ACT Government

ACT TRAFFIC MICROSIMULATION MODELLING GUIDELINES

Transport Canberra and City Services

ACT Traffic Microsimulation Modelling Guidelines

Prepared by

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1 Introduction

1.1 Background

Transport Canberra and City Services (TCCS) have engaged AECOM to establish microsimulation modelling guidelines tailored to meet the requirements of the ACT Government. The development ofproject-specific models in the ACT, model inputs, assumptions, outputs and the general quality of models can vary greatly. This makes it difficult for TCCS to assess the validity and acceptability of traffic microsimulation models as there is no set benchmark that can be referred to.

Microsimulation modelling is the most detailed level of traffic modelling that simulates traffic operationsat a vehicle level. It replicates vehicle behaviour in a virtual transport network environment based on established car-following, lane-changing and gap acceptance theories. It is typically used when the traffic assessment requires consideration of complex operations, such as interactions between closely-spaced junctions and application of public transport priority at signalised intersections. It also has goodvisualisation tools that can be very useful when presenting results to non-technical people. Some examples of microsimulation software currently being used in Australia include, Aimsun, Vissim and Paramics.

This document provides guidelines on model development, calibration and validation, and documentation of results. This aims to facilitate an easier and more systematic process for TCCS to assess microsimulation model quality and subsequently, model outputs. The guidelines provide guidance on input parameters, calibration and validation criteria, expected outputs, and the required reporting structure. This helps to ensure that traffic models and reports produced by different people ororganisations will achieve a certain level of consistency that is acceptable to TCCS.

1.2 Purpose

The purpose of these guidelines is to provide guidance to TCCS staff, as well as professional serviceproviders that are conducting work for TCCS, to achieve consistency in developing traffic microsimulation models in the ACT. More specifically, the guidelines aim to:

- Ensure quality across microsimulation models
- Achieve consistency in microsimulation modelling processes
- Achieve consistency in documentation, reporting and presentation styles.

This document is expected to evolve over time, with regular reviews and updates to ensure that theguidelines remain relevant and up to date in relation to the state of the art in traffic microsimulation modelling.

1.3 Scope and Limitations

This document contains guidelines for traffic modelling practitioners who have reasonable experiencein microsimulation modelling. It is not a manual or a step-by-step tutorial on how microsimulation software works. The guidelines are solely focussed on microsimulation modelling procedures, including calibration and validation.

While some of the sections in this document have been based on existing literature from other jurisdictions, such as the *Traffic Modelling Guidelines*[1] by Roads and Maritime Services (RMS), these initial guidelines drafted for the ACT do not go into that level of detail yet. There are some procedures and parameters proposed for modelling traffic in Canberra, but these would still require adjustments inthe future as TCCS and modelling practitioners determine what works best for microsimulation in an ACT context.

1.4 Process Outline

Microsimulation model development is recommended to follow a process that sets out the expected outcomes by TCCS. Generally, this process includes the following chronological tasks, which are alsoillustrated in **Figure 1**:

1. *Establish the need for microsimulation modelling* – Whether it is an agreement between all stakeholders/parties or simply an instruction from TCCS, it needs to be initially established that traffic microsimulation is the most appropriate level of modelling that needs to be undertaken forthe defined purpose.
2. **Hold Point 1: Modelling scope confirmation with TCCS.**
3. *Base model development and documentation*
4. **Hold Point 2: TCCS review and approval of base model.**
5. *Development of future year models and documentation.*
6. **Hold Point 3: TCCS review and acceptance of future base models (optional, see Section 4.5).**
7. *Independent model audit (optional).*

Each of the tasks listed in items 2 to 7 above are discussed in the subsequent chapters of this document.

[1] https://www.rms.nsw.gov.au/business-industry/partners-suppliers/documents/technical-manuals/modellingguidelines.pdf

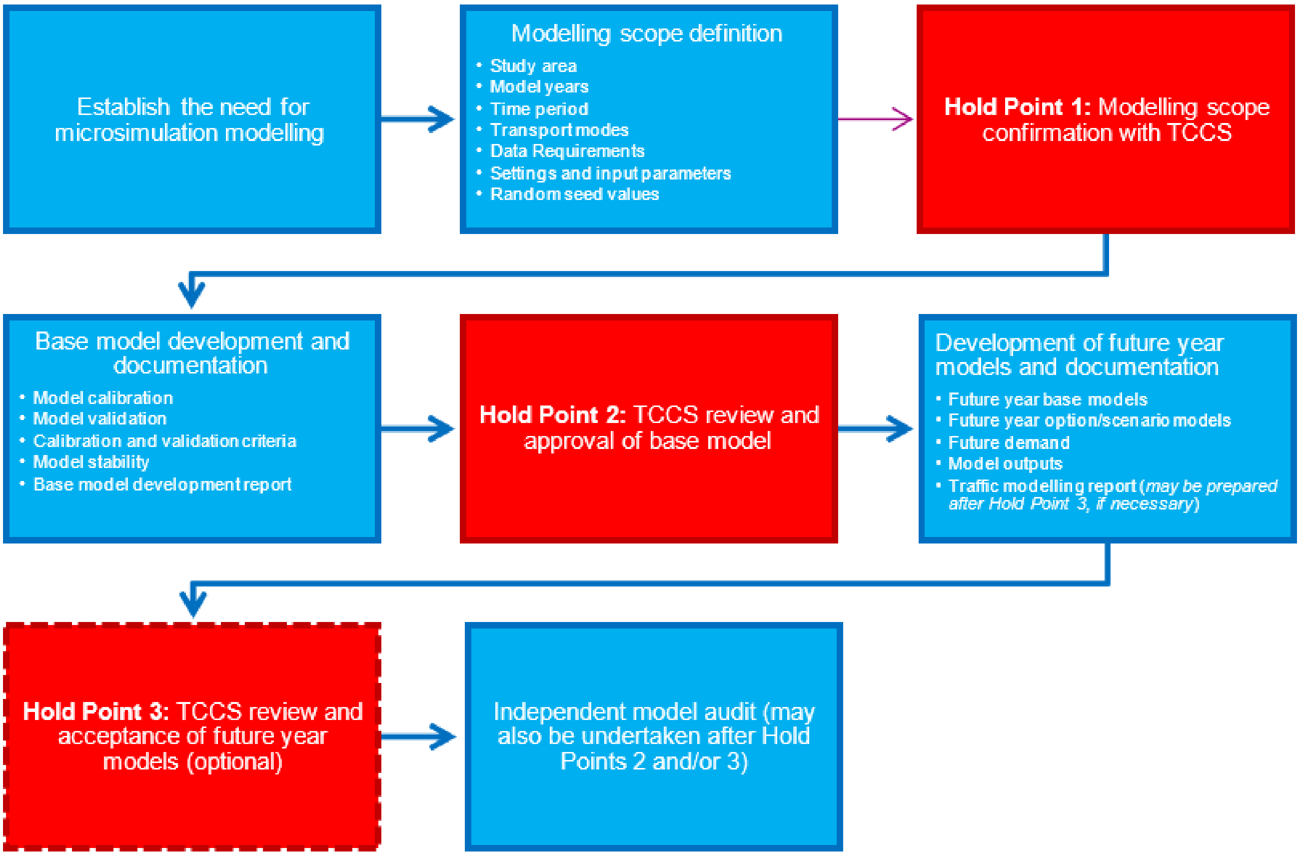


Figure 1 ***Process flowchart – microsimulation modelling in the ACT***

In the following discussions, references to "modeller" or "traffic modeller" could mean either anindividual or an organisation.

2 Modelling Scope

Before any of the actual modelling tasks are started, the scope and purpose of the microsimulation modelling work needs to be clearly defined. This is the first hold point in the process and an importantstep to establish an agreed set of data and parameters that the modellers will use in model development.

The following sections of this chapter discuss the details of model data and parameters that need tobe defined at the outset of a microsimulation modelling project.

2.1 Study Area

The geographic coverage of the model should be defined in consultation with TCCS. In determining the study area, it is important to consider various factors, including but not limited to the following:

- purpose of the microsimulation model
- whether route choice is an important feature of the model
- intersections to be included, generally based on:
- vehicle platooning
- proximity of adjacent intersections
- merging and weaving conditions
- gradient at ramp, overpass and underpass sections
- origin/destination zones
- traffic congestion and queuing
- data availability (e.g., traffic counts, travel time, queue length).

