4.4 Calibration results 18
4.4.1 Total traffic volume calibration statistics 18
4.5 Calibration summary 20
5. Model validation 22
5.1 Overview 22
5.2 Validation statistics 22
5.2.1 General traffic travel time validation results 22
5.3 Validation summary 34
6. Summary and conclusions 35
6.1 Overview 35
6.2 Calibration findings 35
6.3 Validation findings 35

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.

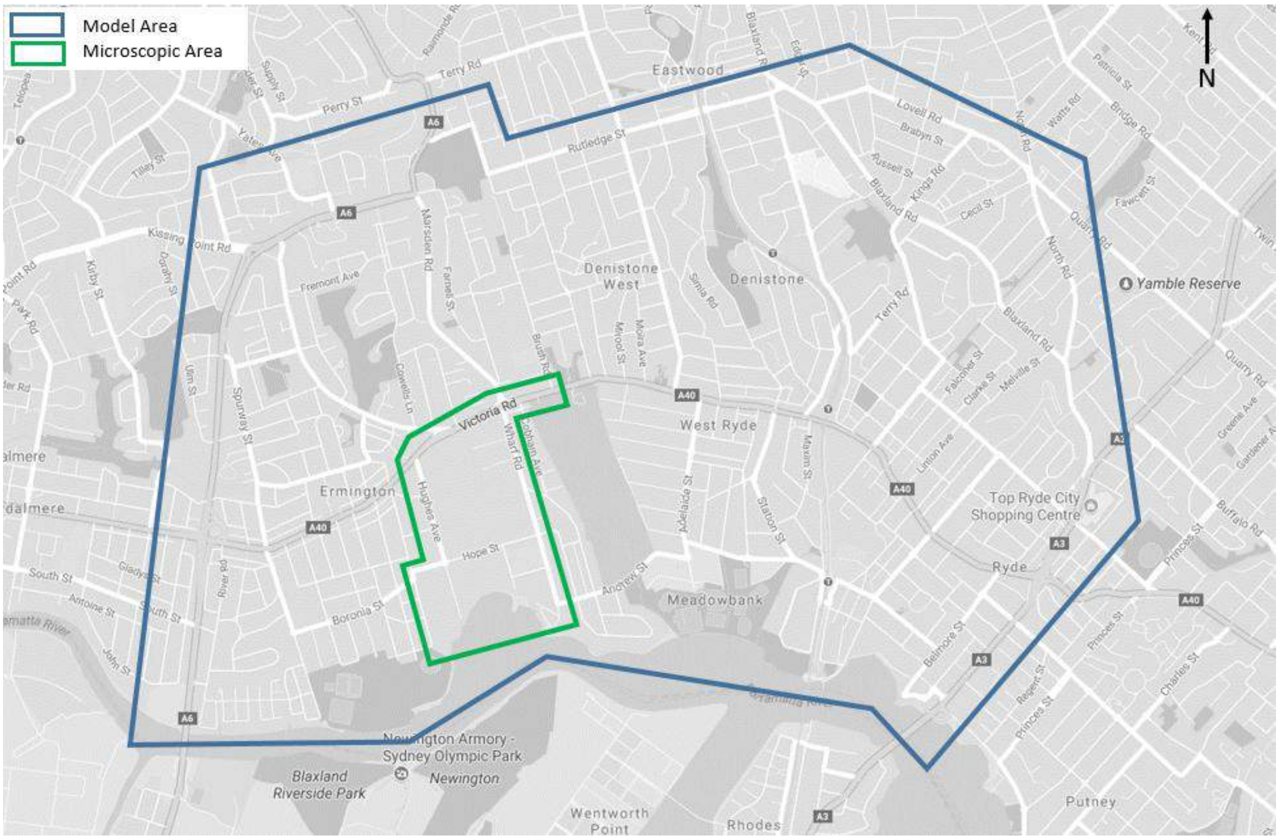
2.2 Model scope

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

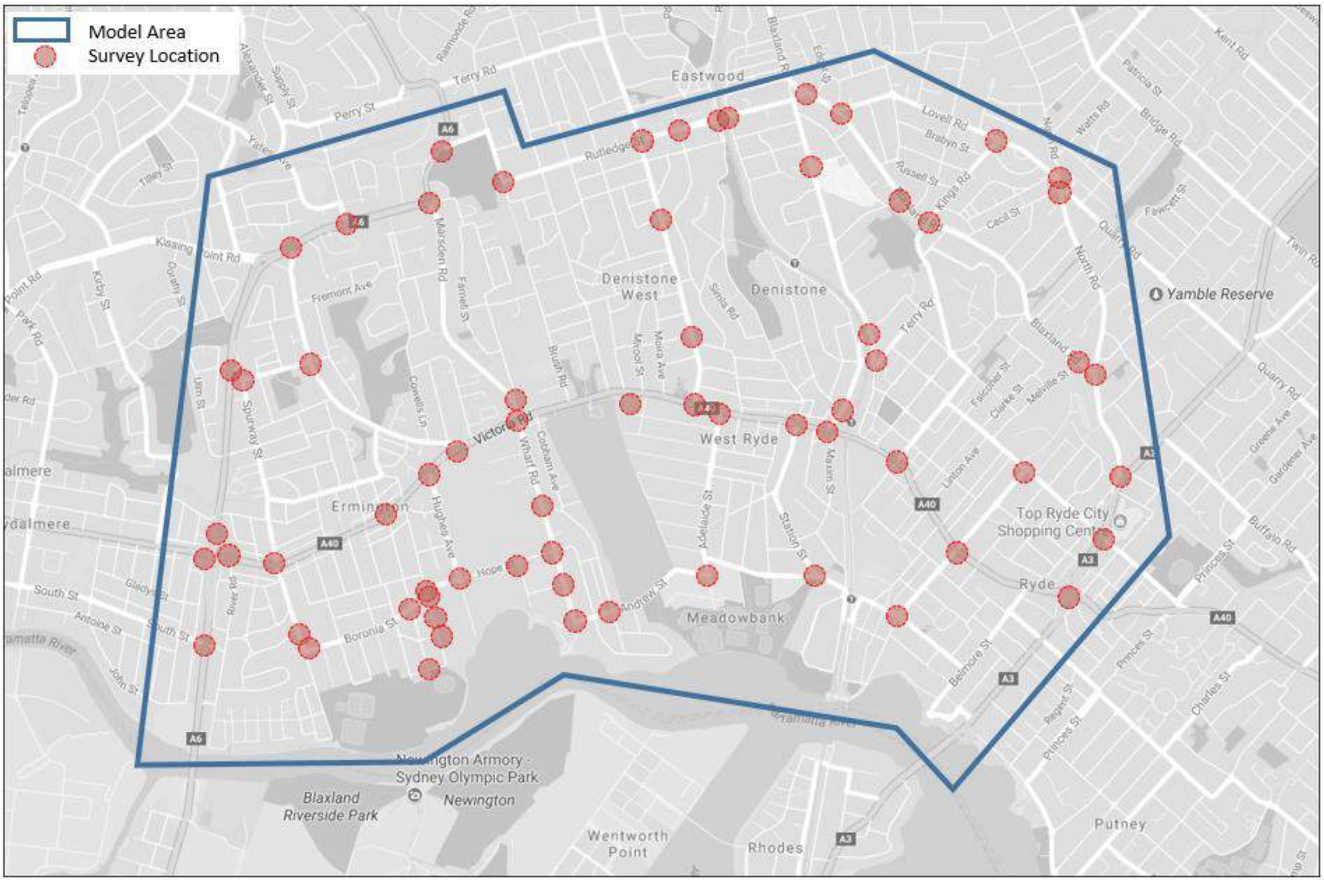
2.5 Model data

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



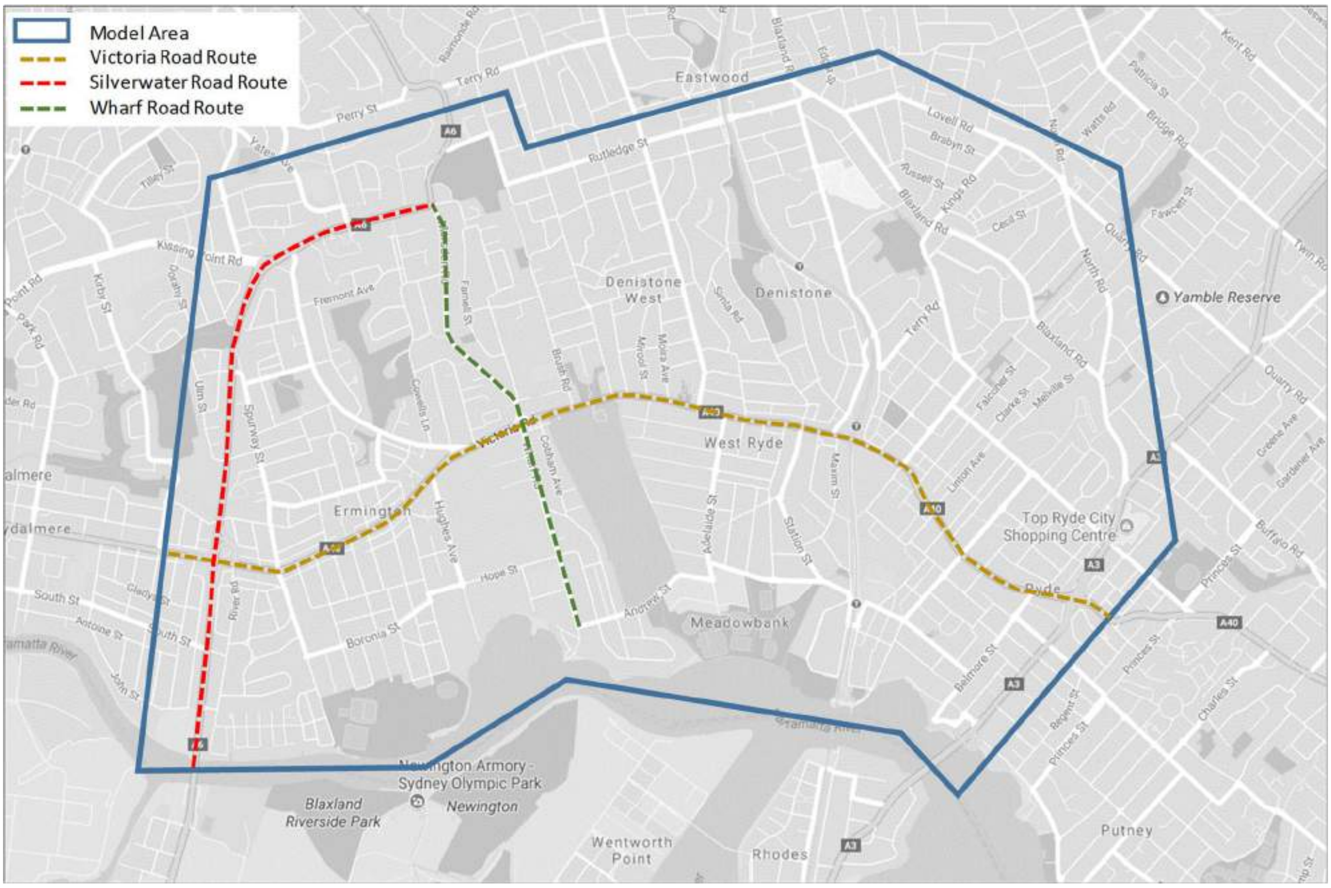
2.5.2 General traffic travel time data

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.

