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Document Control

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<th>Mehdi Langroudi, Manager Network Performance</th>
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<td>Document Number</td>
<td>D17#502268</td>
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<th>Nature of Amendment</th>
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<tr>
<td>Date</td>
<td>June 2018</td>
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Disclaimer

This document is specific to Western Australia. It is intended to be a guide for modelling practitioners and managers undertaking work for Main Roads.

The guidelines provided in this document are accurate and relevant at the time of production.

This document only outlines the minimum requirements for model development, calibration and validation. Some models may require more rigorous standards. It is the user’s responsibility to ensure that the models they develop are fit for their intended purposes.

The application of the guidelines in this document does not guarantee that the traffic modelling thereby developed will be fit for purpose, nor does it guarantee approval or support by Main Roads. The guidelines may not be appropriate in all circumstances.

The information provided in this document is a guide only and is not considered a statutory requirement.

Subject to any responsibilities implied at law which cannot be excluded, Main Roads is not liable to any party for any losses, expenses, damages, liabilities or claims whatsoever, whether direct, indirect or consequential, arising out of or referrable to the use of this document, or its discontinuance, howsoever caused whether in contract, tort, statute or otherwise.
Foreword

Main Roads is responsible for managing and operating the strategic road network within Western Australia. As part of this responsibility, Main Roads uses a range of operationally focussed traffic modelling tools to assess road network performance, optimise the road assets, develop operational strategies and plan for future development of the network in close collaboration with our Portfolio Partners and other stakeholders.

The capacity for the road network to cope with the ever-increasing demands of our State’s growing population and mobility needs is a challenge. Main Roads considers it essential that impacts on the network are adequately assessed in order to Keep WA Moving. In this respect, accurate traffic modelling plays an increasingly vital role in the way we undertake our work in order to effectively operate the network.

I am very proud of the collaborative effort between the Transport Portfolio and industry in Western Australia in producing these Operational Modelling Guidelines. They will provide invaluable support to traffic modelling practitioners in achieving Main Roads’ aspiration to provide world class outcomes for our customers through a safe, reliable and sustainable road-based transport system.

Approved by

Peter Woronzow, A/Managing Director of Main Roads
Acknowledgements

Main Roads would like to thank the following individuals, stakeholders, government agencies and private organisations for their collaboration and support during the creation of this document.

The development of the *Operational Modelling Guidelines* was undertaken by the Network Performance Branch of Network Operations directorate at Main Roads Western Australia:

- Mehdi Langroudi
- Hannah Saunders
- Rafael Carvajal
- Hector Lee
- TK Kim
- Miaad Khayatian

A number of stakeholders were consulted in the development of this document, including:

Main Roads Western Australia internal stakeholders

- Network Operations
- Planning and Technical Services
- Infrastructure Delivery

Other Government stakeholders

- Department of Transport, Western Australia
- Public Transport Authority, Western Australia

Main Roads also acknowledges the input from private organisations in the development of this document:

- AECOM
- Arup
- Aurecon
- WSP
- PTV Group
- Aimsun
- JCT Consultancy
- Sidra Solutions
- Mills Wilson
## Glossary

Definitions of a number of terms used throughout this document are outlined below:

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tbody>
<tr>
<td>Aimsun</td>
<td>traffic modelling software developed by Aimsun (formerly TSS)</td>
</tr>
<tr>
<td>CCGs</td>
<td>common control groups</td>
</tr>
<tr>
<td>DoS</td>
<td>degree of saturation</td>
</tr>
<tr>
<td>DoT</td>
<td>Department of Transport, Western Australia</td>
</tr>
<tr>
<td>JCT</td>
<td>JCT Consultancy Ltd, developer of LinSig</td>
</tr>
<tr>
<td>JDF</td>
<td>junction delay function</td>
</tr>
<tr>
<td>LinSig</td>
<td>traffic modelling software developed by JCT</td>
</tr>
<tr>
<td>LoS</td>
<td>level of service</td>
</tr>
<tr>
<td>Main Roads</td>
<td>Main Roads Western Australia</td>
</tr>
<tr>
<td>MF</td>
<td>maximum flow</td>
</tr>
<tr>
<td>MMQ</td>
<td>mean max queue</td>
</tr>
<tr>
<td>NetPReS</td>
<td>Main Roads Network Performance Reporting System</td>
</tr>
<tr>
<td>NPD</td>
<td>Network Planning and Development, Main Roads</td>
</tr>
<tr>
<td>OD</td>
<td>origin–destination</td>
</tr>
<tr>
<td>OMV</td>
<td>Operational Modelling and Visualisation team, Main Roads</td>
</tr>
<tr>
<td>PCE</td>
<td>passenger car equivalent</td>
</tr>
<tr>
<td>PCU</td>
<td>passenger car unit</td>
</tr>
<tr>
<td>PRC</td>
<td>practical reserve capacity</td>
</tr>
<tr>
<td>PTA</td>
<td>Public Transport Authority, Western Australia</td>
</tr>
<tr>
<td>RIMS</td>
<td>Road Information Mapping System, Main Roads</td>
</tr>
<tr>
<td>RO&amp;DS</td>
<td>Recognising Opportunities &amp; Developing Solutions, Main Roads</td>
</tr>
<tr>
<td>ROM24</td>
<td>24-hr Regional Operations Model is Main Roads’ strategic transport model</td>
</tr>
<tr>
<td>RR67</td>
<td>Research Report 67, publication by TRL describing a methodology for the</td>
</tr>
<tr>
<td></td>
<td>prediction of saturation flow</td>
</tr>
<tr>
<td>SCATS</td>
<td>Sydney Coordinated Adaptive Traffic System</td>
</tr>
<tr>
<td>SCATSIM</td>
<td>Interface software to simulate SCATS</td>
</tr>
<tr>
<td>SIDRA</td>
<td>traffic modelling software developed by Sidra Solutions</td>
</tr>
<tr>
<td>STREAMS</td>
<td>Main Roads ITS control system</td>
</tr>
<tr>
<td>TCS</td>
<td>traffic control signal</td>
</tr>
<tr>
<td>TPF</td>
<td>turning penalty function</td>
</tr>
<tr>
<td>TRANSYT</td>
<td>traffic modelling software developed by TRL</td>
</tr>
<tr>
<td>TRL</td>
<td>Transport Research Laboratory (TRL Ltd), developer of TRANSYT</td>
</tr>
<tr>
<td>TWSC</td>
<td>two-way sign control</td>
</tr>
<tr>
<td>UGT</td>
<td>underutilised green time</td>
</tr>
<tr>
<td>VAP</td>
<td>vehicle actuated programming</td>
</tr>
<tr>
<td>VDF</td>
<td>volume delay function</td>
</tr>
<tr>
<td>VDS</td>
<td>vehicle detection station</td>
</tr>
<tr>
<td>Vissim</td>
<td>traffic modelling software developed by PTV</td>
</tr>
<tr>
<td>WA</td>
<td>Western Australia</td>
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</tbody>
</table>
1 Introduction

The Main Roads’ Operational Modelling Guidelines has been developed by Network Operations directorate, with contributions from the Transport Portfolio, other directorates and external industry experts.

The objective of the guidelines is to ensure consistency in traffic modelling practice and to promote the production of accurate modelling outputs that will result in high-quality project design and assessment that transitions into operations.

The development of this document was influenced by a number of sources including:

- Traffic Modelling Guidelines (Version 1.0) - Roads and Maritime Services
- Traffic Modelling Guidelines (Version 3) - Transport for London (TfL)
- Model Audit Process (Version 3.5) - Transport for London
- Economic Evaluation Manual (Volume 1) - New Zealand Transport Agency
- LinSig User Guide - JCT Consultancy
- SIDRA Intersection 7 User Guide - SIDRA Solutions
- Vissim User Guide - Planung Transport Verkehr (PTV)
1.1 Document Structure

This document is designed to give a common structure for modelling submissions using Main Roads’ currently supported traffic model software. It also provides guidance on the use of these software packages. The structure of this document is as follows:

- Section 1: Background and purpose
- Section 2: Traffic Operational Modelling Overview
- Section 3: LinSig Guidelines
- Section 4: SIDRA Guidelines
- Section 5: Vissim Guidelines
- Section 6: Aimsun Guidelines

This document focuses on:

- SIDRA and LinSig for isolated intersection analysis
- SIDRA and LinSig for deterministic network modelling
- Aimsun and Vissim for microsimulation modelling (isolated intersection or network modelling).

It is intended that this document will be periodically reviewed and updated as required to ensure its currency, usefulness and relevance for practitioners and to incorporate innovative thinking and advancements in traffic and transport modelling.

It is essential for all users to review and familiarise themselves with Sections 1 and 2 of this document as these are applicable for all operational modelling projects.

1.2 Background

Western Australia has one of the world's most expansive road networks. Main Roads is responsible for the planning, delivery and management of a safe and efficient State Road Network. It does this by:

- Building the State's major government road infrastructure projects.
- Providing infrastructure and operations that improve road efficiency and result in improvements in traffic and freight service levels.
- Maintaining the State's major government roads, bridges, verges and reserves.
- Using technology to optimise the real-time management of the network and providing traveller information.
- Improving community amenity by developing roadside stopping places, incorporating public art into infrastructure and understanding the needs of all transport users.
- Providing world class outcomes for our customers through a safe, reliable and sustainable transport system.

Main Roads is also responsible for managing the operation and maintenance of all traffic signals within WA. As part of this responsibility, Main Roads uses a range of analytical tools to assess road network performance and the impact of any road based transport schemes.
1.3 Purpose

The purpose of this document is to ensure consistency in traffic modelling practice and to promote the production of accurate modelling outputs that will result in high-quality project design and assessment that easily transitions into operations.

Traffic modelling should be undertaken for planning projects, development applications, traffic impact assessments, infrastructure upgrades, and traffic signal designs amongst other uses. A number of Main Roads’ policies and guidelines detail the need for traffic modelling assessment or define traffic modelling requirements, such as, Vehicular Signals Policy and Traffic Signals Approval Policy (please refer to Main Roads website for copies of these policies).

The requirement for traffic modelling is also outlined by The Western Australian Planning Commission’s Transport Impact Assessment Guidelines (August 2016) and in the Transport Modelling Guidelines for Development in Activity Centres produced by Department of Transport’s (DoT).

The modelling software guidelines sections of this document provide guidance for the modelling practitioner on what should be considered when building a traffic model using Main Roads supported software (LinSig, SIDRA, Vissim or Aimsun). The guidelines are designed to ensure consistency in the quality of all models received and assessed by Main Roads.

It should be noted that these software-specific guidelines require the reader to have an in-depth understanding of traffic engineering and modelling principles.
2 Traffic Operational Modelling Overview

This section provides key information for anyone undertaking traffic modelling which will be submitted to Main Roads. All modellers are encouraged to familiarise themselves with this section to ensure that the considerations outlined will be met in any existing situation or proposed model for any scheme that requires regulatory approval.

2.1 Purpose

This overview has been designed to provide guidance without being prescriptive or limiting the modeller in the development of their traffic model. The content has been designed to make the model scope and build requirements as transparent as possible for all parties without inhibiting the practitioner in the technical construction of the model. The subsequent modelling software guidelines describe current best-practice modelling techniques that should be applied to traffic modelling projects in WA.
2.2 Modelling Process

An overview of the modelling process is illustrated in Figure 2-1.

*Figure 2-1: Overview of modelling process*
2.3 Appropriate Use of Traffic Modelling and Model Expertise

As traffic modelling can be expensive, it is important to determine whether or not it needs to be undertaken in the first place. Preliminary analysis using first principles, simple analytical methods or site visits may be sufficient to confirm whether traffic modelling is required.

It is important to note that if traffic modelling is required, the next step is to determine the most appropriate level of modelling. Both the appropriate level of modelling and use of the right software are critical to the success of a modelling project, otherwise poor project outcomes, as well as significant cost and delays, may result. Section 2.4 details the modelling software supported by Main Roads and their appropriate use.

Once the appropriate level of modelling and software type has been agreed, the level of detail and the accuracy of a model must be considered. The detail required will depend on the model’s intended purpose and the project’s objectives will directly influence the type and extent of the modelling required.

The quality of the modelling inputs will be reflected in the quality of the outputs. The Main Roads’ Operational Modelling Guidelines (hereafter referred to as Operational Modelling Guidelines) provide modellers guidance of input data required to develop an accurate model.

Throughout a project, a model may pass through a number of development phases and at each stage the required level of detail and modelling accuracy may increase. Common stages of development may include, but are not limited to:

- assessment stage
- business case for funding
- option testing
- developing the preferred option
- project scheme approval\(^1\).

To avoid inaccurate traffic modelling, the person(s) involved in developing traffic models must have the following:

- In-depth knowledge of traffic engineering and modelling.
- Considerable modelling experience using the relevant software.
- Considerable experience in on-site data collection for traffic control parameters including saturation flows, queues, degree of saturation, lane utilisation identification, exit blocking and wasted green measurement.
- An excellent understanding of traffic signal control principles, design and operational requirements (for new traffic signals or traffic signal modification).

---

\(^1\) Not all projects will be developed to the point where approval is sought.
2.4 **Main Roads Supported Traffic Modelling Software**

Specific modelling software is supported by Main Roads to ensure internal reviews can be carried out with confidence. To guide the modeller, Main Roads has developed documentation outlining its preferred approach to model development, standard model parameters, model considerations and calibration and validation requirements.

Examples of supported software and their typical uses are detailed in Table 2-1.

*Table 2-1: Main Roads supported traffic modelling software*

<table>
<thead>
<tr>
<th>Software</th>
<th>Use</th>
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<tbody>
<tr>
<td><strong>LinSig</strong></td>
<td>For existing or proposed signalised intersections or networks:</td>
</tr>
<tr>
<td></td>
<td>1. traffic signal design</td>
</tr>
<tr>
<td></td>
<td>2. traffic signal modification</td>
</tr>
<tr>
<td></td>
<td>3. traffic signal timing improvement</td>
</tr>
<tr>
<td><strong>SIDRA</strong></td>
<td>To analyse feasible intersection types such as:</td>
</tr>
<tr>
<td></td>
<td>1. roundabouts</td>
</tr>
<tr>
<td></td>
<td>2. priority controlled</td>
</tr>
<tr>
<td></td>
<td>3. traffic signals</td>
</tr>
<tr>
<td><strong>Vissim / Aimsun</strong></td>
<td>Where modelling in LinSig or SIDRA is too simplistic</td>
</tr>
<tr>
<td></td>
<td>1. demand dependant phase sequence e.g. bus priority</td>
</tr>
<tr>
<td></td>
<td>2. mix of different intersection control types</td>
</tr>
<tr>
<td></td>
<td>3. heavy vehicle impacts</td>
</tr>
<tr>
<td></td>
<td>4. uneven lane utilisation</td>
</tr>
<tr>
<td></td>
<td>5. weaving/merging behaviours</td>
</tr>
<tr>
<td></td>
<td>6. exit blocking</td>
</tr>
<tr>
<td></td>
<td>7. critical links operate near or above capacity</td>
</tr>
<tr>
<td></td>
<td>To analyse significant infrastructure upgrades</td>
</tr>
<tr>
<td></td>
<td>When the project requires significant stakeholder and public consultation where visualisation would be useful / necessary</td>
</tr>
</tbody>
</table>
2.5 Use of Main Roads’ Traffic Models

If available, third parties may request the use of existing traffic models from Main Roads as a way to reduce model development time and costs.

The Operational Modelling and Visualisation (OMV) team is developing a traffic model library where all traffic models used by Main Roads are stored in one central location and can be provided to external parties for further update, which may reduce model development time and build costs.

It is important to note that if available, the provided model is only a starting point for model development process. Therefore, the model parameters and input data from the supplied model should not be relied upon and Main Roads expects the data to be updated to reflect the requirements specified for the project.

When using the traffic models available from Main Roads, the applicant should be aware of the following terms and conditions:

1. The traffic models should not be used for any purpose other than the stated purpose for which it was requested from Main Roads.
2. It is important to note that this is the responsibility of the modeller to verify parameters and assume ownership for the accuracy of the model.
3. The traffic models should be used by an experienced/qualified modeller, who should refer to Operational Modelling Guidelines when developing, updating and verifying calibration and validation of the supplied traffic model to suit their project.

The Traffic Model Request Form is available for download from the Main Roads website and can be submitted to the OMV Team via omv@mainroads.wa.gov.au.
2.6 Desktop Network Familiarisation

Before commencing any modelling work, it is important for the modeller to familiarise themselves with the area to be modelled. Examples of ways for the modeller to gain an initial understanding of the area prior to undertaking a site visit (Refer to Section 2.9.2) include:

- Inspecting aerial photography and mapping
- Examining local land use data
- Collating and inspecting available traffic data to ensure adequate data is collected and it is reliable and consistent
- Collating recent or planned network or traffic control changes
- Identifying surrounding network restrictions, construction activities and way-finding signage.

2.6.1 Main Roads’ Traffic Data

A selection of traffic data is available from the Main Roads website.

Available data may include:

- Traffic count data for the Perth metropolitan area.
- Traffic map – identifies sites where metro count data is available. The site references provided can be used to search for a specific site of interest.
- Crash analysis reporting system (CARS) data.
- Turning count surveys (request via Feedback Form).
- Road information mapping system (RIMS) – provides information on the road hierarchy (local or state road) and posted speed limits.
- Restricted access vehicle (RAV) mapping system – provides information on heavy vehicle routes (Note: if a route runs through the site being modelled it is important that heavy vehicles are modelled as they will have an impact on intersection performance).
- Traffic control signal (TCS) numbers (request via SCATS Form).
- SCATS traffic/signal data (request via SCATS Form).
2.7 Study Area Selection

The modelling study area should be determined taking into account considerations including, but not limited to:

- proximity of neighbouring intersections
- impact of vehicle platooning on intersection performance
- traffic congestion and queueing in and around the site
- existence of merging / weaving sections
- impact of acceleration profiles (e.g. heavy vehicles) on intersection performance
- road gradient on all intersection approaches.

It is recommended that the study team consult with Main Roads' Network Operations directorate to define, and / or confirm the appropriate study area prior to undertaking modelling assessments.

2.8 Modelling Periods

The time periods to be modelled should be determined by reviewing the traffic volume profile in the core of the study area. The time periods that should be modelled are typically weekday AM and PM peaks, however, off-peak or weekend may be required to be modelled depending on the scope of modelling and nature of the study area (e.g. shopping centre, airport or construction sites). The time periods should be agreed with Main Roads' Network Operations directorate prior to commencing modelling.
2.9 Data Collection and Analysis

To develop a traffic model to the standards required by Main Roads, the modeller must conduct site visits for each time period being modelled in order to:

- Familiarise themselves with general traffic conditions and the surrounding environment.
- Confirm the accuracy of supplied drawings.
- Understand how the intersection/network operates in terms of traffic behaviour, capacity and safety.
- Collect accurate data for developing the calibrated model and validating the base model.

While some of the data required in the development of the traffic model can be collected by third-party survey companies, there is certain data which should only be collected by an experienced modeller to ensure accurate data collection. In addition, all third-party survey data should be checked thoroughly by an experienced modeller with local area knowledge to ensure that it is fit for purpose.

2.9.1 Data Accuracy

Collection of high-quality, accurate traffic data, network characteristics and site observations is extremely important for the development of any traffic model. A significant amount of data collection will be required to produce well-calibrated and validated models.

Modellers should be satisfied with the accuracy of all data used for modelling purposes and ensure that it is included in the modelling report.

All traffic volume data should be checked thoroughly by someone with local area knowledge to ensure validity as there is significant potential for error when collating large volumes of traffic data. The raw data collected should be provided as part of the model submission.

Ideally, all data collected, all observations made and all measurements taken should be on the same day. As this may not be possible, particularly across networks where all data collection and measurements need to be undertaken across multiple sites in one peak hour, it is recommended that surveys be designed to capture as much information as possible by video so that observations and measurements can be made off-site without time restrictions.

2.9.2 Site Observations

Site visits should be carried out during traffic count surveys to collect relevant calibration and validation data and ensure site conditions remain typical. These visits are important as travel time, degree of saturation and queue length surveys should ideally be conducted while traffic counts are taking place. Multiple factors, such as traffic management, may have an impact on survey results and it is important that these, in addition to the usual weather and incident reports provided by survey companies, are identified.
A range of data can be collected and recorded while on-site. To assist in the calibration and validation of the traffic models, it is important that site data, SCATS traffic data and signal data is requested for the same day that the traffic surveys are undertaken.

2.9.2.1 Typical Traffic Conditions

When collecting traffic data, it is important that the data collected represents typical conditions and that the network is operating normally. It is necessary to avoid collecting traffic data at particular times of the year, on particular days or when incidents, works or bad weather could have an impact on traffic demand, traffic patterns or driver behaviour. When possible, data collection should be avoided during:

- Mondays and Fridays
- school or university holidays
- public holidays
- roadwork or temporary road closures
- bad weather
- events (for example, demonstrations or festivals)
- traffic incidents or events
- faulty operation of traffic signals.

When organising traffic surveys, the modeller or their representative should contact Main Roads’ Network Operations directorate to ensure that normal traffic conditions are expected during data collection periods. As unplanned incidents may occur, a contingency plan to collect data at a later date should be made.

Incidents, traffic signal faults, roads works and events affecting road networks are published externally in real time during incident operations in Main Roads’ Travel Map to inform and assist road users with planning their journeys. These incidents are also logged by Main Roads Incident Information Management System (WebEOC).

Data should be collected for all critical time periods to be assessed. The time periods to be assessed should be defined in the project brief and at least three hours of data should be collected for each peak period (AM or PM) to ensure that both the peak period and the shoulder of each peak is also captured. SCATS traffic data may be used to identify the peak hour(s), which may assist the modeller in specifying the period when the traffic survey should be undertaken.

2.9.2.2 Stop Line and Non-Blocking Storage

Storage in front of the stop line is an important input for traffic models, particularly for filter movements and also where left-turning traffic is required to give-way to pedestrian movements. The practical storage in front of the stop line, and non-blocking storage at mixed lanes, should be observed and recorded as part of the site visits. In SIDRA, storage does not need to be observed, instead free queues are observed to confirm the number of vehicles in a lane that may then block traffic movement.
2.9.2.3 Lane Utilisation

In some circumstances, lane usage may be incorrectly assigned in the traffic model compared to what is observed on-site. This may occur for reasons including:

- when a short turning lane blocks the through traffic lane
- exit blocking
- on street parking
- on street bus stops
- bus lanes
- drivers familiarity with the local network.

It is important that the modeller observes the actual lane utilisation when on-site, so that the model can be calibrated appropriately.

2.9.2.4 Exit Blocking / Underutilised Green Time

When on site, it is important to check whether the study area is being affected by exit blocking which typically results in the green time allocated to some movements not being utilised effectively at traffic signals.

Exit blocking refers to traffic at the stop line that has a green signal but cannot cross and exit the intersection or when full saturation flow is impeded. An example of exit blocking downstream could be traffic congestion at the next intersection downstream causing long queues to extend back to the study intersection. If exit blocking is observed, it is important to note what causes the blocking and how much traffic is being blocked (the surveyed traffic crossing the stop line may differ to actual demand at the intersection and should therefore be included in the model to make sure the validation of the model is correct).
Underutilised green time (UGT) refers to the amount of green time in a signal cycle that traffic is unable to discharge across the stop line at saturation flow rate despite the presence of full demand. UGT is measured in seconds and is calculated when measuring the degree of saturation.

There are two types of UGT:

1. ‘Wasted green’ is when traffic wants to cross the stop line but cannot proceed due to downstream blocking.
2. ‘Sub-saturation flow’ is when traffic crosses the stop line at flows lower than the saturation flow, meaning the full capacity of approach lanes is not being used. This can be caused by a number of factors including signal offsets, driver behaviour or downstream blocking.

The appropriate modelling parameters should be modified as part of the calibration process to take into account the observed UGT.

### 2.9.2.5 Degree of Saturation

Degree of saturation (DoS) is generally used to validate LinSig and SIDRA traffic models.

Ideally, a DoS survey should be undertaken on all critical approaches for each modelled period, concurrent with all other traffic surveys. In order to achieve a sample that is representative across a modelled period, sample data should be evenly spread across the whole period to be modelled.

### 2.9.3 Saturation Flow

Saturation flow is defined as the maximum flow that can be discharged from a traffic lane when there is a continuous green indication and a continuous queue on the approach. It is an expression of the maximum capacity of a lane and can be influenced by a number of factors, including road geometry, topography, visibility and vehicle classifications e.g. heavy vehicles.

Saturation flow is a key parameter in traffic modelling and the accuracy of lane saturation flow has significant impacts on model output. Where possible, Main Roads requires that saturation flows of the critical lane(s) of each approach are measured on-site.

Refer to the Saturation Flow Information document (Appendix B) for guidance on how to measure saturation flows. It is available to download from the Main Roads website.

### 2.9.4 Cruise Time

For network models, cruise time is an important input to determine the current performance of existing offsets and optimum offsets. Cruise time refers to the typical un-delayed time taken for a vehicle in the middle of a platoon to travel between stop lines (assuming that no delay is encountered as a result of traffic signals).

As it may be difficult to obtain accurate free-flow cruise times in congested conditions, cruise time should be measured on-site, from stop line to stop line, ideally outside of the peak period.
If it is not possible to measure the cruise time from stop line to stop line, another method is to measure a free-flowing section of the link/route and then extrapolate for the whole link/route distance, based on the relative lengths of the free-flowing and congested sections.

If there is reasonable justification for not measuring cruise times on-site, the posted speed limit may be used instead. This option should be considered as a last resort, as each site can be affected by external factors associated with the study area and the use of the posted speed limit might unrealistically improve or reduce corridor performance.

2.9.5 Travel Time

A common technique used to assess the accuracy of a microsimulation model is to compare surveyed and modelled travel times along key routes in the study area. This is an important comparison since travel times can affect driver route choice and have a significant impact on traffic volumes, contributing to delays and congestion. All travel times should be collected under ‘normal’ network conditions, free from incidents and events. Traffic surveys should also be undertaken on a neutral day (Refer to Section 2.9.2.1) in order to capture typical traffic behaviour and levels of congestion.

When collecting travel time data, it will be necessary to disaggregate the route into smaller predefined sections so that the location of key delays within the overall travel time can be easily identified. These sections may be defined as being the distance between intersection stop lines in an urban area. Travel time surveys should be undertaken on this basis, unless alternative approaches are discussed and agreed with Main Roads.

If private transport travel time measurements are required for microsimulation validation, these should be performed using the ‘floating car’ technique. The ‘floating car’ technique involves one or more survey cars driving along prescribed routes within the study area and recording travel times for the predefined sections. The survey car(s) should attempt to balance the number of vehicles overtaking with those being overtaken, while remaining within the speed limit. Where stop lines are used to define the sections of a route, travel time measurements should begin and end immediately after crossing the stop lines. These segmented travel times provide valuable information with respect to signal coordination and queue delay, which may be useful during later model development.

It is important to ensure that a sufficient number of travel time samples have been undertaken during the data collection stage of the study. This will provide an accurate understanding of:

- average travel time for each route
- variability in travel time for each route.

It is recommended that at least six observations are needed in order to derive a statistically reliable estimate of average travel time. Collecting multiple travel time observations also allows analysis of travel time variability (range, maximum, minimum and standard deviation). This information is useful to compare against model outputs during base model validation.

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2 Some content in Section 2.9.5 has been adapted from the Roads & Maritime Services’ Traffic Modelling Guidelines and reproduced with permission.
Main Roads supports and encourages use of new and innovative technologies for collection of travel time data, including the use of GPS or other similar data sources.

In addition, Main Roads may have travel time data for specific routes and may be able to provide access to this information. If so, this data should be disaggregated into sections. The use of sections allows a cumulative graph of travel time along the route to be developed. This type of graph can provide an accurate analysis that demonstrates how the model is performing in each key section, rather than simply providing a total travel time.

2.9.6 Queue Length

Queue length data can be collected on-site and compared against modelled outputs to provide an indication of how accurately the model replicates congestion on approaches to key intersections in the model.

Although queue lengths are generally used to validate traffic models, the issues with both queue calculation within traffic models and accurate on-site measurement have been well documented. Despite these limitations, queue length data does provide a measure of intersection performance and un-serviced demand.

If queue lengths are to be collected as part of traffic surveys for use in model validation, the following should be considered:

- Queue lengths should be measured at the start of green period. A minimum of 10 samples should be collected across the peak hour. They should be collected on the same day as the traffic survey.
- Accurately identifying the length of the queue can be problematic as it can be difficult to determine whether a vehicle is queued or not, and queue lengths are likely to be subject to significant variation across a data collection period.
- Queue lengths become highly variable on approaches that are operating at or close to capacity, and intersection programs such as LinSig and SIDRA struggle under these conditions to provide an accurate prediction of queuing traffic.

The level of accuracy in queue measurement surveys can often be lower than for other surveys as the definition of a queue can be ambiguous as well as difficult to identify.

Furthermore, counting or calculating queue lengths is a subjective exercise since queued vehicles will often still be moving slowly and it will not always be clear what criteria should be used to constitute a queue. Also, since data is likely to be collected by a number of surveyors, it is unlikely that consistent and accurate reporting will be possible across the study area.

2.9.7 Existing Traffic Counts

Main Roads’ Network Operations directorate should be contacted before commencing road traffic counts in order to establish current best-practice for data collection and to ensure data formatting complies with Main Roads’ requirements.
Traffic surveys can be performed on-site by manual counters, using fixed location video cameras. Wherever possible, traffic counts should be recorded on the same day at all modelled intersection and for all modelled periods. In some cases it may be acceptable to use flow-factoring techniques, based on flows recorded during another representative peak, but approval should be sought from Main Roads before applying this technique.

2.9.7.1 Un-met Demand

Un-met traffic demand is generally the remaining queue of vehicles which could not pass the stop line at the end of the study period. When traffic signal green time is short or exit blocking exists, a traffic count at stop line may not represent the actual demand for the movement. In these situations, the traffic demand should be captured from the upstream links or estimated from the residual queues.

2.9.7.2 Site Survey Classification

Classified turning counts should be obtained at each intersection, with light vehicles and heavy vehicles being surveyed at a minimum. It is recommended that Austroads vehicle classification system is applied. Pedestrian counts should also be carried out if required. Traffic survey requirements should be agreed with Main Roads' Network Operations directorate prior to any data collection being carried out.

2.9.7.3 Vehicle Detection Stations (VDS)

Main Roads has a system of Vehicle Detector Stations (VDS) collecting real time freeway traffic data. The data is used for traffic management functions (detecting incidents, traffic flow information) and is archived in STREAMS and NetPReS for planning and historical analysis.

Detector stations are typically “in-pavement” sensors configured to measure and collect volume, occupancy and speed on a lane-by-lane basis.

Advantages of VDS are:

- high sampling rate (close to 100%)
- high temporal resolution (up to one minute)
- measures speed, occupancy and volume.

VDS sensors are spot measurements and may not accurately reflect upstream or downstream conditions in stop/start traffic.

VDS data can be provided to Main Roads staff or external consultants engaged by Main Roads on request.

2.9.7.4 Time Period and Duration

The time and duration of the peak period to be modelled will be determined from the survey count data. This should represent the time within the survey period during which the largest total volume of traffic was observed. Although a modelled peak period is typically one hour, longer peaks may be appropriate where necessary.
To help minimise survey costs, historical traffic data can be used to identify the likely period when the peak hour will occur. Historical data can also be used to determine seasonal traffic fluctuations, variations in traffic demand during school holidays or public holidays and actual travel demand on an average weekday.

Types of historical data that can be used include:

- Classified turning traffic count surveys.
- SCATS traffic data (this can be requested from Main Roads using the SCATS request form).
- Metropolitan traffic count data (available through the Main Roads' reporting centre).

### 2.9.7.5 Network Traffic Surveys

For networks with complex route choices, an origin–destination (OD) survey may be more appropriate. The chosen approach will depend on the road network being modelled and the type of software being used.

Using an OD survey improves data accuracy and reduces the time required to analyse traffic surveys taken at individual intersections. As OD surveys are expensive, an alternative option is to carry out a desktop analysis of individual surveys and create a traffic flow network for each period being modelled. When using this technique, the following should be considered:

- A check must be made to see whether traffic leaving one intersection arrives at neighbouring intersections. If there is a discrepancy of more than five per cent between intersections, the modeller should augment the classified counts with short site surveys to determine if there are other major sinks and sources of traffic (for example, side roads, car park entries and exits) that were not captured in the original survey. If sinks or sources are found, 15-minute spot counts should be conducted in order to estimate hourly flow rates.

- Analysis of traffic flows across the network as a whole may identify a particular count site as being in error (for example, if flows at neighbouring survey sites are inexact by a similar value). Where a manual counting error appears to have been made, the higher flow count from adjacent survey sites should be used, as it is more common for errors to be the result of under-counting than over-counting. This also represents the worst case scenario as far as the network is concerned, as the highest observed flow will be modelled.

- ROM24’s base year model data may be used as a form of calibration if a desktop study was carried out to determine the OD movements of the intersections combined as a network. If ROM24 data is available, a sub-area matrix from the model may be extracted for the study area.
2.9.7.6 Heavy Vehicles

When undertaking traffic counts, light and heavy vehicles must be considered (Refer to Section 2.9.7.2). A detailed breakdown of heavy vehicle may be required where heavy vehicles are found to have a significant impact on intersection/network performance, such as:

- restricted access vehicles (RAV) routes
- around construction sites
- freight routes
- commercial areas

It is important to confirm Main Roads' requirements on heavy vehicles data collection prior to any surveys being carried out. It may be necessary to categorise the vehicles using the Austroads and/or restricted access vehicle (RAV) classification system.

In WA, heavy vehicles tend to be larger than the default vehicles used in some traffic model software. As such, it is important to confirm whether the heavy vehicles that pass through the study area are modelled correctly. Depending on the model software, the following may need to be considered:

- gap acceptance (s)
- loaded mass (kg) and engine power (kw)
- deceleration and acceleration
- speed acceptance
- clearance (m).
2.9.8 Future Traffic: Growth Factor Techniques

There are various methods that can be used to forecast traffic flows for input into traffic models. At Main Roads the following methods are generally considered:

- historical growth
- strategic model growth.

2.9.8.1 Historical Growth

The historical growth method uses historical data to confirm what the annual traffic growth has been in the area. Historical traffic data tends to be used to identify the growth using metropolitan traffic count data, SCATS traffic flows or turning count survey data. This provides a basis for understanding changes in traffic growth patterns.

Where strategic model data is not available or deemed unsuitable, analysis of historical traffic growth data is often used to carry out short to medium term modelling.

2.9.8.2 Strategic Model Growth

Calculating traffic growth using a strategic model may provide a more accurate analysis of the likely future traffic flows within the study area. Generally, strategic models take into account future land use, road upgrades and public transport schemes along with other factors that influence trip generation and trip distribution which are not be represented in historical data.

Main Roads’ strategic models such as ROM24 can be used for calculating traffic growth. DoT’s STEM strategic model is another model that may be used for the growth rate estimation. It should be noted that access to either strategic model is restricted to use in government-related projects, with the exception of projects where there is likely to be significant impacts on local or state roads.

2.9.8.2.1 ROM24

ROM24 (24-hr Regional Operations Model) is Main Roads’ strategic transport model. It covers the entire Perth metropolitan region from Yanchep to Mandurah and used to model travel demand patterns based on different land use, transport and pricing scenarios.

Based on land use data provided by the Road Planning Branch, ROM24 currently has separate models for 2016, 2021, 2031 and 2051 which are regularly updated.

ROM24 provides forecast traffic volumes for each peak of an average weekday, as well as for the full 24-hour period. As data is generally considered to be most accurate when taken over the full 24-hour period, daily forecast traffic volumes are used in most situations. In some situations the use of peak period forecasts (for example, 7am-9am or 6am-9am and 4pm-6pm or 4pm-7pm) may be more appropriate.

A wide range of data outputs can be generated from ROM24 including:

- Link volume plots – provides modelled forecast traffic volumes for each direction on each road link for a selected model area.
- Turning volumes diagrams (24-hour only) – provides intersection turning movement volumes at any intersection represented in the modelled network.
• Select link plots – plots the distribution of total traffic flows across the network using a specific selected link. This can be used to determine traffic distribution and re-routing.

• Sub-area matrices – provides a matrix of traffic flows within a specifically requested sub-area of the overall model. Sub-area matrices are useful in the determination of trip distribution in the specified sub-area model network and can be used to calculate the overall modelled growth rate for the selected sub-area.

When ROM24 data outputs have been provided by Main Roads, it is the responsibility of the modeller to calibrate the ROM24 data before future traffic flows are determined.

Main Roads’ Guidelines for Calibration of Traffic Volumes from ROM24 (Appendix C) provides guidance on how ROM24 data can be calibrated prior to using the outputs to calculate and determine future traffic flows for the traffic model. In addition to future traffic flow data, the outputs can provide a better understanding of existing traffic behaviour and trip distribution.

It should be noted that the guideline only suggests one method for calculating future traffic flows, which aligns with ‘Method 1’ in the guideline document for Road Planning and Development Using ROM24 road volume outputs for road planning and development work (currently under development). As there are several methods for calculating future traffic flows, it is important that the most appropriate method is discussed and agreed upon at the scope meeting.
2.9.9 Traffic Demand Estimation from Strategic Model

If traffic demand is based on the strategic model, it is recommended that the demand matrix is developed from cordoned strategic demand data. Figure 2-2 outlines the process for estimating traffic demand.

Figure 2-2: Demand estimation methodology

- Strategic Model Matrix
  - Zone Disaggregation
  - Initial Matrix
  - Matrix Furnessing
  - Furnessed Matrix
  - Static Adjustment
  - Adjusted Matrix
  - Departure Adjustment
  - Profiled Adjusted Matrix
  - Manual Adjustment
  - Final Matrix

2.9.9.1 Trip Balancing

As part of the development of the model, surveyed count data, SCATS counts data and other count data should be analysed to develop an indication of volumes at locations throughout the network. As the count data is usually collected from different sources and at different times, sometimes there are discrepancies between the upstream and downstream flows on some road sections. The counts should be carefully balanced to minimise these differences without excessively distorting the collected data.
2.9.9.2 Matrix Furnessing

The prior matrices should be adjusted to reflect the collected survey data using the Furness method. The Furness method of matrix updating is an iterative process to derive matrices that result in the best match to trip end count data. Trip end totals for each zone should be formed from external link survey data, internal link survey data and other filler zones with the values based on surveys, surrounding land use or the number of individual households. Within this, individual OD pairs should be fixed to known survey values or established during the calibration process.

2.9.9.3 Static Adjustment

Static adjustment is a procedure that should be used to calibrate an OD matrix, from a prior matrix, using available section/detector traffic counts or turn traffic counts. The solution algorithm is based on a bi-level model solved heuristically by a gradient algorithm, and includes an assignment during each iteration.

In order to achieve a consistent route choice outcome, it is important that the modeller uses the same settings for static OD adjustment as for the static assignment.

Matrix elasticity is a value between 0 and 1 which indicates the elasticity of the adjusted matrix in regard to the original matrix. A 0 value means that no variation is allowed and 1 means no variation is penalised. A value of 0.5 adds the objective of keeping the original total demand value per cell per user class to the algorithm with the same weight of the objective for matching detection. The recommended value should be between 0.5 and 1.

Maximum deviation permitted should be set up for matrix adjustment. Tests should be carried out to compare different scenarios using different maximum deviation permitted values. The scenario which achieves the best GEH results without significant change to the general composition of the prior matrix should be applied.

Reliability can be set up to apply different weights to different data locations. If no reliability values are set, they are taken as 1 by default and the adjusted weight values become the final reliability. Generally, different reliability values should be used for data sets from different sources.

2.9.9.4 Departure Adjustment

Departure adjustment is a procedure that should be used to create a profiled demand from a static demand. To obtain profiled demand, the original static demand should be distributed through smaller time intervals (for example, every 15-minutes) over a simulation period. The objective is to reproduce the observed traffic counts specified in the real data set per interval while keeping as close as possible to the original number of OD trips for the period.

As with static OD adjustment, the recommended value for matrix elasticity should be between 0.5 and 1.

The maximum deviation permitted should be the same as the value used in the static OD adjustment. Tests should be undertaken to compare different scenarios using different demand bounds. The scenario which achieves good GEH results without significant change to the composition of the prior matrix should be applied.
2.9.9.5 Manual Adjustment

As the last step to match the observed turn counts with the modelled turn counts, the modeller may need to make manual adjustments to the model. Any adjustments must be recorded in the modelling report.

2.9.10 Public Transport

The level of public transport detail required within a traffic model will depend on the objectives of the project and the impact that public transport may have on the overall operation of the network.

Although the development and calibration of public transport elements within a model varies on a case by case basis, for the majority of arterial roads under congested conditions there would be a requirement to model bus operations.

Public transport modelling may be required where there are:

- Buses stopping at on-street stops.
- Buses merging with general traffic from indented bus stops.
- Bus lanes for full or part links.
- PT phases in signal operation altering available green time for general traffic movements.

When the intended purpose of the modelling is to test public transport schemes, a higher level of detail will be required for coding, calibration and validation of public transport parameters.

2.9.10.1 Coding in the Traffic Model

Public transport vehicles are generally defined as an independent vehicle type within the model, but are assigned separately as a public transport line with headway/frequency. The coding of public transport demand and routes depends on the software being used.
2.9.10.2 Public Transport Demand

Public transport services should be coded in the model based on timetable data sourced from the relevant public transport authority.