The size of the study area could determine how complex the model is going to be, so care should betaken to ensure that it only covers the relevant areas of the network.

If specific routes within the study area need to be analysed, these should be defined at this stage.Routes can be between specific points in the model or between an origin and a destination zone.

2.2 Model Years

The current year is usually used as the base model year unless the data to be used for calibration/validation were collected in a past year. The base model year is therefore the year when the calibration/validation data were collected.

The future model year/s will either be based on TCCS's advice or proposed by the traffic modeller. For microsimulation modelling, this is generally 5-15 years from the current year. Longer term future scenarios (e.g., 20+ years into the future) may also be modelled as per the requirements by TCCS, noting that the detailed microsimulation models are typically used for assessing short to medium term traffic scenarios.

2.3 Time Period

The model time period is typically the weekday commuter peak hour– AM or PM or both. Other timeperiods may be selected if weekend traffic is being assessed or if the area being modelled (e.g., retail/shopping centres) does not have the same peak period as the commuter peak.

In the ACT, the usual weekday commuter peak hours used for modelling are as follows:

- AM peak: 8:00am – 9:00am
- PM peak: 5:00pm – 6:00pm

If other time periods are to be modelled or if the time period required is more than an hour, themodeller can propose these to TCCS for discussion and approval.

A warm-up period is required to ensure that the model will have the appropriate demand loaded into the network at the start of the model time period. It should be run for a sufficient length of time. As a minimum, the recommended warm-up period is 15 minutes or the longest travel time during shoulderpeak conditions, whichever is longer.

A cool-down period is also required to consider vehicles that are only completing their trips after the modelled time period. The length of the cool down period is generally the same as the warm-up period, unless there are specific traffic conditions that require it be either longer or shorter.

2.4 Time Interval and Demand Profile

The modelled time period should be broken down into smaller time intervals to better reflect observedtraffic demand. The recommended model time interval is 15 minutes over the specified microsimulation period.

The local demand profile should be established by disaggregating the observed peak hour (ormodelled time period) count data into 15-minute intervals.

2.5 Transport Modes

The specific objectives of individual projects usually determine the type and level of outputs requiredfrom a microsimulation model. While cars and truck are typically included in most models, other transport modes may also have to be included in some models depending on the purpose of the analysis being undertaken.

The following are the transport modes that can be included in a microsimulation model:

- Light vehicle – includes private passenger cars, vans, utility vehicles and taxis
- Heavy vehicle – includes small to medium-sized trucks to B-Doubles

- Public transport – includes buses, trains (heavy rail, light rail, etc) and other public transport typeswith fixed timetables
- Bicycle
- Pedestrian
- Future transport modes – e.g., Connected and Automated Vehicles (CAVs), electric vehicles,demand-responsive transport, etc.

The model should include all vehicle classes (i.e., light vehicle, heavy vehicle, and public transport).The inclusion of other modes (e.g., pedestrians, bicycles) is optional but if these users have stronginfluence on traffic (such as higher pedestrian activity near commercial centres), then the modellershould at least incorporate vehicle delay/ congestion effects of other modes.

Transport modes that need to be included in a model for a specific project should be identified as partof the modelling scope definition. For example, if a project mainly focusses on traffic network operations in an environment where there are zero or negligible cycling and pedestrian volumes, thenbicycles and pedestrian could be excluded in the model. On the other hand, if the model is set in a dense urban environment with shared zones, it would be important to understand the interactions between the various modes so including bicycles and pedestrians in this case is necessary.

Vehicle dimensions and behavioural parameters of typical vehicle types are outlined in Appendix A.For public transport, additional information will be required, including routes, frequencies, stops andinterchanges.

2.6 Future Network Assumptions

Planned future network upgrades associated with the selected future model years must be identifiedat the outset, for confirmation/acceptance by TCCS. This is to ensure that future transport network assumptions that modellers adopt are accurate and in line with current ACT Government plans.

2.7 Data Requirements

The following data, collected at the same model time period (including warm up period) defined for the project, are required for calibration and validation purposes:

- *Midblock counts* – These are typically collected from tube count surveys and are optional if comprehensive intersection turning movement counts are undertaken for the modelled network.The counts are preferably classified but may not be necessary depending on the purpose of the microsimulation model.
- *Intersection turning movement counts* – These are important to enable the base model to replicate accurate turning movements at intersections. At unsignalised intersections (i.e., priority-controlled or roundabouts), turning movement count surveys are necessary to obtain the data. If the intersection is signalised, TCCS can readily provide SCATS count data, but it should be noted thatnot all SCATS data sets are reliable for providing turning movement information. Some older systems have missing loop sensors, usually at slip lanes, while other loop sensors detect shared movements, making it very difficult to

accurately estimate turn counts. Ideally, turning movement count surveys should be undertaken at all intersections within the study area at the same time, regardless of the control type. These need to be checked for consistency before accepting them as acceptable for model calibration.

- *Car park entry/exit counts* – These are important for modelling commercial areas, as they can bemajor traffic generators. Often this data can be obtained from car park operators.
- *Signal phase plans and timings (for signalised intersections)* – These can be provided by TCCS aspart of the SCATS data set.
- *Travel time* – These can be for specific routes within the study area or zone to zone journey times.
- *Queue length* - Queue length data can also be used for base model development, provided that queue length measurement occurs at the same time as the traffic counts and is clearly defined (e.g., maximum number of stopped vehicles on each approach for each traffic signal cycle). Theseguidelines do not include specific numerical targets under the calibration/validation criteria for queue length (see Section 3.3). However, if reliable queue length data is available, it can be usedto aid in the development of the base model, particularly at congested locations.
- *Origin-destination (OD) movements* – As noted in Section 3.1.2, the base year OD demand matrixshould preferably be based on OD survey data. This data should be collected simultaneously withtraffic surveys.
- *Public transport details (if required)* – These include specific public transport (i.e., bus, trains, etc)routes and timetables within the study area. Information relating to public transport priority, such as exclusive lanes and intersection signal personalities, should also be collected and coded into the model as appropriate.

While the modeller's coding and calibration skills are important to achieve an acceptable base model, the quality of data used is also a major consideration. Regardless of the modeller's abilities, it is not possible to properly calibrate a base model if data quality is poor. It is therefore recommended to review the available data as part of Hold Point 1, particularly the consistency of count data as well asits size and adequacy. This is to ensure that the data covers the modelled network sufficiently and provides adequate information to be used in the calibration and validation processes. TCCS and the traffic modeller both need to agree on the data to be used for calibration and validation prior to progressing to base model development.

Where TCCS has available data that may assist in base model development, it will be provided, notingthat the completeness, quality or appropriateness of the data is not guaranteed. The modeller should review the data to assess its suitability. In cases where data is not available or found to be unsuitable, data collection surveys need to be carried out. These surveys can be commissioned by TCCS or the modeller, depending on the services agreement. Once all the required data are available, both need toagree that the data are sufficient and of adequate quality for the base model development to proceed.

2.8 Settings and Input Parameters

The standard settings and input parameters for microsimulation modelling in the ACT are defined inthis section. The following settings are recommended to be used for all models:

- Units: SI/Metric
- Rule of the Road: Left-Hand Traffic (LHT)
- Coordinate System: ACT Standard Grid (EPSG:5824)
- Warm-up/Cool-down Time: 15 minutes or the longest travel time in the shoulder peak, whicheveris greater
- Simulation Time Step: 0.8 sec
- Reaction Time at Stop: 1.2 sec
- Reaction Time at Traffic Lights: 1.2 sec
- Vehicle types[2]:
  - Class 01 – Car
  - Class 02 – Towing
  - Class 03 to 05 – Medium Truck
  - Class 06 to 09 – Semi Trailer
  - Class 10 to 12 – B-Double
  - Class 00 – Bicycle
  - Class 00 – Pedestrian
  - Class 00 – Bus
  - Class 00 - Rail

The dimensions and behavioural characteristics of each vehicle type are summarised in Appendix A.Vehicle types to be modelled can be varied as part of the agreed scope.