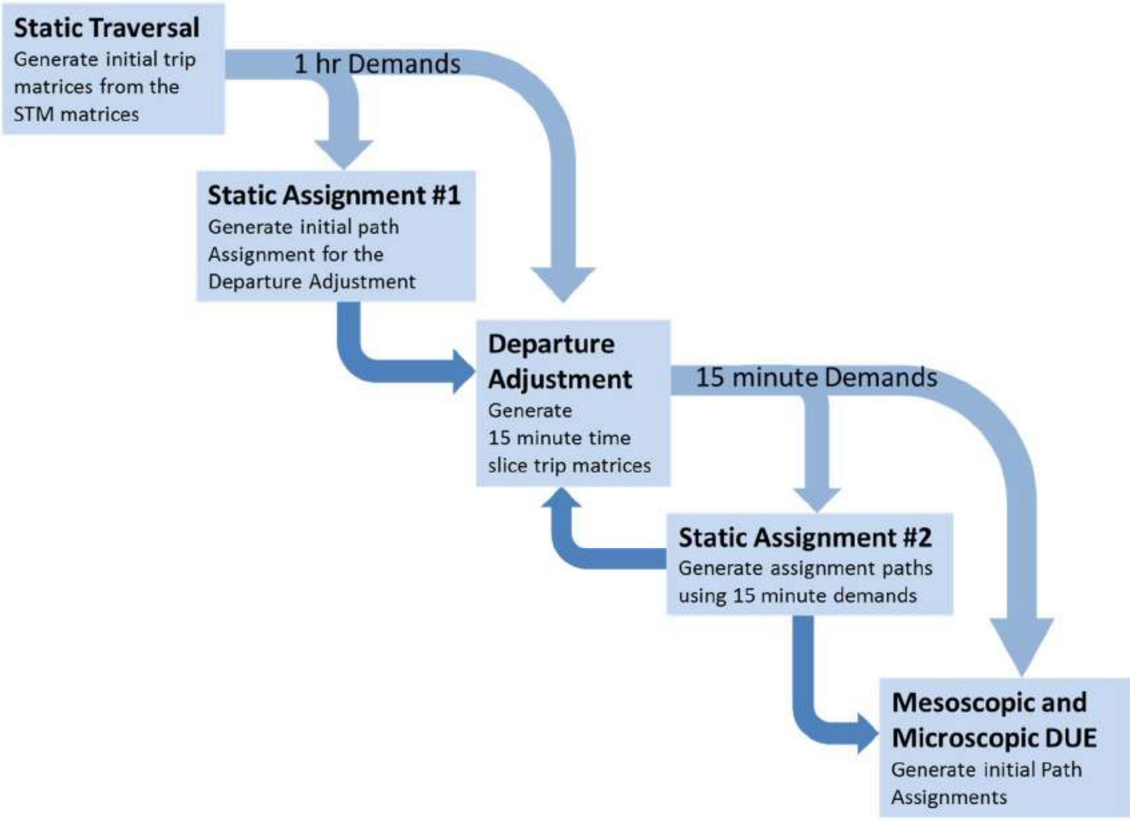
2.11 Traffic assignment and trip demand development

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

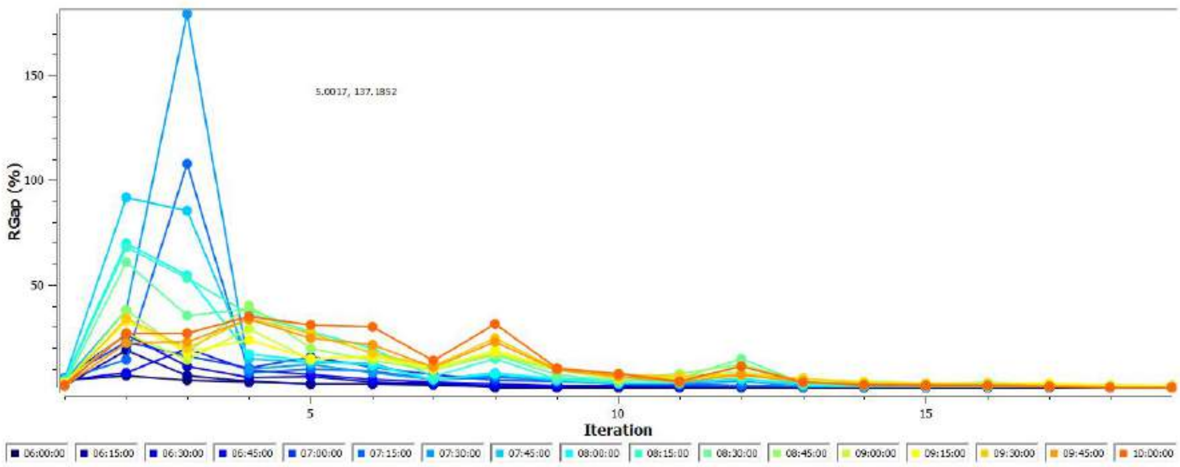
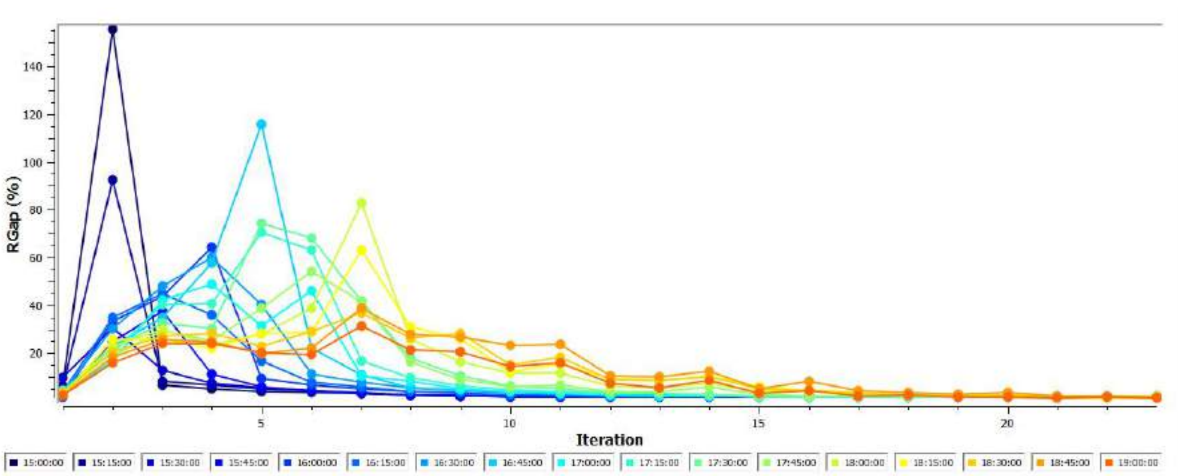