In some areas, non-scheduled bus services may occur (for example, school buses, dead running). To identify these services, existing public transport vehicle movements in the timetables should be removed from the turning count survey. For future traffic model scenarios it is recommended that the Public Transport Authority is contacted to confirm any intention of increasing the existing bus frequency or if there are proposed new routes/rerouting within the study area. As part of the submission of the traffic model, Main Roads may require confirmation that the Public Transport Authority was consulted.

2.9.10.3 Public Transport Behaviour

The modeller should confirm whether the public transport behaviour evident in the area is likely to have a significant impact on the network and code this information in the traffic model accordingly.

Site visits may assist in identifying the impacts of public transport operations and may provide insight into driver behaviour.

An example of the type of observation which can made on-site is the means by which public transport vehicles leave and re-join the main flow of traffic. Where there are indented stops, the interaction of the public transport vehicle with traffic in the main flow can have implications on travel times for the public transport service itself and also general traffic.

Public transport behaviour and any subsequent adjustment to the local capacity can then be calibrated within the model to ensure consistency with the on-site observations.
2.9.10.4 Dwell Time

Dwell times at bus stops should be coded for public transport services using available datasets. Where the dwell time is likely to have a significant impact on road capacity and congestion, dwell time surveys should be undertaken to establish a distribution that can be applied within the model. Where detailed modelling is required, the number of passengers should be counted and the boarding and alighting rates should be measured.

2.9.10.5 Traffic Signals with Public Transport Priority

Other issues that may require attention in the modelling include public transport priority at traffic signals and signalised level crossings. The operation of signals at level crossings may be linked to adjacent signalised sites and this should be investigated prior to coding. For complex situations, microsimulation models should be developed using vehicle actuated signals.

2.9.11 Pedestrians

Pedestrian facilities are provided to assist pedestrians in safely crossing the carriageway. Pedestrian crossings can be standalone or incorporated within intersections. Details of the various types of pedestrian crossings and facilities available in WA are available in DoT’s Planning and designing for pedestrians: guidelines³.

The guidelines outline good practice for the design and construction of pedestrian facilities and focus on mid-block crossings and pedestrian crossings at signalised intersections, which are the most common pedestrian crossing types included in traffic modelling.

2.9.11.1 Modelling Pedestrian Crossings

It is important that the needs of all road users, including pedestrians, are addressed when considering design options at signalised intersections.

Detailed pedestrian modelling may be required for pedestrian-related projects or where the interaction of pedestrian and traffic movements is to be assessed. In such cases, more detailed pedestrian information must be collected.

Main Roads must be consulted to confirm if pedestrian modelling is required. Any justification for the exclusion of pedestrians from modelling must be documented in the modelling report.

³ Department of Transport 2016, Planning and designing for pedestrians: guidelines, Version 6, Department of Transport, Perth.
Modellers should have an understanding of the volume and location of demand for pedestrian movements around the study area, particularly at intersections. This information is useful for accurate modelling and can be obtained from on-site observations and from pedestrian surveys (usually taken as part of the traffic survey). Pedestrian desire lines, which identify major pedestrian movements, should also be recorded. This data is useful in the design of intersection layouts and signal timing plans, and should be used to ensure that proposed facilities will be effectively used by pedestrians.

Modelling software packages provide a variety of ways to account for pedestrian activity and the modeller should choose the most accurate and relevant method for the project\(^4\).

2.9.11.1.1 Pedestrians at Zebra Crossings

As heavily used zebra crossings can cause delays to traffic and restrict the capacity of the local road network, it is important to code zebra crossings and calibrate the associated level of disruption (distribution of times that vehicles are stopped) to replicate observed conditions.

The modeller should assess locations where zebra crossings are likely to have a significant impact on vehicle travel times or where they are likely to discourage drivers from using a route (either due to the delay or the perceived delay that they cause). The level of delay observed on-site should be replicated in the modelling by coding a set of dummy signals or explicitly coding pedestrian movements across the zebra crossing (subject to the software being used providing such capability).

2.9.11.1.2 Pedestrians at Mid-Block Signal Crossings

In addition to the delaying of traffic during the pedestrian invitation and clearance time at mid-block signalised crossings, the increase in platooning of vehicles significantly impacts downstream intersection operations. While flashing yellow periods associated with pelican crossings are dealt with differently by each software package, most are capable of adequately representing this behaviour either directly or by adjusting other parameters to arrive at an appropriate workaround that increases delay to vehicles dependent on the incidence of pedestrians crossing after the green figure (that is during the flashing red figure period).

2.9.11.1.3 Pedestrians at Signalised Intersections

Signalised intersections are one of the key locations where pedestrians and vehicles interact. Pedestrian use of these facilities can have significant impacts on network capacity, affecting left, right and (in the case of shared lanes) through movements on some approaches. There are a number of reasons why this may occur, including:

- A dedicated pedestrian phase is activated, increasing delay for traffic waiting at the stop line and possibly reducing the green time available in subsequent phases.
- Pedestrians crossing during a traffic phase (with or without full pedestrian protection) have priority over left or right turning traffic and reduce the capacity of those movements by blocking the exit for a proportion of the allocated green time (this is particularly significant for left-turning traffic).

\(^{4}\) The modelling scenarios have been adapted from the Roads & Maritime Services’ *Traffic Modelling Guidelines* and reproduced with permission.
Traffic phase durations are altered when pedestrian phases are activated due to the need for longer clearance times. The modeller should assess the impact of pedestrians on traffic movements during site visits in order to develop an understanding of locations that are subject to significant capacity constraints. Where the pedestrian impact on traffic is significant, this should be simulated in the model to improve calibration and provide a more realistic outcome.

### 2.9.11.4 Existing Pedestrian Signal Timings

Existing pedestrian signal timings (invitation to cross, delays and clearance, demand frequency) under SCATS control can be requested from Main Roads using the SCATS request form. This data can provide an indication of the number of times that pedestrian phases are activated during signal operation, allowing the coding of vehicle actuated signals to simulate the call of pedestrian phases on an appropriate basis for any given time period. While this provides useful information on the activation frequency of the phase, it will not provide an indication of the actual volume of pedestrians and the disruption caused for left or right turning vehicles.

### 2.9.11.5 Proposed Modifications to Pedestrian Signal Timings

If pedestrian modifications are proposed, accurate traffic modelling will help determine which type of signalised pedestrian control is most appropriate at the intersection. It will also enable the assessment of multiple options and support design decisions related to user safety, network performance, environmental concerns or physical constraints. In deciding the most appropriate type of pedestrian control, information on pedestrian flow patterns, vehicular degree of saturation and the topographical layout of the network or intersections can be useful.

While signal timings and crossing points can be designed to cater for pedestrians in the direction of heaviest flow, it is important to note that the direction of pedestrian demand can vary according to time of day and day of week. Pedestrian waiting times should also be minimised to prevent overcrowding during peak periods.

Any physical changes to the pedestrian crossing will likely require the pedestrian walk, late start and clearance times to be updated. Refer to Appendix A for information.

Modelling pedestrians can be challenging (correctly modelling pedestrian demand, zebra crossings and shared space) and achieving successful outcomes depends on the capabilities of the modelling software.

### 2.9.12 Signal Data

As it is important that base traffic models are built to represent the current arrangement of the intersection(s), signal phasing and signal group labelling should be consistent with that employed on-site. In addition, pedestrian walk and clearance times, as well as minimum green, late start, early cut-off, all red and yellow times, should also be identical to those currently employed.

To ensure consistency in the traffic models developed, it is recommended that SCATS signal data is used when modelling any signalised intersection. This data can be requested from the Main Roads website using the SCATS request form.
2.9.12.1 SCATS Timings

To assist with the development of traffic models, Main Roads currently provides access to a wealth of SCATS data. Available information includes, but is not limited to:

- Light maintenance (LM) drawings\(^5\) to identify:
  - lane configuration
  - permitted movements
  - signal lantern configurations per signal group.

- SCATS site graphics to identify:
  - TCS number(s)
  - SCATS region(s)
  - phasing arrangement
  - signal group numbers
  - detector locations and numbers (for interpreting SCATS traffic volumes).

- SCATS Time Settings – Phase Times to identify:
  - late start
  - minimum green
  - early cut-off green
  - yellow
  - all-red
  - maximum green.

- SCATS Time Settings – Walks to identify:
  - walk time
  - clearance 1 and clearance 2 times
  - protection time
  - delay times

- SCATS Time Settings – Special Times which contains pedestrian protection time, if there is one

- Phase Sequence Chart which generally contain pedestrian protection and special facilities

- SCATS Intersection Diagnostic Monitor\(^6\) (IDM) or history file viewer to identify:
  - phase lengths
  - cycle times
  - phase sequences
  - traffic phase demand frequency
  - pedestrian demand frequency (IDM and SCATS history file viewer)

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\(^5\) LMA plans are traffic signal drawing plans that show the location of existing signal heads, SCATS detector loops and existing signal phases. LMB plans are signs and lines drawings showing the built geometry, carriageway widths and lane utilisation. LMA and LMB plans can be requested as a PDF or AutoCAD file.

\(^6\) The IDM file (.idm) should be requested at least five business days prior to the required date as there is a lead time for recording this information.
- LX file (for individual SCATS region) to identify:
  - link plans
  - offsets plans
  - maximum flow (MF)
- Strategic Monitor (system data) to identify selected link plans by SCATS
- Traffic flow data (lane by lane)\(^7\).

Related to traffic flow data, it is important to note that those from SCATS should not be used as the primary source of traffic counts. The disadvantage of SCATS data is that sometimes not all traffic is captured and there may be instances when the detectors are not working or may not be available for some turning movements (for example, at left-turn slips at a signalised intersection). Furthermore, SCATS detectors cannot determine turning proportions when the approach lane is shared by two movements (for example, left turn and ahead).

### 2.9.12.2 Phasing and Sequences

For new signalised intersections or when upgrade to an existing signalised intersection(s) is proposed, the existing phasing should be reviewed and alternative phasing and phase sequences may be proposed, taking into consideration road user safety and intersection / network performance. To ensure that the proposed phasing and phase sequences will be acceptable to Main Roads, refer to Appendix A which details the standard phasing and phase sequences that can be used as a starting point.

### 2.9.12.3 Demand Dependency

Demand dependency relates to the calling of a signal phase (for pedestrian or traffic) only if it is demanded. For pedestrians, this is when the pushbutton is pressed while for traffic this is when the presence of a vehicle is detected on one or more of the detector loops located at an intersection. If a signal phase is demand dependent, it is important to know how often the phase is called so that the green time allocated to those movements in the appropriate signal phase is realistically modelled as part of the calibration process.

Demand dependency can be determined using IDM data or history file viewer which can be requested from Main Roads.

### 2.9.12.4 Fixed Time/VA/SCATSIM\(^8\)

It is recommended that fixed time signals are used to model the average SCATS timings for the peak period, if any SIDRA or LinSig traffic model is to be reviewed by Main Roads.

\(^7\) Where there is a detector at the lane approach SCATS traffic count data can be collected. This data can be used to identify peak hour traffic demand and the appropriate time periods for the traffic model. Subject to Main Roads’ agreement, SCATS traffic data may also be used in the absence of traffic turning count survey data.

\(^8\) The timing information has been adapted from the Roads & Maritime Services’ *Traffic Modelling Guidelines* and reproduced with permission.
Signalised intersections can be modelled in microsimulation software using a number of different techniques. Main Roads may recommend a technique to apply for signal control within the project brief. If the brief does not provide signal control guidance, the modeller should apply the technique that is most appropriate for each site by taking into account the significance of each site to both the study area and to the operation of the network. The preferred technique for each location should be agreed with Main Roads prior to the development of a traffic model.

Three techniques are commonly used when coding signalised intersections in microsimulation models:

1. fixed time signals
2. vehicle actuated signal coding
3. SCATS operation through the SCATSIM interface.

2.9.12.4.1 Fixed Time Signal Timings

Average signal timings can be derived from SCATS data provided by Main Roads, site visits or a combination of both. In locations where signal timings show significant variability over the modelled period, it may be necessary to operate a number of fixed-time plans throughout the modelled period (subject to the software offering this functionality).

2.9.12.4.2 Vehicle Actuated Signal Timings

In more complex situations, signals may be coded using vehicle actuated signals. These signals operate under a dynamic plan responding to calls from detectors or other controller logic to provide variable green times, phase calls and cycle times. Vehicle actuated signals provides an excellent representation of intersections that respond to demand from detector loops in the road or for intersections that include public transport priority phases, pedestrian crossing phases or similar. Vehicle actuation can also be used to simulate ramp-metering operations, part-time signals and other logic-controlled situations.

2.9.12.4.3 SCATS Signal Timings

In some cases it may be necessary to simulate the SCATS system of signal control within the model. To do this will require the use of the SCATSIM interface and it will be necessary to obtain data from Main Roads on the current operational set-up. The use of SCATSIM is not required for all projects and will only be requested when it is considered to be critical to the study. As this method of signal control requires significant Main Roads resources, the agreement of NO should be sought prior to specifying that SCATSIM will be used.

2.10 Intergreen Calculations

In existing traffic models, intergreen calculations are based on the SCATS signal timings. If modifications are proposed at the existing signalised intersection, the modeller should confirm whether the intergreens would need to be amended to accommodate the proposed modifications (for example, an additional lane may increase both pedestrian and vehicle intergreens).

For intersections where traffic signals are proposed, for intergreen calculations refer to Appendix A.
2.11 Calibration and Validation

This section provides detail on calibration and validation considerations, so that site characteristics and behaviour are accurately replicated in traffic models.

The modelling report must include separate sections for documenting the calibration and validation process. The modeller must detail which datasets have been used for each process. It is important to note that validation data must be independent and cannot have been used during calibration.

2.11.1 Model Calibration

Calibration describes a wide range of adjustments that can be made to model coding, parameters and demand in order to assist in the development of an accurate representation of on-street conditions. Calibration can generally be split into three core areas:

1. Network verification – refinement of network inputs.
2. Demand calibration – refinement of trip volumes, patterns and driving behaviour.
3. Route choice calibration – refinement of parameters that influence a driver’s route decisions.

Each of these core areas should be investigated and addressed as a part of the overall model calibration.

These core areas are described in more detail in the sections below. While it should be noted that the focus is on microsimulation models, the information is also applicable to deterministic models (such as SIDRA and LinSig).

The calibration of a parameter in one area of the model may have subsequent and unexpected impacts in other areas of the model. It is important to develop a calibration strategy and to approach each step in a logical and disciplined manner. Generally, it is advisable to adjust one single parameter at a time so that the impacts of the change can be isolated and understood when the simulation is run. Adjustments should be logical, reasonable and appropriate for purpose.

It is unlikely that a single iteration of calibration addressing each of the core areas will achieve a sufficiently accurate model in the first attempt. A number of iterations are usually required before the base model is refined to a level of detail that is fit for purpose and will provide reliable forecasts going forward.

2.11.1.1 Basic Network Coding

The initial network coding phase is an important stage in the overall development of the model. The creation of a basic network that is of a consistent and accurate standard can significantly reduce the duration of the subsequent model calibration process. Each area of the network should be verified over the course of the calibration process to ensure that it is accurately representing the observed capacity and driver behaviour for that location.

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9 Model calibration information has been adapted from the Roads & Maritime Services’ Traffic Modelling Guidelines and reproduced with permission
As it is likely that many links and intersections will exhibit similar characteristics, the initial development of a consistent approach to coding provides a stable platform from which to undertake subsequent calibration adjustments.

Each software package represents road networks in a slightly different manner. Some packages use a link and node structure while others use a link and connector structure. Regardless of the technique employed, there are a number of key parameters that must be coded when developing a basic network:

- number of lanes
- lane widths
- lane closures or restrictions
- elevation or gradient
- basic geometry (based on an accurately scaled background).

In all cases, links and intersections must be coded to represent their on-site operation. Aerial photography and survey information may not adequately reflect localised vehicle behaviour or may simply be out of date. Modellers should include any changes made to the model during the calibration process as a result of field observations in the modelling report.

### 2.11.1.2 Vehicle Speeds

Posted speed limits should be assessed for the full extent of the study area and coded during the base model build. The posted speed limit can be sourced from Main Roads’ RIMS. This data will provide a starting point from which any further localised adjustments can be made as required. The method by which the posted speed limits are applied also varies between software with some applying speed distributions to entire links and others using explicit locations to inform drivers of speed changes.
Each software package provides default speed distribution categories that can be used during the initial stages of modelling. As in some cases the distributions may not be appropriate for the localised area, it may be necessary to make adjustments. In some studies (particularly those assessing freeway operations) it is possible to acquire point-speed data from detector loops or other sources. The analysis of this data for periods of low traffic flow can provide an indication of appropriate speed distribution for vehicles under free-flow conditions. This speed data can replace the default software values that represent desired speeds and is a useful calibration tool to ensure that localised driver behaviour is more accurately simulated within the model.

In areas of the network that experience congested conditions, it is inappropriate to adjust speed distributions in the model to match observed values as the observed values are a consequence of the congestion. Observed values can be used as a validation parameter of model outputs but not as a calibration parameter of model input.

For locations where speed data is not available, it may still be acceptable to adjust speed distributions from the default values. In select cases, it may be necessary to adjust the speed distribution on isolated links as a result of activities that cannot otherwise be accurately represented within the model. Examples of this might include side friction from pedestrian activity, narrow lanes, parking activity or visibility issues. It should be noted that the manual adjustment of speeds on individual links should be a last resort and only used if other network coding cannot adequately simulate the actual cause of the issue. If the modeller decides to apply speed distributions on isolated links, these need to be recorded and justified (supply supporting evidence) in the modelling report. Reducing speed distributions on isolated links in order to match modelled travel times with observed datasets is not acceptable. Modellers should use other methods to replicate the desired speed.

2.11.1.3 Priority Intersections

Due to their prevalence across the entire road network, priority intersections often account for a large proportion of all the intersections to be coded in a microsimulation model. They form an important constraint on network capacity in many study areas and can cause significant delays and re-routing in some models. Correctly modelling the parameters associated with priority intersections is an important part of the wider calibration process.

Gap acceptance is one of the critical parameters affecting the capacity of approaches to priority-controlled intersections. Many software packages provide default gap acceptance values and care should be taken to ensure that these values are appropriate for each modelled conflict location. It is not acceptable to assume that the default parameters are suitable at all locations throughout the network without assessing the intersection performance and calibrating values where necessary (for roundabout modelling, refer to Section 2.12).

There are many factors that influence the value of gap acceptance and these should be assessed and taken into account on an individual location basis (where a particular model allows). Key factors that might affect gap acceptance include:

- visibility
- geometry
- vehicle type
- level of congestion.
In locations where visibility is poor or the angle of approach or exit is acute, an increased gap acceptance may be required. In some urban areas where congestion is severe and drivers are prepared to take more risks (or are more familiar with the local network), the gap acceptance may be reduced.

There may also be a need to specify different gap acceptance values for various user classes within the model. Heavy vehicles often require larger gaps than light vehicles to join fast-moving streams of traffic from side roads or to make right-turns across oncoming traffic. If the modelled network has a significant volume of heavy vehicles, it may be necessary to explicitly code different gap acceptance values for each vehicle type (where possible).

### 2.11.1.4 Blocking

In dense urban networks it is possible for intersections to become blocked by queuing vehicles. As blocking can decrease the capacity of some movements at priority intersections and roundabouts, it is an important calibration tool in defining the capacity and efficiency of the local road network.

The nature of blocking behaviour should be observed on-site and replicated in the model. Most software packages offer a direct or indirect method of achieving different levels of blocking – either through specific blocking parameters or via the use of a number of other network coding tools that can be applied through workarounds.

The location of blocking behaviour and the method by which it has been simulated should be described in the modelling report as often cooperation between drivers allows for minor road turns to take precedence over slow-moving major movements.

### 2.11.1.5 Turning Lanes

Turning lanes allow traffic wanting to make a turning movement to queue without blocking traffic on other movements. They can play an important role in local road capacity as congestion can quickly develop when a turning lane becomes full and begins to block other movements on the same approach. It is important to ensure that turning lanes are defined correctly in terms of length, entry location and upstream driver awareness.

The correct calibration of turning lanes in the base model also has implications for any future year scenarios to be assessed. This is important as many intersections in the network may operate at or below capacity in the base year but subsequently operate over capacity in future year scenarios.

Correct calibration of turning lane parameters in the base year may ensure that the behaviour of vehicles within future year models is realistic and that the model will be able to provide an accurate assessment of intersection performance.

If a carriageway is wide enough to accommodate passing vehicles but only line marked as a single lane, it is reasonable for the model to be coded using two lanes to allow for passing traffic. The modeller must ensure that the passing lane is available and not blocked by parking, bus stops or local driver behaviour.
2.11.1.6 Signalised Intersections

Signalised intersections have a significant impact on the capacity of modelled traffic networks as they are the focus of high-volume conflicting traffic movements that are only allocated a portion of available green time to undertake their manoeuvres. The adjustment of signal timings, and associated parameters that affect stop line saturation flow, directly control the throughput of each approach in the model and often dictate capacity.

For fixed signal timings, during the calibration stage signal timings should be verified against SCATS data and observations made on-site to ensure that they provide an accurate representation of typical operation. To account for variability across the peak period, limited adjustment from the observed hourly average can be made. Signal offsets must also be included in the coding of fixed time signals.

For vehicle actuation signal timings, signal timing settings, detector locations and control logic should be sourced from Main Roads for each site to allow an accurate simulation of the on-site control to be developed. Signal offsets must also be included in the coding of vehicle actuated signals.

As both SCATS and vehicle actuation timings are dynamic by nature, it is useful to compare the modelled operation of the simulated intersections against real-world data. This comparison can help ensure that the model is adequately replicating the on-street intersection control over the modelled time period.

Since most microsimulation model applications are for congested urban areas with many signalised intersections, the accurate calibration of parameters is often critical in the development of a robust base model.
The development of an accurate simulation of on-street signal operation has benefits beyond the calibration stage of the modelling. One of the key benefits of microsimulation over other modelling techniques is the ability to simulate signalised intersections operating as part of an integrated wider adaptive control network or as vehicle actuated. To realise these benefits during the scenario testing stage, it is important that base models are developed to a sufficiently high level of accuracy.

In order to accurately code a signalised intersection, the light maintenance (LM) plans and the relevant SCATS signal data for the modelled time periods should be obtained from Main Roads. The intersection coding should reflect the detail in the layout plan and should be confirmed during a site visit. The length of turning lanes should be assessed from plans or from scaled aerial photography and accurately coded into the model to reflect actual vehicle behaviour during the most congested periods.

If a turning movement has a dedicated lane, it is acceptable for this to be coded as a separate link to improve lane discipline on approach to the intersection. Care should be taken to ensure that the entry point to the turning lane is accurately positioned, as observed vehicle behaviour may not correspond with lane markings on the ground.

2.11.1.7 Saturation Flow at Signalised Stop Lines

Saturation flow is used in LinSig and SIDRA for calibration and is used in Vissim and Aimsun for validation. The saturation flow modelled at signalised stop lines has a significant impact on the throughput of any approach. There are a number of factors which may affect the stop line saturation flow on-site and these must be replicated as closely as possible in the model. These factors include:

- geometry
- gradient
- visibility
- gap acceptance for turning traffic
- lane width
- downstream blocking.

The method by which these factors can be controlled depends on the software package used. Most packages allow for the use of gradient on individual links and this should be coded as appropriate for each approach.

While some packages automatically assess the geometry of any turning movement and reduce vehicle speeds accordingly, others require a reduction in speed to be applied manually. Care should be taken to ensure that the geometry for each movement is taken into account. It may be necessary to undertake a basic site survey of saturation flow in order to assess the calibration of some key approaches.

Visibility and lane width also have an impact on the saturation flow and should be assessed on-site. Some packages allow for a visibility parameter to be coded directly into the model, but if this feature is not available visibility issues should be accounted for using other parameters (for example, adjustments to approach speed or gap acceptance).
Lane widths generally have no impact on modelled saturation flow in microsimulation models and the implications of a reduced lane width should be taken into account using other available parameters (if appropriate).

### 2.11.1.8 Lane Utilisation

Lane utilisation can significantly impact on network capacity and network operation in a congested study area and should be calibrated against observed site conditions. It is recommended that modellers with significant local knowledge undertake this process.

A number of different parameters can affect lane utilisation and these should be checked and adjusted as appropriate throughout the network. Modellers should undertake site visits during peak time periods in order to observe lane discipline and utilisation at all major intersections and other areas of significant congestion. This should enable driving behaviour that is consistent with observations made on-site to be developed within the model.

A key parameter affecting lane utilisation is the upstream distance at which a driver will become aware that they are required to change lane for a downstream turn movement. Lane utilisation can be influenced by a number of factors including:

- Drivers who are unfamiliar with the local network may react to signposting or lane markings that indicate the correct lane a short distance in advance of necessary turn manoeuvre.
- Drivers who are more familiar with the network may make the necessary lane choice earlier in order to affect an easier lane changing manoeuvre (sometimes this can be multiple intersections in advance of the turn manoeuvre).

Each software package will provide a method of informing drivers of an upcoming lane change through the use of an upstream awareness distance value. As distance values will vary significantly between approaches and turn movements, they should be adjusted throughout the model. A useful technique is to initially code these distances to reflect the on-street signage and lane marking strategy and subsequently adjust any that require further calibration due to other factors such as driver familiarity.

In order to improve lane discipline, it may be necessary to split approaches into separate links. While this technique is acceptable to Main Roads when used for this purpose, if it is applied too far in advance of the stop line then insufficient weaving distance or insufficient friction due to lane changes may result.
Observations of lane utilisation for different vehicle types should be undertaken (if possible), as some sites demonstrate clear segregation for various reasons (for example, some lanes may be more attractive to heavy vehicles or buses due to lane width or turning geometry). In addition, dedicated lanes (such as bus lanes) may operate at certain times of day.

On links that feed traffic from zones into the model it is important to ensure that the links are sufficiently long to allow vehicles to make lane changing manoeuvres prior to the first turn movement. This is particularly important for freeway links where unrealistic congestion can occur if the fully signposted distance (as a minimum) is not modelled.

2.11.1.9 Public Transport

When calibrating public transport in the traffic model, the modeller should take into consideration the factors outlined in Section 2.9.10. The source of public transport data, together with the dwell times assumed in the modelling, should be documented in the modelling report.

2.11.1.10 Demand Calibration

Demand refers to the trips that drivers want to make from any given origin to any given destination within the modelled study area (including unmet demand, refer to 2.9.7.1). The demand must be calibrated to ensure that the vehicle movements within the model are an accurate representation of the observed vehicle movements that exist on-site.

The demand calibration process comprises adjustments to the definition of different vehicle types, the development of trip volumes for each OD pair and the profiling of the demand over the total modelled time period.

All software packages covered in this document (with the exception of LinSig) enable travel demand to be segmented for a range of vehicle types. The differing characteristics of each vehicle type can affect both route choice through the network and also the localised network capacity. This is due to parameters such as acceleration rates, gap acceptance and vehicle length differing greatly between vehicle types. It is important to ensure that accurate trip demand is defined for each of the vehicle types to be modelled and that these demands are later calibrated to an acceptable level.

The calibration of link flows and turning movements ensures that the model demand is accurate over each hourly period. As microsimulation models assess the performance of the network at every time step, it is also necessary to ensure that the model adequately represents the ‘peakiness’ of travel demand within each hour. This is often referred to as profiling of demand. The profiling of demand at major entry points into the model can have a significant impact on the development of congestion and queue lengths throughout the network. In some locations such as those near schools or areas where shift work is prevalent there may be a short and defined peak when queues at nearby intersections quickly develop at a specific time of day and then dissipate quickly as demand drops. Areas where traffic is fed by more mixed-use zoning may have a flatter profile, with queue lengths sustained over the entire time period.
An assessment of the study area should be made to understand the likely implications of the local demand profile. This assessment should include analysis of count data throughout the network and site observations from key locations. It is recommended that survey data disaggregated into 15-minute intervals is sourced as this provides a good level of detail for the development of a profile.

Profiles should be developed for as many zones as possible and for each vehicle type (where possible). While a single adjusted profile over the entire study area may be acceptable, models should not be developed with a flat profile without justification being provided.

2.11.1.11 Route Choices

Modellers should check all the key route choices before calibrating the traffic volumes in the model. The adjustment of key parameters regarding cost is generally required in order to reduce the number of unreasonable route choices modelled. The main purpose of checking the main key routes is to guarantee that vehicles have been discouraged from using any unreasoned routes through the network.

If changes to default cost values have been made, modellers should document the changes, including the location and justification, in the modelling report.

2.11.1.12 Behavioural Parameters

There is a wide range of behavioural parameters that may affect the calibration of a microsimulation model. Each software package will use some or all of these parameters to simulate driver behaviour. As each package uses the parameters differently, it is not possible to specify the appropriate values for each.

Modellers must check the suitability of default values in the modelling software. Any necessary modifications to these values must be documented in the modelling report.

Some packages allow the user to adjust high-level parameters which influence or determine lower-level parameters (for example, aggressiveness or awareness). Modellers should ensure that they are familiar with the effects of the high-level parameters before making adjustments as the use of these parameters may have unintended impacts throughout the network.
2.11.1.13 **Calibration Guidelines for Main Roads Supported Software**

For guidance on calibration requirements, appropriate criteria to use and the behavioural parameters that can be adjusted to calibrate the traffic model using the different modelling software refer to:

- LinSig – Section 3.12
- SIDRA – Section 4.5.1
- Vissim – Section 5.6.1
- Aimsun – Section 6.6.1.

Assessment of key intersections against the provided guidelines is a useful indication of the level of calibration required for each approach at any given location. The accurate modelling of signal timings and control at an intersection will provide a robust base from which to calibrate and subsequently validate a model. It is recommended that modellers review the operation of modelling area at an early stage during model calibration.
2.11.2 Model Validation

Model validation describes the independent verification process that a model has been calibrated to a sufficient extent to represent on-street conditions accurately.

Modellers compare model outputs with the observed and surveyed site data and this must be data that has not been used during the calibration process.

If the validation process indicates that the model is not yet at a sufficient level of accuracy, the specific areas of concern should be identified and analysed. The model returns to the calibration stage so that the relevant parameters can be adjusted to address the issues. The calibration and validation processes are part of an iterative cycle that continues until the validation can confirm that the model has reached an acceptable level of accuracy.

Adjustments made to parameters during the model development process should be documented in the modelling report to provide a record of the changes. In addition to this record, Main Roads requires a statistical comparison of model performance with on-street observations. This produces a measureable record of the level to which the model has been calibrated and subsequently validated.

The modelling report should include separate sections for the reporting of calibration and validation and the modeller must state which of the observed datasets have been used for each process.

A comparison of each of the observed datasets against modelled outputs should then be presented in either the calibration or validation sections of the report. The software specific guidelines in sections 3 to 6 provide the criteria to confirm if a model represents on-site conditions.

It should be noted that there will be occasions where models may not meet the model validation criteria but are still considered fit for purpose. Likewise, some models may meet the criteria but require further attention in areas of critical significance to the study. The extent, structure and objectives of every modelling exercise are different and these will influence the level of importance placed on achieving each of the targets.

The decision to accept or reject a model lies with Main Roads and modellers must explain any limitations in the modelling that might prevent the model from achieving the guideline calibration and validation criteria.

2.11.2.1 Model Categories for Validation

Main Roads defines the following three model categories for the model validation.

- Model Category 1
  - Single intersection or short corridor model (up to four full movement intersections).
  - Models in this category are built and used to assess the performance of intersections or corridors under different design layouts or traffic conditions.

- Model Category 2
  - Small area network or long corridor model with limited route choices.
  - Models in this category are developed to assess the performance of networks or corridors under different traffic management schemes.
Model Category 3:
- Large area networks including multiple long corridors with various routes between origin and destination zones, and use dynamic traffic assignment.
- Models in this category are generally used in transport network planning, assessment of traffic management and road schemes.

Model category should be agreed with Main Roads prior to the start of the modelling.

In accordance with model categories, various model outputs are required when validating the base model. The model outputs required for individual model category are stipulated in Table 2-2.

<table>
<thead>
<tr>
<th>Output</th>
<th>Category 1 (LinSig &amp; SIDRA)</th>
<th>Category 1 (Vissim &amp; Aimsun)</th>
<th>Category 2 (Vissim &amp; Aimsun)</th>
<th>Category 3 (Vissim &amp; Aimsun)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queue length</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Degree of Saturation</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Saturation flow</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Traffic turning movement and directional link volume</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Travel Time</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Signal timings</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Vehicle speed map</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

2.11.2.2 Validation Statistics

Useful measures of “goodness-of-fit” generally used to compare model flows against observed counts are GEH and R-square ($R^2$).

The GEH (invented by Geoffrey E. Havers) statistic is a formula used to compare two set of traffic volumes.

- $GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$

$M$ is the modelled flow and $C$ is the observed flow.

Plots of observed against modelled hourly flows are required to be reported for all observations.

The R-Square ($R^2$) is a statistical measure of the correlation between the entire count data set and the predicted model volumes. Unlike the GEH statistic (which applies to individual flows and screenlines), the R-Square ($R^2$) applies to the entire comparison data set and is expressed as a single value.
2.12 Operational Modelling of Roundabouts

When modelling roundabouts in SIDRA\textsuperscript{10}, Vissim or Aimsun it may be necessary to adjust the default gap acceptance parameters (critical gap and follow-up headway) in line with the roundabout geometry in order to calibrate or validate the model. Modellers using Vissim and Aimsun must adjust approach and departure speed to simulate site behaviour.

Australian and New Zealand practice for determining the capacity of roundabouts is based on headway acceptance theory. Traffic entering the roundabout gives way to, and accepts opportunities (gaps) in the circulating traffic stream, as depicted in Figure 2-3.

![Figure 2-3: Major and minor flows at a roundabout](image)

In order to calculate the critical gap and follow-up headway modellers need to measure the roundabout geometry and traffic flow through the roundabout. The modeller may use researched values (Troutbeck 1989) from roundabout surveys, which have determined a correlation between geometry and traffic flow, to calculate the gap acceptance parameters.

Gap acceptance parameters are affected by the geometry of the entry. Geometrics which offer an easier entry path give lower gap acceptance values. These parameters are also a function of the circulating flow. At higher circulating flows, the circulating speeds are lower and drivers are more willing to accept smaller gaps. Also at higher circulating flows, more circulating drivers slow and allow entering drivers to move in front of them. This leads to priority sharing or even a reversal of priority.

2.12.1 Estimating the Critical Gap Parameters

(a) For a single lane entry

Table 2-3 lists the dominant stream follow-up headway ($t_{fd}$). If there is one circulating lane, these values are used for the entry stream. If there are two or more circulating lanes, then the values in Table 2-3 should be increased by 0.39 (Refer to Table 2-4).

\footnote{Critical gap and follow-up headway in SIDRA are sensitive to roundabout geometry (i.e. entry radius, entry angle, roundabout size) and circulating and entry flows. These values must be carefully defined in SIDRA to estimate critical gap and follow-up headway.}
The ratio of the critical acceptance gap to the follow-up headway \((t_{a} / t_{fd})\) is given in Table 2-6. The critical acceptance gap is the product of the appropriate values from Table 2-3 and Table 2-6.

(b) For multi-lane approaches

To estimate the entry lane flows at approaches with two or more lanes, it can be assumed that drivers wishing to turn right will use the right hand entry lanes and the drivers turning left will use the left hand lanes. However in some situations lanes may be marked with signs or pavement arrows to restrict them to particular traffic movements and the lane arrangement so marked would be used in the analysis. The through traffic then needs to be proportioned to the appropriate lanes to finalise the lane entry flows.

While the above provides the most accurate assessment, it is pointed out that estimates of approach capacity are not significantly affected by the distribution of traffic in the lanes.

The entry lane with the greatest flow at an approach is termed the `dominant' lane and the traffic in this lane is termed the dominant stream. Other lanes contain subdominant streams.

The critical gap parameters for an approach with two or more entry lanes are estimated using Table 2-3, Table 2-4, Table 2-5 and Table 2-6.

Table 2-3 gives values for the follow-up headway for the dominant stream. These values are adjusted if the number of entry lanes differs from the number of circulating lanes.

### Table 2-3: Dominant Movement Follow-up Headways \((t_{fd})\) (Initial values in seconds)

<table>
<thead>
<tr>
<th>Inscribed Diameter (m)</th>
<th>Circulating Flow (veh/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>2.99</td>
</tr>
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<td>25</td>
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<tr>
<td>75</td>
<td>2.31</td>
</tr>
<tr>
<td>80</td>
<td>2.27</td>
</tr>
</tbody>
</table>

Source: Troutbeck 1989

The adjustment values are given Table 2-4.
**Table 2-4: Adjustment Times for the Dominant Movement Follow-up Headway**

<table>
<thead>
<tr>
<th>Number of circulating lanes</th>
<th>Number of entry lanes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>0.39</td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Troutbeck 1989*

Table 2-5 gives the values of the sub-dominant stream follow-up headway ($t_{fs}$) as a function of the dominant stream follow-up headway ($t_{fd}$) and the ratio of dominant stream entry flow to the sub-dominant stream entry flow.

**Table 2-5: Sub-dominant Movement Follow-up Headway ($t_{fs}$)**

<table>
<thead>
<tr>
<th>Dominant stream follow-up headway ($t_{fd}$) (s)</th>
<th>Ratio of flows (Dominant flow/Sub-dominant flow)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>1.5</td>
<td>2.05</td>
</tr>
<tr>
<td>1.6</td>
<td>2.10</td>
</tr>
<tr>
<td>1.7</td>
<td>2.15</td>
</tr>
<tr>
<td>1.8</td>
<td>2.20</td>
</tr>
<tr>
<td>1.9</td>
<td>2.25</td>
</tr>
<tr>
<td>2.0</td>
<td>2.30</td>
</tr>
<tr>
<td>2.1</td>
<td>2.35</td>
</tr>
<tr>
<td>2.2</td>
<td>2.41</td>
</tr>
<tr>
<td>2.3</td>
<td>2.46</td>
</tr>
<tr>
<td>2.4</td>
<td>2.51</td>
</tr>
<tr>
<td>2.5</td>
<td>2.56</td>
</tr>
<tr>
<td>2.6</td>
<td>2.61</td>
</tr>
<tr>
<td>2.7</td>
<td>2.70</td>
</tr>
<tr>
<td>2.8</td>
<td>2.80</td>
</tr>
<tr>
<td>2.9</td>
<td>2.90</td>
</tr>
<tr>
<td>3.0</td>
<td>3.00</td>
</tr>
</tbody>
</table>

*Source: Troutbeck 1989*

The critical acceptance gap values for each lane are given by the product of the follow-up headway (from Table 2-3 and Table 2-5) and the ratios in Table 2-6. As stated above, critical acceptance gap values need to be calculated separately for each entry lane.
### Table 2-6: Ratio of the Critical Acceptance Gap to the Follow-up Headway ($t_{ac}/t_{fd}$)

<table>
<thead>
<tr>
<th>Circulating flow (veh/h)</th>
<th>Number of circulating lanes / Average lane width (m)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>One</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>More than one</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>2.32</td>
<td>1.98</td>
<td>1.64</td>
<td>2.04</td>
<td>1.70</td>
<td>1.36</td>
<td>2.26</td>
<td>1.92</td>
<td>1.58</td>
<td>1.98</td>
<td>1.64</td>
<td>1.30</td>
<td>2.19</td>
</tr>
<tr>
<td>200</td>
<td></td>
<td>2.01</td>
<td>1.67</td>
<td>1.33</td>
<td>1.73</td>
<td>1.39</td>
<td>1.10</td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
</tr>
<tr>
<td>400</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
<td>1.48</td>
<td>1.14</td>
<td>1.54</td>
<td>1.20</td>
<td>1.10</td>
<td>1.48</td>
</tr>
<tr>
<td>800</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
<tr>
<td>1200</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
<tr>
<td>1400</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
<tr>
<td>1600</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
<tr>
<td>1800</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
<tr>
<td>2200</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
<tr>
<td>2400</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
<tr>
<td>2600</td>
<td></td>
<td>1.94</td>
<td>1.60</td>
<td>1.26</td>
<td>1.67</td>
<td>1.33</td>
<td>1.10</td>
<td>1.88</td>
<td>1.54</td>
<td>1.20</td>
<td>1.60</td>
<td>1.26</td>
<td>1.10</td>
<td>1.82</td>
</tr>
</tbody>
</table>

Source: Troutbeck 1989

Refer to the following sub-section for a worked example of these calculations.
2.12.2 Worked Example - Record the Geometric Properties

The following geometric values are required to calculate the gap acceptance parameters of the roundabout:

- inscribed diameter
- circulating lane(s) width
- entry lane(s) width.

Figure 2-4 illustrates the dimensions of a typical roundabout design.

*Figure 2-4: Roundabout Geometry*

The worked example describes how to calculate gap acceptance using the tables that summarise typical Australian values as researched by Troutbeck (1989).
Table 2-7 shows the geometric properties of the roundabout for the worked example.

**Table 2-7: Geometric properties of the roundabout**

<table>
<thead>
<tr>
<th>Geometric property</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inscribed diameter</td>
<td>50 metres</td>
</tr>
<tr>
<td>Average entry lane width</td>
<td>4 metres</td>
</tr>
<tr>
<td>Number of entry lanes</td>
<td>2</td>
</tr>
<tr>
<td>Number of circulating lanes</td>
<td>2</td>
</tr>
</tbody>
</table>

The traffic flows for the worked example are shown in Figure 2-5.

**Figure 2-5 Traffic flow for the roundabout**
The traffic volumes used in this example are based on the turning movements as described in Table 2-8.

