# Master Specification
# Part RD-GM-D4

## Traffic Analysis and Modelling

**September 2024**

Government of South Australia
Department for Infrastructure and Transport

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# Document Information

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# Document Management

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# Contents

# RD-GM-D4 Traffic Analysis and Modelling

## 1 General

a) This Master Specification Part sets out requirements for undertaking traffic analysis and traffic modelling, including:

i) the traffic analysis and modelling requirements, as set out in section 2;

ii) the traffic data requirements, as set out in section 3;

iii) the documentation requirements, as set out in section 4;

iv) the road design considerations, as set out in section 5; and

v) the Hold Point requirements, as set out in section 6.

b) Traffic analysis and modelling must comply with the Reference Documents, including:

i) Austroads Guide to Traffic Management (AGTM);

ii) Austroads Guide to Road Design (AGRD);

iii) AS 1428 Design for access and mobility;

iv) AP-G34 Austroads Design Vehicles and Turning Path Templates;

v) Department Pavement Marking Manual (available from: https://dit.sa.gov.au/standards/standards_and_guidelines);

vi) Department Operational Instruction 14.2 Traffic Signal Faces (available from: https://dit.sa.gov.au/standards/standards_and_guidelines);

vii) Tactical Adelaide Model (TAM) Guidelines;

viii) Department Traffic Modelling Guidelines: SIDRA Intersection (available from: https://dit.sa.gov.au/standards/standards_and_guidelines);

ix) Department Traffic Modelling Guidelines: TRANSYT 15 (available from: https://dit.sa.gov.au/standards/standards_and_guidelines);

x) Department Standard Drawings (available from: https://dit.sa.gov.au/standards/standards_and_guidelines);

xi) Transport Research Board, Highway Capacity Manual;

xii) VicRoads Managed Motorway Design Guide, Volume 2: Design Practice, Part 3: Motorway Planning and Design; and

xiii) National Transport Council Performance-Based Standards Scheme - Network Classification Guidelines (available from: https://www.nhvr.gov.au/road-access/performance-based-standards/guidelines-and-rules).

c) For the purposes of this Master Specification Part:

i) a “base year model” means a traffic model representing existing conditions (in terms of physical elements, operational controls and traffic volumes);

ii) a “base case model” means a traffic model representing future conditions (in terms of physical elements, operational controls and traffic volumes) but does not include the Works; and

iii) a “project case model” means a traffic model representing future conditions (in terms of physical elements, operational controls and traffic volumes) which includes the Works.

# 2 Traffic analysis and modelling requirements

## 2.1 General

a) The Contractor must use traffic analysis and modelling to:

   i) review and confirm that the proposed road layout, including the length, number and arrangement of lanes required for intersections and interchanges, meets the required operational and performance standards of the Contract Documents and this Master Specification Part;

   ii) undertake traffic signal design in accordance with the requirements of RD-EL-D2 “Traffic Signal Design”, including:

      A. demonstrating that the traffic signal design will be capable of being effectively coordinated with adjacent traffic signal controlled sites; and

      B. ensuring that, for existing intersections in the adjacent road network that are not modified by the Project, there is no reduction in existing Level of Service;

   iii) demonstrate that sufficient capacity is provided in the design to cater for the project case design traffic volumes specified in the Contract Documents to the specified Level of Service; and

   iv) assess the impacts of major traffic arrangements during construction in accordance with the requirements of PC-SM1 “Traffic and Pedestrian Management” and section 2.10.

b) The Contractor must specify its proposed approach to the traffic analysis and modelling required by section 2.1a) within the Traffic Model Scoping Document. The Contractor’s approach to traffic analysis and modelling must be in accordance with the Contract Documents, and may include:

   i) intersection modelling, which must:

      A. use one or a combination of SIDRA, TRANSYT or LINSIG modelling packages;

      B. be used to inform all intersection and traffic signal design forming part of the Project; and

      C. be used to model all intersections specified in the Contract Documents, or where not specified in the Contract Documents, the intersections agreed with the Principal as part of the Traffic Model Scoping Document;

   ii) freeway modelling, which must:

      A. be conducted using HCM analysis conducted in accordance with section 2.9; and

      B. be used to inform all freeway and freeway ramp terminal design forming part of the Project; and

   iii) network modelling, which if undertaken must be conducted in conjunction with intersection modelling or freeway modelling and must:

      A. for the optimisation of linked and coordinated traffic signals, use TRANSYT or LINSIG;

      B. where the Tactical Adelaide Model (Aimsun) is used, support, supplement or enhance the analysis conducted in section 2.1b)i) and 2.1b)ii) (as applicable); and

      C. incorporate all road network elements specified in the Contract Documents, or where not specified in the Contract Documents, all road network elements agreed with the Principal as part of the Traffic Model Scoping Document.

c) For each traffic model proposed to be used, the Contractor must:

i) specify how the model forms part of the Contractor's overall traffic analysis and modelling approach within the Traffic Model Scoping Document, in accordance with the requirements of section 4.1;

ii) calibrate and validate base year models in accordance with the requirements of section 2.5 and the approach specified in the Traffic Model Scoping Document;

iii) provide a Base Year Model Report and the base year models in accordance with the requirements of section 4.2;

iv) develop base case and project case models in accordance with the requirements of sections 2.7 and 2.8 (as applicable) and the approach specified in the Traffic Model Scoping Document;

v) demonstrate that the design achieves the required operational and performance standards;

vi) provide a Traffic Analysis and Modelling Report and a Traffic Signals Operational Performance Report in accordance with the requirements of sections 4.3 and 4.4; and

vii) perform assessments of temporary traffic arrangements in accordance with the requirements of section 2.10.

