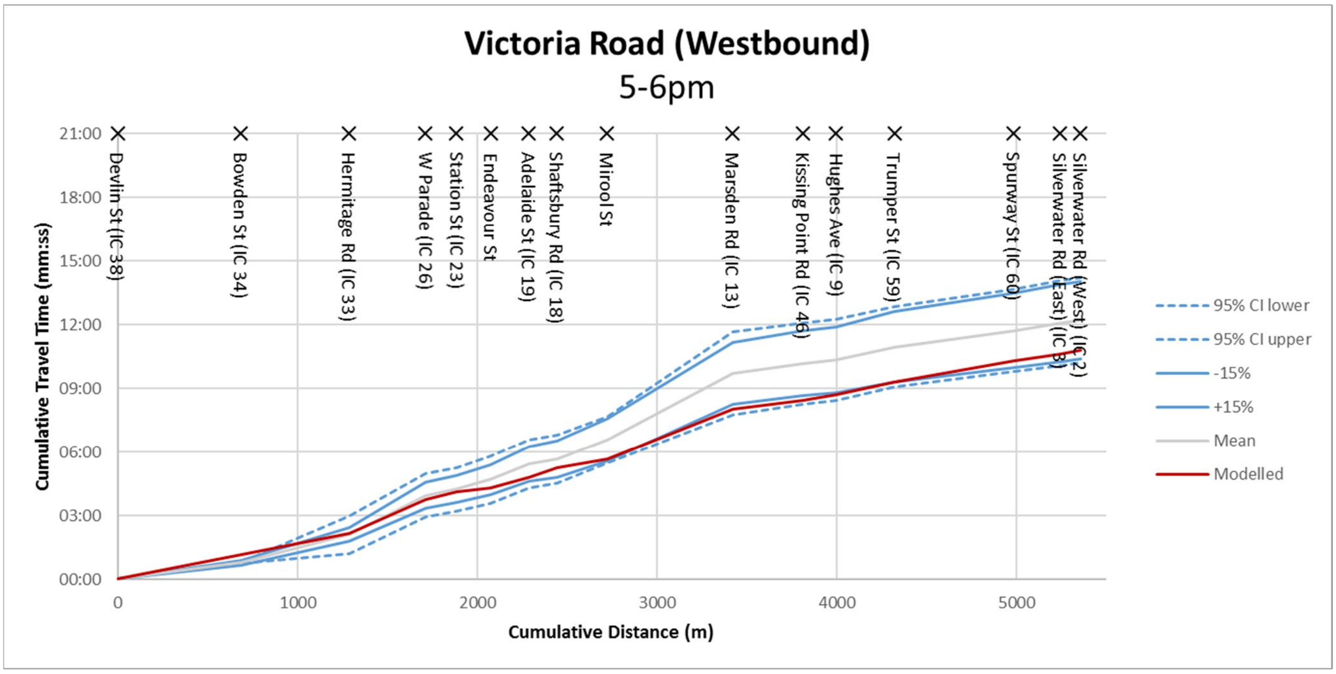


Figure 5.9 : Travel time validation - Silverwater Road northbound 7-8am

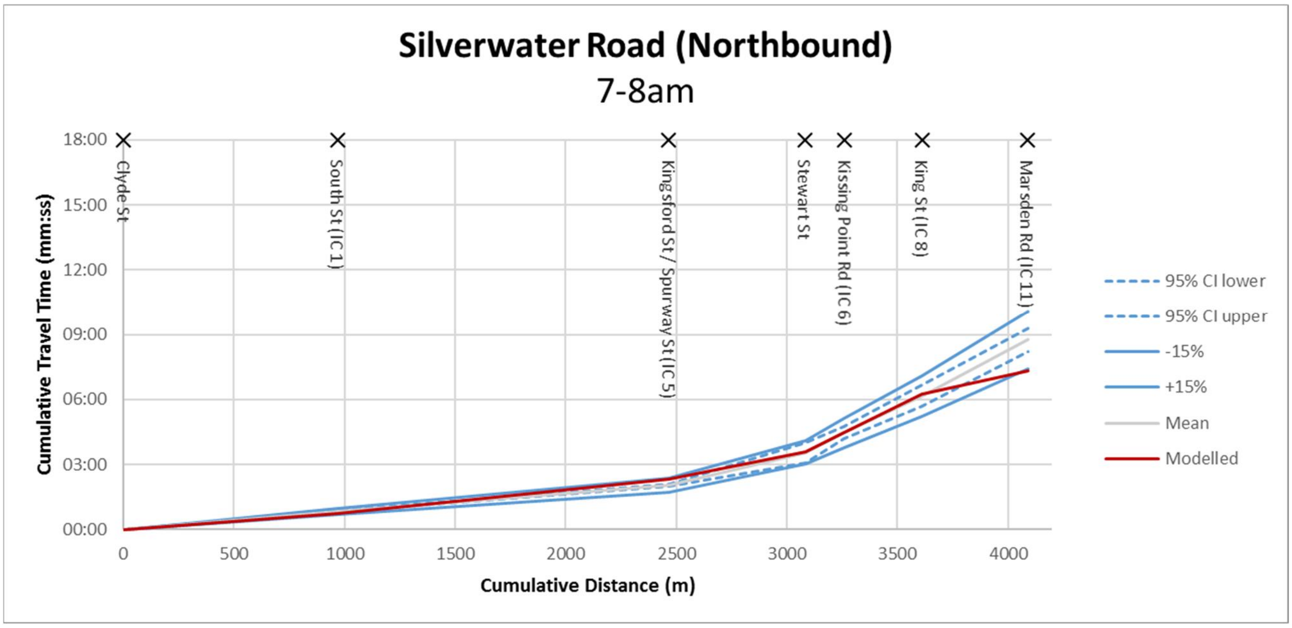


Figure 5.10 : Travel time validation - Silverwater Road northbound 8-9am

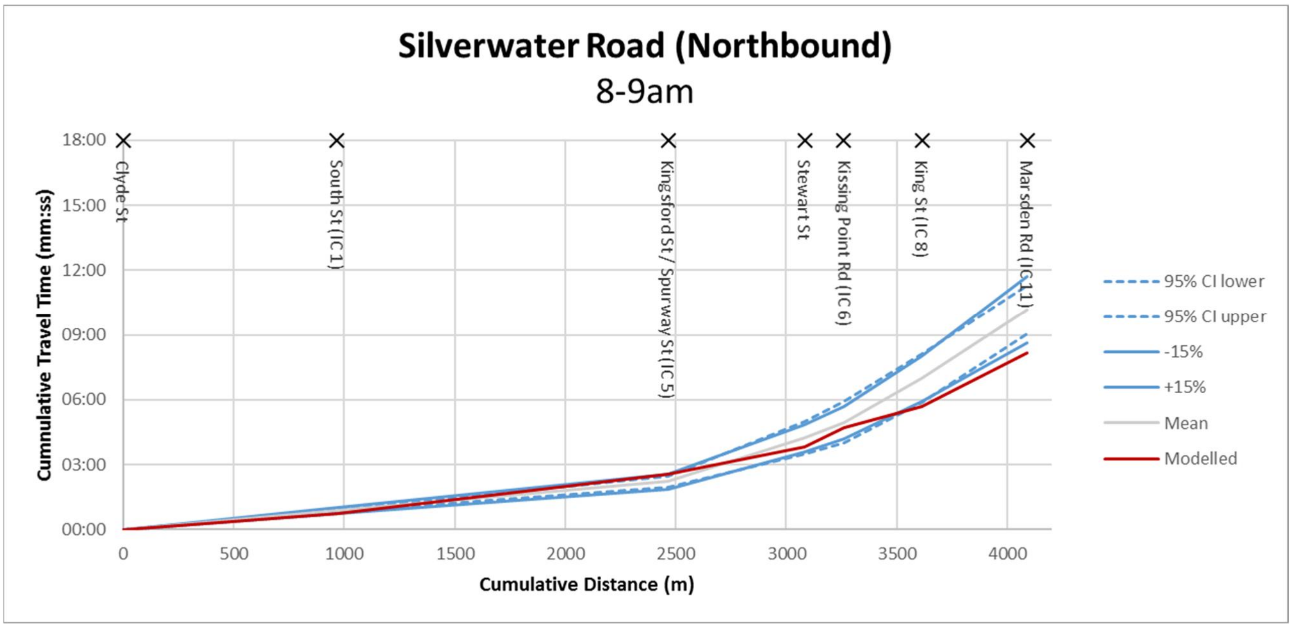


Figure 5.11 : Travel time validation - Silverwater Road southbound 7-8am

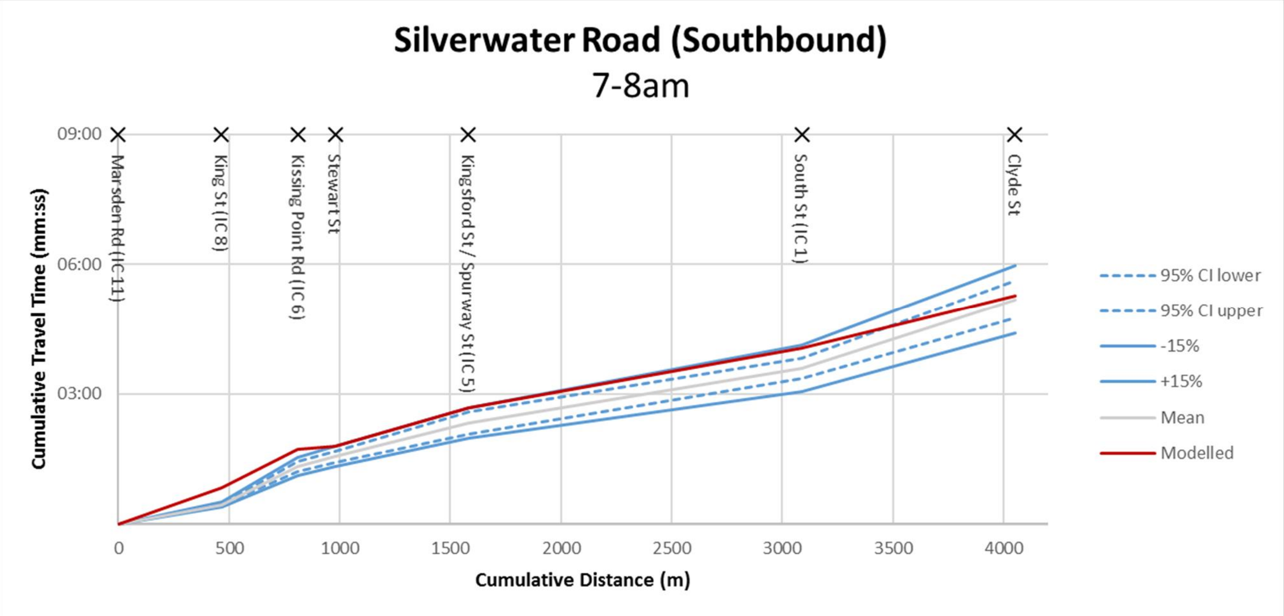


Figure 5.12 : Travel time validation - Silverwater Road southbound 8-9am

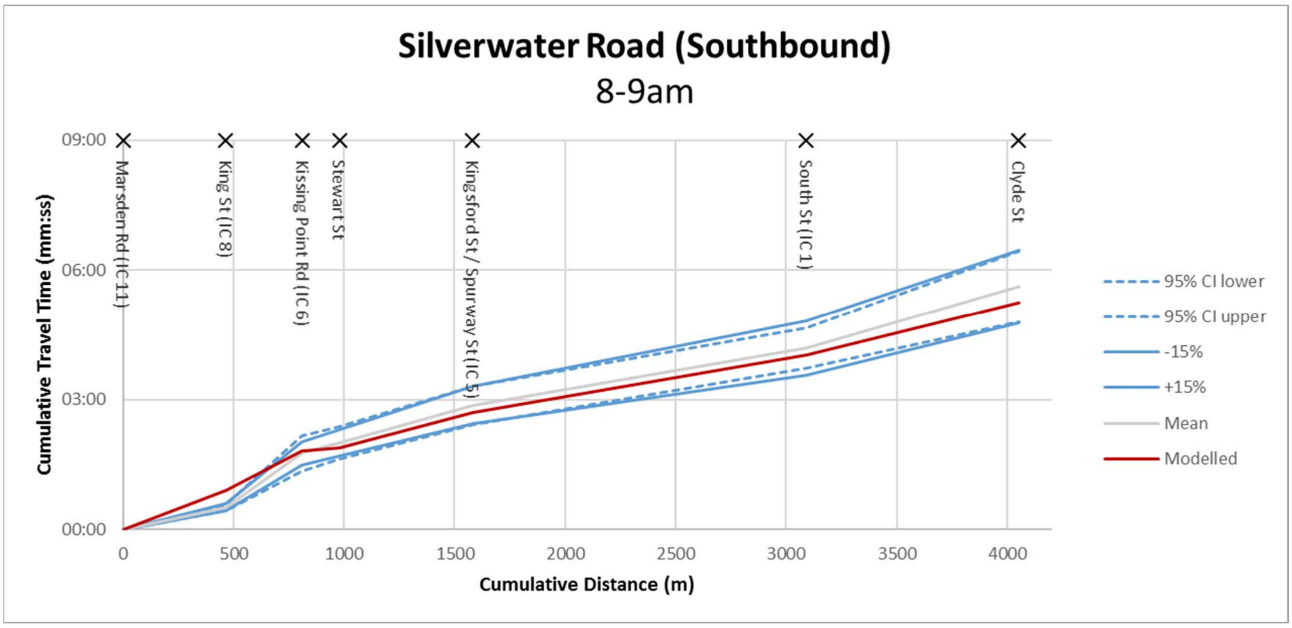


Figure 5.13 : Travel time validation - Silverwater Road northbound 4-5pm

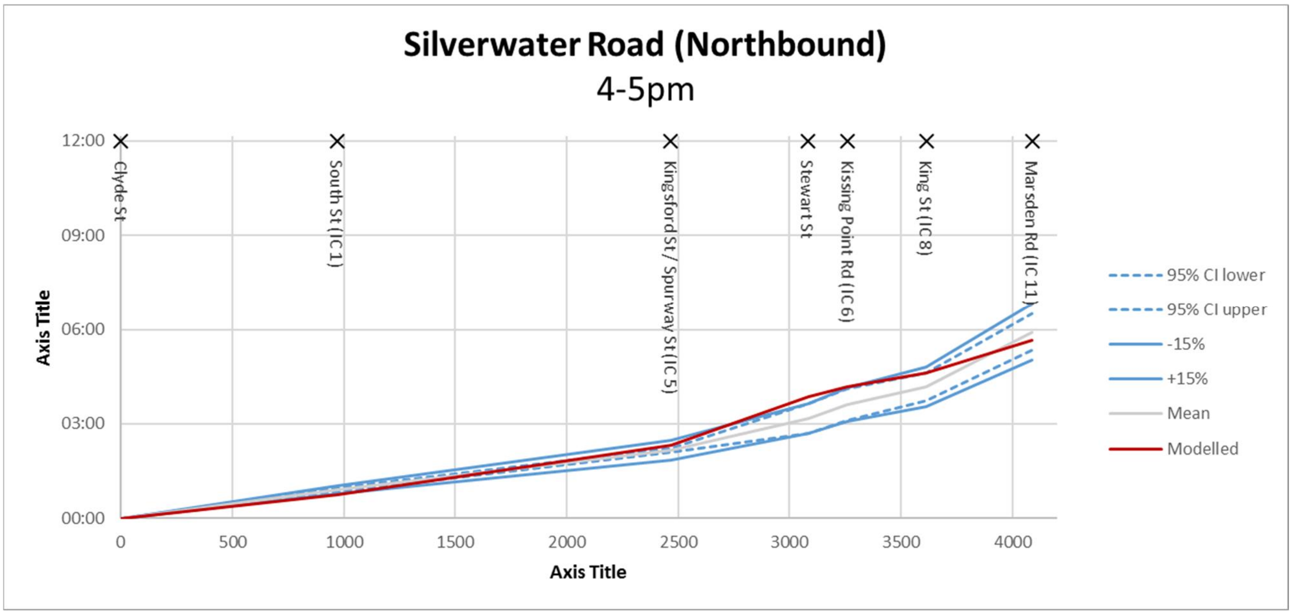