Figure 4.2: PM peak hybrid DUE convergence



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

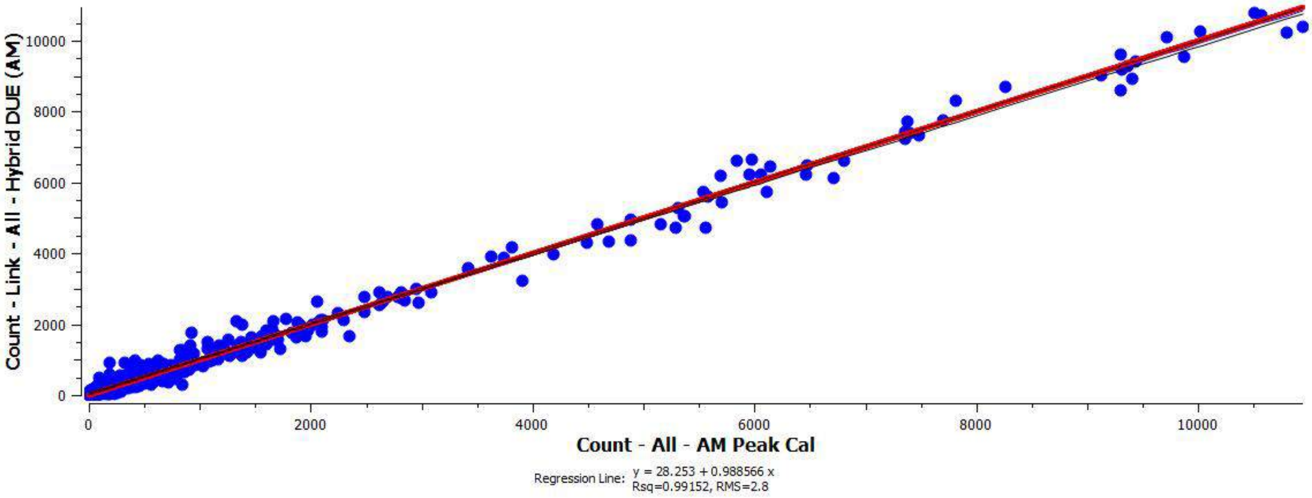


Figure 4.4: Evening peak modelled vs observed flows 3 – 7pm

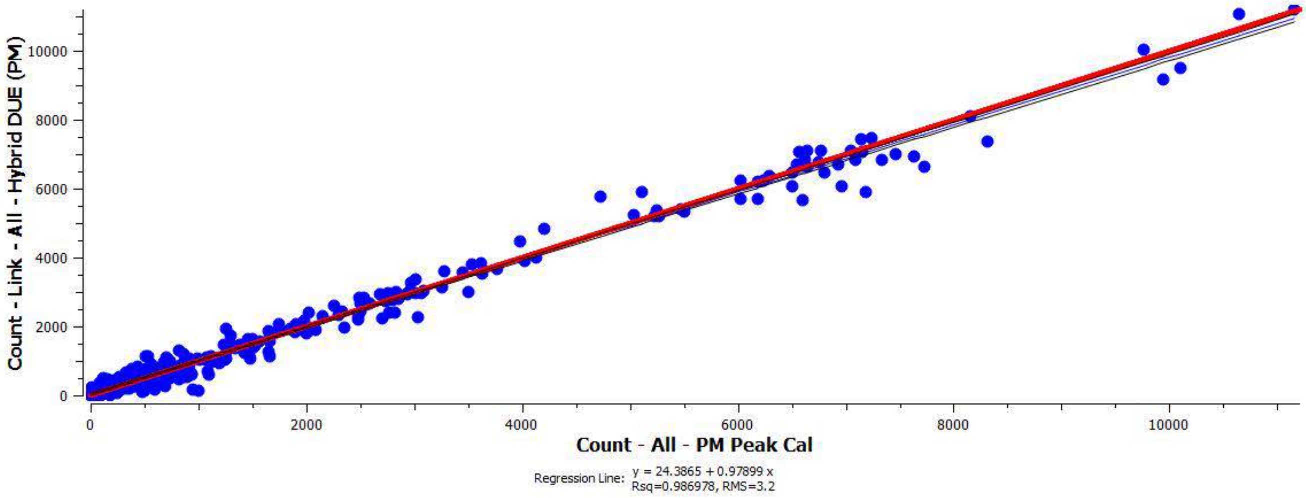


Table 4.1: Summary of model calibration – Regression analysis

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

<table>
<tr><th></th><th>Location</th><th>Comment</th></tr>
<tr><td rowspan="3">AM</td><td>Right turn from West Parade into Rutledge Street eastbound</td><td>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.</td></tr>
<tr><td>Left turn from Bartlett Street into Kissing Point Road northbound</td><td>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.</td></tr>
<tr><td>Left turn from Park Street into Devlin Street northbound</td><td>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.</td></tr>
<tr><td rowspan="3">PM</td><td>Right turn from West Parade into Anthony Road westbound</td><td rowspan="2">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.</td></tr>
<tr><td>Left turn from Anthony Road into West Parade northbound</td></tr>
<tr><td>Right turn from Kings Road into Blaxland Road westbound</td><td>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.</td></tr>
</table>

