Management System Document – Guidance Note

Model Auditing Process (MAP) – Traffic Schemes in London Urban Networks

Engineer Guide for Design Engineer (DE), Checking Engineer (CE) and Model Auditing Engineer (MAE)

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I Introduction

1.1 Purpose

To guide modelling practitioners through the work they are required to do as part of a scheme following the Transport for London (TfL) Model Auditing Process (MAP).

1.2 Structure & Target Audience

The structure of this guide complements the TfL MAP Overview document (SQA-0184).

The target audience for this document is primarily the Design Engineer (DE) and Model Auditing Engineer (MAE) however the Checking Engineer (CE) should also be familiar with this document. The technical and practical advice given in this guide is suitable for a Traffic Engineer or Modeller with limited previous experience of model submission and auditing under MAP.

1.3 Expected Awareness and Competencies of the Reader

This document assumes the reader has some awareness of basic traffic engineering principles covering traffic surveys, traffic flows and traffic signal control. The MAE should be familiar with terminology such as phase minimum, phase intergreen, phase delay, stage minimum, stage intergreen, cycle time, signal offset, saturation flow, degree of saturation, stopline flows, manual classified counts and demand flows.

This level of awareness would typically come from introductory courses to traffic signals as well as courses for industry-standard software packages, combined with some experience in the traffic operations environment.

If there are any additional competencies expected relating to a particular modelling package, these will be stated in the section for that package.

1.4 Approach to MAP

It is important to note that this document is only a guide and as such does not attempt to cover every modelling eventuality. This guidance note provides a structure to divide the auditing process into logical, manageable tasks. It should be used in conjunction with the TfL Traffic Modelling Guidelines and relevant software manuals to identify best modelling practice.

It is expected that the DE undertaking modelling work should be familiar with various techniques for traffic modelling and the applicable software to be used for specific tasks. Furthermore it is expected that the DE should have a thorough understanding of the area being modelled having carried out site visits. This is an
essential aspect of modelling and crucial to being able to successfully complete an accurate model.

A competent modelling engineer must act as a CE to review and approve the work completed by the DE before it is submitted to the MAE. This is important because the MAE is obliged to notify the Promoter (P) that further auditing will cease should they lose confidence in the ability of the DE.

When starting to audit a model, the MAE may face a substantial amount of data to interpret and audit. Additionally, there can often be non-intuitive adjustments and techniques applied within a traffic model in order to produce an accurate reflection of the real life network.

For MAEs with limited experience and exposure to model auditing, support from TfL colleagues who have traffic engineering and modelling experience is recommended, and at times necessary. In addition, the MAE is required to be familiar with the modelled area (local knowledge), and to consider how traffic actually behaves on street (and whether this behaviour has been accurately modelled).

When auditing a model, it is understood that there can be instances where there is more than one method of modelling specific behaviour. However, there are also methods which can be clearly identified as inappropriate. Methodological flaws, as well as straightforward data input errors, will be highlighted through the structured model audit outlined within this document.

Advice for MAEs:

A recommended approach for the comparison of different models, whether representing separate peaks during the same MAP stage or one peak at different MAP stages, is to use file comparison software\(^1\).

This approach highlights differences in content between the files, allowing the auditor to focus on specific changes that have been made between models while saving the time that would be required looking through large amounts of modelling data that remain the same.

1.5 Familiarisation with MAP

Prior to undertaking a model auditing exercise in accordance with AMAP, LMAP, TMAP or VMAP, it is recommended that the DE, CE and MAE are familiar with the MAP Overview document (SQA-0184).

\(^1\) UltraCompare (http://www.ultracompare.com) is used within TfL, although similar software is widely available.
MAP is structured to include non-software-specific stages at the onset (Stage 1) and completion (Stage 6) of the scheme design and approval process, as shown in Figure 1. These stages are software independent because they collate information from several streams to both determine the overall purpose of the scheme and finally to assess whether that purpose has been satisfied within the proposed design.

While this document refers to ‘a model’ in relation to the scheme being audited in practice there could be a number of separate models relating to the one scheme, i.e. as would occur when proposals affect an area covering more than one UTC group.

In this case the models covering the multiple areas would all require approval at each ‘MAP Stage’ before moving on to the next MAP Stage. If this situation arises it would be expected that the proposals would be significant and the work involved with the audit process would require careful planning. If this is the case it is recommended that the DE liaise closely with TfL and specifically the MAE to coordinate the submission and audit of the models. A well planned approach will help to eliminate duplication in terms of auditing and amending models.

It is vital that all parties are aware of the roles and responsibilities for each of the defined MAP participants, i.e. Design Engineer (DE), Checking Engineer (CE), Model Auditing Engineer (MAE), Signals Auditing Engineer (SAE), Network Assurance Engineer (NAE) and Promoter (P). These are outlined in section 2 of the MAP Overview (SQA-0184). In particular, the DE and CE must confirm with the MAE that they understand their responsibilities as outlined within MAP Stage 1.

![Figure 1: The software-independent stages within MAP.](image)

All formal MAP submissions and approvals/rejections at each MAP stage should be copied to RSMSchemeAssessments@TfL.gov.uk to ensure that the progress of scheme submissions can be tracked and monitored.
1.6 What's New in this Version of MAP?

This version of MAP contains a number of changes from previous versions. While many of these are minor in nature, others represent significant and fundamental differences. These have been driven by both user feedback and changes in the modelling software used within TfL.

It is recommended that users take time to familiarise themselves with the new versions of the documents relevant to their MAP role, as detailed in section 1.5. These include the MAP Overview document (SQA-0184), the MAP Engineer Guide for DE, CE & MAE (SQA-0685), and the various MAP Stage Check Sheets (SQA-0523 to SQA-0530, SQA-0544 to SQA-0547 and SQA-8670 to SQA-8677).

Areas of MAP that have significantly changed include:

- New MAP introduced for Aimsun models (AMAP);
- Production of a formal Modelling Expectations Document at MAP Stage 1, detailing the agreed modelling requirements and outputs;
- Microsimulation model results must now be based on a minimum of twenty random seeds to allow Journey Time Reliability (JTR) measurement;
- Matrix-based flow allocation is now acceptable in LinSig and TRANSYT where limited route and lane choice exists, such as for small models or when coding fixed routes (e.g. public transport);
- Signal optimisation strategy for LinSig and TRANSYT models is now checked at MAP Stage 5;
- New formalised MAP Stage 4 Check Sheets (SQA-8673, SQA-8675, SQA-8676 and SQA-8677), confirming that details of the proposals and modelling requirements have been discussed and agreed, with the Modelling Expectations Document reviewed and updated;
- Updated MAP Stage 5 Check Sheet for SAE auditing of proposed methods of control (SQA-0530), to ensure compliance with applicable TfL standards;
- New contact email address for MAP stage submissions and approvals, with the former MAP Coordinator (MAC) role removed; and
- The MAE must now upload MAP-approved base and proposed models to the TfL Model Library at MAP Stages 3 & 5.
### 1.7 Reference Documents

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<td>Guidance Note: Traffic Modelling Guidelines – TfL Traffic Manager and Network Performance Best Practice</td>
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2 MAP Stage 1, Scheme and Network Scope Meeting

MAP STAGE 1

It is encouraged, and highly recommended, that MAP Stage 1 Scheme and Network Scope meetings occur prior to scheme detailed designs being developed. This will ensure that all TfL knowledge and requirements are captured by the Promoter (P) and the Design Engineer (DE) prior to development of the scheme.

A Scheme and Network Scope meeting should be arranged as early as possible when it is clear that the P will require Base and Proposed Models to support their detailed design submission to TfL’s Road Space Management Operations Team (RSM-Operations). The DE, CE and MAE key responsibilities for MAP Stage 1 are outlined below.

2.1 MAP Stage 1 Check Sheet

MAP Stage 1 has a Check Sheet (SQA-0544) which acts as a formal record of task completion within MAP Stage 1. The DE should complete this document following the MAP Stage 1 Scheme and Network Scope meeting and provide the completed version to the MAE.

The following sections need to be agreed and documented, which will be confirmed by the MAE following submission by the DE.

M101 Roles & Responsibilities

The DE must acknowledge that as a representative of the P they understand the roles and responsibilities within MAP. The DE should confirm with the MAE an understanding of the MAP process and relevant duties with the DE during the Scheme and Network Scope meeting.

M102 Scheme and Network Scope Meeting

The DE must document the date of the meeting attended by the P, DE, MAE and SAE. The MAE must ensure that the name and affiliation of all parties have been captured on the MAP Stage 1 Check Sheet (SQA-0544).

M103 Baseline List of Proposed Method of Control Changes

The P, DE and SAE should agree and document the junctions affected by the proposal. The DE can create an initial list based on their knowledge of the proposal. It is recommended that the DE creates this list prior to the first meeting and circulates the list to the interested parties. This will facilitate a productive meeting where the
proposals can be discussed with all parties along with an agreement with the SAE about the junctions affected.

Once agreed, the MAE must confirm the DE-created (and SAE-agreed) Baseline List of all TfL-referenced junctions that are affected by the proposal and for which there are changes to the Method of Control and/or the road layout.

**M104 Baseline List of Junctions to be Modelled**

Once M103 has been agreed, the MAE has to consider the proposals and determine and agree the extent of the affected road network which needs to be modelled in order to carry out a valid network impact assessment. The meeting with the NAE, the MAE, the DE and the P provides an opportunity for the extent of the area to be modelled to be discussed.

The DE must create and provide to the MAE a list of affected TfL-referenced junctions and also have an appreciation for the extent of all physical changes which impact on the network as well as any method of control changes that would be required in conjunction with the proposals.

The final decision and notification on which junctions are to be included in the modelled network would normally be made following the meeting. This allows the MAE time to acquire any additional information, data or conduct a site visit if necessary.

Familiarisation with the area of study and traffic modelling/auditing experience is needed to support this decision so it is likely that the MAE will need support from colleagues and other stakeholders in making a decision. This discussion should involve and be agreed with the NAE.

**M105 ‘Purpose’ Statement for each Network Base Model**

Having established the extent of the network to be considered during M104, it is necessary to clarify what these models will be looking to assess. MAP aims to confirm that a submitted traffic model is both valid and accurate; therefore, the DE and MAE should aim, first and foremost, to reach a stage where the submitted model is a correct account of the study network.

The level of detail and the accuracy of a model must reflect the purpose for which the model is intended. The objectives of a scheme will directly influence the type and purpose of any prerequisite modelling. Traffic modelling to support a scheme through TfL approval represents the highest level of detail and accuracy required of a model. The term used in MAP to assess whether a model is valid and accurate is ‘Fit for purpose’. Through MAP, the MAE is being asked to assess the model and to declare whether a model is (or is not) ‘Fit for purpose’.

As the purpose of every individual model is different, the DE must provide to the MAE a clear statement detailing the purpose of each model. With this in mind the DE should produce a ‘Fit for Purpose Statement’ based upon the proposals being put
forward by the P and taking into consideration local conditions of the network being modelled. A separate statement is required for each separate model, i.e. not for each modelled period but for each modelled area. The purpose of the modelling should come from the P's design brief to the DE.

The statement of purpose created by the DE is a key term of reference for all parties involved in MAP. As a minimum it should contain the following information:

- Stated purpose of the base models;
- TfL junction numbers within the defined network;
- Modelled time periods;
- Scheme specific modelling requirements (M106); and
- Software & agreed versions to be used during the model works (M107).

An example is provided below:

Example Definition of the Purpose of a Base Model

Purpose of Base Models With Respect to the Defined Network
The extent of the network under consideration is as agreed with TfL. The TfL junction numbers for the defined network are 01/051, 01/052, 01/053, 01/054, 01/057, 01/058, 01/060, 01/061, 01/062, 01/104, 01/260, 01/323, 01/324, 01/354, 01/003, 01/006, 01/056, 01/333 and 01/401.

The Purpose of the three Base Network Models to be submitted is to provide an accurate reflection of the current performance of the Network for a typical cycle during the AM Peak, Inter Peak, and PM Peak periods respectively. The modelling will be completed using LinSig version 3.2.33.0 & Vissim 5.40-12.

There are no scheme-specific modelling requirements beyond the considerations outlined in the TfL Traffic Modelling Guidelines. These models will be of sufficient quality to be used as benchmarks for assessment of the Network Impact of the proposals, modelled in three respective Proposed LinSig & Vissim Models. Vissim modelling will be used to assess the wider impact of the scheme. There is no requirement for the DE to supply final controller timings from the Proposed LinSig & Vissim Models.

M106 TfL Modelling Requirements & Modelling Expectations Document

The DE must ensure that any scheme-specific TfL modelling requirements stipulated during the Scheme and Network Scope Meeting have been correctly documented during M105, which should be confirmed by the MAE. This should help inform any agreement regarding model outputs, for example whether controller timing models are required to be produced by the DE in MAP Stage 5.

The TfL Traffic Modelling Guidelines can be used as a reference source when justifying any additional scheme-specific modelling requirements stipulated by TfL.
A Modelling Expectations Document (MED), which summarises the agreed modelling requirements, is to be produced by the MAE with contributions from the P, DE and SAE. A template to assist the MAE in producing a Modelling Expectations Document is available if required.

**M107 Software Version**

It is the collective responsibility of the DE and the MAE to ensure that models are developed using the correct software type and using the latest TfL-approved version of the software following the Scheme and Network Scope Meeting. The DE must ensure the agreed software and version have been correctly documented within M105 and the MAE must confirm to the DE that this software is available for use and supported within TfL.

### 2.1.1 Criteria for Moving to software specific MAP Stage 2

The P, DE and CE have received a signed/dated MAP Stage 1 Check Sheet (SQA-0544) and the Modelling Expectations Document from the MAE, which has also been copied to RSMSchemeAssessments@TfL.gov.uk.

**End of MAP Stage 1**

### 2.1.2 MAP Stage 1 to software-specific MAP Stage 2, Signal Control Data

It is important to note that normally a period of time will have passed between MAP Stage 1 being completed and the submission of modelling work during the software-specific MAP Stage 2. During this time changes may have occurred to the network being modelled.

It is the collective responsibility of the MAE and the DE to ensure that relevant and up-to-date signal control information is available to the DE for modelling purposes. With this in mind it is necessary for the DE to ensure that they have the latest signal control information prior to commencing modelling work. The MAE will be able to provide the DE with current TfL Signal Timing Sheets for all signalised nodes in the Network.

If the junction is:

- operating under UTC Control, the DE will need the UTC weekly timetable;
- operating under Fixed Time Control, the DE will need fixed time plans;
- operating under UTC SCOOT, the DE will need SCOOT messages for the period being modelled (M16, M18, & M37). It is important that the information is gathered for the correct period, during typical traffic conditions with all nodes under SCOOT control and containing no non-timetabled interventions. The
MAE should therefore ensure there are no alarms and interventions during the collection period prior to supplying data; or

- not operating under UTC Fixed Time or SCOOT Control, the MAE must agree on a modelling methodology and the information required. The agreed methodology for modelling should be recorded for future reference.

With all of the above information, as well as traffic surveys and site observations, the DE should be able to submit a Calibrated Network Base Model during MAP Stage 2.

### 2.1.3 Stage 1 to Stage 2, Helping Things Along

As stated in 2.1.2, ensuring the DE has all the relevant information is a collective responsibility. The MAE is likely to be the most suitable person to ensure this is done efficiently and correctly but the DE should collaborate for certain tasks.

The MAE may consider it useful to be involved in gathering some or all of the signal control data with the DE, both to build a good working relationship and to provide advice based on the latest TfL Traffic Modelling Guidelines, or other sources of support considered as industry standard. The MAE will need to have this information available when auditing the model and be satisfied that the data used is accurate and reliable.

It is also possible for the DE to arrange with the MAE to go into the TfL offices to collect specific data, such as direct extraction of information from ASTRID and SCOOT with help and supervision from the MAE. Ideally the DE would do this work with minimum supervision, however since they may not be familiar with the technical details of the UTC system or how signals operate in a live environment, the MAE should be available to guide and supervise the DE where necessary.

The DE is encouraged to communicate regularly with the MAE throughout the initial development of base models, as the MAE may be able to provide valuable data or advice that will assist the DE in developing the models, such as through use of recommended modelling parameter values, background imagery, standard templates or other modelling tools. It is the collective responsibility of the MAE and the DE to ensure that models are developed using the latest version of any template files used.

Reaching agreement regarding modelling parameters before detailed development of the models should ensure that the models progress through the MAP process smoothly, and do not encounter auditing issues at later stages of MAP.
3 Aimsun MAP (AMAP)

3.1 AMAP Scope

AMAP applies to all Aimsun modelling submitted to TfL that will require submission of a Scheme Impact Assessment Report (SIAR)².

3.1.1 Supporting Modelling

It is common practice, and highly recommended, that both base and proposed Aimsun models are developed for networks which already have supporting MAP-approved modelling using traffic signal optimisation software such as LinSig or TRANSYT. This allows for signal optimisation of the proposal and easier auditing of signal timings and saturation flows in Aimsun.

Skeleton LinSig models, although not covered by MAP, may also be useful for the purpose of auditing signal timings and controller behaviour in addition to any MAP-approved models.

3.2 AMAP Stage 2a, Skeleton Base Model Submission

3.2.1 What is a Skeleton Aimsun Model?

A Skeleton Aimsun Model is a non-time-specific model that contains the basic network structure and correct fundamental parameter sets required for model development. The skeleton model should be submitted with a report detailing the modelling methodology, i.e. detailing the approach used for traffic flow assignment and routing.

It is recommended that a base TfL Aimsun template file containing recommended settings is used, and is available upon request. Use of the template is not compulsory, but Skeleton Aimsun models should contain TfL-approved values for the following:

- Simulation Parameters;
- Coordinate System and Model Units;
- Visual overlay or GIS data;

² The Scheme Impact Assessment Report (SIAR) was formerly known as the Traffic Signal Supplementary Report (TSSR)
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- Vehicle Types;
- Road Types;
- Sections; and
- View Styles and Modes.

A single Aimsun Model submission is required for AMAP Stage 2a. The Aimsun version used must match the version agreed at the MAP Stage 1 meeting and recorded in the Modelling Expectations Document.

3.2.2 What is the purpose of a Skeleton Base Aimsun Model?

The development of calibrated and validated micro-simulation modelling can be time-consuming and resource-intensive.

AMAP Stage 2a ensures the model is being constructed using an agreed template and is unlikely to require further changes during subsequent development and auditing stages of AMAP. It is important that the MAE and the DE agree fundamental Aimsun modelling parameters prior to any model development, calibration, and validation.

Once a model has been validated, changing the basic parameter sets outlined in section 3.2.1 may significantly impact the model performance and require the model to be re-calibrated and re-validated.

3.2.3 AMAP Stage 2a Check Sheet

AMAP Stage 2a has a Check Sheet (SQA-8670), which needs to be completed by the DE and CE before being submitted to the MAE. This section identifies the audit checks that the MAE is required to carry out within AMAP Stage 2a, corresponding to individual numbered entries on the Check Sheet.

A201 Technical Note

Skeleton Aimsun Model submissions should be accompanied by a technical report, as described in Part B of the TfL Traffic Modelling Guidelines.

The technical note provides an opportunity for the DE to outline the way in which the model has been set up. It should not be treated as simply a ‘tick box’ requirement. It is an engineering document and it should be specific to the model it accompanies.

Key elements are outlined below:

- The scope and purpose of the Aimsun models, as agreed at MAP Stage 1 and defined in the Modelling Expectations Document;
- Extent of the modelling area, as agreed at MAP Stage 1;
- Modelling periods, as agreed at MAP Stage 1;

- Details of any variation from default Aimsun parameters defined within the TfL Aimsun template, with justification for the changes;

- Source of data used to define parameters within the skeleton model;

- Source of the road network. This may be from a GIS import (e.g. Open Street Map), from another transport model, from a cordoned area of a larger Aimsun model or through manual entry using an overlay file;

- The method used to include traffic demand. An Aimsun "Traffic State" uses entry flows and turn proportions only and is acceptable if there is no reason to model route choice or journey times. OD-based demand must be used if there is route choice or if journey times are to be measured.

- The traffic assignment method to be used in the models. TfL prefers the use of static paths, however if dynamic paths are deemed necessary to support the proposal, this must be discussed and agreed at MAP Stage 1 with supporting justification provided by the DE; and

- Any other modelling assumptions that will impact development of the AMAP Stage 2b calibrated base Aimsun models.

**A202 Simulation Parameters**

The DE should ensure the following parameter sets are appropriate, which will be checked by the MAE:

- Rule of the Road: should be ‘Left for UK models;

- Simulation period: should include the peak period, a warm-up and cool-down period as defined within the TfL Traffic Modelling Guidelines; and

- Simulation step: by default the simulation step corresponds to the reaction time of all vehicles. Values that should be used are in the range 0.6-1.0 seconds. Lower values should be used only if the study requires different vehicles to have different reaction times, as each reaction time must be an integer multiple of the simulation step; this will result in mathematically more accurate model behaviour but slower simulation speeds.

**A203 Coordinate System and Model Units**

The TfL Aimsun template uses the UTM coordinate system, EPSG:32630. To ensure compatibility between models, this should not be altered. Aimsun supports the re-projection to UTM of data from sources in different coordinate systems upon importing.
Aimsun model units may be set to either metric or imperial and switched at any time without altering the simulation results. The TfL Aimsun template uses metric units and it is recommended that the DE and MAE use these units for analysis of model results. The MAE should therefore ensure that metric units are applied within the skeleton model.

A204 Background, Model Import or Cordon

The DE should use an appropriate background - either a CAD drawing, an aerial photo or an image from a mapping system. The background data must be checked to ensure it is scaled correctly and if aerial photos are used, orthographically corrected to prevent distortion. If not, it will result in the development of an Aimsun network to incorrect dimensions and potentially erroneous layout data. The network structure should be correct within an AMAP Stage 2a submission.

The DE should ensure the Aimsun background file is at a resolution sufficient for network development, up-to-date, and correctly scaled and undistorted. This will be checked by the MAE.

The background data may also be used to import the network topology directly from mapping data, from GIS systems or from Open Street Map. If this option is taken, the resulting network must be checked to verify:

- That the correct road types have been imported (i.e. the major routes, the secondary routes, but not the car park internal routes);
- For road type and road attribute consistency. The use of Aimsun view modes to display the static attributes of road sections and visually check consistency is recommended;
- That junction geometry, turns and conflicts are correct; and
- Allocation of imported objects to the correct layers.

The road network may also be generated as a subnetwork of a wider area Aimsun model. If this option is taken then the same checks should be conducted as for a GIS import to verify the network.

It should be noted that after importing or editing data, a change in the coordinate system will not make Aimsun re-project the current data. Because of that, the coordinate system must be set before adding any geographic information.

A205 Vehicle Classes and Types

Vehicle classes and types are provided in the TfL Aimsun template as follows:

Vehicle Classes:
• **Bicycle Class**: This class is able to use bicycle lanes;
• **Car Class**: Light goods vehicles, taxis, and cars;
• **Heavy Class**: Heavy goods vehicles and buses; and
• **Public Class**: Public service vehicles which includes taxis as they are permitted in bus lanes.

**Vehicle types:**

• **Car**: A private car;
• **LGV**: A typical ‘white van’. This has the dimensions of a mid-range van and the performance of a car;
• **OGV1**: A subclass of HGV (Heavy Goods Vehicles). Other Goods Vehicles (1) are two or three axle rigid trucks;
• **OGV2**: A subclass of HGV (Heavy Goods Vehicles). Other Goods Vehicles (2) are four axle rigid trucks, or articulated vehicles;
• **Taxi**: A TX4 London taxi;
• **Routemaster Bus**: The iconic London bus (modern version);
• **Pedestrian; and**
• **Bicycle**.

The Taxi and Routemaster have the same physical dimensions as their real counterparts. Other less specific vehicle types have a range of standard dimensions.

For each vehicle type, the template provides default average, deviation, minimum, maximum of the truncated normal distribution for vehicle parameters including:

• Length;
• Width;
• Maximum desired speed;
• Speed acceptance;
• Clearance;
• Maximum give-way time;
• Guidance acceptance
• Maximum acceleration;
• Maximum deceleration;
• Sensitivity factor; and
• Margin For Overtaking Manoeuvre.

Each vehicle type should have a 3D model associated with it to be used when 3D views are required.

The default values for Reaction Times in normal driving and at stops or traffic signals for vehicles are specified as a probability set for the vehicle type. These may be amended if required in an “Experiment” and this is preferable to changing the vehicle type defaults.
If the chosen assignment method includes both static and dynamic paths, the proportion of each vehicle type using each type of path must be specified.

Changes to vehicle behaviour parameters from default values, as defined within the appropriate TfL Aimsun template, should be specified in A201 and supported by suitable field data or documented TfL advice.

The use of incorrect vehicle parameters may have a significant impact on network performance and hence journey times in later stages of model development. All vehicle types in the skeleton model should therefore be correctly defined.

### A206 Road and Lanes Types

Road types define different sets of default behaviour parameters for Sections and Turns. The number of road types in any model should be kept to a minimum. The creation of additional road types may sometimes be necessary, but supporting evidence explaining their use should be presented in A201.

Lane types are used to reserve lanes for specific classes of vehicle types. The following lane types are recommended by TfL:

- Reserved (Compulsory for Public Vehicle Class);
- Reserved (Compulsory for Heavy Vehicle Class); and
- Reserved for Bicycles

TfL recommends use of the following road types taken from WebTAG Unit 3.1, modified to be classified by speed rather than by lane number:

- Bicycle Track/Pedestrian way;
- Motorway/Dual 40 mph;
- Motorway/Dual 50 mph;
- Motorway/Dual 60 mph;
- Motorway/Dual 70 mph;
- Rural 50 mph;
- Rural 60 mph;
- Urban 20 mph;
- Urban 30 mph;
- Urban 30 mph narrow; and
- Urban 40 mph.

For each road type, the template provides default values for road parameters including:

- Speed limit;
- Capacity (Per lane);
- Lane width ;
- Lane-changing cooperation;
- Lane-changing aggressiveness;
● Braking intensity;
● Improvised lane-changing;
● Yellow box speed;
● Distance zone 1;
● Distance zone 2;
● Waiting time before missing a turn;
● Initial safety margin;
● Final safety margin;
● Initial give-way time factor;
● Final give-way time factor;
● Visibility to give way; and
● Visibility along main stream.

The DE should ensure that the speed limit of each road section corresponds to the relevant prescribed speed limit, altering the default value where needed. As part of the calibration process, the DE should also adapt the other parameters at section or turn level where needed. Significant changes that override values defined by the road type should be specified in A201 and supported by suitable field data.

**A207 Assignment and Route Choice Model**

The DE must ensure, and MAE verify, that the correct traffic assignment choice has been used as agreed during MAP Stage 1.

If OD matrices are used to specify traffic demand, then paths are required to route vehicles in the model. TfL prefers that models are submitted with static paths that do not vary as the model is run. These paths may be entered manually, generated either as the model starts, or at the end of the warm up period, or imported from either a traversal generated by a wider area model or from an assignment process in the current model.

The TfL Traffic Modelling Guidelines advise against use of dynamic models unless static routes cannot be established with accuracy. In cases where dynamic modelling is justified, a combined static-dynamic assignment is preferred to aid convergence within congested networks. TfL only require dynamic assignment to be used if the network includes routing alternatives, and if the changes introduced in future scenarios significantly change travel times or introduce/remove routing options. This should have been agreed at MAP Stage 1. The results analysis must then include an assessment of their impact on vehicle path choice.

The DE should report to the MAE which method was used to generate paths and how vehicles were assigned to them.

If the use of dynamic assignment has been justified and agreed during MAP Stage 1, the MAE should already have informed the DE of the convergence criteria required. Additional MAE checks on stability parameters and convergence of the assignment will be required during AMAP Stage 2b.
A208  Network Structure

The initial model network structure should be accurate and consistent to the base mapping. TfL guidance concerning appropriate section and node structures should be observed.

Key elements of the network structure are:

- **Sections:**
  - Number of lanes;
  - Length;
  - Reserved lanes and lane closures;
  - Presence of lateral lanes; and
  - Pedestrian and cycle links.

- **Nodes:**
  - All possible movements;
  - Lane to lane connectors;
  - Intermediate stoplines;
  - Priority rules; and
  - Turn geometry/speed.

TfL guidance on the length of road sections, coding their shape and their entry and exit angles should be observed. Similarly lateral lanes, lane drops and lane gains should be coded as a single section of adequate length to allow correct vehicle behaviour and lane to lane connections should be coded to avoid conflict, except when it may be necessary, i.e. in the circulating lanes of a roundabout.

A209  Other Modelling Issues

Any concerns the MAE may have with the model that have not already been covered by the checks in A201 – A208 should be recorded in the ‘Other Modelling Issues’ section of the AMAP Stage 2a Check Sheet (SQA-8670). These additional issues for audit may relate to project-specific agreements formalised during MAP Stage 1.

3.2.4 Acceptance/Rejection of Model

When the MAE is satisfied with the modelling parameters and the basic network structure of the Skeleton Aimsun model, the model will be accepted and the DE may proceed to AMAP Stage 2b.

Conversely, if the MAE is not satisfied with the modelling standard, the model will be rejected and returned with reasoning to the P, DE and CE, and should also be copied to RSMSchemeAssessments@TfL.gov.uk.

If there are fundamental flaws within the model or a conflict of opinion, the MAE may organise a meeting with the DE and CE. At the MAE’s discretion, the P may also be
invited as they are often the budget holders for the DE’s modelling work and may need to discuss if the quality of work is as agreed in the project brief.

### 3.2.5 Criteria for Moving to AMAP Stage 2b

The P, DE and CE have received an MAE-approved Stage 2a Check Sheet (SQA-8670), which has also been copied to RSMSchemeAssessments@TfL.gov.uk.

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### End of AMAP Stage 2a

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### 3.2.6 Stage 2a to Stage 2b, Demand-Dependent Stage Count Information

In order to model the frequency of demand-dependent stages at a signalised node, the DE or MAE needs to retrieve data from the UTC system.