d) The Contractor must not commence the development of the base year, base case or project case models until the Principal has released the Hold Point associated with the Design Basis submission in accordance with PC-EDM1 "Design Management" and section 4.1c).

e) The Contractor must not commence the development of the base case or project case models until the Hold Point associated with the submission of the Base Year Model Report in section 4.2b) has been released by the Principal.

f) All traffic modelling must be conducted in accordance with:

i) where SIDRA is used, Department Traffic Modelling Guidelines: SIDRA Intersection;

ii) where TRANSYT is used, Department Traffic Modelling Guidelines: TRANSYT 15;

iii) where LINSIG is used, the principles contained in Department Traffic Modelling Guidelines: TRANSYT 15; and

iv) where the Tactical Adelaide Model (Aimsun) is used, Tactical Adelaide Model (TAM) Guidelines.

g) The Contractor must ensure that all project case traffic analysis and modelling submitted to the Principal reflects the proposed design and is consistent with the Design Documentation at each design stage.

h) Any change to the design of the Project that impacts function, operation or performance requires a reassessment of traffic modelling and analysis which must include update and resubmission of the Traffic Analysis and Modelling Report.

i) Where the Contractor proposes a change to the design of the Project that impacts traffic demand, access or distribution, the Contractor must:

i) revise the project case design traffic volumes accordingly; and

ii) either:

A. where the project case design volumes have been provided in the Contract Documents, submit the revised project case design volumes to the Principal as a Design Departure; or

B. where the project case design volumes have not been provided in the Contract Documents, document and justify the revised project case design volumes as part of the Traffic Analysis and Modelling Report.

## 2.2 Traffic model software licences

The Contractor must not:

a) use externally developed modelling software (including spreadsheet macros) that are not capable of being audited or run by the Principal to replicate the results; and

b) use modelling software versions or variations, including the use of plug-ins, for which the Principal does not own software licences.

## 2.3 Traffic model auditing and checking

The Contractor must ensure that:

a) all traffic modelling complies with the design verification and certification requirements of PC-EDM1 “Design Management”;

b) network models are audited in accordance with the requirements of the applicable guidelines in section 2.1f);

c) traffic models are subject to an Independent Design Review and audited by an Independent Design Certifier in accordance with the requirements of PC-EDM3 “Independent Design Certification”; and

d) in addition to the traffic model submission requirements of section 4 as part of modelling documentation submissions, traffic models are made available for review by the Principal on request, which must include all software licences required to enable the Principal to conduct its review.

## 2.4 Traffic model software applications and integration

a) The Contractor must address the following traffic model software selection considerations as part of the Traffic Model Scoping Document:

   i) overall justification for each type of modelling software application to be applied, including how the output will inform and provide proof that the design will achieve the performance requirements of this Master Specification Part and the Contract Documents;

   ii) quantification of the resources and duration implications for the proposed applications;

   iii) whether a simpler type of modelling or analysis can be used to satisfy the design requirements;

   iv) the pedestrian modelling capability of the chosen model software applications; and

   v) where multiple model applications are proposed, the level of integration that will be applied between each application.

b) Where multiple modelling applications are proposed, the Contractor must specify its proposed methodology for model integration as part of the Traffic Model Scoping Document, including:

   i) how the Contractor will ensure that the integrity and compatibility of integrated models using different applications will be maintained;

   ii) how the Contractor will address the consistency between model applications, for each modelled scenario including the base year, base case and project case models;

   iii) how the Contractor will maintain data integrity and compatibility between applications including where the output data from one model application is an input to another, and how importing and exporting origin-destination matrices and transferring control timing is to be conducted;

   iv) the details of any proposed use of TRANSYT or LINSIG for the optimisation of signal timings; and

v) where applicable as part of freeway design, how the Contractor proposes to integrate the results of any network modelling proposed to be conducted to supplement the freeway modelling and HCM analysis required by section 2.9, and ensure that the design of freeways resulting from an assessment conducted by network modelling is not to a lesser standard than that determined by HCM analysis.

c) Where the Contractor identifies that there is, or there is likely to be, an external influence that impacts on the performance or operation of any given intersection to be assessed as part of the design of the Project, the Contractor must undertake analysis (which may include network modelling) to quantify the impact of that external influence.

d) Where network modelling is undertaken in addition to intersection modelling, the Contractor must ensure that the design of intersections resulting from an assessment conducted within a network model is not to a lesser standard than that determined by an intersection model.

e) The Contractor must document traffic performance outputs from each modelling application used as part of the Traffic Analysis and Modelling Report, which must include an assessment of the differences between each set of modelling application outputs.

f) Where green split values derived in base year, base case or project case scenarios are different in each software application the average time differences must be clearly outlined in the Traffic Signals Operational Performance Report.