2.9 Random Seed Values

Microsimulation models are stochastic models that use random number sequences to produce a smalllevel of variability within each simulation run. Each model run is fed by a unique 'seed' value that is used to generate random numbers that influence how elements of the model operate. While a seed value generates randomness within a single run, it will always produce the same results for that run every time the same seed value is used. Therefore, to better represent real-world variabilities and randomness, microsimulation models need to be run a number of times using different seed values.

The RMS guidelines prescribe random seed values to be used for microsimulation modelling and these are the same seed values recommended to be used in the ACT. Generally, five seed values aresufficient, although this

[2] Based on vehicle type definitions in the South Australian Department of Planning, Transport and Infrastructure (DPTI) trafficsimulation guidelines

can be increased based on the size and complexity of the model. The recommended seed values are outlined in **Table 1** and these should be run in the order shown.

Table 1 Random seed values (Source: Traffic Modelling Guidelines, RMS, 2013)

Normal		Extended	
Seed run no.	Seed value	Seed run no.	Seed value
1	560	6	5321
2	28	7	137
3	7771	8	98812
4	86524	9	601027
5	2849	10	559

The average outputs of the five seed runs should be used to check if the base model meets the calibration and validation criteria. Average seed run outputs will also be used in all other reporting ofmodelling results.

2.10 Hold Point 1

Details of the agreed modelling scope and data should be documented by the modeller, preferably in abrief technical note, which will then be submitted to TCCS as part of Hold Point 1. This technical note, or any documentation detailing the modelling scope, needs to be signed off by TCCS before the modeller can proceed to base model development.

3 Base Model Development

The development of a properly calibrated and validated base model is necessary to ensure that the scenario/option models can provide reliable outputs. This chapter discusses the necessary steps required to develop a base microsimulation model that will be acceptable to TCCS.

3.1 Model Calibration

The base model calibration involves coding the study area network and making the necessary adjustments to the network and travel demand parameters to get the model to represent real-world traffic conditions as close as possible. Getting the base model to replicate observed traffic conditionswill give TCCS confidence that subsequent options testing will provide accurate representations of future traffic conditions under different scenarios.

Traffic Modelling Guidelines by RMS split the calibration into three core areas:

- Network verification – refinement of road network inputs.
- Demand verification – refinement of trip volumes, patterns and driving behaviour.
- Route choice verification – refinement of parameters that influence a driver's routing decisions.

Modellers should refer to the RMS guidelines for the details of the processes involved in these threecore areas. The following sections provide some general guidance on network coding, demand estimation and vehicle behaviour. If further guidance on the procedures is required, modellers are advised to refer to the RMS guidelines.

3.1.1 Network Coding

Once the extents of the study area are known, coding of the road network can begin. References forthis task include, but are not limited to, the following:

- Canberra Strategic Transport Model (CSTM)
- ACTMapi
- OpenStreet Maps
- Google Maps/Earth
- ACT Government Traffic Control Devices (TCD) drawing database.

The following are some of the key features that need to be coded when developing a basic network:

- Road geometry (based on a correctly scaled and geometrically correct road map)

- Lane information – widths, number per section, lane utilisation, closures/restrictions, etc
- Posted speed limits
- Road hierarchy
- Intersections – control types, gap acceptance (priority-controlled intersections), signal phasingplans and timings (signalised intersections, typically from SCATS data)
- Public transport (PT) – routes, stops, PT priority at intersections, frequency
- Pedestrians – footpaths, crossings, shared zones
- Cyclists – paths (on/off-road), crossings, shared zones.

Not all the items listed above are required to be coded. TCCS and the modeller will need to agreeon what needs to be included in the model prior to coding, as part of modelling scope and Hold Point

1. Some projects will require more details than others and the model should be tailored to be fit-for-purpose for any specific project.

It is important to get the network coding as consistent and accurate as possible to avoid or minimiseissues during the calibration process.

3.1.2 Demand Estimation

The development of an Origin-Destination (OD) demand matrix for the base microsimulation modelshould preferably be based initially on OD survey data. The matrix can then be adjusted to match midblock and turning movement counts that were also collected from traffic surveys conducted simultaneously with the OD survey.

In the absence of OD survey data, a sub-area matrix from the CSTM can be used as an initial matrix that will be adjusted to match observed traffic data. Some land uses are not well represented in the CSTM or have variable trip estimates depending on exact use (e.g., car parks in commercial centres, airport, schools, retail/commercial uses). The reasonableness of the CSTM trip estimates should be reviewed in relation to assumed land-use and using available count data and the RTA Guide for TrafficGenerating Developments.

Some traffic modelling software have the ability to facilitate the OD matrix adjustment process. It canalso be carried out using some commonly used techniques outlined in the RMS guidelines, including*matrix furnessing*, *matrix estimation* and *manual adjustment*.

Demand profiling also needs to be taken into consideration to ensure that the development of traffic over the selected time period/interval matches real-world conditions. This would ensure that specific and sometimes short periods of very high demand within the peak period can be captured accuratelyin the model (e.g., associated with schools). On the other hand, there could also be cases where the demand profile is relatively flat, with sustained levels of traffic during the analysis period. Either way,local demand profiles need to be investigated and reflected in the model accordingly.

A demand matrix for each vehicle type/class should be developed. As a minimum, light and heavyvehicles should each have a demand matrix for every scenario modelled.

3.1.3 Vehicle Behaviour

Inputs on vehicle behaviour parameters in microsimulation modelling software determine how eachvehicle type is simulated in the model. Some of the typical parameters that control the behaviour ofvehicles in microsimulation models include:

- Car following (time/distance headway, desired speed, etc)
- Gap acceptance (lane changing, priority-controlled intersections, merging, etc)
- Reaction time
- Vehicle performance (acceleration, braking, etc)
- Awareness of other vehicles and aggressiveness.

If the traffic simulation provides multiple alternative routes between origins and destinations, then route choice will need to be calibrated to replicate observed turning movements, midblock counts and other traffic data. The modeller can select the most appropriate technique for route choice calibration and can seek further guidance from the RMS guidelines, if required. It should be noted that if carried out, this process should be discussed in the Base Mode Development Report.

If no parameter value is specified in these guidelines or the RMS guidelines, then the software default value should be used.

3.2 Model Validation

The model validation process is simply an independent test to check if the model has been calibrated sufficiently to replicate real-world conditions to a certain level of accuracy. The calibrated model is run,and a set of pre-defined model outputs is then compared against an equivalent set of observed data, which should be independent of the data used in model calibration.

If the statistical comparison between the modelled and observed data show that the model does not meet the set targets of any of the criteria, it is an indication that the model is not yet at a sufficient levelof accuracy. If that is the case, then the specific modelling output that causes the inaccuracy should beidentified and analysed. This means that the modeller needs to go back to the calibration process to address the issue by adjusting appropriate input parameters.

This iterative process between calibration and validation, illustrated in **Figure 2**, needs to be carriedout until the validation criteria are met.

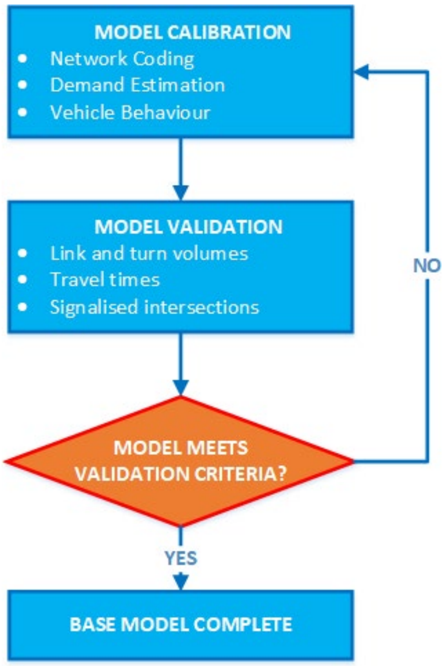


Figure 2 ***Base model calibration and validation process***

3.3 Calibration and Validation Criteria

For the model to be considered fit-for-purpose, it must meet the calibration/validation criteria set in **Table 2**.

As the calibration and validation data sets need to be independent, modellers must be clear in their reporting which ones were used for each process. For example, observed link and turn volume data are usually used by modellers in the calibration process. In this case, the same data set cannot be used for validation, although it still needs to be compared against the corresponding modelled data setand meet the *Link and turn volumes* criteria set in **Table 2**. For validation, the observed *Travel time* and *Signalised intersections* data sets will be used.