UTC is able to retrospectively retrieve the frequency of demand-dependent stage appearances that were observed over a specified period, divided into 15-minute segments. For example, to get the observed frequency of a demand-dependent stage between 9am and 10am (i.e. four 15 minute segments) for Group 59 on 2nd September 2010, the command is:

‘achk g59 t=09:00 p=4 d=02-sep-10’

The UTC log provides the observed stage appearance frequency for every demand-dependent stage in the following format:

‘number of times called (IP)’ / ‘no. of opportunities’ (OP)

If a junction is under SCOOT Control, it is important for the DE to check whether the junction was single or double cycling by identifying the number of opportunities in the plan against the actual opportunities reported by UTC. This should be equal to a whole multiple where a junction was forced to either single or double cycle for the entire observed period. Where a junction was free to either single or double cycle in SCOOT (and has done both within the observed period) a different number of actual opportunities will be seen. In this case the only way to work out the cycle times that occurred is to have SCOOT message data for the monitored period.
AMAP STAGE 2b

3.3   AMAP Stage 2b, Calibrated Aimsun Base Model Submission

3.3.1 What is a Calibrated Aimsun Model?

A calibrated Aimsun model should have:

- Appropriate traffic demand data from on-street surveys, in accordance with the scope and purpose of the model as defined in MAP Stage 1;

- Public transport data collected from reliable sources, and modelled accurately. The level of detail of public transport modelling is dependent on the purpose of the model as defined in MAP Stage 1;

- Correct on-street signal control data with representative signal timings for the network during the period under consideration. These may be modelled using fixed times, actuated signals, or by including SCOOT control depending on the application of the model;

- Calibrated saturation flows at signalised junctions using the Discharged Rate Evaluation Extension;

- Accurately modelled give-way behaviour that results in the correct modelled representation of existing on-street conditions; and

- An appropriate road section structure to replicate on-street traffic behaviour.

Calibrated Aimsun models will be required for all time periods in AMAP Stage 2b. Where multiple scenarios exist in a model, it is important that the DE specifies which scenario is being submitted for auditing.

3.3.2 What is the purpose of Calibrated Aimsun Models?

The submission of calibrated models prior to model validation is useful for both the DE and the MAE, and will improve the standard of the validated model submissions. Calibrated model submissions provide an opportunity to ensure that the DE has understood the UTC and network data they have been provided with, and have collected sufficient knowledge of the network.
3.3.3 AMAP Stage 2b Check Sheet

AMAP Stage 2b has a Check Sheet (SQA-8671), which should be completed and signed by the DE and CE before submission to the MAE with the model and associated technical note.

Below are the checks that the MAE will carry out, corresponding to individual numbered entries on the AMAP Stage 2b Check Sheet:

A221 Technical Note

The DE is required to submit a technical note with the Calibrated Model, as described in the TfL Traffic Modelling Guidelines. The technical note provides an opportunity for the DE to outline to the MAE how the model has been constructed. It should not be treated as a ‘tick box’ requirement. It is an engineering document and it should be specific to the model it accompanies.

The Calibrated Model technical note should contain:

- The stated purpose of the model, as agreed during MAP Stage 1 and defined in the Modelling Expectations Document;
- A list of all the TfL-referenced nodes in the network with addresses, as agreed during MAP Stage 1;
- Notes covering site observations which detail physical constraints within the network and driving behaviour. Where behaviour is specific to a time of day, this should be noted. It is important for the DE to explain how these observations have determined the structure of the model;
- Site datasheets with measured saturation flows or data from accompanying approved TMAP Stage 3 TRANSYT or LMAP Stage 3 LinSig models and those derived from the Aimsun Calibrated Model;
- The source signal timings. If there are no accompanying MAP Stage 3-approved LinSig or TRANSYT models, then in the case of Fixed Time junctions the UTC signal plans should be included. For SCOOT junctions, average representative timings should be calculated using an approved method and clearly presented for audit;
- List of any network changes to the approved AMAP Stage 2a model with justification;
- Sources of data used for development of the Aimsun model (e.g. traffic data, signal data and public transport timetables/routes and source of the background or if it is from a model import or Cordon);
- List of all modelling assumptions with supporting evidence; and
A222 Traffic Data

The DE should define the following parameters, which will be audited by the MAE:

- **Simulation warm up period**: to define an initial state for the simulation period, with sufficient duration to give observed network conditions at the start of the simulation (to be agreed with the MAE);

- **Simulation period**: should cover a pre-peak period (to be able to undertake the analysis required to set the warm-up), the whole of the modelled peak and a post-peak period (to be able to analyse the time required to recover from peak conditions);

- **Vehicle types and the associated parameters**: The vehicle types should those specified in the TfL Aimsun Template with additions made only if required to include behavior or circumstances specific to the modelled area.

- **Traffic Demand**: The demand in the network may be introduced either by using an Aimsun “Traffic State” (using input flows and turning proportions only) or by using an OD matrix and set of route paths. This must be agreed at MAP Stage 1, and should be applied as follows:

  - For Traffic states:
    - Entry flows per vehicle type on all input sections to the modelled area;
    - Turn per vehicle type proportions at each junction. The option to highlight incorrect definitions in the Traffic State must be used to check turn proportions are defined, and that they sum to 100%.

  - For D matrices:
    - The OD matrices appropriately disaggregated by vehicle class; and
    - Either:
      - a scenario in which paths (either static initial paths or recalculated dynamic paths) are automatically generated, and a note to describe how this is achieved in the model; or
      - a “Path Assignment” object and its associated .apa file with a description of how these paths were generated.

The DE must ensure that:

- Turn and link count data used to generate a Traffic State must represent the volume of traffic in the modelled period;
- OD Matrices must similarly represent the volume of traffic in the modelled period; and
- If OD matrices and paths are used then the paths are realistic and capture different access to travel time information, i.e. Static paths or Dynamic User Equilibrium paths for drivers following habitual paths based on past
experience and Stochastic Route Choice paths for drivers who have access to pre-trip or on-trip information;

The MAE should also use the Aimsun “Dynamic Check Tool” verify that there are no “Lost Vehicles” in the simulation indicating that vehicles have no path. If there are vehicles with “Missed Turns”, indicating that they have changed to a new path, the cause should be noted and accepted or not depending on the circumstances causing the change.

The DE must ensure, and MAE verify, that the correct traffic assignment choice has been used as agreed during MAP Stage 1.

A223 Public Transport

The scope of the Aimsun model, as agreed during MAP Stage 1, will determine the level of detail required for public transport modelling. For example, if the models are being prepared to assess the impacts of a bus priority scheme on bus journey times, the DE should ensure all public transport elements have been modelled in detail.

The DE should ensure that the following public transport elements are correctly calibrated, which will be checked by the MAE:

- Bus routes;
- Bus lanes;
- Bus schedules including departure times and departure time variance;
- Bus stop dwell time distributions;
- Location and size of bus stops and stands; and
- Interference with general traffic.

The DE should provide the MAE with details and sources of all data used to calibrate bus routes and their frequencies to allow them to carry out necessary audit checks. Bus lanes, hours of operation and vehicle type restrictions should be checked against on-street data to ensure correct restrictions are active where necessary during the modelled period. Data collection may also include measurement of dwell times per route, per time period on-street, or use of actual passenger numbers at each bus stop.

The interaction between public transport and general traffic can have a significant impact on network performance. Site visits should therefore be carried out by the DE to ensure that any disruptive behaviour that influences junction or section capacity has been modelled correctly, which should be detailed in the DE’s technical report (A221). Site visits should also be undertaken by the MAE to observe behaviour and ensure it is accurately reflected in the submission.
A224 Signal Data

Work carried out under section 2.1.2 should ensure a sufficient quality of traffic signal control data has been provided to the DE by the MAE.

The DE has a responsibility to use this data and incorporate the following into the calibrated Aimsun submission, which will be verified by the MAE:

- Signal groups;
- Cycle length;
- Phase sequence and duration;
- Detectors associated to actuated phases;
- Actuated parameters
- Interphases:
  - Duration;
  - Yellow duration
  - Red percentage;
- Node offsets; and

- The presence of SVD Bus Priority (or in case of Aimsun pre-emption strategies).

It is common practice for MAP Stage 3-approved LinSig or TRANSYT models to be submitted with all base Aimsun models. If this is not the case, the DE must produce skeleton LinSig models for more complex junctions and provide to the MAE to enable an audit of signal data in Aimsun, as outlined in section 3.1.1. These skeleton LinSig models need to contain signal data, although no traffic flow data is required.

If base LinSig or TRANSYT models have been submitted with Aimsun models, it is essential that these are approved MAP Stage 3 models which correctly represent on-street data. The signal data held in both Aimsun and accompanying approved LinSig/TRANSYT models should be consistent.

The DE and MAE should use the Simulation Control dialogue of the node to verify the operation of signal controllers in Aimsun, allowing the interphase, signal group duration and phase change points to be visualised.

Section 3.2.6 describes how the frequency of demand-dependent stages can be obtained from the UTC system.

The DE should ensure that demand-dependent stages within the network show a frequency of at least 90% of that observed on-street, which will be audited by the MAE. The average count should be reported by the DE in the technical note (A221).
and supplied along with control plan statistics generated by Aimsun for each simulation run.

A225 Nodes and Turns

Behaviour at nodes has an impact on congestion and vehicle journey times, especially in networks with give-way junctions and opposed movements at signalised junctions. It is important that the DE models give-way behaviour correctly in Aimsun, thus replicating on-street behaviour in the models.

At nodes, the DE should ensure that the following are appropriate:

- Signs associated to the turns;
- Give-way behaviour between turns;
- Stopline position (at the end of the link, or an advanced stopline);
- Stoplines within a turn where queuing within a junction is allowed;
- Distance Zone settings;
- Gap-acceptance model parameters; and
- Yellow box junction parameters.

The network submitted in AMAP stage 2a will ensure that lane connectivity between the arms of a junction has been set in accordance with road markings. If, in calibration using observed behaviour, lane connectivity is adjusted, the DE must notify the MAE.

The DE should calibrate junction behaviour by:

- In the Node and Turn Editor:
  - First ensure the lane connectivity is consistent with observed behaviour;
  - Adjust stopline positions;
  - Set the Distance Zone values to ensure vehicles make their lane changes on their approach to the junction; and
  - Finally, adjust turn speeds only if the default Aimsun settings are unsatisfactory.

- In the Section Editor on the approach to a Node:
  - Adjust the Additional Reaction times for Queue Discharge;
  - Adjust the Queue Discharge Acceleration Factor;
  - At lane merges; adjust the Co-operation Distance and Merge Distance; and
  - If there is a significant weaving section on the junction approach, adjust the Lane Changing Co-operation, Braking and Aggressiveness values.
A226 Network Operation

The network structure was confirmed during AMAP Stage 2a, but it is not until traffic is simulated that the structure of the modelled network can be fine-tuned by the DE. The experience of the DE, with guidance from CE and MAE, will determine how the network is structured to deliver the best on-street representation and ensure the modelled network is ‘fit for purpose’.

The DE should ensure the following are performed correctly:

- Network changes from the approved AMAP Stage 2a model;
- Lateral lanes (on ramps, off ramps, turning bays);
- Lane to lane connectors, especially at roundabouts;
- Localised lane restrictions;
- Lane change behaviour (distance zones, cooperation);
- Overtaking behaviour;
- Node and turn behaviour parameters affecting queue discharge;
- Checking for lost vehicles, missed turns and virtual queues; and
- Saturation flow calibration at stoplines.

The DE should maintain an active dialogue with the MAE throughout A227 as this allows the DE to explain the techniques used, for approval by the MAE. Techniques may not be approved if they achieve certain behaviour at the cost of unrealistic representation of on-street conditions.

A227 Real Data Sets

The data sets containing observed data must be included in the Aimsun model submitted to the MAE as a ‘Real Data Set’ object and linked to the calibrated base model scenario. Real Data Sets can include journey time, section and turn based data, and are used in calibration to compare simulation results with observed data.

Inclusion of the Real Data Set in the submitted model ensures the MAE can audit the calibration process from data source to calibration comparison. Files referenced by the Real Data Set must be included and their contents documented by the DE in the model technical note.

A228 Other Modelling Issues

Any concerns the MAE may have with the model that have not already been covered by the checks in A221 – A228 will be recorded in the ‘Other Modelling Issues’ section.
of the AMAP Stage 2b Check Sheet (SQA-8671). These additional issues may relate to project-specific agreements formalised during MAP Stage 1 or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive to increase the likelihood of passing the Aimsun model as fit for purpose during later stages of MAP.

### 3.3.4 Acceptance/Rejection of Model

When the MAE is satisfied with Aimsun modelling parameters, network operation, traffic signals, traffic flow and public transport components of the AMAP Stage 2b Aimsun model, it will be accepted and the DE can proceed to AMAP Stage 3.

Conversely, if the MAE is not satisfied with the modelling standard, the reasoning for rejecting the model should be provided in writing, and the models returned to the P, DE and CE, and should also be copied to RSMSchemeAssessments@TfL.gov.uk.

If there are fundamental flaws or conflict of opinion with the standard of modelling, then the MAE may choose to convene a meeting with the DE, CE and/or P to provide all parties with an opportunity to discuss the project.

### 3.3.5 Criteria for Moving to AMAP Stage 3

The P, DE and CE have received an MAE-approved AMAP Stage 2b Check Sheet (SQA-8671), which has also been copied to RSMSchemeAssessments@TfL.gov.uk.
### AMAP STAGE 3

#### 3.4 AMAP Stage 3, Validated Aimsun Base Models Submission

##### 3.4.1 What is a Validated Base Aimsun Model?

AMAP specifies that a validated Aimsun model should be based on an approved AMAP Stage 2b model (see 3.3). In addition, the DE will be required to demonstrate that the models have been validated against on-street data that is independent of data used for model calibration.

The DE must demonstrate evidence of model validation, including validation of saturation flows and the use of random seeds (minimum twenty) to demonstrate model stability. For this reason validation should be conducted using a minimum of twenty seed values and results presented as a mean average of all simulation runs.

**Validated Aimsun models are required for all time periods in AMAP Stage 3.**

##### 3.4.2 AMAP Stage 3 Check Sheet

**A301 Validation Report**

Validated base model submissions must be accompanied by a validation report, as described in Part B of the TfL Traffic Modelling Guidelines.

The DE should ensure that the following information is provided:

- **Detail of the network source:**
  - The origin of any data used in importing a network, i.e. GIS, another traffic model or a cordon from an Aimsun model; and
  - The origin of any images, maps or aerial photographs used to code the model.

- **Detail on the traffic flows:**
  - When the traffic surveys were done and by who;
  - What data was collected during the traffic surveys;

- **Demand-dependency calculations:**
  - Explanation on how the frequency of demand-dependent stages has been accounted for by comparing calibrated model timings to the validated model timings;
  - UTC data should be recorded to confirm any site observations. If pedestrian counts are taken, the frequency of demand can be recorded on-site but should be used in conjunction with a UTC log. The output of the UTC log should be included in the report;
● Evidence of validation, including comparison between on-street data and LinSig/TRANSYT results;

● Flare usage observed on-site;

● Flashing amber usage at pelican crossings;

● Queue lengths (if surveyed);

● Observed network bottlenecks;

● Parking/loading restrictions/behaviour;

● Details on priority intersections; and

● Details on observed congestion or recorded Underutilised Green Time (UGT).

The validation report should contain a list of all changes made to the approved AMAP Stage 2b calibrated model, with justification for any revisions, alongside validation support data aligned to the AMAP Stage 3 Check Sheet (SQA-8672).

Validation data collected from Aimsun models should be taken from an average of many (minimum twenty) replications using different random seeds, as stated in 3.4.1.

**A302 Adjustments from AMAP Stage 2b Calibrated Model**

There should be few changes from the AMAP Stage 2b approved model other than for adjustments for satisfactory validation of saturation flow s (A305), traffic flows (checked in A304), queue length correlation (checked in A305) and journey times (checked in A306).

Where significant changes have been made, these should be detailed in the validation report as described in A301.

The DE and MAE must ensure that any changes are both appropriate and reasonable, and that the following data that was previously checked during AMAP Stage 2a & AMAP Stage 2b remains satisfactory:

- A202 Simulation Parameters;
- A203 Coordinate System and Model Units;
- A204 Background, Model Import or Cordon;
- A205 Vehicle Classes and Types;
- A206 Road and Lane Types;
A207 Assignment and Route Choice Model;
A208 Network Structure;
A222 Traffic Data;
A223 Public Transport;
A224 Signal Data;
A225 Nodes and Turns; and
A226 Network Operation; and
A227 Real Data Sets.

A303 Saturation Flows / Degrees of Saturation

The DE 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 Aimsun model.

Saturation flows are measured in Aimsun by exporting Link Headway files, which contain the headways of vehicles as they cross a stopline at the junction. These must be processed to calculate the saturation flow at each signalled stopline.

Comparison of the observed and modelled saturation flows is required during model validation as it provides a measure of the capacity of signal-controlled approaches. All observed and modelled saturation flows should be tabulated and the percentage difference between the two values reported.

Modelled saturation flow values should be within 10% of observed values, or values used in any corresponding approved LinSig or TRANSYT modelling.

The MAE should not approve a model beyond AMAP stage 2b where the saturation flows do not meet these criteria.

Degrees of saturation (DoS) can only be observed in Aimsun and not directly measured. It should be estimated to ensure it correlates with on-street observations at signalled stoplines within the modelled network. This may not be the case for entry sections as there will be no coordination with upstream signals outside the modelled network. Where the modelled DoS is found to differ significantly from observations, it may indicate that areas of the model are in error, which the DE and MAE should investigate.

A304 Traffic Flow Comparison

The validation report (A301) should contain evidence of a comparison between traffic flows and turning counts recorded on-site against modelled flows and turning counts.
The DE must ensure that the traffic flows and turning counts closely match surveyed data, which will be verified by the MAE. The GEH statistic is fully explained within the TfL Traffic Modelling Guidelines but generally it is a standard measure of the ‘goodness of fit’ between observed and modelled flows. Unlike flow comparison using percentage difference the GEH statistic places more emphasis on larger flows than on smaller flows.

The DE should aim for GEH values less than five when comparing modelled flows to observed flow volumes. However, TfL advocates GEH values of less than three for all important or critical links within the model area. Results should be presented in the DE’s technical note (A301), showing all observed and modelled flows together with calculated GEH values. Modelled flows should be averaged over multiple seeds, as described in 3.4.1. Significant discrepancies between modelled and actual traffic flows should be queried by the MAE.

All entry links into the network should show modelled flows within 5% of observed flows. This requirement should be achieved for all entry links as vehicle flows on external links are direct input values. The MAE should not approve a model beyond AMAP Stage 2b where entry flows do not match observed counts to ensure that all assigned vehicle flows are successfully loaded onto the network during the peak modelled period.

A305 Queue Length Analysis

Given the difficulty of measuring queue lengths on the road in the same way as in a model, a direct comparison of queue lengths is not a reliable validation indicator; journey time validation on defined sub-paths is a more robust indicator of congestion levels but is only available if OD matrix based demand is used.

Queues should, however, appear in the model at locations where they are observed in reality, and queuing behaviour in the model should be consistent with site observations.

If turning count traffic surveys have been used to determine model input flows, then in reality no significant virtual queues should exist on model entry sections as the collected on-site data represents the counted flow across the stopline. However, queues may occur due to high traffic demand during the warm-up period (e.g. queues at the start of the peak hour), or small queues forming due to fluctuations in vehicle arrival patterns.

A306 Journey Time Comparison

Journey time validation combined with section and turning count validation is the most suitable measure of Aimsun model validation.

Modelled journey times should be averaged over multiple seeds and be within 15% of surveyed on-street journey times. Journey time output should be measured for vehicles originating from the start of the route, and be presented as the average.
journey time for individual journey time segments coded as separate subpaths. It may also be necessary to restrict journey time measurements from Aimsun to the same vehicle type that the site measurements were based on (e.g. private vehicles, buses, or taxis).

The MAE will need to be satisfied that journey time validation has been completed according to the principles set out in Part B of the TfL Traffic Modelling Guidelines. If the model has not been validated satisfactorily, the MAE will not approve the model at AMAP Stage 3.

A307 Experiment Checking and Error Logs

Before an experiment is run, the “Check and Fix” tool must be used to verify the Aimsun model has no errors or inconsistencies. All errors must be corrected; warnings may either be fixed or documented to justify any decision not to take action over them.

Additional errors and warnings may appear in the log window in Aimsun during the simulation. These messages should be audited by the DE, CE and MAE as they may indicate such errors as:

- Impossibility of loading an input path file;
- No feasible path between an O/D pair that has demand; and
- Public transport route that has gaps.

In addition to the messages reported in the log window, the DE, CE and MAE should use the appropriate view modes and output statistics to detect issues such as:

- Vehicles missing turns or getting lost in the network; and
- Not all vehicles being loaded onto the network (virtual queues).

If Virtual Queues are present, this indicates that not all vehicles are being loaded onto the network immediately as they are generated. This is not an error, but it is indicative of congestion spreading outside the modelled area and the DE should notify the CE and MAE if Virtual Queues are considered to be excessive.

Ideally, none of the issues mentioned above should occur during the simulation. However, a few non-critical issues are acceptable. The DE must seek further advice from the CE or MAE if unsure about any errors or warnings that are indicated.

A308 Other Modelling Issues

Any concerns the MAE may have with the model that have not already been covered by A301 – A307 will be recorded in the ‘Other Modelling Issues’ section of the AMAP Stage 3 Check Sheet (SQA-8672). These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report
concerns regarding the model methodology to the DE. These comments should be seen as constructive to increase the likelihood of passing the Aimsun model as fit for purpose if resubmitted.

A309  Fit for Purpose Model

If the MAE fails the model on any of the checks A301-A308, or other concerns are raised relating to the standard of modelling, then the model will be deemed as not fit for purpose and will be rejected and returned to the DE.

If the MAE has passed the model on all of the checks A301-A308 and has found no other issues then, referring back to the purpose statement from MAP Stage 1, the MAE will pass the model as fit for purpose by authorising a AMAP Stage 3 Check Sheet (SQA-8672) for each modelled period.

The MAE should email notification of the Approval or Rejection of the submission to RSMSchemeAssessments@TfL.gov.uk. If the submission has been approved, the MAE must upload the model and associated files to the TfL Model Library.

End of AMAP Stage 3

3.4.3  Criteria for Moving to AMAP Stage 4

The P, DE and CE have received MAE-approved AMAP Stage 3 Check Sheets (SQA-8672) for all modelled periods, which have also been copied to RSMSchemeAssessments@TfL.gov.uk.

The MAE has ensured that the approved models have been uploaded to, and are retrievable from, the TfL Model Library.
3.5 AMAP Stage 4, Aimsun Proposed Models Checkpoint Meeting

3.5.1 Checkpoint Meeting

As with MAP Stage 1, the P, DE, MAE, SAE and NAE are required to meet in order to discuss the details of the proposals and how they are to be modelled. The bulk of the modelling work will have been completed during the development of the base model.

It is the responsibility of the DE to record minutes of the meeting and submit these to the other parties who attended the meeting. The minutes will be authorised by the MAE and used to update the Modelling Expectations Document in A406, which will be accepted as an official account of the decisions reached.

3.5.2 AMAP Stage 4 Check Sheet

AMAP Stage 4 has a Check Sheet (SQA-8673), which acts as a formal record of task completion within AMAP Stage 4. The DE should complete this document following the AMAP Stage 4 Proposed Models Checkpoint meeting and provide the completed version to the MAE.

The following sections need to be agreed and documented, which will be confirmed by the MAE following submission by the DE.

A401 Proposed Models Checkpoint Meeting

The DE must document the date of the meeting attended by the P, DE, MAE and SAE. The MAE must ensure that the name and affiliation of all parties have been captured on the AMAP Stage 4 Check Sheet (SQA-8673).

A402 ‘Purpose’ Statement for each Proposed Model

As with the base models in MAP Stage 1, the DE should provide the MAE with a statement of the purpose of each of the modelled periods. This should be based upon the proposals being put forward by the P and taking into consideration local conditions of the network being modelled. The statement of purpose created by the DE is a key term of reference for all parties involved in MAP.

A403 Road Network Changes

It is possible that in some cases a significant amount of time may have passed between approval of AMAP Stage 3 and the start of AMAP Stage 4. In this case changes to the road network will be discussed at the Checkpoint Meeting to outline
A404 Requirements for Proposed Model Build

As an outcome of the Checkpoint meeting, the DE will submit to the MAE an overview of the work they will conduct to prepare proposed models from the approved AMAP Stage 3 base modelling. This should include detail of when any new methods of control will be submitted for audit by the SAE, i.e. prior to the AMAP Stage 5 submission.

It is important that the DE develops any proposed models using the same version of Aimsun that was used to create the base models, which should be confirmed with the MAE.

If LinSig or TRANSYT models are to be used for signal optimisation these need to be provided during AMAP Stage 4 to allow the MAE an opportunity to confirm that they are suitable for use during AMAP Stage 5. The DE should also outline the proposed strategy for signal timing optimisation during each modelled period and confirm agreement of the outputs required from the proposed modelling.

A405 Checking of Proposed Methods of Control

For the P and the DE an important outcome of the Checkpoint meeting is to reach agreement with the SAE on when the new methods of control will be checked. It is a pre-requisite for AMAP Stage 5 that SQA-06403 compliance has been established prior to audit, so correct timetabling of the SAE check is imperative for further progress of the proposal within AMAP.

A406 Modelling Expectations Document

The Modelling Expectations document produced during MAP Stage 1 should be reviewed and updated to incorporate any new information raised during the Checkpoint meeting. This is to be produced and agreed by the P, DE, MAE and SAE.

3.5.3 Criteria for Moving to AMAP Stage 5

To move to AMAP Stage 5, the following need to be agreed by all parties:

- Agreed and dated list of work to be completed by the DE, including method of control submissions to the SAE prior to the AMAP Stage 5 submission;

- Purpose statements for each of the proposed models being submitted during AMAP Stage 5; and

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Modelling Expectations Document to be updated, if necessary.

The MAE-approved signed & dated MAP Stage 4 Check Sheet (SQA-8673) must have been received by the P, DE and CE, together with the Modelling Expectations Document, and copied to RSMSchemeAssessments@TfL.gov.uk

End of AMAP STAGE 4
3.6 AMAP Stage 5, Aimsun Proposed Models Submission

3.6.1 Introduction

The majority of the work both in terms of creating and auditing an Aimsun model is completed during the first three stages of MAP, i.e. when generating fit for purpose base models. Once an Aimsun base model has been accepted by the MAE there will often be a relatively small amount of work required to complete AMAP.

The DE should make a copy of the accepted AMAP Stage 3 base models and update them in line with the proposals agreed during AMAP Stage 4. The DE must create new Master Control Plans, new Demand Plans and new Public Transport plans in the Aimsun Project File and edit them to describe new methods of control, changes in Demand and Public Transport. It is recommended that the DE uses Geometry Configurations to make any changes in the road layout, which can be grouped with other proposed changes into a new Aimsun scenario. It is important that the DE clearly specifies which scenario is being submitted for auditing where multiple scenarios are used.

It is common practice that proposed LinSig or TRANSYT models are also produced alongside the proposed Aimsun models. The signal timings from these models are often incorporated into the Aimsun models, and are manually fine-tuned where necessary. The TfL Traffic Modelling Guidelines contain a strategy for traffic signal optimisation.

In addition to ensuring that the model is correctly developed from a technical point of view the DE should demonstrate that the proposals can be accommodated without jeopardising the day to day operation of the network. This will include maintaining acceptable levels of saturation and queue lengths as well as sufficient provision for the pedestrian demand being modelled.

In common with the preceding stages of AMAP, the MAE will need to consider the technical data, however unlike the previous stages there must be interpretation of their implication. An important additional responsibility for the MAE at AMAP Stage 5 is to make a judgement on whether the network is likely to operate satisfactorily on a day-to-day basis.

As a representative of the TfL Traffic Manager, who will have a duty to manage the new network (if the proposal is given approval by RSM-Operations), the MAE should highlight any issues and concerns with the proposal. These issues are likely to be in respect of safe, efficient network operation and current policy/guidelines.
Proposed models are required for all time periods in AMAP Stage 5. The DE will receive feedback from MAE and will need to address any highlighted issues. The MAE will use their operational experience and knowledge of the network in making informed comments and decisions.

If required by the model scope defined at AMAP Stage 4, the proposed timings within the Aimsun model must be suitable to be used as controller-held background timings. This means that the MAE’s audit is implicitly asking the DE:

‘Are you satisfied that, if observing on-site when these proposals were commissioned, the timings in each of the submitted Aimsun models would provide appropriate network operation under local control and that the network impacts would be as described in the Scheme Impact Assessment Report?’

3.6.2 AMAP Stage 5 Check Sheet

A501 SAE-Approved Proposed Methods of Control

Before commencing the audit of any proposed models, the MAE must ensure that all proposed methods of control have been approved by the SAE and documented on the ‘MAP Stage 5 SQA-0640 Compliance Check Sheet’ (SQA-0530).

Lack of an approved MAP Stage 5 SQA-0640 Compliance Check Sheet for any of the methods of control changes will prevent the MAE from proceeding with the AMAP Stage 5 submission.

A502 Proposal Report

Proposal submissions must be accompanied by a report, as described in the TfL Traffic Modelling Guidelines. The report needs to contain all necessary information and paperwork in order to allow the accurate assessment of criteria A503 - A506.

All assumptions and changes to the models should be clearly stated along with the reasoning behind those changes. There should be clear comparisons between the results of the validated base models and the proposed models for the corresponding periods.

The inclusion of comparisons for all areas of the network that are deemed critical is required. It is the responsibility of the DE to identify all the critical areas. Normally (but not exclusively) critical areas would be those which experience high traffic flows, are close to capacity and/or those areas which are affected by the proposals.