## 2.5 Base year model calibration and validation

a) The Contractor must calibrate and validate intersection and network base year models (as applicable) in accordance with the requirements of this section 2.5, and the approach specified in the Traffic Model Scoping Document.

b) Base year model calibration and validation must comply with the processes, validation criteria and requirements of:

i) for intersection modelling:

A. where SIDRA is used, Department Traffic Modelling Guidelines: SIDRA Intersection; and

B. where TRANSYT or LINSIG is used, Department Traffic Modelling Guidelines: TRANSYT 15; and

ii) for network modelling:

A. where origin-destination matrices are used, the model validation must include checks that the assigned traffic volumes on all links in the model are statistically representative of the actual observed volumes; and

B. the Tactical Adelaide Model (TAM) Guidelines.

c) For base year models in all model applications, existing SCATS data must be used to replicate the phase sequences, intergreen times (yellow and all red), phase splits, signal group times, saturation flows and traffic signal offsets for signalised intersections.

d) The Contractor must submit a Base Year Model Report to the Principal which:

i) demonstrates that the base year model calibration and validation requirements of section 2.5b) have been met for each base year model used; and

ii) includes all base year model input data which must be provided in a format that is auditable by the Principal.

e) As part of the calibration of all base year models, the Contractor must ensure that:

i) the traffic signal site TS numbers, traffic signal group numbers, traffic signal phase labels and detector numbers are labelled within the models and are consistent with the existing personalities for existing intersections; and

ii) where object IDs in the traffic model are numbered automatically and cannot be changed to be consistent with the existing personalities for existing intersections, the descriptive field of the object are completed to match the standards for labelling these features as set out in the existing personalities.

## 2.6 Performance requirements

### 2.6.1 General

a) The Contractor must prepare traffic analysis and modelling which demonstrates that the design achieves the following performance requirements (as applicable):

i) for intersection modelling, all performance requirements specified in this section 2.6, or as specified in the Contract Documents;

ii) for freeway modelling, the Level of Service requirements specified in section 2.6.2, or as specified in the Contract Documents; and

iii) for network modelling, the performance requirements proposed by the Contractor in the Traffic Model Scoping Document and approved by the Principal, or as specified in the Contract Documents.

b) The traffic analysis and modelling required by section 2.6.1a) must:

i) include an assessment for the project opening year and any other future year horizons specified in the Contract Documents; and

ii) be achieved using the project case design traffic volumes:

A. as specified in the Contract Documents; or

B. where not specified in the Contract Documents, developed by the Contractor in accordance with the methodology set out in the Traffic Model Scoping Document.

c) The Contractor must include details of the measures taken to achieve the performance requirements of this section 2.6 as part of the Traffic Analysis and Modelling Report.

### 2.6.2 Level of Service

a) the Contractor must assess the Level of Service for each applicable mode of transport and road system element in accordance with AGTM Part 3 Traffic Studies and Analysis.

b) Subject to sections 2.6.2e) and 2.6.2f), the Contractor must ensure that the design achieves a minimum of Level of Service D using the project case design traffic volumes specified in the Contract Documents for:

i) each mode relevant to the modelling application as specified in the Traffic Model Scoping Document, which may include pedestrians, cyclists, buses, trucks, motorcycles, and cars; and

ii) each permanent road system element (as applicable) including all intersections, roads, road sections, and road related areas.

c) For the Level of Service assessment required by section 2.6.2b), the Contractor must report the Level of Service achieved for all relevant modes collectively and separately as part of the Traffic Analysis and Modelling Report.

d) The Contractor must ensure that Level of Service requirements specified in section 2.6.2b) are achieved:

i) for each temporal period, including the morning and afternoon peak periods, as set out in the Traffic Model Scoping Document; and

ii) for each time period specified in the Traffic Model Scoping Document (for example, each 15 minute modelled period).

e) For existing intersections, roads, road sections, and road related areas within the Site that are not modified by the Works, the Contractor must ensure that existing traffic performance is not degraded by the Works.

f) For temporary signals, the Contractor must ensure that a minimum performance of Level of Service E is achieved.

### 2.6.3 Degree of saturation

The Contractor must use intersection modelling and analysis, and the project case design traffic volumes specified in the Contract Documents, to demonstrate that the design does not exceed a practical degree of saturation of:

a) 0.80 for permanent priority intersections;

b) 0.85 for permanent roundabouts;

c) 0.90 for permanent traffic signals (including each individual movement); and

d) 1.0 for temporary traffic signals.

### 2.6.4 Queue lengths

The Contractor must use intersection modelling to demonstrate that the design accommodates 95$^{th}$ percentile queue lengths for all traffic lanes approaching modelled intersections and interchanges:

a) within the storage length of the lane (storage length does not include deceleration or taper lengths); and

b) without queues extending to any adjacent signalised intersections, pedestrian crossings, level crossings, roundabouts or upstream lane merge, diverge or weave sections,

using the project case design traffic volumes specified in the Contract Documents.

## 2.7 Intersection modelling requirements

The following requirements apply to intersection modelling conducted by the Contractor:

a) intersection modelling must be used to inform the design of the intersections specified in the Contract Documents, or where not specified in the Contract Documents, all signal controlled, roundabout and priority intersections forming part of the Works;

b) for the intersections specified in section 2.7a), intersection modelling must be used to confirm that the design achieves the functional, operational, and performance requirements of section 2.6 using the project case design traffic volumes specified in the Contract Documents;

c) for existing double-cycling intersections:

   i) the Contractor must ensure that repeat phases are able to be modelled; and

   ii) for minor intersections that are being modelled separately in the intersection analysis, the Contractor may model these at half of the existing SCATS cycle length;

d) where double-cycling is proposed at intersections, the Contractor must analyse the network performance effects to ensure that there are no adverse effects on network performance, which must be documented as part of the Traffic Signals Operational Performance Report;

