Roads

Master Specification

RD-EL-D2 Traffic Signal Design

Document Information	
K Net Number:	13354871
Document Version:	1
Document Date:	2/7/2019
Responsible Officer:	

DEPARTMENT OF PLANNING, TRANSPORT AND INFRASTRUCTURE

Government of South Australia
Department of Planning, Transport and Infrastructure

Document Amendment Record

Version	Change Description	Date	Endorsement record (KNet ref.)
1	Initial issue (formerly TS100). Reporting updated match R2P; updated to include “posts”.	2/7/19	

Document Management

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RD-EL-D2 Traffic Signal Design

1 Introduction

General

1.1 This Part specifies the requirements for undertaking the planning, design and documentation of traffic signals.

1.2 The design of traffic signals shall be undertaken in accordance with this Part.

1.3 This Part also provides for the traffic signal performance assessment to demonstrate the traffic signals capability, capacity and signal timing.

1.4 The traffic signal performance assessment will be achieved using traffic analysis and modelling which is specified in RD-GM-D4 “Traffic Analysis and Modelling for Road Design” purposes with additional output related specifically to traffic signal design.

1.5 The Contractor shall demonstrate that sufficient capacity and level of service is provided in the signals design to cater for future year traffic demands.

1.6 The design requirements, for a specific contract will be found in the Contract Documents for Road Design.

1.7 DPTI may have traffic data and existing traffic analysis that can support the design. Unless this is supplied as part of a specific contract it will need to be formally requested in writing.

1.8 Where the DPTI supplied information is deficient, it is the Contractor’s responsibility to augment the data to fill gaps and update the data.

1.9 The design of traffic signals and associated infrastructure shall be capable of installation in accordance with RD-ES-C2 “Installation of Traffic Signals”.

1.10 The design shall provide only for DPTI approved products for traffic signal controllers, traffic signal lanterns, linking control modules, and associated traffic signal control equipment.

Definitions

1.11 The following definitions are used in this Part:

Term	Definition
AIMSUN	The AIMSUN software product produced by Aimsun.
Approved model scenario	The model outcome that describes the final design.
Base case model	The model representing the existing situation.
Contractor	The person responsible for the design of the project including the transport / traffic modelling requirements.
DPTI	Department of Planning Transport and Infrastructure.
DREE	Discharge Rate Evaluation Extension.
Freeway	Any form of restricted access road or part of a road with restricted access.
GTM	Guide to Traffic Management.
GTRD	Guide to Road Design.
HCM	Highway Capacity Manual
ITS	Intelligent Transport Systems
LINSIG	Software produced by JCT Consultancy.
MATSAM	Metropolitan Adelaide Traffic Simulation and Assessment Model.
Motorway	A freeway for the purpose of this specification.
Native files	Data file types generated by the proprietary software application, using a unique file name extension identifier.
PAC	Pedestrian Actuated Crossing
SCATS®	Sydney Coordinated Adaptive Traffic System, property of RMS NSW.
SIDRA	Intersections software produced by Akcelik and Associates.

Term	Definition
TAMR	Traffic Analysis and Modelling Report
Traffic	Generically to include all forms of road transport including pedestrians & cyclists.
Traffic model scoping document	Describes the modelling intention and requirements before commencement of modelling.
TRANSYT	Software produced by TRL Software.
TSOPR	Traffic Signal Operation Performance Report.
TCD	A Traffic Control Device prescribed in the Code of Technical Requirements for the Legal Use of Traffic Control Devices.
TMC	Traffic Management Centre (Norwood unless stated otherwise). (Note: The TMC is responsible for the operational performance of DPTI traffic signal assets and management of the traffic signal controller personalities.)

References

1.12 Unless specified otherwise, all design shall be undertaken in accordance with the following:

a) Road Traffic Act 1961 (SA).

b) DPTI Code of Technical Requirements for the Legal Use of Traffic Control Devices.

c) DPTI Road Design Standards and Guidelines.

d) DPTI RD-GM-D1 “Road Design”.

e) DPTI RD-GM-D4 “Traffic Analysis and Modelling”.

f) DPTI RD-ITS-D1 “Design of Intelligent Transport Systems”.

g) DPTI RD-EL-C2 “Installation of Traffic Signals”.

h) DPTI RD-EL-D3 “Conduit Design for Road Lighting, Traffic Signals and ITS”.

i) DPTI Operational Instruction 14.2 Traffic Signal Faces.

j) DPTI Pavement Marking Manual.

k) DPTI Metropolitan Adelaide Traffic Simulation and Assessment Model (MATSAM) Traffic Simulation Model Development Guidelines - AIMSUN Next.

l) DPTI Traffic Modelling Guidelines – SIDRA 7.

m) DPTI Traffic Modelling Guidelines – TRANSYT 15.