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

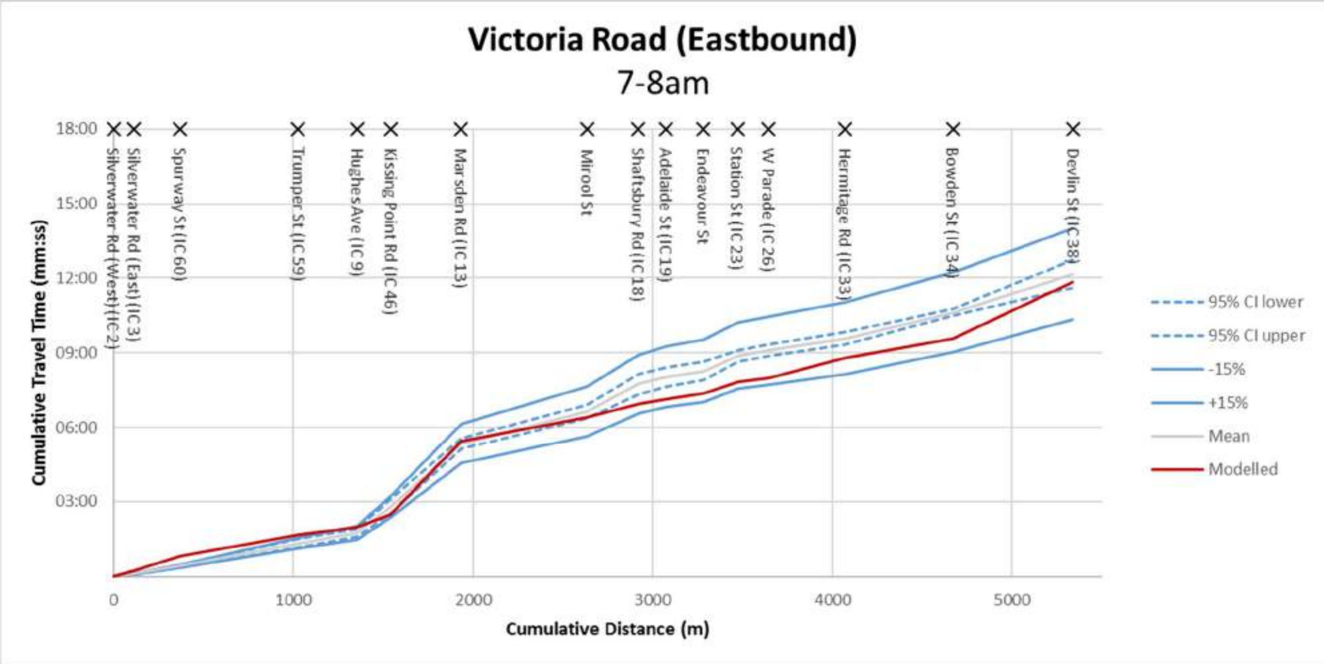


Figure 5.2 : Travel time validation - Victoria Road eastbound 8am-9am

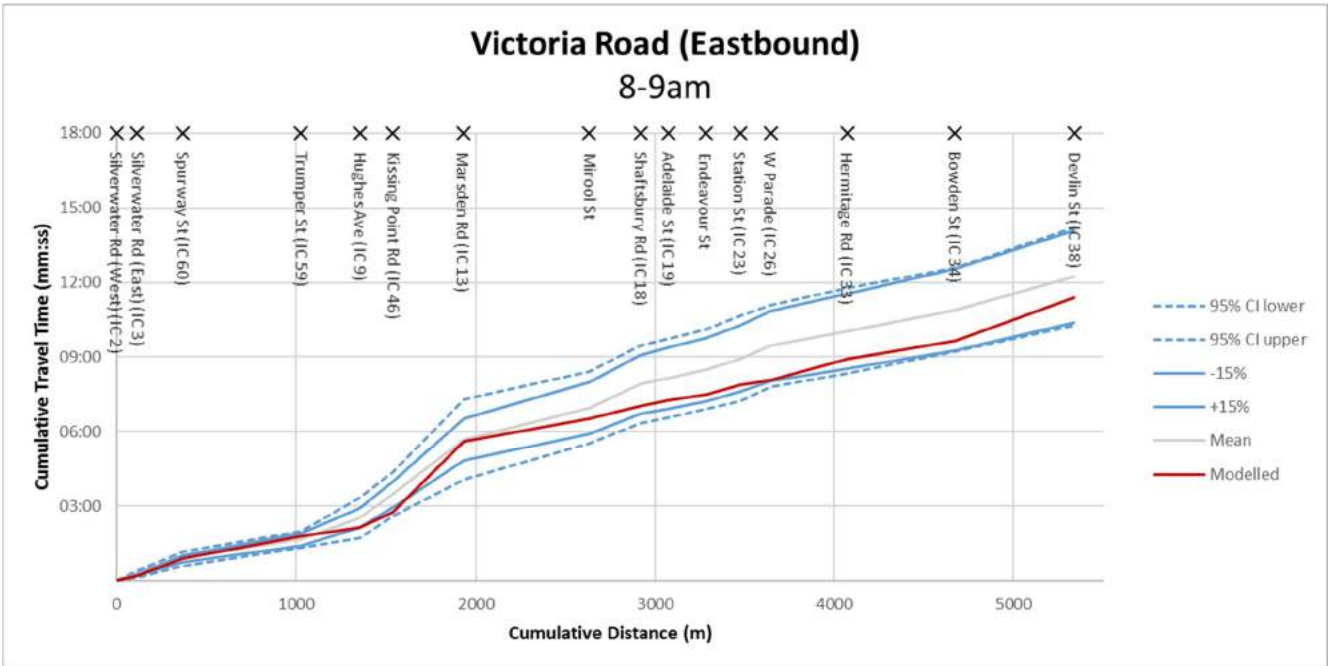


Figure 5.3 : Travel time validation - Victoria Road westbound 7am-8am

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

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

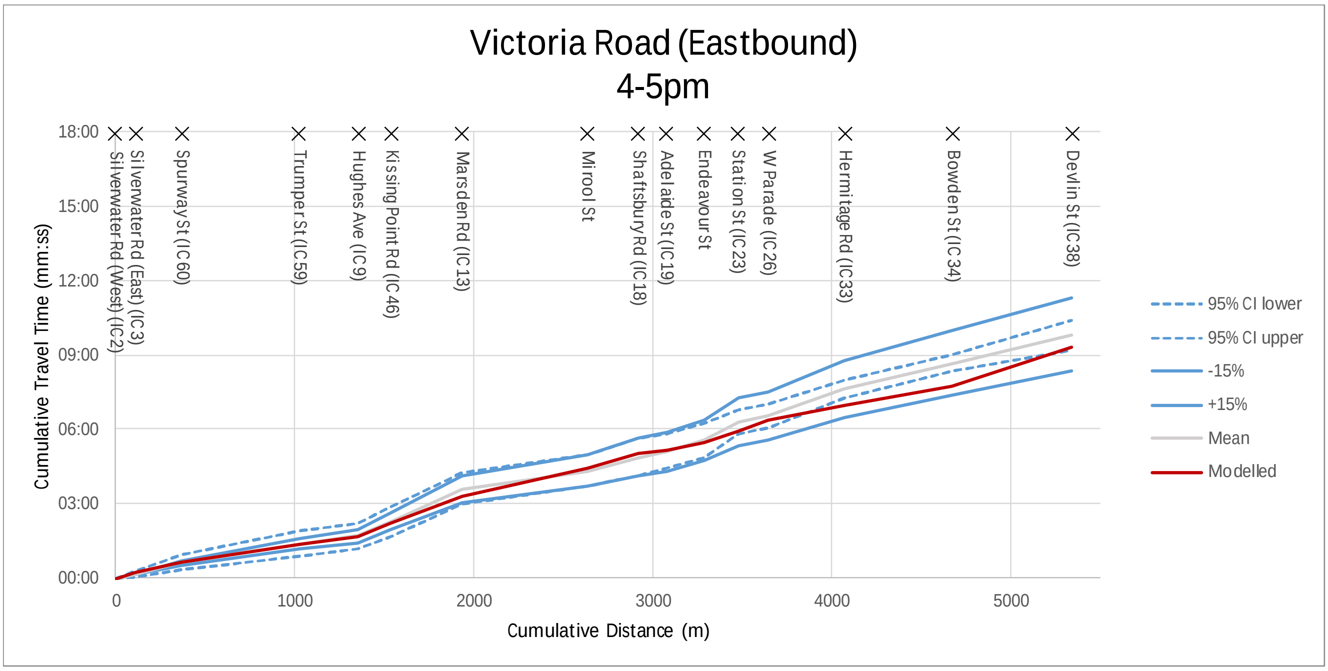


Figure 5.6 : Travel time validation - Victoria Road eastbound 5-6pm

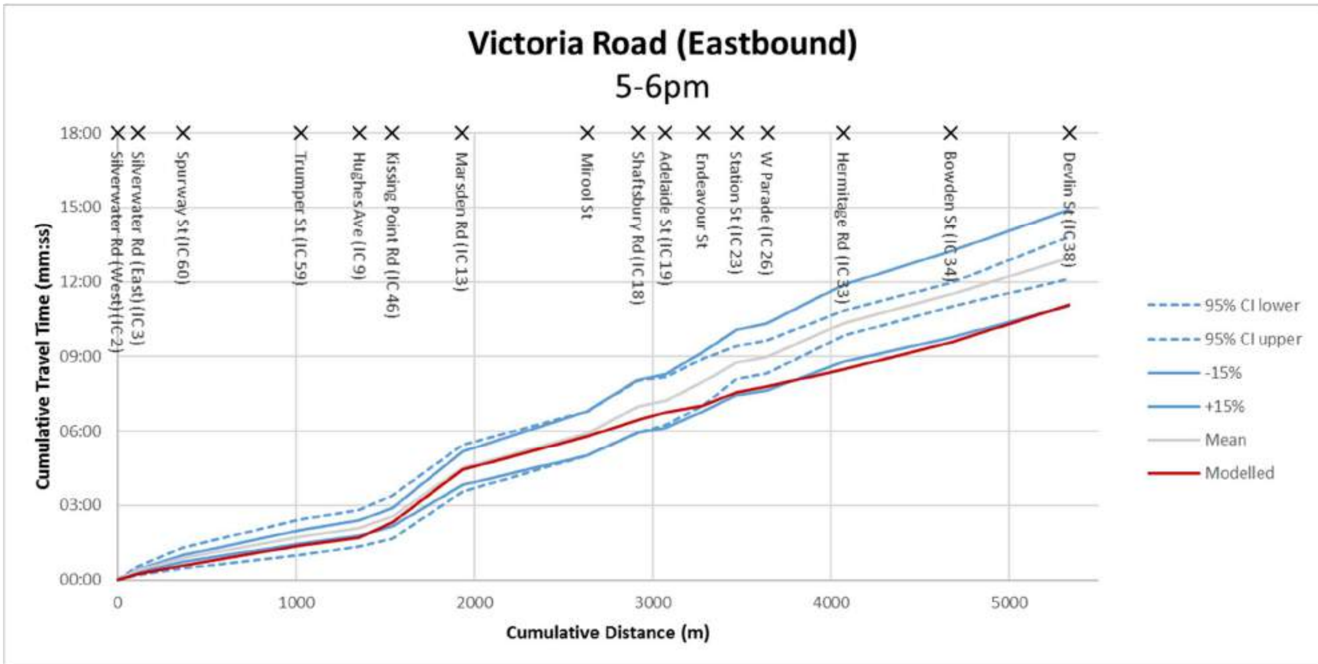


Figure 5.7 : Travel time validation - Victoria Road westbound 4-5pm