The modeller should select the median output among the five base model seed runs (see **Section 2.9**)to compare against the calibration/validation criteria. The selection of the median will be based on the extracted total Vehicle-Hours Travelled (VHT) from each of the seed runs.

The calibration/validation criteria are categorised into four main items, namely:

- Link and turn volumes
- Travel time
- Signalised intersections

- Queue length.

As mentioned earlier, there is no specific numerical target for queue length validation. However, it stillneeds to be checked and compared against real-world data – whether it is actual queue length surveydata or local knowledge of queuing at key locations.

Table 2 ***Microsimulation model calibration/validation criteria***

Item	Criteria	Target	Comment
Link and turn volumes	GEH < 5	**≥ 85%**	If the GEH targets are not achieved, it needs to be explained in the report
	GEH < 10	**≥ 100%**	
	Observed vs modelled hourly flows plot	**$R^2 > 0.95$**	Slope equation to be included in the plot (intercept set to 0)
		Slope = 1 ± 0.05	
Travel time	Journey time average	Average modelled journey time of specific routes, generally broken into sections, to be **within 15% or one minute (whichever is greater)**	Cumulative chart of modelled journey time vs the ±15% or ±1-minute threshold to be plotted and included in the report. See example chart shown in Figure 3. Route sections are typically segments between major intersections.
	Journey time variability	Average and 95 per cent confidence intervals to be plotted for observed and modelled travel times for each journey time route (see example chart shown in Figure 4)	No specific numerical target, but TCCS and the modeller needs to agree that the model reasonably replicates the observed journey time variability.
Signalised Intersections	Cycle time	Average modelled cycle time for each one-hour period to be **within 10%** of observed average cycle time for the same one-hour period	If the cycle time targets are not achieved, it needs to be explained in the report
Queue length	Queue length at key locations	Comparison of observed and modelled queues at key locations within the study area.	No specific numerical target, but TCCS and the modeller needs to agree that the model reasonably replicates the observed queue lengths at key locations.

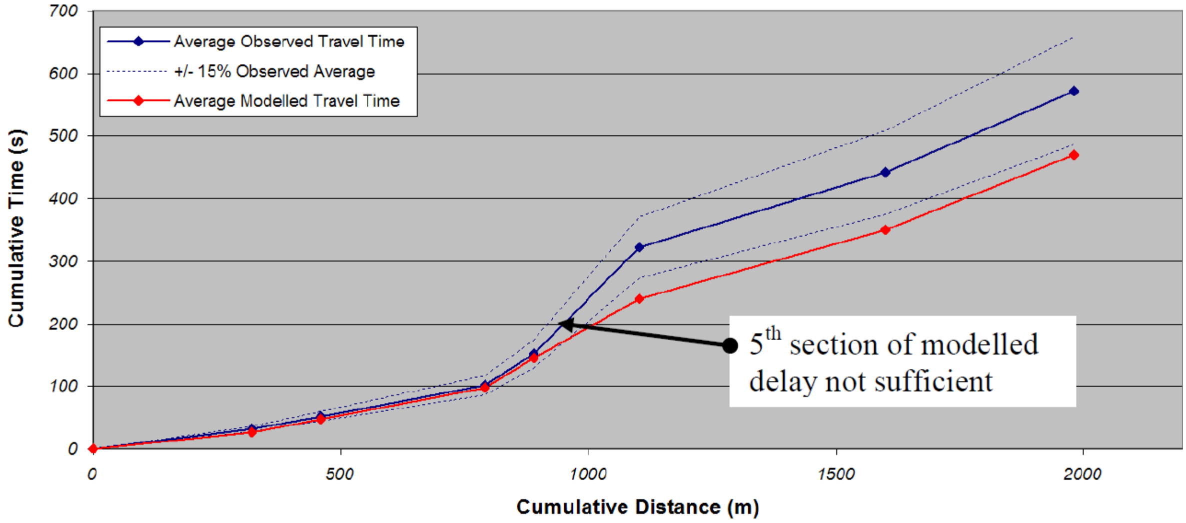


Figure 3 ***Travel time comparison example (Source: Traffic Modelling Guidelines, RMS, 2013)***

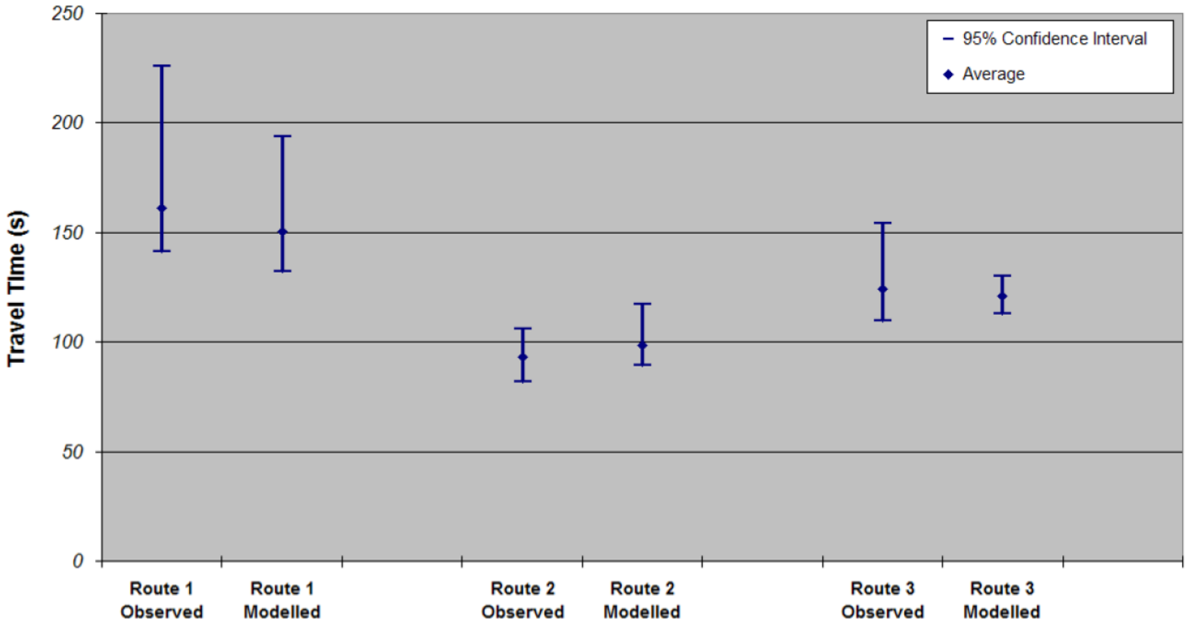


Figure 4 ***Travel time variability comparison example (Source: Traffic Modelling Guidelines, RMS, 2013)***

3.4 Model Stability

Model stability can be tested by comparing results across the five seed runs and checking if there are significant variabilities in the model outputs.

To check the stability of the base model, it is recommended to graphically present the comparison ofthe following model outputs across the five seed runs:

- Number of vehicles in the network
- Total network travel time
- Average network speed.

Model outputs at specified time intervals, say one-minute, should be plotted to easily compare whatthe five seed runs are producing. An example of this comparison chart, in this case the number of vehicles in the network, is shown in **Figure 5**.