n) AUSTROADS Guide to Road Design (GTRD).

o) AUSTROADS Guide to Traffic Management. (GTM).

p) AS 2144 Traffic Signal Lanterns.

q) AS 2578 Traffic Signal Controllers.

r) AS 2339 Traffic Signal Posts, mast arms and attachments.

s) AS 1742 Manual of Uniform Traffic Control Devices.

t) National Heavy Vehicle Register, National Transport Commission Performance Based Standards Scheme Network Classification Guidelines (“NTC Guidelines”) July 2007.

u) Specification No.TSI-SP-069 Control Equipment for Road Traffic Signals by Transport for New South Wales Road and Marine Services.

v) Main Roads Operational Modelling Guidelines V1.1 July 2018 by Main Roads Western Australia.

w) Traffic Modelling Guidelines Version 1.0 February 2013 by Transport for New South Wales.

1.13 The following DPTI standard drawings apply to the design of traffic signals:

Table RD-EL-D2 1-1 Standard Drawings

Drawing Number	Drawing Title
S-6841:sheet 1 and 2	Traffic Signal Design Guide, detectors, Signal Groups, Phasing and Post numbering
S-4500 sheets 1 and 2	Detector Loop Layouts
S-4074 sheet 7	Kerb Ramps for Signalised Locations
GD 703	2 Stage PAC with Kerb Extension Tactile Ground Surface Indicators Layout.
GD 704	PAC Standard - No Median
GD 705	PAC Standard Median up to 3m (solid or painted)
GD 706	PAC Standard Dual Carriage Way Raised Median more than 3m

2 Reports

2.1 The Contractor shall submit a "traffic model scoping document" for approval before commencing modelling, which will include all aspects of the modelling requirements for the assessment of the performance of the traffic signals.

2.2 The traffic model scoping document shall be subject to approval by the Principal and be provided as part of the Design Basis Report (15% completion).

2.3 The Traffic Signals Operational Performance Report (TSOPR) shall explain what performance is expected from the traffic signals for the approved final design. This shall include an assessment of the predicted performance on the day of opening, and of the project with future design volumes and. Other scenarios may be required to be included in the report.

2.4 The TSOPR shall be provided as part of the Preliminary Design Documentation (30% completion).

2.5 The traffic signals design report is to detail the physical and equipment requirements for the provision of the traffic signals including the installation and associated drawings.

2.6 The traffic signals design report shall be completed at the Detailed Design Documentation Stage. (70% completion).

2.7 The TSOPR and the traffic signals design report are subject to approval by the Principal.

2.8 Where the operational performance of major temporary traffic arrangements during construction is required these shall be included as separate components of updated TSOPR and the traffic signals design reports. These construction components will be submitted for approval before Final Design Documentation and the Issued for Acceptance is completed.

2.9 Major temporary traffic arrangements assessments shall be documented in updates of the TSOPR.

3 Traffic Signals Operational Performance Report (TSOPR)

General

3.1 Traffic signal performance analysis shall be undertaken, including:

a) capacity analysis to inform the design and operational requirements of traffic signals;

b) traffic modelling using current and specified future design flows; and

c) assessment of the traffic impacts of alternative traffic management options for major temporary traffic arrangements during construction of the project.

3.2 The following design and operational requirements shall be reported:

a) lane, phasing and coordination requirements at traffic signals that ensures the safe and efficient operation of road network for the current and future design flows, as specified;

b) traffic signals integration within DPTI's current systems used to monitor and control traffic signals operations, and

c) the needs of all road users (e.g. buses, heavy vehicles, freight, cycles, and pedestrians) are taken into account.

3.3 The Traffic Signals Operational Performance Report (TSOPR) describing all aspects of traffic signals operational performance shall be provided at the following stages of design:

Table RD-EL-D2 3-1 TSOPR Reporting Stages

Design Stage	To be Reported
Preliminary Design (30%)	The TSOPR shall be completed including calibration and validation of the base case and assessment of all the options / scenarios including the assessment of the design representing the final design.
Detailed Design 70%	The TSOPR will be updated to account for design changes since the 30% design stage.
Final design stage (100%):	The TSOPR will be reviewed to account for design changes since the 70% design stage. The TSOPR will include the assessment of any major traffic management changes to be included in the IFC.

3.4 The TSOPR shall be accompanied by the respective model files, and data used to develop the traffic modelling analysis, from which the conclusions are drawn and recommendations made.

3.5 The TSOPR, which shall include the completed assessment of all the proposed options and scenarios, and which enables selection of the preferred design, including the preferred traffic signal option, shall be included in the Preliminary Design Documentation (30% complete).