**Table 2-8: Roundabout entry lane turning movements**

<table>
<thead>
<tr>
<th>Movement</th>
<th>Approach Leg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>North</td>
</tr>
<tr>
<td>Left</td>
<td>132</td>
</tr>
<tr>
<td>Through</td>
<td>782</td>
</tr>
<tr>
<td>Right</td>
<td>237</td>
</tr>
<tr>
<td>Total</td>
<td>1151</td>
</tr>
</tbody>
</table>

Only the analysis of the north leg will be described here. The same analysis will be required for each subsequent leg of the roundabout. It is assumed that the left lane will carry the traffic turning left and half the through traffic. Using the figures in the above table for the north entry, the left traffic lane is assumed to be 132 + 782/2 or 523 vehicles per hour. Similarly, the right lane is assumed to be 237 + 782/2 or 628 vehicles per hour. At this approach the right hand lane has the greater flow and will be the dominant movement. The left hand lane will be the sub-dominant movement.

### 2.12.3 Worked Example - Estimating the Gap Acceptance Parameters

The critical gap parameters are evaluated for each entry lane. The dominant movement follow-up time can be interpolated from Table 2-9. For a circulating flow of 912 vehicles per hour and an inscribed diameter of 50 metres, the dominant movement follow-up time is **2.20** seconds.

**Table 2-9: Dominant movement follow-up headways (excerpt)**

<table>
<thead>
<tr>
<th>Inscribed Diameter (m)</th>
<th>0</th>
<th>500</th>
<th>1000</th>
<th>1500</th>
<th>2000</th>
<th>2500</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>2.99</td>
<td>2.79</td>
<td>2.60</td>
<td>2.40</td>
<td>2.20</td>
<td>2.00</td>
</tr>
<tr>
<td>25</td>
<td>2.91</td>
<td>2.71</td>
<td>2.51</td>
<td>2.31</td>
<td>2.12</td>
<td>1.92</td>
</tr>
<tr>
<td>30</td>
<td>2.83</td>
<td>2.63</td>
<td>2.43</td>
<td>2.24</td>
<td>2.04</td>
<td>1.84</td>
</tr>
<tr>
<td>35</td>
<td>2.75</td>
<td>2.55</td>
<td>2.36</td>
<td>2.16</td>
<td>1.96</td>
<td>1.77</td>
</tr>
<tr>
<td>40</td>
<td>2.68</td>
<td>2.48</td>
<td>2.29</td>
<td>2.09</td>
<td>1.89</td>
<td>1.70</td>
</tr>
<tr>
<td>45</td>
<td>2.61</td>
<td>2.42</td>
<td>2.22</td>
<td>2.02</td>
<td>1.83</td>
<td>1.63</td>
</tr>
<tr>
<td>50</td>
<td>2.55</td>
<td>2.36</td>
<td>2.16</td>
<td>1.96</td>
<td>1.76</td>
<td>1.57</td>
</tr>
</tbody>
</table>

*Source: Troutbeck 1989*
Table 2-10 is used to adjust the dominant movement follow-up headway when the number of entry lanes does not equal the number of circulating lanes. As the number of entry lanes is equal to the number of circulating lanes there is no need to use Table 2-10.

Table 2-10: Adjustment times for the dominant movement follow-up headway

<table>
<thead>
<tr>
<th>Number of circulating lanes</th>
<th>Number of entry lanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>-0.39</td>
</tr>
<tr>
<td>3</td>
<td>-0.39</td>
</tr>
</tbody>
</table>

Source: Troutbeck 1989

Table 2-11 gives the sub-dominant movement follow-up time. The ratio of the dominant entry lane flow to the sub-dominant entry is equal to 628/523 or 1.20. Using this value (1.20) and the dominant movement follow-up time (2.20), the sub-dominant movement follow-up time is 2.46 seconds.

Table 2-11: Sub-dominant movement follow-up headway (excerpt)

<table>
<thead>
<tr>
<th>Dominant stream follow-up headway (tfd) (s)</th>
<th>Ratio of flows (Dominant flow/Sub-dominant flow)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>1.5</td>
<td>2.05</td>
</tr>
<tr>
<td>1.6</td>
<td>2.10</td>
</tr>
<tr>
<td>1.7</td>
<td>2.15</td>
</tr>
<tr>
<td>1.8</td>
<td>2.20</td>
</tr>
<tr>
<td>1.9</td>
<td>2.25</td>
</tr>
<tr>
<td>2.0</td>
<td>2.30</td>
</tr>
<tr>
<td>2.1</td>
<td>2.35</td>
</tr>
<tr>
<td>2.2</td>
<td>2.41</td>
</tr>
</tbody>
</table>

Source: Troutbeck 1989

The critical acceptance gaps for both entry movements are evaluated from the ratio of the critical gap to the follow-up time.

Table 2-12 indicates that this ratio is 1.42. The critical acceptance gap for the dominant movement is therefore 1.42 x 2.20 = 3.1 seconds. The sub-dominant movement critical acceptance gap is therefore 1.42 x 2.46 = 3.5 seconds. The gap acceptance values for the sub-dominant movement are always greater than that of the dominant movement.
Table 2-12: Ratio of the critical gap to the follow-up headway (excerpt)

<table>
<thead>
<tr>
<th>Circulating flow (veh/h)</th>
<th>Number of circulating lanes / Average lane width (m)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One (3)</td>
<td>4</td>
<td>5</td>
<td>More than one (3)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>2.32</td>
<td>1.98</td>
<td>1.64</td>
<td>2.04</td>
<td>1.70</td>
<td>1.36</td>
</tr>
<tr>
<td>200</td>
<td>2.26</td>
<td>1.92</td>
<td>1.58</td>
<td>1.98</td>
<td>1.64</td>
<td>1.30</td>
</tr>
<tr>
<td>400</td>
<td>2.19</td>
<td>1.85</td>
<td>1.52</td>
<td>1.90</td>
<td>1.58</td>
<td>1.24</td>
</tr>
<tr>
<td>600</td>
<td>2.13</td>
<td>1.79</td>
<td>1.45</td>
<td>1.85</td>
<td>1.51</td>
<td>1.18</td>
</tr>
<tr>
<td>800</td>
<td>2.07</td>
<td>1.73</td>
<td>1.39</td>
<td>1.79</td>
<td>1.45</td>
<td>1.11</td>
</tr>
<tr>
<td>1000</td>
<td>2.01</td>
<td>1.67</td>
<td>1.33</td>
<td>1.73</td>
<td>1.39</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Source: Troutbeck 1989

Values of the ratio may be interpolated for intermediate widths of entry lane. For single lane circulating carriageways, if the critical gap calculated from Table 2-9 and Table 2-12 is less than 2.1s, use 2.1s. For multi-lane circulating carriageways, the minimum value of critical gap should be 1.5s.

2.12.4 Roundabout Size

Larger roundabouts enable better geometry to be designed. In general, roundabouts in high speed areas need to be larger to enable better entry and approach. The design of these roundabouts is more critical than that for those in low speed areas. A guide for choosing the minimum central radius for a circular roundabout can be found in Austroads Guide to Road Design Part 4b: Roundabouts.
3 LinSig Guidelines

3.1 Introduction

JCT Consultancy’s LinSig software is a design and assessment tool for signalised intersections and small networks. Used extensively in the United Kingdom and worldwide for over 30 years, LinSig has been adopted by numerous road agencies (including Roads and Maritime Services in New South Wales) as the preferred tool for the assessment of existing and new traffic signal sites.

This section is designed to complement JCT’s LinSig 3.2 User Guide SCATS Version. It provides detail on key parameters to be adopted when modelling intersections in WA.

Modellers must refer to Sections 1 and 2 for the overview of traffic modelling.

3.1.1 Appropriate Use of LinSig

As an intersection modelling tool, LinSig is used primarily to assess isolated signals or small networks, including signalised roundabouts, and can optimise traffic signal timings for a single intersection or group of signals. While it is also capable of modelling priority movements within signalised intersections or priority intersections, its use to model isolated priority intersections or conventional roundabouts is not recommended.

LinSig can be used as a design tool to identify new intersection capacity requirements or assess the benefit of intersection improvements and refine options. LinSig should be considered for the following types of project:

- intersection design
- corridor assessment
- signal optimisation
- signal coordination
- bus priority design
- cycling or pedestrian facility assessment
- new development transport assessments
- traffic management plan development
- cost–benefit analysis.

3.1.2 Software Version

This guideline is for Version 3.2 of the LinSig software package. While the Operational Modelling Guidelines will need to be updated for future versions of the software, the general principles outlined will continue to apply.
3.2 Program Settings

Modellers must change the default lane start displacement time and the default PCU length when developing LinSig models for WA road network.

The following default settings must be updated in the Defaults for New Files window, as shown in Figure 3-1:

- **Default lane start displacement** – from 2 seconds to 3 seconds\(^{11}\). This can also be changed for each lane under the Advanced tab of the Edit Lane window, shown in Figure 3-25 on page 84.

- **Default PCU length** – from 5.75m to 7.35m\(^{12}\). Modellers must check that the new value has been applied in the Network Settings window.

**Figure 3-1: Defaults for new files window**

---

\(^{11}\) Akcelik, Besley and Roper (1999) ARRB Research Report ARR340 Fundamental relationships for traffic flows at signalised intersections

\(^{12}\) Main Roads OMV Team (2018), Passenger Car Unit Length Desktop Research D18#213020
Other default program settings should be used and, prior to commencing modelling, the modeller should check that the following default parameters have been applied:

- Default lane end displacement: three seconds
- Use SCATS-based terminology is selected in the Program Settings window

### 3.3 Network Inputs

This section details the LinSig input requirements for developing the network.

#### 3.3.1 Network Information

Network information details should be completed to reflect the overall project. As a minimum, and as shown in Figure 3-2, the following should be completed:

- **project name** – the overall project title, for example traffic signal timing improvement project
- **title** – the element of the overall project, for example Leach Highway network Carrington Street to North Lake Road
- **user name** – name of the modeller
- **company/organisation name** – company undertaking the work
- **location** – location(s) of the study area being modelled
- **latitude** – latitude of the intersection or midpoint of the network (optional)
- **longitude** – longitude of the intersection or midpoint of the network (optional)

Although the provision of latitude and longitude is optional, it provides easy referencing of the site in Google Maps direct from LinSig.

*Figure 3-2: Network information window*
3.3.2 Junction Details and Network Information

Edit Junction details, as shown in Figure 3-3, should be updated to include the following:

- **Junction Name** – the name of the two intersecting roads
- **Is Signal Controlled** – selected where appropriate
- **SCATS Site Number** – the SCATS LM number for the site.

![Figure 3-3: Edit Junction window](unnamed-junction.png)

3.3.3 Arms

The arm layout must replicate the site layout, that is, the northern arm must be located on the northern side of the intersection.

Arms must be added to the model using the following convention:

1. Arm 1 should correspond with the approach containing SCATS loop number 1.
2. Subsequent entry arms should then be added in the same order as the SCATS loop numbers, usually in the anti-clockwise direction.
3. Exit arms should then be added starting at the exit for entry arm 1 and added anti-clockwise.

Arms should be named using the following convention:

4. Road name – for example, Leach Highway.
5. Direction – abbreviated traffic movement by direction of traffic movement for each approach, for example EB.
6. Exit only – label arm as exit.

For the intersection shown in Figure 3-4, an example of the arm, lane and zone layout is shown in Figure 3-5.
Figure 3-4: SCATS arms and loop numbers

Figure 3-5: Arm naming and numbering example
3.3.4 Long and Short Lanes

It is important for the modeller to appreciate that the arm/lane structure should be designed to best model the issues that will have the greatest effect on capacity. This may mean that the arm/lane structure in LinSig may not be exactly as they occur on the street.

A better model may be produced by varying the lane structure to reflect how traffic actually queues and uses the lanes. For example, where a dominant flow movement blocks back from a short lane and in effect forms its own long lane, it may be better to restructure the LinSig lanes to reflect this. Similarly, where complex flaring occurs it is still often possible to model this in LinSig by making assumptions to ensure the most critical capacity issues are measured accurately while lesser issues are modelled with compromises (and insignificant issues are not modelled).

The modeller should design the lane structure to provide the best model rather than simply entering lanes to replicate what is physically on the street.

3.3.5 Lane Lengths

For an isolated intersection model, the length of long lanes can be left as default (60 PCUs). For the requirements for a network model refer to Section 3.11.3.

The length of short lanes should be observed on-site or measured from suitable plans. The lane lengths should be entered directly into LinSig in metres or PCUs (1PCU = 7.35m), measured from the stop line to where the traffic of the short lane would meet the main traffic lane; typically this would be where the lane width is 2.0m at the taper section. When vehicles can fit into the queue past the marked end of the lane, the extra storage area should be considered.

If the short lane is a free flowing lane, i.e. not give way or signal controlled, then the short lane length should be determined by measuring from the stop line of the adjacent main signal lane to where the traffic of the long lane would meet the short lane.

For a network model, if cruise speed is applied in connectors (Refer to Section 3.3.8.1 and Section 3.11.5), then all lane lengths must be modelled accurately as LinSig calculates the cruise time based on users’ inputs of cruise speed values and lane lengths. If cruise time is applied in connectors, it is still recommended that modellers enter correct lane lengths for the internal long lanes for ease of checking.
3.3.6  Saturation Flow

Main Roads’ order of preference for determining the saturation flow (Refer to Section 2.9.3) is to:

1. Measure on-site where possible.
2. Estimate based on similar geometric layout and operation at the same intersection where measurement was possible.
3. Use RR67 geometric calculations, with a local factor applied based on lanes that can be measured on-site.
4. Use RR67 geometric calculations without adjustments.
5. Estimate from SCATS MF values.

Information on the measurement requirements and the understanding of the RR67 geometric calculations can be found in Appendix B. This section discusses the application of saturation flow specifically for LinSig modelling.

3.3.6.1  Directly Entered Lane Saturation Flow

Where possible, saturation flow should be measured on-site. These values should be entered on a lane-by-lane basis using the directly entered lane saturation flow input. Alternatively modellers can enter the values in Lane Grid Data View. All flow groups should have the same directly entered lane saturation flow value and therefore the default box should be checked; however if the saturation flow values are found to be different between flow groups, this must be stated in the modelling report.

3.3.6.2  Geometric Calculated Lane Saturation Flow

Where measurement of saturation flow is not possible for base cases or for proposed intersections, geometric calculated lane saturation flow input can be used. The calculations are based on the RR67 formula and require the following inputs:

- **Lane width** – measured on-site or scaled from LM plan or appropriate aerial photographs or design drawing.
- **Radius** – measured from LM plan or appropriate aerial photographs or design drawing based on the centre of the turning vehicle movement. For through movement, the radius must be left as Inf.
- **Gradient** – calculated from long sections for proposed works or measured using Google Earth. Applicable to uphill gradient only; for flat or downhill, the gradient must be left as 0.
- **Treat as nearside lane** – identification of nearside or offside lane. Modellers must refer to Section 3.3.6.5 for guidance.
- **Turning proportions** – for a lane with mixed movements, estimate the proportion of vehicles making each movement. This is not a direct input in LinSig as LinSig calculates the turning proportions based on the assigned traffic on each lane and the exit connectors.

The modeller must supply evidence of the geometric measurement (such as marked-up plans indicating measurements) in the modelling report.
Modellers must consider if the geometric calculated saturation flow values are representative of the driving behaviour at the modelled intersection, by comparing the calculated saturation flow with the site measured values. A local factor may need to be applied to the intersection. Refer to Section 3.3.6.4.

3.3.6.3 Unconstrained (Infinite Saturation Flow)

The saturation flow for exit lanes must be set to *unconstrained*, unless there is a good modelling reason not to do so. Setting an inappropriate saturation flow at an exit lane can cause undesirable side-effects, such as sliver queues which would not occur in practice.

3.3.6.4 Factored RR67 Saturation Flow Using Site-Measured Saturation Flow

The saturation flow values measured on-site must be compared with the RR67-calculated value. If the average of the site values are found to be more than 5% different from the RR67 values, the modeller must consider applying a local site factor to the RR67 calculated lanes. For consistency, the same factor should also be applied in the option models. Failure to apply a site factor may result in inaccurate assessment of the option model outputs.

LinSig has a built-in geometrically-calculated lane saturation flow function based on the RR67 formula. If a local factor is required, the modeller would need to calculate the RR67 and the factored saturation flow in a separate spreadsheet. The RR67 research paper and the formula can be obtained from the TRL website ([https://trl.co.uk/reports/RR67](https://trl.co.uk/reports/RR67)).

In the example shown in Table 3-1, the site measured saturation flow is found to be on average 93% of the RR67 equivalent values, therefore the local factor of 93% must be applied for the remaining traffic lanes with saturation flow estimated using RR67.

<table>
<thead>
<tr>
<th>Lane</th>
<th>Site measured saturation flow</th>
<th>RR67 calculated saturation flow</th>
<th>Site measured : RR67 ratio (local factor)</th>
<th>Saturation flow used in LinSig modelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1</td>
<td>-</td>
<td>1809</td>
<td>-</td>
<td>1682 Factored RR67</td>
</tr>
<tr>
<td>1/2</td>
<td>-</td>
<td>1925</td>
<td>-</td>
<td>1789 Factored RR67</td>
</tr>
<tr>
<td>1/3</td>
<td>1889</td>
<td>2065</td>
<td>91.5%</td>
<td>1889 Site measurement</td>
</tr>
<tr>
<td>2/1</td>
<td>1816</td>
<td>1955</td>
<td>92.9%</td>
<td>1816 Site measurement</td>
</tr>
<tr>
<td>2/2</td>
<td>1999</td>
<td>2115</td>
<td>94.5%</td>
<td>1999 Site measurement</td>
</tr>
<tr>
<td>3/1</td>
<td>-</td>
<td>1865</td>
<td>-</td>
<td>1734 Factored RR67</td>
</tr>
<tr>
<td>3/2</td>
<td>-</td>
<td>2036</td>
<td>-</td>
<td>1893 Factored RR67</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td></td>
<td>93.0%</td>
<td></td>
</tr>
</tbody>
</table>

*Table 3-1: Saturation flow comparison*
3.3.6.5 RR67 Nearside and Offside Lanes

When using RR67 estimates for lane saturation flow, a lane needs to be identified as nearside or offside. The interpretation of the nearside/offside setting in RR67 is vague. A nearside lane is loosely defined as the first lane from the kerb in which a particular traffic movement appears. Figure 3-6 shows some examples of lane compositions to aid in identification of nearside lanes.

Figure 3-6: Nearside lane identification

If the selection of nearside or offside leads to significantly different engineering consequences in the modelling, then measured or locally-derived saturation flow values should be used to improve the accuracy of the modelling.

3.3.7 Multi-Lanes

Multi-lanes should be avoided where possible. If this is used, the modeller should check that the saturation flow value applied to the multi-lane represents the combined saturation flow of the lanes.

3.3.7.1 Multiple Short Lanes

Where short lanes are present, the effective short lane length should be measured on-site and entered directly into LinSig.

LinSig has a shortcoming when reflecting certain road geometry common in WA, where multiple short lanes are adjacent to one another, such as the layout shown in Figure 3-7.
There are a number of methods that can be adopted to deal with this issue. The modeller must identify the most appropriate approach and document the assumptions and reasoning behind the choice of lane representation. Common techniques to deal with this situation are shown in Figure 3-8. In most cases, for the short lane that is modelled as a long lane, an excess queue limit can be added to prevent modelled queue extends beyond the allowable space. Refer to Section 3.14.5

**Figure 3-8: Common techniques to model double short lane layout in LinSig**

- Ignore one short lane and treat one short lane as a long lane – appropriate in circumstances when one short lane (the longest or closest to the nearside) effectively acts as a long lane.
- Alternatively, when using a long lane to represent a short lane, flow on the link connector can be locked to represent the capacity of the short lane.
- Ignore one short lane but treat an adjacent lane as an effective short lane – appropriate where the nearside short lane demand exceeds that of adjacent long lane, effectively resulting in the adjacent lane behaving like a short lane.
- Multi-lane representation – appropriate when neither of the above techniques reflect actual performance and multi-lane saturation flow can be accurately calculated. Note that all lanes in a multi-lane are assumed to receive the same green time and that traffic is assumed to use all lanes in the multi-lane equally.
- For the saturation flow estimation of the multi-lane, refer to the following calculations.
For a multi-short lane configuration, if the lane lengths are relatively long and both lanes have equal usage, then it is acceptable to combine the saturation flow of individual lanes in the LinSig modelling.

However if the usage of both lanes is significantly different, then the total effective saturation flow for both short lanes needs to be calculated using the following formula:

\[
\text{effective saturation flow} = \frac{S_1(g - Q_2) + Q_2(S_1 + S_2)}{g}
\]

- When \( L_1 > L_2 \) and \( Q_2 < g \),
  \[
  \text{effective saturation flow} = S_1 + S_2
  \]

Refer to Figure 3-7 for an illustration of short lane 1 and short lane 2 configuration.

- \( L_1 = \) effective length of short lane 1 (PCU)
- \( L_2 = \) effective length of short lane 2 (PCU)
- \( S_1 = \) saturation flow of short lane 1 (PCU/hr)
- \( S_2 = \) saturation flow of short lane 2 (PCU/hr)
- \( g = \) green time (seconds)
- \( h_2 = \) headway for shortest lane = \( \frac{3600}{S_2} \)
- \( Q_2 = \) queue clearance time for shortest lane = \( L_2 \times h_2 \)

While this formula can be used to calculate the effective saturation flow of situations with different lane lengths in a multi-lane, it should be used to produce an estimate rather than be re-calculated repeatedly for minor green time changes.

### 3.3.8 Lane Connectors

Lane connectors must be added to represent the allowed movements from each lane. For further information on lane connectors in a network model, refer to Section 3.11.4.

#### 3.3.8.1 Cruise Times

Where only a single intersection is being assessed, there is no need to add cruise times to lane connectors. However, cruise time is required for a network model, refer to Section 3.11.5.

#### 3.3.8.2 Weaving

For an isolated intersection model, weaving connectors should be avoided (where possible). For the weaving requirements in a network model, refer to Section 3.11.4.

#### 3.3.8.3 Buses

If bus flows have been modelled in the network model, mean bus stopped time and bus speed may be added. These must be considered for bus related schemes.

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3.3.8.4 Platoon Dispersion

The setting should be left as default, with Use Platoon Dispersion selected, and platoon dispersion coefficient of 35 applied. Justifications must be provided in the modelling report if these have been changed.

3.3.8.5 Overrides

The Overrides tab should be left blank as default. Justifications must be provided in the modelling report if this has been changed.

3.3.9 Pedestrian Links

When pedestrian movements and the associated delay is important to project design, pedestrian data should be collected and estimates of future demand should be modelled to ensure balanced transport outcomes are provided.

The need to model pedestrian links, connectors, zones and volumes will depend on the project. It is strongly recommended that these are included if there are signalised pedestrian crossings present or proposed, and these must be included for pedestrian schemes for pedestrian delay assessments.

Where pedestrian links are used, the pedestrian link numbers must correspond to the pedestrian crossing numbers used in the signal settings; however, this may not always be possible as often one pedestrian SGroup is applied to multiple crossings on-site.

Note that pedestrian SGroups must be modelled regardless of the type of project (Refer to Section 3.4.2.2). The controlling SGroup must be entered in the Edit Pedestrian Link window.

3.3.9.1 Crossing Time

Crossing time (in the pedestrian link) and mean walk time between crossings (in the pedestrian connector) should be measured on-site or estimated based on the crossing distance divided by typical walking speed of 1.2 m/s.

3.3.10 Bus Lanes

For projects that include bus facilities (such as bus lanes or bus only signals) or where efficient public transport operation is a consideration, buses must be modelled separately from general traffic so that the public transport benefits can be evaluated.

Public transport movements between bus zones should be checked in the Route List View window. In the Edit Permitted Routes window, modellers can change the permitted setting to disallow to prevent general traffic from using the bus lane and vice versa. Note that the disallow setting is applied to all scenarios in the model, therefore if the bus lane is peak dependent then this function is not suitable and modellers may instead ‘lock’ the un-permitted route flows to be 0. Route filter (displaying the groups of routes to be selected and prohibited together) could be used to speed up this process.

General traffic is sometimes permitted to use the last section of the bus lane to make a left turn at the intersection. Two modelling methods to achieve this are shown in Figure 3-9.
This is the preferred method to model a bus lane with left-turning general traffic, as it can replicate the capacity at the bus lane.

Lanes 1/1 and 2/1 are bus lanes. When using the OD routing, the modeller should ensure that general traffic is disallowed to travel from lanes 1/1 to 2/1 in Route List View.

A short lane is added (1/2), attached to the offside general lane (1/3), to replicate that general traffic is able to use the nearside bus lane to turn left. The length of the short lane (1/2) depends on where the left-turning general traffic can enter the bus lane (for example, 50m).

Modellers will also need to add negative bonus greens in the Lane Timings View window to lane 1/1 to replicate that the buses cannot pass the stop line at the start of green due to the presence of the left-turning general traffic. Typically a two-second negative bonus green is applied for each PCU.

An additional upstream arm is added. Lanes 4/1 and 2/1 are bus lanes.

The left-turning general traffic is only permitted to use lane 1/1 via lane 4/2. This is restricted in the Route List View window.

Queue limit should be added to lane 1/1 and the resultant queue on lanes 1/1 and 1/2 should be monitored.

This method is used if there is a short lane for right-turning vehicles, as LinSig does not allow two short lanes to be attached to a long lane.
3.4 Traffic Signals Inputs

This section details the LinSig input requirements for traffic signals.

3.4.1 Controller Details

A separate controller must be added for each signalised intersection based on the site SCATS set-up. The controller details must include the following, as shown in Figure 3-10:

- **Type** – *SCATS Based* must be selected.
- **Name** – location of the intersection.
- **SCN** – LM/site number.
- **Notes** – added if required.
- **Controller Set** – select the appropriate controller set, usually the default controller set. Refer to Section 3.11.7 if different controller sets are available.
- **SCATS Daisy Chain Offset Master** – select the appropriate master site if required, usually selecting *none* is sufficient in LinSig modelling.

![Figure 3-10: Edit Controller window](image)

3.4.2 Signal Groups (SGroups)

SGroups must be added and numbered in a manner that is consistent with the signal groups for existing intersections and the proposed design drawings. Pedestrian SGroups must be numbered after all traffic SGroups have been determined and should be numbered in the order of crossing numbers.

Generally, only *traffic* and *pedestrian* SGroup types should be used. *Non UK arrow* should be avoided, unless it is deemed necessary for the site layout. An example of a SGroup layout (based on the intersection shown in Figure 3-4) is shown in Figure 3-11.
3.4.2.1 Traffic Signal Groups

As the minimum green is entered in the phase details (Refer to Section 3.4.4), it does not generally need to be entered in the edit SGroup window. However if pedestrian protection is applied to a traffic signal group, modellers should consider adding the minimum green in the edit SGroup window to prevent the traffic signal group from running less than its minimum green, as the pedestrian protection time takes away some green time from the traffic signal group.

3.4.2.2 Pedestrian Signal Groups

For all sites where signalised pedestrian crossings are present or proposed, pedestrian SGroups must be added to the model regardless of the type of scheme to be tested.

For pedestrian SGroups, the pedestrian walk time (invitation to cross), clearance 1 and clearance 2 must match the controller/SCATS system for an existing model. If there is a delay time in the pedestrian signal group, it must be added to the walk time.

Walk for green should only be selected if the pedestrian green figure is expected to run for the entire duration of the phase, and not just the minimum green figure time at the start of the phase.
**3.4.2.3 Pedestrian Protection**

If pedestrian protection has been set-up on-site, it must be modelled in the relevant traffic SGroup based on the controller/SCATS system. An example is shown in Figure 3-12. Late start in signal phases (Refer to Section 3.4.4) must not be used for modelling pedestrian protections, as the signal parameter inputs must match the settings in SCATS.

*Figure 3-12: Edit SGroup window (left) and signal timing view (right) for pedestrian protection*

**3.4.3 SGroup Conflict Matrix**

The signal group conflict matrix can be populated if desired. This prevents modellers from accidently activating conflicted signal groups in *Phase View* (Refer to Section 3.4.4). Note that while a filter signal group can be considered as conflicted with the opposing traffic signal group, this must not be selected in LinSig’s conflict matrix, as both signal group / movements would still receive green in the same phase in LinSig.

**3.4.4 Signal Phases**

Signal phases must be coded in accordance with the site LM plan/SCATS information. All phases and alternate phases should be coded, even if they are not used in the signal phasing sequence. This allows for option testing of different phase sequences to be undertaken quickly, as only network control plans need to be changed.

The phasing timings (late starts, minimum greens, early cut-off greens and yellow + all reds) should be directly input from controller/SCATS information. If the SCATS system shows a value is a fraction (for example, 0.5), the modeller must always round up the value for the inputs.

For late starts and early cut-offs not observable on-site, modeller must select the SGroups associated with these in the *edit phase details* window; it may be necessary to obtain the Phase Sequence Chart document to identify the SGroups association. Pedestrian protections must not be modelled using the late start in signal phases, as the signal parameter inputs must match the settings in SCATS (Refer to Section 3.4.2.3).
For option models, the phasing timings (late starts, minimum greens, early cut-off greens and yellow + all reds) must be reviewed and updated based on the proposed change to the intersection or phase configuration, if necessary. Refer to Appendix A for guidance on determining the timings.

### 3.4.5 Signal Phasing Sequence

Phase sequences to be used in base models should be determined from IDM data or SCATS history files and entered in Phase Sequence View. If the phase sequence is the same for each peak, then the same phase sequence can be used for modelling. However if the phase sequences are different between each peak and in the option models, then separate phase sequences will be required to be produced.

### 3.4.6 Network Control Plans

Network Control Plans must be developed for each combination of signal phase sequencing. If the phase sequence is the same for each peak, then the same network control plan can be used for different modelling scenarios, otherwise separate network control plans are required to be produced.

### 3.4.7 Phase Clearance Overlaps

To ensure the intergreen shut down of certain movements (such as filtered movement in diamond phasing) are modelled correctly, modellers must check the relevant phases, and if required, use Phase Overlap View to change the overlap setting from default to No, as shown in Figure 3-13.

*Figure 3-13: Phase overlap view window (left) and signal timings view window (right)*

### 3.4.8 Phase Lengths and Cycle Times

In LinSig base models, phase times and cycle times must be based on the average phase time during the period being assessed. These phase times must be taken from IDM files or SCATS history files. Refer to Appendix A.

The green time for alternative phases (such as diamond overlaps) cannot be captured in IDM or SCATS history files. The sequence and length of alternative phases should be captured on-site. If this is not possible, assumptions can be made based on the proportions of opposing right-turning vehicles and should be discussed in the modelling report.

For option models, the phase times and cycle times can be optimised. Refer to Section 3.14.
3.4.9 Demand Dependency

LinSig models a single 'typical' cycle in the peak hour. However in reality the pedestrian and traffic demand may be different in each cycle, resulting in different signal phase sequence and phase length in each cycle. When using IDM files and history files, the number of occurrences of particular phases can be seen from the outputs. For phases that are demanded very infrequently, this may mean that the average phase time falls below the phase minimum being used in the model.

Situations where demand dependency adjustments are required include:

- pedestrian demand affects the minimum phase lengths (Refer to Section 3.4.9.1)
- pedestrian demand affects the pedestrian protection delay to traffic
- alternative phases e.g. diamond movements.

Modellers should determine the most appropriate way to model demand-dependent phases that do not appear in every cycle, depending on the demand frequency and scheme requirements. The selection of the modelling method should also consider how the intersections will be modelled and optimised for the options and future year scenarios.

It is recommended that modellers add notes in LinSig’s Network Layout View stating the demand dependency frequencies and the modelling method to make it clear for other modellers to understand the assumptions when viewing the LinSig models.

Refer to Section 3.14.6 on the methodology for modelling a future year scenario when the phase timings are required to be optimised.

3.4.9.1 Demand Dependency Modelling Example

In the example shown in Figure 3-14, for 70% of the peak hour, when the pedestrian signal group 6 in C phase is demanded, the traffic green time for signal group 2 is extended due to the required long pedestrian clearance period for pedestrian signal group 6.

For the remaining 30% of the peak hour, the pedestrian signal group 6 in C phase is not demanded; when this occurs, the traffic green time for signal group 2 runs to its minimum green time (eight seconds) based on the phase minimum green time as set out in SCATS.

Figure 3-14: Demand dependency example
In the peak hour, on average the green time for C phase signal group 2 is 18 seconds, as shown in Table 3-2.

Table 3-2: Demand dependency green time calculations

<table>
<thead>
<tr>
<th></th>
<th>A Phase Green Time</th>
<th>C Phase Green Time</th>
<th>D Phase Green Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>70% of the peak hour</td>
<td>48s</td>
<td>22s</td>
<td>9s</td>
</tr>
<tr>
<td>30% of the peak hour</td>
<td>62s</td>
<td>8s</td>
<td>9s</td>
</tr>
<tr>
<td>Average of the peak hour</td>
<td>52s</td>
<td>18s</td>
<td>9s</td>
</tr>
</tbody>
</table>

There are numerous methods to model the demand dependency. Main Roads’ recommended methods are listed in the following sub sections. Note that while this example focuses on how pedestrian demand affects the minimum phase time, the same principles can be applied for other demand dependent situations.

3.4.9.2 Adjust Phase Lengths Modelling Method

3.4.9.2.1 Adjust Phase Lengths

This is the most straight forward method. The phase lengths can be adjusted in Signal Timings View to replicate the average phase lengths in the hour; this can be extracted from IDM or average history files.

3.4.9.2.2 Create a Dummy Phase with Pedestrian Signal Group Deactivated

In this example, C phase in Signal Timings View cannot be reduced to less than 22s due to the presence of the pedestrian crossing and its clearance time. Therefore, modellers can create a dummy alternative phase with the pedestrian signal group de-activated and adjust the timings based on the average phase lengths.

- Create a new dummy phase as an alternative to C phase with signal group 6 deactivated.
- Create a new phase sequence and network control plan with C1 phase instead of C phase.
- Model the average phase lengths in signal timings view as shown in Figure 3-15.

This is used when the pedestrian demand is found to be infrequent. It is important to model the deactivation of the pedestrian signal group as an alternative phase to avoid confusion when comparing with the actual SCATS information.
3.4.9.2.3 Reduce Signal Setup

Reduce the pedestrian signal timings proportionally based on the pedestrian demand.

- Reduce the pedestrian walk time, clearance 1 and clearance 2 time of the relevant pedestrian signal group to be 70% of the SCATS values in the SGroups window.
- Model the average phase lengths as per Table 3-2, as shown in Figure 3-16.

This is the least preferred method because all signal inputs in LinSig should replicate the SCATS settings to avoid confusion, where possible. The adjusted timings are applied to all scenarios in the models, therefore if the demand frequencies are different between scenarios then separate models are to be produced.

This method can be used for modelling alternative phases where the timings may be shorter than the minimum time. If this method is used, modellers must provide justification comments in the modelling reports and add notes in the Network Layout View.
### 3.4.9.3 Apply Bonus Green Time Modelling Method

Determine the average green time given to a particular SGroup as a result of a pedestrian demand is added as a positive or negative bonus green to the traffic SGroups.

- In this example, calculate Bonus green times = average green – 70% of the peak green, refer to Table 3-3.
- Apply positive and negative bonus green times to the relevant traffic lanes in Lane Timings View as shown in Figure 3-17.

This is the generally preferred modelling method. This method can also be used to compensate for the lost pedestrian protection time if the pedestrian crossing is not always demanded, or can be used to model extra green time in alternative phases. Note that different bonus green values need to be entered for each scenario reflecting the different demand in each peak and each setting.

#### Table 3-3: Demand dependency bonus green time calculations

<table>
<thead>
<tr>
<th>Phase</th>
<th>A Phase Green Time</th>
<th>C Phase Green Time</th>
<th>D Phase Green Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average green – 70% of the peak hour green = Bonus greens</td>
<td>52s – 48s = +4s</td>
<td>18s – 22s = -4s</td>
<td>9s – 9s = 0s</td>
</tr>
</tbody>
</table>

#### Figure 3-17: Lane Timings View bonus green time example

![Lane Timings View bonus green time example](image)

### 3.4.9.4 Create Multiple Cycles Sequence

Create a new phase sequence consists of multiple cycles replicating the demand frequency.

- Create a new phase sequence consists of: phases A, C, D, A, C, D, A, C1, D.
- C1 phase is a duplication of the C phase with the pedestrian SGroup 6 de-activated.
- The total cycle time is three times of a single cycle.
- The phase lengths are adjusted based on the timings shown in Figure 3-14 on page 70.

This method can be used if the phase sequence is simple and the frequency is straightforward such as one-in-two or one-in-three cycles. Note that in this example, it assumes the demand frequency is two in every three cycles (67% of the peak hour), rather than the 70% of the peak hour required to be modelled.
However this method increases the optimisation and run time, particularly when the phase sequence is complex or working in a large network; manual adjustments to the phase time may be required. Also in a network modelling situation, due to different cycle times are modelled in the same network, this method may not consider the traffic platoons and queue results well.

*Figure 3-18: Signal Timings View with multiple cycles example*

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### 3.4.10 Aggro Arrow

LinSig can accurately represent situations where movements are shared in a single lane, for example, a through and a left movement. Where these movements are controlled by separate signal groups (an aggro arrow), LinSig can only model a single SGroup per lane. In this instance, both the through and turning movements have the potential to cause a blocking effect, as illustrated in Figure 3-19.

*Figure 3-19: Aggro arrow example*

- This situation occurs when a single diamond or a split phase exists for the side road where the left-turn on the major road does not conflict.
- This situation occurs when there is a fully or partially protected pedestrian crossing, leading to a late start for left-turning traffic.
Given that the two movements operate under separate SGroups, they should be modelled as two separate lanes in order to assign each lane (movement) to its relevant SGroup, as outlined in Figure 3-20.

**Figure 3-20: Modelling method for aggro arrow**

One of the lanes must be modelled as a long lane (lane 1/2) and the other as a short lane with a 0.5 PCU micro short lane (lane 1/1). The micro short lane should be given to the least dominant movement with the lowest flow. The saturation flow for both the long lane (lane 1/2) and the micro short lane (lane 1/1) must be the same. This method ensures that any blocking of through movements by turning movements in shared lanes is accounted for by LinSig.

In instances where the shared movements occur in a short lane, the modeller must determine the most appropriate way to model this situation by considering the carriageway pattern and driver behaviour. As LinSig can model only one short lane to be associated with a long lane, it may be necessary to convert the short lane into a long lane in LinSig in order to model the micro short lane. Modellers can set an excess queue limit to check that the modelled queue does not extend beyond the allowable physical space (Refer to Section 3.14.5). Justification for this approach should be detailed in the modelling report.
3.5 Give-Way Inputs

While the main function of LinSig is to analyse the impact of signalised intersections, LinSig can also analyse give way movements and priority controlled intersections based on users' inputs. This section details the LinSig input requirements for give way situations.

3.5.1 Give-Way Parameters at a Signalised Intersection

The most common give-way parameters at a signalised intersection are shown in Table 3-4 based on the intersection set up as shown in Figure 3-21. Refer to Section 3.5.3 for comments on modification of the give way parameters.

![Figure 3-21: Example of give way modelling at a signal intersection](image)

<table>
<thead>
<tr>
<th>Table 3-4: Give-way parameters at a signal intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Give-way movements at signals</strong></td>
</tr>
<tr>
<td>Opposed lane</td>
</tr>
<tr>
<td>Movement to lane</td>
</tr>
<tr>
<td>Maximum flow while giving way (pcu/Hr)</td>
</tr>
<tr>
<td>Minimum flow while giving way (pcu/Hr)</td>
</tr>
<tr>
<td>Flow when opposing traffic is stopped</td>
</tr>
<tr>
<td>Opposing lanes</td>
</tr>
<tr>
<td>Coefficient</td>
</tr>
<tr>
<td>Opposing movement</td>
</tr>
</tbody>
</table>

Source: JCT Consultancy, with added information by Main Roads
3.5.2 Give-Way Parameters at a Priority Controlled Intersection

Modellers can add priority controlled intersections as part of a network model if required. Modellers must ensure that when modelling a priority controlled intersection in a network model, in the Edit Junction window, the Is Signal Controlled option is deselected. The most common give-way parameters at a priority controlled intersection are shown in Table 3-5 based on the intersection set up as shown in Figure 3-22. Refer to Section 3.5.3 for comments on modification of the give way parameters.

Figure 3-22: Example of give way modelling at a priority controlled intersection

Table 3-5: Give-way parameters at a priority controlled intersection

<table>
<thead>
<tr>
<th>Give-way movements at a priority controlled intersection</th>
<th>Minor Road Left Turn Give Way</th>
<th>Minor Road Right Turn Give Way</th>
<th>Major Road Right Turn Give Way</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opposed lane</td>
<td>2/1</td>
<td>2/2</td>
<td>1/2</td>
</tr>
<tr>
<td>Movement to lane</td>
<td>5/1</td>
<td>4/1</td>
<td>3/1</td>
</tr>
<tr>
<td>Maximum flow while giving way (pcu/HR)</td>
<td>715</td>
<td>600</td>
<td>850</td>
</tr>
<tr>
<td>Minimum flow while giving way (pcu/HR)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Flow when opposing traffic is stopped</td>
<td>Use maximum flow while giving way value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opposing lanes</td>
<td>3/1</td>
<td>3/1</td>
<td>1/1</td>
</tr>
<tr>
<td>Coefficient</td>
<td>0.22</td>
<td>0.22</td>
<td>0.19</td>
</tr>
<tr>
<td>Opposing movement</td>
<td>Ahead only</td>
<td>Ahead only</td>
<td>All opposing</td>
</tr>
</tbody>
</table>

Source: JCT Consultancy, with added information by Main Roads
3.5.3 **Modifications to the Give Way Parameters**

The link and connector structure set up in Sections 3.5.1 and 3.5.2 are based on generic intersections. For some turning movements onto multiple exit lanes, such as the left turn slip lane (lane 2/1) in Figure 3-21 which has two connectors to both exit lanes on arm 7, the turning movement behaviour may be site specific and must be observed on site.