A503 Changes to Model (AMAP Stage 3 to AMAP Stage 5)

There are likely to be three main changes from base to proposed models which should be detailed by the DE:
- Junction control changes, in which case turns and sections will need to be changed;

- Road layout changes, in which case the sections and turns and their related parameters will be changed; and

- Signal timings may have been changed as a result of the proposals. These changes would normally be represented in an accompanying LinSig or TRANSYT model. If signal timings have subsequently been fine tuned in Aimsun, the DE should be aware that all sources of signal timing information must corroborate within the final submission.

The DE will need to ensure that all modelling parameters including driving behaviour parameters, vehicle type, road type and others are consistent with the base models passed during AMAP Stage 3. If there are inconsistencies these should be highlighted for the MAE and discussed in A502.

**A504 Flow Consistency Check**

Traffic flows should be similar to those in the base model. However, if there are changes to the routing of traffic e.g. where the base model is a one way system but the proposed model introduces two way operation, then the DE should provide the MAE with the detailed methodology, assumptions and other relevant data used to reassign traffic flows from the approved base case. In particular, any input equilibrium path file should be obtained by “fixing” the one used in the base model and warm-starting the assignment process with it, rather than calculating a new equilibrium assignment from scratch. The MAE will audit these outputs during A504.

**A505 Saturation flows, queue lengths and journey times**

The proposal report (A502) should contain a comparison of base and proposed saturation flows, and the implications for the operation of the network. The MAE must be satisfied that the proposed scheme saturation flows are acceptable. Any adjustments to the network that may impact saturation flows or lane usage must therefore be documented by the DE.

The report does not have to contain a comparison for every part of the model, but it is the responsibility of the DE to ensure that all areas which are considered as critical to the model or the proposals are included.

The A502 report should contain a comparison of base and proposed queue lengths and journey times. There should be interpretative comment regarding the implications of this data upon network performance. If Aimsun indicates a negative impact on queue lengths and journey times (for traffic and/or public transport) these should be investigated and discussed by the DE.
The MAE should report the overall network impact of a proposal in the SIAR. The MAE will cite reported changes in saturation flow, degree of saturation, queue lengths, and journey times as justification for any assessment of network impact.

**A506 Stage Timings & Demand-Dependency**

The proposal report (A502) should comment on the frequency of demand-dependent stages in the base model and whether any assumptions have been applied to the proposed network. If any changes are based on estimates then these should be detailed for assessment by the MAE.

Proposals should consider pedestrians as described in the TfL Traffic Modelling Guidelines. From a modelling perspective this means allowing for sufficient appearance of pedestrian stages where they operate on demand.

The MAE will audit stage timings to ensure they corroborate with any other submitted modelling, contain appropriate stage minimums and demonstrate accurate interstage design.

**A507 Advising the client**

It is important for the DE to ensure that the traffic models delivered for the scheme proposal are fit for purpose (i.e. the base and proposed models give an accurate reflection of the likely network conditions) and have been approved by the MAE.

The DE may find it useful during the design process to consider arranging meetings with the MAE or to follow advice on optimising signal timings within capacity constrained networks as outlined in Part B of the Traffic Model Guidelines.

However, even with an approved set of models, results can indicate that there are capacity or operational impacts in which case the MAE is obliged to outline these in the SIAR. If this is the case, it is advisable for the MAE to provide the DE and P an opportunity to make changes to the proposed models to address these issues before they make a submission to RSM-Operations.

It may be the case that the proposal is unsound, for example where a proposed junction has much less capacity than existing and that the network impact in terms of degrees of saturation, queuing and delay is estimated to be severe. In this case, the MAE may have no alternative but to document this in the SIAR. However, the approach should be for the DE, P, MAE and SAE to discuss design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIAR.

It is ultimately the P and the DE’s responsibility to provide a workable design and remains their choice whether to submit a SIAR to RSM-Operations. If the MAE has informed all parties of the issues that will be raised in the SIAR the P and DE may still wish to proceed with the proposal.
A508  Fit for Purpose Model

If the MAE has failed the proposed models on any of the checks A501-A506 or has highlighted other significant issues with the models, then the models are not fit for purpose and will have to be ‘Rejected’ and returned to the P, DE and CE, and should also be copied to RSMSchemeAssessments@TfL.gov.uk.

If the MAE has passed the model during A501-A506 and there are no other outstanding issues then, referring back to the purpose statement from AMAP Stage 4, the MAE will pass the model as fit for purpose and authorise release of the AMAP Stage 5 Check Sheets (SQA-8674). The MAE must upload the approved model and associated files to the TfL Model Library.

An AMAP Stage 5 Check Sheet should be completed for each of the modelled periods.

3.6.1  Criteria for moving to MAP Stage 6

The P, DE, CE and SAE have received MAE-approved AMAP Stage 5 Check Sheets (SQA-8674) for all modelled periods, which have also been copied to RSMSchemeAssessments@TfL.gov.uk.

The MAE has ensured that the approved models have been uploaded to, and are retrievable from, the TfL Model Library.

End of AMAP STAGE 5
4 LinSig MAP (LMAP)

4.1 LMAP Scope

LMAP applies to LinSig models submitted to TfL that will require submission of a Scheme Impact Assessment Report (SIAR). It applies to all models that contain multiple traffic signal controllers, and for models containing single controllers where deemed necessary for scheme-specific requirements.

It is not necessary to apply LMAP to ‘skeleton’ or ‘controller-only’ LinSig models that have been submitted to support network modelling using other software such as Aimsun, TRANSYT or Vissim. These LinSig models should still be checked for accuracy, for which elements of LMAP may prove useful, however LMAP should not be applied in full.

LMAP STAGE 2

4.2 LMAP Stage 2, Calibrated LinSig Base Model Submission

4.2.1 What is a Calibrated LinSig Model?

A Calibrated LinSig Model should contain:

- all the signal control data with representative signal timings for the network during the period under consideration, without adjustments to account for the non-appearance of demand-dependent stages; and

- the appropriate network structure, measured cruise times, measured saturation flows (or calculated, if necessary) and measured lane lengths.

A single Calibrated LinSig Model is required for LMAP Stage 2. The LinSig software version used must match the version agreed at the MAP Stage 1 meeting and recorded in the Modelling Expectations Document.

4.2.2 What is the purpose of a Calibrated LinSig Model?

Experience has shown that the submission of one model early in the modelling exercise is a very useful starting point for both the DE and the MAE, and will improve the standard of subsequent model submissions.

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4 The Scheme Impact Assessment Report (SIAR) was formerly known as the Traffic Signal Supplementary Report (TSSR)
The Calibrated model submission will provide the MAE the opportunity to see that the DE has fully understood the UTC data they have been provided with, and has collected relevant knowledge of the network. This is particularly relevant if the MAE has not received any modelling from the DE previously. The initial model submission will ensure that the signal data is correct.

### 4.2.3 Tasks before looking at the LMAP Stage 2 Check Sheet

- It is recommended that the DE obtains from the MAE TfL Signal Timing Sheets for all the nodes in the network, who should check them against relevant controller specifications for accuracy. These documents need to be consistent, the only acceptable differences are those changed directly within the on-street controller, e.g. phase delays. These controller amendments should be listed in the ‘Historical Amendments’ section at the end of the timing sheet. If the timing sheet is not consistent with method of control on street, the MAE should detail the changes for the Fault Management team in TfL and ask for the timing sheet to be up issued.

- The DE should obtain a copy of each of the UTC timing plans from the MAE for all the nodes in the Network for all modelled periods.

### 4.2.4 LMAP Stage 2 Check Sheet

LMAP Stage 2 has a Check Sheet (SQA-0545), which should be completed and signed by the DE and CE before being submitted to the MAE for auditing along with the model and associated technical note.

This section identifies the checks that the MAE is required to carry out, corresponding to individual numbered entries on the Check Sheet. The most convenient, and recommended, way of checking the majority of data is through use of the ‘Model Audit View’ in LinSig, as shown in Figure 2.

### L201 Technical Note

The DE is required to submit a technical note along with Calibrated Model submissions, as described in Part B of the TfL Traffic Modelling Guidelines.

The DE should ensure that the note contains, at a minimum:

- The stated Purpose of the model, as agreed with the P and MAE during MAP Stage 1 and defined in the Modelling Expectations Document;

- A list of all the TfL-referenced nodes in the modelled network, with addresses;

- Notes on all relevant site observations, covering both the physical constraints of the network and vehicle behaviour. Where the behaviour is specific to a time
of day, this should be noted. It is important to clearly explain how these factors have determined the structure of the model;

- Site datasheets with measured cruise times and saturation flows;

- A table of saturation flows for each lane in the network. The table should indicate clearly whether the value has been measured on-site or has been calculated using RR67. Where RR67 has been used an explanation should be given detailing why it couldn’t be measured; and

- The derivation of the signal timings. In the case of Fixed Time junctions the UTC signal plans should be included. For SCOOT junctions, average representative timings should be calculated from SCOOT messages or ASTRID data and displayed clearly.

The MAE may elect to collect their own on-site data to verify the accuracy of submissions, for example by measuring lane lengths, cruise times or saturation flows.
Figure 2: Model Audit View in LinSig v3.1.
L202  Network Settings and Network Layout

Here, the MAE will check the following aspects of the DE’s model:

Network Settings:

- **PCU Length**: this should be unchanged from the default value of 5.75m.

Network Layout View:

- **Junctions**: ensure that all junctions to be modelled are included and clearly labelled with an appropriate description. All junctions should also be associated with the correct controller(s) where they include arms with signal-controlled lanes.

- **Arms**: ensure that all relevant junction arms are included in the model and are associated with the correct junction. Junction arms should be named where appropriate to ensure it is clear which roads they represent.

- **Short/long lanes**: short lanes should be used to model flares or right-turn bays, unless the lane contains a multi-lane, and should be associated with an appropriate long lane. Where multi-lanes are used flare contributions can be directly entered within the multi-lane properties, otherwise a short lane’s Custom Occupancy should be adjusted to get the required flare usage. Flare usage will be checked in LMAP Stage 3. Note that blocking effects are not modelled when using multi-lane flares and may therefore need to be accounted for through other means, such as manual flow manipulation or the addition of upstream Underutilised Green Time. Blocking effects are inherently accounted for when using short lanes.

- **Multi-lanes**: where adjacent lanes exhibit identical behaviour in terms of queuing and signal control they can be grouped using the multi-lane option (analogous to single TRANSYT links containing multiple lanes). Where these are used the number of grouped lanes and on-street signal-control/queuing behaviour should be checked.

- **Connectors**: all observed traffic movements at junctions should be represented by individual connectors, including any upstream lane-to-lane connectors that may be required to capture the correct stopline queuing and turning behaviour.

- **Zones**: zones and zone-based routes are used where flows are entered using Origin-Destination (O-D) format, where Matrix Estimation has been used to calculate O-D flows from turning count data or for route-based analysis of network performance (whether or not zone-based flows have been used). The preferred approach for LMAP is not to use zone-based flow entry, but to enter flows directly onto lanes using appropriate Lane-Based Flow Groups as described in L305, as this gives full control over flow distribution and lane usage. It is however acceptable to use Matrix-Based Flow Group entry for fixed
routes (e.g. buses), or where there is minimal route and lane choice within the network (e.g. for smaller models). Where Matrix Estimation is deemed necessary to obtain an Origin-Destination matrix, it is recommended to use a fully validated assignment model based on dedicated assignment modelling software and a verified Prior Matrix.

The DE should perform site observations to ensure that relevant data is collected to recreate site-specific behaviour, which may need to be verified by the MAE.

Full details of typical site observations are provided in Part B of the TfL Traffic Modelling Guidelines but commonly include queuing behaviour, flared approaches, parking and loading issues, bus lane usage and setbacks, right turn behaviour and exit blocking. As traffic behaviour can change by time of day it may be necessary to observe these phenomena for each modelled period.

It is advisable for DEs or MAEs with limited experience to ask for assistance for key observations, such as from the CE or other TfL colleagues. This will provide an understanding of more detailed site-specific issues which may be highlighted in later stages of MAP. For example, it may be found that whilst two lanes have been indicated on the site drawing, there is parking in the nearside lane close to the stopline, which results in a single lane discharge.

Flare lengths should be modelled with special attention to how traffic behaves on-street, e.g. where a bus lane setback creates an effective flare. It is important that all flared approaches are accurately captured at this stage of MAP. If flares are not correctly coded the model may overestimate stopline capacity with a consequent impact during model validation.

L203 Lane Data

The lane data within the DE’s model that the MAE will audit include:

- **Lane length:**

  This should be as measured on-site for the lane concerned.

  The DE should record in the technical note how lane lengths were measured when building the model, which should determine the appropriate level of information required during auditing. The MAE may check lane lengths on site or use measurements from available scaled drawings or electronic mapping for reference.

- **Saturation flow:**

  This should be as measured on-site, or where not possible calculated, for the lane concerned.

  Saturation flows are fundamental to the integrity of any traffic model, and should have been measured on-site by the DE for all lanes. If this was not
possible, an explanation should be given in the technical note. Where saturation flows have been calculated, RR67\textsuperscript{5} should have been used.

It may be acceptable for the DE to use default saturation flows (1800 PCU hr\textsuperscript{-1} per lane) for Pelican crossings or non-critical side roads and pedestrian crossings where there is insufficient traffic demand (or queuing) to measure saturation flows accurately, however this should be agreed with the MAE. Similarly, it may be acceptable for the DE to specify some lanes as unconstrained (infinite saturation flow) where it is unnecessary or inadvisable to model lane capacity (e.g. exits from the network or dummy links modelling internal junction movements).

The DE and MAE should identify the critical junction(s) and lane(s) in the network, for which it is most necessary to accurately model and check saturation flows. If critical modelled saturation flows are not accurate, they are likely to result in modelling inaccuracies during later stages of MAP.

- **Right-turn storage in front of stopline:**

  This should correspond to the storage (in PCU) available in front of the stopline for waiting vehicles from opposed, signalised movements.

- **Maximum turners during intergreen:**

  This should correspond to the maximum number of turners (in PCU) that are able to clear the junction during the intergreen period.

- **Right Turn Move Up:**

  This should be set to the default value of ‘Auto-Calc Using Storage’.

- **Right Turn Factor:**

  This controls bonus capacity due to right-turning traffic storing in front of the stopline and should be left at the default value of 0.5. It should only be changed if accompanied by measured site data.

- **Non-blocking storage:**

  Where a lane contains a mixture of both opposed and unopposed traffic, the number of PCUs of opposed vehicles that are able to store without blocking unopposed vehicles should be specified here.

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• **Controlling phase(s) & controller:**

For signal-controlled lanes, the controlling phase(s) should be specified along with the corresponding traffic signal controller.

• **Multi-lanes:**

Where it is considered appropriate to use multi-lanes (see L202), the following parameters must be checked are correct:

  o Number of lanes to be represented by the multi-lane;
  o Saturation flow, which should be the cumulative total of saturation flows for all long lanes in the multi-lane;
  o Number of flares; and
  o Individual flare lane saturation flows.

• **Start & end displacements:**

These should be left at the default values of 2s and 3s respectively, unless measured site data suggests different values (e.g. where a survey of start & end lost times has been performed).

• **Queue de-sliver:**

This should be left blank (i.e. zero) during LMAP Stage 2. Values up to 1.0 PCU can be applied later during LMAP Stage 3 if sliver queues are observed to be produced once flows are added to the model (see L309).

• **Ignore random delay:**

This option should be left unchecked unless appropriate for the specific lane being modelled, for example circulating movements at signal-controlled roundabouts where the distance between entry and circulating stoplines are small and platoon arrival patterns are regular and non-random. Where this option is enabled its use should be reported and justified.

**L204 Connector Data**

The connector data that the MAE will check includes:

• **Cruise time / cruise speed:**

Cruise times should be entered as measured on-site for each traffic movement. Cruise speeds should not be used, nor should the ‘Custom Lane Length’ feature be used unless agreed by the MAE and justified with valid site data.
The cruise time for a connector in LinSig is defined as the average time for a free-flowing vehicle driving in a platoon to travel from the stopline of the upstream lane to the stopline of the downstream lane. The connector cruise time will apply to all flows that pass through the connector unless a custom cruise time has been defined for a particular Flow Group or route, which is checked in L305 during MAP Stage 3.

**Note for MAEs:**

Particular attention should be paid to the accuracy of cruise times in view of the fact that they are based on vehicle speeds which can vary significantly both from network to network and within a network.

The MAE may wish to discuss with the DE how auditing time is best utilised within L204. If necessary the MAE can identify critical journey times which should be checked for accuracy on-site. Less critical cruise times should be checked to ensure they are at least reasonable based on expected vehicle speeds at individual sites.

- **Platoon dispersion behaviour:**

  The platoon dispersion behaviour & dispersion coefficient can be used to control whether or not platoon dispersion should be modelled. It may be appropriate not to model platoon dispersion for short lanes that are closely coordinated with adjacent upstream lanes, where traffic platoons remain tightly defined.

  Where platoon dispersion is modelled the platoon dispersion coefficient should be unchanged from the default value of 35 unless supported by site-measured data.

**L205 Controller Data**

The following controller data should be checked by the MAE:

- **Controller name & SCN:**

  Each LinSig controller should have a suitable description to aid in its identification, together with the specific TfL site reference number (SCN, or System Code Number) as shown on the appropriate TfL Signal Timing Sheet. The LinSig controller number that is used is arbitrary.
• **Controller type:**

Where known, the controller type should be entered for the specific hardware that exists on-street (e.g. ‘Siemens’, ‘Peek’, ‘Microsense’ etc). Where the hardware type is not known and cannot be determined, it may be acceptable to leave the type as ‘Generic’.

It should be noted that the controller type can have a significant impact on the interpretation of values entered for phase delays in L206. Where ‘Generic’ controller types are used, particular attention should be paid to ensure that phase delays are correctly represented.

• **Treat Phase Minimums as Street/Controller minimums:**

It is important that, in developing LinSig Models, phase minima are treated as ‘controller minimums’ rather than ‘street minimums’.

• **Allow multiple stage streams:**

If a controller runs multiple streams on-street, then this should also be represented within the LinSig model. Where this option is specified the DE and MAE must ensure that all streams are correctly represented and associated with the correct controller.

• **Non-standard filters:**

This value should be left unchecked, preventing filter phases from terminating when the associated phase loses green, as this signal behaviour is not used in London.

### L206 Phase Data

The following phase data will be checked by the MAE:

• **Associated stream & controller:**

These should be checked to confirm that the phase has been associated with the correct controller and stream.

• **Phase letters:**

These should correspond to the phase letters as used on the appropriate TfL Signal Timing Sheet.

• **Phase description:**
The phase description should be suitable to correctly identify the on-street phase and/or movement that the modelled phase represents.

- **Phase type:**

  This should be set to the appropriate value for the phase concerned, e.g. ‘Traffic’, ‘Pedestrian’, ‘Bus’, ‘Cycle’, ‘Filter’, ‘Indicative Arrow’ or ‘Dummy’.

**Phase minimum:**

  The phase minima should be set to the values specified on the TfL Signal Timing Sheet and/or Controller Specification.

- **Phase delays:**

  These should be specified using the Interstage & Phase Delays View. They can be quickly checked using the Model Audit View, and should correspond to entries on TfL Signal Timing Sheets and/or Controller Specifications. Particular care should be taken to ensure that phase delays are represented using the correct controller hardware and that appropriate values are used (i.e. relative or absolute values for phase-gaining delays).

  Typically, the values on TfL Signal Timing Sheets and Controller Specifications correspond to values for the specific controller, which may be either relative or absolute. These should correspond to the ‘Controller Values’ in LinSig, rather than the directly entered value. Common sense can often determine the purpose of the phase delay and therefore which representation is correct, however if in doubt the DE should consult the MAE and green times should be checked on-street and compared to the timings in LinSig.

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**L207 Lane Behaviour & Control Data**

The lane behaviour & control data that the MAE will check includes:

- **Signalised / give-way control:**

  For lanes with signalised control the controlling phase and controller should already have been specified in L203. For lanes with give-way movements, ‘This movement gives way’ should be selected for each individual give-way movement.

- **Opposing lanes:**

  For each lane that gives way, the opposing lanes and movements need to be individually specified. For each opposing lane, the give-way coefficient and ‘Clr Conflict’ parameter need to be entered.
The give-way (or ‘slope’) coefficient represents the effect of the opposing flow on the capacity at the give-way line and is determined by the nature of the give-way movement. The LinSig manual\(^6\) suggests appropriate values of 0.22 for a give-way controlled left turn and 1.09 for an opposed right-turn at a signalised junction.

The ‘Clr Conflict’ parameter represents the time for a vehicle to travel from the opposing stopline to a point where it is no longer in conflict with the give-way movement. Thus vehicles that are giving way and stored in the junction at the end of green cannot clear until the ‘Clr Conflict’ time has passed following the start of the intergreen. A default value of 2s is typically used; however a larger value may be required for large junctions.

- **Maximum flow while giving way:**

  This should be set to the maximum capacity for the give-way movement (in PCU hr\(^{-1}\)), during which vehicles are giving way but while there is no opposing flow (i.e. the ‘intercept’). The LinSig manual\(^6\) suggests values of 715 PCU hr\(^{-1}\) are appropriate for a give-way controlled left turn and 1440 PCU hr\(^{-1}\) for an opposed right-turn at a signalised junction.

- **Flow when opposing traffic is stopped:**

  This is the maximum flow for the give-way movement when the opposing traffic flow is stopped. It should be set to either:

  - ‘Use Maximum Flow when Giving Way’, where the rate of flow is unlikely to be different from the flow while giving way. This may be the case for some left-turn give-way movements where it is not clear from a driver’s point of view when the opposing traffic flow has stopped;

  - ‘Use Lane Saturation Flow’, where vehicles are free to discharge at the lane’s saturation flow, for example during an indicative right arrow where turning vehicles know they have priority; or

  - ‘Use Custom Value, where a user-specified value is considered more appropriate. If this is the case the reasoning should be given along with how the entered value has been determined.

**L208 Intergreen & Interstage Data**

The phase intergreen tables for each of the controllers in the model should be specified individually using data from the relevant TfL Signal Timing Sheets and/or Controller Specifications. After entering intergreen data using the Interstage & Phase

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Delays View, the DE should also ensure that any prohibited stage moves have been correctly specified.

Assuming that phase (L206), stage (L209) and stage sequence (L210) data is correct; the interstage durations for each controller should also be checked against the UTC system using the DTSJ command.

Any discrepancies in the intergreen or interstage times when compared to UTC data should be investigated by the MAE. In cases where data does not correlate but the reason is not obvious, the MAE may require a second opinion from a Principal Engineer as there can be UTC-specific explanations.

L209 Stage Data

The stage data that will be audited for each controller and stream includes:

- **Stage number:** this should match the stage number shown on the TfL Signal Timing Sheet where possible, or alternatively appropriate stages should be renumbered in a logical fashion (e.g. stage 0 may be renumbered to the highest unused stage or for an additional stream stage numbering can restart from 1).

- **Phases red/green in stage:**

  These should correspond to the phase/stage relationship defined on the TfL Signal Timing Sheet and Controller Specification.

- **Stage minima:**

  Stage minima should be calculated for all observed stage sequences by reducing the cycle time to a minimum in LinSig (it may be helpful to include a separate ‘MINS’ LinSig Scenario for this purpose). These should then be compared against the UTC system using the PDJ command. If there are discrepancies, these should be investigated. In cases where data does not correlate but the reason is not obvious, the MAE may require a second opinion from a Principal Engineer as there can be UTC-specific explanations.

  Where controllers are configured with dummy phases these need to be replicated in LinSig to ensure the correct stage minima. The stage minima may also be dependent on the stage sequence followed.

L210 Stage Sequence and Signal Timings (without Demand-Dependency)

The DE and MAE must ensure that an appropriate stage sequence is used for each stream & controller in the Network Control Plan for the relevant LinSig Scenario being audited. The stage sequences used in the Calibrated LinSig Model should contain all demand-dependent stages appearing with 100% demand.

The timings that will be checked by the MAE include:
• **Stage change points and cycle time:**

If the modelled network is running under Fixed Time UTC, the stage change points and cycle time should directly correlate with the UTC plans. If the modelled network is running under SCOOT Control, it is important to note that SCOOT Stages are not the same as the UTC Stages modelled in LinSig. The MAE should examine the SCOOT background plans to understand the relationship between the SCOOT and UTC stages from the plan structure. The DE must provide details of the derivation methodology used to determine the average cycle time and SCOOT stage change points to the MAE in the DE’s Technical Note (L210).

A common method of modelling SCOOT Control in LinSig is by use of SCOOT M16 and M37 stage duration messages together with M18 offset messages recorded for a representative day, with no interventions to the weekly timetabled control. A DE or MAE with limited experience may require support from more experienced colleagues, such as the CE or a TfL Principal Engineer, in order to corroborate that timings are correct.

When using M16 messages, it is important to note that SCOOT Stages are not identical to UTC Stages. The DE and MAE should examine the SCOOT background plans to understand the SCOOT stage change points relative to the UTC Stage change points (which are modelled in LinSig).

• **Phase green times:**

Assuming that the stage change points, phase delays (L206) and phase intergreens (L208) have been correctly specified, the phase green times should also be correct. It is nevertheless worth checking the phase green times in the Signal Timings View to ensure timings are correct, and in the case of Fixed Time UTC plans these should correlate directly with observed phase timings on-street for the stage sequence modelled.

• **Stage & interstage durations:**

Interstage durations should have been checked in L208, however the Signal Timings View also provides a way of checking interstage and stage durations using a graphical interface. These should correlate with timings from the UTC system using the DTSJ command.

**L211 LinSig Scenarios**

It is important that all Scenarios contained within the LinSig model are clearly labelled so that their purpose can easily be understood. In addition, a specific Scenario must be entered on the LMAP Stage 2 Check Sheet (SQA-0545) so that it is clear to the MAE which Scenario is being submitted by the DE for auditing.
In addition to the Scenario being submitted for auditing it may be useful to include additional Scenarios, for example when investigating alternative stage sequences or for looking at stage minima.

L212 Other Modelling Issues

The DE has no direct input into this section, however the DE should take note of any comments provided by the MAE in the ‘Other Modelling Issues’ section of the LMAP Stage 2 Check Sheet (SQA-0545). This details any concerns the MAE may have with the model that have not already been covered by the checks in L201 – L211. These additional issues may relate to project specific agreements formalised during MAP Stage 1.

4.2.5 Acceptance/Rejection of Model

Once the MAE has checked that the signal control data is correct and is also satisfied with the technical note, site observations, measurements and the model structure, then the submitted model may be accepted as a ‘Calibrated Model’.

Conversely, if the MAE is not satisfied with the modelling standard, the reasoning for rejecting the model should be provided in writing, and the models returned to the P, DE, CE, and copied to RSMSchemeAssessments@TfL.gov.uk.

If there are fundamental flaws within the model, the MAE may organise a meeting with the DE. At the MAE’s discretion, the P may also be invited as they are often the budget holders for the DE’s work and may need to discuss if the quality of work is as agreed in the project brief.

4.2.6 Criteria for Moving to LMAP Stage 3

The P, DE and CE have received an MAE-approved Stage 2 Check Sheet (SQA-0545), which has also been copied to RSMSchemeAssessments@TfL.gov.uk.

End of LMAP Stage 2

4.2.7 Stage 2 to Stage 3, Demand-Dependent Stage Count Information

In order to model the frequency of demand-dependent stages at a signalised node, the DE or MAE needs to retrieve data from the UTC system.

UTC is able to retrospectively retrieve the frequency of demand-dependent stage appearances that were observed over a specified period, divided into 15-minute segments. For example, to get the observed frequency of a demand-dependent stage between 9am and 10am (i.e. four 15 minute segments) for Group 59 on 2nd September 2010, the command is:

‘achk g59 t=09:00 p=4 d=02-sep-10’
The UTC log provides the observed stage appearance frequency for every demand-dependent stage in the following format:

‘number of times called (IP)’ / ‘no. of opportunities’ (OP)

If a junction is under SCOOT Control, it is important to check whether the junction was single or double cycling by identifying the number of opportunities in the plan against the actual opportunities reported by UTC. This should be equal to a whole multiple where a junction was forced to either single or double cycle for the entire observed period. Where a junction was free to either single or double cycle in SCOOT (and has done both within the observed period) a different number of actual opportunities will be seen. In this case the only way to work out the cycle times that occurred is to have SCOOT message data for the monitored period.
4.3  LMAP Stage 3, Validated LinSig Base Models Submission

4.3.1  What is a Validated LinSig Model?

LMAP defines that a Validated LinSig Model should be based on an approved Calibrated Model where the frequency of demand-dependent stage appearance has been defined.

Validation in LinSig is completed by comparing modelled degrees of saturation (DoS) with those recorded on-site. Queue lengths may also be examined but are not considered compulsory criteria for validation.

Validated LinSig models are required for all time periods in LMAP Stage 3.

4.3.2  LMAP Stage 3 Check Sheet

L301 Validation Report

Validated Base Model submissions must be accompanied by a Validation report, as described in Part B of the TfL Traffic Modelling Guidelines. The DE should ensure that the following information is provided to the MAE:

- Detail on the traffic flows:
  - When were the traffic surveys done and by who?
  - What data was collected during the traffic surveys?

- Demand-dependency calculations:
  - Explanation on how the frequency of demand-dependent stages has been accounted for by comparing Calibrated Model Timings to the Validated Model Timings;
  - UTC data should be recorded to confirm any site observations. If pedestrian counts are taken, the frequency of demand can be recorded on-site but should be used in conjunction with a UTC log. The output of the UTC log should be included in the report;

- Evidence of validation, with comparison between on street data and LinSig results;

- Flare usage observed on-site;

- Flashing amber usage at pelicans; and
• Queue lengths (if surveyed).

L302 Adjustments from Calibrated Model

There should be few changes in the Validated Model as compared to the Accepted Stage 2 Calibrated Model, other than modification for peak-specific signal timings (checked in L303 & L304), the addition of flows (L305) and the inclusion of public transport (L306). Flare usage may also be expected to vary between models and should correspond to observed measurements recorded in each peak. The DE should ensure, and MAE verify, that effective flare usage is correct and matches surveyed data.