Figure 5.14 : Travel time validation - Silverwater Road northbound 5-6pm

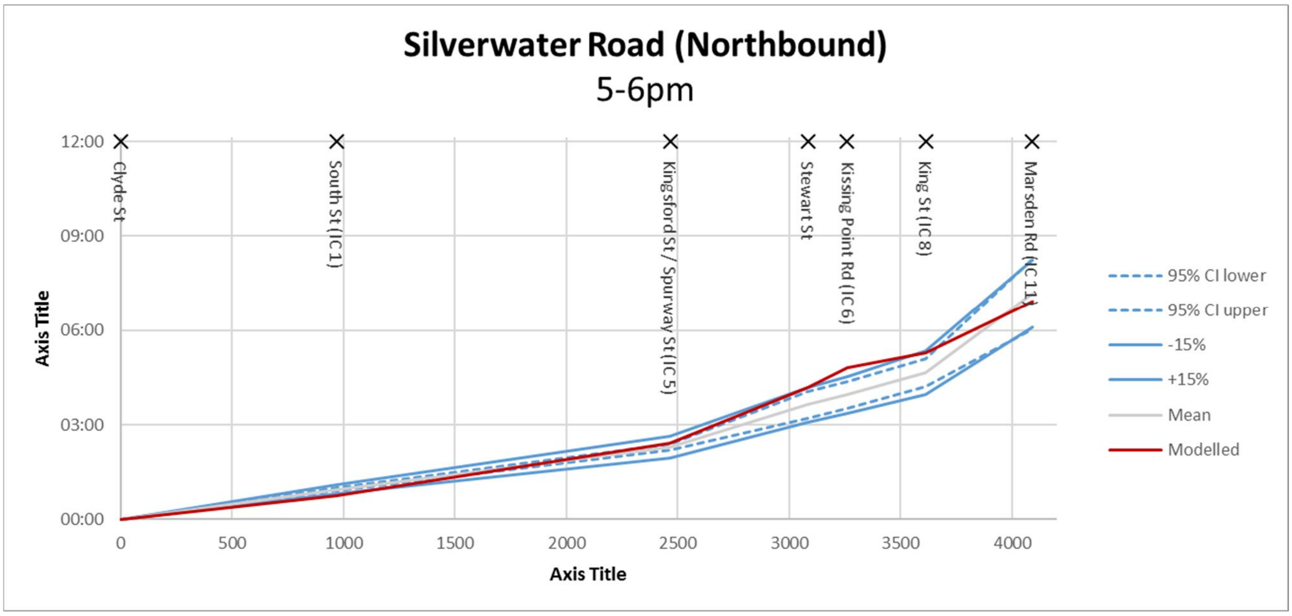


Figure 5.15 : Travel time validation - Silverwater Road southbound 4-5pm

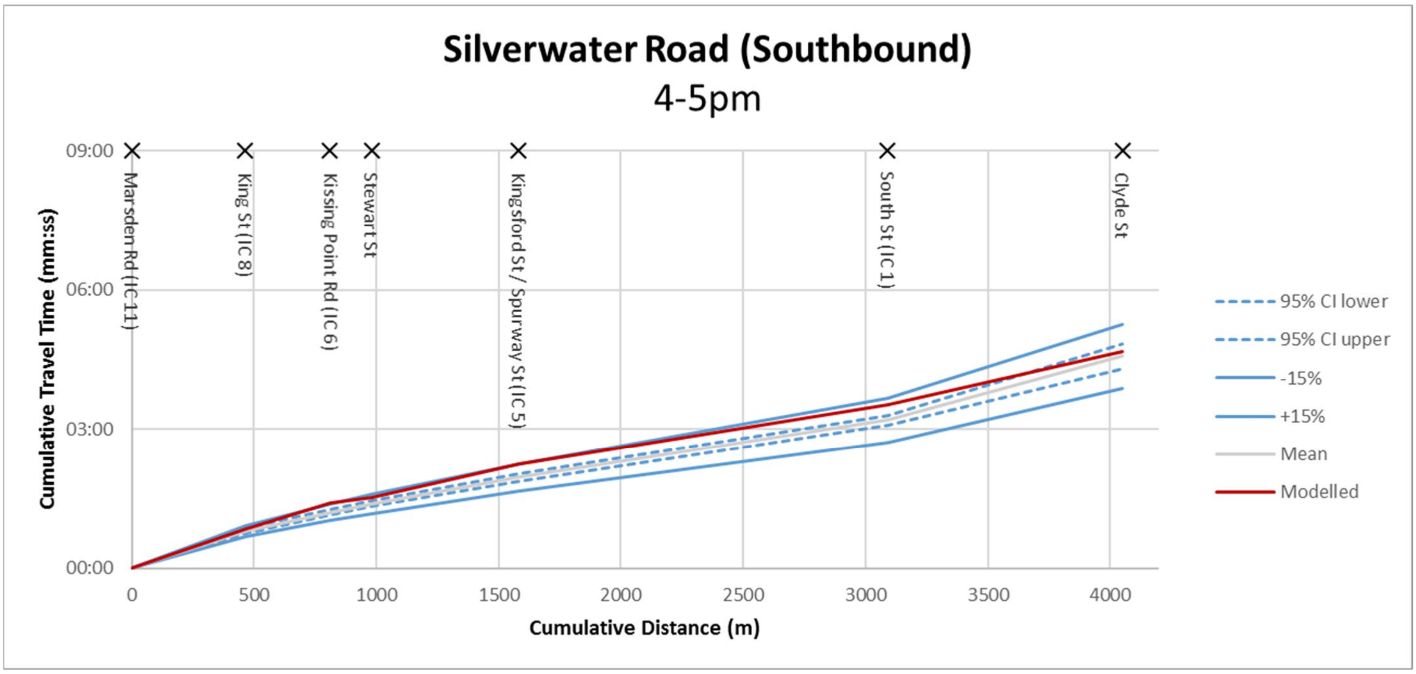


Figure 5.16 : Travel time validation - Silverwater Road southbound 5-6pm

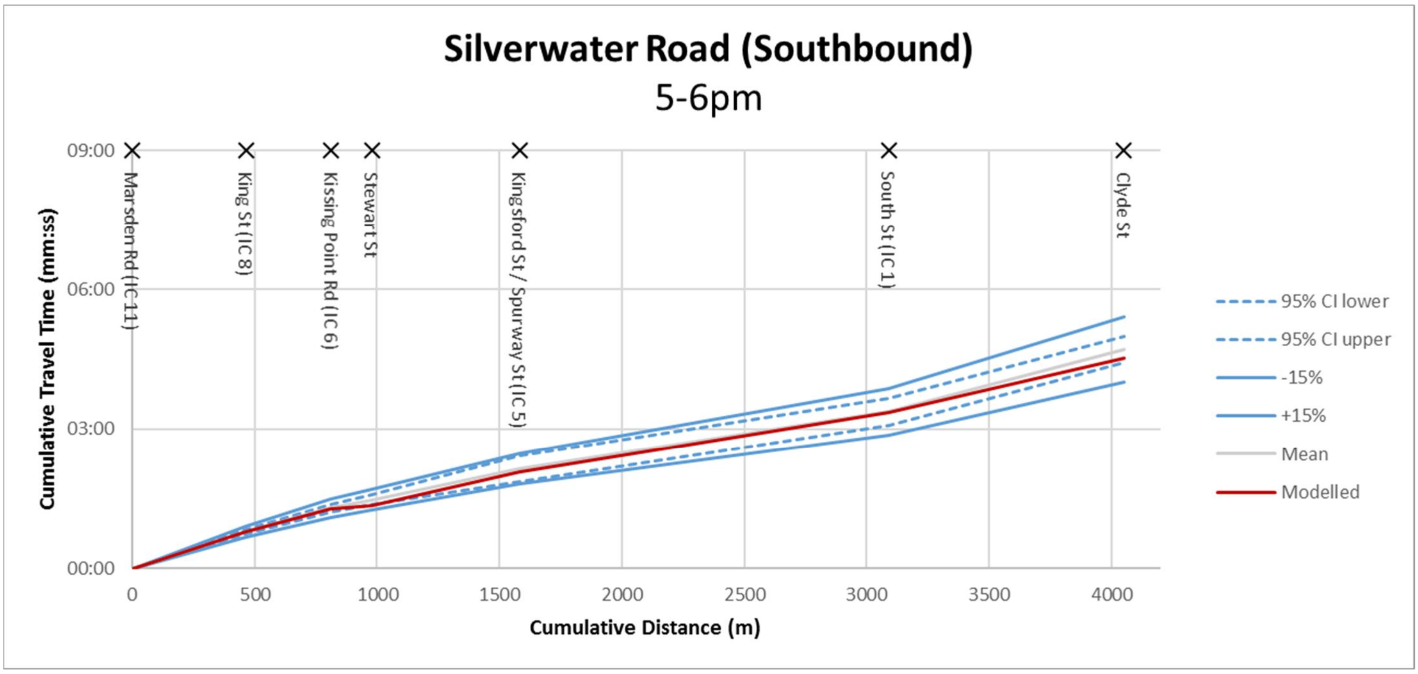


Figure 5.17 : Travel time validation - Wharf Road northbound 7-8am

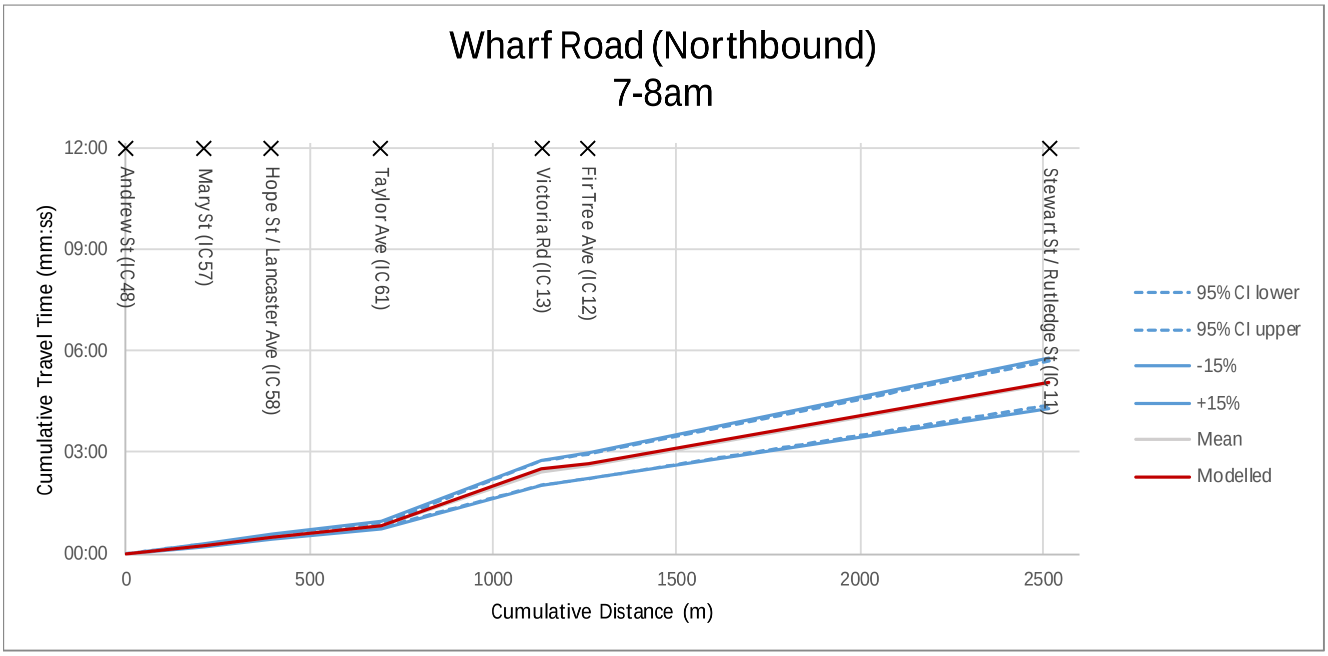


Figure 5.18 : Travel time validation - Wharf Road northbound 8-9am

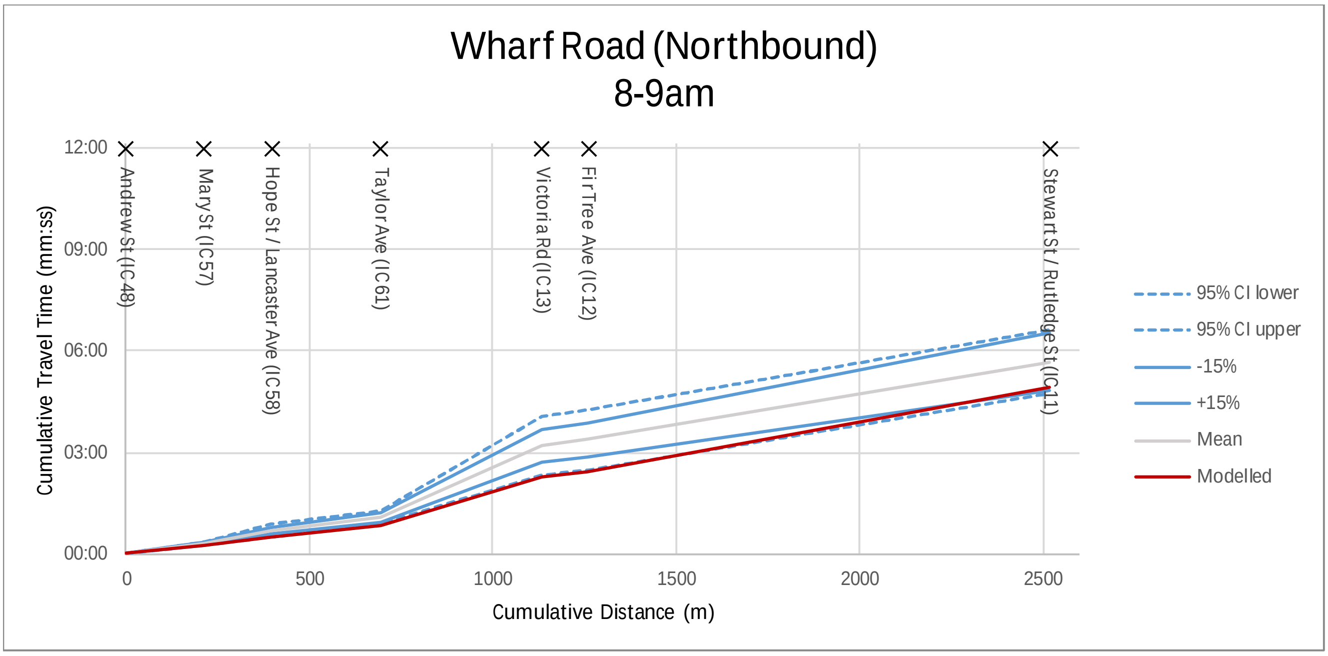