It should be noted that the give way values in Table 3-4 and Table 3-5 are derived from UK research and in some instances may not provide an accurate representation of existing performance. If these values are to be adjusted (for example, for the left-turn give-way slip, the maximum flow while giving-way can be increased up to 1000 pcu/hr, or the minimum flow while giving-way can be increased up to 100 pcu/hr), the modelling report should include justification and evidence from site observations to support the changes.

In some instances it may be appropriate to calculate new values based on site geometry such as the guidance found in the UK’s Design Manual for Roads and Bridges Volume 6 Part 7 (TA 23/81).

http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol6/section2.htm

3.5.4 **Clear Conflict**

The clear conflict time is the time between a vehicle crossing the opposing lane’s stop line and the time it ceases to oppose traffic on the give way lane. The value must be reviewed and observed on-site for each opposing movement, or estimated by measuring the distance from the opposing stop line to the conflict point and divided by the travelling speed. The clear conflict time needs to be entered under each **Opposing Lane** in the **Movement to tab** of the **Edit Lane** window.

3.5.5 **Storage in Front of Stop Line**

For signal controlled, mixed through and filtered right turn lanes, modellers need identify if the right turning vehicles would wait to filter in front of the stop line. Where required, the **right-turn storage in front of stop line** and **maximum right-turns in intergreen** values should be updated based on site observations, driving behaviour and local driving rules.

*Right turn move up* time and *right turn factor* must be left as default. If the values are updated, justifications must be provided in the modelling report.

3.5.6 **Non-Blocking Storage**

For mixed through and turning lanes, modellers need to identify if the opposed turning traffic blocks the non-opposed through traffic. Where required, the **total number of PCUs on a give-way movement that can store without blocking the non-giving way movement** value should be updated based on site observations, driving behaviour and local driving rules.

3.5.7 **Zebra crossings**

LinSig is not able to model the impact of traffic giving way to pedestrians at zebra crossings. However, if it has been observed that zebra crossings at left turn slip lanes have caused an impact to traffic, modellers can consider reducing the **maximum flow while giving way** value. The assumption must be noted in the modelling report.
3.6 Traffic Flows Inputs

This section details the LinSig input requirements for traffic flows.

3.6.1 Traffic Flow Assignment

There are numerous methods to assign traffic flows into the LinSig network. The common methods are discussed in the following sub-sections.

3.6.2 Delay Based Assignment

The most common and preferred method to assign traffic in a LinSig model is to develop an origin–destination (OD) matrix in the Traffic Flows View window and use delay based assignment to allocate the traffic flows to the lanes.

The modeller must check that the lane distributions assigned by LinSig are similar to observed site lane distributions, as on-street signing, parking, perceived delay, perceived risk of delay, perceived safety and other sometimes irrational factors may affect driver route choice. Although the use of SCATS data is not recommended to develop base models, comparisons can be made to traffic volumes on a lane-by-lane basis and proportions determined that will closely reflect actual lane use.

Only after reviewing other input parameters, and the LinSig assigned flows are not realistic and significantly different from other lane based data, then the modeller can consider ‘locking’ the traffic flows for a particular route in the Route List View window. However, the modeller must not ‘lock’ all the routes as it removes the purpose of the delay based assignment. Engineering judgement is required when deciding the traffic volume to be locked, as future year lane distributions may not be the same as the current conditions if the lane layout, traffic volume and signal timings have been changed.

3.6.2.1 Lane Based Flow Entry Method

For base models, using the lane-based flow entry method is acceptable, but not desirable. Although this method can model the lane flows as per site visit, it takes longer to update the flows for each scenario and it may not be a fair comparison to the future year flow models. If the lane-based flow entry method is chosen, justification should be made in the modelling report. Care much be taken to ensure that there are no discrepancies between lanes and connectors; Flow consistency mode can be used to display flow discrepancies in the network layout view.

For future year flow models and option models, delay-based assignment must be used, as this method takes into consideration the capacity based on the new layout and new timings when assigning traffic to the network.

It is acceptable, but not desirable, to combine lane-based flow entry and delay-based assignment methods for future year traffic analysis; for example, if lane-based flow entry method is used for the base traffic flows, the modeller can develop a new traffic flow OD group with only the future additional traffic, and use delay-based assignment to assign the additional traffic to the network which already contains the lane-based base traffic flows.
### 3.6.3 Traffic Flows Group

In the *Traffic Flows View* window, the modeller must provide suitable description names and enter the start time and end time to distinguish between different flow groups. For existing traffic flows, the date of the existing traffic count should be included in the description names for the base traffic flow groups to ease the checking.

Modellers are advised to disable the *Auto Assign* function in *Traffic Flows View*. This is to avoid LinSig reassigning the traffic flows automatically every time an adjustment is made in the LinSig model as this causes needless delays particularly when working on a large file, with multiple intersections or multiple routes with the same origin and destination.

### 3.6.4 Traffic Zones

When an OD matrix is used for delay based assignment, traffic zones are required for the network with *zone A* corresponding to the approach containing SCATS loop number 1. Subsequent zones should then be added in the same order as the arm numbers, usually in the anti-clockwise direction, as shown in Figure 3-5.

### 3.6.5 PCU Conversion

Traffic is composed of various types of vehicles, the range and relative composition of which can vary from location to location. LinSig utilises a common unit, known as the Passenger Car Unit (PCU), to represent general traffic. Common vehicle types are assigned a conversion factor so that an equivalent PCU value can be generated from classified vehicle data collected as described in Table 3-6.

Base case traffic data should be determined from Classified Turning Count surveys as they provide much greater accuracy than SCATS counts and allow the conversion of vehicles into Passenger Car Units (PCUs).

*Table 3-6: PCU conversion factors*

<table>
<thead>
<tr>
<th>Austroads’ vehicle class</th>
<th>PCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>2-5</td>
<td>2.0</td>
</tr>
<tr>
<td>6-9</td>
<td>3.0</td>
</tr>
<tr>
<td>10-11</td>
<td>4.0</td>
</tr>
<tr>
<td>12</td>
<td>5.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>PCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedal cycle</td>
<td>0.2</td>
</tr>
<tr>
<td>Motorcycle</td>
<td>0.4</td>
</tr>
<tr>
<td>Rigid buses</td>
<td>2.0</td>
</tr>
<tr>
<td>Articulated buses</td>
<td>3.0</td>
</tr>
</tbody>
</table>
3.6.6 Pedestrian Flows

If pedestrian links have been modelled (Refer to Section 3.3.9), pedestrian volume should be entered as per site survey (if available). Pedestrian zones should be added for entering pedestrian flows. If the pedestrian volume is not known, a nominal pedestrian volume (e.g. 10) should be entered to generate the delay per pedestrian results and this should be stated in the modelling report in order to avoid confusion on the source of the pedestrian volume.

3.6.7 Bus Flows

For public transport schemes and for intersections consisting of bus lanes or special bus facilities, the bus traffic must be modelled separately from general traffic with separate bus zones. The buses are entered in PCU (Refer to Table 3-6). Care must be taken not to ‘double count’ the bus traffic in the general traffic flow matrix.

Note that even if the bus facilities are not present in the existing situation but modelled in the options testing, bus traffic must still be modelled in the base model for a ‘like for like’ comparison of the bus traffic related results, such as delay time.

3.7 Scenarios

As the Scenario tab in the toolbar can only display the start of the scenario names, the names should be clear, with critical information placed at the start to make it easy to distinguish each scenario in the same model. For example, AM 2018 Base, PM 2018 Base Optimised, AM 2023 Option Optimised are acceptable.

In the Scenarios View window, under the automatically recalculate results for and when optimising optimise for drop down menus, modellers are advised select the current scenario option, rather than the all scenarios option. This is to avoid LinSig processing the results automatically every time an adjustment is made in the LinSig model as this can cause needless delays; this is particularly important when working on a large file, with multiple intersections or multiple scenarios.

3.8 Bonus Greens Calibration

In the Lane Timings View window, bonus greens can be used to replicate the traffic behaviour described below:

- Underutilised green time (UGT) – entered as a negative value to replicate slow movement or exit blocking during the green time (Refer to Section 3.8.1).
- UGT – entered as a negative value for the turning traffic giving-way to pedestrians (Refer to Section 3.8.2).
- Demand dependency – entered as negative or positive values to replicate an ‘average’ cycle (Refer to Section 3.4.9).
- Other – entered as a negative value on a bus lane if the general traffic is permitted to use the bus lane and results in delaying the bus traffic (Refer to Section 3.3.10).
- Other – entered as a negative value if the presence of the on-road cyclists at the front of the queue delays traffic moving at the start of the traffic green time.
• Other – entered for other situations, for example as a positive value if traffic is constantly observed to cross the stop line during the non-green time.

Justifications must be made in the modelling report if bonus green times (whether positive or negative) are added to the LinSig models.

### 3.8.1 Exit Blocking and Underutilised Green Time

Exit blocking and slow-moving traffic should be accounted for by modelling the underutilised green time (UGT) to replicate situations where vehicles are not able to discharge when there is a green signal on street.

These situations are generally the result of downstream blocking, traffic giving way to pedestrians at parallel or partially protected crossings, these can also occur as a result of driver behaviour, public transport operations, pedestrian movements on side streets or poor signal coordination.

UGT can be observed and measured on-site, or estimated from video surveys in some circumstances, by timing the length of time when traffic cannot proceed on a green signal. UGT is entered as negative bonus greens on a lane-by-lane basis in lane timings view.

As changes in demand or capacity may result in an increase or decrease in UGT, care should be taken to not replicate the impact of UGT in project cases or future case models. If UGT in future cases is to be reduced or increased, the justification for this should be provided in the modelling report.

It should be noted that UGT in LinSig modelling refers to when there is a green signal on the street and there is still traffic demand but the traffic is not able to travel at the saturation flow rate. UGT does not refer to when there is green signal on the street but there is no traffic demand to utilise the green time.

### 3.8.2 Traffic Giving-Way to Pedestrians

With the exception of the exclusive pedestrian phase and full red arrow-protected crossings, each pedestrian protection crossing type can potentially increase delays to turning traffic at the start of green as there is a requirement for vehicles to give-way to pedestrians still on the crossing. This is further delay to the turning traffic, in addition to the pedestrian protection time discussed in Section 3.4.2.3.

For base models, it is important that the additional delay per cycle at the start of green is observed for turning traffic. This additional average delay should then be added as negative bonus greens in the Lane Timings View window for the lanes delayed for each scenario. Site observations should also identify any non-blocking storage in front of the stop line and this should also be included in base models.

In the example shown in Figure 3-23, pedestrian link P4 already has five seconds parallel protection from lane 2/1 and lane 2/2 (Refer to Section 3.4.2.3 for modelling pedestrian protection). If the site observations indicate that for this scenario, the left-turning traffic on lane 2/1 is delayed by a further three seconds (the total delay is eight seconds) as the traffic gives-way to the pedestrians who are still crossing, a negative bonus green of three seconds must be entered in the Lane Timings View window to replicate the additional delay, as shown in Figure 3-24.
For option models, some assumptions may need to be made based on the number of expected pedestrian movements and assumed delay in order to estimate any potential turning traffic delay.

### 3.9 Error Messages

If the model contains error messages, notifications are shown on the error bar at the bottom of the LinSig window. Typical error messages include:

- **Critical error messages** (shown in red) – must be resolved before the model is submitted, as LinSig is not able to calculate outputs when there are critical errors.

- **Warning messages** (shown in yellow) – must be investigated and resolved, as while LinSig can generate outputs, the results may not be accurate due to incorrect inputs. In some situations, some warning messages may be acceptable due to certain modelling assumptions and the justification should be included in the modelling report.

- **Information messages** (shown in green) – should be investigated and resolved where possible.
In the *Error View* window, it is possible to ‘hide’ warning and information messages; this function must not be used as it is better to show the error messages for transparency, as some of the messages may be acceptable due to modelling assumptions. If this has been applied the modeller must provide the justification in the comment section.

### 3.10 Advanced Settings

The *Advanced* tab can be found in the *Edit Lane* window, an example is shown in Figure 3-25. With exception of the effective green start displacement, all other parameters must be left as default unless justifiable:

- **Effective green start displacement** – must be changed from two seconds to three seconds (Refer to Section 3.2).
- Effective end green start displacement – as default 3 seconds.
- **Optimiser Queue Constraints** – Refer to Section 3.14.5.1 if this is required for the option model.
- **Optimiser Weightings** – Refer to Sections 3.14.5.2, 3.14.5.3 and 3.14.5.4 if changes are required for the option model.
- Random Delay – Ignore Random Delay must be left unchecked.
- **Queue De-silver** – Refer to Section 3.11.12 if this is required.
- **Entry Profiles** – *Inherit cycle flow profile from upstream exit lane* should be left unchecked; this is only applicable if separate OD matrices are used for each individual intersection. Refer to *LinSig3 User Guide* for information.

*Figure 3-25: Edit Lane window, Advanced tab*
3.11 Modelling Networks

This section details the model inputs that modellers should be aware of when developing a networked model (multiple intersections) in LinSig.

3.11.1 Model Extent

In terms of the extent of small networks, it is not possible to put an upper limit on the number of controllers or length of corridor to be assessed. Modellers need to consider the specific nature of each corridor in the project that needs to be modelled. For example, LinSig may be appropriate over a significant length of corridor with several intersections if the carriageway pattern is reasonably uniform and it is subject to controlled access and limited side friction. The SCATS settings should be reviewed to decide if neighbour intersections are linked and if the neighbour intersections are required to be modelled.

3.11.2 Network Structure

When modelling multiple intersections in a network model, it is recommended that each intersection contain separate exit arms and entry arms, as shown in Figure 3-26. The network layout missing an exit arm of the upstream intersection in Figure 3-27 is not recommended. However for an interchange model that operates under one signal controller, such as on/off ramps at freeways, all the lanes can be grouped under the same junction and there is no need to model separate exit and entry arms within the interchange.

Figure 3-26: Preferred lane structure for network modelling
3.11.3 Lane Length

The total lane lengths of the internal long lanes should be measured between the upstream stop line to the downstream stop line, typically based on the through movement between the two intersections, where:

- The upstream exit lane length is typically the distance from the upstream intersection stop line to the exit of the intersection.

- The downstream entry lane length is measured from the exit of the upstream intersection to the downstream intersection stop line.

An example is shown in Figure 3-28. The combined distance of the two lanes must be the same as the physical distance on site.

Source: SkyView

For internal short lanes, the lengths are measured using the same method as outlined in Section 3.3.5.

For the entry lanes and exit lanes of the whole network (i.e. connected to the traffic zones), the lane lengths can be left as default 60 PCU.

Note that entering lane lengths for the internal lanes is not a compulsory requirement for LinSig modelling provided cruise time, not cruise speed, is used in the connectors. However Main Roads strongly recommends that the lane lengths be entered in the LinSig model in all situations for ease of checking for consistency.
3.11.4 Weaving Connectors

To model traffic weaving in network modelling, weaving connectors may be added between intersections only if deemed necessary, as shown in Figure 3-29. Providing an excessive number of weaving opportunities could cause LinSig to evaluate all the possible scenarios and increase the run times, particularly when the number of intersections is increased; weaving connectors must only be added if the weaved movements are required between intersections to avoid increasing the run time of the model.

Figure 3-29: Weaving connectors

When using delay-based traffic assignment, the modeller should check if the weaved traffic volume on those connectors are realistic. For example, Figure 3-30 shows that 310 PCU travel from lane 1 to lane 2, and at the same time 210 PCU travel from lane 2 to lane 1; where in reality only 100 PCU may travel from lane 1 to lane 2 and no traffic changing from lane 2 to lane 1.

It is therefore recommended that the modeller should review the connector structure in the first instance and consider deleting any unnecessary connectors such as from lane 2 to lane 1 in this example. Alternatively, a delay-based assignment cruise time weighting may be added to the weaving connectors to reduce the amount of traffic being assigned to the weaving connectors.

Figure 3-30: Avoid excessive weaving traffic crossing over

If unrealistic weaving routes are observed, such as shown in Figure 3-31, modellers should review the connector structure in the first instance and delete any unnecessary connectors. After the structure has been thoroughly reviewed, the modeller can open the Route List View window and use the edit permitted routes function to disallow the unrealistic weaving routes. It should be noted that the disallowed route is applied to all scenarios in the LinSig model.

Figure 3-31: Avoid unrealistic weaving routes
3.11.5 Cruise Time

When networks are being modelled, cruise time is required to be added to lane connectors. The total cruise time (as measured on-site between stop lines) should be represented by the sum of lane connectors between the entry and exit arms at the first intersection and between the exit arm of the first intersection and the entry arm of the first downstream intersection.

Providing the remainder of the measured cruise time is applied to the downstream lane connector, cruise time within intersections can be estimated or a nominal value used, for example three to five seconds to reflect the lane lengths of the upstream exit lane (Refer to Section 3.11.3).

If cruise times cannot be measured on-site, it may be acceptable to apply a cruise speed. The cruise speed is typically the same as the posted speed limit for long distances between intersections. However note that cruise speeds often are less than the posted speed limit as some vehicles will travel at less than the speed limit and geometry, such as turning and closely spaced intersections, may limit cruise speeds.

If cruise speed is used in the LinSig, the modeller must ensure that all of the internal lane lengths (Refer to Section 3.11.3) are modelled correctly, as LinSig calculates the cruise times based on user’s inputs of the cruise speed and lane lengths. Modellers can use the multi-select function (Ctrl + left click mouse to draw a box) to edit multiple connectors with the same parameter (such as cruise speed) at the same time.

Modellers must note that the cruise time / speed at the connectors represent the time / speed travelling into the next connector. The example in Figure 3-32 displays the cruise speed at the connectors, in which the major road has a posted speed limit of 70km/h and minor road with 50km/h.

Figure 3-32: Modelled cruise speed (shown on connectors) to major and minor roads

Cruise time / speed for exit lanes is not a required input; however it would not affect the overall results if these have been entered.
3.11.6 **Bus Speed**

If buses are modelled in the network, a bus speed, usually the posted speed, is required as an input and it is important that the lane lengths are modelled accurately.

3.11.7 **Controller Sets**

Depending on the linking setup in SCATS, all controllers with the common cycle time should be grouped under the same controller set. This can be edited in the *Controller List View* window, as shown in Figure 3-33.

*Figure 3-33: Controller List View window*

3.11.8 **Network Control Plans**

As there are now multiple signal controllers in the network, Network Control Plans must be developed for each combination of signal phase sequencing for different controllers. If the phase sequences for all controllers are the same for each peak, then the same network control plan can be used for different modelling scenarios.

3.11.9 **Offsets**

When modelling networks, and particularly existing intersections, it is important to understand how SCATS operates in order to achieve coordination between two or more adjacent intersections. Refer to Appendix A for information on determining the offset timings.

If there is a fixed time offset relationship between two close-by intersections, the modeller must replicate the offsets as per the site conditions, in particular for the base model.

In a base model, it is recommended that the reference phase of the master site starts at zero and the other intersections are shifted based on the offset setting.

If the offsets need to be maintained in the option models, the modeller can lock the offset of the first phase in the sequence by choosing this function in the *Signal Timings View* window. If this locking function is used, it may be necessary to rearrange the phases in the *phase sequence* so that the first phase of the sequence is the reference phase.
3.11.10 Traffic Data

The main method of entering traffic demand into LinSig is via demand matrices, and it is recommended that this approach is adopted. All traffic data used in base models should be based on surveys – classified OD surveys or classified intersection turning counts – taken on the same day.

While surveyed OD matrices should be checked for consistency, in most cases they can be directly applied in LinSig.

The peak hour could be slightly different for each intersection in the network and a common peak hour needs to be determined by analysing all the input flows into the network (not the input flows of each intersection as the traffic flows would be duplicated). In some situations, the peak hour could be determined by analysing the flows of the most critical intersection of the network.

LinSig has a built-in matrix estimation tool, which is based on the turning count flows entered by the modeller. If the tool is used, modellers must use the matrix estimation view window to review the estimated matrix flows against the turning counts, GEH must be less than 5.0 for all movements. Modellers must also check if the matrix flows are reasonable, particularly between two adjacent side roads in which the traffic is likely to travel via local roads outside of the modelled area rather than travel via the network within the study area.

The counts may need to be adjusted if the entry and exit flows do not match. Considerations include:

- Potential inaccuracy of survey data.
- Traffic entering and exiting the network by un-surveyed side roads or property crossovers.
- Adjacent intersections not being surveyed on the same day.
- Locations where large volumes of un-serviced demand exist at the start and/or end of the survey period.

In these instances, raw turning counts should be processed outside of LinSig to produce a consistent set of data and any assumptions or significant adjustments included in the modelling report.

When large discrepancies exist between intersections, and these are explained by real sources or sinks of traffic, internal zones can be used to represent these sources and sinks. These should only be used where the sources and sinks are significant, as adding numerous internal zones for minor discrepancies may unnecessarily complicate the model.

3.11.11 Traffic Assignment

Following matrix estimation, traffic is assigned to the network. This is an iterative process undertaken on a lane-by-lane basis. For base models, it is important that existing lane use and routes are reflected in the model.

It may be necessary to edit routes within the model to remove any unlikely route choice and to influence lane use.
A further option is to examine flows on particular lane connectors and lock these to values that reflect existing or expected lane use. Although the use of SCATS data is not recommended to develop base models, comparisons can be made to traffic volumes on a lane-by-lane basis and proportions determined that will closely reflect actual lane use.

The modeller should review the use of any weave connectors to ensure that traffic can be distributed across downstream lanes. The use of weave connectors should be based on observed weaving or lane-changing. In order to maintain only realistic traffic routes in a network and increase the speed of traffic assignment calculations, care should be taken to minimise the number of weave connectors in the network.

### 3.11.12 Sliver Queues

Sliver queues occur when LinSig predicts a high queue length but a low number of vehicles in that queue. These occur when the arrival rate of traffic exceeds the maximum discharge rate of a lane and common causes of this include:

- Two lane connectors are attached to a single lane.
- Merges downstream of intersections.
- Lower saturation flow at the downstream section.

It is important to eliminate sliver queues, particularly when observed queue lengths are used for model validation, otherwise LinSig will predict an unrealistic mean max queue (MMQ).

Although sliver queues can be addressed by adding weave connectors to unconstrained lanes (exit arms), this may not represent the true location of weaving movements.

Where two closely-spaced stop lines exist and the downstream one has a lower saturation flow, sliver queues will often form. In practice, the closeness of the stop lines would mean that the upstream saturation flow would be limited to a similar value to the downstream saturation flow. In this case it is often preferable to eliminate the sliver queue by reducing the upstream saturation flow to a similar value to the downstream value. Modellers may do this intuitively, rather than using the de-sliver parameter.

Alternatively, a de-sliver threshold can be applied in the advanced tab of the lane setting.

To identify the number of vehicles in a queue of excessive length that would represent a sliver queue, a lower value should be investigated first and then gradually increased up to one PCU. This value should not be used as a means of calibrating/validating queue lengths.

Queue graphs should be examined for lanes with potential sliver queues. If the above methods have been adopted and sliver queues still occur, the excessive queues are likely to be caused by other issues and modeller should review other input parameters. The de-sliver threshold value should not be more than one PCU.

### 3.11.13 Exit Blocking

LinSig has limitations when it comes to modelling the effects of downstream blocking. In a network model, even if LinSig predicts a queue at the downstream signal stop line, it would not recognise if the queue would block back onto the upstream signal stop line. Therefore underutilised green times can be added in the lane timings view to account for the effect of downstream queueing. Refer to Section 3.8.1
3.11.14 Cyclic Flow Profile Graphs

Cyclic flow profile graphs can be used to examine the traffic platoons between intersections. These can either be presented in Network Layout View or in Flow Profiles View, an example of the latter is shown in Figure 3-34. Refer to JCT’s LinSig 3.2 User Guide for further information.

Figure 3-34: Cyclic Flow Profile graphs in Flow Profiles View

3.11.15 Time Distance View

Time Distance View can be used to examine the signal offsets and traffic green waves along a route; modellers can adjust the green time and offsets manually in this window, if required. An example of the time distance view is shown in Figure 3-35. Refer to JCT’s LinSig 3.2 User Guide for further information.

Figure 3-35: Time Distance View window
3.12 Base Model Calibration

Base model calibration is the process of employing verifiable observed data into a model to replicate on-street conditions. All input data used for calibration should be auditable and collected as described in Section 2.

It may be necessary to adjust some parameters based on the time period being modelled. As such, calibrated base models are likely to differ slightly between modelled periods.

3.12.1 Calibration Data Requirements

To develop the calibrated base model, the following observed data and controller information inputs should be used:

- accurate road geometry
- classified turning movements/OD data
- observed saturation flow values
- observed lane utilisation
- observed weaving patterns
- SCATS signal timings
- controller phase minimums, intergreens and pedestrian timings
- observed UGT
- observed non-blocking storage and storage in front of the stop line
- observed right-turning during the intergreen
- observed delays to turning traffic, and
- correct routing for general and public transport vehicles.

3.13 Base Model Validation

Validating the LinSig base model ensures that the models developed accurately reflect the performance of the network or intersection being modelled. Validated models can then form the basis of any future models and should provide a reliable measure of future performance following upgrades or changes to the network/intersection.

Validation requirements should be agreed with Main Roads prior to undertaking any data collection or modelling. The validation comparisons must include:

- degree of saturation
- queue length.

3.13.1 Degree of Saturation

Degree of saturation (DoS) is a LinSig output that represents the ratio of flow to capacity. As it is recognised as the most reliable indication of model validity, it is the primary validation method.
For a base model, if the traffic data is collected using stop line turning counts and the signal timings are extracted from the SCATS system, the DoS must not exceed 100%.

Main Roads may request on site recording the DoS at critical intersections to be compared with the modelled DoS results for validation purpose.

### 3.13.2 Queue Lengths

Queue lengths must to be used for validation. The modeller should ensure that the queue at the start of the green period on each lane is captured, rather than recording the maximum back of the queue.

Multiple queue cycles should be recorded from site visits or videos, spread over each peak period, to form an average queue representation of the traffic conditions evident over each peak period.

The average site queue at the start of the green period should be compared to the back of uniform queue at end of red (PCU) output in the Network Results window. The values must be similar with the same magnitude between the site measured queue and the LinSig output queues.

Traditionally, queue lengths have been used for model validation as they can be observed on-site without any need for data manipulation and provide a useful indication of un-serviced demand and intersection performance. There are some issues with using queue lengths for LinSig model validation and the use of this method should be approached with caution. Considerations include:

- As it is difficult to define and measure the actual end of a queue, ensuring accuracy and consistency amongst surveyors is problematic.
- Under high-demand conditions, queue lengths become highly variable and LinSig cannot provide an accurate prediction of queue lengths under these conditions.
- Variability of queue length requires a high number of samples to provide an accurate estimate of on-street average queue lengths.

As a minimum, the queue of each lane on the critical approaches should be recorded on-site and compared to the LinSig outputs. For the less critical approaches of a network, it may be acceptable to record and compare groups of lanes undertaking the same movement.

#### 3.13.2.1 Queue Graphs

Queue graphs can be used to examine how the queue is formed throughout the cycle, taking account of the traffic arrival and departure at each lane. Modellers can also add the random and oversaturated component in the queue graphs, if required for the analysis. An example of the queue graph is shown in Figure 3-36. Refer to JCT’s *LinSig 3.2 User Guide* for further information.
3.13.2.2 Short Lane Queues

It should be noted that the MMQ reported for a long/short lane pair is the longest extent of the queue in either of the two lanes. If a scheme requires examining the potential queue blocking between the long and short lanes, storage graphs should be used.

In the example of the storage graphs shown in Figure 3-37:

- Lane 2/3 is a short lane with a physical lane length of 5 PCU.
- The storage graph (brown graph) for lane 2/3 suggests that the short lane is full at time 68 in the cycle; this is where the graph becomes flat with 5 PCU, the physical length of the short lane.
- Through traffic can no longer join the queue on the long lane 2/2 after time 68, due to the queue on the short lane. Based on the storage graph for lane 2/2, the queue is 3.8 PCU.
- LinSig reports the MMQ for the lane group rather than individual long/short lanes; in this example the MMQ for the lane group 2/2+2/3 is 32.2 PCU, as shown in the queue graph (blue graph).
3.14 Proposed Models

It is recommended that development of proposed models should only commence following the validation of base models. The calibrated and validated base models should be used as the basis for developing proposed models.

Using a copy of the relevant models, the proposed network and traffic demands can be coded, leaving all other aspects of the base models unchanged. This approach ensures that the calibration and validation of the base model is retained as far as possible in future scenarios.

3.14.1 Traffic Flows

Modellers can utilise the Flow Group Formula function in the Edit Flow Group window to calculate new flow groups to reduce the chance of introducing errors when entering the flow values individually for each flow group. For example, if the modeller wants to add a 2% growth to the base traffic group $F1$, modellers can create a new flow group and enter $F1 \times 1.02$ in the formula box.

Modellers can also select the Component Flow Group option if the flow group is only used as part of a formula, and not intended to be assigned to the model. For example, development only traffic, which is expected to be assigned without the background traffic.

3.14.2 Signal Timing Optimisation

Signal timing optimisation is a key feature of LinSig and can be used to optimise phase splits on the basis of either delay or practical reserve capacity (PRC). Delay-based optimisation should minimise overall network delay, while optimising for PRC should maximise network capacity (and minimise DoS), potentially increasing reliability and network resilience.

When optimising signal timings, modellers must use Optimising for PRC as a starting point because DoS is the main assessment criteria for LinSig modelling. Following the LinSig signal optimisation, modellers need to review the optimised timings and adjust the phase splits manually to meet the scheme requirements.

There may be instances where optimising for delay is more appropriate and in these cases the justification for using this approach should be included in the modelling report.

When optimising signal timings with LinSig it is important to critically assess the resulting green times from the optimisation to ensure that the results make good engineering sense, as well as good mathematical sense. There can be factors which affect the choice of signal times which cannot easily be taken into account by a mathematical optimiser. The modeller may need to adjust the signal timings manually to meet the criteria.

Note that the traffic flows must then be reassigned in LinSig to re-distribute the traffic based on the adjusted signal timings. Refer to Section 3.14.3.
3.14.3 Iterations Between Optimised Signal Timings and Traffic Assignment

Following signal optimisation (Refer to Section 3.14.2), the modeller must re-assign the OD traffic using delay-based assignment (Refer to Section 3.6.2). To ensure that the traffic flow assignment and the signal timings are optimal for the study area, the modeller must repeat the signal optimisation and traffic assignment processes until the signal timings are unchanged window displays, as shown in Figure 3-38.

*Figure 3-38: Signal timings are unchanged window*

3.14.4 Cycle Time Optimisation

For proposed model scenarios, cycle time optimisation should be used to determine the most appropriate cycle time for a network or corridor.

The cycle time optimisation graph, as shown in Figure 3-39, displays the vehicle delay and PRC results for a range of cycle times. Note that the blue value at the top of the graph (cycle time slider) shows the initial cycle time, rather than an optimised cycle time suggested by LinSig. The modeller can move the cycle time slider manually to the desired cycle time that meets the scheme criteria. The modeller must then repeat the iteration of signal optimisation and traffic re-assignment until the model is optimised, as discussed in Section 3.14.3.

There are other practical and operational factors that LinSig does not consider in the optimisation, such as pedestrian LoS, coordination and management of queues. These factors need to be considered when choosing a future year cycle time, as the cycle time could be determined by other intersections outside of the modelled network.

Screenshots of the cycle time optimisation graph should be included in the modelling report to justify the proposed cycle time.

*Figure 3-39: Cycle time optimisation*
3.14.5 Influencing the Optimiser

The type of optimisation used is likely to be influenced by the operational objectives of the network or corridor (for example, to reduce delay, to maximise capacity or to maintain reliability). There may be instances where a particular movement or objective is being assessed which can be influenced by settings within the LinSig optimiser. The network or operational objectives can be influenced by parameters discussed in the following sub sections, which can be entered in the Advanced tab of the Edit Lane window.

Applying these optimiser parameters requires an advanced understanding of modelling and an experienced modeller. It may be more appropriate to adjust the signal timings manually to achieve the specific objectives rather than applying the optimiser parameters.

When using any of the parameters, careful consideration needs to be given to achieving the required outcome without unduly penalising other movements or side roads. Any use of these factors needs to be justified on the basis of network or operational objectives and detailed in the modelling report.

3.14.5.1 Excess Queue Limit

The Optimise Queue Constraints set up is used to prevent queues exceeding available storage between intersections or within turning short lanes. This is normally set to three-quarters of the queuing space on the lane, i.e. if the physical length is 8 PCU, then 6 PCU is used in the model. Low DoS weighting and low delay weighting (for example, 1 or 2) are recommended as the starting point to examine the impact.

3.14.5.2 Optimiser Stops Weighting

The Apply Optimiser Stops Weighting (%) option increases the cost associated with vehicle stops and provides additional green time on particular lanes to provide a more favourable offset to reduce the number of stops. 100% is the default ‘do nothing’ value; if 200% is used then it implies the lane is twice as important, similarly if a value less than 100% is used then it implies the lane is less critical.

3.14.5.3 Optimiser Delay or DoS Weighting

Depending on the type of optimiser being used (delay or PRC), the optimiser increases the cost to either delay or DoS to provide additional green time or more favourable offsets to reduce delay or DoS, based on the value entered in the Apply Optimiser Delay/DegSat Weighting (%) option. This is particularly useful if the scheme has a stricter delay or DoS requirement on certain lanes. 100% is the default ‘do nothing’ value; if 200% is used then it implies the lane is twice as important, similarly if a value less than 100% is used then it implies the lane is less critical.

3.14.5.4 Degree of Saturation Limit

The Apply DegSat Limit (%) option is used to influence the LinSig optimiser to ensure the DoS does not exceed this value (where possible). This is particularly useful if the scheme has a stricter DoS requirement on certain lanes.
3.14.6 Demand Dependency for Proposed Modelling

Demand dependency should be taken into consideration when optimising the signal timings for the option models. While it is usually acceptable to consider the demand dependency frequency for the option model remains unchanged from the existing situation, many factors in the future scenarios, such as land use, pedestrian demand or cycle time, could also affect the demand frequency.

The following method can be used to consider the potential demand frequency, this is particularly useful for a diamond signal arrangement when alternative phases may run:

1. For the alternative phases, reduce the restrictions of minimum green from the existing timing to one second.
2. Optimise the signal timings for PRC and note the resultant phase lengths.
3. Re-enter the minimum green as per the site condition.
4. Apply the bonus green time to replicate the traffic lane green time as per point 2 above.

3.15 Model Audit View

The Model Audit View window can be used for reviewing models and to compare scenarios and LinSig files. This is particularly useful when comparing a base model with an option model, as LinSig highlights and displays the differences between two scenarios or two LinSig files, which can save significant time when reviewing models and also reduce errors.
4 SIDRA Guidelines

4.1 Introduction

SIDRA Solutions’ SIDRA Intersection (SIDRA) software is used to aid the design and evaluation of individual intersections and networks. This section is designed to complement the SIDRA Intersection 7 User Guide. It provides detail on key parameters to be adopted when modelling intersections in WA.

Modellers must refer to Sections 1 and 2 for the overview of traffic modelling.

As shown in Figure 4-1, this guide is based on three key areas: Settings, Site Input and Site Output.

Figure 4-1: Key areas of user interface

4.1.1 Appropriate Use of SIDRA

SIDRA can be used to model isolated intersections or networks where there are signalised and non-signalised (priority controlled or roundabout) intersections.

4.1.2 Software Version

This guideline is written for version 7 of SIDRA. While the Operational Modelling Guidelines will need to be updated for future versions of the software, the general principles outlined will continue to apply.
4.2 Settings

General initial settings for all scenarios and model outputs are defined in Settings tab.

4.2.1 Output Options Group

The Output Options group window allows the modeller to produce:

- Output Reports, Movement Displays and Lane Displays.
- Tables to be included in the Detailed Output report.
- Performance measures to be included in the Graphs Display and Variable Run Report.
- Various options applicable to Volume Displays, Signal Timing Output and Layout Options.

4.2.2 Manage Software Setup Group

In the Manage Software Setup group window, the standard left option should be selected as the current set-up, or a user-defined set-up based on standard left should be used.

4.3 Site Input

This section discusses the input dialogs for sites in SIDRA.

4.3.1 General

The key points to note for file set-up are:

- It is generally acceptable to choose the default program option for a large number of parameters instead of entering user-defined input values. This guide will help to clarify which values can be left as the default values and which should be modified to reflect site conditions.
- Rotate site layout to provide the north direction to the top.
- Ensure that either stop (two-way) or give-way/yield (two-way) is selected to match the sign control which is to be modelled.

4.3.2 Intersection

When using the Intersection tab, the following should be noted:

- Site Name generally includes the intersecting road names, peak period (AM or PM), and year of modelling.
- For Site ID, the TCS (traffic control system) reference supplied by Main Roads should be used.
- Approach Distance should be specified for network models (Refer to Network Configuration in Section 4.6.1.1).
- Exit Distance should be left as program if it is the same as Approach Distance.
• **Area Type Factor** for signals allows calibration of saturation flow. This value should be left at the 1.0 default value if no calibration of saturation flow is required.

• **Extra Bunching** allows for the effect of upstream signals on gap acceptance to be modelled and should be specified as a percentage based on *Approach Distance* and *Proportion Queued* at upstream signals (this is of most relevance to roundabouts and two-way sign-controlled intersections and opposed turns at signalised intersections). When *Extra Bunching* is set to *program*, with site analysis, the *Extra Bunching* value will be zero. Figure 4-2 shows *Extra Bunching* value specification as function of approach distance and proportion queued. For example, Table 4-1 shows *extra bunching* values for *proportion queued* of 70%. The amount of platooning should be documented in the modelling report.

![Figure 4-2: Extra bunching specification as function of approach distance and proportion queued (pq)](image)

### Table 4-1: Extra Bunching Values for PQ=70%

<table>
<thead>
<tr>
<th>Distance to upstream Signals (m)</th>
<th>&lt;100</th>
<th>100-200</th>
<th>200-400</th>
<th>400-600</th>
<th>600-800</th>
<th>&gt;800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra Bunching (%)</td>
<td>25</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

*Source: SIDRA Intersection 7 User Guide*

### 4.3.3 Movement Definitions

The **Movement Definitions** dialog contains **Movement Classes** and **Origin-Destination (OD) Movements** tabs.

### 4.3.3.1 Movement Classes

The default movement classes are for light vehicles and heavy vehicles. The standard light vehicle and heavy vehicle movement classes used in SIDRA are based on seven light vehicle classifications and six heavy vehicle classifications. Refer to *SIDRA Intersection 7 User Guide* for more information about default vehicle compositions and other parameters.
In certain situations there may be a need to consider the additional standard movement classes; therefore, additional to the predefined movement classes in SIDRA (Buses, Bicycles, Large Trucks and Light Rail / Trams), it is possible to define up to six further user classes using the standard base model data and then altered in Parameter Settings dialog and Vehicle Movement data dialog.

Main Roads recommends defining five separate movement classes for modelling heavy vehicles in SIDRA where there are significant numbers of Austroads vehicle classes 3 to 12. The classifications are:

- rigid trucks (Austroads class 3 to 5)
- semi-trailers (Austroads class 6 to 9)
- B-doubles (Austroads class 10)
- double road trains (Austroads class 11)
- triple road train (Austroads class 12).

The recommended mass, maximum power, length and PCE (passenger car equivalent) value for the individual movement classes are specified in Table 4-2. These should be defined in the Model Parameters and Fuel & Emissions tabs of the Parameter Settings dialog and Calibration tab in Vehicle Movement Data dialog, as shown in Figure 4-3.

Table 4-2: Recommended Movement Classes by Main Roads

<table>
<thead>
<tr>
<th>Austroads Vehicle Class</th>
<th>Vehicle Mass (kg)</th>
<th>Power (kw)(^\text{14})</th>
<th>Length (m)(^\text{15})</th>
<th>PCE (pcu/veh)(^\text{15})</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1600</td>
<td>120</td>
<td>4.85</td>
<td>1</td>
</tr>
<tr>
<td>2, 3, 4, and 5</td>
<td>22500</td>
<td>160</td>
<td>12.5</td>
<td>2</td>
</tr>
<tr>
<td>6, 7, 8 and 9</td>
<td>42500</td>
<td>350</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>64000 – 70000(^\text{16})</td>
<td>400</td>
<td>27.5</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>80000 – 90000(^\text{17})</td>
<td>450</td>
<td>36.5</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>115000</td>
<td>450</td>
<td>53.5</td>
<td>5</td>
</tr>
</tbody>
</table>

Source: Main Roads

\(^{14}\) the maximum length of vehicle for these classes

\(^{15}\) Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis

\(^{16}\) application of upper or lower range should be confirmed with Main Roads.
4.3.3.2 Origin Destination Movements

The *Origin-Destination Movements* tab allows the designation of the movements that are permitted at the intersection. Where there is a restricted movement on an approach (such as a right-turn ban), the *Movement Exists* box should be unchecked. U-turn movements that exist should be checked.

4.3.4 Lane Geometry

This section discusses lane geometry parameters in SIDRA.