e) the saturation flows for existing traffic signal sites must be consistent with SCATS maximum flow values. For intersections that are not modified by the Works, the input saturation flow in the project case intersection models must remain unchanged from the base year model;

f) all new and modified intersections must have phase sequences that assume each phase is serviced in sequence for every cycle of the traffic signals. Phase skipping or undemanded phases are not permitted to be used in models;

g) The SIDRA analysis is to consider only the performance of individual intersections and not as a network assessment application;

h) phase splits for project case modelling scenarios must be determined by the Contractor using SIDRA, TRANSYT or LINSIG models;

i) offset timings for traffic signal networks in project case modelling scenarios must be determined using TRANSYT or LINSIG models;

j) where LINSIG or TRANSYT is used (in conjunction with SIDRA for the modelling of network-level performance), the network impacts from LINSIG or TRANSYT must be incorporated into the SIDRA modelling analysis such that the models reflect the same conditions (i.e. the predicted queuing effects are consistent in both models);

k) for new intersections, the input basic saturation flow values must reflect those typical of existing sites in the same environment and the values produced by SIDRA must be consistent with measured saturation flow values experienced at adjacent SCATS sites;

l) where intersections are closely spaced:

   i) the full length lane - lane length parameter must be equal to the measured storage space between intersections in order to identify upstream blocking effects; and

   ii) consideration must be given to the expected lane utilisation distribution as a result of upstream and downstream turning movements;

m) pedestrian and cycle movements must be incorporated in the phasing at all sites, on all approaches, with phase times that reflect existing demands unless a significant change is predicted to future demands;

n) the user given phase times in SIDRA must be used to calibrate the base year models;

o) the green splits for the base case model scenario must be consistent with the operating cycle time;

p) any downstream merges, and the lane length measured from the intersection to the start of the merge taper, must be used before making manual adjustments to lane distributions;

q) the lane utilisation feature must be used to calibrate the traffic flow lane distribution;

r) the cycle time used for project case models must be no more than the greater of:

   i) the existing cycle time;

   ii) the site maximum cycle time;

   iii) the maximum cycle time of the SCATS linking group; or

   iv) 120 seconds; and

s) all intersections in the same SCATS linking groups must use the same cycle length.

## 2.8 Network modelling requirements

The following requirements apply to network modelling conducted by the Contractor:

a) network modelling must be used where required by the Traffic Model Scoping Document and the Contract Documents;

b) for the design of freeways, network modelling may be required in addition to the HCM analysis required by section 2.9 to:

   i) ensure there is no discontinuity between adjacent road sections;

   ii) assess where additional capacity is required due to the interactions between different elements of the road network; and

   iii) ensure that the freeway design achieves the performance requirements of this section 2,

   which must be documented in a proposal as part of the Traffic Model Scoping Document;

c) all intersections in the same SCATS linking groups must use the same cycle length;

d) network models must reflect any instances of double-cycling that are proposed at intersections, and must be used to analyse the network-level effects which must be included as part of the Traffic Signals Operational Performance Report; and

e) network models must comprehensively reflect the road network elements contained within the required extents including all key intersections (including both controlled and uncontrolled intersections), pedestrian and cyclist facilities, bus stops and level crossings, or as otherwise specified in the Contract Documents.

## 2.9 Freeway analysis and modelling requirements

a) The Contractor must undertake HCM analysis of all freeway elements based on the Transport Research Board, Highway Capacity Manual to determine the Level of Service for freeway and ramp terminals, as well as ramp merge, diverge and weaving requirements.

b) The HCM analysis required by section 2.9a) must:

i) be used as the basis for freeway design, including the number, length, and arrangement of lanes to meet the performance requirements of this Master Specification Part; and

ii) use project case design traffic volumes:

A. as specified in the Contract Documents; or

B. where not specified in the Contract Documents, developed by the Contractor in accordance with the methodology set out in the Traffic Model Scoping Document.

c) In addition to the HCM analysis required by section 2.9a), the Contractor may undertake network modelling of freeways in accordance with the requirements of section 2.8 to ensure there is no discontinuity of performance between adjacent road sections.

d) Where the Contractor proposes to undertake network modelling to supplement HCM analysis under section 2.9c), the Contractor must:

i) document its proposed methodology as part of the Traffic Model Scoping Document; and

ii) provide evidence of the network modelling assessment and a comparison to the HCM analysis as part of the Traffic Analysis and Modelling Report.

e) The HCM analysis must include the following 3 conditions for merging, weaving, and diverging movements for each section of freeway assessed:

i) maximum ramp volume and corresponding freeway volume;

ii) maximum freeway volume and corresponding ramp volume; and

iii) maximum combined volume within the freeway segment.

f) For the analysis of capacity, density, and Level of Service of each of the 3 conditions required by section 2.9e), the highest 15 minute period volume multiplied by 4 must be used as the volume criteria, with the analysis fully documented as part of the Traffic Analysis and Modelling Report.

g) In relation to freeway exit ramps, queue storage requirements must be assessed at the ramp terminal to ensure deceleration is provided to the 95$^{th}$ percentile back of queue.

h) The HCM analysis must not include any effects associated with ITS infrastructure.