Where any other changes have been made, the DE should identify what was changed and why the change was considered necessary within the Validation report. The following data that was audited during LMAP Stage 2 should be checked:

- **Network Settings & Network Layout (L202):** PCU length, junctions, arms, short/long lanes, multi-lanes & connectors;
- **Lane Data (L203):** lane lengths, saturation flows, junction storage, flare usage, turners in intergreen, right-turn move-up, right-turn factor, start/end displacements, random delay;
- **Connector Data (L204):** cruise times, platoon dispersion;
- **Controller Data (L205):** controller types, streams, controller/street minima, non-standard filters;
- **Phase Data (L206):** phase letters/descriptions, phase types, phase types, phase minima, phase delays;
- **Lane Behaviour & Control Data (L207):** signalised/give-way control, opposing movements, give-way parameters (slope/intercept), clr conflicts, flow without opposed traffic;
- **Intergreen & Interstage Data (L208):** phase intergreens, interstages, prohibited stage moves;
- **Stage Data (L209):** stage numbers, red/green phases in stages, stage minima;
- **Stage Sequence & Signal Timings (L210):** stage change points, UTC/SCOOT stage, relationship, cycle time, phase green times, stage & interstage durations, network control plan; and
- **LinSig scenarios (L211):** scenario name.
L303 Appropriate Peak-Specific Signal Timings

The checks that were performed in LMAP Stage 2 during L210 should be repeated for each LinSig Base model to ensure that appropriate peak-specific base timings have been used for the period being modelled.

Note that the timings shown in the Signal Timings View should not be affected by adjustments for Demand-Dependency & Underutilised Green Time (see L304) as these will be implemented on a lane-by-lane basis using the Lane Timings View.

L304 Adjustments for Demand-Dependency & Underutilised Green Time

The DE should detail adjustments to the traffic signal control information made to account for the non-appearance of demand-dependent stages over the modelled period, and for situations where congestion-related issues prevent fully saturated discharge.

The preferred method for modelling both demand-dependency and Underutilised Green Time (UGT) in LinSig is to add or remove green time for individual lanes through Lane Timing adjustments. This is performed by adjusting the start & end of lane green times in the LinSig Lane Timings View, as shown in Figure 3 (analogous to bonus greens in TranEd or start/end lags in TRANSYT).

![Figure 3: Lane Timings View in LinSig 3.1, showing Bonus Green adjustment.](image)

Separate Lane Timing adjustments should be made for each bonus green type, which include ‘Demand Dependency’, ‘Underutilised Green Time’ or ‘Other’. Disaggregating components of bonus green allows for simpler auditing and also differentiates between modelling adjustments and the original interstage design approved during MAP Stage 2.

Demand-dependent stage frequency can vary by time of day to affect lane capacity. It is therefore imperative that the DE and MAE confirm that the modelled adjustments provide appropriate green times for critical lanes. As an example, if a junction has been modelled with a pedestrian stage being called every cycle, when on site this...
situation occurs in 50% of signal cycles, then the model is likely to underestimate the capacity of one or more of the major movements.

All demand-dependent stages within the network should show a frequency of at least 90% of that observed on-street.

Where fully saturated traffic appears to discharge at a rate less than the saturation flow (e.g. due to driver behaviour or exit-blocking), this should not be accounted for by changing the saturation flow in a model. Instead, it is recommended that UGT is used to quantify this behaviour. UGT can commonly occur during periods of congestion within networks operating at or over capacity. Traffic may only be travelling marginally slower than would be the case during unrestricted saturation flow which may not be noticeable to an on-street observer but its impact will be captured by UGT during data processing. UGT is fully described within Part B and Appendix I of the TfL Traffic Modelling Guidelines.

The DE should measure the average amount of green time that is lost due to UGT (e.g. wasted green due to exit blocking) and adjust the relevant lane timings accordingly. Site data showing how Demand-Dependency and UGT values were measured and calculated should be provided with L301 for auditing by the MAE to verify that this aspect of modelling has been addressed correctly.

L305 Traffic Flows, Routes and Flow Consistency

LinSig models are usually constructed using stop-line flows from manual classified traffic surveys. The DE should have selected a common peak hour for the whole area under consideration which should be illustrated for the MAE, for example by a graph showing the sum of the total flow at each junction. The peak hour for all junctions in the model can then be audited. In some situations, the appropriate peak may not be the peak for all modelled junctions but for a particular group of junctions within the network, such as a roundabout or gyratory system. This should be confirmed as acceptable with the MAE.

The preferred method for flow entry in LinSig is to use Lane Based Flow Groups, which require flows to be entered directly onto modelled lanes and connectors for each user-defined flow group layer. This gives full control over flow allocation to lanes, and also allows disaggregation of flows by traffic mode (or any other groups of interest) when entering flows and analysing model results.

Matrix Based Flow Group entry is also acceptable for fixed routes (e.g. buses), or where minimal route and lane choice exists within the network, such as for smaller models where the Origin-Destination matrix is known or can easily be estimated. When using Matrix Based Flow Groups, the DE and MAE must ensure that unrealistic routes do not exist (through configuration of LinSig’s Permitted Routes), and that lane usage is accurately represented (flows on specific routes can be manually fixed where necessary). Zone-based flow entry may also be useful to model & optimise complex junctions such as signalised roundabouts. If the Origin-Destination matrix is not known and Matrix Estimation needs to be employed, it is recommended to use a fully
validated assignment model based on dedicated assignment modelling software and a verified Prior Matrix.

For the preferred method of flow entry, Lane Based Flow Groups, flow group layer flows can be entered within the Edit Lane window for individual lanes, or alternatively via an interactive ‘drag and drop’ process using the ‘Lane-Based Flow Entry Mode’. The Flow Group’s start and end times should reflect the peak period being modelled.

Typical flow group layers would include ‘Private Transport’ and ‘Public Transport’ at a minimum, with a combined ‘General Traffic’ layer if appropriate. Additional flow layers can be defined to break flows down into further vehicle categories if necessary, though the DE should be aware that this will increase the amount of auditing required.

When allocating flows, custom cruise time values can be used for specific Lane-Based Flow Groups, Matrix-Based Flow Groups or routes that will override the connector cruise time, as explained in L204. Where custom cruise times have been used for specific lane flows the DE should clearly explain and document their use, which should be checked by the MAE.

As most traffic surveys are carried out manually, there will inevitably be human counting errors. It is not expected that neighbouring survey counts will match, and in cases where they do, this warrants closer inspection as they may have been manually adjusted. Further information on an acceptable approach to traffic flow smoothing can be found within section 2.4.3 within Part B of the TfL Traffic Modelling Guidelines.

Where there is a discrepancy in flows on a modelled lane, the MAE should examine the flow data used for modelling. If this does not correspond with modelled flows and resolve the concerns, the MAE may conduct a sample spot count on site. To get an accurate count, it is recommended that the flow is recorded over a whole number of cycles, during a section of the modelled peak, i.e. start and end timings should be from the start of green on the movement being measured.

Where multiple upstream lanes feed two lanes downstream, the DE should provide evidence that they have recorded the percentage split of flow from each of the origin lanes to each of the destination lanes. In the example within Figure 4 the DE would record the percentage of traffic from origin A going to destinations D and E and likewise for origins B and C. Once this data had been gathered, the combination of flows from A, B and C with their respective percentage destinations can be calculated. The sum of the resulting inflows for lanes D and E should reconcile reasonably with the observed stopline flows from the original survey.
The MAE should examine the following public transport elements of the model:

- Bus flows, routes & frequencies;
- Bus lanes;
- Location of bus stops;
- Bus stop dwell times; and
- Influence on general traffic.

The DE should calculate bus flows, routes and their frequencies as described in the TfL Traffic Modelling Guidelines, based on available data which should be provided to the MAE for auditing. Bus lanes, hours of operation and vehicle type restrictions should also be checked against on-street data to ensure that bus lane usage is accurately represented. Buses should be added using one or more Lane-Based Flow Group layers on each lane along their routes, to distinguish Public Transport from Private Transport. When creating additional Lane-Based Flow Group Layers for Public Transport in LinSig they should be specified as representing buses in the Flow Group Layer options.

Alternatively zone-based routes can be used, with specific Permitted Routes edited or fixed appropriately to ensure correct lane usage. As with Lane-Based Flow Groups, relevant zones should be specified as Bus Zones to distinguish them from other traffic types and to ensure they are correctly modelled.

Where a bus stop exists on a lane, the ‘Mean Stopped Time’ on the upstream connector should be set to the average bus stop dwell time that has been determined. Where more than one bus stop exists, the dwell times should be added
together with an additional delay added to reflect the time lost slowing down and accelerating for the additional bus stop(s).

As mentioned in L305, cruise times can be specified separately for each Lane-Based Flow Group layer, Matrix-Based Flow Group or route when adding flows, allowing different cruise times to be specified for Public Transport compared to General Traffic if desired. In a similar manner, different ‘Mean Stopped Time’ values can also be specified for each Lane-Based Flow Group layer, Matrix-Based Flow Group or route, allowing different dwell times to be used by different bus routes at the same bus stops if this level of detail is considered necessary.

The scope of the LinSig model agreed in MAP Stage 1 will determine the level of detail required for public transport modelling. For example, if the models are being prepared to assess the impacts of a public transport-related scheme, the DE should ensure that all relevant public transport elements have been modelled in detail. This may include detailed on-street measurement of dwell times per bus stop and per time period, or separate Lane-Based Flow Group layers or Matrix-Based Flow Groups for different bus routes. In models where public transport is considered less of a priority the use of a collective ‘Public Transport’ Lane-Based Flow Group layer or Matrix-Based Flow Group for all bus routes and/or default dwell times may be satisfactory.

The influence of public transport on general traffic often can have a significant impact on network capacity and performance, such as the creation of effective flares for general traffic in the case of bus lane setbacks and funnelling at bus lane entries. The DE should provide in the accompanying technical report any notes on site observations to demonstrate that any influences on capacity due to public transport are accurately represented. Site visits can be undertaken by the MAE to observe behaviour and ensure they have been accurately reflected in the submission.

L307 LinSig Scenarios

As for the Calibrated LinSig Model at LMAP Stage 2, it is important that all Scenarios contained within the LinSig model are clearly labelled so that their purpose can easily be understood. In addition, a particular Scenario must be specified on the LMAP Stage 3 Check Sheet (SQA-0546) so that it is clear to the MAE which Scenario is being submitted for auditing.

In addition to the specific Scenario being submitted for auditing, it may be useful to include additional Scenarios for investigating alternative stage sequences, for looking at stage minima or with/without demand-dependency.

The scenario time period should match the specific peak period being modelled, which is determined by the start/end times of the relevant Flow Group (as audited in L305).

L308 Degree of Saturation Validation

The correct recording of on-street DoS is essential to the validation of a model. The TfL Traffic Modelling Guidelines outline the preferred approach for surveying DoS.
however it is strongly recommended that the DE contacts the MAE prior to surveys being undertaken to discuss the approach to be used. It may also be appropriate for the MAE to accompany the DE on an initial site visit to observe and/or measure DoS.

The DoS recorded on-street and shown in the model should correlate. Lanes close to practical reserve capacity (90%+ DoS) should be given particular attention during auditing.

The following criteria should be used to indicate validation of base LinSig models:

- Degrees of saturation within 5% of observed values;
- Degree of saturation for lanes upstream of pedestrian crossings within 10% of observed values; and
- Observed Cyclic Flow Profiles (CFP) for critical lanes showing similar peaks, dispersion and spacing.

It is important to note that, for models built using stopline counts, by definition, the degree of saturation cannot be over 100%. This is because a stopline count is the traffic that has cleared the stopline rather than the demand. For models with lane DoS above 100%, model discrepancies may exist for one or more of the following: saturation flows, lane/connector structure, green times, and/or stopline flows.

Another consideration is that, although the signal timings in the model are accurate, the timings that were in operation during the traffic surveys may have been different to the modelled average signal timings, e.g. where contingency plans were in operation. This is possible but unusual if sufficient checks were made during the data collection phase of LMAP Stage 2. If the DE or MAE suspects this to have occurred it is appropriate to investigate UTC logs for the date of the traffic surveys. If in doubt, a sample traffic count during the modelled period (as detailed in L305) is advisable.

Flare usage should be represented correctly in each model and fully documented in the DE’s technical report (L301), based on observed measurements recorded in each peak. If flare usage has not been documented then the MAE should request clarification from the DE with regards to the impact on degrees of saturation.

There may be instances where periods of Underutilised Green Time have occurred on-street that have not been correctly accounted for in the models. In these cases, the modelled DoS is likely to be lower than was recorded on-street for the lanes in question. Please refer to L304 for further guidance.

### L309 Appropriate Queue De-Sliver and Queue Length Correlation

When analysing queue data in LinSig the DE should determine if and where it is appropriate to use queue ‘de-sliver’ and whether its use is justified. It is intended to be employed where artificially large and unrealistic queue lengths are generated due to LinSig’s algorithms not accounting for actual driver behaviour. The ‘De-Sliver Threshold’ considers queue lengths less than a particular value to be treated as sliver queues, thus preventing additional vehicles from joining the back of an artificially created queue.
The DE should make clear in the accompanying technical report (L301) where de-sliver adjustment has been applied, which should be checked by the MAE. The MAE must also ensure that de-sliver has not been employed elsewhere in the model where its use may not be considered appropriate.

Figure 5: Uniform queue graphs showing formation of a Sliver Queue (left) and removal using correct use of the De-Sliver Threshold (right)

Where sliver queues are observed in a CFP (see Figure 5), the value of the De-Sliver Threshold should be set to the smallest value that just removes the sliver queue from forming, and should be no larger than 1.0 PCU. De-Sliver Thresholds should not be used where sliver queues are not observed.

LinSig allows the display of a variety of queue-related information from models including Uniform Queues, Random & Oversaturation Queues, Mean Maximum Queues & Lane Length Excess Queues.

Queue length analysis can be performed for individual lanes by adding Uniform Queue Graphs to the LinSig Network View. This is achieved by first selecting a lane, right-clicking the mouse and then choosing the ‘Add Cyclic Flow Profile Graph / Add Queue Graph’ option. Uniform Queue Graphs show the typical variation in uniform queue over a single cycle, but do not by default include the Random & Oversaturated Queue components, which become increasingly important above 90% DoS. These can be added by right-clicking the Uniform Queue Graph and choosing the ‘Show Random and Oversat Component’.

Queue results can also be displayed for all lanes simultaneously by accessing the Network Results View or Model Audit View. The most commonly referenced measure is the Mean Maximum Queue (MMQ) for each lane, as this indicates the average of the Maximum Queue that occurs across all cycles, including Random and Oversaturated Queue components. This can be measured on-street when platoon arrival patterns are regular and distinct, however if vehicle arrival patterns are less pronounced the MMQ is difficult to observe.
If queue data has been surveyed, it is the responsibility of the DE to provide this data for audit by the MAE. Modelled queue lengths should not exceed the lane length as it cannot physically do so on street. Excess queuing is indicated in LinSig through Lane Length Excess Queue values greater than zero. This parameter should therefore be checked for each lane in the network to determine whether modelled queues exceed the storage space available on the lane.

If queues in a model exceed lane lengths, the DE and MAE have to consider whether the green times, offsets, saturation flows and flows for the lanes are correct. If these parameters have been correctly modelled and queues are observed on-street to block upstream lanes the DE may need to account for excess queuing by applying Underutilised Green Time to upstream lanes. Please refer to L304 for further guidance.

**L310  Fit for Purpose Model**

If the MAE fails the model on any of the checks L301-L309, or other concerns exist relating to the standard of modelling, then the model is not considered fit for purpose and will be rejected and returned to the P, DE and CE.

If the MAE has passed the model on all of the checks L301-L309 and there are no other issues then, referring back to the purpose statement from MAP Stage 1, the MAE will pass the model as fit for purpose and authorise the LMAP Stage 3 Check Sheet (SQA-0546).

The DE, CE and MAE must complete a separate LMAP Stage 3 Check Sheet for each of the modelled periods. The MAE should inform the P, DE and CE of the Approval or Rejection of the LMAP submission, which should also be copied to RSMSchemeAssessments@TfL.gov.uk. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

**4.3.3  Criteria for moving to LMAP Stage 4**

The P, DE and CE have received MAE-approved LMAP Stage 3 Check Sheets (SQA-0546) for all modelled periods, which have also been copied to RSMSchemeAssessments@TfL.gov.uk.

The MAE has ensured that the approved models have been uploaded to, and are retrievable from, the TfL Model Library.

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**End of LMAP Stage 3**
4.4 LMAP Stage 4, LinSig Proposed Models Checkpoint Meeting

4.4.1 Checkpoint Meeting

As with the base models the P, DE, MAE, SAE and NAE must meet to discuss the details of the proposals and re-confirm how they are to be modelled. The bulk of the modelling work will have been completed during the development of the base model. The DE, CE and MAE key responsibilities for LMAP Stage 4 are outlined below.

It is the responsibility of the DE to record the minutes of the meeting and formally submit these to the other parties who attended the meeting. The minutes will be authorised by the MAE and used to update the Modelling Expectations Document in L406, which will be accepted as an official account of the decisions reached.

4.4.1 LMAP Stage 4 Check Sheet

LMAP Stage 4 has a Check Sheet (SQA-8675), which acts as a formal record of task completion within LMAP Stage 4. The DE should complete this document following the LMAP Stage 4 Proposed Models Checkpoint meeting and provide the completed version to the MAE.

The following sections need to be agreed and documented, which will be confirmed by the MAE following submission by the DE.

L401 Proposed Models Checkpoint Meeting

The DE must document the date of the meeting attended by the P, DE, MAE and SAE. The MAE must ensure that the name and affiliation of all parties have been captured on the LMAP Stage 4 Check Sheet (SQA-8675).

L402 ‘Purpose’ Statement for each Proposed Model

As with the base models in MAP Stage 1, the DE should provide the MAE with a statement of the purpose of each of the modelled periods. This should be based upon the proposals being put forward by the P and taking into consideration local conditions of the network being modelled. The statement of purpose created by the DE is a key term of reference for all parties involved in MAP.

L403 Road Network Changes

It is possible that in some cases a significant amount of time may have passed between approval of XMAP Stage 3 and the start of XMAP Stage 4. In this case changes to the road network will be discussed at the Checkpoint Meeting to outline
any adjustments required to the base modelling. These adjustments should be documented by the DE.

L404 Requirements for Proposed Model Build

As an outcome of the Checkpoint meeting, the DE will submit to the MAE an overview of the work they will conduct to prepare proposed models from the approved LMAP Stage 3 base modelling. This should include detail of when any new methods of control will be submitted for audit by the SAE, i.e. prior to the LMAP Stage 5 submission.

It is important that the DE develops any proposed models using the same version of LinSig that was used to create the base models, which should be confirmed with the MAE.

The DE should outline the proposed strategy for signal timing optimisation during each modelled period and confirm agreement of the outputs required from the proposed modelling.

L405 Checking of Proposed Methods of Control

For the P and the DE an important outcome of the Checkpoint meeting is to reach agreement with the SAE on when the new methods of control will be checked. It is a pre-requisite for LMAP Stage 5 that SQA-00640 compliance has been established prior to audit, so correct timetabling of the SAE check is imperative for further progress of the proposal within LMAP.

L406 Modelling Expectations Document

The Modelling Expectations Document produced during MAP Stage I should be reviewed and updated to incorporate any new information raised during the Checkpoint meeting. This is to be produced and agreed by the P, DE, MAE and SAE.

4.4.2 Criteria for Moving to LMAP Stage 5

To move to LMAP Stage 5, the following need to be agreed by all parties:

- Agreed and dated list of work to be completed by the DE including method of control submissions to the SAE prior to the LMAP Stage 5 submission;
- Purpose statements for each of the models being submitted during LMAP Stage 5; and
- Modelling Expectations Document updated if necessary.

---

The MAE-approved signed & dated MAP Stage 4 Check Sheet (SQA-8675) must have been received by the P, DE and CE, together with the Modelling Expectations Document, and copied to RSMSchemeAssessments@TfL.gov.uk

End of LMAP STAGE 4
4.5 LMAP Stage 5, LinSig Proposed Models Submission

4.5.1 Introduction

The majority of the work, both in terms of creating and auditing a LinSig Model, is completed when generating fit for purpose base modelling. Once LMAP Stage 3 has been passed there is often a relatively small amount of work required to complete LMAP.

The DE should make a copy of the accepted base models and input the new methods of control and/or lane structure in line with the proposals. In addition to ensuring that the model is correctly developed from a technical point of view the DE has the responsibility of demonstrating that the proposals can be accommodated within the network without jeopardising the normal day to day operation of the network. This will include maintaining acceptable levels of DoS and queue lengths as well as sufficient provision for pedestrian demand being modelled.

In common with the preceding stages, the MAE will need to consider all the technical data and their implications. However, an important additional responsibility of the MAE at Stage 5 is to make a judgement of whether they agree that the network is likely to operate satisfactorily on a day-to-day basis.

As a representative of the TfL Traffic Manager who will have a duty to manage the new network (if the proposal is given the go-ahead by RSM-Operations), the MAE must highlight any apparent issues or concerns with the proposals. These issues are likely to be in respect of safe, efficient network operation and current policy/guidelines.

The DE will receive feedback from MAE and will need to address any issues highlighted. The MAE can use their operational experience in making informed comments and decisions.

If required by the model scope the proposed timings must be suitable to be used as controller-held background timings for new methods of control. This means that the MAE’s audit is implicitly asking the DE:

‘Are you satisfied that, if observing on-site when these proposals were commissioned, the timings in each of the submitted LinSig models would provide appropriate network operation under local control and that the network impacts would be as described in the Scheme Impact Assessment Report?’
4.5.2 LMAP Stage 5 Check Sheet

L501 SAE-Approved Proposed Methods of Control

Before submitting any proposed modelling, the DE must ensure that all proposed methods of control have been approved by the SAE and documented on the ‘MAP Stage 5 SQA-0640 Compliance Check Sheet’ (SQA-0530). This needs to be confirmed by the MAE before further auditing can commence.

Lack of an approved MAP Stage 5 SQA-0640 Compliance Check Sheet for any of the methods of control changes will prevent the MAE from proceeding with LMAP Stage 5.

Proposed LinSig Models are required for all time periods in LMAP Stage 5.

L502 Proposal Report

Proposal submissions must be accompanied by a report, as described in the TfL Traffic Modelling Guidelines. The report needs to contain all necessary information and paperwork in order to assess criteria L503 - L507, together with an assessment of the likely impact of the proposals.

As for the Validated Model report in LMAP Stage 3, it is vital that the DE communicates all of their assumptions relating to the proposals and how they have been modelled. This should include detailed technical accounts of how all parameters that are not known have been derived. All known data which has been used (whether from surveys or trusted third parties) should be referenced and included in full as appendices to the report.

All changes to the models should be clearly stated along with the reasoning behind the changes and any required supporting information or data.

There must be clear comparisons between the results of the validated base models and the proposed models for the corresponding periods. The inclusion of comparisons for all links which are deemed critical is required. It is the responsibility of the DE to identify all the critical links. Normally (but not exclusively) critical links would be those which experience high traffic flows, are close to capacity and/or those links which are affected by the proposals. If the MAE believes that the DE has not included links in the comparison which are critical then they will ask the DE to amend the report accordingly.

L503 Changes to Model (LMAP Stage 3 to LMAP Stage 5)

There are likely to be three main changes from base to proposed models which should be detailed by the DE:

- Method of control changes, in which junction and lane control data will have changed;
• Road layout changes, in which case the network structure may have changed, including alterations to lanes, connectors and saturation flows; and

• The model will have been optimised following the pathway detailed in the TfL Traffic Modelling Guidelines, in which case the signal timings may have been modified.

L504 Model Scenario

As for the Validated Base LinSig Model at LMAP Stage 3, it is important that all Scenarios contained within the LinSig model are clearly labelled so that their purpose can easily be understood. In addition, a particular Scenario must be specified on the LMAP Stage 5 Check Sheet (SQA-0529) so that it is clear to the MAE which Scenario is being submitted for auditing.

In addition to the specific Scenario being submitted for auditing, it may be useful to include additional Scenarios for investigating alternative stage sequences, for looking at stage minima or with/without demand-dependency.

The scenario time period should match the specific peak period modelled in the LMAP Stage 3 Validated Base Model, which is determined by the start/end times of the relevant Flow Group (as audited in L305).

L505 Flow Consistency Check

The flows within a proposal may often be similar to those in the base model. However, if there are changes to the routing of traffic e.g. where the base model is of a one way system but the proposed model moves introduces a two way system, then the DE should provide the MAE with the detailed methodology, assumptions and all other relevant information used for the reassignment of traffic flows.

L506 Demand-Dependent Stage Frequencies

The DE’s proposal report (L502) should comment on the frequency of demand-dependent stages in the base model and the assumptions that have been made for the proposed network. These will need to be audited by the MAE.

Proposals must consider pedestrians as described in the TfL Traffic Modelling Guidelines. From a modelling point of view this means allowing for the appearance of pedestrian stages where they are envisaged to operate in parallel to traffic movements on a demand-dependent basis.

L507 Model Optimisation Strategy

The optimisation strategy to be used for the proposed modelling should be agreed with the MAE and documented by the DE in the technical report (L502). The choice of optimisation strategy is likely to depend on the nature and purpose of the proposed modelling.
Factors to consider include the following:

- **Demand-dependency adjustments may need to be:**
  - Left unchanged in the case of capacity assessment;
  - Modified if any flows demanding demand-dependent stages are expected to change significantly, for example due to additional development traffic or growth;
  - Removed to preserve offsets if the model is to be used to produce controller-held signal timings using offset-only optimisation;

- **Underutilised Green Time adjustments may need to be:**
  - Included if the cause of the UGT is likely to remain in the proposed scenario;
  - Recalculated if a change in UGT can be predicted and estimated based on the existing UGT value, for example due to a change in cycle time; or
  - Removed if the cause of the UGT is likely to be removed following the proposal implementation, which may in fact be one of the goals of the proposal; and

- **Iterative optimisation & flow adjustment:**
  - A dedicated assignment model may be used in conjunction with a proposed LinSig model to iteratively adjust flows and signal timings in both models until convergence is achieved, to account for wider traffic reassignment outside the LinSig model area. This may be the case where traffic management strategies are to be employed or to take account of other scheme changes in a wider area.

Whichever decisions are agreed between the DE and MAE regarding the optimisation strategy, it is important that they are documented and that any changes from the Stage 3 Validated Base LinSig Model are clearly identified and justified, with any calculations used to produce estimated values included.

**L508 Degrees of Saturation**

The DE’s proposal report (L502) should contain a quantitative comparison of base and proposed degrees of saturation and the implications for the operation of the network. Where these are observed to change, analysis should be presented to determine the reason for the change, what the impact is and whether it will have an adverse effect on operation of the network. The MAE must be satisfied that the proposed scheme degrees of saturation are acceptable.

The report does not necessarily have to contain a comparison of every link in the model, but it is the responsibility of the DE to ensure that all links which are considered as critical to the model or the proposals are included. The DE must also ensure any adjustments to saturation flows, effective flare usage or traffic flows on a lane have been fully documented. If they have not been documented then the MAE will approach the DE to fully explain their impact on degrees of saturation.
Note for MAEs:

The MAE must be satisfied that the proposed scheme degrees of saturation are acceptable. Degrees of saturation are affected by cycle time, available green time, traffic flow and saturation flow. Therefore, care must be taken to ensure techniques such as adjusting saturation flows or flows on a lane have not been used in order to manipulate degrees of saturation. Particular attention should be paid to lanes with little stacking capacity, e.g. at signalised roundabouts or staggered junctions. The MAE should expect small lanes to have spare capacity nearer to 20-30% (i.e. degree of saturation less than 70-80%), to prevent exit blocking to closely associated upstream lanes.

L509 Queue Lengths

The DE’s proposal report (L502) should contain a quantitative comparison of base and proposed queue lengths and the implications for the operation of the network, in a similar manner to the analysis undertaken in L508 for DoS.

Modelled queue lengths should not exceed lane lengths as they could not physically do so on street. Excess queuing is indicated in LinSig through Lane Length Excess Queue values greater than zero. This parameter should therefore be checked for each lane in the network.

Particular attention should be paid to lanes with limited stacking capacity for queued traffic. If small lanes operate at or near physical capacity the network can be susceptible to cross junction exit blocking and eventually locking up. Therefore, if the queue lengths on these lanes are at, or close to, the lane length then the DE and MAE should give consideration to whether signal timings can be manipulated to place queued traffic into less sensitive areas of the network.

L510 Advising the client

It is important for the DE to ensure that the traffic models delivered for the scheme are fit for purpose (i.e. the base and proposed models give an accurate reflection of the likely network conditions) and have been approved by the MAE.

The DE may find it useful during the design process to consider arranging meetings with the MAE, who may be able to provide advice on optimising signal timings within capacity constrained networks as outlined in Part B of the Traffic Model Guidelines.

However, even with an approved set of models, results can indicate that there are capacity or operational impacts in which case the MAE is obliged to outline these in the SIAR. If this is the case, it is advisable for the MAE to provide the DE and P an opportunity to make changes to the proposed models to address these issues before they make a submission to RSM-Operations.
It may be the case that the proposal is unsound, for example where a proposed junction has much less capacity than the existing situation and the network impact in terms of degrees of saturation, queuing and delay is estimated to be severe. In this case, the MAE may have no alternative but to document this in the SIAR. However, the approach should be for the DE, P, MAE and SAE to work through these design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIAR.

It is ultimately the P and the DE’s responsibility to provide a workable design and remains their choice whether to submit a SIAR to RSM-Operations. If the MAE has informed all parties of the issues that will be raised in the SIAR, the P and DE may still wish to proceed with the proposal.

**L511 Fit for Purpose Model**

If the MAE has failed the proposed models on any of the checks L501-L507 or has highlighted other significant issues with the models, then the models are not fit for purpose and will be ‘Rejected’ and returned to the P, DE and CE, and should also be copied to RSMSchemeAssessments@TfL.gov.uk.