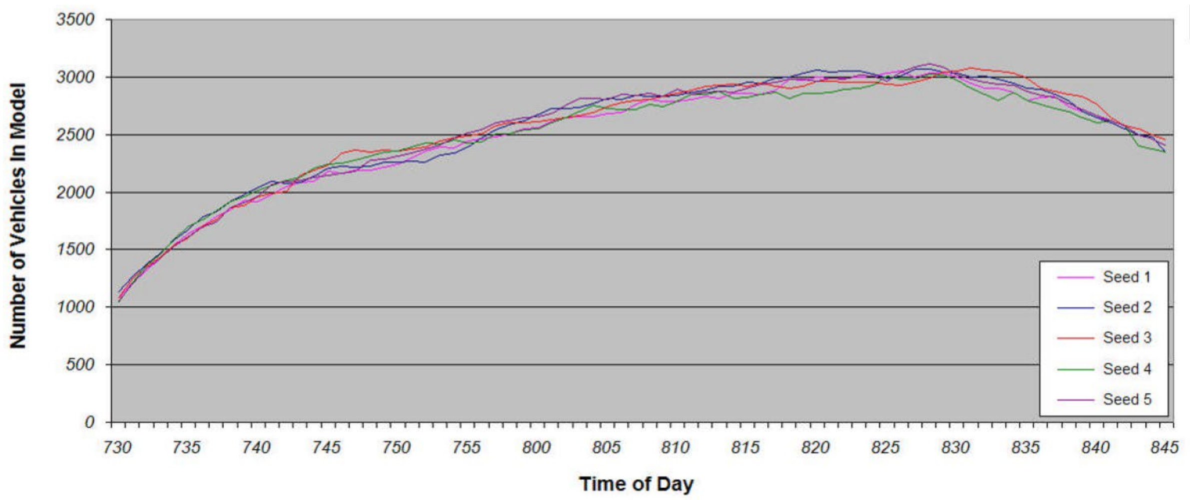


Figure 5 ***Model stability check example – number of vehicles in the network (Source: Traffic Modelling Guidelines,RMS, 2013)***

While these guidelines do not set specific criteria to determine model stability, a model can be generally considered stable if there are no major variations between the five seed runs. Small variabilities may be acceptable as it could represent operational variations across different days orcould better replicate real-world network conditions if it actually operates in a relatively unstable fashion. The modeller needs to provide commentary and articulate well on the report why the base model can be considered stable.

3.5 Base Model Development Report

The Base Model Development Report will provide TCCS details of how the base model was developed and if the model is fit-for-purpose. It will include a description of the model extents and itspurpose, data collection and processing, and discussions about the calibration and validation.

The following are the key information that should be included in the Base Model Development Report:

- Project background
- Purpose of the microsimulation model
- Study area
- Data collection and processing
- Model time periods

- Model input parameters
- Network coding and development, including software package used
- Demand estimation
- Model calibration and validation

The outline set out below is the recommended structure of the Base Model Development Report:

- Introduction
  - Background
  - Project objective
  - Study area
- Existing conditions
  - Data collection
  - Existing conditions assessment
- Model inputs and assumptions
  - Software used
  - Time period/s and profiles
  - Vehicle types
  - Traffic zones
  - Road types
  - Behaviour parameters
  - Calibration and validation criteria/targets
  - Other modes (if required)
  - Other inputs and assumptions
- Model calibration
  - Network coding
  - Demand estimation
  - Vehicle behaviour
- Model validation
  - Calibration and validation results
- Model stability
  - Results comparison across five seed runs
- Model limitations
- Conclusions

- Appendices – GEH results, OD matrices, signal phasing plans, completed internal audit checklist by modellers

The structure presented above is a general guide to modellers on how to structure the Base Model Development Report. The main headings should generally be followed but the sub-headings are flexible and can be modified to whatever is appropriate for individual projects.

The Base Model Development Report should be submitted to TCCS, together with the calibrated baseyear model files, for review. This milestone triggers Hold Point 2 wherein the modeller cannot proceedto modelling future year scenarios (including base models) until TCCS accepts/approves the base year model calibration.

3.6 Hold Point 2

A Base Model Development Report (see **Section 3.5** for details) must be produced by the modeller to summarise the base model development process. The report, together with the associated base microsimulation model files, need to be submitted to TCCS for review as part of Hold Point 2.

The development of future year models cannot proceed until the Base Model Development Report andthe base model have been approved/ accepted by TCCS.

4 Future Year Models

Future year models (or option/future scenario models) should be developed from the calibrated/ validated base model that has been approved by TCCS. Any adjustments made to the input parameters and geometry configurations during the calibration process should not be changed. Partsof the network that are not expected to change in future model scenarios should remain as they are, as making unnecessary changes to these could invalidate the model calibration.

There are generally two types of future year models used in microsimulation modelling, as follows:

- Future Year Base Models
- Future Year Option/Scenario Models

The following sections in this chapter discuss the expected features of each of these future year model types, as well as guidance on how to estimate future demand.

4.1 Future Year Base Models

A future base model is necessary for each future planning horizon included in the analysis. This will beused as a reference to compare proposed options/scenarios for each specified future year.

Future year base models need to account for all planned or committed transport network upgrades foreach corresponding year. The initial reference for this should be the CSTM as its future base models contain all the planned transport network upgrades for 2021, 2026, 2031 and 2041. While the CSTM isassumed to always be up to date in terms of future transport network information, modellers are advised to confirm future network changes with TCCS, especially those that directly or indirectly influence the microsimulation model study area.

The operation of all intersections in the model will need to be reviewed to determine the need for changes to the model to overcome significant traffic congestion issues. This will include the refinementof signal phasing and timing and the consideration of new signals, depending on the project objectives.

4.2 Future Year Option/Scenario Models

The future option or scenario models should be developed using each corresponding future base model as the initial reference model. Proposed network changes associated with the options or scenarios being assessed are to be coded into the future base model of the same future year. For example, if the impacts of a 2031 road duplication need to be assessed, then it needs to be coded intothe 2031 base model to create the associated future year option/scenario model.

4.3 Future Demand

While the CSTM produces future travel demand forecasts, it is not recommended to directly take the projected demands from the CSTM and apply them to future year microsimulation models. As it is a high-level transport model, it will not have the same level of traffic demand replication of real-world conditions as a calibrated microsimulation model. However, it does consider both future land use projections and planned upgrades, capturing travel pattern changes and increases in demand at specific parts of the network. Therefore, the most important inputs from the CSTM are the growth factors that can be derived for any localised sub-area that is the same as any given microsimulation model's study area.

The modeller will initially need to define a sub-area in the CSTM that is consistent with the microsimulation model's study area. This will produce a sub-area matrix that is similar to the demandmatrix used in the microsimulation model. The appropriate growth factors will then have to be extracted from the CSTM, at an OD level, between the latest calibrated base year (currently 2016) towhatever future planning horizon that needs to be assessed. These OD growth factors can then be applied to the base year model's demand matrix to estimate the demand matrix for the future year models.

As noted in Section 3.1.2, some land-uses are not well represented in the CSTM or have variable trip estimates depending on exact use. Thus, the reasonableness of the CSTM trip estimates should be reviewed against available assumptions regarding changes in land use and associated trip rates.

The application of growth rates does not apply to zones in greenfield development areas or to areas where there is little existing development. Growth rates are also likely to be inaccurate in commercialareas where trips are generated to/from car parks and not necessarily buildings/land-use. For these zones, the CSTM trip estimates can provide a guide to future trip rates, but they need to be reviewedand revised to reflect expected land-uses and trip rates.

The OD growth rates may have to be taken for both base year to future base and base year to future option/scenario models. This is to ensure that changes in travel patterns and the associated network volumes due to the proposed option are captured at the CSTM level and therefore captured in the resulting growth rates as well. Some future upgrade options may not necessarily induce significant (orany) change in demand patterns in the CSTM, so the details of future demand estimation need to be discussed and agreed with TCCS beforehand.

Consideration should be given to changing the demand profile in models with significant congestion.Over time, peak spreading occurs, especially in congested networks.

4.4 Model Outputs

To compare the modelled options/scenarios against the base, relevant model outputs need to be specified according to the objectives of the project associated with the microsimulation modelling work.Some of the typical outputs used in comparative analyses of base and project (i.e., option/scenario) cases are outlined in **Table 3**.

Table 3 ***Typical model outputs to assess options/scenarios***

Level	Output	Comment
Network	Vehicle-Kilometres Travelled (VKT)	Modeller needs to include a brief explanation in the report how VKT and VHT are extracted/calculated from the model
	Vehicle-Hours Travelled (VHT)	
	Average Travel Speed (km/h per vehicle)	
	Average Travel Time (min per vehicle)	
	Number of unreleased vehicles (if any)	
Corridor	Traffic Volume (veh/h)	
	Density (veh/km)	
	Level of Service (A-F)	As per Highway Capacity Manual (HCM) criteria
Local	Route Travel Time (min)	Route/s need to be defined as part of the modelling scope definition process
	Route Delay (min)	
	Route Travel Speed (km/h)	
Intersections	Average Delay (sec)	Modeller needs to include a brief explanation in the report how this is calculated
	Approach Average Delay (sec)	
	Level of Service (A-F) – can be for the whole intersection, or for each approach and/or turning movement	As per Highway Capacity Manual (HCM) criteria

Note that the list in **Table 3** is not exhaustive and only includes those that are usually used to compare network performance and levels of service between different scenarios. Other model outputs may be necessary to address specific project objectives. These will have to be defined and agreed with TCCS beforehand, so the modeller can set up the model and the outputs appropriately.