## 2.10 Temporary traffic arrangements

a) In relation to temporary traffic arrangements forming part of the Contractor's Activities, the Contractor must:

i) identify all major temporary traffic arrangements that are proposed to be implemented; and

ii) prepare intersection, freeway and network models (as applicable) in accordance with the approach specified in the Traffic Model Scoping Document to analyse the impacts of each major temporary traffic arrangement identified in section 2.10a)i), and to ensure that the required temporary traffic performance targets are met.

b) The Contractor must:

i) set out its proposed modelling methodology and program for the major temporary traffic arrangements identified in section 2.10a)i) as part of the Traffic Model Scoping Document; and

ii) provide the intersection, freeway and network models and modelling results (as applicable) as part of the Traffic Signals Operational Performance Report.

c) Where a construction stage change involves the provision of traffic signals which require controller programming, these models are to be developed and processed as if they were used to assess a permanent traffic signal installation.

# 3 Data requirements

In relation to data used for traffic modelling and analysis, the Contractor must:

a) collect all data required to enable completion of the traffic analysis and modelling required by this Master Specification Part and the Contract Documents;

b) demonstrate that the data is fit for purpose;

c) where origin-destination trip matrices are to be used, ensure that:

i) the matrices contain values that are suitable for use in the traffic modelling and analysis;

ii) the vehicle type information is being used correctly in the relevant traffic model or analysis; and

iii) the profiled traffic demand flows have been developed in accordance with the relevant Reference Document;

d) undertake additional surveys to measure the effects on-site of pedestrian behaviour where crowding is a known or predicted issue;

e) where data is used as part of the base year model calibration or validation, demonstrate as part of the Traffic Model Scoping Document that the traffic data is a suitable representation of the existing traffic flows and has generally been collected within 2 years of the Commencement Date;

f) adjust and correct any traffic volume and composition data as required to meet the requirements of this Master Specification Part, and provide details of this process as part of the Traffic Model Scoping Document and Base Year Model Report; and

g) where passenger car units are used:

i) for traffic analysis, vehicle volumes must be converted to passenger car units using a passenger car equivalent based on the existing vehicle (including heavy vehicle) type composition, the details of which must be provided as part of the Traffic Model Scoping Document;

ii) to aggregate traffic volumes and estimate equivalent vehicle queue lengths, the equivalency factors in Table RD-GM-D4 3-1 must be used; and

iii) where there are no changes to the underlying fleet composition, the passenger car unit equivalent values used must be consistent between the base year, base case and project case models.

**Table RD-GM-D4 3-1 Passenger car vehicle lengths**

| Austroads vehicle type | Austroads class | Passenger car unit value | Average vehicle length (m)(1) |
|---|---|---|---|
| Short <5.5 m | 1 | 1 | 5 |
| Medium (short + trailer or rigid) 5.5 m - 14.5 m | 2 - 5 | 2 | 12 |
| Long (articulated) 11.5 m - 19 m | 6 - 9 | 3 | 19 |
| Medium combination 17.5 m - 36.5 m | 10 - 11 | 4 | 26 |
| Road trains >33 m | 12 | 5 | 33 |
| Tram (Bombardier Flexity) | | 4 | 30 |

**Table notes:**
(1) To account for vehicle queue space, a 2-metre gap must be added to the average vehicle lengths.

# 4 Documentation

## 4.1 Traffic Model Scoping Document

a) In addition to the requirements of PC-EDM1 “Design Management”, the Design Basis must include a Traffic Model Scoping Document.

b) The Traffic Model Scoping Document must set out the Contractor’s proposed plan for developing and executing traffic modelling and analysis in accordance with the requirements of this Master Specification Part and the Contract Documents, and must include:

i) a data report, which in relation to the data proposed to be used for traffic analysis and modelling, must:

A. set out the data which is already available to the Contractor;

B. identify the gaps in the available data and the additional data proposed to be collected by the Contractor, including the details of survey methodology and timing;

C. set out format, age, source, time period and type of all data to be used;

D. provide details of any adjustments or corrections made (or proposed to be made) to the data by the Contractor, including justification for these adjustments or corrections;

E. provide justification that the data to be used is fit for purpose, is compatible between the traffic models proposed to be used and meets the requirements of section 3e);

F. set out how peak hourly volume profiles have been derived;

G. sets out the passenger car unit factors to be used, where they differ from those specified in section 3g); and

H. demonstrates that the data requirements of section 3 have been met;

ii) a detailed proposal setting out the Contractor’s proposed traffic analysis and modelling methodology, including:

A. the extent of any intersection, freeway and network modelling to be undertaken, including justification that the proposed modelling approach is appropriate to the nature and scale of the Project;

B. a description of all base year models, base case models, project case models and any other alternative model scenarios to be developed, including their purpose;

C. an outline of how the overall traffic analysis and modelling process is to be staged, and a timetable for the completion of each stage;

D. the proposed naming convention for each model scenario developed which must, within the name, include the modelled year;

E. details of the Project specifications, which clearly delineates scope elements that will and will not be captured within the traffic analysis and modelling;

F. details of model audit processes to be undertaken, in accordance with the requirements of section 2.3;

G. details of all modelling software applications to be used and the Contractor's proposed approach to integrating models (where applicable), in accordance with the requirements of section 2.4b);

H. the Contractor's proposed approach to base year model calibration and validation, including all calibration parameters and validation performance targets to be used in accordance with the requirements of section 2.5;

I. for each project case model scenario assessed using intersection modelling, the performance targets and metrics to be used to measure design performance which at minimum must include those required by section 2.6;

J. for each project case model scenario assessed using freeway or network modelling, the Contractor's proposed performance targets and metrics to be used to measure design performance;