If the MAE has passed the model during L501-L509 and there are no other outstanding issues then, referring back to the purpose statement from LMAP Stage 4, the MAE may pass the model as fit for purpose and authorise release of the LMAP Stage 5 Check Sheets (SQA-0547). The MAE must upload the approved model and associated files to the TfL Model Library.

A separate LMAP Stage 5 Check Sheet must be completed for each of the modelled periods.

**4.5.3 Criteria for moving to MAP Stage 6**

The P, DE, CE and SAE have received MAE-approved LMAP Stage 5 Check Sheets (SQA-0547) for all modelled periods, which have also been copied to RSMSchemeAssessments@TfL.gov.uk.

The MAE has ensured that the approved models have been uploaded to, and are retrievable from, the TfL Model Library.

End of LMAP STAGE 5
5 TRANSYT MAP (TMAP)

5.1 TMAP Scope

TMAP applies to all TRANSYT modelling submitted to TfL that will require submission of a Scheme Impact Assessment Report (SIAR)\(^8\).

5.2 TMAP Stage 2, Calibrated TRANSYT Base Model Submission

5.2.1 What is a Calibrated TRANSYT Model?

A Calibrated TRANSYT Model should contain:

- all the signal control data with representative signal timings for the network during the period under consideration, without adjustments to account for the non-appearance of demand-dependent stages; and

- the appropriate link structure, measured cruise times, measured saturation flows, traffic flows and measured link lengths. Traffic flows should also be included to allow TRANSYT to produce output data; however these will not be checked until TMAP Stage 3.

A single TRANSYT model is required for TMAP Stage 2. The TRANSYT software version used must match the version agreed at the MAP Stage 1 meeting and recorded in the Modelling Expectations Document.

5.2.2 What is the purpose of a Calibrated TRANSYT Model?

Experience has shown that the submission of one model early in the modelling exercise is a very useful starting point for both the DE and the MAE, and will improve the standard of subsequent model submissions.

The Calibrated Model submission will provide the DE with an opportunity to demonstrate to the MAE that they have fully understood the UTC data they have been provided with, and have collected relevant knowledge of the network. This is particularly relevant if the MAE has not received any modelling from the DE previously. The initial model submission will ensure that the signal data is correct.

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\(^8\) The Scheme Impact Assessment Report (SIAR) was formerly known as the Traffic Signal Supplementary Report (TSSR)
5.2.3 Tasks before looking at the TMAP Stage 2 Check Sheet

- It is recommended that the MAE (or DE with MAE supervision) obtains TfL Signal Timing sheets for all the nodes in the network. These timing sheets should be checked against the controller specification. These two documents need to be consistent, the only acceptable differences are those changed directly within the memory of the on-street controller, e.g. phase delays. These should be listed in the ‘Historical Amendments’ section at the end of the timing sheet. If the timing sheet is not consistent with method of control on street, the MAE should detail the changes for the Fault Management team in TfL and ask for the timing sheet to be up issued.

- The MAE (or DE with MAE supervision) should obtain a copy of each of the UTC timing plans for all the nodes in the Network for all modelled periods.

- It is recommended that the DE builds a skeleton LinSig model for each of the junctions included in the Calibrated TRANSYT model to allow for convenient checking of the phase-stage relationship. A skeleton LinSig model allows the DE and MAE to easily check and confirm correct representation of phases, phase minimums, stages, stage minimums, the stage sequence, intergreens and phase delays against up to date timing sheets. If the DE does not provide a skeleton LinSig model the MAE may ask for one to be provided for auditing or build their own.

- A skeleton LinSig model does not need to include traffic flows (traffic flows will be included in TRANSYT) and will effectively be a “control-data-only” model, as described in the TfL Traffic Modelling Guidelines. The stage sequence should be based on the current UTC timing plans, and the cycle time should be reduced within LinSig to the minimum cycle time. It is good practice to name the filename using the UTC junction number and the issue number of the timing sheet used, e.g. “02055_tsheet_iss10.lsgx”.

- There is a “Junction Information” section in LinSig (accessed from the “Junction” menu) which the DE is encouraged to complete with the junction location, controller data source (e.g. timing sheet/controller specification issue number) and purpose of the LinSig model (e.g. skeleton model for auditing purposes).

- Since TRANSYT uses ‘links’ to represent the different traffic streams it is more complicated for both the DE and the MAE to ensure that minimum green and interstage times are correct when using TRANSYT alone. The software package TranEd has a function which allows phase/link intergreen conversion. It is recommended that this is used, however it does not negate the usefulness of LinSig as a tool and it is therefore recommended that the DE uses both. In cases where there are parallel stream stages in separate nodes only LinSig allows the correct representation of the phase-stage relationship. For proposed junction designs it will be necessary to produce LinSig models, therefore providing more reason to generate LinSig models at the beginning of a project.
• It is important that, in developing skeleton LinSig models, phase minimums are treated as ‘controller minimums’ rather than ‘street minimums’.

• The MAE should audit the interstage durations in the skeleton model against the UTC System using the DTSJ command. The MAE should also check the stage minimums with a PDJ command. If there are discrepancies, the MAE should investigate. In cases where data does not correlate but the reason is not obvious, the MAE may require a second opinion from a more experienced colleague as there can be UTC-specific explanations.

5.2.4 TMAP Stage 2 Check Sheet

TMAP Stage 2 has a Check Sheet (SQA-0523), which must have been completed by the DE and CE before being submitted to the MAE for auditing along with the model and associated technical note.

Below are the checks the MAE will carry out, corresponding to the individual numbered entries on the Check Sheet. Where examples are given for illustrative purposes, TRANSYT 12 examples are taken from the output ‘.PRT’ file and TRANSYT 13 examples are from the Report Builder:

T201 Technical Note

The DE is required to submit a technical note with the Calibrated Model which describes the network being modelled and the various input data used, as described in Part B of the TfL Traffic Modelling Guidelines. The technical note provides the opportunity for the DE to outline the way in which the model has been set up. It should not be treated as simply a ‘tick box’ requirement. It is an engineering document and it should be specific to the model it accompanies.

The technical note should contain:

• The stated Purpose of the model as agreed with MAE during MAP Stage 1 and defined in the Modelling Expectations Document;

• A list of all the TfL-referenced nodes in the network with addresses as agreed within MAP Stage 1;

• Clear notes on all site observations, covering both the physical constraints of the network and vehicle behaviour. Where the behaviour is specific to a time of day, this should be noted. It is important to clearly explain how these factors have determined the structure of the model;

• Site datasheets with measured saturation flows;
• Table of Saturation Flows for each link in the network. The table should indicate clearly whether the value has been measured on-site or has been calculated using RR67. Where RR67 has been applied an explanation should be provided as to which site conditions prevented measurement;

• Site datasheets with measured cruise times; and

• The derivation of the signal timings. In the case of Fixed Time junctions the UTC signal plans should be included. For SCOOT junctions, average representative timings should be calculated from M16, M18 & M37 messages.

T202 Network Data

Within TRANSYT 12 (T12) or earlier T202 will be audited via information contained within the data input section of the .PRT file (see Figure 6). The same data will be audited within TRANSYT 13 (T13) via the Report Builder but, in addition, the DE must ensure that the Traffic Model is set to PDM (Platoon Dispersion Model) with the Cruise Scaling Factor set to 100% (see Figure 7). TfL does not currently accept TRANSYT modelling using the Cell Transmission Model (CTM).

For both T12 and T13 the DE and MAE need to ensure that the following are specified correctly:

• Cycle Time: matches an agreed on street value for the modelled period;

• Number of steps per cycle: the same as the Cycle Time up to 64s cycle and half the Cycle Time thereafter;

• Time Period: 60 minutes;

• Effective Green Displacements: Start = 2s, End = 3s;

• Equisat: 0;

• Equal Cycle: 1;

• Flow Scale: 100%;

• Cruise Speeds Card 32: zero (Times);

• Optimise: zero as Base Models should not be optimised;

• Delay Value: 1420 pence per PCU-hour (T12) or £14.20 per PCU-hour (T13)

• Stop Value per 100 stops: 260 pence (T12) or £2.60 (T13);

• List of Nodes to be optimised: should be empty for a Base Model, however TranEd requires a single node.
### DATA INPUT:

| CARD NO. | CARD TYPE | CYCLE TIME PER (SEC) | STEPS NO. | EFFECTIVE GREEN TIME (SEC) | EQUISAT 0=UNEQUAL FLOW | CRUISE-SPEEDS OPTIMISE EXTRA HILL- DELAY STOP | SCALE CARD3 | NO. OF PERIOD DISPLACEMENTS | SETTINGS CYCLE | SCALE | SCALE | CARD 32 | 0=NONE COPIES | CLIMB VALUE | VALUE | P PER 1-1200 | START END | 0=NO 1=EQUAL 10-200 50-200 0=TIMES 1=O/SET FINAL OUTPUT | 1=YES CYCLE | % | % | 1=SPEEDS 2=FULL OUTPUT | 1=FULL PCU-H | 100 |
|---------|-----------|----------------------|-----------|----------------------------|-------------------------|-----------------------------------------------|------------|----------------------------|----------------|-------|-------|--------|----------------|-------------|-------|---------------|------------|------|------|----------------|-------------|-----|
| 1       |           |                      |           |                            |                         |                                               |            |                             |                |       |       |        |                 |              |       |               |            |      |      |                 |              |     |
| 2       | 1         | 1                    | 80        | 40                         | 60                      | 2                              | 3          | 0                           | 1              | 100   | 0     | 0       | 0                 | 0              | 0     | 0             | 0           | 0    | 0    | 0                 | 1420          | 260 |
| 3       | 2         |                      |           |                            |                         |                                               |            |                              |                |       |       |        |                     |              |       |               |            |      |      |                     |              |     |

**Figure 6:** TRANSYT 12 Card Type 1 & 2 data within the .PRT file.
### Network Options

#### Network Timings

<table>
<thead>
<tr>
<th>Network Cycle Time (s)</th>
<th>Lock Number Of Steps</th>
<th>Number Of Steps</th>
<th>Time Segment Length (min)</th>
<th>Number Of Time Segments</th>
<th>Modelled Time Period (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>48</td>
<td>60</td>
<td>1</td>
<td></td>
<td>60</td>
</tr>
</tbody>
</table>

#### Signals Options

<table>
<thead>
<tr>
<th>Use EQS SAT</th>
<th>Optimisation Level</th>
<th>Hill Climb Increments</th>
<th>OUT Profile Accuracy</th>
<th>Use Enhanced Optimisation</th>
<th>Signals Representation Mode</th>
<th>Equal Length Multiple Cycling</th>
<th>Start Displacement (s)</th>
<th>End Displacement (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TRANSYT13 Mode</td>
<td>Yes</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Traffic Options

<table>
<thead>
<tr>
<th>Traffic Model</th>
<th>Generate Cell Data</th>
<th>DOS Threshold (%)</th>
<th>Flow Scaling Factor (%)</th>
<th>Cruise Scaling Factor (%)</th>
<th>Cruise Times Or Speeds</th>
<th>Use Link Stop Weightings</th>
<th>Use Link Delay Weightings</th>
<th>Exclude Pedestrian Links</th>
<th>Random Delay Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDM</td>
<td></td>
<td>90</td>
<td>100</td>
<td>100</td>
<td>Cruise Times</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Simplified</td>
</tr>
</tbody>
</table>

#### Economics

<table>
<thead>
<tr>
<th>Unit Of Cost</th>
<th>Monetary Value Of Delay (£ per PCU-hr)</th>
<th>Monetary Value Of Stops (£ per 100 stops)</th>
</tr>
</thead>
<tbody>
<tr>
<td>£</td>
<td>14.20</td>
<td>2.60</td>
</tr>
</tbody>
</table>

**Node Optimisation Order**

**Node Optimisation Order**

### Figure 7: TRANSYT 13 Network Options information within Report Builder.
T203  Stage Minimums

The DE should ensure that the stage minimum is correctly represented as determined by the phase minimums running in the stage. The most transparent method for calculating the stage minimums for any junction is to use a skeleton LinSig as described in 5.2.3.

The TRANSYT ‘Card Type’ which corresponds to the stage minimum is Card Type 10. For TRANSYT 12 the Card Type 10 values can be seen in the .PRT file, while for TRANSYT 13 they can be seen in the Stages data table within Report Builder.

Before submitting the ‘Calibrated Model’ during TMAP Stage 2 the DE should compare the minimum stage times for each TRANSYT node to the LinSig calculated stage minimums to check that the TRANSYT model is correct. The MAE is required to relate the TfL Junction Reference Number to the TRANSYT Node Number and verify that, for the Minimum Stage Sequence in each skeleton LinSig model, the minimum stage times are correct. At this MAP stage these should all be correct. Special attention should be paid to ensure that stage minimums are derived from skeleton LinSig models and fixed to ensure that TRANSYT cannot compromise ‘controller minimums’ during later stages of MAP. Where TranEd has been used to create TRANSYT 12 or earlier models these fixed stage minima will need to be explicitly defined by the DE.

Figure 8 highlights where minimum stage durations are presented within the TRANSYT 12 or earlier output '.PRT' file. Within TRANSYT 13 the Stages table in the Report Builder contains information labelled Stage Minimum (see Figure 9). Note that the Stage Index does not necessarily correspond to the actual on-street stage number and may alter between TRANSYT 13 simulations, so the Display ID column should be used during audit.
<table>
<thead>
<tr>
<th>CARD NO.</th>
<th>CARD TYPE</th>
<th>NODE NO.</th>
<th>NODE CARDS:</th>
<th>MINIMUM STAGE TIMES (WORKING)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27)</td>
<td>10</td>
<td>13</td>
<td>10 11</td>
<td></td>
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<td>28)</td>
<td>10</td>
<td>14</td>
<td>9 7 1</td>
<td></td>
</tr>
<tr>
<td>29)</td>
<td>10</td>
<td>15</td>
<td>7 8 5</td>
<td></td>
</tr>
<tr>
<td>30)</td>
<td>10</td>
<td>16</td>
<td>1 7 10 7</td>
<td></td>
</tr>
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<td>7 5</td>
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<td>7 5</td>
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<td>1 7 7</td>
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<td>4 7</td>
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<td>7 7</td>
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<td>7 10</td>
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<td>40)</td>
<td>10</td>
<td>28</td>
<td>10 7</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 8:** TRANSYT 12 Card Type 10 data within the .PRT file.
<table>
<thead>
<tr>
<th>Node</th>
<th>Stage Index</th>
<th>Is Base Stage</th>
<th>Display ID</th>
<th>Links In This Stage</th>
<th>Stage Start (s)</th>
<th>Stage End (s)</th>
<th>User Stage Minimum (s)</th>
<th>Stage Minimum (s)</th>
<th>TRANSYT Stage Start (s)</th>
<th>TRANSYT Minimum Preceding Interstage (s)</th>
<th>TRANSYT Actual Preceding Interstage (s)</th>
<th>TRANSYT Stage Minimum (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1</td>
<td>Yes</td>
<td>2</td>
<td>821,852,863,864</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>6</td>
<td>86</td>
<td>10</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>Yes</td>
<td>3</td>
<td>861,862,863,864,865</td>
<td>23</td>
<td>29</td>
<td>0</td>
<td>6</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>Yes</td>
<td>1</td>
<td>811,813,841,843,848</td>
<td>44</td>
<td>86</td>
<td>0</td>
<td>7</td>
<td>29</td>
<td>15</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td></td>
<td>2</td>
<td>921,933</td>
<td>16</td>
<td>26</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>6</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>Yes</td>
<td>1</td>
<td>911,931</td>
<td>32</td>
<td>58</td>
<td>0</td>
<td>10</td>
<td>26</td>
<td>6</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>9</td>
<td>3</td>
<td>Yes</td>
<td>2</td>
<td>921,933</td>
<td>64</td>
<td>74</td>
<td>0</td>
<td>10</td>
<td>58</td>
<td>6</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td></td>
<td>1</td>
<td>911,931</td>
<td>80</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>74</td>
<td>6</td>
<td>6</td>
<td>16</td>
</tr>
</tbody>
</table>

Figure 9: TRANSYT 13 Stages data table.
T204 Interstage Durations

The interstage duration will be determined by the phases present in the current and previous stages, and the corresponding phase intergreens. The DE should determine the correct interstage durations by creating skeleton LinSig models.

The TRANSYT ‘Card Type’ which corresponds to the stage intergreen is Card Type 11. For TRANSYT 12 the Card Type 11 values can be seen in the .PRT file (see Figure 10), while for TRANSYT 13 they can be seen in the Stages data table listed as ‘TRANSYT Actual Preceding Interstage’. Note that for TRANSYT 13 the Stage Index value may not necessarily match the stage number and could change between TRANSYT runs, so the Display ID should be used as the stage reference.

Before submitting the ‘Calibrated Model’ during TMAP Stage 2 it is suggested that the DE compares data to the LinSig calculated stage intergreens to check that the model is correct. The MAE needs to relate the TfL junction reference number to the TRANSYT node number and then verify that, for the minimum stage sequence in each skeleton LinSig model, the preceding interstage times are correct. At this MAP stage these should all be correct.
**Figure 10:** TRANSYT 12 Card Type 11 data within the .PRT file.
T205 Stage Change Points

If the modelled network is running under Fixed Time UTC, the stage change points should directly correlate with the UTC plans. At this point, the TRANSYT Model should include the appearance of all demand-dependent stages. If the study network is running under SCOOT Control, the methodology used to derive the stage change points should be agreed with the MAE and documented in the DE’s Technical Note.

A common method of modelling SCOOT Control in TRANSYT is by use of SCOOT M16 and M37 stage duration messages together with M18 offset messages recorded for a representative day, with no interventions to the weekly timetabled control. A DE or MAE with limited experience may require support from more experienced colleagues, such as the CE or a TfL Principal Engineer, in order to corroborate that the timings are correct.

When using M16 messages it is important to note that SCOOT Stages are not identical to UTC Stages. The DE and MAE should examine the SCOOT background plans to understand the SCOOT stage change points relative to the UTC Stage change points (which are modelled in TRANSYT).

For TRANSYT 12 or earlier, stage change points should be checked using the Card Type 12 data (see Figure 11).

For TRANSYT 13 stage change points are listed in the Stages data table under ‘TRANSYT Stage Start’ (see Figure 9). Note that the Stage Index does not necessarily match the stage number and could change between TRANSYT runs, so the Display ID column should be used as the stage reference.
<table>
<thead>
<tr>
<th>CARD NO.</th>
<th>CARD TYPE</th>
<th>NODE NO.</th>
<th>Sgl/Dbl Cycled</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
<th>S10</th>
</tr>
</thead>
<tbody>
<tr>
<td>38)</td>
<td>12</td>
<td>8</td>
<td>1</td>
<td>29</td>
<td>86</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39)</td>
<td>12</td>
<td>9</td>
<td>2</td>
<td>26</td>
<td>58</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40)</td>
<td>12</td>
<td>87</td>
<td>1</td>
<td>51</td>
<td>13</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41)</td>
<td>12</td>
<td>117</td>
<td>2</td>
<td>23</td>
<td>57</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42)</td>
<td>12</td>
<td>225</td>
<td>1</td>
<td>64</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43)</td>
<td>12</td>
<td>253</td>
<td>1</td>
<td>33</td>
<td>78</td>
<td>87</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44)</td>
<td>12</td>
<td>346</td>
<td>2</td>
<td>32</td>
<td>65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 11:** TRANSYT 12 Card Type 12 data within the .PRT file.
T206 Link Control Data

The link control data defines the following for each link in the network:

a. The stage in which the link’s start of green occurs;
b. The number of seconds into that stage the start of green occurs;
c. The stage in which the link’s end of green occurs; and
d. The number of seconds into the stage the end of green occurs.

As in previous sections, a skeleton LinSig model should be used by the DE to verify that the correct link control information is correctly entered based on the link-phase relationships for every link in the network. This will be verified by the MAE and should be 100% correct at this stage of MAP.

For TRANSYT 12, these parameters can be seen within the .PRT file. The MAE should check the node that each link relates to (the fifth column in the Card Type 31 data, as shown in Figure 12). In the accompanying skeleton LinSig created for that node, the phase that is controlling the link should then be determined. Once the correct phase has been identified, a, b, c and d can be easily verified against columns four to eight within the Card Type 31 data.

In the example shown in Figure 12, links 119, 139, 179, 199 and 209 have zeros in columns 5, 6, 7 and 8. This is because they are shared links where the start stage, start lag, end stage and end lag are defined by the main link. Shared links are defined in the card type 7 part of the .PRT file, as shown in Figure 13. In this example link 20 is a major link that has a shared link 209, so link 209 uses the link control data for link 20 in card type 31.

It is good housekeeping for shared links to have zeros in the Card Type 31 data. However, any link control information will be ignored. Using the Card Type 31 example (Figure 12) link 259 is a shared link and will only use control information from link 25, despite having 1, 13, 2, 0 entered.
Figure 12: TRANSYT 12 Card Type 31 data within the .PRT file.
<table>
<thead>
<tr>
<th>CARD NO.</th>
<th>CARD TYPE</th>
<th>FIRST SET</th>
<th>SECOND SET</th>
<th>THIRD SET</th>
</tr>
</thead>
<tbody>
<tr>
<td>4)</td>
<td>7</td>
<td>11 119</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>5)</td>
<td>7</td>
<td>13 139</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>6)</td>
<td>7</td>
<td>17 179</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>7)</td>
<td>7</td>
<td>19 199</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>8)</td>
<td>7</td>
<td>28 289</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>9)</td>
<td>7</td>
<td>21 219</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>10)</td>
<td>7</td>
<td>22 229</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>11)</td>
<td>7</td>
<td>25 259</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>12)</td>
<td>7</td>
<td>42 429</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
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<tr>
<td>13)</td>
<td>7</td>
<td>61 619</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
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<tr>
<td>14)</td>
<td>7</td>
<td>71 719</td>
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<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>15)</td>
<td>7</td>
<td>1997 1996</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
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<td>16)</td>
<td>7</td>
<td>1999 1998</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>17)</td>
<td>7</td>
<td>2999 3000</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>18)</td>
<td>7</td>
<td>3999 3998</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

Figure 13: TRANSYT 12 Card Type 7 data within the .PRT file.
The TRANSYT 13 equivalents to card type 31 parameters are:

a. TRANSYT Starting Stage;
b. TRANSYT Start Lag;
c. TRANSYT Ending Stage; and
d. TRANSYT End Lag.

These can be found in the Link Green Periods data table, as shown in Figure 14, while shared links are defined in the Links data table, shown in Figure 15.

At this stage of TMAP the columns for Relative Start and End Displacement should be zero. Within TRANSYT 13 the Starting and Ending Stages refer to the Stage Index, which does not necessarily match the stage number. The DE and MAE should refer to the Stages data table (see Figure 9) to verify the correct Stage Index using the Display ID as the stage reference, especially as the Stage Index can change between TRANSYT runs.
<table>
<thead>
<tr>
<th>Link</th>
<th>Green Period</th>
<th>Is Base Green Period</th>
<th>Relative Start Displacement (s)</th>
<th>Relative End Displacement (s)</th>
<th>Start Time (s)</th>
<th>End Time (s)</th>
<th>TRANSYT Starting Stage (s)</th>
<th>TRANSYT Ending Stage (s)</th>
<th>TRANSYT Start Lag (s)</th>
<th>TRANSYT Minimum Start Lag (s)</th>
<th>TRANSYT End Lag (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>811</td>
<td>1</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>44</td>
<td>90</td>
<td>3</td>
<td>1</td>
<td>15</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>813</td>
<td>1</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>37</td>
<td>90</td>
<td>3</td>
<td>1</td>
<td>8</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>821</td>
<td>1</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>95</td>
<td>12</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>841</td>
<td>1</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>44</td>
<td>86</td>
<td>3</td>
<td>1</td>
<td>15</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>843</td>
<td>1</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>44</td>
<td>86</td>
<td>3</td>
<td>1</td>
<td>15</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>848</td>
<td>1</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>44</td>
<td>86</td>
<td>3</td>
<td>1</td>
<td>15</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>852</td>
<td>1</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>95</td>
<td>12</td>
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<td>9</td>
<td>0</td>
</tr>
<tr>
<td>861</td>
<td>1</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>23</td>
<td>29</td>
<td>2</td>
<td>3</td>
<td>11</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>862</td>
<td>1</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>22</td>
<td>29</td>
<td>2</td>
<td>3</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>863</td>
<td>1</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>29</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>864</td>
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<td>0</td>
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<td>1</td>
<td>3</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
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<td>0</td>
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<td>29</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>9</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 14: TRANSYT 13 Link Green Periods data table.
### Links

<table>
<thead>
<tr>
<th>Link</th>
<th>ID</th>
<th>Name</th>
<th>Description</th>
<th>Saturation Flow (PCU/hr)</th>
<th>Length (m)</th>
<th>Link Control Type</th>
<th>Traffic Node</th>
<th>Signals Node</th>
<th>Separate Signals Node</th>
<th>Is Give Way Link</th>
<th>Is Pedestrian Link</th>
<th>Is Minor Shared Link</th>
<th>Major Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>811</td>
<td>811</td>
<td></td>
<td></td>
<td>3369</td>
<td>135.00</td>
<td>Signalised</td>
<td>8</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>811</td>
</tr>
<tr>
<td>812</td>
<td>812</td>
<td></td>
<td></td>
<td>(3369)</td>
<td>135.00</td>
<td>(Signalised)</td>
<td>(8)</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>813</td>
<td>813</td>
<td></td>
<td></td>
<td>1617</td>
<td>125.00</td>
<td>Signalised</td>
<td>8</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>814</td>
<td>814</td>
<td></td>
<td></td>
<td>(1617)</td>
<td>125.00</td>
<td>(Signalised)</td>
<td>(8)</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>821</td>
<td>821</td>
<td></td>
<td></td>
<td>1956</td>
<td>100.00</td>
<td>Signalised</td>
<td>8</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>822</td>
<td>822</td>
<td></td>
<td></td>
<td>(1956)</td>
<td>200.00</td>
<td>(Signalised)</td>
<td>(8)</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>821</td>
</tr>
<tr>
<td>841</td>
<td>841</td>
<td></td>
<td></td>
<td>1964</td>
<td>95.00</td>
<td>Signalised</td>
<td>8</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>842</td>
<td>842</td>
<td></td>
<td></td>
<td>(1964)</td>
<td>95.00</td>
<td>(Signalised)</td>
<td>(8)</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>841</td>
</tr>
<tr>
<td>843</td>
<td>843</td>
<td></td>
<td></td>
<td>1617</td>
<td>95.00</td>
<td>Signalised</td>
<td>8</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>844</td>
<td>844</td>
<td></td>
<td></td>
<td>(1617)</td>
<td>95.00</td>
<td>(Signalised)</td>
<td>(8)</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>843</td>
</tr>
<tr>
<td>848</td>
<td>848</td>
<td></td>
<td></td>
<td>1800</td>
<td>20.00</td>
<td>Signalised</td>
<td>8</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>852</td>
<td>852</td>
<td></td>
<td></td>
<td>1780</td>
<td>175.00</td>
<td>Signalised</td>
<td>8</td>
<td>(8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 15: TRANSYT 13 Links data table.
T207  Cruise Times

The cruise time for a link in TRANSYT is defined as the average time for a free-flowing vehicle driving in a platoon to travel from the stopline of the upstream link to the stopline of the defined link. Cruise times should be recorded on site by the DE for every link as this is the only way to achieve the required level of accuracy. The TfL Traffic Modelling Guidelines provide detailed guidance on how to measure cruise times but the method and approach used should be outlined in T201.

**Note for MAEs:**

Particular attention should be paid to the accuracy of cruise times in view of the fact that they are based on vehicle speeds which can vary significantly both from network to network and within a network.

The MAE may wish to discuss with the DE how auditing time is best utilised within T207. If necessary the MAE can identify critical journey times which should be checked for accuracy on-site. Less critical cruise times should be checked to ensure they are at least reasonable based on expected vehicle speeds at individual sites.