4.5 Hold Point 3 (Optional)

This hold point is suggested at the end of the future year modelling tasks to give TCCS the opportunityto review the results of the options/scenarios testing before the Traffic Modelling Report is prepared.

The modeller will submit to TCCS a summary of the model outputs for all scenarios (including base models) and the associated model files for review. The purpose is to identify and address issues withthe modelling results before any effort is made in the preparation of the Traffic Modelling Report. Thiscould avoid or minimise major revisions after the submission of the report that could have significant impacts on the project program.

While there are advantages to having this Hold Point in the modelling process, it could also be an onerous and potentially unnecessary task, depending on the size and complexity of the model. As thisHold Point is optional, TCCS may choose not to go through it and direct the modeller to prepare the Traffic Modelling Report when all the modelling tasks are done.

TCCS and the modeller therefore need to discuss and agree whether Hold Point 3 is necessary beforethe preparation of the Traffic Modelling Report.

4.6 Traffic Modelling Report

The Traffic Modelling Report is the primary document that contains all the relevant information and processes associated with the microsimulation modelling, including those undertaken during base model development. The following is the recommended structure of this report.

- Introduction
  - Background
  - Project objective
  - Study area
- Base Model Development
  - [Brief summary of the base model development process]
- Model inputs and assumptions
  - [Brief summary of inputs assumptions discussed in the Base Model Development Report]
  - Additional inputs and assumptions associated with the future year models
- Options/Scenarios
  - Description of options/scenarios to be modelled
  - [Include drawings/diagrams/maps where possible]
- Future year demand
  - Land use changes (if any)
  - Demand growth
- Modelling results
  - Base year model results
  - Future year base model outputs
  - Option/scenario model outputs
  - Comparative analysis of modelling results
- Conclusions and recommendations
- Appendices – modified signal phasing plans, future demand matrices, developmentdemand matrices, proposed road design treatments

Shown below are some examples of how model outputs should be presented in reports. Network results tables summarising VKT and VHT are shown in **Table 4**, while a graphical presentation ofnetwork travel time and average speed is shown in **Figure 6**. Example results showing the performance of specific travel routes in the network are shown in **Figure 7** and **Figure 8**.

Total Vehicles Kilometres Travelled (VKT)		
Time Interval	**Base Model**	**Option Model**
08:15-08:30	8955	9386
08:30-08:45	8653	8861
08:45-09:00	8301	7579
09:00-09:15	7635	7227
Average	**8386**	**8263**

Total Vehicles Hours Travelled (VHT)		
Time Interval	**Base Model**	**Option Model**
08:15-08:30	191	172
08:30-08:45	215	174
08:45-09:00	221	145
09:00-09:15	142	124
Average	**192**	**154**

Average Network Travel Speed (VKT/ VHT)		
Time Interval	**Base Model**	**Option Model**
08:15-08:30	47	55
08:30-08:45	40	51
08:45-09:00	38	52
09:00-09:15	54	58
Average	**45**	**54**

Table 4 ***Example of network results tables***

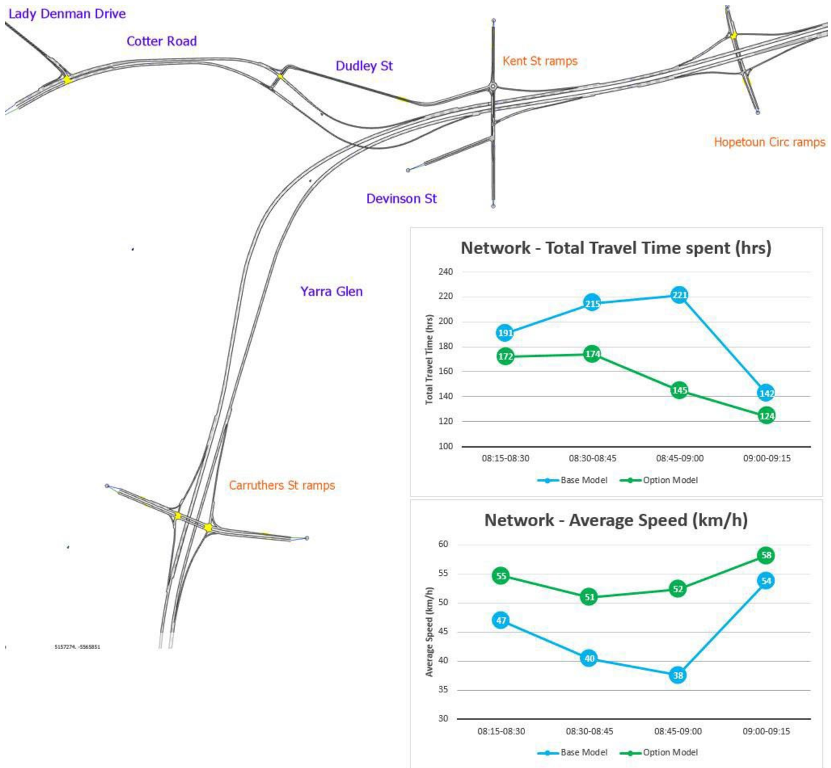
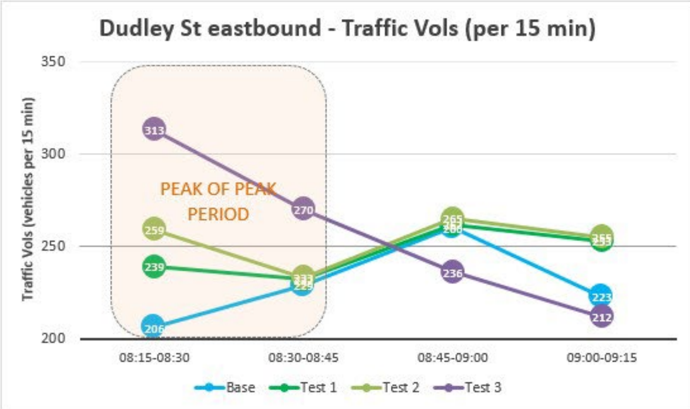
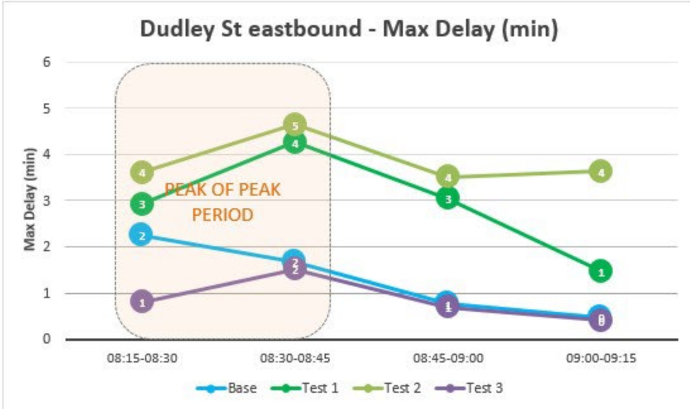
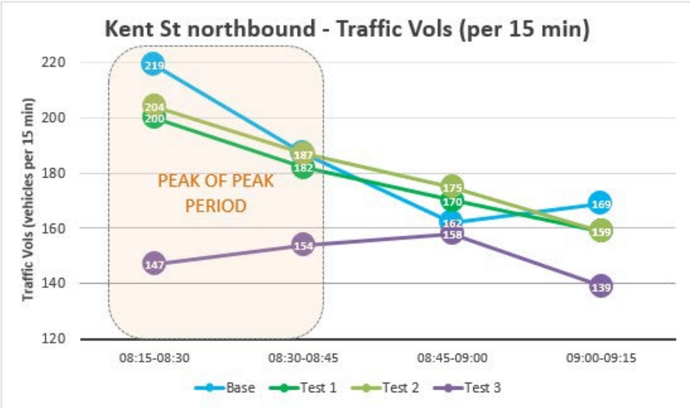
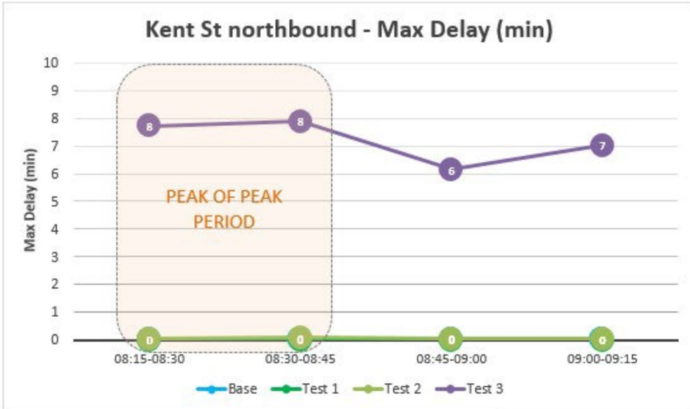