4.3.4.1 Lane Configuration

The *Lane Configuration* should be specified, with consideration given to:

- *Lane Editor* – the number of approach and exit lanes on each approach (including medians or strip islands).
- *Lane Configuration* – the short lane with parking and two-segment lane options must be considered when appropriate, with the two-segment lane option typically used to model the beginning or termination of a bus lane adjacent to the intersection.
- *Lane Type* – comprising normal lanes and slip/bypass lanes, with low angle typically used for free flow slip lanes that continuously adjoin an added lane on the exit approach and high angle typically used for left turn give-way lanes.
- Lane Control (normal or slip/bypass) – signals, continuous, give-way/yield or stop.
- Detailed measurement of *Lane Widths, Lane Lengths* and *Grade* including:
  - For short lanes, the lane length should be taken from the stop line to where the traffic of the pocket lane would meet the main traffic lane (typically it would be where the lane width is 2.0 m at the taper section) and in the situations where vehicles can fit into the queue past the marked end of the lane, the extra storage area should be considered (Refer to Section 0).
– For short lanes, the lane in which the queue overflow will spill into should be specified (Overflow Lane Number).
– For two-segment lanes, ensure that the Segment Length and Overflow Lane Number of both segments are specified.
– The gradient should be included unless the intersection is noticeably flat (zero for level road).
– The gradient should be in the direction of travel (positive values for uphill grade and negative values for downhill grade).

- Lane ID can provide a two-letter reference inserted onto the particular lane where required to highlight lane function or use (such as for bus lanes or transit lanes).
- Lane Colour can be used to highlight lanes which are restricted to certain vehicles (bus lanes or cycle lanes), or can be used to highlight another issue.

The Lane Configuration tab is shown in Figure 4-4.

Figure 4-4: Lane configuration tab

4.3.4.2 Lane Disciplines

Lane Discipline should be specified, with consideration given to:

- By default, all movement classes are allowed on each approach lane/movement. Should certain movements or lanes be restricted to specific vehicle classes, the appropriate box is to be unchecked. For two-segment lanes, ensure that the correct lane disciplines are specified for both the downstream and upstream segments.
- *Free Queue Distance* can be used for shared lanes in signalised at-grade intersections and single point interchanges. It defines the length that the vehicles performing a movement can queue away from the lane without blocking other movements sharing that lane. It is specified as a distance value in metres. Figure 4-5 illustrates the use of the *Free Queue Distance* parameter for a shared slip lane, while Figure 4-6 illustrates the use of the parameter for opposing turns in a shared lane.

*Figure 4-5: Free Queue parameters for a shared slip lane*

In this figure, the Free Queue concept is explained in terms of vehicle units. The Free Queue input in the Lane Geometry dialog is specified as a distance value in metres / feet.
4.3.4.3 Lane Data

*Lane Data* should be specified, with consideration given to:

- **Basic Saturation Flow** (starting value for saturation flow estimation) should be left as the default value of 1950 through car units per hour (tcu/h)
  - *Basic Saturation Flow* is adjusted using factors for traffic composition (left, through and right turns, light and heavy vehicles and other movement classes), lane width, gradient, turn radius, conflicting pedestrian volumes, parking and buses, and the adjusted saturation flow is used in the calculation of lane capacity.
  - Higher or lower values of saturation could be defined in situations where traffic conditions are poorer or better than average, based on on-site observations and with adequate justification provided in the modelling report.
  - When measured lane saturation flows are available, those should not be specified as the *Basic Saturation Flow* values but rather the *Basic Saturation Flow* values should be adjusted so that the adjusted saturation flow value estimated by SIDRA is the measured value (Refer to Section 4.5.1.1).

- **Lane Utilisation Ratio** is used to determine the reduced flow rate of an underutilised lane relative to the critical lane of the approach, using a specified percentage value (range one per cent to 100%).
  - If the Lane Utilisation Ratio is set to the default *Program* option, a lane utilisation ratio of 100% (that is, full lane utilisation) is applied, subject to various cases of
program-determined lane underutilisation, for example due to a downstream short lane effect.

– A user-defined input for the Lane Utilisation Ratio should only be provided as part of the model calibration process, subject to appropriate intersection data being collected, observed or provided, with adequate justification provided in the modelling report (Refer to Section 0).

• Saturation Speed is set to the program option by default or set to input to use an observed value from a car crossing the stop line after accelerating from a queued position at the signals, where its position was about the sixth car, or further back, in the queue (Refer to the SIDRA Intersection 7 User Guide).

• Capacity Adjustment is a general parameter which can be used to specify capacity gain/loss with respect to the value calculated by the program, and it is not recommended to use this parameter in lieu of saturation flow adjustment as it is best if the network model determines capacity adjustment due to lane blockage (Lane Blockage Factor values can be specified to override program-determined values).

• Buses Stopping allows specification of the number of buses per hour which stop within approximately 80m upstream or downstream of a signalised intersection and have an impact on the saturation flow (default setting being zero buses).

• Parking Manoeuvres allows specification of the number of parking manoeuvres per hour which occur within approximately 80m upstream or downstream of a signalised intersection and have an impact on the saturation flow (default setting being zero parking manoeuvres).

• Data on Buses Stopping and Parking Manoeuvres should be collected and included in the model where this data is expected to have a significant impact on the performance of the intersection. A summary of the collected data should be included in the modelling report.
The standard SIDRA values for saturation flows are based on research by Andrew Cuddon (1994) and are shown in Table 4-3. More recent research (Akçelik, Besley and Roper 1999 and Akçelik and Besley 2002) has identified that values of 2100 and 1900 tcu/h may be appropriate for environmental classes 1 and 2 respectively.

Table 4-3: Basic Saturation Flows in through car units per hour

<table>
<thead>
<tr>
<th>Environment class (area type)</th>
<th>Definition</th>
<th>Basic saturation flow, $S_0$ (tcu/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (ideal)</td>
<td>Near ideal conditions for free movement of vehicles on both approach and exit sides indicated by good intersection geometry, long distances to upstream and downstream intersections, good visibility, small numbers of pedestrians, and little interference due to loading and unloading of goods vehicles, buses or parking turnover.</td>
<td>1950 1900</td>
</tr>
<tr>
<td>2 (average to poor)</td>
<td>Average to poor conditions indicated by adequate to poor intersection geometry, usually closely-spaced intersection environment, possibly poor visibility, moderate-to-large numbers of pedestrians, and interference from standing vehicles, loading and unloading of goods vehicles, buses, parking turnover, and vehicles entering and leaving premises.</td>
<td>1800 1750</td>
</tr>
</tbody>
</table>
The Lane Data tab is shown in Figure 4-7.

Figure 4-7: Lane Data tab

4.3.5 Lane Movements

The Lane Movements dialog allows the nature of vehicle movements on the departure side of a modelled intersection to be specified in terms of flow proportions and blockage calibration.

In the Flow Proportions tab, the percentage split of each approach lane’s flow on the corresponding exit can be specified. By default, a 100% value is applied to the closest and the most direct exit lane and whether these values need to be amended depends on the operation of the network.

Blockage Calibration applies to the probability of blockage by exit queues and this value would generally be set to the default value of 1.0.

Any adjustment of Lane Movement Flow Proportions and Lane Blockage Calibration Factor should be justified in the modelling report.

4.3.6 Roundabouts

In the Options tab, the default settings (the SIDRA standard capacity model and SIDRA roundabout level of service method options selected and no other box checked) should be used in most cases. Main Roads will advise if any other roundabout model options need to be considered.
For the Roundabout Data tab, the various aspects of the roundabout’s geometry should be carefully specified, including Number of Circulating Lanes, Circulating Width, Island Diameter, Inscribed Diameter, Entry Radius and Entry Angle for each arm. This data is critical to the calculation of approach capacity.

The Environment Factor and the Entry/Circulating Flow Adjustment allow calibration of the model to be undertaken. The default Entry/Circulating Flow Adjustment is medium, with high providing higher capacity and low providing lower capacity. Generally, the Environment Factor parameter can be used to adjust the Critical Gap and Follow-up Headway values, while the Entry/Circulating Flow Adjustment parameter is more relevant to roundabouts where unbalanced flow patterns cause queuing conditions that indicate a need for model calibration. These calibration factors should only be changed as part of the model calibration process, with all adjustments justified in the modelling report.

4.3.6.1 Metered Roundabouts

Signal settings for signalised roundabouts should be defined in the Roundabout Metering tab.

For a metered approach:

- The Stop Line Setback Distance should be defined based on the existing or proposed layout.
- Start Loss should be three seconds.
- End Gain should be three seconds.

For controlling approach, Queue Detector Setback Distance should be defined based on the existing or proposed layout.

Where there is a need to identify the practical cycle time for a new signalised roundabout, the Optimum Cycle Time check box should be ticked. The Cycle Time - Upper Limit and Increment should be defined based on the project requirements.

For an existing signalised roundabout, the cycle timing options will generally be set to User-Given Phase Time, reflecting the current cycle time in operation or that which is proposed. Therefore, the modeller should define the Phase Time based on the observed average phase times.

For proposed modifications or new intersections, Yellow Time, All-Red Time and Minimum Phase Time should be specified in accordance with Main Roads’ standards (Refer to Appendix A).

4.3.7 Pedestrians

The key information to specify in the Pedestrian Movements tab is the pedestrian crossing type (none, full crossing or staged crossing, slip/bypass lane crossing or diagonal crossing) and the pedestrian volumes. For the other parameters, where default settings need to be adjusted, supporting information should be provided in the modelling report.
In the Pedestrian Movement Data tab, if the program value is selected for the Crossing Distance (shown in Figure 4-8), SIDRA calculates this based on the lane geometry coded in the Lane Configuration tab. Where the Crossing Distance is known to be wider (such as with the presence of kerb alignment or cycle lanes or parking lanes that are not included in the model), a user input value can be specified. The Crossing Distance and Walking Speed should be used to calculate Minimum Green time for pedestrians crossing which can significantly influence the calculated phase times depending on the cycle time option selected. Therefore, Walking Speed of 1.2m/s value should be applied here in accordance with Main Roads’ standards for pedestrian timing calculation.

For signalised intersections, Pedestrian Timing Data must also be adjusted based on the Main Roads requirements (Refer to Appendix A):

- **Walk Time Extension** should only be ticked if the pedestrian green figure is expected to run for the entire duration of the phase, and not just the minimum green time at the start of the phase.
- **Crossing Speed** should be keep as the default value of 1.2m/s.
- **Minimum Walk Time** should meet Main Roads’ walk time requirements.
- **Minimum Clearance Time** should be equal to total clearance time (sum of clearance time 1 and clearance time 2) for the pedestrian crossing.
- **Clearance Time Overlap** should be set equal to clearance time 2.
- Other parameters should be left as default.

For a new signalised intersection or an existing intersection with geometry modifications, the timing calculations should be provided in the modelling report.

*Figure 4-8: Pedestrian Movement Data tab*
4.3.8 Volumes

The default volume data settings are:

- Unit Time for Volumes (in the Vehicle Volumes tab) – 60 minutes
- Peak Flow Period (in the Vehicle Volumes tab) – 30 minutes
- Peak Flow Factor (in the Volume Factors tab) – 95%.

Where changes to these parameters are made, supporting traffic data and justification should be provided in the modelling report.

The Volume Data Method provides three different methods for specifying the volume data, with a specific method chosen depending on the format of the volume data source.

The use of the separate or Total & Veh volume data options are recommended when movement classes such as buses and bicycles need to be modelled.

It is possible to import vehicle volume data from other sites within the same SIDRA model file.

In the Volume Factors tab, shown in Figure 4-9, the Flow Scale and Growth Rate inputs should be used for assessing variances in traffic volume. If the Flow Scale parameter is used for calibration purposes, justification should be provided in the modelling report. The Growth Rate parameter should be used in conjunction with the Demand & Sensitivity dialog. Refer to SIDRA Intersection 7 User Guide for more information.

Figure 4-9: Volume Factors tab
4.3.9 Priorities

The *Priorities* dialog is only used for signal and two-way sign control (TWSC) intersections and allows the specification of which movements are opposing and not opposing a movement of interest. While specification of the opposing movements is set automatically based on the intersection geometry and control conditions specified, it is recommended that these are carefully checked and modified (where required) to reflect actual site conditions. An example of the *Priorities* dialog is shown in Figure 4-10, where the opposing left-turn movement using a sign-controlled slip/bypass lane on the northern approach gives-way to the through movement from the west and the right-turn movement from the south.

Figure 4-10: Priorities dialog

Staged crossing at a TWSC intersection (modelled as a two-site network) is detailed in Section 4.4.
4.3.10 Gap Acceptance

The Gap Acceptance dialog is used for specifying gap acceptance data relevant to opposed movements at signals and, in particular, TWSC intersections and roundabouts. Default values provided by SIDRA are based on the coded geometry and movements, and may be adjusted based on site observations. Refer to SIDRA Intersection 7 User Guide for more information. Follow-up headway is generally 60% of the critical gap. As sign-controlled intersections are particularly sensitive to gap acceptance parameters, caution should be used when modifying these parameters. Table 4-4 provided by SIDRA Intersection 7 User Guide can be used as a guideline for critical gap acceptance and follow-up headway parameter values adjustment.

Table 4-4: Austroads and SIDRA Standard Model Gap Acceptance Parameters

<table>
<thead>
<tr>
<th>Type of movement</th>
<th>Austroads Road Design Guide Part 4A (AGRD04A-10)</th>
<th>SIDRA Standard Model Defaults and reasonable range for user specification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Critical Gap (Sec)</td>
<td>Follow-up Headway (sec)</td>
</tr>
<tr>
<td>Left Turn</td>
<td>5</td>
<td>2 - 3</td>
</tr>
<tr>
<td>1-lane opposing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-lane (or more) opposing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Through movement crossing one-way road

<table>
<thead>
<tr>
<th></th>
<th>Critical Gap (Sec)</th>
<th>Follow-up Headway (sec)</th>
<th>Critical Gap (Sec)</th>
<th>Follow-up Headway (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-lane one-way</td>
<td>4</td>
<td>2</td>
<td>4.5 (4 – 5)</td>
<td>2.5 (2 – 3)</td>
</tr>
<tr>
<td>3-lane one-way</td>
<td>6</td>
<td>3</td>
<td>5.5 (5 – 6)</td>
<td>3.0 (2.5 – 3.5)</td>
</tr>
<tr>
<td>4-lane one-way</td>
<td>8</td>
<td>4</td>
<td>6.0 (5 – 8)</td>
<td>3.5 (3 – 4)</td>
</tr>
</tbody>
</table>

Through movement crossing two-way road

<table>
<thead>
<tr>
<th></th>
<th>Critical Gap (Sec)</th>
<th>Follow-up Headway (sec)</th>
<th>Critical Gap (Sec)</th>
<th>Follow-up Headway (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-lane two-way</td>
<td>5</td>
<td>3</td>
<td>5.0 (4.5 – 5.5)</td>
<td>3.0 (2.5 – 3.5)</td>
</tr>
<tr>
<td>4-lane two-way</td>
<td>8</td>
<td>5</td>
<td>6.5 (5 – 8)</td>
<td>3.5 (3 – 5)</td>
</tr>
<tr>
<td>6-lane two-way</td>
<td>8</td>
<td>5</td>
<td>7.5 (7 – 8)</td>
<td>4.5 (4 – 5)</td>
</tr>
</tbody>
</table>

Right Turn from Major Road

<table>
<thead>
<tr>
<th></th>
<th>Critical Gap (Sec)</th>
<th>Follow-up Headway (sec)</th>
<th>Critical Gap (Sec)</th>
<th>Follow-up Headway (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Across 1 lane</td>
<td>4</td>
<td>2</td>
<td>4.0 (3.5 – 4.5)</td>
<td>2.0 (2 – 3)</td>
</tr>
<tr>
<td>Across 2 lane</td>
<td>5</td>
<td>3</td>
<td>4.5 (4 – 5)</td>
<td>2.5 (2 – 3)</td>
</tr>
<tr>
<td>Across 3 lane</td>
<td>6</td>
<td>4</td>
<td>5.5 (5 – 6)</td>
<td>3.5 (3 – 4)</td>
</tr>
</tbody>
</table>

Note ¹ to ³ below are not included in the Austroads Guide:

1. This is considered to apply to left-turn movement from minor road, as well as slip-lane left-turn movement from minor road.
2. This case is relevant to two-way major road conditions with one direction of major road opposing (1-lane, 2-lane or 3-lane)
3. This is considered to apply to left-turn movement from minor road, as well as slip-lane left-turn movement from minor road.
<table>
<thead>
<tr>
<th>Type of movement</th>
<th>Austroads Road Design Guide Part 4A (AGRD04A-10)</th>
<th>SIDRA Standard Model Defaults and reasonable range for user specification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Critical Gap (Sec)</td>
<td>Follow-up Headway (sec)</td>
</tr>
<tr>
<td>Right Turn from Minor Road</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-way</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2-lane two-way</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>4-lane two-way</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>6-lane two-way</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Merge from acceleration lane</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

The TWSC calibration should initially be undertaken using the Low/Medium/High options for the Level of Reduction with Opposing Flow Rate field in the Two-Way Signal Control tab. This decreases the critical gap and follow-up headway of minor (opposed) movements with increasing opposing flow rates. Alternatively, the Apply TWSC Calibration option in the Gap Acceptance Data tab may be unchecked with specific values being input (although these will not be sensitive to changes in geometry).

The Gap Acceptance Data tab default is shown in Figure 4-11.

---

19 The conditions specified (one-way, 2-lane two-way, 4-lane two-way, 6-lane two-way) are relevant to the opposing movement lanes on the major road.
Figure 4-11: Gap Acceptance Data tab

The Two-Way Sign Control tab defaults are shown in Figure 4-12. The Major Road Turning Flow Factor should be left at 1.0.
Figure 4-12: Two-way signal control calibration tab

The Settings tab is shown in Figure 4-13. The default SIDRA Standard (Akçelik M3D) capacity model based on bunched exponential headway distribution of opposing traffic headways should be used.

Figure 4-13: Settings tab
4.3.11 Vehicle Movement Data

This section discusses vehicle movement data in SIDRA.

4.3.11.1 Path Data

Modifications to the Path Data tab defaults, as shown in Figure 4-14, should take into consideration:

- All the parameters listed can be specified for each movement, either by movement class or collectively for all movement classes. While these parameters do not affect capacity, they affect geometric delay, cost, fuel consumption and emissions.

- Approach Cruise Speed and Exit Cruise Speed (default setting is 60 km/h) should be updated to the posted speed limits, if required.

- The Negotiation Speed, Negotiation Distance and Negotiation Radius default values (as calculated by the program based on specified geometric data) may need to be overridden to reflect situations like roundabouts with deflected (reverse-curved) approaches and sign-controlled intersections where two-staged crossings can be performed (Refer to 4.4).

- All user-given values overriding the default and program-calculated values should be detailed and justified in the modelling report.

Figure 4-14: Path Data tab

4.3.11.2 Calibration

In the Calibration tab the Vehicle Length for all movement classes should be modified based on Table 4-2. To calculate Queue Space, Main Roads recommends to add 2.5 metres to the vehicle length of each movement class.
Table 4-5 shows the recommended *Gap Acceptance Factor* and *Opposing Vehicle Factor* for discussed movement classes.

**Table 4-5: Gap Acceptance & Opposing Vehicle Factors**

<table>
<thead>
<tr>
<th>Austroads Class</th>
<th>Gap Acceptance Factor</th>
<th>Opposing Vehicle Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>3-5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>6-9</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>11</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>12</td>
<td>4.5</td>
<td>4.5</td>
</tr>
</tbody>
</table>

*Source: Main Roads*

The *Calibration* tab is shown in Figure 4-15.

**Figure 4-15: Calibration tab**
4.3.11.3 Signals

In the *Signals* tab, the key parameters which should be checked and modified include:

- **Signal Coordination** should normally be set to *program* to use platoon patterns based on signal offsets in network modelling. If *arrival type* or *arrivals during green* options are applied, it should be justified in the modelling report.

- Start Loss – three seconds

- **End Gain** – three 3 seconds

- Minimum Green – should meet Main Roads requirements (Refer to Appendix A)

- **Phase Actuation** should be set to *none* in most cases.

- Early Cut-Off and Late Start – if applicable should meet Main Roads requirements (Refer to Appendix A)

The rest of the parameters, as shown in Figure 4-16, should generally be left as default. If any modifications are made, these should be justified in the modelling report.

*Figure 4-16: Signals tab*

4.3.12 Phasing and Timing

The *Phasing & Timing* dialog contains key information on the configuration of the traffic signals and the timings to be adopted. The *Sequences* tab allows definition of the signal analysis method, which should be set to *Fixed-Time/Pre-timed* for intersections running under SCATS-coordinated or master-isolated control. The *Actuated* analysis method should be used for intersections operating under a traditional actuated control method.
A new sequence can be added or cloned using existing sequences in the list. The Sequence Name can be used to specify descriptions of the sequence, such as client supplied data or sequence testing. New user-defined sequences can be modified in the Sequence Editor tab.

The Sequence Editor tab allows the definition of phases, their sequence as well as the OD movements by movement class and pedestrian movements that run in each phase. The Phase and Sequence Data tab allows specification of:

- **Variable Phases** – are not compulsory and can be skipped depending on the demand pattern.
- **Reference Phase** (compulsory) – used for signal coordination purposes.
- **Phase Times** – only to be used if the user-given phase times is selected in the Timing Options tab.
- **Phase Frequency** – allows the specification of the percentage of signal cycles when the phase is called, with the default being that the phase is called each cycle. User-given phase frequencies should be justified in the modelling report.
- **Yellow Time and All-Red Times** – for proposed modifications or new intersections, intergreens should be specified in accordance with Main Roads’ standards (Refer to Appendix A). Calculations should be provided in the modelling report.

**Dummy Movement Data** may be needed in certain advanced instances, such as where there is no unique movement in the phase. Detection data is typically left at the default values.

IDM data or SCATS history data at existing intersections are available from Main Roads and provide details on phases, phase times, intergreen times and cycle times. In the absence of IDM data and SCATS history data, on-site observations of phase arrangements, intergreen times and cycle time should be taken. The observations should be undertaken during each period that is to be modelled, with modelling undertaken based on those phases which are regularly called. For a new signal or modifications to an existing signal time setting refer to Appendix A.

The Timing Options tab will generally be set to User-Given Cycle Time, reflecting the current cycle time which is in operation or proposed. The Timing Options tab can also be set to User-Given Phase Time, reflecting the observed average signal time for the base model. Where there is a requirement to identify the optimum cycle time for new signalised intersections, the Optimum Cycle Time check box should be used. The Cycle Time - Upper Limit and Cycle Time - Increment should be defined based on the project requirements. For existing signalised intersections, observed existing minimum and maximum cycle times should be used for lower and upper limits respectively.

The green split priority method should be used to allocate longer green times to a movement’s assigned high priority for green splits while keeping other movements at their target degree of saturation (DoS). Using this feature is not recommended; otherwise justification should be provided in the modelling report.
The Advanced tab allows for specification of undetected movements, allowing slip/bypass lanes to be excluded from signal timing analysis. While this can be used where slip/bypass lanes do not cross over the stop line detectors, it should not be used where the turning vehicles using slip/bypass lanes cross over advanced detector loops or with controllers using fixed-time signal plans where the plans are designed to accommodate all turning vehicles.

The Phase Transition box needs to be checked to ensure the intergreen of the filter movements (such as diamond phasing) and phasing overlaps are modelled correctly.

### 4.3.13 Demand and Sensitivity

The Demand & Sensitivity dialog should be used to assess the forecast operation of the intersection based on certain growth scenarios. Options are provided to test the analysis objective, for both Design Life and Flow Scale, and the method of presenting results (Sensitivity).

### 4.3.14 Parameter Settings

The Parameter Settings dialog applies to the intersection as a whole and contains important parameters that can significantly affect the results of the modelling.

The key parameters to be considered with respect to the Options tab, as shown in Figure 4-17, are:

- Site Level of Service Method – should be set to delay (SIDRA).
- Site Level of Service Target – should be set to LoS D.
- Percentile Queue – should be set to 95% but it may be changed to average for calibration purposes.
- All other values – should be set to SIDRA defaults and if any modifications are made, these should be justified in the modelling report.

*Figure 4-17: Options tab*
The values in the *Model Parameters* tab, shown in Figure 4-18, should generally be set to the SIDRA defaults. However, as explained in Section 4.3.3.1, *passenger car equivalent* (PCE) parameters should be defined by modellers (Refer to Table 4-2) to more accurately reflect the vehicle composition. All user-defined PCE values used and any modifications to the default values for the other parameters should be detailed in the modelling report.

*Figure 4-18: Model Parameters tab*

The SIDRA default values should generally be used for all parameters in the *Cost* tab, shown in Figure 4-19. Any modifications should be justified and detailed in the modelling report.
The SIDRA default values should generally be used for all parameters in the *Fuel & Emissions* tab, shown in Figure 4-20. Any modifications should be justified and detailed in the modelling report.

*Figure 4-20: Fuel & Emissions tab*
4.4 **Staged Crossing at Two-way Sign Control**

To model staged crossings at two-way sign control (TWSC) intersections where the major road has sufficient median width to store at least one vehicle, it is recommended that the intersection is modelled as a network consisting of two separate sites. The two sites are created to model the two stages of crossing that a vehicle from the minor road effectively completes when either driving through/across the major road or turning right onto the major road.

**Stage 1:** Exiting the minor road onto the median storage area/merging section. This stage is modelled as a four-way intersection with an exit-only leg defined opposite the minor road to replicate the major road median storage area or merging section. The template, shown in Figure 4-21, should be used to model this type of intersection.

*Figure 4-21: Template model of stage 1 of a staged crossing (named ‘Stop 3-way Stage 1 (Minor Road)’)*

The modeller should ensure that:

- The exit lane distance is set equal to the storage area on the median or to the acceleration/merging area length.
- The negotiation parameters (negotiation speed and negotiation distance) are set for the exit lane.
- *Apply TWSC calibration* checkbox in the *Gap Acceptance Data* tab (in the *Gap Acceptance* dialog) is ticked; and
• **Critical Gap and Follow-up Headway** for the minor approach through movement are set as 6.0 seconds and 3.4 seconds, respectively.

**Stage 2**: Crossing from the median storage area onto the opposite minor road (as a through movement) or entering the major road from the median storage area/merging section (as right turn movement). This stage is modelled as an intersection (T-intersection if the actual intersection is a T-intersection, four-way intersection if the actual intersection is a four-way intersection) with an entry-only leg defined to replicate the median/merging section. Figure 4-22 and Figure 4-23 show two templates which should be used to model the Stage 2 crossing for the right-turn movement from the minor road.

*Figure 4-22: Template model of stage 2 of a staged crossing with median storage (named ‘Stop 3-way Stage 2 (Median)’)*

*Figure 4-23: Template model of stage 2 of a staged crossing with merge movement (named ‘Merge from Right L’)***
The modeller should ensure that the:

- approach lane distance is set equal to the storage area on the median or to the acceleration/merging area length;
- negotiation parameters (Negotiation Speed and Negotiation Distance) is set for the approach lane;
- apply TWSC calibration in the Gap Acceptance Data tab (in the Gap Acceptance window) is checked when there is storage in the median, but not checked when there is merging; and
- Critical Gap and Follow-up Headway for the minor approach lane is set as outlined in Table 4-6.

**Table 4-6: Stage2 Gap Acceptance and Follow-up Headway**

<table>
<thead>
<tr>
<th>Stage 2 site of stage crossing</th>
<th>Gap Acceptance</th>
<th>Follow-up Headway</th>
<th>Apply TWSC Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>With storage in the median</td>
<td>7.0 seconds</td>
<td>4.0 seconds</td>
<td>Checked</td>
</tr>
<tr>
<td>With acceleration lane and merging area</td>
<td>3.0 seconds</td>
<td>2.0 seconds</td>
<td>Not checked</td>
</tr>
</tbody>
</table>

Source: SIDRA Intersection 7 User Guide

### 4.5 Site Output

There are key site output parameters which should be considered when assessing calibration of existing models and also assessing forecast operation of proposed models.

#### 4.5.1 Calibration Overview

The capacity and performance characteristics (for example, delay, queue length, stops) of a traffic facility are influenced by both the intersection geometry and the driver behaviour. While all input parameters related to intersection geometry and driver behaviour are important for calibrating SIDRA models, those parameters which reflect the general road and driver characteristics of the local areas, as well as the conditions of the intersection, are the most important.

The key elements of base model calibration are shown in Table 4-7, with the second column highlighting key model parameters that need to be calibrated and the third column highlighting the key parameters recommended for modification.
Table 4-7: Key elements of model calibration

<table>
<thead>
<tr>
<th>Site Type</th>
<th>Key parameters used in the capacity model</th>
<th>Recommended key calibration parameter</th>
<th>Input dialogue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Signals</strong></td>
<td>Saturation Flow Rate</td>
<td>Area Type Factor</td>
<td>Intersection (per approach)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Basic Saturation Flow</td>
<td>Lane Geometry dialog – Lane Data tab (per lane)</td>
</tr>
<tr>
<td><strong>Roundabouts</strong></td>
<td>Follow-up Headway and Critical Gap</td>
<td>Environment Factor</td>
<td>Roundabouts (per approach)</td>
</tr>
<tr>
<td><strong>Two-Way Sign Control</strong></td>
<td>Follow-up Headway and Critical Gap</td>
<td>Basic Follow-up Headway and Critical Gap</td>
<td>Gap Acceptance (per movement)</td>
</tr>
</tbody>
</table>

Source: SIDRA Intersection 7 User Guide

4.5.1.1 Saturation Flow Calibration

To calibrate saturation flows, the following method is recommended:

1. Undertake on-site measurements of saturation flow (vehicle/h) in accordance with standard methodologies defined in Appendix B.

2. Compare the measured saturation flow with the lane saturation flow estimated by SIDRA, provided in the lane flow and capacity information table in the detailed output report (not the basic saturation flow).

3. Calculate a calibration factor, by dividing the observed saturation flow by the saturation flow estimated by SIDRA.

4. Adjust the basic saturation flow, by multiplying the calibration factor with the previous basic saturation flow, and enter the new value in the Lane Data tab in the Lane Geometry window.

5. Repeat steps above as required.

4.5.1.2 Traffic Demand Calibration

For oversaturated approaches (e.g. exit blocking), observed flows from the stop / give-way line may not represent the actual demand for that approach. Applying the observed flows from the stop / give-way line in the model may not replicate the observed queue in the model.

Therefore, demand for that approach can be scaled. The scaling factor can be estimated by observing upstream traffic flows.

In SIDRA, the scaling factor can be applied in Flow Scale in the Volumes dialog. If a scaling factor is applied, supporting data and justification should be provided in the modelling report.
4.5.2 Validation

The validation criteria for the base model in SIDRA are described in this section.

4.5.2.1 Queue Length

For validation purposes, back of queue data collected on site should be utilised to review consistency with Back of Queue estimates given by SIDRA *(average back of queue)*. Back of Queue is ‘the maximum backward extent of the queue relative to the stop line or give way line during a signal cycle or gap acceptance cycle. The last queued vehicle that joins the back if queue is the last vehicle that departs at the end of the saturated part of green interval of the available gap interval’.

4.5.2.2 Degree of Saturation

For validation purposes, the base model, which was developed based on recorded signal timing data and traffic flows for the same day, should have less than or equal to 100% degree of saturation for all of the movements.

---

20 When SIDRA Version 8 is used for modelling, instead of back of queue, the observed queue length on site at the start of green should be utilised for validation the model.
4.6 Network Modelling

Network modelling in SIDRA involves the modelling of the individual sites that constitute the network.

4.6.1 Network Input

The network input dialogs are described in the following sections.

4.6.1.1 Network Configuration

A new network can be created or the existing network can be updated in the Network Configuration dialog shown in Figure 4-24.

*Figure 4-24: Network Configuration dialog*

The left-hand side bar presents the individual sites modelled. To add a new site into the network, drag and drop the site from the left-hand side bar into the Network Configuration area to the right.

To create a connection between two sites, left-click inside the grey area at the end of the site leg and drag to connect to the grey area at the end of the other site.

Connection between two sites is a virtual connection. This means the mid-block leg between two connected sites is essentially the same road and the lane–based flow rates and platoon patterns of upstream lanes are transferred to the downstream lanes at the virtual connection every second of simulation. Figure 4-25 demonstrates the connectivity between two intersections.
Figure 4-25: Concept of Network Connection

Source: SIDRA Intersection 7 User Guide
Before completing the network layout specification in the *Network Configuration* dialog, the modeller should ensure there is no network connection with error or warning (all the connectors should be *green*, indicating a valid connection which means the geometry of the upstream exit lanes matches the geometry of the downstream approach lanes).

To avoid any error or warning when creating connection(s) between two sites, modellers should check the:

- number of lanes between the two sites
- movement classes
- approach and exit distance values for the common internal leg.

### 4.6.1.1.1 Number of Lanes between the Two Sites

To connect the legs of two or more sites, the number of exit traffic lanes in the upstream site should match the number of approach traffic lanes in the downstream site. Conflict in the number of lanes is recognised by *red* connection lines in the *Network Configuration* dialog. Examples of when the number of lanes between two sites does not match are shown in Figure 4-26.

*Figure 4-26: Examples when the number of traffic lanes for network connection do not match \( N_A \neq N_E \)*

![Diagram showing examples of mismatch in number of lanes between two sites](source: SIDRA Intersection 7 User Guide)

The modeller should update the configuration in the *Site Lane Geometry* dialog (Refer to Section 4.3.4).

### 4.6.1.1.2 Movement Classes

Total discontinuity of a movement class at a mid-block connection will have an effect on inflow/outflow when:

- A movement class exists at the upstream section but does not exist in any lane in the downstream section – the movement class should be treated as an outflow (will leave the network mid-block).
- A movement class does not exist in any lane at the upstream section but exists in the downstream section – the movement class should be treated as an inflow (enters the network mid-block).

In those cases, there will be a warning message displayed.
Discontinuities in a movement class allocated to different lanes at the upstream and downstream locations will have lane change implications. There will not be any warning messages displayed in this case. An example of matching movement classes in two-segment lanes is shown in Figure 4-27.

Corrections made to movement classes should be specified in the Site Lane Geometry dialog (Refer to Section 4.3.4).

**Figure 4-27: Two-segment lane examples with matching movement classes**

![Two-segment lane examples with matching movement classes](image)

Source: SIDRA Intersection 7 User Guide

### 4.6.1.1.3 Approach and Exit Distances

For an internal approach in a network in SIDRA, approach distance should be measured from stop line to the upstream intersection. The exit distances in the upstream site should match the approach distances in the downstream site. Conflict in the length of approach and exit lanes is recognised by dark orange connection lines in the Network Configuration dialog. This can be corrected in the Site Intersection dialog (Refer to Section 4.3.2).

After completing work in the Network Configuration window, modellers should check the network configuration in the Network Layout to ensure that the connections between intersections are appropriately made and the network is correctly presented.

Although all the connections are green, the picture layout may still have some drawing issues. Figure 4-28 and Figure 4-29 show common drawing issues in the Network Layout. While a layout picture problem does not necessarily mean the model will not work, it is recommended that layout display issues are avoided where possible, for example by leaving enough space between site legs to enable the green connection to be visible.
Modellers should ensure that the network has the right geographic orientation, with north to the top.
4.6.1.2 Network Data

When defining the network data, the modeller should refer to the following for key data:

- **Network Name** – generally includes the road names or location of the network, peak period (AM or PM) and year of modelling.

- **Network ID** – when there is one controller for the whole network the Main Roads TCS reference can be used.

- **Network Level of Service** – the SIDRA Speed Efficiency method should be used to determine the results in the Network Summary report.

- **Desired Speed** – should be set as *program* if posted speed limits in the network vary significantly, or set using the majority posted speed limit in the network.

- **Lower Limit of Speed Efficiency** – should be set at the default value (0.1).

- **Site Level of Service** – should be set to the default value (*delay (SIDRA)*) to ensure the levels of service for the individual sites in the network are determined based on the same method.

- **Performance Measure** – should be set to the default (*delay (SIDRA)*).

- **Percentile Queue** – should be reported using *percentile* or *average*. Base model calibration should be based on the average queue length.

- **Hours per Year** – should be set at default (480 hours for peak hour models).

- **Cost Unit** – should be set at default (dollar ($)).

- **Apply Platoon Dispersion check box** – to be unchecked if the distance between network sites is short and there is zero offset for individual sites.

- If **Include Short Lanes in determining Approach Queue Storage Ratio** checkbox is checked (will overwrite the setting for the sites in the network) – justification should be included in the modelling report.

- **Maximum Number of Iterations** – should be set at default (10) or higher value (up to 30) for the output calculation process.

- **Percentage Stopping Condition** – should be set at default (1.0%) or lower value (down to 0.1%) for the output calculation process.

Figure 4-30 shows the *Network Data* dialog in SIDRA version 7.
4.6.1.3 Common Control Groups (CCGs)

This section provides information on common control group settings in SIDRA.

4.6.1.3.1 Define CCGs Dialog

Common control groups (CCGs) are defined in the Define CCGs Dialog, as shown in Figure 4-31. The modeller should note:

- For CCG ID – the Main Roads TCS reference should be used.
- CCGs – sites should be allocated to their corresponding CCGs.
- The CCG ID for other intersections in the network – should be set as NA.
4.6.1.3.2 Common Control Group Dialog

The Common Control Groups dialog (shown in Figure 4-32) should be added in the Network Input section, if at least one CCG is defined.

Phasing, sequence and timings of the CCG settings have similar principles as the isolated intersections. Modellers should ensure that the intended CCG is selected when there is more than one.

For parameter settings for Sequences, Sequence Editor, Phase & Sequence Data and Advanced tabs, refer to Section 4.3.12.

The Timing Options tab will generally be set to User-Given Phase Time, reflecting the current cycle time in operation or that which is proposed. Where there is a requirement to identify the optimum cycle time for new signalised intersections, the Optimum Cycle Time check box should be used. The Cycle Time - Upper Limit and Cycle Time - Increment should be based on the project requirements.

The Green Split Priority method should be used to allocate longer green times to the movement assigned high priority for green splits while keeping other movements at their target Degree of Saturation. Using this feature is not recommended; otherwise justification should be provided in the modelling report.
4.6.1.4 Network Timing

Lane-based second-by-second platoon model is used to calculate signal coordination effects in the internal approach movements in a network. The relevant parameters should be set in the Network Timing dialog.

If there are signalised sites in the network, all signalised sites and CCGs included in the network should be listed in a table in the Network Timing Data tab, as shown in Figure 4-33.

Figure 4-33: Network Timing Data tab
For traffic signal coordination, the modeller should ensure the relevant network connections are set up for the sites and CCGs (Connected Site/CCG must be yes):

- **Coordinated Site / CCG** should be set as yes, if the internal approach movements for that site in the network should be treated as a part of the coordinated movement (applicable for networks with more than one signalised site or CCG).

- The **Signal Coordination** parameter (in the Signals tab in the Vehicle Movement Data dialog) should be set as program and if either the Arv Type or %Green option is used it should be justified in the modelling report.

For the existing coordinated sites/CCGs:

- One of the coordinated sites in the network must be set as the reference site, and for the existing network the reference site must be based on SCATS (Refer to Appendix A).

- For all coordinated sites/CCGs, the relevant **Reference Phase** must be selected (in the Phase & Sequence Data tab in the Phasing & Timing dialog for sites, and in the Phase & Sequence Data tab in the Common Control Groups dialog for CCGs).

- Offset time should be input into **User Offset** in the Network Timing Data based on SCATS offset settings (Refer to Appendix A), and user option should be selected in the Signal Offset tab.

- All of the routes in the Signal Offset tab should be deselected.

- For the base model, in the Network Timing Data tab, **Cycle Times and Phase Times** should generally be set to user-given cycle time, reflecting the current cycle time in operation or that which is proposed (Refer to Appendix A).

For the new coordinated sites/CCGs or proposed offsets:

- **Program** should be selected for Signal Offsets.

- At least one route should be defined (Refer to SIDRA Intersection 7 User Guide) and the relevant route(s) for offset calculations should be selected in Signal Offset tab. It is recommended that the route which includes the reference site/CCG with the most critical movements should be selected.

- **Signal Offset Method** (for program signal offsets only) should be set at the default value (start of green (leading)).

- **Movement Class** should be set to the majority vehicle class observed on the route.

- Signal Offset Definition should be set to Green Start Offsets.

- Where there is a need to identify the cycle time for a new coordinated network, in the Network Timing Data tab the program check box should be used, with the Maximum Cycle Time and Cycle Rounding should meet Main Roads requirements.

Program cycle time or user-given cycle time will be applied to signalised sites / CCGs without relevant connection into the coordinated network if the Coordinated Site is set to yes.

The signal coordination between two signalised sites/CCGs will be disabled, if those are connected via at least one of the following site types:

- Minor road of a TWSC site.

- A signal site where the coordinated is set to no.
- A roundabout site.
- An all-way stop control (AWSC) site.

Signal offsets tab is shown in Figure 4-34.

**Figure 4-34: Signal Offsets tab**

![Signal Offsets tab](image)

### 4.6.1.5 Network Routes

The *Network Routes* dialog, as shown in Figure 4-35. When the network outputs by routes are required, the modeller should define and select the relevant routes. The network output by routes options should be set to *Approaches on Routes*.

**Figure 4-35: Network Routes dialog**

![Network Routes dialog](image)
4.6.2 Case Study

Figure 4-36 shows a signalised interchange network which incorporates two signalised sites (West and East).

Figure 4-36: Signalised Interchange Network

4.6.2.1 Flow Distribution

By default, SIDRA allocates 100% of the flows turning right from the freeway off-ramp west to lane 4 of the exit to eastbound mid-block. In practice, almost 100% of the traffic flows turn right in to lanes 1, 2 and 3, as shown in Figure 4-37.