K. how heavy vehicles, public transport and cyclists will be assessed;

L. details of the methodology and software to be used for modelling pedestrian movements (where applicable), including how crowding will be assessed;

M. how traffic queuing effects of new or modified traffic signals adjacent to level crossings will be assessed in accordance with the requirements of section 5.5a)

N. how modelling will be undertaken to ensure that signalised roundabouts within the Site operate without internal queues blocking access to the roundabout, in accordance with the requirements of section 5.6b);

O. how HCM analysis will be conducted for freeways in accordance with the requirements of section 2.9;

P. the Contractor's proposed traffic analysis methodology and program for temporary traffic arrangements, including an outline of the scenarios to be modelled, in accordance with the requirements of section 2.10b)i);

Q. the details and methodology for any network-level analysis proposed to be undertaken;

R. a description of the limitations applicable to the Contractor's proposed modelling approach;

S. details of all modelling parameters and assumed values to be adopted in the assessment of project case model scenarios;

T. modelled time periods to be evaluated and their definitions;

U. sources for base year model, base case model and project case model traffic demands; and

V. where project case design traffic volumes for HCM analysis have not been specified in the Contract Documents, the Contractor's methodology for developing project case design traffic volumes including technical justification;

iii) where network modelling is proposed to be undertaken:

A. the proposed geographical extents of all base year, base case and project case network models to be used, and the intersections to be modelled (including any intersections specified in the Contract Documents);

B. a list of all road network elements to be modelled across all base year, base case and project case intersection models (including any road network elements specified in the Contract Documents) as required by section 2.1b)iii)C;

C. how route choice is to be modelled;

D. how intersection controls will be modelled including traffic signals, roundabouts and priority intersections;

E. how network-level analysis will be conducted, including the approach to developing the reporting metrics and information required by the Traffic Analysis and Modelling Report;

F. any proposals for videos to be prepared of the project case models, which if undertaken must include details of the proposed form and content including 2D and 3D representations and drive-through scenarios; and

G. how network modelling requirements specified in the Contract Documents and in this Master Specification Part are proposed to be achieved; and

iv) where intersection modelling is proposed to be undertaken:

A. a list of all intersections to be modelled across all base year, base case and project case intersection models (including any intersections specified in the Contract Documents);

B. where TRANSYT or LINSIG is proposed to be used, how multiple SCATS linking groups with different operating cycle lengths will be accommodated; and

C. how intersection modelling requirements specified in the Contract Documents and this Master Specification Part are proposed to be achieved.

c) The Contractor must not commence the development of the base year, base case or project case models until the Principal has released the Hold Point associated with the relevant Design Basis submission in accordance with PC-EDM1 “Design Management”.

## 4.2 Base Year Model Report

a) The Contractor must develop a Base Year Model Report, which must for all base year models used:

i) provide evidence that the base year model calibration and validation requirements of section 2.5 have been met;

ii) identify any instances where the Contractor has departed from the validation and calibration approach specified in the Traffic Model Scoping Document and provide full details and justification for each departure, including all relevant approvals by the Principal for any such departure;

iii) set out how the Contractor has addressed any data gaps identified in the Traffic Model Scoping Document, including details of any additional data collected;

iv) include a copy of all data used in a format that is auditable by the Principal; and

v) include copies of all base year models used such that they can be reviewed by the Principal.

b) The Base Year Model Report must be submitted to the Principal prior to the development of any base case or project case models, and will constitute a **Hold Point**. Development of base case or project case models must not commence until this Hold Point has been released by the Principal.

## 4.3 Traffic Signals Operational Performance Report

a) In addition to the requirements of PC-EDM1 “Design Management”, the Design Documentation must include a Traffic Signals Operational Performance Report which must set out how the modelled project case performance for signalised intersections meets the requirements of this Master Specification Part and RD-EL-D2 “Traffic Signal Design”.

b) The Traffic Signals Operational Performance Report must include:

i) an executive summary which includes all findings and recommendations;

ii) an overview of all intersections modelled in accordance with the Traffic Model Scoping Document;

iii) a full description of how the optimised traffic signal operation is intended to operate for each time period of the day, including the following information for each signalised intersection:

A. intersection layout plans and diagrams;

B. traffic signal phasing;

C. phase sequence;

D. green splits;

E. cycle, yellow, red and minimum green times;

F. pedestrian crossing walk and clearance times;

G. turning movement operation;

H. saturation flow;

I. offset parameters for coordination with adjacent traffic signal sites, including time-distance diagrams; and

J. how traffic signals will be integrated with the Principal’s existing systems,

in accordance with the Traffic Signal Design Report;

iv) for each intersection modelled, the following information from the base year, base case and project case models (as applicable):

A. volume;

B. capacity;

C. degree of saturation;

D. average delay;

E. Level of Service;

F. $95^{th}$ percentile queue lengths; and

G. number of stops,

which must be provided for:

H. each modelled period;

I. each specified user class;

J. each movement;

K. each lane;

L. each approach; and

M. the intersection as a whole;

v) the following performance metrics for network-level analysis (where applicable):