Figure 6 ***Example network results charts***









Legend:

Base	Existing Intersection Configuration (i.e. Cotter Rd off-ramp to giveway to Yarr Glen traffic)
Test 1	Cotter Rd off-ramp continuous lane
Test 2	Test 1+ Canberra Works roundabout access at Dudley Street
Test 3	Test 2 + Signalisation of Kent Street ramps and Denison Street

Figure 7 ***Example route performance results – volume and maximum delay***

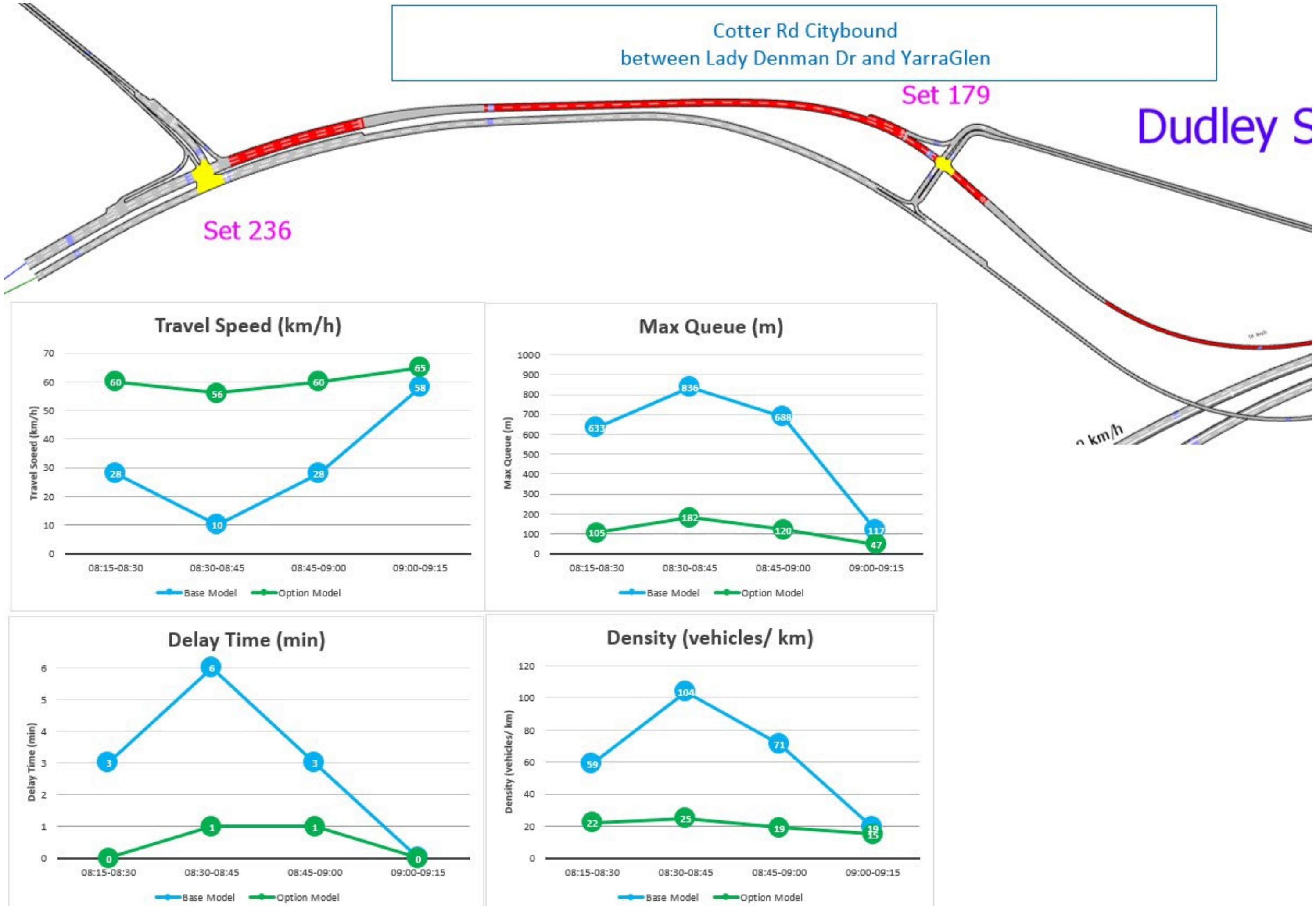


Figure 8 ***Example route performance results – travel speed, queue, delay and density***

5 Independent Model Audit/Peer Review

An independent audit of the microsimulation model should be carried out by a qualified model auditor who has not been involved in the model development process. This is to ensure that the model has been calibrated and validated to the standards outlined in this document and meaningful results can be obtained from the model outputs.

The audit can be done at the end when all modelling tasks have been completed and the Traffic Modelling Report has been submitted to TCCS, or it can alternatively be undertaken as part of Hold Points 2 and 3. The advantage of the latter is that potential issues are identified and addressed earlyin the process, but it could be more expensive as the independent auditor has to be engaged at various stages of the modelling process.

TCCS will provide direction in terms of the model auditing requirements of each individual project. This needs to be agreed at the project's outset, ideally as part of the modelling scope definition process (i.e., Hold Point 1). The independent audit or peer review will generally be sought by TCCS due to the following reasons:

- TCCS staff cannot undertake the review themselves due to lack of in-house expertise or the relevant software licence. Currently, TCCS prefers modellers to consider using Aimsun for microsimulation modelling, but if another software is used then it is likely that TCCS will seek independent third-party expert advice.
- Large projects that require complex microsimulation modelling work
- TCCS is not satisfied with the quality of the model and requires independent advice.

A checklist is given in **Table 5** to provide guidance in the model auditing process. The checklist is simply a guide on what needs to be checked and is designed to be flexible. It may need to be customised to specific projects depending on the modelling objectives. For example, a microsimulationmodel with a focus on bus operations and passenger movements will need to include more detailed elements specific to public transport and pedestrians.

Table 5 ***Microsim modelling audit checklist***

Item No.	Model Elements	Base Year Model (Modeller)	Future Year Model (Modeller)	Base Year Model (Auditor)	Future Year Model (Auditor)	Auditor's Review Status	Modeller's Response	TCCS Response	Final Status
1.0	**Model Setup**								
1.1	Software Type and Version								
1.2	Study Area								
1.3	Model Year(s)								
1.4	Model Time Periods								
2.0	**Model Data**								
2.1	Midblock counts								
2.2	Turning movement counts								
2.3	Signal phase plans and timings								
2.4	Travel time								
2.5	Queue length (if available)								
2.6	Public transport routes and stops (if required)								

3.0	**Model Development**								
3.1	Model layout and configuration								

Item No.	Model Elements	Base Year Model (Modeller)	Future Year Model (Modeller)	Base Year Model (Auditor)	Future Year Model (Auditor)	Auditor's Review Status	Modeller's Response	TCCS Response	Final Status
3.1.1	*Zoning structure*								
3.1.2	*Intersections and midblocks*								
3.1.3	*Road and lane type*								
3.1.4	*Traffic signal configuration*								
3.1.4	*Public transport network*								
3.2	Model settings								
3.2.1	*Network settings*								
3.2.2	*Intersection settings*								
3.2.3	*Vehicle type and behaviour settings*								
4.0	**Model Performance**								
4.1	Visual checks								
4.2	Model stability								
4.3	Vehicle behaviour								
4.4	Route choice								
4.5	Link and turn flows								