Figure 4-37: West site

To address this issue, the Lane Movement Flow Proportions should be modified for the site (in the Flow Proportions tab in the Lane Movements dialog). In this example, these changes should also be applied to the freeway off-ramp east.
4.6.2.2 Early Cut-Off or Late Start

Figure 4-38 shows ‘A’ phase of the signalised interchange. Signal Group α and Signal Group β are run during ‘A’ phase.

*Figure 4-38: ‘A’ phase with early cut-off*

In this example, Signal Group α has an early cut-off of six seconds. Early cut-off and late starts for the relevant site should be defined in the Signals tab in the Vehicle Movement Data dialog. In this case, the west site should be updated, as shown in Figure 4-39.

*Figure 4-39: Early cut-off example*
4.6.3 Network Outputs

Main Roads recommends that the following outputs are reported:

- **Level of Service (LoS)** – This can be found in *Movement Summary* in *Site Output for Network* (in the Network tab) and *Routes* (in the Route tab).

- **Capacity adjustment (Cap Adj %) and blockage probability (Prob. Block %)** – should be checked if the capacity adjustment (reduction) was applied on any downstream lane in the network due to upstream lane blockage. These can be found in *Lane Summary* in *Site Output for network* (in the Network tab).

- **Degree of Saturation (DoS)** – lane DoS should be checked for all lanes.

- **Lane utilisation ratio (Lane Util %)** – should be checked and reported if it is less than 100%. This can be found in *Lane Summary* in *Site Output for network* (in the Network tab).

- **Mid-block inflow and outflow rates (Net Inflow/Outflow)** – should be checked and reported if it is not zero. Network flows can be displayed as an image in the modelling report. These can be found in the *Network Flows* (in the Network tab).

- **Mid-block lane change rates** – should be checked and reported if the value is high. This can be found in the *Lane Changes* in *Site Output for network* (in the Network tab).

- **Arrival flow rates (Arrival Flows)** – should be checked and reported if the capacity constraint at oversaturated upstream lanes causes a reduction in the arrival flow values. This can be found in the *Lane Summary* in *Site Output for network* (in the Network tab).

- **Platoon ratio** – a platoon ratio greater than 1 is desirable. This can be found in the Signal Coordination in Site Output for Network.
Figure 4-40: Platoon models for signal coordination effects on arrival flow pattern

Lane-based second-by-second platoon model using signal Offsets

Number of arrivals during red, \( N_R = 5 \text{ veh} \)
Number of arrivals during green, \( N_G = 20 \text{ veh} \)

Number arrivals per cycle:
\[ N_L = N_G + N_R = 20 + 5 = 25 \text{ veh} \]
Proportion arriving during green:
\[ P_G = N_G / N_L = 20 / 25 = 0.80 \]
Average arrival flow rate:
\[ q_a = 3600 N_G / c = 900 \text{ veh/h} \]
Green time ratio: \[ u = g / c = 0.60 \]
Platoon ratio: \[ P_A = P_G / u = 0.80 / 0.60 = 1.333 \]

Simple platoon model using Arrival Types or Percent Arriving During Green

Source: SIDRA Intersection 7 User Guide
5 Vissim Guidelines

5.1 Introduction

Vissim is a mesoscopic and microscopic multi-modal traffic flow simulation software that is generally used as a tool to simulate real-world transport systems. Vissim enables users to model and assess the performance of a wide range of transport modes including pedestrians, cyclists, freight, and public transport by simulating individual vehicles.

The software uses a behaviour-based stochastic modelling approach to simulate vehicle-to-vehicle and control device interactions. It has the ability to provide visual outputs to demonstrate the modelled condition in a simulation and graphical format.

This section is designed to complement Vissim User Manual. It provides detail on key parameters to be adopted when undertaking Vissim mesoscopic, microscopic and hybrid simulation modelling in WA.

Modellers must refer to Sections 1 and 2 for the overview of traffic modelling.

5.1.1 Appropriate Use of Vissim

Vissim can assess the performance of any transport networks, however, it is typically data and labour intensive to achieve accurate modelling of the complex and adaptive operations, compared to micro-analytical software such as LinSig and SIDRA. It is therefore recommended to use Vissim when evaluating the performance of detailed operations that exhibit:

- Network-wide traffic capacity implications when part of the network becomes over-saturated.
- Closely spaced intersections or interchanges.
- Advanced traffic management schemes (for example priority signals, congestion management).
- Complex intersection or interchange layouts.
- Complex or dynamic (non-cyclic or demand-based) signal operations.
- Feasibility studies for high occupancy vehicle and high occupancy toll lanes.
- Impact analysis of infrastructure design such as highway corridor improvement.
- Impact of heavy vehicles to network capacity.
- Evaluation of variable speed policies and other intelligent transportation systems.
- A high level of pedestrian interaction.

5.1.2 Software Version

This guideline is based on version 9 of Vissim. While the Operational Modelling Guidelines will need to be updated for future versions of the software, the general principles outlined will continue to apply.
5.2 Model Base Data

The base data for simulation models should be defined prior to building the models. The defined base data includes network settings, model input time periods, various vehicle types, vehicle classes and driving behaviours.

5.2.1 Network Settings

Network settings are the general base data for the entire network. This section discusses the recommended network settings for WA transport network in Vissim.

5.2.1.1 Vehicle Behaviour

*Left-hand traffic* should be adopted for *Traffic regulations*.

If the model includes network components in which link gradients will play an important part in the modelling (for example the impacts of heavy vehicle performance), these should be included in the *Vehicle Behaviour* tab in the *Network Settings* window (as shown in Figure 5-1). The modeller can either use the gradient attribute as a direct input or use Z-coordinates with the model calculating the gradient based on link lengths:

- Gradient attribute – is recommended where the number of locations is minimal and gradients/elevations are unlikely to change across models.
- Z-coordinate approach – is more appropriate for use across a larger network or for networks with significant elevation changes.

*Figure 5-1: Recommended vehicle behaviours*
5.2.1.2 Units

In the Units tab (as shown in Figure 5-2), the metric system should be adopted.

Figure 5-2: Recommended units

5.2.2 Time Period Settings

The modelling should not only include the simulation assessment period, but also the warm-up and cool-down periods. The warm-up period is the time that allows the traffic demands and queues to get into a realistic level of congestion that were observed on-site at the beginning of analysis period. The cool-down period is the time that loads vehicles to complete their trips and to replicate the congestion observed at end of analysis period.

The duration of the warm-up and cool-down periods should be sufficient so that the traffic volumes and queues in the network reflect the traffic conditions observed on-site. Depending on the model network size, a minimum of 15 minutes should be defined for each of the warm-up and cool-down periods. The duration for the warm-up and cool-down periods should be agreed with Main Roads.

Figure 5-3 demonstrates time intervals defined for a static assignment model for a one-hour assessment period, and 15-minute warm-up and cool-down periods.

Figure 5-3: Vehicle input time intervals
5.2.3 Vehicle Types

Traffic surveys should contain information on the vehicle compositions to be modelled.

Vehicles in WA can be classified using the Austroads Vehicle Classification System. The model should include vehicle types which are critical to the performance of the network or are a primary component of the project’s objectives. Table 5-1 shows the breakdown of the recommended minimum vehicle types to be defined in the model.

Table 5-1: Recommended vehicle types

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Axles</th>
<th>Axle groups</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Short</td>
<td></td>
<td>1 or 2</td>
<td>Short (up to 5.5 m)</td>
</tr>
<tr>
<td>2 Short – towing</td>
<td>3, 4 or 5</td>
<td>3</td>
<td>Medium (5.5 m to 14.5 m)</td>
</tr>
<tr>
<td>3 Two-axle truck or bus</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4 Three-axle truck or bus</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>5 Four-axle truck</td>
<td>&gt; 3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>6 Three-axle articulated</td>
<td>3</td>
<td>3</td>
<td>Long (11.5 m to 19.0 m)</td>
</tr>
<tr>
<td>7 Four-axle articulated</td>
<td>4</td>
<td>&gt; 2</td>
<td></td>
</tr>
<tr>
<td>8 Five-axle articulated</td>
<td>5</td>
<td>&gt; 2</td>
<td></td>
</tr>
<tr>
<td>9 Six-axle articulated</td>
<td>6≥</td>
<td>&gt; 2</td>
<td></td>
</tr>
<tr>
<td>10 B-double</td>
<td>6&gt;</td>
<td>4</td>
<td>Medium combination (17.5 m to 36.5 m)</td>
</tr>
<tr>
<td>11 Double road train</td>
<td>6&gt;</td>
<td>5 or 6</td>
<td></td>
</tr>
<tr>
<td>12 Triple road train</td>
<td>6&gt;</td>
<td>&gt; 6</td>
<td>Large combination (over 36.5 m)</td>
</tr>
</tbody>
</table>

For projects that include the evaluation of public transport facilities, schemes or operation efficiencies, the Vissim default vehicle types for public transportation can be used.
5.2.3.1 2D/3D Model

For all vehicle types, 2D and 3D models should be defined based on the vehicle model profiles and connected with the corresponding 2D and 3D model distributions and vehicle types. An example of 2D and 3D models and model distributions defined in a Vissim model is shown in Figure 5-4.

Figure 5-4: 2D and 3D models defined in Vissim

5.2.3.2 Acceleration and Deceleration Attributes

In the base model build, the default maximum acceleration, and desired and maximum deceleration attributes can be adopted as a starting point for the vehicle types. For the desired heavy vehicle acceleration the values in Table 5-2 should be adopted (Refer to Heavy vehicle dynamics and microsimulation modelling, 2010 Main Roads)
<table>
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<th>Vehicle Type</th>
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<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>110</th>
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<tr>
<td>3 Y(m/s²)</td>
<td>1.300</td>
<td>1.300</td>
<td>1.300</td>
<td>1.300</td>
<td>1.300</td>
<td>1.235</td>
<td>0.949</td>
<td>0.719</td>
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<td>0.806</td>
<td>0.806</td>
<td>0.806</td>
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<td>2.096</td>
<td>2.096</td>
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<td></td>
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<td>0.806</td>
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<td>0.734</td>
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<td>0.634</td>
<td>0.634</td>
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<td>0.734</td>
<td>0.561</td>
<td>0.421</td>
<td>0.299</td>
<td>0.187</td>
<td>0.080</td>
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<tr>
<td>6 Y(m/s²)</td>
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<td>0.806</td>
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<td>0.806</td>
<td>0.734</td>
<td>0.561</td>
<td>0.421</td>
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<td>1.719</td>
<td>1.719</td>
<td>1.719</td>
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<td>1.719</td>
<td>1.719</td>
<td>1.703</td>
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<td>0.806</td>
<td>0.806</td>
<td>0.806</td>
<td>0.734</td>
<td>0.561</td>
<td>0.421</td>
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<td>1.719</td>
<td>1.719</td>
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<td>1.719</td>
<td>1.719</td>
<td>1.703</td>
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<td>0.567</td>
<td>0.567</td>
<td>0.567</td>
<td>0.567</td>
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<td>0.378</td>
<td>0.318</td>
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</tr>
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<td>0.725</td>
<td>0.725</td>
<td>0.636</td>
<td>0.473</td>
<td>0.331</td>
<td>0.200</td>
<td>0.075</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>9 Y(m/s²)</td>
<td>0.473</td>
<td>0.473</td>
<td>0.473</td>
<td>0.473</td>
<td>0.473</td>
<td>0.473</td>
<td>0.390</td>
<td>0.295</td>
<td>0.213</td>
<td>0.138</td>
<td>0.067</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>yMin(m/s²)</td>
<td>0.334</td>
<td>0.334</td>
<td>0.334</td>
<td>0.334</td>
<td>0.334</td>
<td>0.334</td>
<td>0.303</td>
<td>0.232</td>
<td>0.174</td>
<td>0.125</td>
<td>0.080</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>yMax(m/s²)</td>
<td>0.661</td>
<td>0.661</td>
<td>0.661</td>
<td>0.661</td>
<td>0.661</td>
<td>0.661</td>
<td>0.641</td>
<td>0.487</td>
<td>0.353</td>
<td>0.231</td>
<td>0.116</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>10 Y(m/s²)</td>
<td>0.352</td>
<td>0.352</td>
<td>0.352</td>
<td>0.352</td>
<td>0.352</td>
<td>0.352</td>
<td>0.284</td>
<td>0.218</td>
<td>0.161</td>
<td>0.109</td>
<td>0.061</td>
<td>0.014</td>
<td></td>
</tr>
<tr>
<td>yMin(m/s²)</td>
<td>0.254</td>
<td>0.254</td>
<td>0.254</td>
<td>0.254</td>
<td>0.254</td>
<td>0.254</td>
<td>0.174</td>
<td>0.132</td>
<td>0.097</td>
<td>0.064</td>
<td>0.034</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>yMax(m/s²)</td>
<td>0.531</td>
<td>0.531</td>
<td>0.531</td>
<td>0.531</td>
<td>0.531</td>
<td>0.531</td>
<td>0.526</td>
<td>0.405</td>
<td>0.301</td>
<td>0.207</td>
<td>0.119</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>11 Y(m/s²)</td>
<td>0.254</td>
<td>0.254</td>
<td>0.254</td>
<td>0.254</td>
<td>0.254</td>
<td>0.254</td>
<td>0.174</td>
<td>0.132</td>
<td>0.097</td>
<td>0.064</td>
<td>0.034</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>yMin(m/s²)</td>
<td>0.202</td>
<td>0.202</td>
<td>0.202</td>
<td>0.202</td>
<td>0.202</td>
<td>0.202</td>
<td>0.122</td>
<td>0.092</td>
<td>0.066</td>
<td>0.043</td>
<td>0.021</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>yMax(m/s²)</td>
<td>0.450</td>
<td>0.450</td>
<td>0.450</td>
<td>0.450</td>
<td>0.450</td>
<td>0.450</td>
<td>0.411</td>
<td>0.316</td>
<td>0.234</td>
<td>0.160</td>
<td>0.091</td>
<td>0.024</td>
<td></td>
</tr>
<tr>
<td>12 Y(m/s²)</td>
<td>0.266</td>
<td>0.266</td>
<td>0.266</td>
<td>0.266</td>
<td>0.266</td>
<td>0.266</td>
<td>0.232</td>
<td>0.181</td>
<td>0.138</td>
<td>0.100</td>
<td>0.064</td>
<td>0.031</td>
<td></td>
</tr>
<tr>
<td>yMin(m/s²)</td>
<td>0.148</td>
<td>0.148</td>
<td>0.148</td>
<td>0.148</td>
<td>0.148</td>
<td>0.121</td>
<td>0.093</td>
<td>0.072</td>
<td>0.053</td>
<td>0.037</td>
<td>0.022</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>yMax(m/s²)</td>
<td>0.364</td>
<td>0.364</td>
<td>0.364</td>
<td>0.364</td>
<td>0.364</td>
<td>0.364</td>
<td>0.292</td>
<td>0.224</td>
<td>0.164</td>
<td>0.108</td>
<td>0.054</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Heavy vehicle dynamics and microsimulation modelling, 2010 Main Roads
5.2.3.3 Power and Weight Distributions

In the base model build, the default power and weight distributions can be adopted for vehicle types including cars, buses, coaches, motorcycles and bicycles. In addition, appropriate power and weight distributions should be identified and defined for the heavy vehicle types.

Table 5-3 demonstrates the recommended vehicle types and the attributes that should be adopted in the base model build and referenced at the calibration stage (Refer to *Heavy vehicle dynamics and microsimulation modelling, 2010 Main Roads*).

**Table 5-3: Recommended attributes**

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Category</th>
<th>Power (kW)</th>
<th>Weight (tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Short</td>
<td>Car</td>
<td>55-166</td>
<td>0.2 – 2</td>
</tr>
<tr>
<td>2 Short – towing</td>
<td>Car</td>
<td>55-166</td>
<td>0.8 – 2</td>
</tr>
<tr>
<td>3 Two-axle truck</td>
<td>HGV</td>
<td>160-200</td>
<td>3 – 12</td>
</tr>
<tr>
<td>4 Three-axle truck</td>
<td>HGV</td>
<td>200-250</td>
<td>8 – 21</td>
</tr>
<tr>
<td>5 Four-axle truck</td>
<td>HGV</td>
<td>200-250</td>
<td>12 – 28</td>
</tr>
<tr>
<td>6 Three-axle articulated</td>
<td>HGV</td>
<td>200-250</td>
<td>4 – 18</td>
</tr>
<tr>
<td>7 Four-axle articulated</td>
<td>HGV</td>
<td>200-250</td>
<td>4 – 26</td>
</tr>
<tr>
<td>8 Five-axle articulated</td>
<td>HGV</td>
<td>280-320</td>
<td>14 - 36</td>
</tr>
<tr>
<td>9 Six-axle articulated</td>
<td>HGV</td>
<td>300-350</td>
<td>16 – 43</td>
</tr>
<tr>
<td>10 B-double</td>
<td>HGV</td>
<td>350-400</td>
<td>22 – 64</td>
</tr>
<tr>
<td>11 Double road train</td>
<td>HGV</td>
<td>350-400</td>
<td>28 – 89</td>
</tr>
<tr>
<td>12 Triple road train</td>
<td>HGV</td>
<td>430-480</td>
<td>38 – 140</td>
</tr>
</tbody>
</table>

*Source: Heavy vehicle dynamics and microsimulation modelling, 2010 Main Roads*

5.2.3.4 Colour Distributions

In the base model build, colour distributions should be defined and adopted for the vehicle types. The different colour for each vehicle type enables modellers and model auditors to check models efficiently by easily identifying different vehicle type while running Vissim simulation.

Table 5-4 demonstrates the recommended colour distributions that were are categorized based on vehicle classes stipulated in Section 5.2.4. When the scope of modelling is to assess bus operations, the modellers should define a separate vehicle type and colour distribution for buses accordingly. The recommended colour for buses is green.
**Table 5-4: Recommended colour distribution**

<table>
<thead>
<tr>
<th>Name</th>
<th>Colour</th>
<th>Share (%)</th>
<th>Vehicle Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car/short</td>
<td>Blue</td>
<td>100%</td>
<td>Car</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td>Green</td>
<td>100%</td>
<td>Short-towing, two-axle truck or bus, three-axle truck or bus, four-axle truck</td>
</tr>
<tr>
<td><strong>Long</strong></td>
<td>Purple</td>
<td>100%</td>
<td>Three-axle articulated, four-axle articulated, five-axle articulated, six-axle articulated</td>
</tr>
<tr>
<td><strong>Medium combination</strong></td>
<td>Orange</td>
<td>100%</td>
<td>B-double, double road train</td>
</tr>
<tr>
<td><strong>Large combination</strong></td>
<td>Red</td>
<td>100%</td>
<td>Triple road train</td>
</tr>
</tbody>
</table>

Figure 5-5 shows an example of the colours defined for recommended colour distributions, and adopted to each vehicle type in a Vissim model.

**Figure 5-5: Recommended colour distributions for vehicle types**
5.2.4 Vehicle Classes

The defined vehicle types should be grouped into vehicle classes based on vehicle characteristics such as vehicle length and turning speed. The recommended vehicle classes for the vehicle types defined (based on the Austroads Vehicle Classification System) are set out in Table 5-5. The vehicle classes are grouped together based on vehicle length.

Table 5-5: Recommended vehicle classes

<table>
<thead>
<tr>
<th>Vehicle class</th>
<th>Vehicle types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car/short</td>
<td>Car</td>
</tr>
<tr>
<td>Medium</td>
<td>Short-towing, two-axle truck or bus, three-axle truck or bus, four-axle truck</td>
</tr>
<tr>
<td>Long</td>
<td>Three-axle articulated, four-axle articulated, five-axle articulated, six-axle articulated</td>
</tr>
<tr>
<td>Medium combination</td>
<td>B-double, double road train</td>
</tr>
<tr>
<td>Large combination</td>
<td>Triple road train</td>
</tr>
</tbody>
</table>

When the project area includes specific vehicles facilities (for example an exclusive bus lane, bicycle lane, pedestrian footpaths), appropriate vehicle types and classes should be defined to reflect the vehicle movements associated with user characteristics.

5.2.5 Driving Behaviours

Various link types represent the different roadway classes in WA, such as urban roads, freeways and merging areas.

5.2.5.1 General

Driving behaviours should be defined for each of the link types:

- Urban – for all urban roads including collectors, distributors and arterial networks.
- Freeway – for use on motorways with no controls on lane choice.
- Merging areas – the modeller should define additional driving behaviours and link type to reflect the merging behaviour observed from the site visit.

Default driving behaviours should generally be adopted, with the exception of car following model parameters and waiting time before diffusion to reflect Western Australian urban road saturation flow.

Car following model parameters to be updated are:

- Standstill distances – 2.5 metres
- Additive part of safety distance – 2.5
- **Multiplic. part of safety distance** – 3.5

Figure 5-6 highlights the car following model parameters that should be amended for urban driving behaviours.

*Figure 5-6: Car following model parameters for urban driving behaviours*

Waiting time before diffusion in the urban driving behaviour parameters should be increased to the maximum observed signal cycle time to avoid waiting vehicles being removed during simulation.

Driving behaviour for a merging area should be defined based on the updated urban driving behaviours with changes made to the lane-change parameters, for example the safety distance reduction factor and maximum deceleration for cooperative braking. Changes can also be made in the lateral parameter, for example keep lateral distance to vehicles on next lane(s). For ordinary merging sections, the following value ranges for the driving parameters are recommended:

- Safety distance reduction factor – 0.25 to 0.45.
- Maximum deceleration for cooperative braking – from -5.00 m/s² to -9.00m/s².

The factors should be determined based on driving behaviours observed on-site. Figure 5-7 highlights the driving behaviour parameters that should be amended for a merging area.
For specific locations where the observed driving behaviours are different from the simulation, modellers can adjust the driving behaviour parameters to better reflect the observed behaviours. This should be documented in the modelling report.

At locations where vehicles on adjacent lanes are observed to be affected by the lateral clearance between vehicles, the modeller should apply appropriate lateral driving behaviour settings for the relevant links and connectors.

The number of driving behaviour types should be minimal and the modeller should ensure that all similar driving behaviour types are consolidated unless they needed to be modelled separately.
5.2.5.2 Display Types

Display types can be used when specifying the representation of network objects in Vissim model. Using display types for different network object types (e.g. links with different link behaviour types), modellers and model auditors can review Vissim models efficiently by easily recognising network object types. Therefore, it is recommended that modellers define different display types and use them representing different link types or lane types.

Figure 5-8 demonstrates the recommended display types for link behaviour and lane types.

![Recommended display types](image)

5.2.5.3 Desired Speed Profile

Default speed profiles (linear) should be adopted for all speed limits up to and including 60 km/h. For speed limits of 70 km/h or greater, the default values should be adjusted to align with prevailing driver behaviour.

Modellers should consult Main Road for the speed distributions for the speed limits of 70 km/h or greater roads prior to commencing modelling.
5.3 Network Data

Network data is used when building transport network in Vissim. This section outlines recommended ways for WA transport network development in Vissim.

5.3.1 Background Information

Main Roads recommends to upload background images for the network coding and verification. Modellers can also import network data from existing Visum and Vissim models.

5.3.1.1 Background Image

When developing the existing network the modeller should ensure up-to-date background aerial imagery is used. Changes to the existing network that may not be reflected in the background imagery must be incorporated into the network. Scaling of the background imagery should be undertaken using the project areas’ coordinates and dimensions. It is the modeller’s responsibility to ensure that the aerial imagery coordinate system is aligned with the proposed design coordinate system.

5.3.1.2 Import Network Data from VISUM

Whilst a VISUM\textsuperscript{21} network can be exported to create a Vissim network, the modeller should review and refine the network outputs and all associated network parameters and objects.

5.3.1.3 Import Network Data from Other Vissim Models

If the model is comprised of any elements from another model, all parameters should be checked to ensure there is consistency across all network objects including the base data. The details of the duplicated model components and the process should be provided in the modelling report.

5.3.2 Model Boundaries

To help confirm the time period to model and the model boundaries, site visits should be undertaken in the relevant peak periods to confirm the geographic extent of congestion within the project area. This should be done prior to undertaking data collection exercises.

The boundary of the model should also consider the location of adjacent intersections surrounding key intersections. The inclusion of upstream and downstream intersections to control arrival and departure rates are often necessary.

\textsuperscript{21} PTV VISUM software is used to model transport networks and travel demand, to analyse expected traffic flows, to plan public transport services and to develop advanced transport strategies and solutions.
5.3.2.1 Upstream Congestion

Links should be long enough so that all queuing traffic is within the model boundary. Vehicles queuing beyond the boundary may affect the number of vehicles within the model and the performance of the network modelled. As a result of certain existing traffic conditions, the back of queue may not always be contained. Where the road link extension is considered to be impractical, the modeller should report the un-captured condition as a limitation of the developed model. If the links have been extended and no longer represent the modelled network, visualisation should be turned off in the link display tab (as shown in Figure 5-9).

Figure 5-9: Link display tab

5.3.2.2 Downstream Congestion

Downstream congestion such as exit blocking, which may exist beyond the boundary of the initial modelling area and has an impact on traffic in the project area, should be included in the final modelling area to reflect the existing traffic conditions of the site. The modeller should illustrate the induced delays and congestion through the calibration and validation process.

5.3.3 Links and Connectors

Links and connectors are used for roads and paths that vehicles and pedestrians can move on. When coding links and connectors, it is recommended that

- The number of links and connectors should be minimal
- Overlapping between links and connectors should be minimal
- Lane gains and lane drops (Refer to Section 5.3.3.2) should be modelled using one connector to ensure merging and diverging movements are smoother and occur within the link. This will also minimise the number of alternative paths.
5.3.3.1 Connector Route Parameters

Connectors have attributes and options that affect vehicle behaviour in model simulation. Among the connector’s attributes emergency stop and lane change parameters are used to model the lane change role of vehicle that follow their route or path.

The default values of emergency stop and lane change parameters are 5 metres and 200 metres respectively, however, modellers should adjust the parameters to better reflect the driving behaviour and lane discipline observed on-site.

Figure 5-10 and Figure 5-11 show examples of updated emergency stop and lane change parameters.

Figure 5-10: Emergency stop parameter update

![Emergency stop parameter update](image)

Emergency stop parameter of a turning lane connector should be at least the length of approach lane’s solid line.

Lane change parameter of a connector at the section that two lane forms one lane can be reduced to the length of the two lane section of the exit link whilst the lane change parameter for high speed road off ramp should be increased to the level that observed lane change behaviour is reflected in simulation.
5.3.3.2 Merging and Diverging Section Coding

For merging and diverging sections, modellers should code the sections in detail to better reflect the on-site observed behaviour, capacity and queue space.

Figure 5-12 demonstrates the link coding and link behaviour adopted for a two-lane section merging into one lane. The predefined behaviour type of merging (Refer to Section 5.2.5.1) is selected for the connector that two lane forms one lane, and *Lane change parameter* is changed to 30 meters.

*Figure 5-12: Merging section behaviour type*

The merging area in Figure 5-12 consists of multiple links and connectors. Table 5-6 shows the links and lane widths adopted for each link lane for the merging section.
The intersection approach's diverging areas should be coded in a similar manner with merging area link coding when lane utilisation is critical to the approach's capacity, as shown in Figure 5-13.

**Figure 5-13: Diverging section link coding**

<table>
<thead>
<tr>
<th>Link number</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane 1 width</td>
<td>3.5 m</td>
<td>3.5 m</td>
<td>3.5 m</td>
</tr>
<tr>
<td>Lane 2 width</td>
<td>3.5 m</td>
<td>0.5 m</td>
<td>-</td>
</tr>
</tbody>
</table>

**Table 5-6: Merging section links**

5.3.3.3 Dedicated Bus and Heavy Vehicle Lane

Where heavy vehicles are observed to only use a specific lane(s), for example corners with tight radii, lane closures should be used to ensure correct lane use.

To enable interaction between buses and general traffic, bus lanes should be coded as one lane of a link using lane closures rather than as a separate link. Bus lanes modelled using a separate link will not allow interaction between vehicles, especially at merge points or locations where general traffic must cross the bus lane to turn left (as shown in Figure 5-14).

**Figure 5-14: Bus lane coding**
Along with the default link behaviour types, any additional link behaviour types with adjusted parameters can be defined in the model to reflect the traffic behaviours observed on-site. Additional link behaviour types and associated driving behaviour must be described and explained in the modelling report. User-defined driving behaviour links should be coded in a different display colour.

5.3.3.4 Pedestrian Crossings

Where pedestrian crossings are observed to impact the performance of the network (for example intersections in the CBD), Use as pedestrian area (as shown in Figure 5-15) can be selected to simulate the interaction between vehicle and pedestrian movements.

*Figure 5-15: Link for pedestrian crossing*

![Link for pedestrian crossing](image)

Figure 5-16 shows an example of a 3D pedestrian model that includes links defined as pedestrian areas.

*Figure 5-16: Pedestrian links at intersection*
5.3.4 Desired Speed Decisions

Desired speed decision markers should be set where vehicles are observed to change speed. This is generally at posted speed limit sign locations. Modellers should generally follow the speed limit published in the road information mapping system available from Main Roads website.

5.3.5 Reduced Speed Areas

Reduced speed areas should be set at any location at which the road geometry prevents traffic from travelling at the posted speed safely (for example, tight bends, all turning movements or areas of poor visibility). Travelling speed should be measured on-site and modelled accordingly for each vehicle class.

The speed should be lower for heavy vehicles and buses. Table 5-7 presents the recommended heavy vehicle reduced speed limits. The speeds have been based on different turn types and radii outlined in the Austroads Design Vehicle and Turning Path Templates.

Table 5-7: Heavy vehicle reduced speed range

<table>
<thead>
<tr>
<th>Turn type</th>
<th>Radius (approx.)</th>
<th>Typical example</th>
<th>Desired speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very tight turn</td>
<td>12.5 m</td>
<td>Turns entering/leaving car parks, driveways or other narrow roads/lanes</td>
<td>5 km/h (4-6km/h)</td>
</tr>
<tr>
<td>Tight turn</td>
<td>15.0 m</td>
<td>Most left-turn operations and small single lane roundabouts</td>
<td>12 km/h (12-15 km/h)</td>
</tr>
<tr>
<td>Moderate turn</td>
<td>20.0 m</td>
<td>Most right-turn operations and medium-sized roundabouts</td>
<td>15km/h (15-20 km/h)</td>
</tr>
<tr>
<td>Gentle turn</td>
<td>30.0 m</td>
<td>Large multi-lane intersections and large (multi-lane) roundabouts</td>
<td>25km/h (25-30 km/h)</td>
</tr>
</tbody>
</table>

Default speed distribution profiles should be used unless the desired speed range does not match the default distribution and site observations show that these are not valid for the specific location modelled. Any change in the default speed distributions must be justified in the modelling report.
5.4 Intersection Control Data

Intersections can be categorised into two types that are priority controlled and traffic signal controlled intersections. This section discusses the recommended network objects and parameters for each intersection type in Vissim.

5.4.1 Priority Controlled Intersection

Priority controlled intersections can be managed by conflict areas or priority rules. In general, conflict areas are recommended to be used, however, for complex intersections priority rules should be used.

5.4.1.1 Conflict Areas

Typically, conflict areas are a more streamlined way of identifying vehicle priority between two conflicting streams. Conflict areas are the preferred approach for non-critical intersections with no obvious unusual priorities and which do not include overlapping and contradicting priorities.

When using conflict areas, the default gap acceptance parameters such as front gap, rear gap, and safety distance factor should be refined based on intersection and movement types.

- Front gap is the minimum gap time in seconds between the rear end of a vehicle in the main traffic stream and the front end of a vehicle in the minor traffic stream.

- Rear gap is the minimum gap time in seconds between the rear end of a vehicle in the minor traffic stream and the front end of a vehicle in the main traffic stream. This is the time that must be provided, after a yielding vehicle has left the conflict area and before a vehicle with the right of way enters it.

- Safety distance factor is only used for the merging sections. The factor is multiplied with the normal desired safety distance of a vehicle in the main traffic stream in order to determine the minimum distance a vehicle of the yielding traffic stream must keep when it is completely in the conflict area merging conflicts.

When using conflict areas, the gap acceptance parameters defined in Table 5-8 can be adopted as a starting point for calibration.

Figure 5-17 shows examples of left-hand and right-hand turns and updated conflict area parameters.
The status of conflict areas can be indicated by its colour:

- **Green**: main flow (right of way).
- **Red**: minor flow (yield).
- **Both red**: for branching conflicts, so that vehicles can "see" each other. There is no right of way, as vehicles simply remain in their original sequence.
- **Both yellow**: passive conflict area without right of way.

### 5.4.1.2 Priority Rules

For complex intersections, locations with a high heavy vehicle percentage and intersections which are deemed critical to the performance of the overall network, priority rules should be used, as illustrated in Figure 5-18.
When using priority rules, gap acceptance parameters in Table 5-8 can be adopted as a starting point.

**Table 5-8: Critical acceptance gaps and follow-up headways from Austroads**

<table>
<thead>
<tr>
<th>Movement</th>
<th>Diagram</th>
<th>Description</th>
<th>Critical acceptance gap</th>
<th>Follow up headway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-hand turn</td>
<td><img src="Image1" alt="Diagram" /></td>
<td>Requiring a to slow</td>
<td>5 seconds</td>
<td>2-3 seconds</td>
</tr>
<tr>
<td>Crossing</td>
<td><img src="Image2" alt="Diagram" /></td>
<td>One-way</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- two-lane</td>
<td>4 seconds</td>
<td>2 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- three-lane</td>
<td>6 seconds</td>
<td>3 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- four-lane</td>
<td>8 seconds</td>
<td>4 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two-way</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- two-lane</td>
<td>5 seconds</td>
<td>3 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- four-lane</td>
<td>8 seconds</td>
<td>5 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- six-lane</td>
<td>8 seconds</td>
<td>5 seconds</td>
</tr>
<tr>
<td>Right-hand turn from major road</td>
<td><img src="Image3" alt="Diagram" /></td>
<td>Across 1 lane</td>
<td>4 seconds</td>
<td>2 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Across 2 lanes</td>
<td>5 seconds</td>
<td>3 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Across 3 lanes</td>
<td>6 seconds</td>
<td>4 seconds</td>
</tr>
<tr>
<td>Right-hand turn from minor road</td>
<td><img src="Image4" alt="Diagram" /></td>
<td>One-way</td>
<td>3 seconds</td>
<td>3 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two-way</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- two-lane</td>
<td>5 seconds</td>
<td>3 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- four-lane</td>
<td>8 seconds</td>
<td>5 seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- six-lane</td>
<td>8 seconds</td>
<td>5 seconds</td>
</tr>
<tr>
<td>Merge</td>
<td><img src="Image5" alt="Diagram" /></td>
<td>Acceleration lane</td>
<td>3 seconds</td>
<td>2 seconds</td>
</tr>
</tbody>
</table>

These timings should be compared to the existing operation of the project location and amended accordingly. For example, the default parameters may need to be changed as a result of geometry. To accommodate variations in acceleration, different gap acceptance parameters are recommended for different vehicle types. The exact gap acceptance will need to be determined during the calibration process.
5.4.2 Signalised Intersection

The type of signal control used for the modelling should be agreed with Main Roads. The accuracy of the signal operation will generally depend on the complexity of the project location, type of assessment and its impact on network performance. Signal offsets should be correctly modelled using the information from SCATS (where applicable).

5.4.2.1 Traffic Signal Groups

Signal groups in the model must be defined in accordance with the site LM plan and SCATS information for existing signals (Refer to Appendix A). Signal group numbers in Vissim models must match the signal groups defined in SCATS.

The signal phase timings (minimum greens and yellow + all reds) should be directly input from controller/SCATS information and should not be changed. If the SCATS system shows a value as a fraction (for example, 0.5), the modeller should always round up the value for the inputs. For late starts and early cut-offs not observable on-site, it may be necessary to obtain the Phase Sequence Chart document from the Main Roads’ SCATS data request to identify the signal groups associated with these.

5.4.2.2 Signal Heads

Signal heads should generally be set on links or on connectors where partially controlled turns exist. To ensure that signal heads are not mismanaging traffic or being ignored, care should be taken in the setting of signal heads relative to the adjacent lanes and link/ connectors.

5.4.2.3 Fixed Time Signals

Fixed time signals should generally be used where there is minimal variation of phase sequences and timing throughout the assessment period. IDM data or SCATS history files should be used to determine the average phase lengths for the intersection(s) during the modelled time periods.

Pedestrians should be modelled where there are high levels of pedestrian movements which may result in delays to the corridor due to crossing movements or signal controls. SCATS signal time settings can be used as the base data for pedestrian signals. If the pedestrian crossing is not fully protected, priority rules can be set to reflect vehicle movements during pedestrian signal clearance times.

5.4.2.4 SCATSIM

The use of SCATSIM should be considered if high level accuracy of signal operations is required or if the signal operations are of high complexity. To ensure all required SCATSIM input files are accessible and available for modelling purposes, modellers should consult Main Roads.

The use of SCATSIM may require the development of personality files (.sft) in order to model proposed intersections or phasing arrangement operations. Mixing SCATSIM with other forms of signal control is not generally recommended.
5.4.2.5 Vehicle Actuated Programming (VAP)

VAP signal controls should be considered to mimic the SCATS operations for complex signal operations, such as infrequent demand dependant phases that have severe impact to the signal operations (e.g. bus priority, alternative and pedestrian phases). Prior to using VAP in Vissim, two files should be defined:

- Inter-stage file – a text file which details all stages, inter-greens, phase delays and inter-stage timings, with the detailed information derived from SCATS data.
- Logic file – the actual control logic to be executed by the program file.

The recommended VAP (.vv file) structure is:

- Program initiation – initiation of the program.
- Program schedule – various phase proportions or time setting throughout the modelling period.
- Signal linking module – for signal coordination purposes.
- Recording functions – to enable the recording of the modelled phase and cycle frequency, time checks or validation process.
- Stage logic module – for phase transition purposes and should consider gap-out, minimum green, maximum phase time and phase call/detection operations.
- Other transport priority and pedestrian operations that may apply to more than one phase should be kept separate to the stage logic module (where applicable).
- All numerical values (such as minimum green time, phase splits settings) should be stalled in the parameters section and not within the main logic module (flow chart).
- Expressions should be used where possible for the simplification of the logic code and to streamline review processes. The expressions module should contain gap-out and phase call conditions.

While direct coding of VAP may be appropriate, it is recommended modellers use VisVAP\textsuperscript{22} to code a VAP program. The use of VisVAP should be noted in the modelling report.

5.4.2.6 Detectors

Signal detectors generally need to be set when SCATSIM or VAP is adopted for signal control in the model. Signal detectors in the model should reflect existing or design information (for example, traffic signal plans or operation sheets).

If there is no information provided to indicate the detector size and location, signal detectors for vehicle detections should be modelled 2.0m back from signal heads and 4.5m in length at intersection approaches.

\textsuperscript{22} VisVAP is a tool for defining the program logic of actuated signal controllers as flow charts.
5.5 Traffic Data

Once transport network is built in Vissim, modellers should define traffic data such as demands and routes in the model. This section discusses recommended traffic input types.

5.5.1 Vehicle Composition

Vehicle composition used within the model should be determined using recent classified traffic counts and aligned with the vehicle types (Refer to Section 5.2.3).

5.5.2 Public Transport Stops and Lines

Public transport operations should be modelled where they may have a significant impact on the performance of the project area, such as bus only lanes and intersections with public transport priority operations. Public transport coding should be based on the information obtained from Transperth, including public transport routes, stop locations, timetables and dwell time.

On-site observations of dwell time should be used to help determine bus dwell time parameters. If there is no dwell time data available, and the model does not require detailed public transport operations, the parameters shown in Table 5-9 should be applied.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Suggested value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>20 seconds</td>
</tr>
<tr>
<td>Deviation</td>
<td>5 seconds</td>
</tr>
</tbody>
</table>

Modellers should include school buses in the public transport coding. The routes and timetables of school buses can be obtained from the Transperth website.

The layout of the public transport bays should reflect existing or design configurations.

5.5.3 Parking

Vehicle parking spaces and parking manoeuvres should be modelled where they may have a significant effect on the operation and capacity of the network within the project area. The layout and vehicle movements associated with parking should reflect the existing or design conditions. Parking delays should not be induced by setting reduced speed areas in the model.

5.5.4 Nodes

Nodes are primarily used for dynamic assignment, intersection evaluation or mesoscopic modelling purposes.

For dynamic assignment, nodes should be set at locations where a route decision needs to be made by a vehicle, as shown in Figure 5-19.
To limit the links in which the node is being assigned, the modeller may convert the node. This is particularly relevant for situations where the primary highway should be excluded from the interchange above/below the highway (for example, at multi-level single point interchanges as shown in Figure 5-20).

Nodes can also be used to evaluate intersection performance. Particular care should be taken with node structure if node evaluation is being used (Refer to Section 5.8.2.2).
5.5.5 Static Assignment

While the use of static vehicle routes is generally recommended, the model assignment method should be agreed with Main Roads.

5.5.5.1 Vehicle Inputs

Traffic demands should generally be introduced using the vehicle inputs in network objects. Modellers should define peak period demands and include warm-up and cool-down periods. Main Roads recommends that modellers use at least 15 minutes of warm-up and cool-down periods with a minimum of 85% of peak hour volumes unless modellers have justifications to use other values.

It is recommended for model category 1 (Refer to Section 2.11.2.1) that traffic count data are analysed for 15 minute intervals and vehicle inputs are set accordingly for peak periods to enable a model replicate on-site observed traffic flow accurately.