A. traffic flow;

B. average delay;

C. density;

D. vehicle kilometres travelled;

E. vehicle hours travelled;

F. average speed;

G. average travel time;

H. total number of vehicle stops;

I. missed turns; and

J. vehicles waiting to enter;

vi) an outline of the traffic modelling methodologies and all assumptions used in accordance with the Traffic Model Scoping Document;

vii) where network modelling is used, details of how intersection modelling and analysis has been integrated with network modelling for the design of signal phasing, in accordance with the requirements of section 2.4;

viii) where green split values derived in base year, base case or project case scenarios are different in each software application, the differences between the average times in accordance with the requirements of section 2.4f);

ix) copies of all intersection, freeway and network models used, including files and outputs used to develop the Traffic Signals Operational Performance Report;

x) an assessment of the impacts associated with different signal cycle lengths as part of traffic signal optimisation;

xi) a description of the existing intersection conditions and performance relating to the Site;

xii) how the existing data set out in the Traffic Model Scoping Document has informed the design of signal phasing;

xiii) the models and modelling results developed for the assessment of major temporary traffic arrangements in accordance with section 2.10b)ii);

xiv) a summary of the validation and calibration performance of the traffic models, in accordance with the Base Year Model Report;

xv) a summary of any non-compliant traffic signal design elements;

xvi) where split-phasing is used, evidence that the capacity and intersection delay benefits are for whole of day operations in accordance with the requirements of RD-EL-D2 “Traffic Signal Design”;

xvii) where double-cycling is used, the network performance assessment in accordance with the requirements of section 2.7d);

xviii) in relation to pedestrian and cyclist movements:

A. the methodology for designing and assessing pedestrian signals;

B. where existing pedestrian crossings are to be upgraded, or new crossings are to be provided, how the co-ordination with adjacent traffic signals sites has been modelled to determine the signal offsets, in accordance with the requirements of section 5.4c);

C. the pedestrian and cyclist volumes assumed in the design of pedestrian signal phasing; and

D. how the design of traffic signals impacts pedestrian and cyclist movements;

xix) justification for the adopted lane distributions used in the models as part of the traffic signal design;

xx) an assessment of the traffic queuing effects of new or modified traffic signals on adjacent level crossings, in accordance with the requirements of section 5.5;

xxi) an assessment of signalised roundabouts within the Site, in accordance with the requirements of section 5.6; and

xxii) the design storage lengths, cycle lengths and projected maximum wait times for entry ramp meters in accordance with the requirements of section 5.7f).

## 4.4 Traffic Analysis and Modelling Report

a) In addition to the requirements of PC-EDM1 “Design Management”, the Design Documentation must include a Traffic Analysis and Modelling Report, which must set out how the Contractor has conducted traffic analysis and modelling in accordance with the approach specified in the Traffic Model Scoping Document.

b) The Traffic Analysis and Modelling Report must include:

i) an executive summary addressing all key findings and outcomes;

ii) the results of all base year, base case and project case models and traffic analysis conducted by the Contractor in accordance with the approach specified in the Traffic Model Scoping Document;

iii) the findings of all traffic model auditing and verification conducted in accordance with the requirements of section 2.3;

iv) how the Contractor has developed project case intersection, freeway and network models in accordance with the approach specified in the Traffic Model Scoping Document, including (as applicable):

A. details of the Project specifications, which clearly delineates scope elements that will and will not be captured within the traffic analysis and modelling;

B. sources of project case design traffic volumes;

C. signal timings; and

D. justification for inputs or parameters that have changed compared to those specified in the Traffic Model Scoping Document;

v) for each intersection modelled, the following information from the base year, base case and project case models (as applicable):

A. volume;

B. capacity;

C. degree of saturation;

D. average delay;

E. Level of Service;

F. 95$^{th}$ percentile queue lengths; and

G. number of stops,

which must be provided for:

H. each modelled period;

I. each specified user class;

J. each movement;

K. each lane;

L. each approach; and

M. the intersection as a whole;

vi) for each arterial and local road section modelled (including each merge, diverge and weave segment), the following information from the base year, base case and project case network models (as applicable):

A. volume;

B. travel time;

C. capacity;

D. density;

E. speed;

F. speed efficiency; and

G. Level of Service,

which must be provided for:

H. each modelled period;

I. where network modelling is used, each 15-minute period; and

J. each link, route and origin-destination pair (as applicable);

vii) for each freeway section where HCM analysis is undertaken in accordance with section 2.9, the following information from the HCM analysis:

A. volume;

B. capacity;

C. density;

D. speed;

E. Level of Service; and

F. where specified in the Traffic Model Scoping Document, a comparison to the supporting network modelling,

which must be provided for each modelled period;

viii) the following performance metrics for network-level analysis (where applicable):

A. traffic flow;

B. average delay;

C. density;

D. vehicle kilometres travelled;

E. vehicle hours travelled;

F. average speed;

G. average travel time;

H. total number of vehicle stops;

I. missed turns; and

J. vehicles waiting to enter;

ix) details of the measures taken to achieve the performance requirements set out in the Traffic Model Scoping Document;

x) the models and modelling results developed for the assessment of major temporary traffic arrangements in accordance with section 2.10;

xi) an assessment of the differences in the results between each set of modelling application results in accordance with the requirements of section 2.4e);

xii) an assessment of the incremental benefits of the proposed ITS infrastructure compared to the performance achieved with traffic engineering measures and conventional traffic control devices, in accordance with the requirements of section 5.8b);

xiii) where specified in the Traffic Model Scoping Document, videos to demonstrate the operation of the Project;

xiv) the Traffic Model Scoping Document;

xv) the Base Year Model Report;

xvi) the Traffic Signals Operational Performance Report; and

xvii) copies of all base year, base case and project case models used, including all associated files used to define the network, and associated database files.