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

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

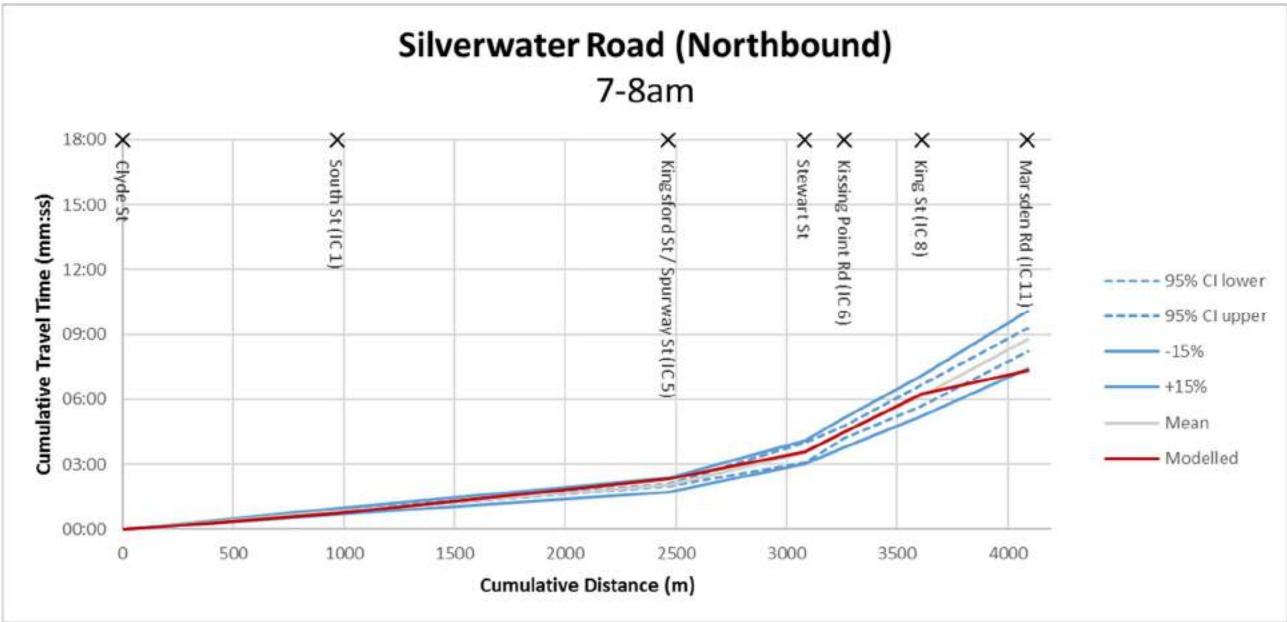


Figure 5.10 : Travel time validation - Silverwater Road northbound 8-9am

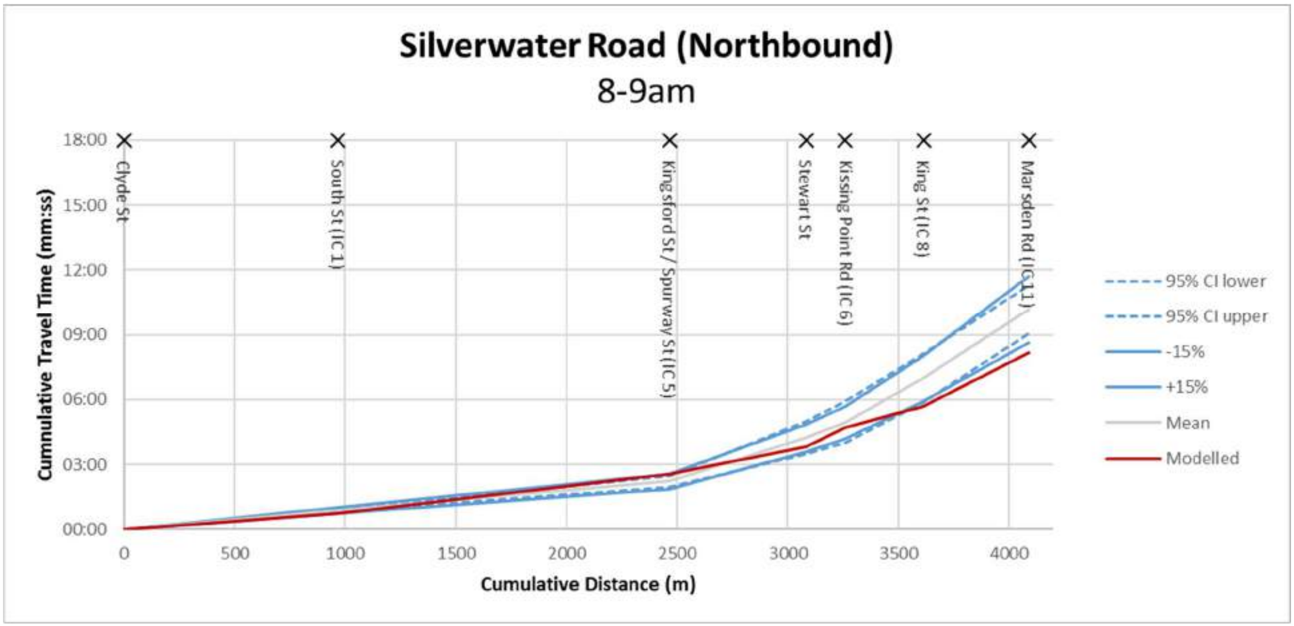


Figure 5.11 : Travel time validation - Silverwater Road southbound 7-8am

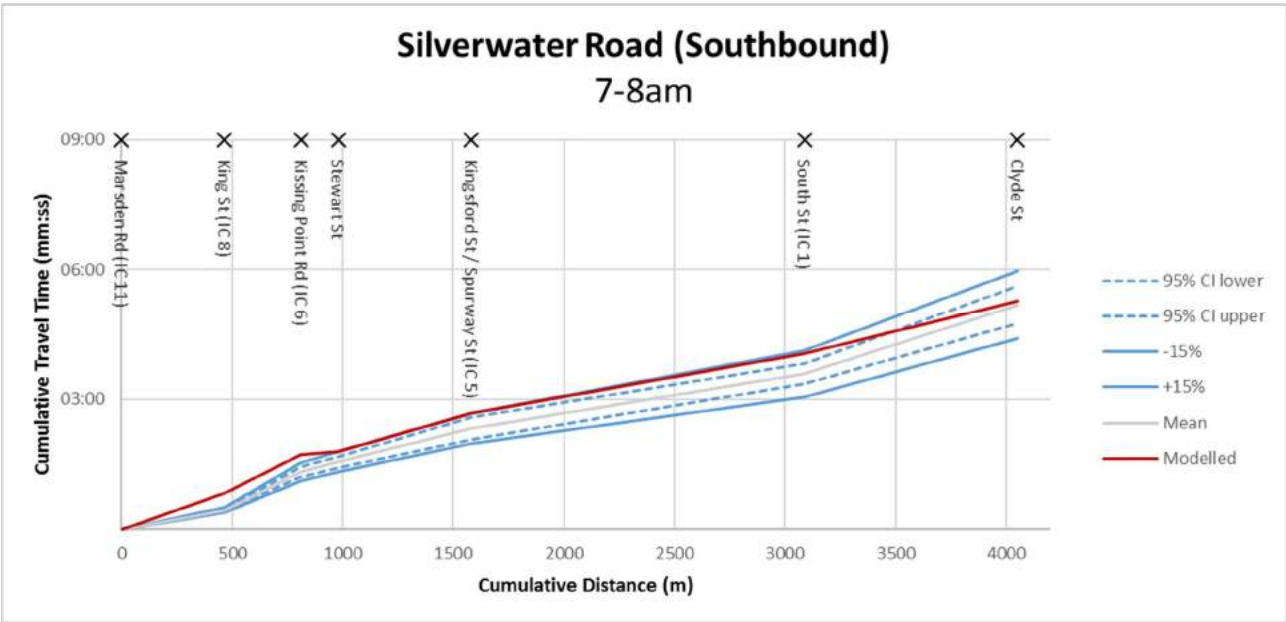


Figure 5.12 : Travel time validation - Silverwater Road southbound 8-9am

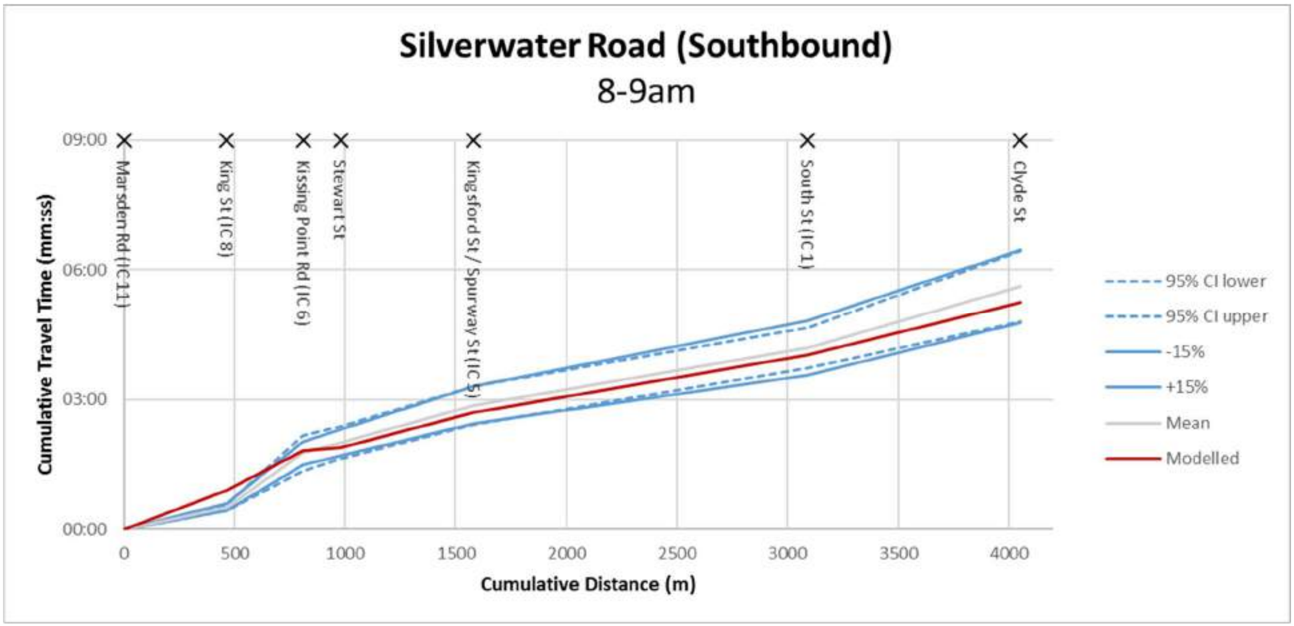


Figure 5.13 : Travel time validation - Silverwater Road northbound 4-5pm