For TRANSYT 12, link cruise time information can be found within the TRANSYT 12 .PRT file (see Figure 16). For TRANSYT 13, the equivalent data is split between two ‘Link Sources’ tables: one for entry links and one for internal links (see Figure 17).
### Figure 16: TRANSYT 12 Card Type 32 data within the .PRT file.

```plaintext
<table>
<thead>
<tr>
<th>CARD NO.</th>
<th>TYPE</th>
<th>LINK NO.</th>
<th>TOTAL FLOW</th>
<th>UNIFORM FLOW</th>
<th>ENTRY 1</th>
<th>ENTRY 2</th>
<th>ENTRY 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>114</td>
<td>32</td>
<td>811</td>
<td>624</td>
<td>0</td>
<td>8711</td>
<td>8741</td>
<td>0</td>
</tr>
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### Link Sources - default sources for entry links

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<th>Entry Cruise Speed (kph)</th>
<th>Entry Free Running Speed (kph)</th>
<th>Entry Stationary Time (seconds)</th>
<th>Entry Profile Type</th>
<th>Entry DIRECTFlows (PCU/hr)</th>
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<tbody>
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<tr>
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### Link Sources - sources for internal links

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<td>(N/A)</td>
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<td>37.50</td>
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</table>

Figure 17: TRANSYT 13 Link Sources data tables.
T208  Link Lengths

Link lengths should ideally be physically measured on site, or using up-to-date electronic mapping or aerial photography. The DE should detail the methodology used for link measurement within T201.

The methodology used by the DE should determine the appropriate level of information required during auditing. Depending on availability, the MAE can, ideally, verify link lengths on site with a measuring wheel. Alternatively, the MAE can measure link lengths from available scaled drawings, or using electronic mapping. A practical compromise is to identify critical links and measure those on-site, and then measure non-critical links from available drawings/mapping. Figure 18 details where this information can be found within the .PRT file for TRANSYT 12. The equivalent data for TRANSYT 13 can be found in the Report Builder Links table, as shown in Figure 19.
### Figure 18: TRANSYT 12 Card Type 31 Information.

<table>
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<th>CARD NO.</th>
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<th>EXIT NODE</th>
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<th>END STAGE</th>
<th>LAG</th>
<th>START STAGE</th>
<th>LAG</th>
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## Links

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<th>Length (m)</th>
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<th>Traffic Node</th>
<th>Signals Node</th>
<th>Separate Signals Node</th>
<th>Is Give Way Link</th>
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</table>

*Figure 19: TRANSYT 13 Links data table.*
T209 Saturation Flows

Saturation flows are fundamental to the integrity of a TRANSYT Model. If modelled saturation flows are not accurate, they are likely to result in modelling inaccuracies which may cause problems during later stages of MAP.

Saturation flows should be measured on-site by the DE for all links where possible. If this is not possible, an explanation should be given in the DE’s technical note (T201). Where saturation flows have been derived, TRL RR67\(^9\) should be used and the calculations recorded. It may also be acceptable to use default saturation flows (1800pcuh\(^{-1}\) per lane) for pelican crossings or non-critical side roads and pedestrian crossings where there is insufficient traffic demand (or queuing) to measure the saturation flows accurately, however this should be agreed with the MAE.

The MAE should identify the critical node(s) and link(s) in the network. Of all the site work relating to auditing, on-site measurement of saturation flows for critical links in the network should be seen as necessary. If critical modelled saturation flows are not accurate, they are likely to result in modelling inaccuracies during later stages of MAP.

The source of saturation flow data are shown in Figure 18 for TRANSYT 12 and Figure 19 for TRANSYT 13.

---

T210  Link Structure, Bus Links, Flares, Give Ways

While on-site measuring link lengths, cruise times and/or saturation flows, the DE should observe and record site-specific behaviour in order to construct a representative link structure.

Further details of typical site observations are provided in Part B of the Traffic Modelling Guidelines but may include common queuing behaviour, flared approaches, parking/loading issues, bus lane usage and setbacks, right turn behaviour and exit blocking. This list should not be considered exhaustive however, and other observations may need to be made depending on engineering judgement. As traffic behaviour changes by time of day it may be necessary to observe these phenomena separately for each modelled period. It is essential that the DE has a thorough understanding of the area covered in the modelling they are undertaking.

It is advised that DEs or MAEs with limited experience ask for assistance from a more experienced colleague (such as the CE or a TfL Principal Engineer) to determine key observations. This will provide understanding of more detailed network-specific issues which may be highlighted in later stages of MAP. For example, it may be found that whilst two lanes have been indicated on the site drawing, parking in the nearside lane close to the stopline results in a single lane discharge. Any observed behaviour that impacts on the operation of the network should be reported in T201.

Figure 20 highlights where the Give Way and Flare information is held within the TRANSYT 12 .PRT file, with the bus link information shown in Figure 16. TRANSYT 13 retains bus link data within the Link Sources tables (Figure 17) whilst Give Way and Flare data are in separate tables as shown in Figure 21.

Flare lengths should be audited with attention to the potential presence of flares which haven’t been correctly modelled, e.g. where a bus lane setback or parking bay creates an effective flare. It is important that all flared approaches are accurately captured at this stage of MAP. If effective flares are not correctly coded the model will overestimate stopline capacity with a consequent impact during Model Validation.
<table>
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<th>CARD</th>
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<th>TYPE</th>
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<th>NO.</th>
<th>% FLOW</th>
<th>X100</th>
<th>X100</th>
<th>LENGTH</th>
<th>WT.X100</th>
<th>FLOW</th>
<th>WT.X100</th>
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**Figure 20:** TRANSYT 12 Card Types 30 & 33 data within the .PRT file.
### Give Way Data

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<th>Controlling Link 1</th>
<th>Controlling Link 2</th>
<th>Percentage Opposed (%)</th>
<th>Opposed By Link 1 Only (%)</th>
<th>Max Flow At Give Way (PCU/hr)</th>
<th>A1 Coefficient</th>
<th>A2 Coefficient</th>
<th>Use RR67 Opposed Right-Turn Model</th>
<th>Number Of Storage Spaces</th>
<th>Radius Of Turn (m)</th>
</tr>
</thead>
<tbody>
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<td>1000</td>
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<td>(N/A)</td>
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<tr>
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### Flares

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<th>Description</th>
<th>Saturation Flow</th>
<th>Effective Storage (Vehs)</th>
</tr>
</thead>
<tbody>
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<tr>
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</tbody>
</table>

Figure 21: TRANSYT 13 Give Way & Flares data tables.
T211 Other Modelling Issues

Any concerns the MAE may have with the model that have not already been covered by the checks in T201 – T210 will be recorded in the ‘Other Modelling Issues’ section of the TMAP Stage 2 Check Sheet (SQA-0523). These additional issues may include project-specific agreements formalised during MAP Stage 1.

5.2.5 Acceptance/Rejection of Model

Once the MAE has checked that the signal control data is correct and is also satisfied with the site observations, measurements and the model structure, then the submitted model may be accepted as a ‘Calibrated Model’.

Conversely, if the MAE is not satisfied with the modelling standard, the reasoning for rejecting the model should be provided in writing, and the models returned to the P, DE, CE, and copied to RSMSchemeAssessments@TfL.gov.uk.

If there are fundamental flaws within the model, the MAE may organise a meeting with the DE. At the MAE’s discretion, the P may also be invited as they are often the budget holders for the DE’s work and may need to discuss if the quality of work is as agreed in the project brief.

5.2.6 Criteria for Moving to TMAP Stage 3

The P, DE and CE have received an MAE-approved TMAP Stage 2 Check Sheet (SQA-0523), which has also been copied to RSMSchemeAssessments@TfL.gov.uk.

End of TMAP Stage 2

5.2.7 Stage 2 to Stage 3, Demand-Dependent Stage Count Information

In order to model the frequency of demand-dependent stages at a signalised node, the DE or MAE needs to retrieve data from the UTC system.

UTC is able to retrospectively retrieve the frequency of demand-dependent stage appearances that were observed over a specified period, divided into 15-minute segments. For example, to get the observed frequency of a demand-dependent stage between 9am and 10am (i.e. four 15 minute segments) for Group 59 on 2nd September 2010, the command is:

‘achk g59 t=09:00 p=4 d=02-sep-10’

The UTC log provides the observed stage appearance frequency for every demand-dependent stage in the following format:

‘number of times called (IP)’ / ‘no. of opportunities’ (OP)
If a junction is under SCOOT Control, it is important to check whether the junction was single or double cycling by identifying the number of opportunities in the plan against the actual opportunities reported by UTC. This should be equal to a whole multiple where a junction was forced to either single or double cycle for the entire observed period. Where a junction was free to either single or double cycle in SCOOT (and has done both within the observed period) a different number of actual opportunities will be seen. In this case the only way to work out the cycle times that occurred is to have SCOOT message data for the monitored period.
5.3 TMAP Stage 3, Validated TRANSYT Base Models Submission

5.3.1 What is a Validated TRANSYT Model?

TMAP defines that a Validated TRANSYT Model should be based on the TMAP Stage 2 approved Calibrated Model (see 5.2.1) where the frequency of demand-dependent stage appearance has been defined.

Validation in TRANSYT is completed by comparing modelled degrees of saturation (DoS) with those recorded on-site. Queue lengths may also be examined but are not considered compulsory criteria that determine the validation of a model.

Validated TRANSYT models are required for all time periods in TMAP Stage 3.

5.3.2 TMAP Stage 3 Check Sheet

T301 Validation Report

Validated Base Model submissions must be accompanied by a Validation report, as described in Part B of the Traffic Modelling Guidelines.

The DE should include the following information in the report:

- Detail on the traffic flows:
  - When were the traffic surveys done and by who?
  - What data was collected during the traffic surveys?

- Demand-dependency calculations:
  - Explanation on how the frequency of demand-dependent stages has been accounted for by comparing Calibrated Model Timings to the Validated Model Timings;
  - UTC data should be recorded to confirm any site observations. If pedestrian counts are taken, the frequency of demand can be recorded on-site but should be used in conjunction with a UTC log. The output of the UTC log should be included in the report;

- Evidence of validation, including comparison between on street data and TRANSYT results;

- Flare usage observed on-site;

- Flashing amber usage at pelicans; and
• Queue lengths (if surveyed).

T302 Adjustments from Calibrated Model

There should be few changes in the Validated Model as compared to the Accepted Stage 2 Calibrated Model, other than modification for peak-specific signal timings, the addition of flows, and the inclusion of public transport.

Where any other changes have been made, the DE should identify what was changed and why the change was considered necessary within the Validation report. The DE should specifically document any changes to the following data that was previously checked during TMAP Stage 2, and the MAE will need to check any changes that have been made.

• T202 Network Data;
• T203 Stage minimums;
• T204 Interstage Durations;
• T205 Stage Change Points;
• T206 Link Control Data;
• T207 Cruise Times;
• T208 Links Lengths;
• T209 Saturation flows; and
• T210 Link structure, Bus Links, Flares, Give Ways.

T303 Appropriate Peak-Specific Signal Timings

The stage information that was specified in TMAP Stage 2 during T205 & T206 should be repeated for each time-specific TRANSYT Base model to ensure that appropriate base signal timings have been applied to the period being modelled.

Note that the timings may have been affected by adjustments for Demand-Dependancy (T304) & Underutilised Green Time (T308) but these modifications from the base timings should be clearly marked within the DE’s technical note.

T304 Demand-Dependent Stage Adjustments

The DE should adjust traffic signal control information to account for the non-appearance of demand-dependent stages over the modelled period, and fully
document these adjustments. All demand-dependent stages within the network are required to show a frequency of at least 90% of that observed during data collection, which must be verified by the MAE.

The preferred method for modelling demand-dependency in TRANSYT 12 is to adjust appropriate links by modifying start and/or end lags. If the TRANSYT 12 model is constructed using TranEd, the DE should use the ‘Bonus Greens’ facility to adjust the start and end lags as these differentiate modelling adjustments from the original interstage design. In TRANSYT 13 these adjustments to the effective green time should be modelled using Relative Start and End Displacements.

Demand-dependent stage frequency can vary by time of day to directly influence link capacity. It is recommended that the DE and MAE confirm that the modelled adjustments provide appropriate green times for critical links within the modelled network. As an example, if a junction has been modelled with a pedestrian stage being called every cycle, when on site this situation occurs for 50% of signal cycles, then the model is likely to underestimate the capacity of one or more of the major movements.

**T305 Flow Consistency Check**

TRANSYT models are usually constructed using stop line flows from manual classified traffic surveys. The DE should calculate a common peak hour for the entire modelled network as agreed in MAP Stage 1. The peak hour for all junctions in the model should be demonstrated by the DE via a graph showing the sum of the total flows at each junction over the survey period, typically divided into 15-minute segments, thereby illustrating the peak hour for all junctions in the model.

As most traffic surveys are carried out manually, there will be human counting errors. It is not expected that neighbouring survey counts will match, and in cases where they do, this warrants closer inspection as they may have been manually adjusted.

If it is necessary to adjust the surveyed flow data to reduce inconsistencies, the DE should make adjustments and detail the changes in the validation report. Normally it would be expected that where two flows do not balance the higher of the two should be used and the lower flows manually increased to match. Problems with model validation can often be caused by use of incorrect flow data. Careful checking of flow data by the CE is recommended before submitting the Validated Model for approval at TMAP Stage 3.

Where there is a discrepancy in flows on a modelled link, the MAE should examine the flow data used in the model to confirm that the highest of the two flow counts has been applied. If this does not correspond and resolve any concerns, the MAE may conduct a sample spot count on site and discuss a method to resolve discrepancies with the DE. To get an accurate count, it is recommended that the flow is recorded over a whole number of cycles, during a section of the modelled peak, i.e. start and end timings should be from the start of green on the movement being measured. Further information on an acceptable approach to traffic flow smoothing can be found within Part B of the Modelling Guidelines.
Where multiple upstream links feed two links downstream, the DE should provide evidence that they have recorded the percentage split of flow from each of the origin links to each of the destination links. In the example within Figure 22 the DE would record the percentage of traffic from origin A going to destinations D and E and likewise for origins B and C. Once this data has been gathered, the combination of flows from A, B and C with their respective percentage destinations can be calculated. The sum of the resulting inflows for links D and E should reconcile reasonably with the observed stopline flows from the original survey.

![Diagram of multiple links feeding downstream stoplines.](image)

*Figure 22: Multiple links feeding downstream stoplines.*

The preferred method for flow entry in TRANSYT is to use direct data entry for each link. TRANSYT 13 contains an option for flow allocation to be based upon origin/destination traffic flows specified in a matrix. Flows are placed onto links according to paths between different zones. This methodology for flow allocation is only supported by TMAP for smaller models that have minimal route choice available. When using origin destination flow allocation, the DE and MAE must ensure that unrealistic routes do not exist by disabling the allocation type, and that lane usage is accurately represented (flows on specific routes can be manually fixed where necessary). The use of origin/destination traffic flows in TRANSYT 13 models should be agreed in advance with the MAE.

**T306 Public Transport Modelling**

The MAE should examine the following public transport elements of the model:

- Bus flows, routes & frequencies;
- Bus lanes;
- Location of bus stops;
- Bus stop dwell times; and
- Influence on general traffic.

The DE should calculate bus flows, routes and their frequencies as described in the TfL Traffic Modelling Guidelines, based on available data which should be provided to the MAE for auditing. Bus lanes, hours of operation and vehicle type restrictions should also be checked against on-street data to ensure that bus lane usage is accurately represented.

Buses should be modelled using minor links where they share the carriageway with general traffic or using major links for dedicated bus lanes.

Where a bus stop exists on a link, the ‘Mean Stopped Time’ on the upstream connector should be set to the average bus stop dwell time that has been determined. Where more than one bus stop exists, the dwell times should be added together with an additional delay added to reflect the time lost slowing down and accelerating for the additional bus stop(s).

Bus link cruise speeds are to be entered in km/hr, regardless of whether cruise times or cruise speeds have been selected in T202.

The scope of the TRANSYT model agreed in MAP Stage 1 will determine the level of detail required for public transport modelling. For example, if the models are being prepared to assess the impacts of a public transport-related scheme, the DE should ensure that all relevant public transport elements have been modelled in detail. This may include detailed on-street measurement of dwell times per bus stop and per time period. In models where public transport is considered less of a priority the use of default dwell times may be satisfactory.

As mentioned in T210, the influence of public transport on general traffic often can have a significant impact on network capacity and performance, such as the creation of effective flares for general traffic in the case of bus lane setbacks and funnelling at bus lane entries. The DE should provide in the accompanying technical report any notes on site observations to demonstrate that any influences on capacity due to public transport are accurately represented. Site visits can be undertaken by the MAE to observe behaviour and ensure they have been accurately reflected in the submission.

**T307 Degrees of Saturation**

The correct recording of on-street DoS is essential to the validation of a model. The TfL Traffic Modelling Guidelines outline the preferred approach for surveying DoS, however it is strongly recommended that the DE contacts the MAE prior to surveys being undertaken to discuss the approach to be used. It may also be appropriate for the MAE to accompany the DE on an initial site visit to observe and/or measure DoS.

DoS recorded on-street and in the model should correlate, especially on links operating close to their practical reserve capacity (90%+ DoS). Links close to practical reserve capacity should be given particular attention during auditing.
The following criteria should be used to indicate validation of base TRANSYT models:

- **Degrees of saturation within 5% of observed values;**
- **Degree of saturation for links upstream of pedestrian crossings within 10% of observed values; and**
- **Observed Cyclic Flow Profiles (CFP) for critical links showing similar peaks, dispersion and spacing.**

It is important to note that, for models built using stopline counts, by definition, the degree of saturation cannot be over 100%. This is because a stopline count is the traffic that has cleared the stopline rather than the demand. For models with link DoS above 100%, model discrepancies may exist for one or more of the following: saturation flows, link structure, green times, and/or stopline flows.

Another consideration is that, although the signal timings in the model are accurate, the timings that were in operation during the traffic surveys may have been different to the modelled average signal timings, i.e. where contingency plans were in operation. This is possible but unusual if sufficient checks were made during TMAP Stage 2. If the MAE suspects this may have occurred it is appropriate to investigate UTC logs for the date of the traffic surveys. If in doubt, a sample traffic count during the modelled period (as detailed in T305) is advisable.

Flare usage should be represented correctly in each model and fully documented in the DE’s technical report (T301), based on observed measurements recorded in each peak. If flare usage has not been documented then the MAE should request clarification from the DE with regards to the impact on degrees of saturation.

It is possible that Underutilised Green Time may have occurred on-street and has not been fully applied within the submitted model. In these cases, the DoS in the model will be lower than those surveyed on-street. In these cases the MAE should refer to ‘T308 Modelling of Underutilised Green Time’ for guidance.

**T308 Queue Lengths**

TRANSYT calculates the Mean Maximum Queue (MMQ) for each link as the average of the maximum queue that occurs throughout the signal cycle. This can be measured on-street where platoon arrival patterns are observed to be regular and distinct. However, if vehicle arrival patterns are less pronounced then the MMQ can be difficult to accurately survey. If queue data has been surveyed, it is the responsibility of the DE to provide this data for auditing by the MAE.

Modelled queue lengths should not exceed the link length as they cannot physically do so on street. Excess queuing is indicated by a ‘+’ in the ‘Average Excess Queue’ column in the TRANSYT 12 output .PRT file, and by a ‘+’ in the ‘Mean Max Queue’ column in the TRANSYT 13 Report Builder.

If queues in a model exceed link lengths, the DE and MAE have to consider whether the green times, offsets, saturation flows and flows for the links are correct. If these
parameters have been correctly modelled, it may be useful to consider the advice in ‘T308 Modelling of Underutilised Green Time’ for guidance. A model will undergo further scrutiny by the MAE if an excess queue is indicated within modelled results.

**T309 Modelling of Underutilised Green Time**

Where fully saturated traffic appears to discharge at a rate less than the saturation flow (e.g. due to driver behaviour or exit-blocking), this should not be accounted for by changing the saturation flow in a model. Instead, it is recommended that Underutilised Green Time (UGT) is used to quantify this behaviour. UGT can commonly occur during periods of congestion within networks operating at or over capacity. At times traffic may only be travelling marginally slower than would be the case during unrestricted saturation flow. This may not be noticeable to an on-street observer but its impact will be captured by UGT during data processing. UGT is fully described within Part B and Appendix I of the TfL Traffic Modelling Guidelines.

UGT is calculated to quantify situations where congestion-related issues prevent fully saturated discharge. Where UGT is measured on street during the modelled period, it needs to be accounted for with manual adjustments during validation. The DE should calculate the average amount of green time that is lost due to UGT (e.g. wasted green due to exit blocking) and adjust the link control data accordingly. For TRANSYT 12, adjustments to effective green time should be made via appropriate start and end lags. Where the model is built in TranEd, the bonus green facility may be used as it differentiates modelling adjustments from interstage design. In TRANSYT 13 these adjustments to the effective green time should be modelled using Relative Start and End Displacements.

The MAE will be required to audit data to verify that this aspect of modelling has been addressed correctly.

**T310 Fit for Purpose Model**

If the MAE fails the model during any of the checks T301-T309, or other concerns exist relating to the standard of modelling, then the model is not fit for purpose and will be rejected and returned to the DE.

If the MAE has passed the model on all of the checks T301-T309 and there are no other issues then, referring back to the purpose statement from MAP Stage 1, the MAE will pass the model as fit for purpose and authorise the TMAP Stage 3 Check Sheet (SQA-0524).

The DE, CE and MAE must complete a TMAP Stage 3 Check Sheet for each of the modelled periods. The MAE should inform the P, DE and CE of the Approval or Rejection of the TMAP submission, which should also be copied to RSMSchemeAssessments@TfL.gov.uk. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.
5.3.3 Criteria for moving to TMAP Stage 4

The P, DE and CE have received an MAE-approved TMAP Stage 3 Check Sheet (SQA-0524) for all modelled periods, which have also been copied to RSMSchemeAssessments@TfL.gov.uk.

The MAE has ensured that the approved models have been uploaded to, and are retrievable from, the TfL Model Library.

End of TMAP Stage 3
5.4 TMAP Stage 4, TRANSYT Proposed Models Checkpoint Meeting

5.4.1 Checkpoint Meeting

As with the base models the P, DE, MAE, SAE and NAE are required to meet to discuss the details of the proposals and re-confirm how they are to be modelled. The bulk of the modelling work is completed during the development of the base model. The DE, CE and MAE key responsibilities for LMAP Stage 4 are outlined below.

It is the responsibility of the DE to record the minutes of the meeting and formally submit these to the other parties who attended the meeting. The minutes will be authorised by the MAE and used to update the Modelling Expectations Document in T406, which will be accepted as an official account of the decisions reached.

5.4.2 TMAP Stage 4 Check Sheet

TMAP Stage 4 has a Check Sheet (SQA-8676), which acts as a formal record of task completion within TMAP Stage 4. The DE should complete this document following the TMAP Stage 4 Proposed Models Checkpoint meeting and provide the completed version to the MAE.

The following sections need to be agreed and documented, which will be confirmed by the MAE following submission by the DE.

T401 Proposed Models Checkpoint Meeting

The DE must document the date of the meeting attended by the P, DE, MAE and SAE. The MAE must ensure that the name and affiliation of all parties have been captured on the TMAP Stage 4 Check Sheet (SQA-8676).

T402 ‘Purpose’ Statement for each Proposed Model

As with the base models in MAP Stage 1, the DE should provide the MAE with a statement of the purpose of each of the modelled periods. This should be based upon the proposals being put forward by the P and taking into consideration local conditions of the network being modelled. The statement of purpose created by the DE is a key term of reference for all parties involved in MAP.

T403 Road Network Changes

It is possible that in some cases a significant amount of time may have passed between approval of TMAP Stage 3 and the start of TMAP Stage 4. In this case changes to the road network will be discussed at the Checkpoint Meeting to outline
any adjustments required to the base modelling. These adjustments should be documented by the DE.

**T404 Requirements for Proposed Model Build**

As an outcome of the Checkpoint meeting, the DE will submit to the MAE an overview of the work they will conduct to prepare proposed models from the approved TMAP Stage 3 base modelling. This should include detail of when any new methods of control will be submitted for audit by the SAE, i.e. prior to the TMAP Stage 5 submission.

It is important that the DE develops any proposed models using the same version of TRANSYT that was used to create the base models, which should be confirmed with the MAE.

The DE should outline the proposed strategy for signal timing optimisation during each modelled period and confirm agreement of the outputs required from the proposed modelling.

**T405 Checking of Proposed Methods of Control**

For the P and the DE an important outcome of the Checkpoint meeting is to reach agreement with the SAE on when the new methods of control will be checked. It is a pre-requisite for TMAP Stage 5 that SQA-0640 compliance has been established prior to audit, so correct timetabling of the SAE check is imperative for further progress of the proposal within TMAP.

**T406 Modelling Expectations Document**

The Modelling Expectations document produced during MAP Stage I should be reviewed and updated to incorporate any new information raised during the Checkpoint meeting. This is to be produced and agreed by the P, DE, MAE and SAE.
5.4.3 Criteria for Moving to TMAP Stage 5

To move to TMAP Stage 5, the following need to be agreed by all parties:

- List of work to be completed by the DE including method of control submissions to the SAE prior to the TMAP Stage 5 submission;
- Purpose statements for each of the models being submitted during TMAP Stage 5; and
- Modelling Expectations Document updated if necessary.

The MAE-approved signed & dated MAP Stage 4 Check Sheet (SQA-7676) must have been received by the P, DE and CE, together with the Modelling Expectations Document, and copied to RSMSchemeAssessments@TfL.gov.uk

End of TMAP STAGE 4
5.5 TMAP Stage 5, TRANSYT Proposed Models Submission

5.5.1 Introduction

The majority of the work, both in terms of creating and auditing a TRANSYT Model, is completed when generating fit for purpose base modelling. Once TMAP Stage 3 is complete there will often be a relatively small amount of work required to complete TMAP.

The DE should make a copy of the TMAP Stage 3 accepted base models and input new methods of control and/or link structure in line with the outlined proposals. In addition to ensuring that the model is correctly developed from a technical point of view the DE has the responsibility of demonstrating that the proposals can be accommodated within the network without jeopardising the day to day operation of the network. This will include maintaining acceptable levels of DoS and queue lengths as well as sufficient provision for pedestrian demand.

In common with the preceding stages, the MAE will need to consider all the technical data and their implications. However, an important additional responsibility of the MAE at Stage 5 is to make a judgement of whether they agree that the network is likely to operate satisfactorily on a day-to-day basis.

As a representative of the TfL Traffic Manager who will have a duty to manage the new network (if the proposal is given the go-ahead by RSM-Operations), the MAE should highlight any issues and concerns with the proposals. These issues are likely to be in respect of safe, efficient network operation and current policy/guidelines.

Proposed TRANSYT models are required for all time periods in TMAP Stage 5. The DE will receive feedback from MAE and will need to address any issues highlighted. The MAE can use their operational experience in making informed comments and decisions.

If required by the model scope the proposed timings must be suitable to be used as controller held background timings for new methods of control. This means that the MAE’s audit is implicitly asking the DE:

> ‘Are you satisfied that, if observing on-site when these proposals were commissioned, the timings in each of the submitted TRANSYT models would provide appropriate network operation under local control and that the network impacts would be as described in the Scheme Impact Assessment Report?’
5.5.2 TMAP Stage 5 Check Sheet

T501 SAE-Approved Proposed Methods of Control

Before submitting any proposed modelling, the DE must ensure that all proposed methods of control have been approved by the SAE and documented on a ‘MAP Stage 5 SQA-0640 Compliance Check Sheet’ (SQA-0530). This needs to be confirmed by the MAE before further auditing can commence.

Lack of an approved MAP Stage 5 SQA-0640 Compliance Check Sheet for any of the methods of control changes will prevent the MAE from proceeding with TMAP Stage 5.

T502 Proposal Report

Proposal submissions must be accompanied by a report, as described in the TfL Traffic Modelling Guidelines. The report needs to contain all necessary information and paperwork in order to assess criteria T503 - T506, together with an assessment of the likely impact of the proposals.

There must be a comparison between the results of the validated base models and the proposed models for the corresponding periods. The inclusion of comparisons for all links which are deemed critical is required.

It is the responsibility of the DE to identify critical links. Normally (but not exclusively) critical links would be those which experience high traffic flows, are close to capacity and/or those links which are affected by the proposals.

T503 Changes to Model (TMAP Stage 3 to TMAP Stage 5)

There are likely to be three significant changes from base to proposed models which should be detailed by the DE:

- Method of control changes, in which node and link control data will have changed;

- Road layout changes, in which case the link structure and saturation flows may have changed; and

- The model will have been optimised following the pathway detailed in the TfL Traffic Modelling Guidelines, in which case the stage change points may have been modified.

T504 Flow Consistency Check

The flows should be similar to those in the base model. However, if there are changes to the routing of traffic e.g. where the base model is of a one way system but the proposed model introduces a two way system, then the DE should provide the MAE
with the detailed methodology, assumptions and all other relevant information used during the reassignment of traffic flows.

**T505 Stage Minima & Demand-Dependent Stage Frequencies**

Stage minima should be audited against the TMAP Stage 3 base models. Where proposals have impacted stage minima these should be noted by the DE and checked by the MAE to ensure the proposed stage minimums can be used to generate local signal timings. Modified stage minima should be compliant with the signal controller hardware being used within the proposed design.

The DE’s report (T502) should comment on the frequency of the appearance of demand-dependent stages in the base model and whether any assumptions regarding demand have been made for the proposed network. If any changes in demand have been estimated then this must be explicitly noted for consideration by the MAE.

Proposals should consider pedestrians as described in the TfL Traffic Modelling Guidelines. From a modelling point of view this means allowing for sufficient appearance of pedestrian stages where they operate on a demand-dependent frequency.

**T506 Model Optimisation Strategy**

The optimisation strategy to be used for the proposed modelling should be agreed with the MAE and documented by the DE in the technical report (T502). The choice of optimisation strategy is likely to depend on the nature and purpose of the proposed modelling.

Factors to consider include the following:

- Demand dependency adjustments may need to be:
  - Left unchanged in the case of capacity assessment;
  - Modified if any flows demanding demand-dependent stages are expected to change significantly, for example due to additional development traffic or growth;