Figure 5.19 : Travel time validation - Wharf Road southbound 7-8am

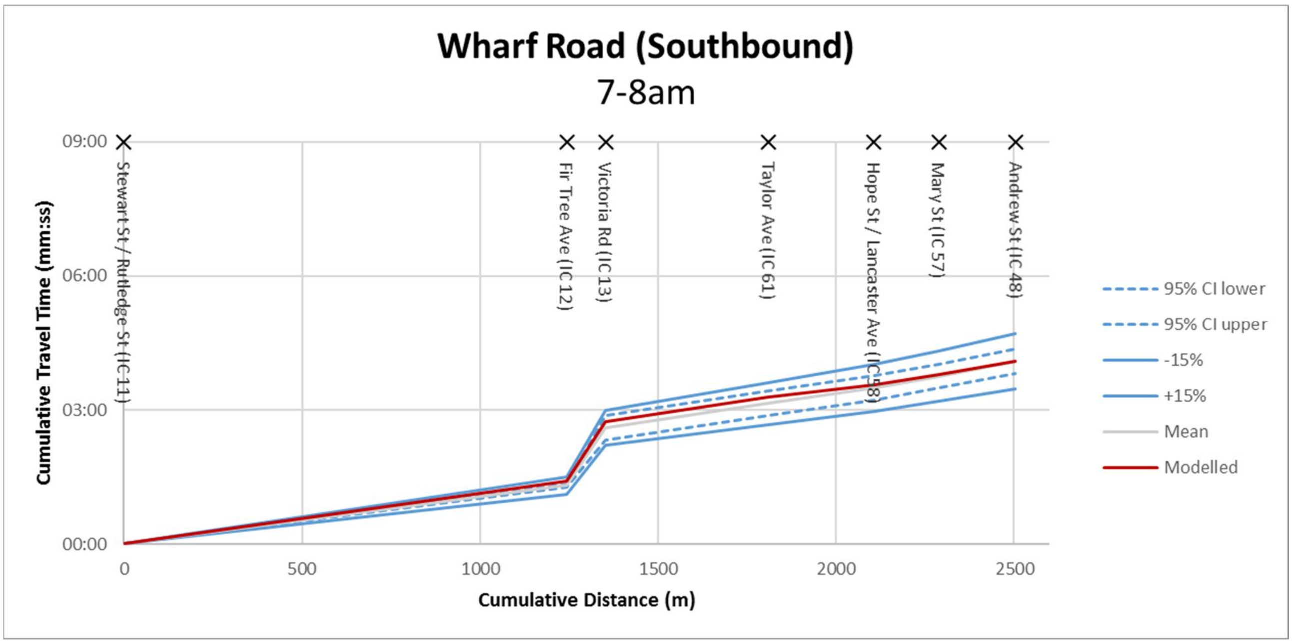


Figure 5.20 : Travel time validation - Wharf Road southbound 8-9am

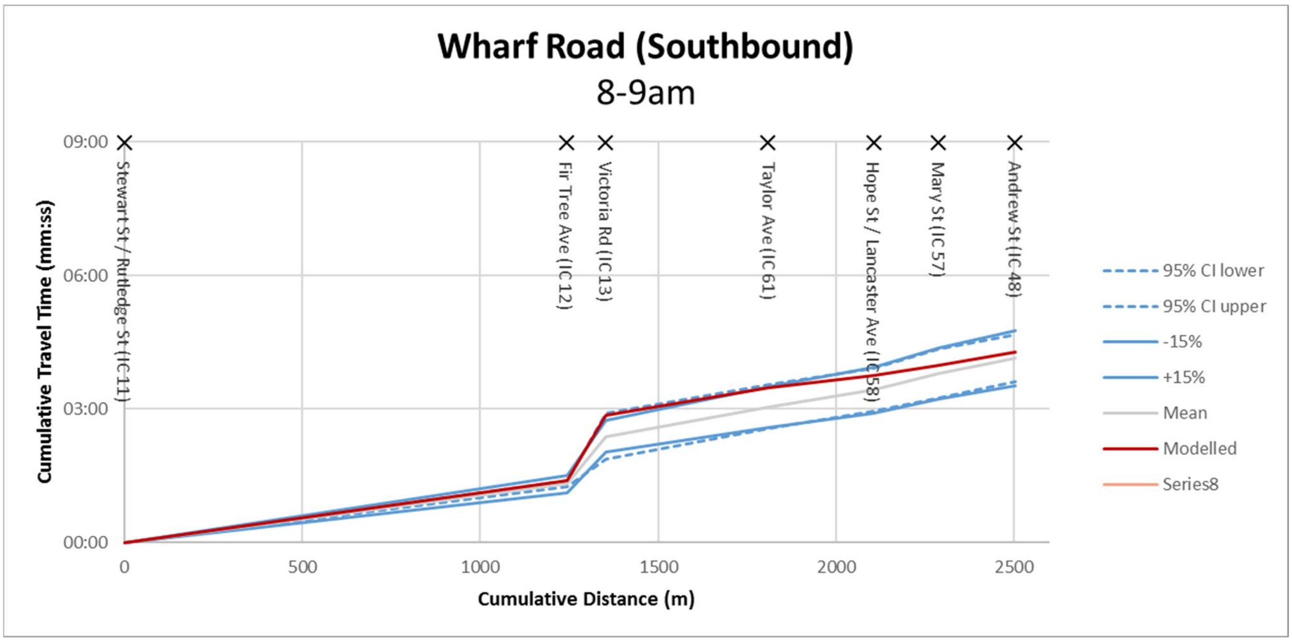


Figure 5.21 : Travel time validation - Wharf Road northbound 4-5pm

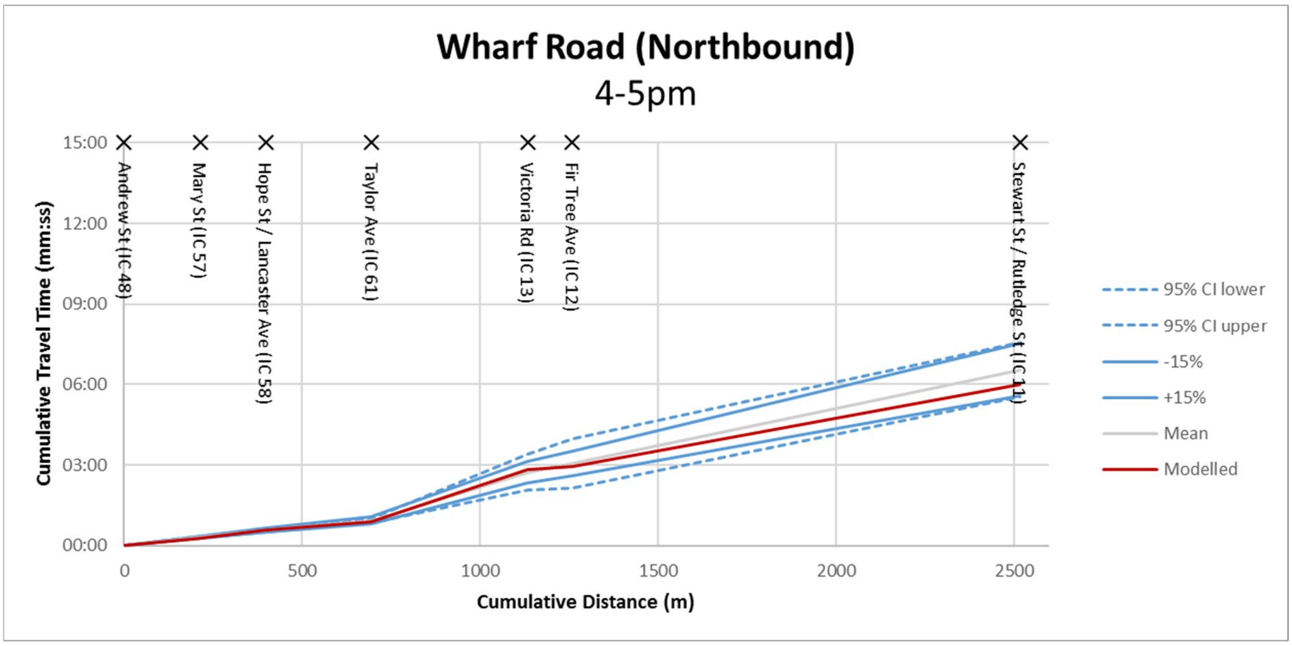


Figure 5.22 : Travel time validation - Wharf Road northbound 5-6pm

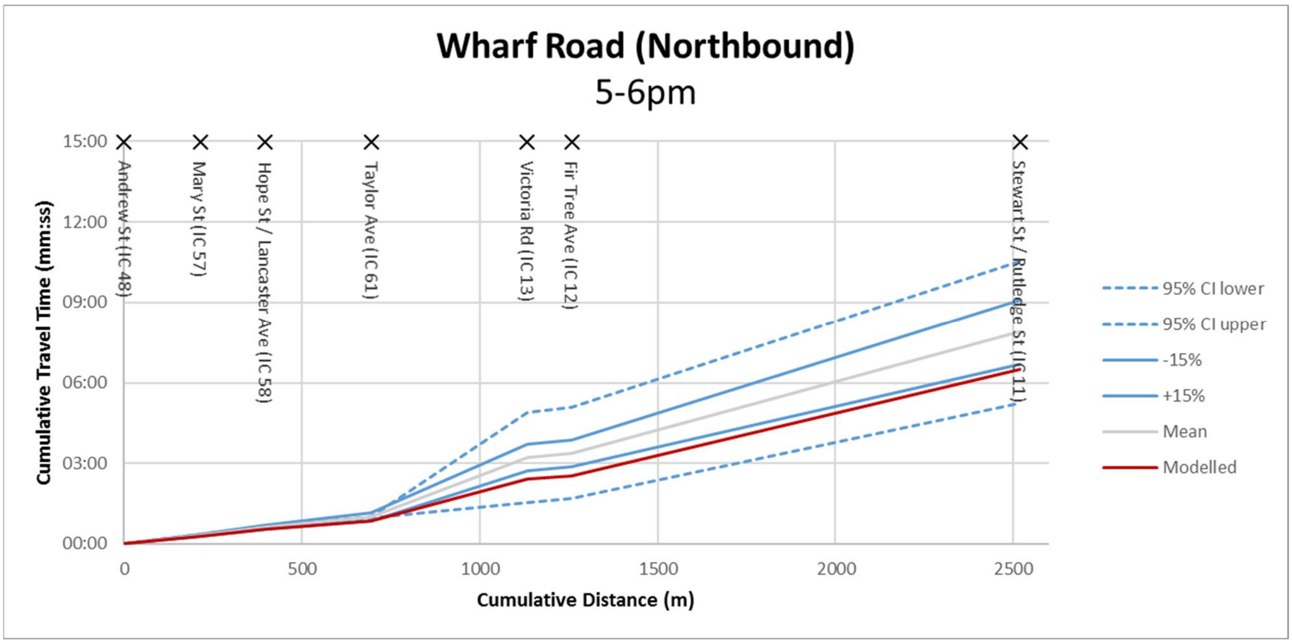


Figure 5.23 : Travel time validation - Wharf Road southbound 4-5pm

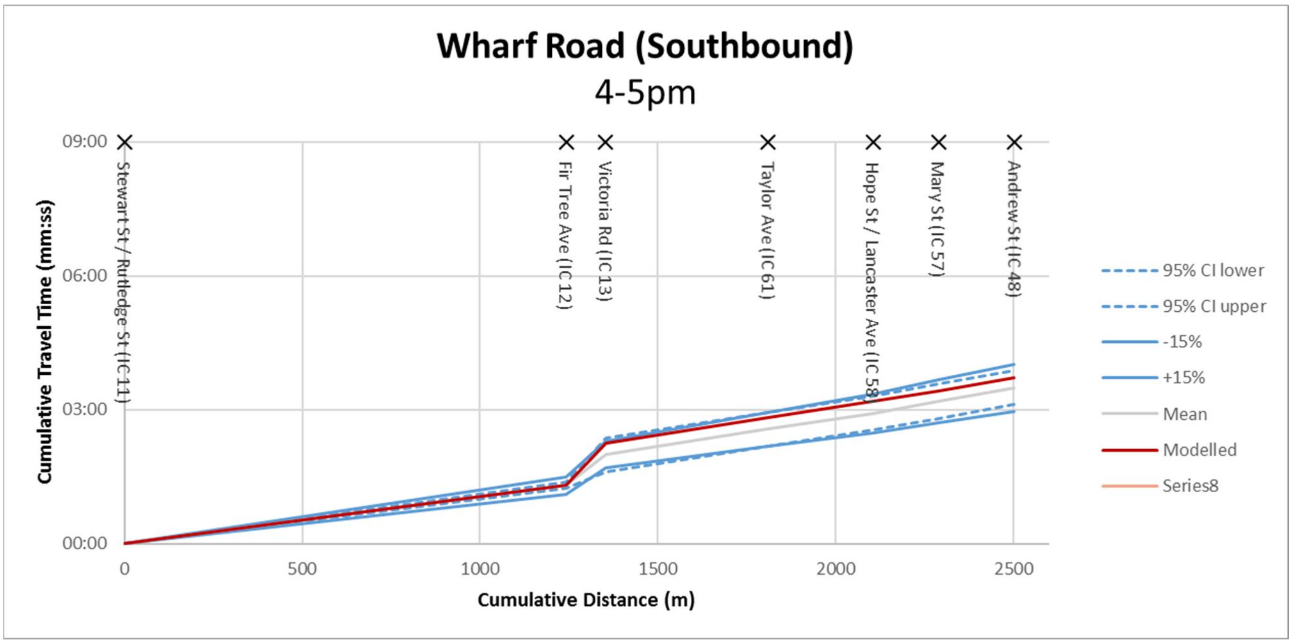
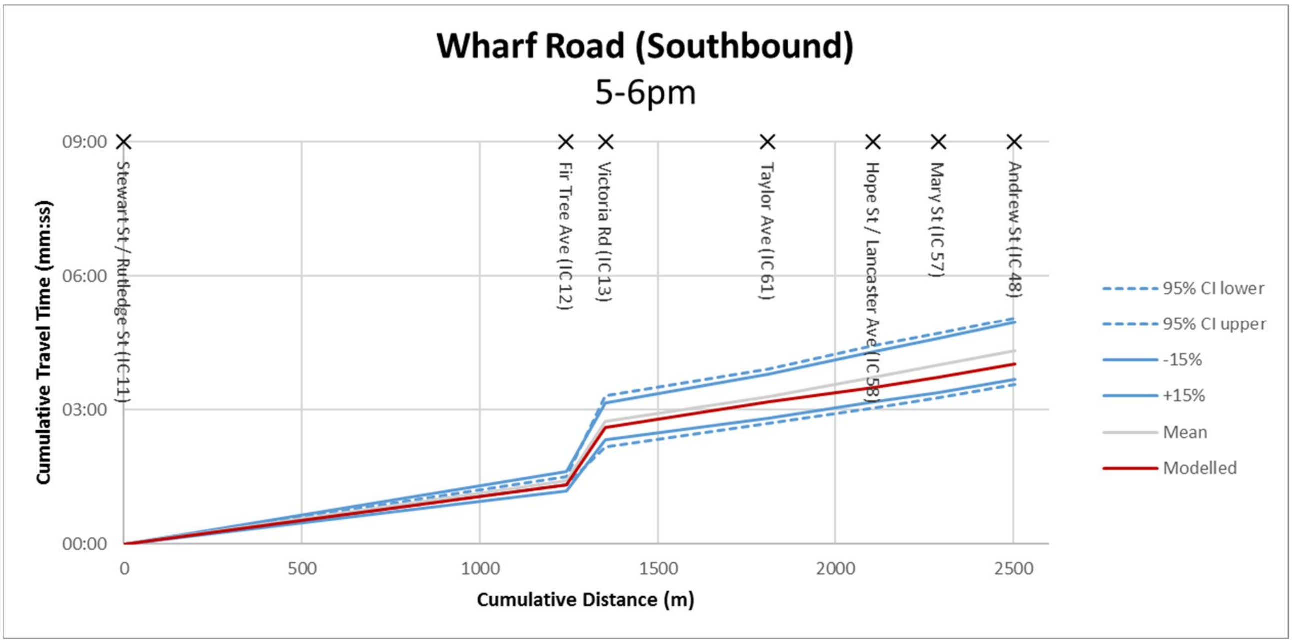


Figure 5.24 : Travel time validation - Wharf Road southbound 5-6pm