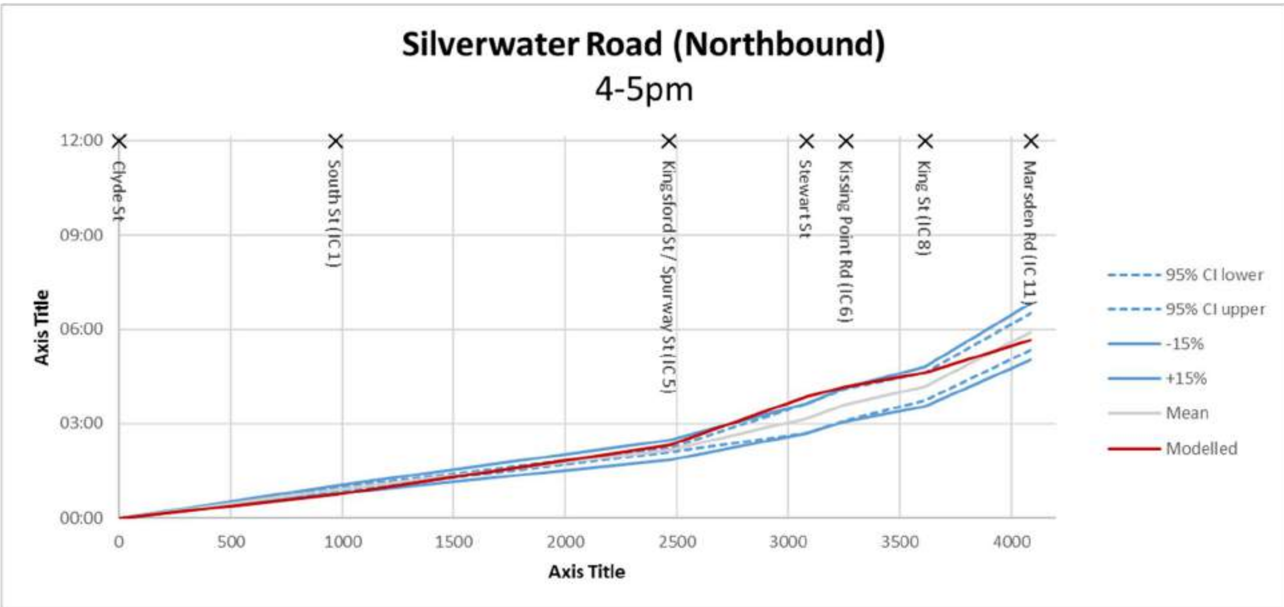


Figure 5.14 : Travel time validation - Silverwater Road northbound 5-6pm

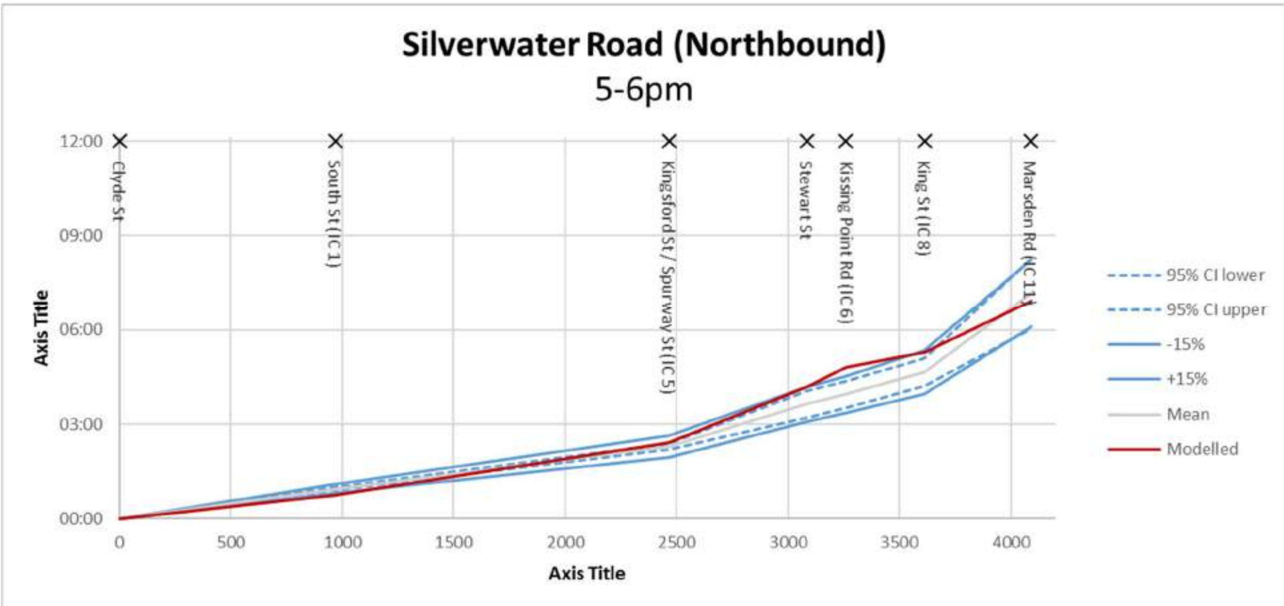


Figure 5.15 : Travel time validation - Silverwater Road southbound 4-5pm

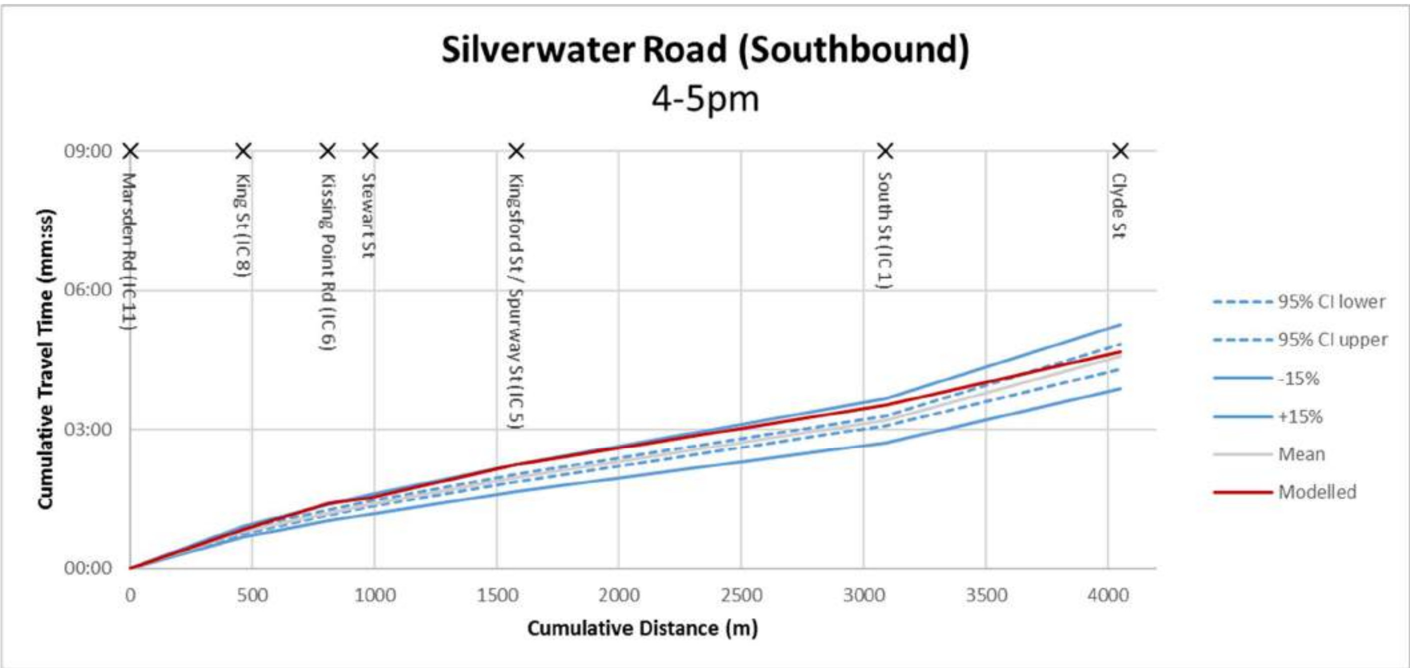


Figure 5.16 : Travel time validation - Silverwater Road southbound 5-6pm

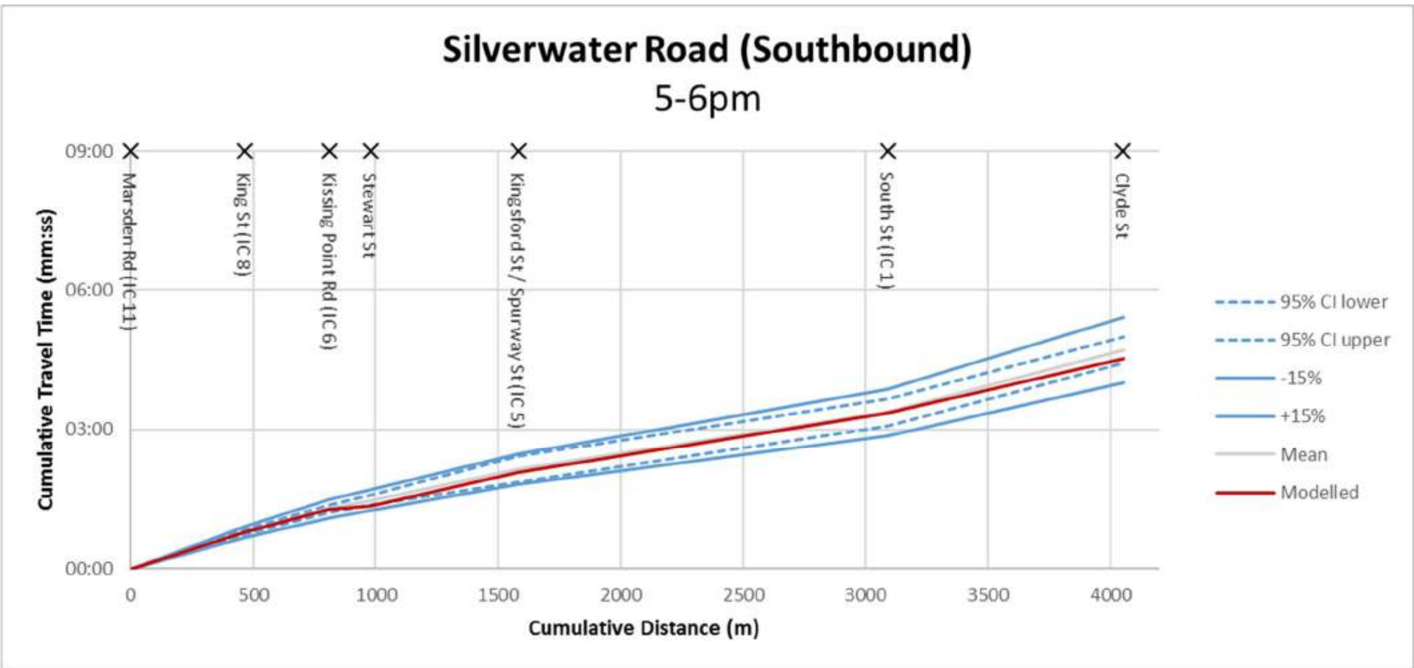


Figure 5.17 : Travel time validation - Wharf Road northbound 7-8am

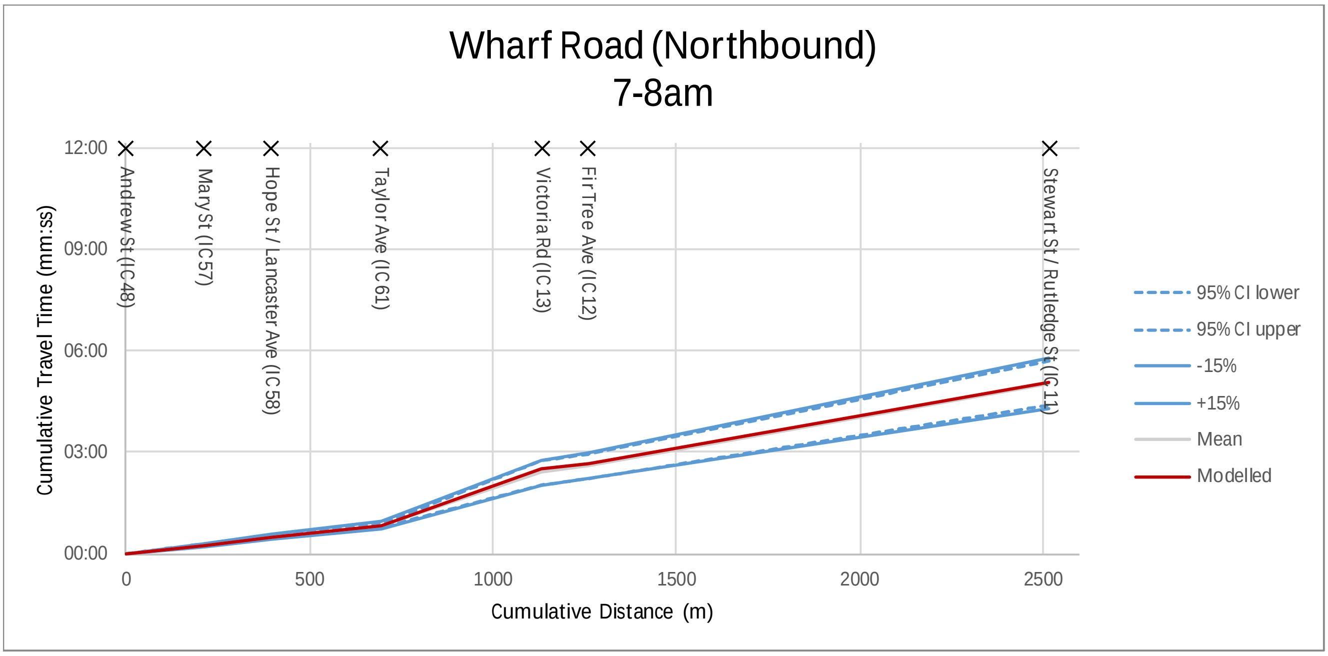


Figure 5.18 : Travel time validation - Wharf Road northbound 8-9am

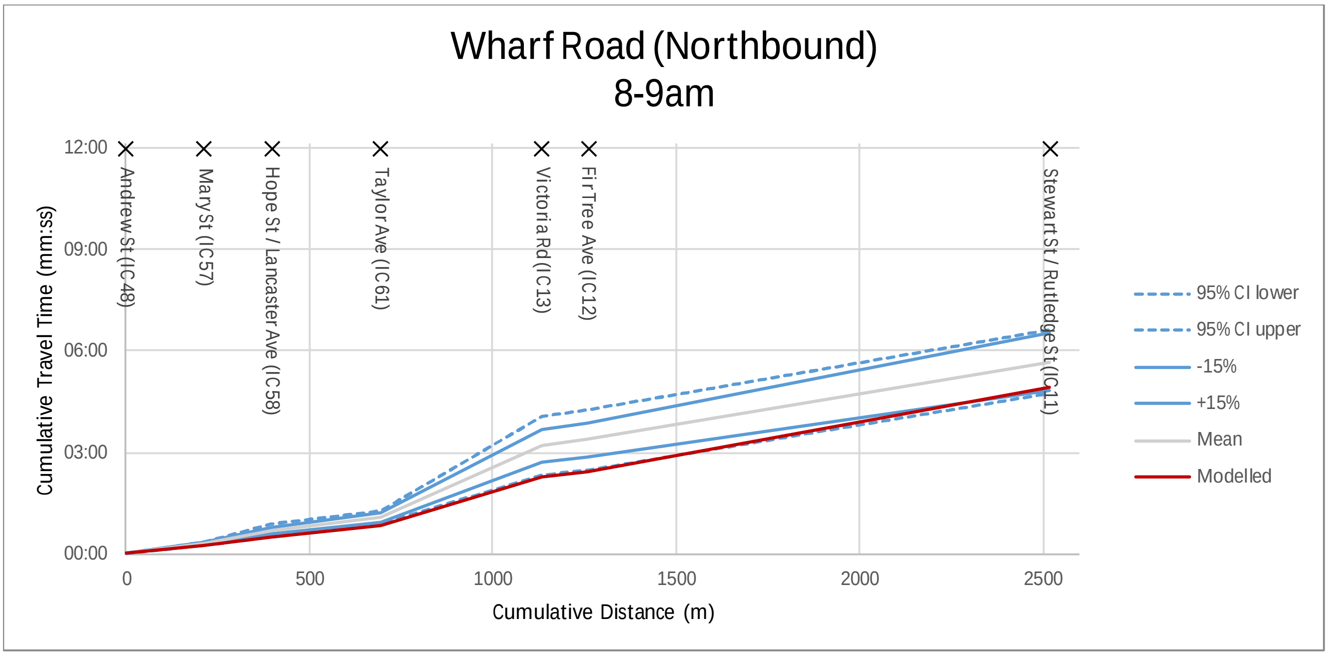