  - Removed to preserve offsets if the model is to be used to produce controller-held signal timings using offset-only optimisation;

- Underutilised Green Time adjustments may need to be:
  - Included if the cause of the UGT is likely to remain in the proposed scenario;
  - Recalculated if a change in UGT can be predicted and estimated based on the existing UGT value, for example due to a change in cycle time; or
  - Removed if the cause of the UGT is likely to be removed following the proposal implementation, which may in fact be one of the goals of the proposal; and
• Iterative optimisation & flow adjustment:
  o A dedicated assignment model may be used in conjunction with a proposed TRANSYT model to iteratively adjust flows and signal timings in both models until convergence is achieved, to account for wider traffic reassignment outside the LinSig model area. This may be the case where traffic management strategies are to be employed or to take account of other scheme changes in a wider area.

Whichever decisions are agreed between the DE and MAE regarding the optimisation strategy, it is important that they are documented and that any changes from the Stage 3 Validated Base TRANSYT Model are clearly identified and justified, with any calculations used to produce estimated values included.

T507 Degrees of Saturation

The proposal report (T502) should contain a quantitative comparison of base and proposed degrees of saturation and the implications for the operation of the network. The MAE will need to be satisfied that the proposed scheme degrees of saturation are acceptable.

The report does not necessarily have to contain a comparison of every link in the model, but it is the responsibility of the DE to include all links which are considered as critical to the model or the proposal. The DE should ensure that any adjustments to saturation flows, effective flare lengths or traffic flows on links that exhibit changes in DoS have been fully documented. If any changes have not been highlighted then the MAE should approach the DE to explain their impact on degrees of saturation.

It is important to note that it is not possible to provide a datum at which DoS becomes significant. In some cases a small change in DoS or even relatively low values of DoS can cause problems, for example on the circulatory carriageway of a roundabout or at staggered junctions.

Note for MAEs:
The MAE must be satisfied that the proposed scheme degrees of saturation are acceptable. Degrees of saturation are be affected by cycle time, available green time, traffic flow and saturation flow. Therefore, care must be taken to ensure techniques such as adjusting saturation flows or flows on a link have not been used in order to manipulate degrees of saturation. Particular attention should be paid to short links with modest stacking capacity e.g. signalised roundabouts or within staggered junctions. The MAE should expect these short links to have spare capacity nearer to 20-30% (i.e. degree of saturation less than 70-80%), to prevent exit blocking onto upstream links.
T508  Queue Lengths

The DE’s proposal report (T502) should contain a quantitative comparison of base and proposed queue lengths and the implications for the operation of the network, in a similar manner to the analysis undertaken in T505 for DoS. Excess queuing is indicated by a ‘+’ in the ‘Average Excess Queue’ column in the TRANSYT 12 output .PRT file, and by a ‘+’ in the ‘Mean Max Queue’ column in the TRANSYT 13 Report Builder.

Particular attention should be paid to links with limited stacking capacity for queued traffic. If short links operate at or near physical capacity the network can be susceptible to cross junction exit blocking and loss of capacity. Consideration should be given to whether signal timings can be manipulated to place queued traffic into less sensitive areas of the network if queue lengths on critical links are at, or close to, the link length.

T509  Advising the client

It is important for the DE to ensure that the traffic models delivered for the scheme are fit for purpose (i.e. the base and proposed models give an accurate reflection of the likely network conditions) and have been approved by the MAE.

The DE may find it useful during the design process to consider arranging meetings with the MAE or to follow advice on optimising signal timings within capacity constrained networks as outlined in Part B of the Traffic Model Guidelines.

However, even with an approved set of models, results can indicate that there are capacity or operational impacts in which case the MAE is obliged to outline these in the SIAR. If this is the case, it is advisable for the MAE to provide the DE and P an opportunity to make changes to the proposed models to address these issues before they make a submission to RSM-Operations.

It may be the case that the proposal is unsound, for example where a proposed junction has much less capacity than existing and that the network impact in terms of degrees of saturation, queuing and delay is estimated to be severe. In this case, the MAE may have no alternative but to document this in the SIAR. However, the approach should be for the DE, P, MAE and SAE to discuss design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIAR.

It is ultimately the P and the DE’s responsibility to provide a workable design and remains their choice whether to submit a SIAR to RSM-Operations. If the MAE has informed all parties of the issues that will be raised in the SIAR, the P and DE may still wish to proceed with the proposal.

T510  Fit for Purpose Model

If the MAE has failed the proposed models on any of the checks T501-T508 or has highlighted other significant issues with the models, then the models are not fit for
purpose and will be ‘Rejected’ and returned to the P, DE and CE, and should also be copied to RSMSchemeAssessments@TfL.gov.uk.

If the MAE has passed the model during T501-T508 and there are no other outstanding issues then, referring back to the purpose statement from TMAP Stage 4, the MAE will pass the model as fit for purpose and authorise release of the TMAP Stage 5 Check Sheets (SQA-0525). The MAE must upload the approved model and associated files to the TfL Model Library.

A TMAP Stage 5 Check Sheet must be completed for each of the modelled periods.

5.5.3 Criteria for moving to MAP Stage 6

The P, DE, CE and SAE have received MAE-approved TMAP Stage 5 Check Sheets (SQA-0525) for all modelled periods, which have also been copied to RSMSchemeAssessments@TfL.gov.uk.

The MAE has ensured that the approved models have been uploaded to, and are retrievable from, the TfL Model Library.

End of TMAP STAGE 5
6 Vissim MAP (VMAP)

6.1 VMAP Scope

VMAP applies to all Vissim modelling submitted to TfL that will require submission of a Scheme Impact Assessment Report (SIAR)\textsuperscript{11}.

6.1.1 Supporting Modelling

It is common practice, and highly recommended, that both base and proposed Vissim models are developed for networks which already have supporting MAP-approved modelling using traffic signal optimisation software such as LinSig or TRANSYT. This allows for signal optimisation of the proposal and easier auditing of signal timings and saturation flows in Vissim.

Skeleton LinSig models, although not covered by MAP, may also be useful for the purpose of auditing signal timings and controller behaviour in addition to any MAP-approved models.

6.2 VMAP Stage 2a, Skeleton Base Model Submission

6.2.1 What is a Skeleton Vissim Model?

A Skeleton Vissim Model is a non-time-specific model that contains the basic network structure and correct fundamental parameter sets required for model development. The skeleton model should be submitted with a report detailing the modelling methodology, i.e. detailing the approach used for traffic flow assignment and routing.

It is recommended that a base TfL Vissim template file containing recommended settings is used, and is available on request. Use of the template is not compulsory, but Skeleton Vissim models should contain TfL-approved values for the following:

- Simulation Parameters;
- Model Units;
- Background;

\textsuperscript{11} The Scheme Impact Assessment Report (SIAR) was formerly known as the Traffic Signal Supplementary Report (TSSR)
A single Vissim Model submission is required for VMAP Stage 2a. The Vissim software version used must match the version agreed at the MAP Stage 1 meeting and recorded in the Modelling Expectations Document.

6.2.2 What is the purpose of a Skeleton Base Vissim Model?

The development of calibrated and validated micro-simulation modelling can be time-consuming and resource-intensive.

VMAP Stage 2a ensures the model is being constructed using an agreed template and is unlikely to require further changes during subsequent development and auditing stages of VMAP. It is important for the MAE and the DE agree fundamental Vissim modelling parameters prior to any model development, calibration, and validation.

Once a model has been validated, changing the basic parameter sets outlined in section 6.2.1 may significantly impact the model performance and require the model to be re-calibrated and re-validated.

6.2.3 VMAP Stage 2a Check Sheet

VMAP Stage 2a has a Check Sheet (SQA-0526), which needs to be completed by the DE and CE before being submitted to the MAE. This section identifies the audit checks that the MAE is required to carry out within VMAP Stage 2a, corresponding to individual numbered entries on the Check Sheet.

V201 Technical Note

Skeleton Vissim Model submissions should be accompanied by a technical report, as described in Part B of the TfL Traffic Modelling Guidelines.

The technical note provides an opportunity for the DE to outline the way in which the model has been set up. It should not be treated as simply a ‘tick box’ requirement. It is an engineering document and it should be specific to the model it accompanies. Key elements are outlined below:

- The scope and purpose of the Vissim models, as agreed at MAP Stage 1 and defined in the Modelling Expectations Document;
• Extent of the modelling area, as agreed at MAP Stage 1;

• Details of any variation from default Vissim parameters defined within the TfL Vissim template, with justification for the changes;

• Source of data used to define parameters within the skeleton model;

• The traffic assignment method to be used in the models. If ‘dynamic modelling’ is to be used, the DE should provide justification as to why static route modelling would not be sufficient for the proposal; and

• Any other modelling assumptions that will impact development of the VMAP Stage 2b calibrated base Vissim models.

V202 Simulation Parameters

The DE should ensure the following parameter sets are appropriate, which will be checked by the MAE:

• Traffic regulation: should be ‘Left-side traffic’ for UK models; and

• Simulation resolution: should be set a minimum of 4 to ensure accuracy during simulation. Higher values will result in mathematically more accurate model behaviour but slower simulation speeds.

V203 Model Units

Vissim model units may be set to any value but the below are TfL-recommended units for modelling in UK. Modelling parameters such as speeds and acceleration profiles are checked against these model units to ensure consistency.

• Distance: m and km;

• Speed: mph (for comparison with site speed limits); and

• Acceleration: m/s²

V204 Background

The DE should use Vissim background files at a resolution sufficient for network development, whilst ensuring it is up-to-date, correctly scaled and undistorted.

If the background file lacks detail or is not scaled correctly, it will result in the development of a Vissim network to incorrect dimensions and potentially erroneous layout data. The coarse network structure should be correct within a VMAP Stage 2a submission.
V205  Functions

The DE must ensure, and MAE verify, that any changes to the maximum and desired acceleration/deceleration profiles from default values, as defined within the appropriate TfL Vissim template, are specified in V201 and supported by suitable field data or documented TfL advice.

V206  Desired Speed Distributions

Details of speed limits present within the modelled network should be specified in the DE’s technical note (V201). The DE should then ensure that appropriate speed distributions have been defined for:

- Different speed limits in the study area;
- Different vehicle types:
  - Pedestrians;
  - Light vehicles;
  - Buses and heavy vehicles; and
  - Cyclists.
- A range of reduced speeds for turns, depending on turning radii; and
- A range of reduced speeds for saturation flow calibration.

Since VMAP Stage 2a models contain no traffic, all that needs to be checked at this stage is that the defined distributions would produce sensible behaviour if applied to vehicles in Stage 2b.

TfL have acceleration profiles for some vehicle types, notably articulated buses and HGVs. TfL also have a range of speed distributions for cars, motorcycles and buses, for different UK road speed limits. These distributions are contained within the TfL Vissim template and are based on data published by the Department for Transport\(^\text{12}\) and research carried out by TRL.

V207  Vehicle Data

The DE should specify, and MAE verify, that vehicle data is as listed below:

- **Vehicle Model**: correct 3D models have been selected for additional vehicles such as taxis, articulated buses and other vehicle types;
- **Vehicle Types**: have been correctly identified and defined. A common error is for incorrect desired and maximum acceleration/deceleration profiles to be selected for vehicle types. This may have an impact upon network performance and journey times during later stages of model development. Any

variation of the following parameters from default values should therefore be reported or highlighted for discussion between the DE and MAE:
  - Vehicle Category;
  - Vehicle Model;
  - Acceleration/deceleration profiles; and
  - Colours.

- **Vehicle Classes**: where all relevant vehicle classes have been defined.

### V208 Driving Behaviour

Correct driving behaviour parameters should be specified prior to development of the Vissim model in order to accurately recreate observed vehicle behaviour. Parameter values should not be changed from Vissim default values, or those contained within the base TfL Vissim template, unless supported by site observation and measurement. Where driving behaviour parameters are changed from default values this should be explicitly documented and justified within V201.

The DE should specify appropriate values for the following parameters, which will be checked by the MAE:

- **Following**:
  - Look ahead distance (min & max): when combined with ‘observed vehicles’, these determine how vehicles react to other vehicles either in front or to the side. Where lateral behaviour is important (i.e. for overtaking) the ‘min look ahead distance’ can be increased from zero;
  - Observed vehicles: determines how well vehicles predict and react to other network elements and vehicle movements. Increasing this value can be necessary where multiple network elements occur within a short distance;
  - Look back distance (min & max) [Vissim 5.10+]: determines how far a vehicle can see backwards in order to react to approaching vehicles. Where lateral behaviour is important (i.e. for overtaking), the ‘min look back’ distance can be increased;
  - Standstill distance: defines the average desired distance between stopped cars. It is recommended to set this value to 1.2m; and
  - Additive and multiplicative parts of safety distance: impact upon link saturation flow and should remain as default values. The TfL Traffic Modelling Guidelines recommend the use of reduced speed areas for saturation flow calibration.

- **Lane change**: 

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o Should remain as default values as illustrated in Figure 23. Changes to these values should be supported by DE justification within V201. Note that the Advanced merging parameter [Vissim 5.40+] should be switched on; and

o The MAE should check if cooperative lane changing has been applied, and any use should be justified by the DE in V202 as agreed in MAP Stage 1, and checked by the MAE. In Vissim version 5.30 cooperative lane changing is applied by manually editing the *.INP file (this is determined by the inclusion of the keyword COOPERATIVE within each driving behaviour).

- **Lateral:**
  o Should be left at default values for motorised vehicles, with desired position at free-flow set to ‘Middle of the Lane’, unless ‘overtaking on the same lane’ is to be enabled in the model. If ‘overtaking on the same lane’ is to be active in the Vissim model, additional link types may be defined using the Urban (motorized) parameter set as a base, as described in V209; and
  o When modelling cyclists, refer to the template for advice on lateral behaviour parameters. An example file is available on request to demonstrate situations in which each driving behaviour should be used.

- **Signal Control:**
  o *Reaction to amber signal:* should remain at default with the decision model set to ‘Continuous Check’ (except models built using Vissim versions 6 – 8); and
  o *Behavior at red/amber signal:* should be ‘Stop (same as red)’.

### V209 Link Types

The DE and MAE should ensure within V209 that model links types correspond to the correct Driving Behaviour Parameter Sets. The number of link types in any model should be kept to a minimum where possible. The default links types should not be changed without good reason and supporting evidence. The creation of additional link types may sometimes be necessary, but if this is the case supporting evidence explaining their use should be presented in the DE’s modelling report (V201).

It is recommended that different link display types are used to easily identify link types in the model network during the model build, however the application of appropriate link types in the Skeleton Model will still need to be audited by the MAE since any display type can be applied to any link type.

### V210 Route Assignment Choice

The DE must ensure, and MAE verify, that the correct traffic assignment choice (static or dynamic traffic assignment) has been used as agreed during MAP Stage 1.

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13 Vissim models built using versions 6 – 8 should use ‘One Decision’ for the Reaction to amber signal, due to a bug that exists in these versions at the time of publication. PTV does not intend to fix this issue in these versions (PTV Vissim & Viswalk Release Notes for version 8.00–13, 5 September 2016).
The TfL Traffic Modelling Guidelines advise against use of dynamic models unless static routes cannot be established with accuracy. In cases where dynamic modelling is justified, a combined static-dynamic assignment is preferred to aid convergence within congested networks.

If the use of dynamic assignment has been justified and agreed during MAP Stage 1, the MAE should already have informed the DE of the convergence criteria required. Additional MAE checks on stability parameters and convergence of the assignment will be required during VMAP Stage 2b.

**Figure 23:** Default lane change parameters for the Urban (motorized) parameter set, as used in the TfL base Vissim 8.00 template v1.0.
V211 Network Structure

The initial model network structure should be accurate and consistent with the layout on-street. The TfL Traffic Modelling Guidelines contain advice concerning appropriate link/connector structures.

Key elements of the network in the Skeleton Vissim model that will be checked by the MAE are:

- **Link Structure:**
  - Number of lanes;
  - Link lengths;
  - Bus lanes and lane closures;
  - Pedestrian and cycle links; and
  - Presence of flared approaches.

- **Connectors:**
  - All possible movements;
  - Lane to lane structure;
  - Connector lengths; and
  - Bus lanes and connector closures.

It is recommended that a single connector be used when modelling lane gain or loss, rather than multiple lane-to-lane connectors which enforce strict lane change behaviour. ‘Lane Change’ and ‘Emergency Stop’ distances for connectors should be carefully specified as they play a role in lane changing behaviour on upstream links.

There can be different ways of structuring the network to obtain similar results. It is recommended that advice is sought from an experienced Vissim modeller if there is any doubt regarding the effectiveness of a specific network structure.

V212 Other Modelling Issues

Any concerns the MAE may have with the model that have not already been covered by the checks in V201 – V211 should be recorded in the ‘Other Modelling Issues’ section of the VMAP Stage 2a Check Sheet (SQA-0526). These additional issues for audit may relate to project-specific agreements formalised during MAP Stage 1.

6.2.4 Acceptance/Rejection of Model

When the MAE is satisfied with the modelling parameters and the basic network structure of the Skeleton Vissim model, the model will be accepted and the DE may proceed to VMAP Stage 2b.

Conversely, if the MAE is not satisfied with the modelling standard, the model will be rejected and returned with reasoning to the P, DE, CE, and CE, and should also be coped to RSMSchemeAssessments@TfL.gov.uk.
If there are fundamental flaws within the model or a conflict of opinion, the MAE may organise a meeting with the DE and CE. At the MAE’s discretion, the P may also be invited as they are often the budget holders for the DE’s modelling work and may need to discuss if the quality of work is as agreed in the project brief.

6.2.5 Criteria for Moving to VMAP Stage 2b

The P, DE and CE have received an MAE-approved VMAP Stage 2a Check Sheet (SQA-0526), which has also been copied to RSMSchemeAssessments@TfL.gov.uk.

End of VMAP Stage 2a

6.2.6 Stage 2a to Stage 2b, Demand-Dependent Stage Count Information

In order to model the frequency of demand-dependent stages at a signalised node, the DE or MAE needs to retrieve data from the UTC system.

UTC is able to retrospectively retrieve the frequency of demand-dependent stage appearances that were observed over a specified period, divided into 15-minute segments. For example, to get the observed frequency of a demand-dependent stage between 9am and 10am (i.e. four 15 minute segments) for Group 59 on 2nd September 2010, the command is:

`'achk g59 t=09:00 p=4 d=02-sep-10'`

The UTC log provides the observed stage appearance frequency for every demand-dependent stage in the following format:

`'number of times called (IP)' / 'no. of opportunities' (OP)`

If a junction is under SCOOT Control, it is important for the DE to check whether the junction was single or double cycling by identifying the number of opportunities in the plan against the actual opportunities reported by UTC. This should be equal to a whole multiple where a junction was forced to either single or double cycle for the entire observed period. Where a junction was free to either single or double cycle in SCOOT (and has done both within the observed period) a different number of actual opportunities will be seen. In this case the only way to work out the cycle times that occurred is to have SCOOT message data for the monitored period.
6.3 VMAP Stage 2b, Calibrated Vissim Base Model Submission

6.3.1 What is a Calibrated Vissim Model?
A calibrated Vissim model should have:

- Appropriate traffic flow data from on-street surveys, in accordance with the scope and purpose of the model as defined in MAP Stage 1 and defined in the Modelling Expectations Document;

- Public transport data collected from reliable sources, and modelled accurately. The level of detail of public transport modelling is dependent on the purpose of the model as defined in MAP Stage 1 and defined in the Modelling Expectations Document;

- Correct on-street signal control data with representative signal timings for the network during the period under consideration;

- Accurately modelled priority rules that result in the correct modelled representation of existing on-street conditions;

- Reduced speed areas placed at appropriate places in the network, and used as a mechanism to calibrate saturation flows at signalised junctions; and

- An appropriate link structure to replicate on-street traffic behaviour.

Calibrated Vissim models are required for all time periods in VMAP Stage 2b.

6.3.2 What is the purpose of Calibrated Vissim Models?
The submission of calibrated models prior to model validation is useful for both the DE and the MAE, and will improve the standard of the validated model submissions. Calibrated model submissions provide an opportunity to ensure that the DE has understood the UTC and network data they have been provided with, and have collected sufficient knowledge of the network.

6.3.3 VMAP Stage 2b Check Sheet
VMAP Stage 2b has a Check Sheet (SQA-0527), which should be completed and signed by the DE and CE before submission to the MAE with the model and associated technical note.
Below are the checks that the MAE will carry out, corresponding to individual numbered entries on the VMAP Stage 2b Check Sheet:

**V221 Technical Note**

The DE is required to submit a technical note with the Calibrated Model, as described in the TfL Traffic Modelling Guidelines. The technical note provides an opportunity for the DE to outline to the MAE how the model has been constructed. It should not be treated as a ‘tick box’ requirement. It is an engineering document and it should be specific to the model it accompanies.

The Calibrated Model technical note should contain:

- The stated purpose of the model, as agreed during MAP Stage 1 and defined in the Modelling Expectations Document;
- Modelled time periods, as agreed at MAP Stage 1;
- A list of all the TfL-referenced nodes in the network with addresses, as agreed during MAP Stage 1;
- Notes covering site observations which detail physical constraints within the network and vehicle behaviour. Where behaviour is specific to a time of day, this should be noted. It is important for the DE to explain how these observations have determined the structure of the model;
- Site datasheets with measured saturation flows or data from accompanying approved TMAP Stage 3 TRANSYT or LMAP Stage 3 LinSig models;
- The source signal timings. For VAP controlled junctions, if there are no accompanying MAP Stage 3-approved LinSig or TRANSYT models, then in the case of Fixed Time junctions the UTC signal plans should be included. For SCOOT junctions, average representative timings should be calculated using an approved method and clearly presented. For UTC-Vissim controlled junctions the timings sheets should be provided along with a link to the cell(s) which have been used;
- List of any network changes to the approved VMAP Stage 2a model with justification;
- Sources of data used for development of the Vissim model (e.g. traffic data, signal data and public transport timetables/routes);
- List of all modelling assumptions with supporting evidence; and
- List of any default parameter changes with supporting evidence.
V222 Traffic Data

The DE should specify the following parameters, which will be checked by the MAE:

- **Simulation start time:** should be set to a time before the start of the modelled peak, to allow for a suitable warm-up period during which representative traffic flows and queues can be obtained within the network prior to the start of the peak period of interest;

- **Simulation period:** should cover the warm-up period, the whole of the modelled peak and a cool-down period, as defined within the TfL Traffic Modelling Guidelines (NB: one hour equals 3600 simulation seconds);

- **Traffic composition:**

- **Vehicle types and the associated speed distributions.** It should have been decided at MAP Stage I whether cyclists and motorcycles will be included in the models. This will be included in the Modelling Expectations Document. Cyclists in particular can have a significant impact on the modelling of vehicle capacity but, due to the increase in cyclist numbers in recent years, they should not be omitted without good reason;

- **Vehicle inputs:** flows should be specified using the ‘Exact Volume’ of vehicles on entry points, rather than a ‘Stochastic Volume’. Flow inputs during the warm-up and cool-down periods may vary from the peak flows, but should result in correct conditions during the peak;

- **Vehicle input profiles:** and

- **Routing decisions and distributions:** the DE must ensure that routing decision start points are placed sufficiently upstream of any junction, to allow vehicles to get into the appropriate lanes. Vehicle behaviour should be observed by the DE and MAE to ensure compliance with routing decisions. All vehicle inputs into the model will require at least one routing decision as in the absence of this Vissim does not produce warnings, but instead routes traffic randomly within the network.

Vissim allows static routing decisions to be specified by vehicle class. Each class in each input should be covered by a routing decision (there should be at least one routing decision per vehicle input). All static routing decisions should have a legitimate link-connector sequence.

Where dynamic assignment has been used, vehicle input flows should be correctly specified in the O-D matrix files (*.FMA). It is also important to review the modelled network for stability during the flow assignment process to ensure that the model reaches a converged state.
The MAE will deem convergence to have been achieved when the following criteria have been met over the modelled peak period:

- 95% of all path traffic volumes change by less than 5% for at least four consecutive iterations; and
- 95% of travel times on all paths change by less than 20% for at least four consecutive iterations.

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 works. The MAE should ensure that these path and cost files correspond to submissions made during VMAP Stage 3.

### V223 Public Transport

The scope of the Vissim model, as agreed during MAP Stage 1, will determine the level of detail required for public transport modelling. For example, if the models are being prepared to assess the impacts of a bus priority scheme on bus journey times, the DE should ensure all public transport elements have been modelled in detail.

The DE should ensure that the following public transport elements are correctly calibrated, which will be checked by the MAE:

- Bus routes;
- Bus lanes;
- Bus frequencies;
- Bus route offsets;
- Bus stop dwell time distributions;
- Location and size of bus stops and stands; and
- Interference with general traffic.

The DE should provide the MAE with details and sources of all data used to calibrate bus routes and their frequencies to allow them to carry out necessary audit checks. Bus lanes, hours of operation and vehicle type restrictions should be checked against on-street data to ensure correct restrictions are active where necessary during the modelled period. Data collection may also include measurement of dwell times per route, per time period on-street, or use of actual passenger numbers at each bus stop.

The interaction between public transport and general traffic can have a significant impact on network performance. Site visits should therefore be carried out by the DE.
to ensure that any disruptive behaviour that influences junction or link capacity has been modelled correctly, which should be detailed in the DE’s technical report (V221). Site visits should also be undertaken by the MAE to observe behaviour and ensure it is accurately reflected in the submission.

V224 Signal Data

Work carried out under section 2.1.2 should ensure a sufficient quality of traffic signal control data has been provided to the DE by the MAE.

The DE has a responsibility to use this data and incorporate the following into the calibrated Vissim submission, which will be verified by the MAE:

- Controller configuration;
- Cycle times;
- Stage change points;
- Stage durations;
- Interstage design:
  - Phase intergreens;
  - Phase delays;
- Node offsets;
- The presence of SVD Bus Priority; and
- Signal head positioning: where heads should be positioned on links rather than connectors, and at least two meters upstream of the end of the link/start of the connector.

It is common practice for MAP-approved LinSig or TRANSYT models to be submitted with all base Vissim models. If this is not the case, the DE must produce skeleton LinSig models for more complex junctions and provide to the MAE to enable an audit of signal data in Vissim, as outlined in section 6.1.1. These skeleton LinSig models need to contain signal data, although no traffic flow data is required.

If base LinSig or TRANSYT models have been submitted with Vissim models, it is essential that these are approved MAP Stage 3 models which correctly represent on-street data. The signal data held in both Vissim and accompanying approved LinSig/TRANSYT models should be consistent.

The DE and MAE should use the Signal Times Table Window in Vissim to verify the operation of modelled signal controllers. This allows the intergreen, phase duration and stage change points to be visualised.
The two main signal control types that should be used are UTC-Vissim and VAP. Which one is to be used for each junction should have been decided in MAP Stage 1 and detailed in the Modelling Expectations Document.

If VAP is used to control the signal timings, VAP signal control within Vissim should be structured and implemented by the DE. The MAE should therefore understand VAP in order to audit the signal control logic and interstage files. Unless the TfL Anyplan VAP routine is used (this is freely available on request), all VisVAP files must be provided by the DE to aid the auditing process.

It is important to ensure that Vissim treats the starting red/amber period as red to get the same vehicle behaviour as observed on-street. This behaviour should be set in the driving behaviour parameters (V208). For Vissim versions before 5.30, the TfL Traffic Modelling Guidelines detail a methodology to achieve this by extending the all red period by two seconds. Where this approach is employed the DE and MAE must ensure that the first two seconds of green for all traffic phases are included in the ‘red-amber’ aspect of signal groups.

Section 5.2.7 describes how the frequency of demand-dependent stages can be obtained from the UTC system. The recommended method for modelling demand-dependent stages in Vissim is described in the TfL Traffic Modelling Guidelines.

The DE should ensure that demand-dependent stages within the network show a frequency of at least 90% of that observed on-street, which will be audited by the MAE. The average count should be reported by the DE in the technical note (V221) and supplied along with any generated VAP TRACE files for each simulation run.

If UTC-Vissim is used then both the model and the cell must be set up correctly, including the following:

- In the model:
  - Signal controller configuration in the Vissim model. Note that changing the filename of the *.INP file will break the links to the signal configuration *.CFG files. Correct TfL signal timing sheet data must be used for the Vissim signal configuration.

- In the cell:
  - Junction configurations;
  - Plans;
  - Timetables;
  - Procedures;
  - Gating/SASS; and
More detailed examination of SCOOT data in SCODA should be carried out if the MAE or NAE finds it necessary, based on model performance and/or the purpose of the model.

V225 Priority Rules / Conflict Areas

Priority rules have an impact on both congestion and vehicle journey times, especially in networks with give-way junctions and opposed movements at signalised junctions. It is important that the DE models priority rules correctly in Vissim, thus replicating on-street behaviour in models.

For Priority Rules the DE and MAE should ensure that the following are appropriate:

- Position of the yielding markers;
- Priority between different streams of traffic;
- Operation of the priority rules;
- Headways (time and distance); and
- Yellow box junctions.

With respect to Conflict Areas, the DE must ensure that movement priority, visibility, gaps and safety distance factors are specified accurately and realistically enough to reflect on-street observations, which will be checked by the MAE. The use of conflict areas is preferred at locations such as zebra or pelican crossings, where the area of conflict is clearly defined.

V226 Reduced Speed Areas

Reduced speed areas are used in Vissim models for a variety of purposes, most importantly to:

- Replicate lower speeds used by turning vehicles within the model;
- Represent localised changes in speeds due to network geometry or driver psychology; and
- Calibrate saturation flows at junction stoplines.

The TfL Traffic Modelling Guidelines recommend that reduced speed areas should be placed at all stoplines and wherever road geometry or other factors cause drivers to decelerate, for example bends, turning movements, speed reduction measures, complex junction layouts or where there is poor visibility.

Suitable desired speed distributions should be associated with each reduced speed area, which will be checked by the MAE. Where separate distributions are applied to
different vehicle types, the DE should ensure that each vehicle type uses an appropriate desired speed distribution.

V227  Link-Connector Structure / Network Operation

The network structure was confirmed during VMAP Stage 2a, but it is not until traffic is simulated that the structure of the modelled network can be fine-tuned by the DE. The experience of the DE, with guidance from the CE and MAE, will determine how the network is structured to deliver the best on-street representation and ensure the modelled network is ‘fit for purpose’.