Modellers can use hourly volumes for model categories 2 and 3 and set at 15 minute intervals using continued attribute in vehicle input.

It should be noted that vehicle inputs in Vissim are expressed in hourly volumes. Therefore, the analysed 15 minute interval traffic flows must be recalculated to one-hour traffic flows (for example, an analysed 15 minute flow is 200 veh, then the value for the vehicle input must be 800).

Traffic volumes can be assigned a vehicle composition and either set to generate exact volumes or, if variability is required, to a stochastic loading, however, it is recommended that modellers use exact volume to minimise the discrepancies of model outputs between simulation runs with different seed numbers.

Figure 5-21 shows an example of vehicle input defined for model category 1 while Figure 5-22 illustrates an example of vehicle input defined for model category 2 or 3.

Figure 5-21: Example of vehicle input defined for model category 1
If route choice exists, vehicles can be loaded into the network by using OD matrices and dynamic assignment.

### 5.5.5.2 Vehicle Routes

Vehicle route decision markers should be set to mimic the decision point location where motorists would likely begin to perform lane changes to reach their desired destination. To manage demands for trip purposes or vehicle types, the use of vehicle routes for individual vehicle classes is recommended.

### 5.5.6 Dynamic Assignment

Dynamic assignment provides drivers with choices on routes to a destination based on different traffic conditions. Assignment should be set according to the user-defined route selection criteria for distance and travel time.

The use of dynamic assignment should be agreed with Main Roads prior to commencing with modelling.

When dynamic assignment is used, the modeller needs to ensure that traffic flows are correctly specified in the OD matrix files and that the method used to estimate OD matrices is documented in the modelling report. The modeller must also ensure that the modelled network is stable during the assignment process to enable the model to reach a converged state.

It is up to the modeller to decide what the most appropriate method is to achieve the desired outcome and best reflect the traffic conditions observed in the network.

It is recommended that traffic is initially loaded at a reduced level of demand (typically 50%) and then progressively increased.

If equilibrium assignment is used in place of stochastic user equilibrium, the modelling report should contain details on why this assignment method was considered more appropriate.

### 5.5.6.1 Convergence

Main Roads recommends modellers use the dynamic assignment convergence criteria:
- 95% of travel times on all paths and edges change by less than 20% for at least four consecutive iterations as shown in Figure 5-23.

Figure 5-23: Dynamic assignment parameters

Once convergence has been achieved, the convergence evaluation file (*.CVA), path file (*.WEG) and cost file (*.WGA) for each calibrated model should be stored for use during all subsequent modelling and provided to Main Roads as part of the base model submission.
5.6 Model Calibration and Validation

In general, calibration and validation require an iterative process of adjusting parameters and analysing model results until the model has achieved an accepted level of confidence when compared to the on-street conditions.

The calibration and validation requirements could be defined based on the importance of a specific project and its significance to the region. It is recommended that modellers discuss the requirements with Main Roads.

5.6.1 Model Calibration Requirements

Base model calibration is the process of employing verifiable observed data into a model to replicate on-street conditions. The following sub-sections discuss the recommended requirements and model input data for the base model calibration.

5.6.1.1 Data Collection

The type of data required for the modelling should be determined specifically for each project. It is the modeller’s responsibility to ensure appropriate data is collected to enable the development of the model. The format of output should be specified for modelling purposes. For consistency and accuracy of the modelling, it is recommended that all data is collected on the same day. The following list of data that could be collected is not exhaustive but should be considered:

- design layout information
- SCATS data
- traffic counts
- OD surveys
- public transport route and timetable information
- travel time data
- queue length
- saturation flow
- vehicle speed
- video footage

5.6.1.2 Site Observations

It is important for modellers to observe the existing site conditions. Driving behaviours, network configuration, signal operations and other events which may impact on the performance should be captured and reported as part of the modelling. The operating conditions and site findings should be captured in the form of photographs and videos.
5.6.1.3 **Model Input Check**

Modellers should check network coding and network objects’ attributes to confirm that the model network replicates the existing or the proposed transport network, and that the simulation is consistent with the observed on-street vehicle behaviour. The key inputs to be checked include:

- number of lanes
- lane width
- lane closure
- link behaviour type
- elevation ($Z$-height)
- feasible movements
- vehicle speed (desired speed decisions and reduced speed areas)
- priority control (conflict areas and priority rules)
- signalised intersection control (signal timing plans, signal groups, signal heads)
- traffic demands (vehicle inputs or OD matrices)
- vehicle routes
- dynamic assignment cost parameters (cost and surcharges)

5.6.1.4 **Vehicle Behaviour**

As it is difficult to set up a standard for vehicle behaviour, modellers should undertake a visual check to confirm the observed on-street vehicle behaviour is consistent with that observed in the model. Vehicle behaviour such as speed/flow performances, bottlenecks, queue formation and discharging need to be carefully compared and calibrated.

A correctly coded network should reflect on-street vehicle behaviour, especially during congested peak times. Main Roads recommends modellers drive through the network and capture videos of critical locations to familiarise themselves with driving behaviour.

Modellers should include notes and changes to the network in the modelling report.

5.6.1.5 **Error Files**

Ideally, there should be no error messages for a calibrated and validated base model.

If error messages are generated and persistent errors (e.g. latent traffic demands and diffused vehicles) occur at certain location(s), modellers must review network coding and model parameters to ensure all model deficiencies are addressed.

5.6.2 **Simulation Parameters**

This section discusses the recommended simulation parameters.
5.6.2.1 Key Parameters

The simulation period is defined as the total simulation time which includes warm-up, cool-down and the assessment period. The simulation period and start time should be reflected in the simulation parameters prior to simulations being run.

Simulation resolution should be set to the default 10 time steps per second, as shown in Figure 5-24. This should not be changed, especially when modelling different scenarios. If time steps need to be modified for specific operational modelling purposes, consistency should be maintained across all compared scenarios.

Figure 5-24: Simulation parameters general tab

5.6.2.2 Seed Values

There is variability in traffic conditions as a result of random driver behaviour and different daily events. Vissim attempts to replicate this random variability by altering individual driver decisions based on random numbers. The set of random numbers is determined by Vissim random seed value (Refer to Figure 5-24) at the start of a simulation run.

Modellers must run a minimum of five and a maximum of 10 simulations with different random seed values and present average model outputs. The modeller should list the used seed numbers in the modelling report.
For dynamic assignment models, one seed value should be used to search for paths and to achieve convergence. Once the model has met convergence criteria, the paths should be locked and the multi-runs undertaken. Model calibration and validation results should be based on the average of the seed runs and not on the single seed model used to search for the paths.

Seed values must remain consistent across all scenarios.

5.6.3 Model Validation Requirement

Main Roads defines the three model categories for model validation, based on the network size and modelling purposes (Refer to Section 2.11.2.1). The following sub-sections discuss the validation criteria for VisSim models.

5.6.3.1 Traffic Volumes

Main Roads requires hourly turning movement and directional link volume to be validated for each major vehicle type. Table 5-10 demonstrates the model validation criteria for individual model categories.

Table 5-10: Traffic flow validation criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEH &lt; 5</td>
<td>95%</td>
<td>85%</td>
<td>80%</td>
</tr>
<tr>
<td>GEH &lt; 10</td>
<td>100%</td>
<td>95%</td>
<td>90%</td>
</tr>
<tr>
<td>&lt; 700 vph within 100 vph</td>
<td>95%</td>
<td>90%</td>
<td>85%</td>
</tr>
<tr>
<td>700 – 2,700 vph within 15%</td>
<td>95%</td>
<td>90%</td>
<td>85%</td>
</tr>
<tr>
<td>&gt; 2,700 vph within 400 vph</td>
<td>95%</td>
<td>90%</td>
<td>85%</td>
</tr>
<tr>
<td>R squared value</td>
<td>&gt;0.95</td>
<td>&gt;0.95</td>
<td>&gt;0.9</td>
</tr>
</tbody>
</table>

Where throughput between upstream and downstream intersections do not match due to survey error, the flow discrepancy should be identified and detailed in the modelling report. While it is recommended that in these circumstances the most appropriate traffic flow be used based on engineering judgement, this will also need to be explained in the modelling report.

5.6.3.2 Travel Times

Travel time is a common technique used to assess the accuracy of a model by comparing surveyed and modelled travel times along key routes in the study area. It is important to ensure that a sufficient number of travel time surveys have been undertaken during the data collection stage of the project. When collecting data the route should be disaggregated into smaller sections so that the location of key delays within the overall travel time can be easily identified.

Main Roads recommends modellers measure travel times between intersection stop lines along key routes in the study area. The sections to compare should be agreed with Main Roads during the scope meeting. The extracted travel time for the model validation should be average values over several simulation runs (Refer to 5.6.2.2).
The use of sections allows a cumulative graph of travel time along the route to be developed. This type of graph can provide an accurate analysis that demonstrates how the model performs in each key section, rather than simply providing a total travel time. Figure 5-25 provides an example of this type of comparison.

*Figure 5-25: Example of travel time comparison*

The modelled travel times should be within 15% or one minute (whichever is greater) of average observed travel time. Table 5-11 demonstrates the model validation criteria for individual model categories.

*Table 5-11: Travel time validation criteria*

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 % or one minute of average observed travel time</td>
<td>100%</td>
<td>90%</td>
<td>85%</td>
</tr>
</tbody>
</table>

Where there are insufficient observed sample sizes to compare with the modelled average travel time, the minimum and maximum observed travel time should be shown.

5.6.3.2.1 Travel Time Variability

While the cumulative graph of travel times by section provides a good assessment of average travel times for each route, it is also important to ensure that the model accurately represents the variability of the travel times noted during the surveys.

In order to provide a comparison of observed and modelled variability, a graph plotting the average travel time and a 95% confidence interval for both the observed and modelled datasets can be used. This graph will demonstrate the level of variability within each dataset and provide a clear indication of how closely the model reflects the observed values.

An example graph showing this data for a number of travel time routes is shown in Figure 5-26. It should be noted that the purpose of the graph is not to achieve a numerical target for model calibration/validation, but to provide a visual indication of how accurately the model is performing in respect to observed and modelled travel time variability.
Main Roads may request that a more detailed assessment be made of any isolated sections of the travel time routes that are of critical significance to the study area. This assessment will require an analysis of the relationship between travel time and traffic volume for both the observed and modelled datasets for that section.

A useful way to confirm the validity of the traffic model is to perform a sense check between the observed and the modelled travel time data. This can be shown as a scatter graph that depicts travel time data collected at any time of day and under any flow conditions. Data points in the scatter graph should correspond to section traffic volume on the X-axis and section travel time on the Y-axis.

The graph in Figure 5-27 shows the relationship between traffic flow and travel time. This data may be useful as it provides an indication of how closely the model replicates the operation of the links and intersections at different levels of congestion, rather than simply the average peak hour observation.
Figure 5-27: Traffic flow rates vs. travel time

5.6.3.3 Queue Length

Queue length data should be collected on-site and compared with modelled outputs to provide an indication of how accurately the model replicates congestion on approaches to key intersections in the model.

Modelled queues should correlate reasonably with site observations of queuing behaviour and any significant discrepancies may indicate that areas of the model require further calibration including link driving behaviour, vehicle inputs and traffic controller updates.

It is recommended that the modelled average maximum queue length be compared to observed queue length data. The queue data should be surveyed and recorded for five-minute intervals over the peak period.

5.6.3.4 Signal Timing

An evaluation of model output and surveyed data should provide confidence that signal cycles and timings are comparable in the model to the recorded average SCATS operation.

The modeller should compare selected signalised intersections in the core area of the model with the recorded average SCATS history data. The nominated intersections should be agreed with Main Roads during the scope meeting.

Table 5-12 shows the signal timing validation criteria for the intersections.
### Table 5-12: Microsimulation signal timing validation criteria

<table>
<thead>
<tr>
<th>Signal operation</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed time control - cycle time</td>
<td>Within 5% of recorded average of SCATS history data for same one hour period</td>
</tr>
<tr>
<td>Fixed time control - green time</td>
<td>Within 10% of recorded average phase of SCATS history data for same one hour period</td>
</tr>
<tr>
<td>Vehicle actuated control - Call frequency</td>
<td>Call frequency of demand-dependent phases (including pedestrian phases) to be compared with recorded average phase of SCATS history data for same one hour period</td>
</tr>
</tbody>
</table>

#### 5.6.3.5 Saturation Flow

Lane saturation flow model outputs should be validated against saturation flow measured on-site for critical lanes. The critical lanes and key intersections to be compared should be agreed with Main Roads during the scope meeting.

The preferred method to extract saturation flow outputs from Vissim is using the discharge record. The modeller should select *discharge record active* in the *Signal Head* window and *discharge record* in the *Evaluation Configuration* window. Figure 5-28 shows an example of discharge record configuration selection. Once the discharge record is produced, modellers should calculate the saturation flow for the desired link according to the saturation flow measurement method outlined in Section 2.9.3.

**Figure 5-28: Example of discharge record configuration**

All observed and modelled saturation flow values should be tabulated and the percentage error between the two values provided in the modelling report.

Modelled saturation flow values should be within 10% of observed values.
5.6.3.6 Vehicle Speed

For all freeway modelling projects, speed plots (heat maps) must be produced to compare the modelled and observed freeway segment condition. Critical bottlenecks may require lane-by-lane comparisons. Figure 5-29 provides an example of speed plots.

Figure 5-29: Example of speed plots

<table>
<thead>
<tr>
<th>Type</th>
<th>Observed</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>VDS/Time</td>
<td>6:00</td>
<td>6:30</td>
<td>7:00</td>
<td>7:30</td>
<td>8:00</td>
<td>8:30</td>
<td>6:00</td>
<td>6:30</td>
<td>7:00</td>
<td>7:30</td>
</tr>
<tr>
<td>Russell Off</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Russell On</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>NoRussell</td>
<td></td>
<td></td>
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<tr>
<td>SoArmadale</td>
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<tr>
<td>Armadale Off</td>
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<tr>
<td>Armadale On</td>
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<tr>
<td>NoArmadale</td>
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<tr>
<td>Berrigan Off</td>
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<td>Berrigan On</td>
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<tr>
<td>NoBerrigan</td>
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<td>Roe Off</td>
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<td>Farrington</td>
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<td>Farrington On</td>
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<td>Richardson</td>
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<tr>
<td>Mounts Bay Off</td>
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</tr>
</tbody>
</table>

LEGEND

- < 30 km/h
- 30 - 50 km/h
- 50 - 70 km/h
- 70 - 90 km/h
- > 90 km/h
5.7 Proposed Option Models

Once the base model meets validation criteria and is approved by Main Roads, the modeller can build and assess proposed option models. The calibrated and validated base models should be used as the basis for developing proposed models.

5.7.1 Scenario Management

Scenario management can be used for establishing the scenarios using the developed modifications. The naming and descriptions of each modification should be easily comprehended by other users. The order of the scenarios should be in sequence and a consistent naming convention should be adopted to assist users in identifying the relevant scenarios more effectively. Figure 5-30 shows an example of scenario naming and descriptions.

*Figure 5-30: Example of scenario naming and descriptions*

![Example of scenario naming and descriptions](image)

The structure and scope of the modifications developed should be provided in the modelling report. It is important that modellers pay extra attention to which modifications should be amended.

To prevent unnecessary changes being made to the original external files, modellers should ensure that external files (such as signal program, cost and path files) are duplicated and renamed for each scenario.
5.8 Model Output

Modellers are required to report model assessment results to Main Roads for the review when the base model is validated and when proposed option models are completed. This section outlines model evaluation outputs to be reported and recommended ways to extract the data from Vissim models.

5.8.1 Evaluation Configuration

The evaluation time and interval should be specified for each of the result attributes. To enable class-specific results to be recorded, vehicle classes that need to be assessed individually should be highlighted in the ‘Vehicle Classes’ window, as shown in Figure 5-31.

All results lists used for any form of assessment should be saved in a results folder in the modelling report.

Figure 5-31: Evaluation configuration
5.8.2 Model Evaluation Outputs

Main Roads will require the model evaluation results to be reported as the final model outcomes in the modelling report. The model outputs include, but are not limited to, those shown in Table 5-13. The results extracted from the model should be clearly presented in tabular or graphical forms.

Table 5-13: Model evaluation outputs

<table>
<thead>
<tr>
<th>Type</th>
<th>Model output</th>
<th>Evaluation method</th>
<th>Time period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network-wide</td>
<td>Number of vehicle served</td>
<td>Vehicle network performance</td>
<td>Total analysis period (peak)</td>
</tr>
<tr>
<td></td>
<td>Total travel distance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total travel time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average speed</td>
<td></td>
<td></td>
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<td></td>
<td>Total delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average delay per vehicle</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total latent traffic demand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intersection</td>
<td>Turning movement volume</td>
<td>Node Queue counter</td>
<td>15 minute interval analysis period</td>
</tr>
<tr>
<td></td>
<td>Approach queue length</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average delay for each approach and intersection</td>
<td></td>
<td></td>
</tr>
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<td></td>
<td>LoS for each turning movement and intersection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical corridor</td>
<td>Traffic volume</td>
<td>Link</td>
<td>15 minute interval analysis period</td>
</tr>
<tr>
<td>(for example, bottle neck)</td>
<td>Density</td>
<td></td>
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<tr>
<td></td>
<td>LoS</td>
<td></td>
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<tr>
<td></td>
<td>Heat map</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Route</td>
<td>Volume</td>
<td>Vehicle travel time</td>
<td>Total analysis period (peak)</td>
</tr>
<tr>
<td></td>
<td>Average travel time</td>
<td>Delay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Travel distance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average delay time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.8.2.1 Vehicle Network Performance

Vehicle network performance results enable detailed network performance analysis and performance comparison between different scenarios. Vehicle network performance results should be collected for the scoped evaluation time period with appropriate time interval. Table 5-14 shows an example of network performance outputs for different scenarios for scenario comparisons.
Table 5-14: Example of network performance outputs

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Base model</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Interval</td>
<td>7:15-7:30 AM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicles arrived (veh)</td>
<td>1,584</td>
<td>1,568</td>
<td>1,191</td>
</tr>
<tr>
<td>Total travel distance (km)</td>
<td>15,203</td>
<td>15,108</td>
<td>11,937</td>
</tr>
<tr>
<td>Total travel time (hh:mm)</td>
<td>241:30</td>
<td>246:04</td>
<td>381:59</td>
</tr>
<tr>
<td>Average vehicle speed (km/h)</td>
<td>63.1</td>
<td>61.4</td>
<td>31.3</td>
</tr>
<tr>
<td>Total delay (hh:mm)</td>
<td>63:48</td>
<td>69:34</td>
<td>232:20</td>
</tr>
<tr>
<td>Average delay (s)</td>
<td>88</td>
<td>95</td>
<td>282</td>
</tr>
<tr>
<td>Demand latent (veh)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

5.8.2.2 Node

Node enables modellers to analyse the performance of intersections including directional traffic volume, vehicle delay, level of service and queue length. Figure 5-32 demonstrates an example of a signalised intersection performance based on the node evaluation outputs.

Figure 5-32: Node outputs

Start of delay segment length and maximum queue length definition can be adjusted to fully capture the extent of the evaluation. Delays should generally be measured from intersection controls to the next major intersection.

For nodes used for evaluation purposes, the size and shape of the node should be specifically drawn to maximise the extent of the evaluation area. The distance between the node boundary and upstream of signal or priority controls should be minimised. In node evaluation, performance can only be evaluated as far as the next upstream node. This can result in incorrect measurements if the node structure is not well considered.
5.8.2.3 Queue Counter

Queue length measurement should be carried out by node evaluation. When queue counter is used, queue counter markers should be set immediately upstream of signal heads, priority controlled locations or site entrance/exit barriers to ensure the modelled queue length is captured. In the evaluation configurations, the default queue counters maximum length may need to be extended to ensure the back of queue is recorded. Any changes to the default settings should be provided in the modelling report.

Other than the maximum length setting, default queue definition should be adopted and kept consistent across all scenarios, as shown in Figure 5-33.

Figure 5-33: Queue counter

![Queue counter](image)

5.8.2.4 Links

Link evaluation enables detailed analysis of the link performance including vehicle volume, speed and density. Link evaluation results should be collected on a per lane segment basis for the scoped evaluation time period with appropriate time interval. Default link evaluation segment length can be adjusted based on project’s objectives and link location. Figure 5-34 demonstrates an example of link evaluation configuration.

Figure 5-34: Example of link evaluation configuration

![Link evaluation](image)
Link evaluation can also be used for heat maps by setting link drawing mode as colour scheme and defining colour scheme configuration. Figure 5-35 illustrates an example of heat map and colour scheme configuration.

**Figure 5-35: Example of link color scheme**

![Link evaluation heat map and colour scheme configuration](image)

### 5.8.2.5 Travel Time Sections and Output

Travel time sections are one of the network objects that can be used to collect travel time, volumes and delays (in conjunction with delay measurements) within the modelled network. The application of travel time sections enables modellers to explicitly and precisely define the extent of collection.

When defining travel time sections, modellers should manually input the start and finish points of each section to ensure that there is no missing or overlap area along the measurement route. Figure 5-36 shows an example of travel time section defined in a Vissim model.

**Figure 5-36: Example of defined travel time sections**

![Travel time section in Vissim](image)
5.8.2.6 Signal Control Detector Record

The signal control detector record should be extracted to demonstrate the validity of the modelled vehicle actuated signal operations. It is recommended that the modelled phase frequency and average phase time be compared with actual SCATS data. All significant discrepancies should be detailed in the modelling report.

Signal control detector record will require:

- Coding within the vehicle actuated program to enable variables to be recorded.
- Configurations in the Vissim signal controller setting under the ‘SC detector record configuration’ tab.

5.8.3 Presentation

All videos can be recorded in 2D or 3D mode or via external screen capturing software. In 3D mode it is recommended to have the 3D anti-aliasing function switched on to improve the video quality. Videos should be produced in generic video format.

It is recommended that the graphic and layout settings are set to enable clear visibility of all network objects and are consistent between all models produced. Figure 5-37 shows an example of a Vissim 3D video.

*Figure 5-37: Example of 3D video*
6 Aimsun Guidelines

6.1 Introduction

TSS-Transport Simulation Systems’ Aimsun is an integrated transport modelling software package. The simulation software allows integration between different tiers of the model, provides high speed simulations and combines travel demand modelling and static assignment with mesoscopic, microscopic and hybrid simulation within a single software application.

This section is designed to complement Aimsun User Manual. It provides detail on key parameters to be adopted when undertaking Aimsun mesoscopic, microscopic and hybrid simulation modelling in WA.

Modellers must refer to Sections 1 and 2 for the overview of traffic modelling.

6.1.1 Appropriate Use of Aimsun

Aimsun allows users to carry out traffic operation assessments for projects of most scales and complexity. However, it is typically data and labour intensive to achieve accurate modelling of the complex and adaptive operations, compared to micro-analytical software such as LinSig and SIDRA. It is therefore recommended to use Aimsun when evaluating the performance of detailed operations that exhibit:

- Network-wide traffic capacity implications when part of the network becomes over-saturated.
- Closely spaced intersections or interchanges.
- Advanced traffic management schemes (for example priority signals, congestion management).
- Complex intersection or interchange layouts.
- Complex or dynamic (non-cyclic or demand-based) signal operations.
- Feasibility studies for high occupancy vehicle and high occupancy toll lanes.
- Impact analysis of infrastructure design such as highway corridor improvement.
- Impact of heavy vehicles to network capacity.
- Travel demand management strategies.
- Variable speed policies and other intelligent transportation systems.

6.1.2 Software Version

This guideline is for Version 8.1 of the Aimsun software package. While the Operational Modelling Guidelines will need to be updated for future versions of the software, the general principles outlined will continue to apply.
6.2 Model Set-up

Main Roads recommends the use of OpenStreetMap option to set-up a new Aimsun model and recent aerial images to confirm network layout.

6.2.1 OpenStreetMap

OpenStreetMap is a free open format, crowd-sourced mapping resource available from www.OpenStreetMap.org. Aimsun provides the option to automatically create an initial network by importing OpenStreetMap data from the internet.

The automatically generated network needs to be refined in order to fit the purposes of the project.

Figure 6-1 shows the interface of starting a new project from OpenStreetMap.

![OpenStreetMap - new project options](image)

6.2.2 Aerial Images

Geo-referenced aerial images may provide the base for the network coding. The background image should be imported in a separate layer. It is necessary to check the coordination system of the aerial images to ensure they are the same as the Aimsun model network. To align the network geometry with the imported aerial images, manual network refinement is usually needed after the import has been undertaken.
6.2.3 Model General Settings

Modellers must ensure that the correct settings for WA are applied. These settings are the
general base data for the entire network.

- **Units** – metric
- **Rules of the road** – left-hand drive

The general settings can be checked through *Localisation* in *Project Preference Editor*
dialog. Figure 6-2 shows an example of the general settings defined for an Aimsun model.

*Figure 6-2: Recommended general settings*
6.3 **Network Coding**

After the initial set-up, modellers must ensure that model details including network geometry, traffic controllers, and traffic management strategies correspond to the existing road network condition.

### 6.3.1 General Settings

The following elements need to be included in the network coding:

- **Network geometry** – network layout and geometry configurations including road sections, nodes, turns, section and turn parameters.
- **Zone system** – centroids and how centroids are connected to the network for the matrices including centroids, centroid ID and centroid parameters.
- **Traffic signals** – traffic signals and signal settings including the signal type, cycle time, offset, yellow time, red percentage, signal groups, signal timing, interphase time, and signal phases.
- **Public transport** – including public transport vehicles, public transport stops, public transport routes, and public transport timetables.
- **Traffic management plans** – all the traffic management operations to modify the traffic network conditions to affect driver behaviour or to simulate events on the traffic network including speed changes and incidents.

The following features need be checked and considered for inclusion in the network coding:

- **Turn restrictions** – turn bans for all vehicles or different vehicle types including allowed lanes to turn into and the restriction time.
- **Speed limits** – the maximum posted speed including permanent and variable speed limits for sections and turns.
- **On-street parking** – road sections where on-street parking is allowed including parking areas and time allowed.
- **Heavy vehicle restrictions** – including heavy vehicle restriction areas and the restriction time.
- **Bus only lanes** – road lanes where only buses are allowed to travel at certain times.
- **School zones** – road sections near schools which have reduced speed limits during school hours.

### 6.3.2 Network Geometry

As outlined in Section 6.2, a new modelling project can be set-up through different sources. After initial set-up, network refinement will be needed to ensure that the model network geometry, including sections, nodes and turns, reflects the existing road network.

Modellers should use latest geo-referenced aerial images as the base (Refer to Section 6.2.2).
6.3.3 **Section Parameters**

This section provides information on section parameters to be used in Aimsun models.

6.3.3.1 **Road Type**

Road types allow the classification of sections and the fast editing of a set of sections using the road type editor.

Modellers must identify the road types using relevant names used in the model. The list below shows common name of road types:

- Arterial
- Freeway
- On/Off Ramp
- Pedestrian Area
- Perth Base Link Type 1
- Perth Base Link Type 2
- Urban Road
- Roundabout

6.3.3.2 **Capacity and Attractiveness**

Capacity defines the maximum number of vehicles that can get through the section. Section capacity is a key factor in determining route choices in static assignment.

As there is no absolute capacity in mesoscopic or microscopic simulation, by default, section capacity is used as an indication of the attractiveness of a section. The higher the attractiveness (capacity) of a section, the higher traffic volume it attracts. Attractiveness is one of the main components in determining the dynamic generalised cost of an OD pair.

While it is recommended that modellers use the default method where capacity is equal to attractiveness, in some cases the modeller may need to calibrate the section attractiveness based on locally observed behaviour that could not be justified by other parameters. Modellers must document any changes in the modelling report.

6.3.3.3 **Speed Limit**

The section speed limit should follow the speed limit published in the Main Roads road information mapping system available from Main Roads website.

6.3.3.4 **Meso Parameters**

*Jam Density* and *Reaction Time Factor* are two major section parameters for mesoscopic simulation. *Penalise Shared Lanes* and *Penalise Slow Lanes* options can be selected to influence lane utilisation, as shown in Figure 6-3.

*Figure 6-3: Default section meso parameters*
The default value for reaction time factor is 1.00 and the default value for jam density (per lane) is 170 veh/km. As the gap between vehicles tends to be smaller when a network is congested, the reaction time factor can be reduced slightly. Modellers should also consider increasing jam density marginally when the level of congestion is high. All changes to these parameters should be documented in the modelling report.

**6.3.3.5 Micro Parameters**

Figure 6-4 describes the default values for typical section micro parameters.

**Figure 6-4: Typical section micro parameters**

Main Roads recommends the use of default setting for merge sections. If simulations does not reflect street observations, modellers can adjust lane changing and side lane parameters. Figure 6-5 illustrates suggested values as starting point. These parameters should be calibrated based on the observed merging conditions. Changes to these parameters must be documented in the modelling report.

**Figure 6-5: Merge section micro parameters**

The *Queue Discharge* parameters should only be changed when the changing of other parameters cannot replicate the observed driver behaviours at an intersection. Changes to these parameters must be documented in the modelling report.
6.3.4 Node Parameters

This section provides information on node parameters to be used in Aimsun models.

6.3.4.1 Turn Speed

The turning speed should generally be lower than the approach speed for turning movements.

Aimsun automatically calculates turning speed based on the angle of a turn movement. Main Roads recommends that modellers maintain the automatically calculated speed for all turn movements.

6.3.4.2 Dynamic Model Parameters

Figure 6-6 shows the default dynamic model parameters for a turn.

*Figure 6-6: Default turn dynamic model parameters*

The look-ahead distance and give way parameters can be adjusted based on the different circumstances. For example, for a freeway off-ramp or a right-turn movement, the look-ahead distance can be increased to the same distance as the advanced warning sign. Figure 6-7 and Figure 6-8 show examples of turn parameters for a freeway ramp and a right-turn movement. Values should be adjusted based on site conditions and must be documented in the modelling report.

*Figure 6-7: Example of turn dynamic model parameters for a freeway ramp*
6.3.4.3 Static Model Parameters

Figure 6-9 shows the default static model parameters for a turn at a signalised intersection. The key parameters involved in this interface include the turn penalty function and the user-defined cost. While these settings should generally follow the strategic model setting, changes are acceptable during the calibration process and must be documented in the modelling report.

6.3.4.4 Yellow Box

The default yellow box speed is 10 km/h. This parameter can be changed during the calibration process to replicate specific behaviour (for example, courtesy give-ways).

6.3.5 Zone System

This section provides information on setting up zone systems to be used in Aimsun models.

When coding a new model based on OpenStreetMap or aerial images, modellers must create centroids at each entry and exit section for the study area.

When coding a new model based on a strategic model, model zones or centroids are generally already established, however, they may not be sufficiently disaggregated for mesoscopic or microscopic modelling. Zonal disaggregation and aggregation are needed to provide a detailed representation of trip loading points.

As the strategic model zones are directly connected into strategic level nodes, the strategic connector configurations are likely to generate unrealistic delays or congestion in the network at the mesoscopic or microscopic level. The zone connections should be modified to model more realistic trip generation and attraction locations, such as local streets, parking entrances and exits, taxi ranks or other access points.

Figure 6-10 shows an example of strategic level zones that have been disaggregated and edited to microscopic Aimsun zones.
6.3.6 Signal Control Types

Aimsun allows users to simulate signal operations using different signal control types, including:

- Fixed-time signal control with fixed offsets between intersections.
- Vehicle actuated signal operation with fixed offsets between intersections.
- A SCATSIM interface plug-in.

6.3.6.1 Fixed-Time Signals

Fixed time signals should generally be used where there is minimal variation of phase sequences and timing throughout the assessment period.

Fixed-time control also allows modellers to easily simulate the signal offset. In order to model the signal offset correctly, it is recommended to set-up the coordinated sites with the same cycle time value or a multiple of each other. The offset value can be determined by analysing the LX file, SM file or history file from the SCATS outputs (Refer to Appendix A).

6.3.6.2 Vehicle Actuated Signals

Vehicle actuated signals are used for particular tasks such as boom gates, public transport priority or variable phase sequences.

The set-up and operation of vehicle actuated signals should follow the SCATS set-up and operations.

6.3.6.3 SCATSIM

The coding of signalised intersections as SCATSIM-controlled allows realistic replication of the network conditions and is an efficient way for information transfer.
To guarantee correct connection between Aimsun and SCATS, it is essential that the SCATS objects such as signals and detectors correspond with the Aimsun objects. The following rules should be followed:

- **SCATS intersections** – each SCATS intersection should be represented in Aimsun as one SCATS type controller, setting the SCATS intersection ID in the intersection ID tab. One SCATS intersection can be represented by one or more Aimsun intersections. All intersections that represent one SCATS intersection should be represented using connections between its SCATS controller and the associated Aimsun intersections.

- **SCATS SGroups** – the model must contain the same SGroup definition as SCATS with the same association of turns.

- **SCATS detector** – SCATS has two types of detectors:
  - physical detectors which measure count and occupancy
    » each SCATS detector should be modelled as one corresponding Aimsun detector and must have count and occupancy as measuring capabilities
  - logical detectors (beacons) identify public transport vehicles and are associated with one physical detector and a set of public transport lines
    » If this detector represents one physical detector associated with one logical detector then the Aimsun detector must have at least equipped vehicle as a measuring capability. All public transport lines associated with logical detectors should be modelled as public transport lines with 100% of equipped vehicle in the public transport vehicle types
  - Note that detector length is strongly related to the measured occupancy and the Aimsun detector length should be set to match the expected SCATS occupancies.

- **Control plan** – for each intersection controlled by SCATS it is necessary to set the control type as external and define a pre-timed or fixed control plan with the definition of all phases with their durations.

The Aimsun-SCATS ITS interface can be used to support the coding of the SCATS intersection geometry, SGroups, detectors, controllers, historical signal timings and detector counts.

It is the responsibility of the modeller to ensure that all required SCATS system files are available for the modelling exercise (the SCATS files can usually be obtained from Main Roads). The SCATS system files required include:

- central manager database (.mdb)
- region system files for each region
  - sys.lx
  - sys.tc
  - sys.ram
- *WinTraff* file (.sft) for each intersection
  - *SimHub* or equivalent connection software

It is recommended that the modeller follows the set-up specifications of *SCATSIM*. 
6.3.7 Pedestrians

Aimsun allows pedestrians to be modelled as a vehicle type walking on sections. It also has the option to include detailed pedestrian modelling using the embedded Legion for Aimsun plug-in.

Modellers are able to set up the priority rules in a conflict point to allow vehicles to give-way to pedestrians at locations such as zebra crossings, parallel walks at signalised intersections or in shared space situations.

6.3.8 Priority Rules

There are two priority types: give-way and stop. Priorities for the movements need to be set up correctly. It is essential for modellers to use the correct control type, that is, the give-way warning for give-way-controlled intersections and the stop warning for stop sign-controlled intersections.

**Give-way priority rules must also be coded for any filter right-turn movements at a signalised intersection.**

Checks may be needed to ensure that opposing movements are correctly represented, for example that the right-turn movements in and out of side roads interact correctly. This can be completed on the Give Way tab in the Node window.

6.3.9 Public Transport

Public transport coding should be based on the information obtained from Transperth, including public transport routes, stop locations, timetables and dwell time. On-site observations of dwell time should be used to help determine bus dwell time parameters. If there is no dwell time data available, and the model does not require detailed public transport operations, the parameters shown in Table 6-1 may be used.

<table>
<thead>
<tr>
<th>Table 6-1: Bus dwell time parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Deviation</td>
</tr>
<tr>
<td>Offset(s)</td>
</tr>
</tbody>
</table>

Modellers should include school buses in the public transport coding. The routes and timetables of school buses can be obtained from the Transperth website.

All bus only lanes should be included in the model. This can be done by applying the public transport only lane type.

6.3.10 Parking

Off-street parking should be modelled as zones if they are considered to have a significant impact on traffic flow. Part-time on-street parking and clearways can be modelled as lane closures using a traffic management plan.
6.3.11 Traffic Management

A traffic management strategy consists of a number of policies which are applied to a traffic network to replicate existing conditions or to test specific traffic management measures, that is, to manage traffic around roadworks.

Possible traffic management actions under each policy are presented in Table 6-2.

Table 6-2: Traffic management actions and examples

<table>
<thead>
<tr>
<th>Traffic management actions</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane closure</td>
<td>On-street parking and clearways</td>
</tr>
<tr>
<td>Turn closure</td>
<td>Time-dependent turn bans</td>
</tr>
<tr>
<td>Turn cooperation model activation</td>
<td>Turn priority change</td>
</tr>
<tr>
<td>Speed change</td>
<td>School zones, VMS</td>
</tr>
<tr>
<td>Forced turn</td>
<td>A certain percentage of vehicles need to turn at a certain location</td>
</tr>
<tr>
<td>Force en route assignment</td>
<td>A certain percentage of vehicles need to use alternative routes</td>
</tr>
<tr>
<td>Destination change</td>
<td>When the destination zone is required to change (this should be done carefully as it is essentially a change to the matrix)</td>
</tr>
<tr>
<td>Park and ride</td>
<td>Similar to destination change but relating to public transport</td>
</tr>
<tr>
<td>Section incident</td>
<td>Blocks lane(s) to replicate an incident</td>
</tr>
<tr>
<td>Periodic section incident</td>
<td>A time-based section incident</td>
</tr>
<tr>
<td>Deactivation of a reserved lane</td>
<td>Makes reserved lane accessible to all vehicle types</td>
</tr>
<tr>
<td>Control plan change</td>
<td>Changes the current plan to alternative signal control plans, similar to a SCATS action being implemented</td>
</tr>
<tr>
<td>Section behavioural parameters change</td>
<td>Mesoscopic reaction time change</td>
</tr>
</tbody>
</table>

6.3.12 Attribute Override

Aimsun holds a base network that can be modified without having to create a new model, reducing the errors inherent in creating variants of the network.

The aim of the attribute override object is to allow the modification of attributes without having to replicate networks for each configuration such as section distance zones, capacities, section VDFs and turn penalties.

6.3.13 Scripts

Python scripting is ideal for writing small utilities to automate some operations that would usually be done manually with the graphical user interface (GUI). Typical tasks that might be performed with scripting are:
• modifying the model or a group of objects
• importing or exporting data
• performing calculations with the model’s data
• modifying the meta data model
• introducing new attributes.

The scripts which are commonly used are:
• TSS-Macro Turning Penalties (Priority) – used for automatically apply turning penalties to priority intersections.
• TSS-Macro Turning Penalties (Signal) – used for automatically apply turning penalties to signalised intersections.
• TSS-Change Signal Control External – used for changing signal control from fixed to external or from external to fixed, and can be used when running SCATSIM signals.

6.3.14 Subpaths

A subpath is a set of consecutive sections that can have any length and can be located anywhere in the model. Subpaths have two main uses:

• To gather subpath statistics, for example travel time, flow, counts, and delays.
• To be used in traffic management actions as part of a vehicle’s route.

For analysis of critical routes, Main Roads recommends the use of subpaths to obtain path statistics.

6.3.15 Subnetworks

A subnetwork is a subarea of the global network that can be analysed independently. Subnetworks are used for detailed analysis of an area within a wider network. Typical applications of subnetworks include:

• Analysis of a subarea within the wider strategic network. Generally, the strategic model information should be stored in the main model and subnetworks should be created for each project.
• Analysis of a subarea within an existing simulation model

Once a subnetwork is defined, a traversal demand should be generated based on the assignment results from the main model. To generate the traffic demand in a subnetwork, a static traversal or a dynamic traversal may be used. A traversal requires input from a previously-run static experiment or dynamic simulation replication of the wider project network to provide the demand data for the subnetwork demand.

6.3.16 Geometry Configuration

Geometry configuration is an alternative network geometry of a traffic network. For example, it can be used to code an intersection upgrade, including new links to the intersection (sections and nodes) and smaller modifications to the intersection (for example, an additional turn lane). It allows modellers to simulate different scenarios with different combination of possible network changes.
Geometry configuration is implemented as a list of objects that exist only (*exist only here*) and a list of objects that do not exist (*non-exist here*) in a specific scenario when the configuration is selected. Objects that are not selected in any geometry configuration are common to all scenarios.

Main Roads recommends that modellers use a single geometry configuration for each distinct project, as this allows maximum flexibility for the assessment of individual projects as well as the aggregated impacts of each project. The same geometry configurations should be used consistently in each related level of modelling in order to ensure consistent outcomes.

As geometry configurations will affect the network in terms of link connectivity, checks and changes will be needed for the following aspects:

- public transport lines
- subpaths
- traffic management plans
- network attribute overrides
- section and turn parameters
- traffic signal plans

6.3.17 Revisions

A revision is a traffic network modification which only stores those elements that have been changed. Revisions are useful for projects that start from an initial situation and want to study changes or events without creating new scenarios, geometry changes or demands in the base model file. Revisions are also useful when several modellers are working on different parts of the network and their changes need to be combined into one model revision.

A revised network contains objects which overwrite those in the base model network file with only those modified objects. The base network must be present when loading a revised network and if it cannot be found, Aimsun will request its location. As the objects in the revised network overwrite the base network objects, any subsequent changes to the base network for those objects will not be included in the revised network.

As it only contains the revision modifications, a revision needs the base network to load the whole network. It is possible to transform a revision into a full network by consolidating the base and the revision information in the same file. This can be done from the Project/Consolidate Revision window where:

- *Consolidate in base* – copies the revisions into the base which in turn will affect any other revisions based on this base model. This also updates object IDs in the base revision.
- *Consolidate in revision* – copies the base into the revised model and makes the base and revision into two independent documents.