4.6	Intersections								
4.7	Travel time								

Item No.	Model Elements	Base Year Model (Modeller)	Future Year Model (Modeller)	Base Year Model (Auditor)	Future Year Model (Auditor)	Auditor's Review Status	Modeller's Response	TCCS Response	Final Status
4.8	Delay and queue length								
4.9	Public transport								
4.10	Cyclists and pedestrians								
5.0	**Model Documentation**								
5.1	Base Model Development Report								
5.2	Traffic Modelling Report								

6 References

1. Roads and Maritime Services, *Traffic Modelling Guidelines*, New South Wales (NSW), Version1.0, February 2013
2. Department of Planning, Transport and Infrastructure (DPTI), *Traffic Simulation Model Development Guidelines – Aimsun Next*, South Australia (SA), August 2018
3. Main Roads Western Australia, *Main Roads Operational Modelling Guidelines*, Western Australia(WA), Version No. 1.1, July 2018

7 Appendix A: Vehicle Type Parameters

	Vehicle	Class 01 – Car				
		Mean	Deviation	Min	Max	Units
Main	Length	4.6	0.45	3.35	5.35	metres
	Width	1.75	0	1.75	1.75	metres
	Max Desired Speed	110	10	80	120	km/h
Microscopic Models	Max Acceleration	2.7	0.2	2.2	3.5	m/s^2
	Normal Deceleration	3.5	0.5	3	4	m/s^2
	Max Deceleration	6	0.5	5	7	m/s^2
Dynamic Models	Speed Acceptance	0.958	0.088	0.75	1.12	
	Clearance	1.85	0.8	0.5	3.2	metres
	Min Give Way Time	15	5	5	30	secs
	Guidance Acceptance	100	0	100	100	%
Car Following	Sensitivity Factor	1	0	1	1	
	Gap	1.1	0.2	0.5	2.5	secs
	Headway Aggressiveness	0.0	0	0	0	

	Vehicle	Class 02 – Towing				
		Mean	Deviation	Min	Max	Units
Main	Length	9.6	0.45	8.35	10.45	metres
	Width	1.75	0	1.75	1.75	metres
	Max Desired Speed	110	10	80	120	km/h
Microscopic Models	Max Acceleration	2.7	0.2	2.2	3.5	m/s^2
	Normal Deceleration	3.5	0.5	3	4	m/s^2
	Max Deceleration	6	0.5	5	7	m/s^2
Dynamic Models	Speed Acceptance	0.958	0.088	0.75	1.12	
	Clearance	1.85	0.8	0.5	3.2	metres
	Min Give Way Time	15	5	5	30	secs
	Guidance Acceptance	100	0	100	100	%
Car Following	Sensitivity Factor	1	0	1	1	
	Gap	1.1	0.2	0.5	2.5	secs
	Headway Aggressiveness	0.0	0	0	0	

	Vehicle	Class 03 to 05 – Medium Truck				
		Mean	Deviation	Min	Max	Units
Main	Length	8.65	1.9	5.6	11.65	metres
	Width	2.4	0	2.4	2.4	metres
	Max Desired Speed	100	5	80	110	km/h
Microscopic Models	Max Acceleration	1.6	0.8	0.8	2.4	m/s^2
	Normal Deceleration	3	0.3	2	3.5	m/s^2
	Max Deceleration	5	0.5	4	6	m/s^2
Dynamic Models	Speed Acceptance	0.934	0.104	0.69	1.09	
	Clearance	2	1.3	0.5	3.8	metres
	Min Give Way Time	15	5	5	30	secs
	Guidance Acceptance	100	0	100	100	%
Car Following	Sensitivity Factor	1	0	1	1	
	Gap	1.3	0.2	0.5	2.5	secs
	Headway Aggressiveness	0.0	0	0	0	

	Vehicle	Class 06 to 09 – Semi Trailer				
		Mean	Deviation	Min	Max	Units
Main	Length	17	2	12	19.1	metres
	Width	2.4	0	2.4	2.4	metres
	Max Desired Speed	100	5	80	110	km/h
Microscopic Models	Max Acceleration	1	0.5	0.5	1.5	m/s^2
	Normal Deceleration	3	0.3	2	3.5	m/s^2
	Max Deceleration	5	0.5	4	6	m/s^2
Dynamic Models	Speed Acceptance	0.945	0.101	0.69	1.09	
	Clearance	2	1.3	0.5	3.8	metres
	Min Give Way Time	15	5	5	30	secs
	Guidance Acceptance	100	0	100	100	%
Car Following	Sensitivity Factor	1	0	1	1	
	Gap	1.3	0.2	0.5	2.5	secs
	Headway Aggressiveness	0.0	0	0	0	

	Vehicle	Class 10 to 12 – B-Double				
		Mean	**Deviation**	**Min**	**Max**	**Units**
Main	Length	25.5	0	25.5	25.5	metres
	Width	2.4	0	2.4	2.4	metres
	Max Desired Speed	100	10	80	110	km/h
Microscopic Models	Max Acceleration	0.8	0.5	0.3	1.3	m/s^2
	Normal Deceleration	3	0.3	2	3.5	m/s^2
	Max Deceleration	4.5	0.5	3.5	5.5	m/s^2
Dynamic Models	Speed Acceptance	0.945	0.101	0.69	1.09	
	Clearance	2	1.3	0.5	3.8	metres
	Min Give Way Time	15	5	5	30	secs
	Guidance Acceptance	100	0	100	100	%
Car Following	Sensitivity Factor	1	0	1	1	
	Gap	1.3	0.2	0.5	2.5	secs
	Headway Aggressiveness	0.0	0	0	0	

	Vehicle	Class 00 – Bicycle				
		Mean	**Deviation**	**Min**	**Max**	**Units**
Main	Length	2	0.3	1.5	2.2	metres
	Width	1	0.2	0.8	1.1	metres
	Max Desired Speed	30	10	20	40	km/h
Microscopic Models	Max Acceleration	1.5	0.2	1	2	m/s^2
	Normal Deceleration	2.2	0.2	1.4	3	m/s^2
	Max Deceleration	3	0.25	2	4	m/s^2
Dynamic Models	Speed Acceptance	1	0.3	0.8	1.2	
	Clearance	0.8	0.2	0.6	1	metres
	Min Give Way Time	30	10	20	40	secs
	Guidance Acceptance	100	0	100	100	%
Car Following	Sensitivity Factor	1	0	1	1	
	Gap	0	0	0	0	secs
	Headway Aggressiveness	0.0	0	0	0	

	Vehicle	Class 00 – Pedestrian				
		Mean	Deviation	Min	Max	Units
Main	Length	0.34	0	0.34	0.34	metres
	Width	0.5	0.02	0.47	0.53	metres
	Max Desired Speed	4.5	2	2.5	5.4	km/h
Microscopic Models	Max Acceleration	0.5	0.2	0.2	0.7	m/s^2
	Normal Deceleration	1.2	0.2	0.2	1.6	m/s^2
	Max Deceleration	1.5	0.2	1	2	m/s^2
Dynamic Models	Speed Acceptance	1	0.5	0.25	1.5	
	Clearance	0.2	0.15	0.05	0.35	metres
	Min Give Way Time	20	5	10	30	secs
	Guidance Acceptance	100	0	100	100	%
Car Following	Sensitivity Factor	1	0	1	1	
	Gap	0	0	0	0	secs
	Headway Aggressiveness	0.0	0	0	0	

	Vehicle	Class 00 – Bus				
		Mean	Deviation	Min	Max	Units
Main	Length	15.5	2	12.5	19	metres
	Width	2.4	0	2.4	2.4	metres
	Max Desired Speed	90	5	80	100	km/h
Microscopic Models	Max Acceleration	0.9	0.2	0.8	1.6	m/s^2
	Normal Deceleration	3	0.3	2	3.5	m/s^2
	Max Deceleration	5	0.5	4	6	m/s^2
Dynamic Models	Speed Acceptance	0.934	0.104	0.69	1.09	
	Clearance	2.5	0.3	1.5	3.5	metres
	Min Give Way Time	15	5	5	30	secs
	Guidance Acceptance	100	0	100	100	%
Car Following	Sensitivity Factor	1	0	1	1	
	Gap	1.1	0.2	0.5	2.5	secs
	Headway Aggressiveness	0.0	0	0	0	