Figure 5.19 : Travel time validation - Wharf Road southbound 7-8am

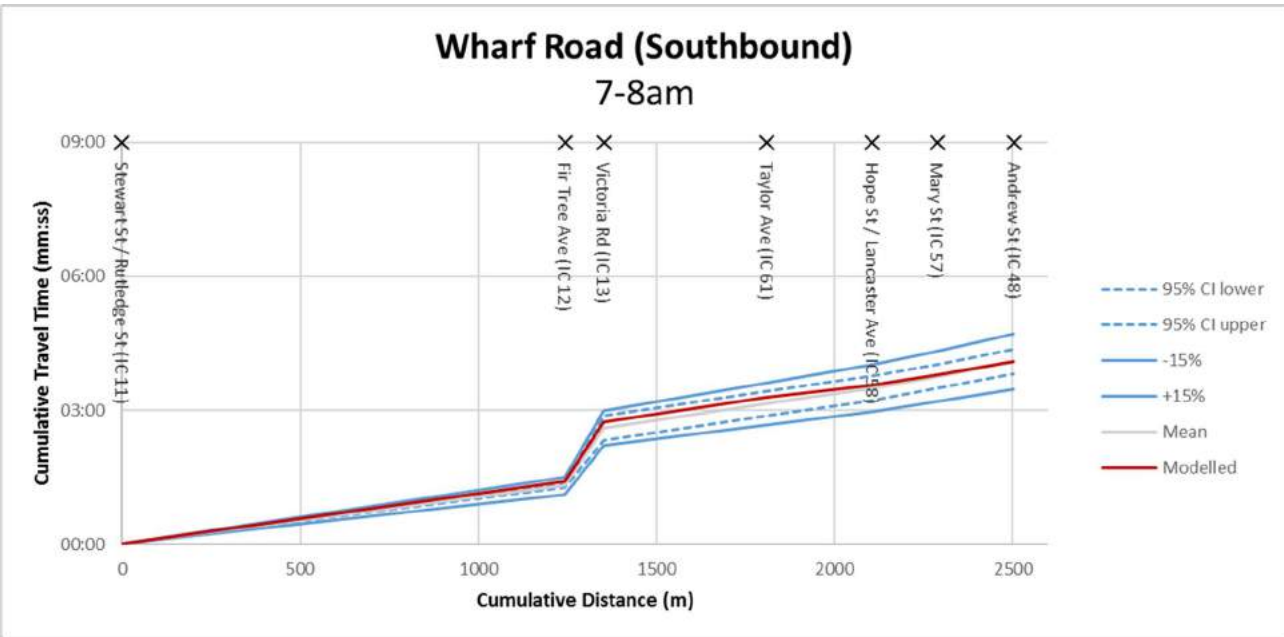


Figure 5.20 : Travel time validation - Wharf Road southbound 8-9am

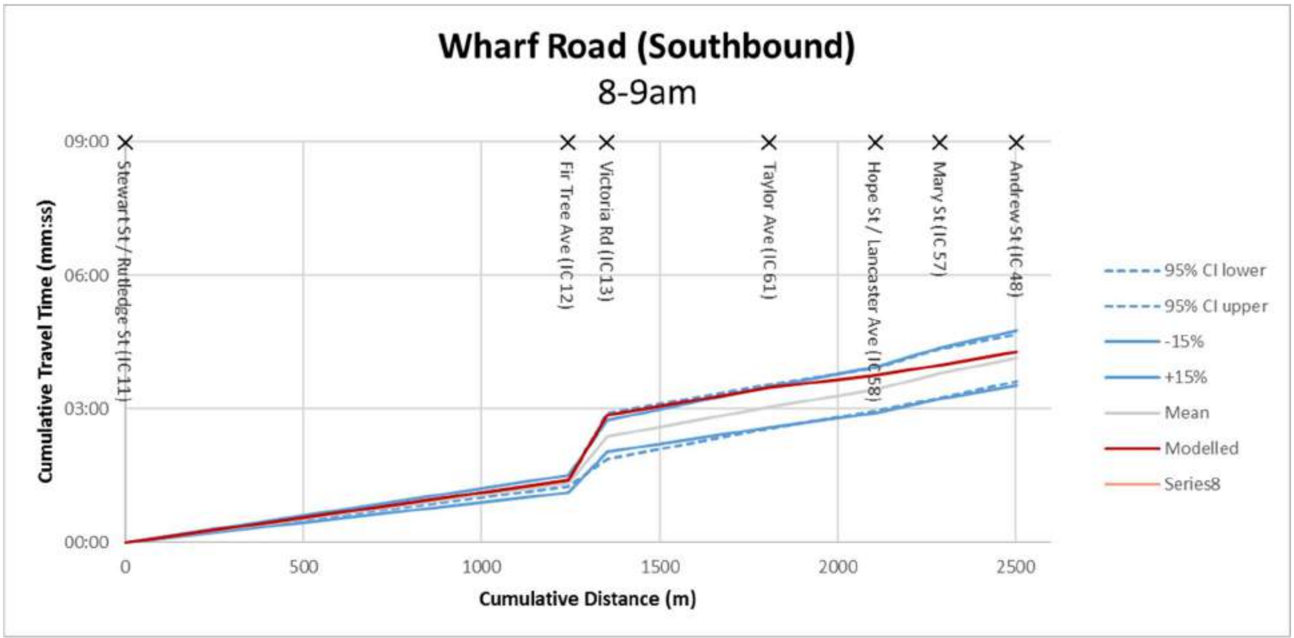


Figure 5.21 : Travel time validation - Wharf Road northbound 4-5pm

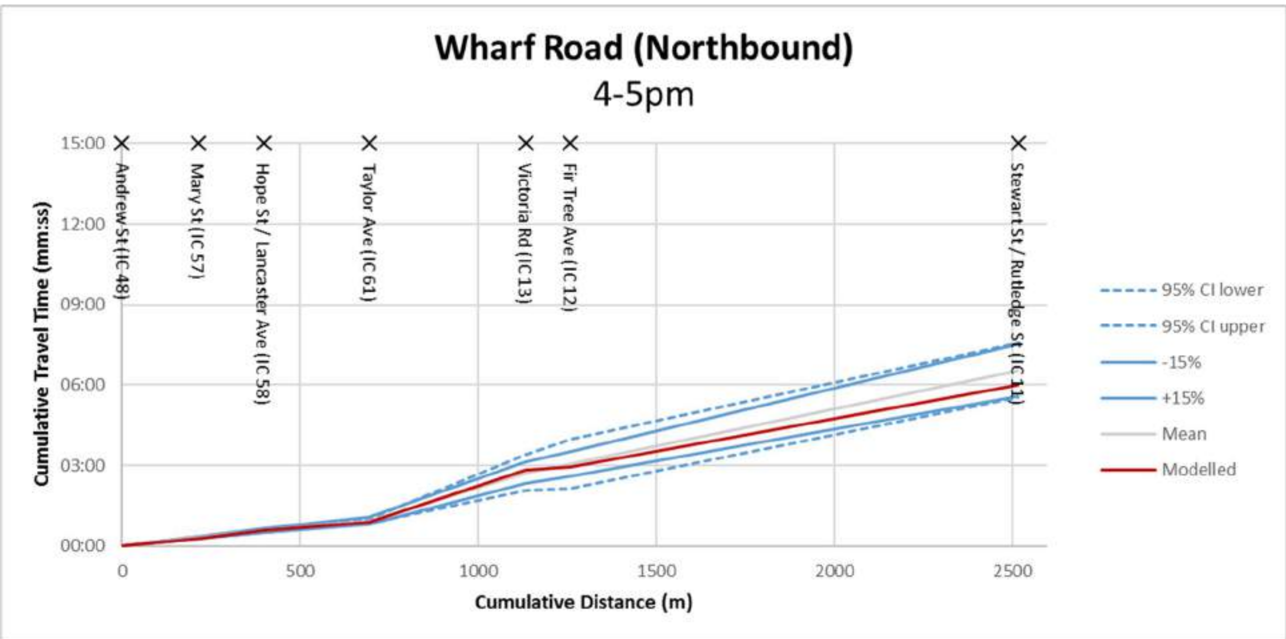


Figure 5.22 : Travel time validation - Wharf Road northbound 5-6pm

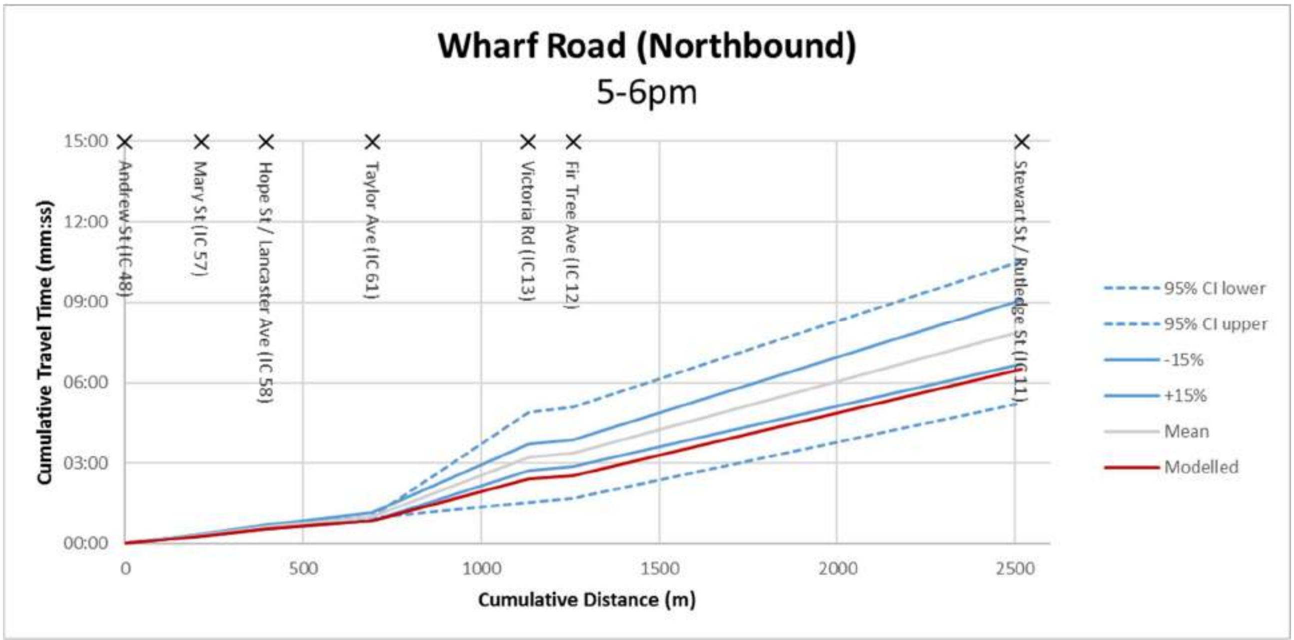


Figure 5.23 : Travel time validation - Wharf Road southbound 4-5pm

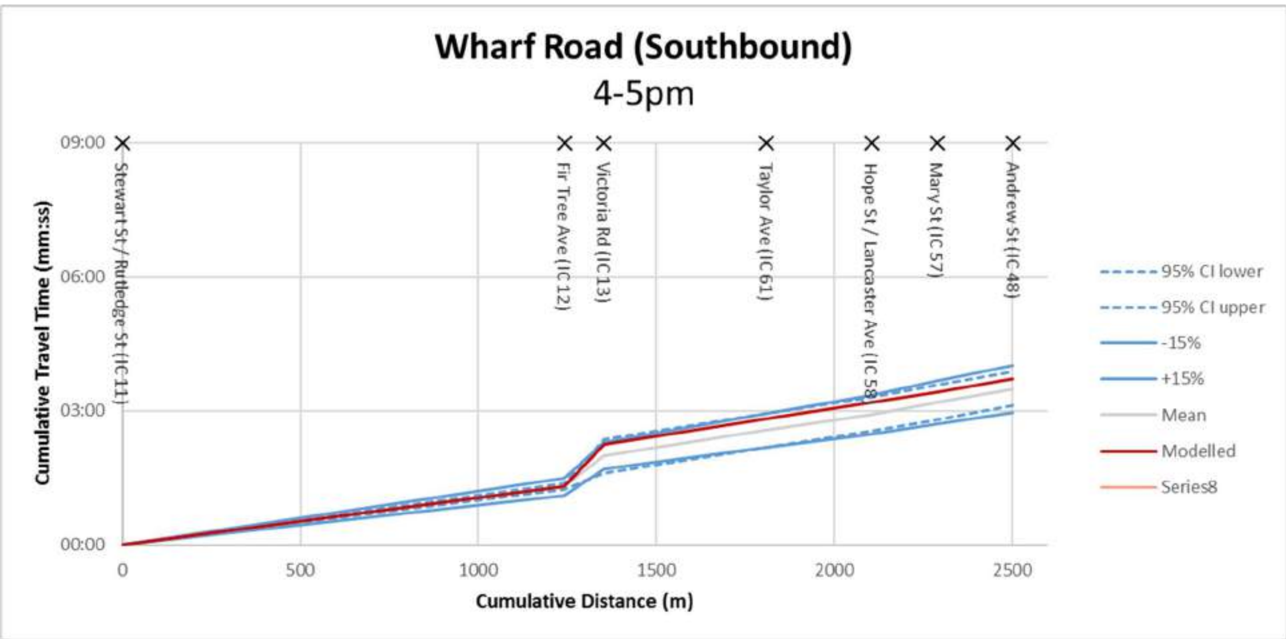
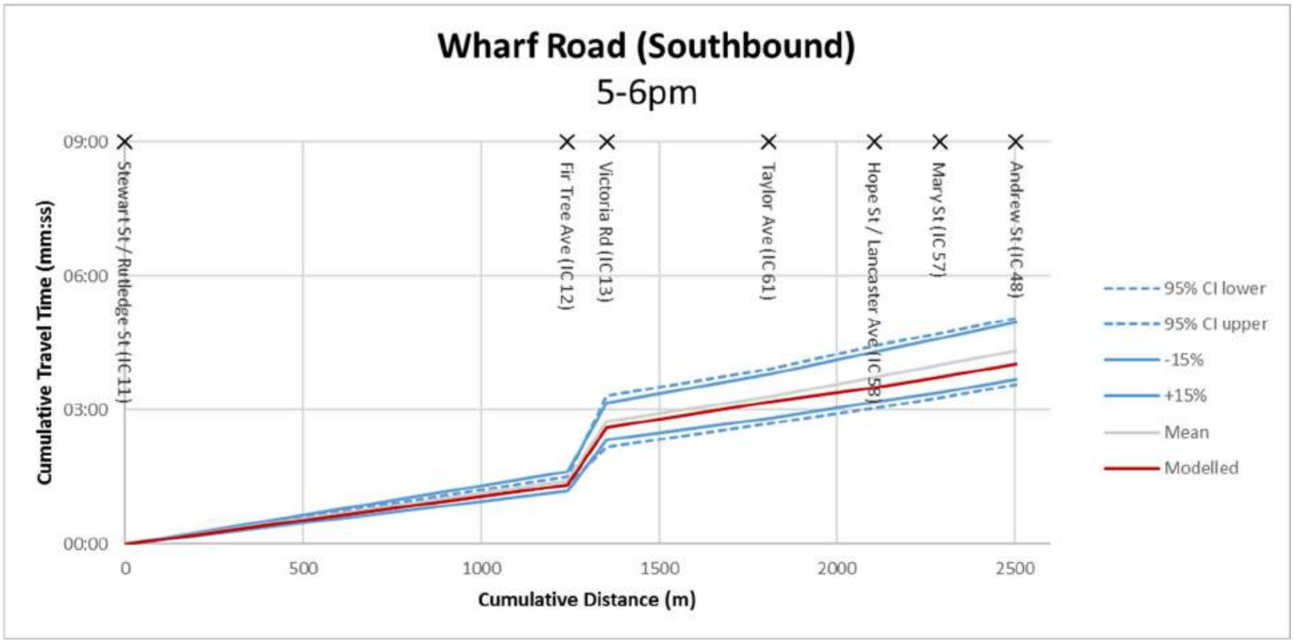