6.4 Demand Set-up

Once transport network and network parameters are coded in a model, modellers should define traffic demand data to be assigned in the network. This section discusses the information for demand data set-up in Aimsun.
6.4.1 Centroid Configuration

A Centroid Configuration holds a set of centroids, OD matrices and routes related to those centroids. A network may have multiple centroid configurations; these are used to hold

- OD matrices for the whole network
- OD matrices for sub areas.
- Variations of demand due to future infrastructures.

More than one configuration can exist in the same network but only one can be active for editing or in use in a simulation at the same time. Only centroids from the active configuration will be drawn.

6.4.1.1 OD Matrices

The traffic conditions to be simulated can be defined by a set of OD matrices.

An OD matrix contains all the trips that will be generated in a network for a particular vehicle type and trip purpose in a defined time period. Each cell of an OD matrix contains the number of vehicles going from origin to destination zones. An OD matrix is linked to Centroid Configuration.

Main Roads recommends that every new OD matrix is named accordingly using year, peak time and any specific use.

Figure 6-11 shows an example of OD matrices naming convention.

Figure 6-11: Example of OD Matrices naming convention

6.4.2 Path Assignment

A path assignment contains the information about the paths generated in a traffic assignment (either dynamic or static). It is stored as a binary file with an Aimsun specific format (.apa).

The information in a path assignment can be explored as an output of static assignments and of dynamic assignments.
A Path Assignment object in Aimsun contains information about the path assignment data file location and the objects that are using it (scenarios can use it as input, experiments or replications can produce an .apa file as output).

Figure 6-12 shows an example of a Path Assignment object window.

Figure 6-12: Example of Path Assignment details

Main Roads recommends that the modeller names Path Assignments according to the scenario and assignment type to avoid confusion.

6.4.3 Traffic Demand

A Traffic Demand is a collection of OD Matrices, which can be placed as a single object in different scenarios. Traffic Demand object is intended to simplify the process of managing demand states and facilitate allocating them consistently across scenarios.

In Aimsun, OD matrices are created for a single vehicle type and trip purpose (in the case of OD matrices, that is, for a single user class) in a single time period. Several OD matrices will be grouped into a Traffic Demand which contains traffic data for several vehicle types (or several user classes) and time intervals and are used as input for one or more Aimsun scenarios.

There is also a global factor that can be used for scaling all the OD matrices included in a traffic demand. Modellers can set a percentage to scale all the trips in the OD matrix for future year or other scenario assessments.

Figure 6-13 shows an example of how to set-up a Traffic Demand in Aimsun.
Figure 6-13: Example of Traffic Demand editor

The Profile folder shows the demand profile, that is, a diagram showing the percentage of trips of each of the matrices in the demand, for each user class.

Figure 6-14 shows an example of a Traffic Demand profile used in Aimsun.

Figure 6-14: Example of Traffic Demand Profile
Main Roads recommend that modellers use at least 15 minutes of warm-up and cool-down periods with a minimum of 85% of peak hour volumes unless modellers have justifications to use other values.

It is recommended for model category 1 (Refer to Section 2.11.2.1) that traffic count data are analysed for 15 minute intervals and demand profile are set accordingly for peak periods to enable a model replicate on-site observed traffic flow accurately.

Modellers can use hourly volumes for model categories 2 and 3 and set at 15 minute intervals with a flat demand profile.

### 6.4.4 Real Data Sets

Aimsun can read external detection data as a time series that can be used to calibrate and validate a model, to adjust an OD matrix or to display the current traffic data on the network. The time value in the real data set .txt file should be the end time, while the time value in real data simple file reader editor should be the initial time.

Figure 6-15 shows an example of real data simple file reader editor settings and Figure 6-16 shows an example of a real data set .txt file.

**Figure 6-15: Real data simple file reader editor settings**
6.4.5 Vehicle Settings

The vehicle settings have been developed based on on-site conditions in WA as well as with reference to other states’ guidelines. The recommended vehicle parameter ranges are shown in Table 6-3 to Table 6-9.

Table 6-3: Car parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (m)</td>
<td>4.0 - 4.6</td>
<td>0.45 - 0.5</td>
<td>3 - 3.35</td>
<td>5 - 5.35</td>
</tr>
<tr>
<td>Width (m)</td>
<td>1.75 - 2.00</td>
<td>0 - 0.25</td>
<td>1.75 - 2.00</td>
<td>1.75 - 2.00</td>
</tr>
<tr>
<td>Max. desired speed (km/h)</td>
<td>110</td>
<td>5.5 - 10.0</td>
<td>80 - 99</td>
<td>120</td>
</tr>
<tr>
<td>Speed acceptance</td>
<td>0.96 - 1.05</td>
<td>0.05 - 0.09</td>
<td>0.75 - 0.95</td>
<td>1.12 - 1.16</td>
</tr>
<tr>
<td>Clearance (m)</td>
<td>1.85 - 3.00</td>
<td>0.25 - 0.80</td>
<td>0.50 - 2.50</td>
<td>3.20 - 3.50</td>
</tr>
<tr>
<td>Max. give-way time (seconds)</td>
<td>15 - 30</td>
<td>3 - 5</td>
<td>5 - 24</td>
<td>30 - 36</td>
</tr>
<tr>
<td>Guidance acceptance (%)</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Max. acceleration (m/s2)</td>
<td>2.70 - 2.80</td>
<td>0.20 - 0.56</td>
<td>1.68 - 2.20</td>
<td>3.50 - 3.92</td>
</tr>
<tr>
<td>Normal deceleration (m/s2)</td>
<td>3.5 - 4.0</td>
<td>0.2 - 0.4</td>
<td>3.0 - 3.2</td>
<td>4.0 - 4.8</td>
</tr>
<tr>
<td>Max. deceleration (m/s2)</td>
<td>6.0 - 6.5</td>
<td>0.50 - 0.65</td>
<td>5.0 - 5.2</td>
<td>7.0 - 7.8</td>
</tr>
<tr>
<td>Sensitivity factor</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gap (s)</td>
<td>1.1</td>
<td>0.2</td>
<td>0.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Margin for overtaking manoeuvre</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

23 Department of Planning, Transport and Infrastructure’s (South Australia) Aimsun Traffic Simulation Model Development Manual, and Department of Transport and Main Roads’ (Queensland) Aimsun Template
### Table 6-4: Bus parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (m)</td>
<td>12.0 - 15.5</td>
<td>2.0</td>
<td>9.0 - 12.5</td>
<td>15.0 - 19.0</td>
</tr>
<tr>
<td>Width (m)</td>
<td>2.3 - 2.4</td>
<td>0.0 - 0.5</td>
<td>1.9 - 2.4</td>
<td>2.4 - 3.0</td>
</tr>
<tr>
<td>Max. desired speed (km/h)</td>
<td>90</td>
<td>5 - 10</td>
<td>80</td>
<td>100 - 120</td>
</tr>
<tr>
<td>Speed acceptance</td>
<td>0.93 - 1.00</td>
<td>0.10</td>
<td>0.69 - 0.9</td>
<td>1.09 - 1.10</td>
</tr>
<tr>
<td>Clearance (m)</td>
<td>1.5 - 3.0</td>
<td>0.15 - 0.5</td>
<td>1.0 - 2.7</td>
<td>2.5 - 3.5</td>
</tr>
<tr>
<td>Max. give-way time (s)</td>
<td>15 - 50</td>
<td>5 - 20</td>
<td>5 - 30</td>
<td>30 - 80</td>
</tr>
<tr>
<td>Guidance acceptance (%)</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Max. acceleration (m/s²)</td>
<td>0.9 - 1.0</td>
<td>0.2 - 0.3</td>
<td>0.8</td>
<td>1.6 - 1.8</td>
</tr>
<tr>
<td>Normal deceleration (m/s²)</td>
<td>2.0 - 3.0</td>
<td>0.3 - 2.0</td>
<td>1.5 - 2.0</td>
<td>3.5 - 4.8</td>
</tr>
<tr>
<td>Max. deceleration (m/s²)</td>
<td>5.0</td>
<td>0.5 - 2.0</td>
<td>4.0 - 4.5</td>
<td>6.0 - 7.8</td>
</tr>
<tr>
<td>Sensitivity factor</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gap (s)</td>
<td>1.1</td>
<td>0.2</td>
<td>0.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Margin for overtaking manoeuvre (s)</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

### Table 6-5: Truck parameters (Short-towing, two-axle, three-axle, four-axle truck)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (m)</td>
<td>8.65 - 12.00</td>
<td>1.0 - 1.9</td>
<td>5.5 - 10.0</td>
<td>11.65 - 14.5</td>
</tr>
<tr>
<td>Width (m)</td>
<td>2.4 - 2.5</td>
<td>0.0</td>
<td>2.4 - 2.5</td>
<td>2.4 - 2.5</td>
</tr>
<tr>
<td>Max. desired speed (km/h)</td>
<td>100 - 110</td>
<td>5.0 - 5.5</td>
<td>80 - 99</td>
<td>110 - 121</td>
</tr>
<tr>
<td>Speed acceptance</td>
<td>0.94 - 1.00</td>
<td>0.05 - 0.10</td>
<td>0.69 - 0.90</td>
<td>1.09 - 1.10</td>
</tr>
<tr>
<td>Clearance (m)</td>
<td>2.0 - 3.0</td>
<td>0.15 - 1.30</td>
<td>0.50 - 2.70</td>
<td>3.30 - 3.80</td>
</tr>
<tr>
<td>Max. give-way time (s)</td>
<td>15 - 30</td>
<td>3 - 5</td>
<td>5 - 24</td>
<td>30 - 36</td>
</tr>
<tr>
<td>Guidance acceptance (%)</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Max. acceleration (m/s²)</td>
<td>1.50 - 1.60</td>
<td>0.15 - 0.80</td>
<td>0.80 - 1.20</td>
<td>1.80 - 2.40</td>
</tr>
<tr>
<td>Normal deceleration (m/s²)</td>
<td>2.2 - 3.0</td>
<td>0.22 - 0.30</td>
<td>1.76 - 2.00</td>
<td>2.64 - 3.50</td>
</tr>
<tr>
<td>Max. deceleration (m/s²)</td>
<td>3.00 - 5.00</td>
<td>0.06 - 0.50</td>
<td>2.88 - 4.00</td>
<td>3.12 - 6.00</td>
</tr>
<tr>
<td>Sensitivity factor</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gap (s)</td>
<td>1.3</td>
<td>0.2</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Margin for overtaking manoeuvre (s)</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>
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#### Table 6-6: Semi-trailer parameters (Three-axle, four-axle, five-axle, six-axle articulated)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (m)</td>
<td>17.0 - 19.0</td>
<td>0.0 - 2.0</td>
<td>11.5 - 19.0</td>
<td>19.0 - 19.1</td>
</tr>
<tr>
<td>Width (m)</td>
<td>2.4 - 2.5</td>
<td>0.0</td>
<td>2.4 - 2.5</td>
<td>2.4 - 2.5</td>
</tr>
<tr>
<td>Max. desired speed (km/h)</td>
<td>100 - 110</td>
<td>5.0 - 5.5</td>
<td>80 - 99</td>
<td>110 - 121</td>
</tr>
<tr>
<td>Speed acceptance</td>
<td>0.94 - 1.00</td>
<td>0.05 - 0.10</td>
<td>0.69 - 0.90</td>
<td>1.09 - 1.10</td>
</tr>
<tr>
<td>Clearance (m)</td>
<td>2.0 - 4.0</td>
<td>0.25 - 1.30</td>
<td>0.5 - 3.0</td>
<td>3.8 - 5.0</td>
</tr>
<tr>
<td>Max. give-way time (s)</td>
<td>15 - 30</td>
<td>3 - 5</td>
<td>5 - 24</td>
<td>30 - 36</td>
</tr>
<tr>
<td>Guidance acceptance (%)</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Max. acceleration (m/s²)</td>
<td>1.00</td>
<td>0.05 - 0.50</td>
<td>0.50 - 0.90</td>
<td>1.10 - 1.50</td>
</tr>
<tr>
<td>Normal deceleration (m/s²)</td>
<td>2.0 - 3.0</td>
<td>0.2 - 0.3</td>
<td>1.6 - 2.0</td>
<td>2.4 - 3.5</td>
</tr>
<tr>
<td>Max. deceleration (m/s²)</td>
<td>2.90 - 5.00</td>
<td>0.09 - 0.50</td>
<td>2.73 - 4.00</td>
<td>3.07 - 6.00</td>
</tr>
<tr>
<td>Sensitivity factor</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gap (s)</td>
<td>1.3</td>
<td>0.2</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Margin for overtaking manoeuvre (s)</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

#### Table 6-7: B-double parameters (B-double, double road train)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (m)</td>
<td>25.0 - 25.5</td>
<td>0</td>
<td>17.5</td>
<td>25.0 - 36.5</td>
</tr>
<tr>
<td>Width (m)</td>
<td>2.5</td>
<td>0</td>
<td>2.4 - 2.5</td>
<td>2.4 - 2.5</td>
</tr>
<tr>
<td>Max. desired speed (km/h)</td>
<td>100 - 110</td>
<td>10 - 11</td>
<td>80 - 88</td>
<td>110 - 132</td>
</tr>
<tr>
<td>Speed acceptance</td>
<td>0.94 - 1.00</td>
<td>0.02 - 0.10</td>
<td>0.69 - 0.90</td>
<td>1.04 - 1.09</td>
</tr>
<tr>
<td>Clearance (m)</td>
<td>2.0 - 4.0</td>
<td>0.2 - 1.3</td>
<td>0.5 - 3.6</td>
<td>3.8 - 4.4</td>
</tr>
<tr>
<td>Max. give-way time (s)</td>
<td>15 - 60</td>
<td>5-6</td>
<td>5 - 48</td>
<td>30 - 72</td>
</tr>
<tr>
<td>Guidance acceptance (%)</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Max. acceleration (m/s²)</td>
<td>0.80</td>
<td>0.04 - 0.60</td>
<td>0.50 - 0.72</td>
<td>0.88 - 2.40</td>
</tr>
<tr>
<td>Normal deceleration (m/s²)</td>
<td>2.0 - 3.0</td>
<td>0.2 - 0.3</td>
<td>1.6 - 2.0</td>
<td>2.4 - 3.5</td>
</tr>
<tr>
<td>Max. deceleration (m/s²)</td>
<td>2.75 - 5.00</td>
<td>0.08 - 0.50</td>
<td>2.59 - 4.00</td>
<td>2.92 - 6.00</td>
</tr>
<tr>
<td>Sensitivity factor</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gap (s)</td>
<td>1.3</td>
<td>0.2</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Margin for overtaking manoeuvre (s)</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Parameter</td>
<td>Mean</td>
<td>Deviation</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-------</td>
<td>-----------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Length (m)</td>
<td>36.5</td>
<td>0</td>
<td>36.5</td>
<td>36.5</td>
</tr>
<tr>
<td>Width (m)</td>
<td>3.0</td>
<td>0.20</td>
<td>2.50</td>
<td>3.50</td>
</tr>
<tr>
<td>Max. desired speed (km/h)</td>
<td>100</td>
<td>10</td>
<td>90</td>
<td>110</td>
</tr>
<tr>
<td>Speed acceptance</td>
<td>1.0</td>
<td>0.1</td>
<td>0.95</td>
<td>1.05</td>
</tr>
<tr>
<td>Clearance (m)</td>
<td>1.50</td>
<td>0.50</td>
<td>1.0</td>
<td>2.50</td>
</tr>
<tr>
<td>Max. give-way time (s)</td>
<td>35.0</td>
<td>10.0</td>
<td>20.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Guidance acceptance (%)</td>
<td>100</td>
<td>0.00</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Max. acceleration (m/s²)</td>
<td>0.60</td>
<td>0.25</td>
<td>0.40</td>
<td>0.80</td>
</tr>
<tr>
<td>Normal deceleration (m/s²)</td>
<td>2.00</td>
<td>0.50</td>
<td>2.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Max. deceleration (m/s²)</td>
<td>3.50</td>
<td>0.30</td>
<td>3.20</td>
<td>3.80</td>
</tr>
<tr>
<td>Sensitivity factor</td>
<td>1.00</td>
<td>0.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Gap (s)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Margin for overtaking manoeuvre (s)</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 6-9: Pedestrian parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (m)</td>
<td>0.30 - 0.34</td>
<td>0</td>
<td>0.30 - 0.34</td>
<td>0.30 - 0.34</td>
</tr>
<tr>
<td>Width (m)</td>
<td>0.45 - 0.50</td>
<td>0.02</td>
<td>0.47</td>
<td>0.53</td>
</tr>
<tr>
<td>Max. desired speed (km/h)</td>
<td>3.60 - 4.86</td>
<td>0.918 - 2.00</td>
<td>2.34 - 2.50</td>
<td>5.40 - 7.38</td>
</tr>
<tr>
<td>Speed acceptance</td>
<td>1.00</td>
<td>0.50</td>
<td>0.25</td>
<td>1.50</td>
</tr>
<tr>
<td>Clearance (m)</td>
<td>0.20</td>
<td>0.15</td>
<td>0.05</td>
<td>0.35</td>
</tr>
<tr>
<td>Max. give-way time (s)</td>
<td>20</td>
<td>5</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Guidance acceptance (%)</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Max. acceleration (m/s²)</td>
<td>0.5</td>
<td>0.2</td>
<td>0.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Normal acceleration (m/s²)</td>
<td>1.2</td>
<td>0.2</td>
<td>0.2</td>
<td>1.6</td>
</tr>
<tr>
<td>Max. deceleration (m/s²)</td>
<td>1.5</td>
<td>0.2</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Sensitivity factor</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gap (s)</td>
<td>1.3</td>
<td>0.2</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Margin for overtaking manoeuvre (s)</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>
6.5 Scenario Set-up

Once the model network and demand data are set up, modellers should determine the traffic assignment method. This section discusses different traffic assignment types and recommended method for WA road network.

6.5.1 Static

Static traffic assignment is generally used inmacroscopic modelling to estimate the routes between origin and destination zones and link traffic volumes on a network. The path assignment (Refer to Section 6.4.2) as an output of static assignments can be used as an initial path data for dynamic assignments in large mesoscopic and microscopic models.

There are five different static assignment methods available:

- all or nothing assignment
- incremental assignment
- MSA assignment
- Frank-Wolfe method for equilibrium traffic assignment
- stochastic assignment.

It is recommended that modellers use the assignment type which corresponds with that used in the strategic model. Frank-Wolfe assignment used in ROM24 should be applied to a model developed from ROM24.

Before undertaking a static traffic assignment, the modeller should set or check all the input data needed, including road type, section capacity, speed limit, school zones, cost functions, and parameters they depend on.

Figure 6-17 shows the recommended parameters setting for Frank-Wolfe assignment for the models developed from ROM24. These settings should be adjusted based on the needs of the specific project.

**Figure 6-17: Recommended parameters for Frank-Wolfe assignment**

There are three types of functions which model the macroscopic costs on the network:

- Volume delay functions (VDF) – model the generalised cost of the sections and centroid connections.
- Turn penalty functions (TPF) – model the primary generalised cost of crossing a turn.
- Junction delay functions (JDF) – model the delay caused in a turn due to conflicting turn volumes, the own turn volume or the origin’s section volume.

For consistency, it is recommended that the primary functions used in the static assignment should be a direct reference to the relevant strategic model.
6.5.2 **Dynamic User Equilibrium**

A dynamic scenario of mesoscopic, microscopic and hybrid models can assign traffic using either dynamic user equilibrium or stochastic route choice.

Table 6-10 outlines the recommended parameters for setting up a dynamic user equilibrium assignment. The listed parameter settings are a recommendation only, and adjustment and calibration of these parameters will be needed for different models. Modellers must justify any changes to the parameter values in the modelling report.

It is recommended to use a single seed value to run the dynamic user equilibrium experiment in order to obtain the path assignment to be used in the stochastic route choice replications.

**Table 6-10: Recommended dynamic user equilibrium assignment parameter setting**

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameter</th>
<th>Suggested value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stopping criteria</td>
<td>Max. iterations</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Relative gap</td>
<td>3</td>
</tr>
<tr>
<td>Lane changing</td>
<td>Look-ahead distance variability</td>
<td>40%-100%</td>
</tr>
<tr>
<td>Micro parameters</td>
<td>Two-lane car following model</td>
<td>Follow</td>
</tr>
<tr>
<td></td>
<td>Number of vehicles</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Max. speed difference</td>
<td>30 km/h</td>
</tr>
<tr>
<td></td>
<td>Max. distance</td>
<td>100 m</td>
</tr>
<tr>
<td></td>
<td>Max. speed difference on ramp</td>
<td>50 km/h</td>
</tr>
<tr>
<td></td>
<td>Speed difference setting</td>
<td>Relative</td>
</tr>
<tr>
<td></td>
<td>Queue entry speed</td>
<td>1 m/s</td>
</tr>
<tr>
<td></td>
<td>Queue exit speed</td>
<td>4 m/s</td>
</tr>
<tr>
<td>Simulation step</td>
<td>Simulation step</td>
<td>0.45 s</td>
</tr>
<tr>
<td>Micro reaction time</td>
<td>Reaction time</td>
<td>0.9 s</td>
</tr>
<tr>
<td>(car)</td>
<td>Reaction time at traffic light</td>
<td>1.35 s</td>
</tr>
<tr>
<td>Micro reaction time</td>
<td>Reaction time</td>
<td>1.35 s</td>
</tr>
<tr>
<td>(truck and bus)</td>
<td>Reaction time at traffic light</td>
<td>1.7 s</td>
</tr>
<tr>
<td>Meso reaction time</td>
<td>Reaction time</td>
<td>1.35 s</td>
</tr>
<tr>
<td>(car)</td>
<td>Reaction time at traffic light</td>
<td>1.6 s</td>
</tr>
<tr>
<td>Meso reaction time</td>
<td>Reaction time</td>
<td>1.35 s</td>
</tr>
<tr>
<td>(truck and bus)</td>
<td>Reaction time at traffic light</td>
<td>1.7 s</td>
</tr>
<tr>
<td>Arrival type</td>
<td>Global arrivals</td>
<td>Exponential</td>
</tr>
</tbody>
</table>
### 6.5.3 Stochastic Route Choice

Table 6-11 describes the typical parameters for setting up a stochastic route choice assignment. The listed parameter settings are a recommendation only, and adjustment and calibration of parameters will be needed for different models. Modellers must justify any changes to the parameter values in the modelling report.

If the model has limited route choice, it is recommended that modellers use fixed travel time under free-flow conditions in the model (in the *Dynamic Traffic Assignment* window).

**Table 6-11: Recommended stochastic assignment parameter settings**

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameter</th>
<th>Suggested value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane changing</td>
<td>Look-ahead distance variability</td>
<td>40%-100%</td>
</tr>
<tr>
<td>Micro parameters</td>
<td>Two-lane car following model</td>
<td>Follow</td>
</tr>
<tr>
<td></td>
<td>Number of vehicles</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Max. speed difference</td>
<td>30 km/h</td>
</tr>
<tr>
<td></td>
<td>Max. distance</td>
<td>100 m</td>
</tr>
<tr>
<td></td>
<td>Max. speed difference on ramp</td>
<td>50 km/h</td>
</tr>
<tr>
<td></td>
<td>Speed difference setting</td>
<td>Relative</td>
</tr>
<tr>
<td></td>
<td>Queue entry speed</td>
<td>1 m/s</td>
</tr>
<tr>
<td></td>
<td>Queue exit speed</td>
<td>4 m/s</td>
</tr>
<tr>
<td>Meso reaction time</td>
<td>Reaction time</td>
<td>1.35 s</td>
</tr>
<tr>
<td>(car)</td>
<td>Reaction time at traffic light</td>
<td>1.6 s</td>
</tr>
</tbody>
</table>

#### Dynamic assignment

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameter</th>
<th>Suggested value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic assignment</td>
<td>Feedback cycle</td>
<td>Dependent on model size, should be less than the average model travel time</td>
</tr>
<tr>
<td></td>
<td>Number of intervals</td>
<td>1-3</td>
</tr>
<tr>
<td></td>
<td>User-defined cost weight</td>
<td>Dependent on model route choice calibration, can be of a value of up to 5 or more</td>
</tr>
<tr>
<td></td>
<td>Attractiveness weight</td>
<td>Dependent on model route choice calibration, can be of a value of up to 10</td>
</tr>
<tr>
<td></td>
<td>Assignment model</td>
<td>Gradient</td>
</tr>
<tr>
<td></td>
<td>Path cost</td>
<td>Experienced</td>
</tr>
<tr>
<td></td>
<td>Max. paths from path assignment results</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Max. paths per interval</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Initial K-SP trees</td>
<td>1</td>
</tr>
<tr>
<td>Type</td>
<td>Parameter</td>
<td>Suggested value</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td><strong>Meso reaction time</strong></td>
<td>Reaction time</td>
<td>1.35 s</td>
</tr>
<tr>
<td>(truck and bus)</td>
<td>Reaction time at traffic light</td>
<td>1.7 s</td>
</tr>
<tr>
<td><strong>Simulation step</strong></td>
<td>Simulation Step</td>
<td>0.45 s</td>
</tr>
<tr>
<td><strong>Micro reaction time</strong></td>
<td>Reaction time</td>
<td>0.9 s</td>
</tr>
<tr>
<td>(car)</td>
<td>Reaction time at traffic light</td>
<td>1.35 s</td>
</tr>
<tr>
<td><strong>Micro reaction time</strong></td>
<td>Reaction time</td>
<td>1.35 s</td>
</tr>
<tr>
<td>(truck and bus)</td>
<td>Reaction time at traffic light</td>
<td>1.7 s</td>
</tr>
<tr>
<td><strong>Arrival type</strong></td>
<td>Global arrivals</td>
<td>Exponential</td>
</tr>
<tr>
<td><strong>Dynamic assignment</strong></td>
<td>Feedback cycle</td>
<td>Should be less than the average network travel time</td>
</tr>
<tr>
<td></td>
<td>Number of intervals</td>
<td>1-3</td>
</tr>
<tr>
<td></td>
<td>User-defined cost weight</td>
<td>Dependent on model route choice calibration, can be of a value of up to 5 or more</td>
</tr>
<tr>
<td></td>
<td>Attractiveness weight</td>
<td>Dependent on model route choice calibration, can be of a value of up to 10</td>
</tr>
<tr>
<td></td>
<td>Stochastic route choice model</td>
<td>C-Logit</td>
</tr>
<tr>
<td></td>
<td>En route</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>En route after virtual queue</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Max. paths from path assignment results</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Max. paths per interval</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Do not consider paths with a percentage below</td>
<td>1 (can be adjusted)</td>
</tr>
<tr>
<td><strong>C-Logit parameters</strong></td>
<td>Scale</td>
<td>Average travel time in minutes / 60</td>
</tr>
<tr>
<td></td>
<td>Beta</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>Gamma</td>
<td>1</td>
</tr>
<tr>
<td><strong>En route percentage</strong></td>
<td>Following OD routes</td>
<td>Depends on the project</td>
</tr>
<tr>
<td></td>
<td>Following path assignment result</td>
<td>Depends on the project, at least 50%</td>
</tr>
<tr>
<td></td>
<td>Following route choice models</td>
<td>100% but can be adjusted</td>
</tr>
</tbody>
</table>
6.5.4 Seed Number

There is variability in traffic conditions as a result of random driver behaviour and different daily events. Aimsun attempts to replicate this random variability by altering individual driver decisions based on random seed numbers.

For a dynamic user equilibrium scenario, it is important to ensure the random seed number is the same as the mesoscopic, microscopic or hybrid scenario which created the assigned paths.

For stochastic route choice replications, modellers must run a minimum of five and a maximum of 10 replications with different random seed values and present average model outputs. The modeller should list the used seed numbers in the modelling report.

It is recommended to use a single seed value to run the dynamic user equilibrium experiment in order to obtain the path assignment to be used in the stochastic route choice replications.

Seed values must remain consistent across all scenarios.

6.6 Model Calibration and Validation

The general calibration and validation require an iterative process of adjusting parameters and analysing model results until the model has achieved an accepted level of confidence when compared to the on-street conditions.

The calibration and validation requirements could be defined based on the importance of a specific project and its significance to the region. It is recommended that modellers discuss the requirements with Main Roads.

6.6.1 Model Calibration Requirement

Base model calibration is the process of employing verifiable observed data into a model to replicate on-street conditions. The following sub-sections discuss the recommended requirements and model input data for the model calibration.

6.6.1.1 Data Collection

For consistency and accuracy of the modelling, it is recommended that all data is collected on the same day. The following list of data, although not exhaustive, should be collected.

- design layout information
- SCATS data
- traffic counts
- OD surveys
- public transport route and timetable information
- travel time data
- queue length
- saturation flow
• vehicle speed
• video footage

6.6.1.2 Site Observations

It is important for modellers to observe the existing site conditions. Driving behaviours, network configuration, signal operations and other events which may impact on the performance should be captured and reported as part of the modelling. The operating conditions and site findings should be captured in the form of photographs and videos.

6.6.1.3 Model Input Check

Modellers should check network coding and network objects’ attributes to confirm that the model network replicates the existing or the proposed transport network, and that the simulation is consistent with the observed on-street vehicle behaviour.

The key input to be checked includes:
• number of lanes
• lane width
• lane closure
• section parameters (type)
• Z-height
• feasible movements
• vehicle speed
• priority intersection controllers
• signal control
• traffic demands (OD matrices)
• vehicle routes
• dynamic assignment parameters

6.6.1.4 Vehicle Behaviour

As it is difficult to set up a standard for vehicle behaviour, modellers should undertake a visual check to confirm that the observed on-street vehicle behaviour is consistent with that observed in the model. Vehicle behaviour such as speed/flow performances, bottlenecks, queue formation and discharging need to be carefully compared and calibrated.

A correctly coded network should reflect on-street vehicle behaviour, especially during congested peak times. Main Roads recommends modellers drive through the network and capture videos of critical locations to familiarise themselves with driving behaviours.

Modellers should include notes and changes to the network in the modelling report.

6.6.1.5 Error Files

Ideally, there should be no error messages for a calibrated and validated model.
If error messages are generated and consistent errors occur at certain location(s), modellers must review network coding and model parameters to ensure all model deficiencies are addressed or reported.

6.6.2 Model Validation Requirement

Main Roads defines the three model categories for model validation, based on the network size and modelling purposes. Refer to Section 2.11.2.1 for the model category definitions and validation requirements. The following sub-sections discuss the validation criteria for Aimsun models.

6.6.2.1 Traffic Volumes

Main Roads requires hourly turning movement and directional link volume to be validated for each major vehicle type. Table 6-12 below demonstrates the model validation criteria for individual model categories.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEH &lt; 5</td>
<td>95%</td>
<td>85%</td>
<td>80%</td>
</tr>
<tr>
<td>GEH &lt; 10</td>
<td>100%</td>
<td>95%</td>
<td>90%</td>
</tr>
<tr>
<td>&lt; 700 vph within 100 vph</td>
<td>95%</td>
<td>90%</td>
<td>85%</td>
</tr>
<tr>
<td>700 – 2,700 vph within 15%</td>
<td>95%</td>
<td>90%</td>
<td>85%</td>
</tr>
<tr>
<td>&gt; 2,700 vph within 400 vph</td>
<td>95%</td>
<td>90%</td>
<td>85%</td>
</tr>
<tr>
<td>R squared value</td>
<td>&gt;0.95</td>
<td>&gt;0.95</td>
<td>&gt;0.9</td>
</tr>
</tbody>
</table>

Plots of observed against modelled hourly flows are required to be reported for all observations.

Where throughput between upstream and downstream intersections does not match potentially due to survey error, the flow discrepancy should be identified and detailed in the modelling report. While it is recommended that in these circumstances the most appropriate traffic flow be used based on engineering judgement, this will also need to be explained in the modelling report.

Aimsun compares the modelled result with the real data set in the Validation tab. Modellers can check three different available comparisons: by means of a graph, a regression chart or a table.

Under the same Validation tab, there is an option to calculate the GEH/Theil statistic for a specific replication and the function will automatically generate a view mode that display the results in the user interface, as shown in Figure 6-18. Results should be tabulated and included in the modelling report.
6.6.2.2 Travel Times

As discussed in Section 2.9.5 travel time is a common technique used to assess the accuracy of a microsimulation model and compare surveyed and modelled travel times along key routes in the study area. Travel times can affect driver route choice through the model and have a significant impact on traffic volumes and the development of delays and congestion.

To collect travel times it is important to create *subpaths* of smaller sections. A subpath is a set of consecutive sections that can be any length and located anywhere in the model.

Main Roads recommends modellers measure travel times between intersection stop lines along key routes in the study area. The sections to compare should be agreed with Main Roads during the scope meeting. The extracted travel time for the model validation should be average values over five replications.

The use of sections allows a cumulative graph of travel time along the route to be developed. This type of graph can provide an accurate analysis that demonstrates how the model performs in each key section, rather than simply providing a total travel time. Figure 6-19 provides an example of this type of comparison.
The modelled travel times should be within 15% or one minute (whichever is greater) of average observed travel time. Table 6-13 shows travel time validation criteria for individual model categories.

Table 6-13: Microsimulation travel time validation criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 % or one minute of average observed travel time</td>
<td>100%</td>
<td>90%</td>
<td>85%</td>
</tr>
</tbody>
</table>

6.6.2.2.1 Travel Time Variability

While the cumulative graph of travel times by section provides a good assessment of average travel times for each route, it is also important to ensure that the model accurately represents the variability of the travel times noted during the surveys.

In order to provide a comparison of observed and modelled variability, a graph plotting the average travel time and a 95% confidence interval for both the observed and modelled datasets can be used. This graph will demonstrate the level of variability within each dataset and provide a clear indication of how closely the model reflects the observed values.

An example graph showing this data for a number of travel time routes is shown in Figure 6-20. It should be noted that the purpose of the graph is not to achieve a numerical target for model calibration/validation, but to provide a visual indication of how accurately the model is performing in respect to observed and modelled travel time variability.
Main Roads may request that a more detailed assessment be made of any isolated sections of the travel time routes that are of critical significance to the study area. This assessment will require an analysis of the relationship between travel time and traffic volume for both the observed and modelled datasets for that section.

A useful way to confirm the validity of the traffic model is to perform a sense check between the observed and the modelled travel time data. This can be shown as a scatter graph that depicts travel time data collected at any time of day and under any flow conditions. Data points in the scatter graph should correspond to section traffic volume on the X-axis and section travel time on the Y-axis.

The graph in Figure 6-21 shows the relationship between traffic flow and travel time. This data may be useful as it provides an indication of how closely the model replicates the operation of the links and intersections at different levels of congestion, rather than simply the average peak hour observation.
6.6.2.3 Queue Length

Measuring queue lengths on the road is a difficult process and differs to the way Aimsun measures queue lengths on sections.

While Main Roads does not consider queue lengths as a robust indicator to validate a model, queues should appear in the model at the locations where they are observed during site visits and travel time surveys. The model queuing behaviour should be consistent with site observations.

6.6.2.4 Signal Timing

An evaluation of model output and surveyed data should provide confidence that signal cycles and timings are comparable in the model to the recorded average SCATS operation.

Modellers should compare selected signalised intersections in the core area of the model with the recorded average SCATS history data. The intersections to compare should be agreed with Main Roads during the scope meeting.

Table 6-14 shows the signal timing validation criteria for the intersections.
Table 6-14: Microsimulation signal timing validation criteria

<table>
<thead>
<tr>
<th>Signal operation</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed time control - cycle time</td>
<td>Within 5% of recorded average of SCATS history data for same one hour period</td>
</tr>
<tr>
<td>Fixed time control - green time</td>
<td>Within 10% of recorded average phase of SCATS history data for same one hour period</td>
</tr>
<tr>
<td>Vehicle actuated control - Call frequency</td>
<td>Call frequency of demand-dependent phases (including pedestrian phases) to be compared with recorded average phase of SCATS history data for same one hour period</td>
</tr>
</tbody>
</table>

Source: RMS 2013, Traffic Modelling Guidelines

6.6.2.5 Saturation Flows

Saturation flows are measured by exporting link headway files, which contain the headways of vehicles as they cross a stop line at the intersection. These should be processed to calculate the saturation flow at each signalised stop line.

The file is generated using the discharge rate evaluation extension API module. This is selected in the scenario editor section in the ‘Aimsun API’ tab. There are two extensions: one that works in mesoscopic simulation and another one that works in microsimulation. If the model uses hybrid simulation, then both extensions must be selected.

Figure 6-22: Aimsun API Discharge Rate Evaluation Extension

The modeller must ensure that saturation flows are measured on-site for all key sections where queues are observed and that these are used to validate the saturation flows derived from the model. The intersections to compare should be agreed with Main Roads during the scope meeting. All observed and modelled saturation flow values should be tabulated and the percentage error between the two values provided in the modelling report.

Table 6-15 shows saturation flow validation criteria.

Table 6-15: Microsimulation saturation flow validation criteria

<table>
<thead>
<tr>
<th>Saturation flow</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modelled saturation flows against observed values</td>
<td>Within 10%</td>
</tr>
</tbody>
</table>
6.6.2.6 Vehicle Speed

For all freeway modelling projects, speed plots (heat maps) must be produced to compare the modelled and observed freeway segment condition. Critical bottlenecks may require lane-by-lane comparisons. Figure 6-23 provides an example of speed plots.

Figure 6-23: Example of speed plots
6.7 Model Outputs

Modellers are required to report model assessment results to Main Roads for review when the base model is validated and again when proposed option models are completed. This section outlines model evaluation outputs to be reported and recommended ways to review the model outputs in Aimsun models.

6.7.1 Model Evaluation Outputs

Main Roads requires the model evaluation results to be presented in the modelling report. The model outputs include, but are not limited to, those shown in Table 6-16. The results extracted from the model should be clearly presented in tabular or graphical forms.

Table 6-16: Model evaluation outputs

<table>
<thead>
<tr>
<th>Type</th>
<th>Model output</th>
<th>Evaluation method</th>
<th>Time period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network-wide</td>
<td>Number of vehicle</td>
<td>Replication Output (Summary, Time Series – Variables)</td>
<td>Total analysis period (peak)</td>
</tr>
<tr>
<td></td>
<td>Total travel distance</td>
<td>SQLite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total travel time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average delay per vehicle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intersection</td>
<td>Turning movement volume</td>
<td>Node (Time Series – Variables)</td>
<td>15 minute interval analysis period</td>
</tr>
<tr>
<td></td>
<td>LoS for each turning movement and intersection</td>
<td>Section (Time Series – Variables)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Approach queue length</td>
<td>SQLite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average delay for each approach and intersection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical corridor (for example, bottle neck)</td>
<td>Traffic volume</td>
<td>Subpaths (Time Series – Variables)</td>
<td>15 minute interval analysis period</td>
</tr>
<tr>
<td></td>
<td>Density</td>
<td>Section (Time Series – Variables)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LoS</td>
<td>SQLite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heat map</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Route</td>
<td>Volume</td>
<td>Subpaths (Time Series – Variables)</td>
<td>Total analysis period (peak)</td>
</tr>
<tr>
<td></td>
<td>Average travel time</td>
<td>SQLite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Travel distance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average delay time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.7.2 Outputs Set-up

Model outputs can be obtained from view mode, table view and the output database. View mode allows modellers to view the map-based outputs such as section delays, section density and section flows. Figure 6-24 shows an example of 2D view mode.
Table view enables modellers to view the outputs in a table format. There are options to select specific object type, filter the objects based on their attributes and to display a subset of all attributes. Figure 6-25 shows an example of table view displaying modelled outputs.

**Figure 6-24: 2D view mode**

**Figure 6-25: Table view**

The simulation outputs (statistics and detection) can be stored in either an automatic or a custom database. The database can be defined in the Project Properties window or may be defined separately for each scenario in the Scenario Editor window.

The databases supported are:

- Windows 64-bit – Access 64-bit, SQLite and ODBC.
- Linux – SQLite, MySQL, ODBC and Postgres 9.
- Mac OS X – SQLite, MySQL, ODBC and Postgres 9.
Modellers can select the statistics they want to store in the database. The typical statistics required for almost all projects include sections, section lanes, nodes and turns, subpaths and public transport. Other statistics can be selected based on the needs of the project.

For a detailed explanation of the output database terms, modellers should refer to the Output Database Definition section in the *Aimsun 8.1 User Manual*.

### 6.7.3 View Modes and View Styles

A view mode is a combination of several view styles that are applied at the same time. To modify how the network objects are displayed using static or dynamic information, a view mode is applied to a 2D view.

To assist the modeller in interpreting the behaviour in the model, a view mode will often have several view styles attached to it which change the display of objects. View styles may be applied at different levels of zoom, for example a view mode may display a section-related measure by lane at close zoom levels but as a section aggregate at higher zoom levels. Styles may be complementary, using different objects displaying, for example, lost vehicles and nodes where vehicles get lost.

View styles may use dynamic data where the display will be updated as the simulation runs to display different network behaviour, or they may be static and used to find network coding anomalies (for example, displaying section types in different colours to assist the modeller in spotting any discontinuity in road type).

### 6.7.4 Presentation

Aimsun allows modellers to record the simulation as video outputs. The video quality, recording speed, recording size and output folder can be adjusted in the *Microsimulator* section in the *Project Preference Editor* window, as shown in Figure 6-26.

*Figure 6-26: Video recording*
## References

<table>
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<tr>
<th>Title</th>
<th>Author</th>
<th>Year</th>
</tr>
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<td>Year</td>
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<td>-----------------------------------------------------------------------------------</td>
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</tbody>
</table>
Appendices

- Appendix A: Signal Data Information for Modelling
- Appendix B: Saturation Flow Information
- Appendix C: Guidelines for Calibration of Traffic Volumes from ROM24