5.3 Validation summary

Comparison of the general traffic travel times with observed data shows that the model is generally replicating the pattern of delays and observed cumulative travel times during the peak periods. Minor divergences from the observed data occurs on Victoria Road, east of the study area and outside the key areas of influence of the Melrose Park development. This is generally due to delays which cannot be fully captured by mesoscopic modelling. These differences between modelled and observed travel times are expected based on the model assumptions and limitations, particularly in the mesoscopic model areas, and do not substantially affect the suitability of the model for assessing impacts of large scale land use changes.

6. Summary and conclusions

6.1 Overview

This report covers the calibration and validation results of the base *Melrose Park Hybrid Model*. The base model has been developed to inform the Melrose Park traffic and transport assessment.

The Sydney Strategic Travel Model (STM) has been used to provide initial travel demand and will also be used for future demand development.

Data for the model calibration was obtained from Transport for NSW and consisted of:

- Classified intersection counts
- Travel time surveys
- SCATS history files

6.2 Calibration findings

The model has been developed using the Aimsun modelling platform (version 8.2.1) and has been calibrated and validated based on the criteria adopted in Section 4.2.

The model has targeted regression parameters of R^2 greater than 0.95 and slope between 0.95 and 1.05 and 80% of turning movements with GEH less than 5.

All periods achieve the adopted regression targets. The results indicate the model achieves the adopted GEH criteria for the combined 4 hour periods in both the morning and evening peak periods. On an hour by hour basis, the model generally achieves the criteria. Some hourly periods achieve less than 80% for the GEH<5 criteria however no period is lower than 78%.

6.3 Validation findings

Validation of the model has been undertaken based on general traffic travel times. The travel time validation targets are for modelled times to be within 15% of the average observed travel times.

Comparison of modelled general traffic travel times with observed data shows that the model is replicating the pattern of delays and observed cumulative travel times during the peak period.