# 5 Road design considerations

## 5.1 General

a) The Contractor must ensure that all traffic analysis and modelling is conducted in accordance with the requirements of RD-GM-D1 “Road Design”, including:

i) accounting for the effects of the turning paths of large vehicles and the resulting reduction in lane capacity;

ii) allowing for the required design vehicles, including accommodation of vehicle swept paths;

iii) allowing for the required clearances between swept paths for cross intersections controlled by traffic signals;

iv) accounting for pedestrian use of intersections, including traffic islands and the effects of encroachment of turning vehicles on pedestrian usage and capacity;

v) accommodating the use of the roads by existing vehicle types, including the use of local roads;

vi) for intersections with bus routes, making allowance for 19-metre articulated buses; and

vii) making allowance for over-dimensional and over-mass vehicles.

b) The Contractor must ensure that all traffic analysis and modelling allows for traffic signal phasing and timings in accordance with RD-EL-D2 “Traffic Signal Design”.

## 5.2 Traffic lanes

a) The Contractor must undertake traffic analysis and traffic modelling to determine the number, configurations, and length of traffic lanes to meet the:

i) capacity requirements of the project case design traffic volumes;

ii) performance requirements specified in section 2.6 and the Traffic Model Scoping Document (as applicable); and

iii) minimum traffic lane requirements as set out in the Contract Documents.

b) The traffic analysis and modelling required by section 5.2a) must demonstrate that the design meets the performance requirements specified in section 2.6 and the Traffic Model Scoping Document (as applicable) in respect of each traffic lane.

c) In addition to the requirements of section 5.2a), intersection approaches must be designed in accordance with the requirements of:

i) RD-GM-D1 “Road Design”; and

ii) RD-EL-D2 “Traffic Signal Design”.

## 5.3 Traffic signals

a) Traffic signals must comply with the requirements of RD-EL-D2 “Traffic Signal Design”.

b) Traffic signal design must be based on intersection modelling conducted in accordance with section 2.7.

## 5.4 Pedestrian activated crossings

a) Pedestrian crossing and cycling facilities must be designed in accordance with the requirements of RD-EL-D2 “Traffic Signal Design”.

b) All traffic models must reflect the Design Documentation in relation to the proposed provision of pedestrian and cyclist crossing facilities.

c) Where existing pedestrian crossings are proposed to be upgraded, or new pedestrian crossings are proposed to be provided, the co-ordination with adjacent traffic signals sites must be modelled to determine the signal offsets, the details of which must be included as part of the Traffic Signals Operational Performance Report.

## 5.5 Level crossing requirements

a) The traffic queuing effects of new or modified traffic signals adjacent to level crossings must be assessed at minimum using intersection modelling. The Contractor may additionally use network modelling as part of this assessment where necessitated by the nature and scale of the Works.

b) The Contractor’s proposed modelling approach under section 5.5a) must be specified in the Traffic Model Scoping Document.

c) The assessment required by section 5.5a) must include modelling assessments of the existing queue relocation signals.

d) The Contractor must document the results of the assessment required by section 5.5a) in the Traffic Signals Operational Performance Report.

## 5.6 Signalised roundabouts

a) Roundabout signals must conform to the requirements of RD-EL-D2 “Traffic Signal Design”.

b) The Contractor must undertake modelling to ensure that signalised roundabouts within the Site operate without internal queues blocking access to the roundabout. The Contractor may use network modelling in addition to intersection modelling as part of this assessment where necessitated by the nature and scale of the Works.

c) The Contractor’s proposed modelling approach under section 5.6b) must be specified in the Traffic Model Scoping Document.

d) The Contractor must assess the predicted phasing, cycle lengths, queue lengths and roundabout geometry for signalised roundabouts, which must be documented in the Traffic Signals Operational Performance Report.

## 5.7 Freeway ramp metering

a) Freeway entry ramps must be designed to be capable of being controlled by ramp metering.

b) The storage capacity of freeway entry ramps must be designed to ensure that there is sufficient storage so that ramp queues do not extend to the upstream intersecting roads or the interconnecting arterial roads.

c) The freeway entry ramp lane widths and lane storage requirements must be determined based on VicRoads Managed Motorway Design Guide, Volume 2: Design Practice, Part 3: Motorway Planning and Design.

d) Average cycle times for ramp metering must not be less than:

   i) 7.5 seconds for 1 and 2 lane ramps; and

   ii) 6.5 seconds for 3 and 4 lane ramps.

e) The design of freeway entry ramp metering must:

   i) permit only 1 vehicle per green display per lane; and

   ii) be based on a ‘maximum wait time’ parameter of at least 4 minutes.

f) The Contractor must document the resultant design storage lengths, cycle lengths and projected wait times as part of the Traffic Signals Operational Performance Report.

## 5.8 ITS provision

a) ITS infrastructure must meet the requirements of RD-ITS-D1 “Design of Intelligent Transport Systems (ITS)”.

b) The Contractor must use network modelling to assess the incremental benefits of the proposed ITS infrastructure compared to the performance achieved with passive traffic engineering measures and conventional traffic control devices. The Contractor must provide this assessment as part of the Traffic Analysis and Modelling Report.

# 6 Hold Points

Table RD-GM-D4 6-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.

**Table RD-GM-D4 6-1 Hold Points**

| Section reference | Hold Point | Documentation or construction quality | Review period or notification period |
|---|---|---|---|
| 4.2b) | Provision of the Base Year Model Report (including base year models) | Documentation | 10 Business Days review |