Figure 5.24 : Travel time validation - Wharf Road southbound 5-6pm



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

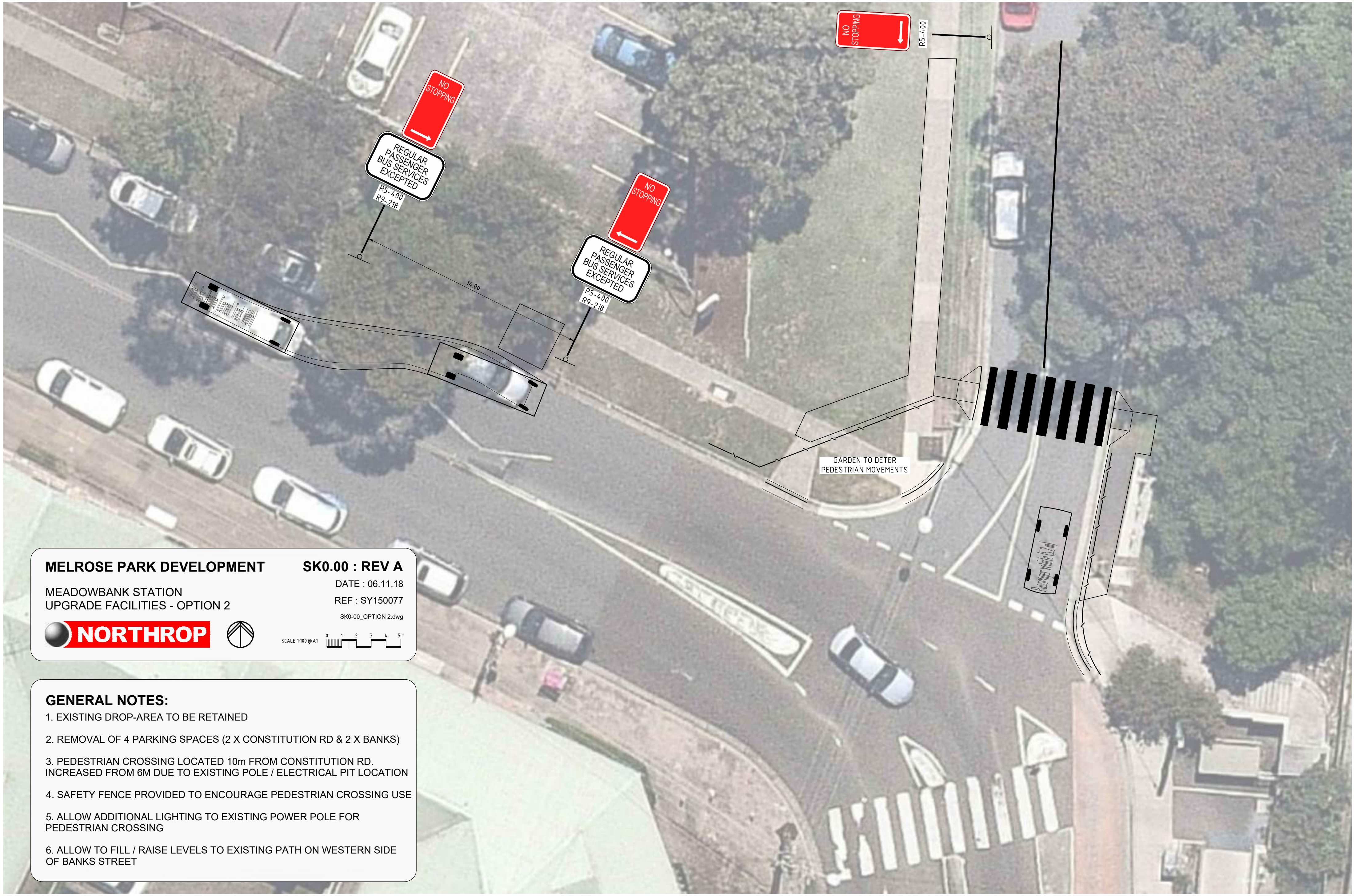
SK0-00_OPTION 1.dwg

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**

MEADOWBANK STATION
UPGRADE FACILITIES - OPTION 2

DATE : 06.11.18
REF : SY150077
SK0-00_OPTION 2.dwg

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

Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Level 7, 177 Pacific Highway
North Sydney NSW 2060 Australia

PO Box 632 North Sydney
NSW 2059 Australia

T +61 2 9928 2100
F +61 2 9928 2500

www.jacobs.com

JACOBS