APPENDIX C - SWEPT PATH ANALYSIS

MELROSE PARK DEVELOPMENT **SK0.00 : REV A**

MEADOWBANK STATION
UPGRADE FACILITIES - OPTION 1

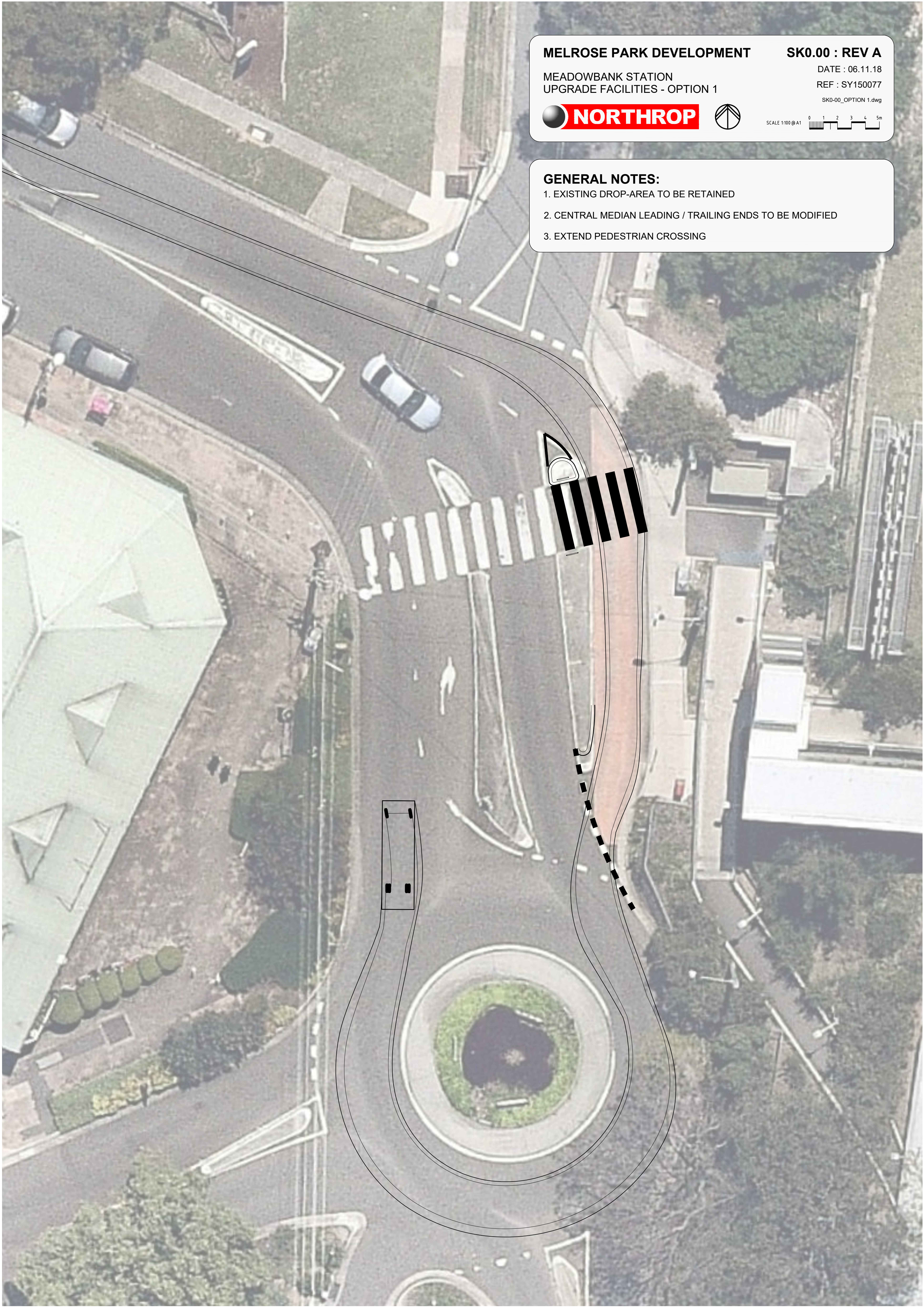
DATE : 06.11.18
REF : SY150077
SK0-00_OPTION 1.dwg

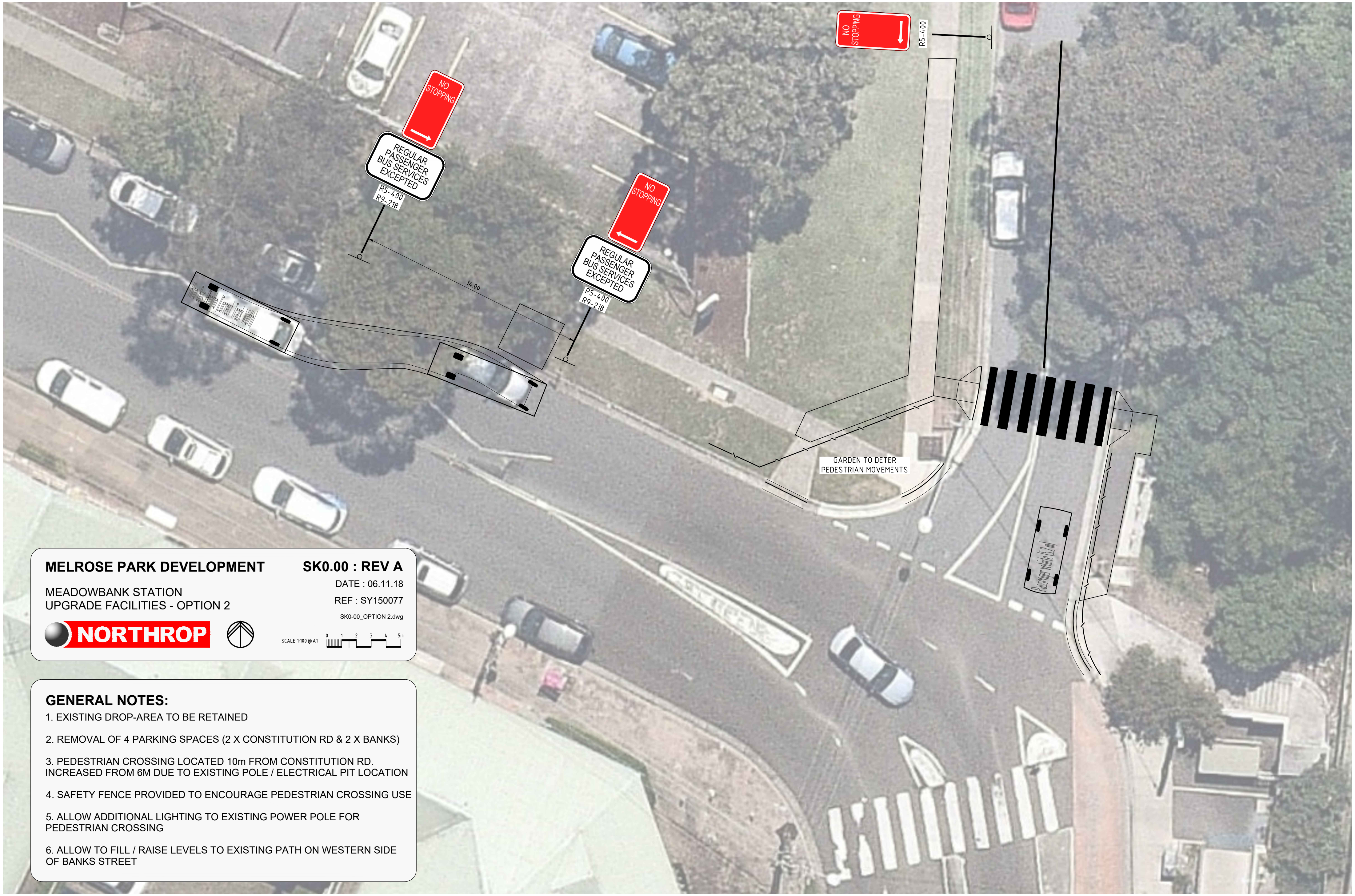
NORTHROP

SCALE 1:100 @ A1

GENERAL NOTES:

1. EXISTING DROP-AREA TO BE RETAINED
2. CENTRAL MEDIAN LEADING / TRAILING ENDS TO BE MODIFIED
3. EXTEND PEDESTRIAN CROSSING





MELROSE PARK DEVELOPMENT

SK0.00 : REV A

DATE : 06.11.18

REF : SY150077

SK0-00_OPTION 2.dwg

MEADOWBANK STATION
UPGRADE FACILITIES - OPTION 2

NORTHROP

SCALE 1:100 @ A1 0 1 2 3 4 5m

GENERAL NOTES:

1. EXISTING DROP-AREA TO BE RETAINED
2. REMOVAL OF 4 PARKING SPACES (2 X CONSTITUTION RD & 2 X BANKS)
3. PEDESTRIAN CROSSING LOCATED 10m FROM CONSTITUTION RD. INCREASED FROM 6M DUE TO EXISTING POLE / ELECTRICAL PIT LOCATION
4. SAFETY FENCE PROVIDED TO ENCOURAGE PEDESTRIAN CROSSING USE
5. ALLOW ADDITIONAL LIGHTING TO EXISTING POWER POLE FOR PEDESTRIAN CROSSING
6. ALLOW TO FILL / RAISE LEVELS TO EXISTING PATH ON WESTERN SIDE OF BANKS STREET

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