The DE should ensure that the following are correctly applied:

- Network changes from the approved VMAP Stage 2a model;
- Lane utilisation;
- Flare utilisation;
- Traffic stream merges / diverges;
- Exit blocking;
- Bottlenecks in the network;
- Queuing;
- Lane change behaviour; and
- Overtaking.

The DE should maintain an active dialogue with the MAE throughout the V227 as this allows the DE to explain the techniques used, for approval by the MAE. Techniques may not be approved if they achieve certain behaviour at the cost of unrealistically representing on-street conditions. Queue lengths and locations should be observed to be similar to on-street conditions. It is strongly recommended for DE to carry out site visits and record evidence of the behaviour to be used in Vissim model. MAE may ask for the photo/video evidence of the observed on-street conditions coded in Vissim model. It is strongly recommended that the DE carries out site visits and records evidence (e.g. photos/videos) of behaviour calibrated in the Vissim model. The MAE may ask for evidence to corroborate model behaviour against observed on-street conditions.

V228  Other Modelling Issues

Any concerns the MAE may have with the model that have not already been covered by the checks in V221 – V227 will be recorded in the 'Other Modelling Issues’ section of the VMAP Stage 2b Check Sheet (SQA-0527). These additional issues may relate to
project-specific agreements formalised during MAP Stage 1 or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive to increase the likelihood of passing the Vissim model as fit for purpose during later stages of MAP.

**V229 Fit for Purpose Model**

When the MAE is satisfied with Vissim modelling parameters, network structure, traffic signals, traffic flow and public transport components of the VMAP Stage 2b Vissim model, it will be accepted and the DE can proceed to VMAP Stage 3.

Conversely, if the MAE is not satisfied with the modelling standard, the reasoning for rejecting the model should be provided in writing, and the models returned to the P, DE and CE, and should also be copied to RSMSchemeAssessments@TfL.gov.uk.

If there are fundamental flaws or conflict of opinion with the standard of modelling, then the MAE may choose to convene a meeting with the DE, CE and/or P to provide all parties with an opportunity to discuss the project.

**6.3.4 Criteria for Moving to VMAP Stage 3**

The P, DE and CE have received an MAE-approved VMAP Stage 2b Check Sheet (SQA-0527), which has also been copied to RSMSchemeAssessments@TfL.gov.uk.

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End of VMAP Stage 2b
6.4 VMAP Stage 3, Validated Vissim Base Models Submission

6.4.1 What is a Validated Base Vissim Model?

VMAP specifies that a validated Vissim model should be based on an approved VMAP Stage 2b model (see 6.3). In addition, the DE will be required to demonstrate that the models have been validated against on-street data that is independent of data used for model calibration.

The TfL Traffic Modelling Guidelines provide guidance to support Vissim model validation, including validation of saturation flows and the use of random seeds to demonstrate model stability. For this reason validation should be conducted using a minimum of twenty seed values and results presented as a mean average of all simulation runs. The seed values used should be detailed in the Validation Report and should use a common seed increment, i.e. there should be no “cherry picking” of seed values. Twenty seed runs are required in order to measure the Journey Time Reliability (JTR) of routes in the model. JTR is a TfL Key Performance Indicator.

In Vissim versions prior to 5.30, it is important that the Vissim Simulation Parameters are set to use a single processor core, as described in the TfL Traffic Modelling Guidelines. This is to ensure that validation data can be reproduced.

Validated Vissim models are required for all time periods in VMAP Stage 3.

6.4.2 VMAP Stage 3 Check Sheet

V301 Validation Report

Validated base model submissions must be accompanied by a validation report, as described in Part B of the TfL Traffic Modelling Guidelines.

The DE should ensure that the following information is provided:

- Detail on the traffic flows:
  - When the traffic surveys were done and by whom;
  - What data was collected during the traffic surveys;

- Demand-dependency calculations:
  - Explanation on how the frequency of demand-dependent stages has been accounted for by comparing calibrated model timings to the validated model timings;
  - UTC data should be recorded to confirm any site observations. If pedestrian counts are taken, the frequency of demand can be recorded
The validation report should contain a list of all changes made to the approved VMAP Stage 2b calibrated model, with justification for any revisions, alongside validation support data aligned to the VMAP Stage 3 Check Sheet (SQA-0528).

Validation data collected from Vissim models should be the average of multiple (minimum twenty) runs using different random seeds, as stated in 6.4.1.

**V302 Adjustments from VMAP Stage 2b Calibrated Model**

There should be few changes from the VMAP Stage 2b approved model other than for calibration of saturation flows (checked in V303), adjustments for satisfactory validation of traffic flows (checked in V304), queue length correlation (checked in V305) and journey times (checked in V306).

Where significant changes have been made, these should be detailed in the validation report as described in V301. The DE and MAE must ensure that any changes are both appropriate and reasonable, and that the following data that was previously checked during VMAP Stage 2a & VMAP Stage 2b remains satisfactory:

- V202 Simulation Parameters;
- V203 Model Units;
- V204 Background
- V205 Functions;
- V206 Desired Speed Distributions;
• V207 Vehicle Data;
• V208 Driving Behaviour;
• V209 Link Types;
• V210 Route Assignment Choice;
• V211 Network Structure;
• V222 Traffic Data;
• V223 Public Transport;
• V224 Signal Data;
• V225 Priority Rules / Conflict Areas;
• V226 Reduced Speed Areas; and
• V227 Link-Connector Structure / Network Operation.

V303 Saturation Flows / Degrees of Saturation

The DE must ensure that link saturation flows are measured on-site for all important network links and are validated against data collected in Vissim. Saturation flows can be measured from Vissim in a number of ways, but the three preferred approaches are:

- Using ‘special evaluation files’ as described in the Vissim manual. TfL can provide a spreadsheet to compile Vissim output information and aid collation of saturation flow data for audit;
- By producing output from a VAP routine that reports saturated vehicle headways; or
- By manually counting vehicles across the stopline and using the simulation time, to replicate the way the saturation flows are collected on site. This method, although time-consuming, may be required in certain circumstances, particularly in the presence of cyclists.

Comparison of the observed and modelled saturation flows is required during model validation as it provides a measure of the capacity of signal-controlled approaches.

Where Reduced Speed Areas are applied to turning movements in close proximity to stoplines, the turning movements can significantly affect stopline saturation flows.
these situations priority should therefore be given to calibration of the ahead
movements at stoplines before the turning movements.

If saturation flows are seen to vary between peaks in the associated MAP Stage 3-
approved LinSig or TRANSYT models (e.g. due to tidal flow movements), those
saturation flows should be validated separately within each Vissim base model.

All observed and modelled saturation flows should be tabulated and the percentage
error between the two values reported.

Modelled saturation flow values should be within 10% of observed values, or values
used in any corresponding approved LinSig or TRANSYT modelling.

The MAE should not approve a model beyond VMAP Stage 2b where the saturation
flows do not meet these criteria.

While it cannot be calibrated directly in Vissim, DoS can be estimated to ensure it
correlates with on-street observations at internal stoplines within the modelled
network. This will not be the case for entry links as there will be no coordination with
upstream signals outside the modelled network. Where the modelled DoS is found to
differ significantly from observations, it may indicate that areas of the model are in
error, which the DE and MAE should investigate.

V304 Traffic Flow Comparison

The validation report (V301) should contain evidence of a comparison between traffic
flows and turning counts recorded on-site against modelled flows and turning counts.

The DE must ensure that the traffic flows and turning counts closely match surveyed
data, which will be verified by the MAE. The GEH statistic is fully explained within the
TfL Traffic Modelling Guidelines but generally it is a standard measure of the
‘goodness of fit’ between observed and modelled flows. Unlike flow comparison
using percentage difference the GEH statistic places more emphasis on larger flows
than on smaller flows.

The DE should aim for GEH values less than five when comparing modelled flows to
observed flow volumes. However, TfL advocates GEH values of less than three for all
important or critical links within the model area. Results should be presented in the
DE’s technical note (V301), showing all observed and modelled flows together with
calculated GEH values. Modelled flows should be averaged over multiple seeds, as
described in 6.4.1. Significant discrepancies between modelled and actual traffic flows
should be queried by the MAE.

All entry links into the network should show modelled flows within 5% of observed
flows. This requirement should be achieved for all entry links as vehicle flows on
external links are direct input values. The MAE should not approve a model beyond
VMAP Stage 2b where entry flows do not match observed counts to ensure that all
assigned vehicle flows are successfully loaded onto the network during the peak
modelled period.
If necessary, entry links should be extended so that all vehicles can enter the network and consideration should be given to whether the proposal might increase queuing. The links should be long enough so that a journey time marker can be placed beyond the back of the queue in both base and proposed models.

V305 Queue Length Analysis

Comparison of simulated queue lengths in Vissim to actual queues measured on-site is a common method of calibration. However, validation of Vissim traffic models using queue lengths collected on-site for input links, without adjusting the traffic flows, is incorrect. Queue length comparison is therefore not considered a suitable validation criterion.

Modelled queues should, however, correlate reasonably with site observations of queuing behaviour and any significant discrepancies may indicate that areas of the model require further calibration.

It is possible that queue length output data will be required for comparison with the proposal as part of the report, which should be specified in the Modelling Expectations Document. This will provide an indication that queues have got longer or shorter, but should not be used as a prediction of the exact length.

If turning count traffic surveys have been used to determine model input flows, then in reality no significant queues should exist on model entry links as the collected on-site data represents the counted flow across the stopline. However, queues may occur due to high traffic demand during the warm-up period (e.g. queues at the start of the peak hour), or small queues forming due to fluctuations in vehicle arrival patterns.

V306 Journey Time Comparison

Journey time validation is the most suitable measure of Vissim model validation.

Modeled journey times should be averaged over multiple seeds (minimum twenty) and be within 15% of surveyed on-street journey times. Journey time output should be measured for vehicles originating from the start of the route, and be presented as the cumulative journey time for individual journey time segments as well as the total journey time for the complete route. It may also be necessary to restrict journey time measurements from Vissim to the same vehicle type that the site measurements were based on (e.g. private vehicles, buses, taxis etc).

The MAE will need to be satisfied that journey time validation has been completed according to the principles set out in Part B of the TfL Traffic Modelling Guidelines. If the model has not been validated satisfactorily, the MAE will not approve the model at VMAP Stage 3.
V307  Error Logs

Vissim and VAP error (*.ERR) files are generated at the end of a simulation. These files should be audited by the DE and MAE as they may indicate such errors as:

- Minimum green and/or minimum stage lengths violations;
- Unusual stage change sequence;
- Disappearing vehicles/buses in the network; and
- Not all vehicles being loaded onto the network.

Ideally, no error files should be produced at the end of the simulation runs. However, small error files with non-critical error messages are acceptable. The DE must seek further advice from the CE or MAE if unsure about the type of errors that have been produced.

For models with a large number of error file entries, and for simultaneous checking of error files from multiple seeds, a macro-enabled spreadsheet to aid the process of error file examination is available from TfL.

V308  Other Modelling Issues

Any concerns the MAE may have with the model that have not already been covered by V301 – V307 will be recorded in the ‘Other Modelling Issues’ section of the VMAP Stage 3 Check Sheet (SQA-0528). These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the model methodology to the DE. These comments should be seen as constructive to increase the likelihood of passing the Vissim model as fit for purpose if resubmitted.

V309  Fit for Purpose Model

If the MAE fails the model on any of the checks V301-V308, or other concerns are raised relating to the standard of modelling, then the model will be deemed as not fit for purpose and will be rejected and returned to the DE.

If the MAE has passed the model on all of the checks V301-V308 and has found no other issues then, referring back to the purpose statement from MAP Stage 1, the MAE will pass the model as fit for purpose by authorising a VMAP Stage 3 Check Sheet (SQA-0528) for each modelled period.

The MAE should email notification of the Approval or Rejection of the submission to RSMSchemeAssessments@TfL.gov.uk. If the submission has been approved, the MAE must upload the model and associated files to the TfL Model Library.

End of VMAP Stage 3
6.4.3 Criteria for Moving to VMAP Stage 4

The P, DE and CE have received an MAE-approved VMAP Stage 3 Check Sheet (SQA-0528) for all modelled periods, which have also been copied to RSMSchemeAssessments@TfL.gov.uk. The MAE has ensured that the approved models have been uploaded to, and are retrievable from, the TfL Model Library.
6.5 VMAP Stage 4, Vissim Proposed Models Checkpoint Meeting

6.5.1 Checkpoint Meeting

As with MAP Stage 1, the P, DE, MAE, SAE and NAE are required to meet in order to discuss the details of the proposals and how they are to be modelled. The bulk of the modelling work will have been completed during the development of the base model. The DE, CE and MAE key responsibilities for VMAP Stage 4 are outlined below.

It is the responsibility of the DE to record minutes of the meeting and submit these to the other parties who attended the VMAP Stage 4 meeting. The minutes will be authorised by the MAE and used to update the Modelling Expectations Document in V406, which will be accepted as an official account of the decisions reached.

6.5.2 VMAP Stage 4 Check Sheet

VMAP Stage 4 has a Check Sheet (SQA-8677), which acts as a formal record of task completion within VMAP Stage 4. The DE should complete this document following the VMAP Stage 4 Proposed Models Checkpoint meeting and provide the completed version to the MAE.

The following sections need to be agreed and documented, which will be confirmed by the MAE following submission by the DE.

V401 Proposed Models Checkpoint Meeting

The DE must document the date of the meeting attended by the P, DE, MAE and SAE. The MAE must ensure that the name and affiliation of all parties have been captured on the VMAP Stage 4 Check Sheet (SQA-8677).

V402 ‘Purpose’ Statement for each Proposed Model

As with the base models in MAP Stage 1, the DE should provide the MAE with a statement of the purpose of each of the modelled periods. This should be based upon the proposals being put forward by the P and taking into consideration local conditions of the network being modelled. The statement of purpose created by the DE is a key term of reference for all parties involved in MAP.

V403 Road Network Changes

It is possible that in some cases a significant amount of time may have passed between approval of VMAP Stage 3 and the start of VMAP Stage 4. In this case changes to the road network will be discussed at the Checkpoint Meeting to outline
any adjustments required to the base modelling. These adjustments should be
documented by the DE.

V404 Requirements for Proposed Model Build

As an outcome of the Checkpoint meeting, the DE will submit to the MAE an
overview of the work they will conduct to prepare proposed models from the
approved VMAP Stage 3 base modelling. This should include detail of when any new
methods of control will be submitted for audit by the SAE, i.e. prior to the VMAP
Stage 5 submission.

It is important that the DE develops any proposed models using the same version of
Vissim that was used to create the base models, which should be confirmed with the
MAE.

If LinSig or TRANSYT models are to be used for signal optimisation these need to be
provided during VMAP Stage 4 to allow the MAE an opportunity to confirm that they
are suitable for use during VMAP Stage 5. The DE should also outline the proposed
strategy for signal timing optimisation during each modelled period and confirm
agreement of the outputs required from the proposed modelling.

V405 Checking of Proposed Methods of Control

For the P and the DE an important outcome of the Checkpoint meeting is to reach
agreement with the SAE on when the new methods of control will be checked. It is a
pre-requisite for VMAP Stage 5 that SQA-0640\textsuperscript{14} compliance has been established
prior to audit, so correct timetabling of the SAE check is imperative for further
progress of the proposal within VMAP.

V406 Modelling Expectations Document

The Modelling Expectations document produced during MAP Stage 1 should be
reviewed and updated to incorporate any new information raised during the
Checkpoint meeting. This is to be produced and agreed by the P, DE, MAE and SAE.

6.5.3 Criteria for Moving to VMAP Stage 5

To move to VMAP Stage 5, the following need to be agreed by all parties:

- Agreed and dated list of work to be completed by the DE, including method of
  control submissions to the SAE prior to the VMAP Stage 5 submission;

- Purpose statements for each of the proposed models being submitted during
  VMAP Stage 5; and

\textsuperscript{14} Policy, Standards and Guidance to Procedures for the Design of Traffic Signals, Specification SQA-
• Modelling Expectations document to be updated, if necessary.

The MAE-approved signed & dated MAP Stage 4 Check Sheet (SQA-8677) must have been received by the P, DE and CE, together with the Modelling Expectations Document, and copied to RSMSchemeAssessments@TfL.gov.uk

End of VMAP STAGE 4
6.6 VMAP Stage 5, Vissim Proposed Models Submission

6.6.1 Introduction

The majority of the work both in terms of creating and auditing a Vissim model is completed during the first three stages of MAP, i.e. when generating fit for purpose base models. Once a Vissim base model has been accepted by the MAE there will often be a relatively small amount of work required to complete VMAP.

The DE should make a copy of the accepted VMAP Stage 3 base models and input the new methods of control and/or link structure in line with the proposals agreed during VMAP Stage 4. Any changes to flows must also be incorporated.

It is common practice that proposed LinSig or TRANSYT models are also produced alongside the proposed Vissim models. The signal timings from these models are often incorporated into the Vissim models, and are manually fine-tuned where necessary. The TfL Traffic Modelling Guidelines contain a strategy for traffic signal optimisation.

In addition to ensuring that the model is correctly developed from a technical point of view the DE should demonstrate that the proposals can be accommodated without jeopardising the day to day operation of the network. This will include maintaining acceptable levels of saturation and queue lengths as well as sufficient provision for the pedestrian demand being modelled.

In common with the preceding stages of VMAP, the MAE will need to consider the technical data, however unlike the previous stages there must be interpretation of their implication. An important additional responsibility for the MAE at VMAP Stage 5 is to make a judgement on whether the network is likely to operate satisfactorily on a day-to-day basis.

As a representative of the TfL Traffic Manager, who will have a duty to manage the new network (if the proposal is given approval by RSM-Operations), the MAE should highlight any issues and concerns with the proposal. These issues are likely to be in respect of safe, efficient network operation and current policy/guidelines.

Proposed models are required for all time periods in VMAP Stage 5. The DE will receive feedback from MAE and will need to address any highlighted issues. The MAE will use their operational experience and knowledge of the network in making informed comments and decisions.
If required by the model scope the proposed timings within the Vissim model must be suitable to be used as controller-held background timings. This means that the MAE’s audit is implicitly asking the DE:

‘Are you satisfied that, if observing on-site when these proposals were commissioned, the timings in each of the submitted Vissim models would provide appropriate network operation under local control and that the network impacts would be as described in the Scheme Impact Assessment Report?’

6.6.2 VMAP Stage 5 Check Sheet

V501 SAE-Approved Proposed Methods of Control

Before commencing the audit of any proposed models, the MAE must ensure that all proposed methods of control have been approved by the SAE and documented on the ‘MAP Stage 5 SQA-0640 Compliance Check Sheet’ (SQA-0530).

Lack of an approved MAP Stage 5 SQA-0640 Compliance Check Sheet for any of the methods of control changes will prevent the MAE from proceeding with the VMAP Stage 5 submission.

V502 Proposal Report

Proposal submissions must be accompanied by a report, as described in the TfL Traffic Modelling Guidelines. The report needs to contain all necessary information and paperwork in order to allow the accurate assessment of criteria V503 – V506.

All assumptions and changes to the models should be clearly stated along with the reasoning behind those changes. There should be clear comparisons between the results of the validated base models and the proposed models for the corresponding periods.

The inclusion of comparisons for all areas of the network that are deemed critical is required. It is the responsibility of the DE to identify all the critical areas. Normally (but not exclusively) critical areas would be those which experience high traffic flows, are close to capacity and/or those areas which are affected by the proposals.

V503 Changes to Model (VMAP Stage 3 to VMAP Stage 5)

There are likely to be three main changes from base to proposed models which should be detailed by the DE:

- Method of control changes, in which case signal control data will need to be changed;
• Road layout changes, in which case the link structure and saturation flows (Reduced Speed Areas) will need to be changed; and

• Signal timings may have been changed as a result of the proposals. These changes would normally be represented in an accompanying LinSig or TRANSYT model. If signal timings have subsequently been fine tuned in Vissim, the DE should be aware that all sources of signal timing information must corroborate within the final submission.

The DE will need to ensure that all modelling parameters including driving behaviour parameters, acceleration data, speed data and others are consistent with the base models passed during VMAP Stage 3. If there are inconsistencies these should be highlighted for the MAE and discussed in V502.

V504 Flow Consistency Check

Traffic flows should be similar to those in the base model. However, if there are changes to the routing of traffic e.g. where the base model is a one way system but the proposed model introduces two way operation, then the DE should provide the MAE with the detailed methodology, assumptions and other relevant data used to reassign traffic flows from the approved base case. The TfL Traffic Modelling Guidelines provide advice to achieve stable convergence should the proposal use dynamic assignment and the MAE will audit these outputs during V504.

V505 Saturation flows, queue lengths and journey times

The proposal report (V502) should contain a comparison of base and proposed saturation flows, and the implications for the operation of the network. The MAE must be satisfied that the proposed scheme saturation flows are acceptable. Any adjustments to the network that may impact saturation flows or lane usage must therefore be documented by the DE.

The report does not have to contain a comparison of every link in the model, but it is the responsibility of the DE to ensure that all areas which are considered as critical to the model or the proposals are included.

The V502 report should contain a comparison of base and proposed queue lengths and journey times. There should be interpretative comment regarding the implications of this data upon network performance. If Vissim indicates a negative impact on queue lengths and journey times (for traffic and/or public transport) these should be investigated and discussed by the DE.

The MAE should report the overall network impact of a proposal in the SIAR. The MAE will cite reported changes in saturation flow, degree of saturation, queue lengths, and journey times as justification for any assessment of network impact.
V506 Stage Timings & Demand-Dependency

The proposal report (V502) should comment on the frequency of demand-dependent stages in the base model and whether any assumptions have been applied to the proposed network. If any changes are based on estimates then these should be detailed for assessment by the MAE.

Proposals should consider pedestrians as described in the TfL Traffic Modelling Guidelines. From a modelling perspective this means allowing for sufficient appearance of pedestrian stages where they operate on demand.

The MAE will audit stage timings to ensure they corroborate with any other submitted modelling, contain appropriate stage minimums and demonstrate accurate interstage design.

V507 Advising the client

It is important for the DE to ensure that the traffic models delivered for the scheme proposal are fit for purpose (i.e. the base and proposed models give an accurate reflection of the likely network conditions) and have been approved by the MAE.

The DE may find it useful during the design process to consider arranging meetings with the MAE or to follow advice on optimising signal timings within capacity constrained networks as outlined in Part B of the Traffic Model Guidelines.

However, even with an approved set of models, results can indicate that there are capacity or operational impacts in which case the MAE is obliged to outline these in the SIAR. If this is the case, it is advisable for the MAE to provide the DE and P an opportunity to make changes to the proposed models to address these issues before they make a submission to RSM-Operations.

It may be the case that the proposal is unsound, for example where a proposed junction has much less capacity than existing and that the network impact in terms of degrees of saturation, queuing and delay is estimated to be severe. In this case, the MAE may have no alternative but to document this in the SIAR. However, the approach should be for the DE, P, MAE and SAE to discuss design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIAR.

It is ultimately the P and the DE’s responsibility to provide a workable design and remains their choice whether to submit a SIAR to RSM-Operations. If the MAE has informed all parties of the issues that will be raised in the SIAR the P and DE may still wish to proceed with the proposal.

V508 Fit for Purpose Model

If the MAE has failed the proposed models on any of the checks V501-V506 or has highlighted other significant issues with the models, then the models are not fit for
purpose and will have to be ‘Rejected’ and returned to the P, DE and CE, and should also be copied to RSMSchemeAssessments@TfL.gov.uk.

If the MAE has passed the model during V501-V506 and there are no other outstanding issues then, referring back to the purpose statement from VMAP Stage 4, the MAE will pass the model as fit for purpose and authorise release of the VMAP Stage 5 Check Sheets (SQA-0529). The MAE must upload the approved model and associated files to the TfL Model Library.

A VMAP Stage 5 Check Sheet should be completed for each of the modelled periods.

6.6.3 Criteria for moving to MAP Stage 6

The P, DE, CE and SAE have received MAE-approved VMAP Stage 5 Check Sheets (SQA-0529) for all modelled periods, which have also been copied to RSMSchemeAssessments@TfL.gov.uk.

The MAE has ensured that the approved models have been uploaded to, and are retrievable from, the TfL Model Library.

End of VMAP STAGE 5
7 MAP Stage 6, Submission of Scheme Impact Assessment Report

MAP STAGE 6

7.1 Submission of the SIAR

7.1.1 MAE Responsibilities

The SIAR is written by P, DE, MAE and the SAE.

The P and the DE should complete the relevant sections of the SIAR, including all model output tables required, and then submit this to the MAE and SAE. The MAE then needs to:

- Complete relevant sections of the SIAR;
- Agree the content of the SIAR with the SAE; and
- Send the completed and authorised SIAR to the P, DE and CE, with a copy to RSMSchemeAssessments@TfL.gov.uk.

If the P, DE or CE have any issues with the contents of the SIAR they can query the content and the MAE and/or SAE can choose whether to redraft the report. If the MAE or SAE do not wish to make any changes, they are entitled to leave it as it is.

If they deem it appropriate to do so, the P, DE and CE will complete the remainder of the SIAR before submitting to RSM-Operations.

7.1.2 Criteria for Completion of MAP Stage 6 (end of MAP)

MAP Stage 6 is the final stage of MAP. The process is declared complete when the P submits the SIAR to RSM-Operations.

It is possible, but not common, that the P will choose not to submit the proposal to RSM-Operations. If this is the case, it is recommended that the P, DE or CE provides written confirmation to the MAE and SAE stating that the proposal has completed MAP Stage 6 and that no further work is required, which should be copied to RSMSchemeAssessments@TfL.gov.uk.

If the proposals are to be submitted at a later date, this date should be no later than two years after the completion of the initial MAP. If a submission is delayed the road network should be reviewed by the DE and MAE to ensure that the network has not undergone major changes prior to submission of the SIAR.

End of MAP STAGE 6 (MAP complete)
8 Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Aimsun</td>
<td>Micro, meso and macroscopic modelling software developed by TSS-Transport Simulation Systems</td>
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<tr>
<td>AMAP</td>
<td>Aimsun Model Auditing Process</td>
</tr>
<tr>
<td>ASTRID</td>
<td>TfL software used to extract historic SCOOT signal timings</td>
</tr>
<tr>
<td>CE</td>
<td>Checking Engineer, the MAP role responsible for checking and signing off the Design Engineer’s work as fit for purpose for the Promoter</td>
</tr>
<tr>
<td>DE</td>
<td>Design Engineer, the MAP role responsible for creating the modelling for the Promoter</td>
</tr>
<tr>
<td>DoS</td>
<td>Degree of Saturation, a measure of capacity utilisation at a stopline</td>
</tr>
<tr>
<td>JTR</td>
<td>Journey Time Reliability, a TfL Key Performance Indicator, which measures the consistency of link journey times</td>
</tr>
<tr>
<td>LinSig</td>
<td>Modelling software developed by JCT Consultancy Ltd, used for detailed junction design, signal optimisation, assessment of scheme proposals and the creation of skeleton models for checking against junction Controller Specification</td>
</tr>
<tr>
<td>LMAP</td>
<td>LinSig Model Auditing Process</td>
</tr>
<tr>
<td>MAE</td>
<td>Model Auditing Engineer, the TfL MAP role responsible for auditing submitted models and assessing the network impact of a scheme</td>
</tr>
<tr>
<td>MAP</td>
<td>Model Auditing Process</td>
</tr>
<tr>
<td>MED</td>
<td>Modelling Expectations Document, document created by the MAE in MAP Stage 1, and updated in MAP Stage 4, which summarises the agreed modelling requirements</td>
</tr>
<tr>
<td>NAE</td>
<td>Network Assurance Engineer, the TfL MAP role responsible for assessment, then approval/rejection of the Promoter’s proposal under TfL’s NMD on behalf of the TfL Traffic Manager</td>
</tr>
<tr>
<td>NMD</td>
<td>Network Management Duty, duty to efficiently manage the road network under the TMA</td>
</tr>
<tr>
<td>P</td>
<td>Promoter, the person responsible for delivering and project managing the proposal</td>
</tr>
<tr>
<td>PCU</td>
<td>Passenger Car Unit</td>
</tr>
<tr>
<td>RR67</td>
<td>Research Report 67, publication by TRL Ltd describing a methodology for the prediction of saturation flows</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
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<tr>
<td>RSM-Operations</td>
<td>Road Space Management Operations, team within TfL which ensures compliance with the TMA</td>
</tr>
<tr>
<td>SAE</td>
<td>Signals Auditing Engineer, the engineer responsible for checking and safety approving the Proposal on behalf of TfL</td>
</tr>
<tr>
<td>SCOOT</td>
<td>Split, Cycle and Offset Optimisation Technique, method of dynamically optimising signal timings at a large proportion of London’s junctions</td>
</tr>
<tr>
<td>SIAR</td>
<td>Scheme Impact Assessment Report, a document which identifies the impact of implementing a scheme on the network. This provides RSM-Operations with all of the required information to make an informed decision on approval or rejection of the scheme.</td>
</tr>
<tr>
<td>SRN</td>
<td>Strategic Road Network, road network in London where TfL has a strategic interest and must be consulted over any planned changes</td>
</tr>
<tr>
<td>TfL</td>
<td>Transport for London</td>
</tr>
<tr>
<td>TfL Traffic Modelling Guidelines</td>
<td>TfL’s overarching framework, in conjunction with MAP, to deliver modelling quality and indicate recommended ‘Best Practice’ relating to the approach and methodology of model development</td>
</tr>
<tr>
<td>TfL Traffic Manager</td>
<td>TfL’s representative responsible for meeting TfL’s Network Management Duty under the TMA</td>
</tr>
<tr>
<td>TLRN</td>
<td>Transport for London Road Network, 580km of London’s roads which are managed by TfL and for which TfL is the highway authority</td>
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<tr>
<td>TMA</td>
<td>The Traffic Management Act (2004), which places a duty on local traffic authorities to ensure the expeditious movement of traffic on their or adjacent road networks</td>
</tr>
<tr>
<td>TMAP</td>
<td>TRANSYT Model Auditing Process</td>
</tr>
<tr>
<td>TranEd</td>
<td>Software developed by JCT Consultancy Ltd to provide an alternative graphical user interface for TRANSYT versions 12 and earlier</td>
</tr>
<tr>
<td>TRANSYT</td>
<td>Modelling software produced by TRL Ltd, used for modelling and optimising signalised networks</td>
</tr>
<tr>
<td>TSSR</td>
<td>Traffic Signal Supplementary Report, TfL form that has now been replaced by the Scheme Impact Assessment Report (see SIAR)</td>
</tr>
<tr>
<td>UGT</td>
<td>Underutilised Green Time, measurement of green time that is not fully used, for example due to congestion or blocking</td>
</tr>
<tr>
<td>UTC</td>
<td>Urban Traffic Control, centralised system controlling the majority of traffic signals in London</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
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<td>---------</td>
<td>----------------------------------------------------------------------------</td>
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<tr>
<td>Vissim</td>
<td>Micro-simulation software developed by PTV AG</td>
</tr>
<tr>
<td>VMAP</td>
<td>Vissim Model Auditing Process</td>
</tr>
<tr>
<td>WebTAG</td>
<td>Department for Transport guidance on the conduct of transport studies</td>
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9 Document Control

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<th>Purpose</th>
<th>Author</th>
<th>Checker</th>
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<td>Mar 17</td>
<td>Multiple MAP updates detailed in section 1.6 of this document.</td>
<td>R Blewitt</td>
<td>J Green</td>
<td>M Pooke</td>
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