3.6 The TSOPR report shall include:

a) an executive summary, including all recommendations;

b) a description of the intersections projected performance, of all scenarios, using the specified design traffic flows;

c) an outline of the traffic modelling methodologies adopted for the analysis of intersection and network performance including reasons for model selection and statement of compliance with specified parameters included in the Contract Documents (and reasons for and list of deviations from these);

d) a description of the existing traffic conditions including the signalised intersection performance at the intersections within close proximity that may influence the operation of the intersections which are included in the project;

e) a summary of the assessment of the existing (base case model) and forecast AM peak hour, PM peak hour, and any other specified design hour;

f) a description of all assumptions used in the models;

g) degree of saturation, LOS and 95th percentile queue lengths for individual traffic movements;

h) use vehicle delay as a performance measure for modelled output;

i) a report on the calibration and validation of the base case models;

j) discussion of alternative scenarios considered;

k) any variations from the requirements of an approved design or specified requirement;

l) reasons for the recommendations of the preferred and approved designs;

m) intersection layout plans, traffic signal phasing, phase sequences and time settings; and

n) a full description (including diagrams) of how the optimised traffic signal coordination is intended to operate for each period of the day. Include the Offset parameters for linking to adjacent traffic signal sites.

3.7 The performance measures that shall be reported shall include, but are not limited to the following:

a) overall network delay time;

b) queue lengths;

c) number of stops per vehicle;

d) average speed;

e) travel time – network average and for key routes;

f) intersection delay;

g) Degree of Saturation; and

h) Level of Service.

Operational Analysis

General

3.8 The operational analysis will include a combination of both individual intersection analysis and network analysis to predict the future performance of the traffic signals for various scenarios with combinations of possible changes to road geometry, signal phasing and phase sequences. .

Intersection Analysis

3.9 There are several minimum performance measures of traffic signal controlled intersection analysis that shall be achieved for future year model scenarios. Those listed below shall apply unless alternative measures are prescribed in the Contract Documents.

Table RD-EL-D2 3-2 Intersection Performance Measures

Measure	New Signals	Temporary Signals
Degree of Saturation for each signal site	≤ 0.9	≤ 1.0
Level of Service (LOS) (use Standard left)	"D" or better	"E" or better

Notes:

a) No signal controlled intersection movement shall have a degree of saturation greater than 0.90.

b) The 95th percentile queue lengths for each intersection lane shall not exceed the storage length of the lane. The storage length does not include the additional deceleration length of the turning bay.

c) For continuous lanes, the 95th percentile queue length shall not extend to any adjacent signalised intersection, pedestrian crossing, level crossing, or upstream lane merge, diverge or weaving manoeuvre.

d) For closely-spaced intersections, consideration shall be given to the expected lane utilisation distribution as a result of upstream and downstream turning movements.

3.10 The Contractor shall ensure the lane distribution (utilisation) of traffic on approaches is representative of the existing and projected scenarios. Justification for lane distributions in the models shall be provided in the TSOPR.

3.11 For base case models use the average cycle length of the SCATS® linked group to which the intersection belongs. This cycle length may be found in the SCATS® Summaries and SCATS® Group System Links reports.

3.12 Use the data available in the SCATS® Summaries and SCATS Group System Links reports, available from DPTI (Manager TMC) for configuring the base case models.

3.13 All intersections in the same SCATS® linking groups shall use the same cycle length.

3.14 Where there is more than one SCATS® linking grouping within the scope of the project, i.e. SCATS® groups with different operating cycle lengths, this shall be reflected in the model development. Some model applications will require the development of separate models for each SCATS® grouping.

3.15 For existing double-cycling intersections in network models, the Contractor will need to consider how repeat phases will need to be modelled for the particular modelling application. For proposed double cycling, the network performance effects shall be analysed to ensure that there is no adverse effect on network performance. Where minor intersections are normally operated with double cycling, and are being modelled separately in the intersection analysis, these may be modelled at half of the SCATS® cycle length.

3.16 Intersection layouts shall be designed to provide the most flexible signal operation possible. Split-approach phasing shall be avoided, unless the benefits of increased capacity and reduced delays can be demonstrated for the whole of day operations.

3.17 Shared lanes shall not be used. A shared lane means one which has two movements, e.g. left and through, or through and right, in the same lane.

3.18 All right turn movements, in new or modified intersections, are to be controlled with right turn arrows, and controlled separately from through movements. Opposed right turns at cross intersections shall be designed to run concurrently to allow diamond right turn operation.

3.19 Intergreen times shall ensure that vehicles have sufficient time to safely clear the conflict zones of any vehicle or pedestrian movements that run in the following signal phase.

3.20 Intersection phase times need to take into consideration the impact of pedestrian movements, particularly if they require longer phase times than those needed for vehicle traffic. In these cases, the likelihood of the pedestrian phase running needs to be averaged across the peak hour and the phase time fixed to this value.

3.21 Where analysis includes existing signal sites, use the current controller settings for red / yellow and pedestrian times.

3.22 For new and proposed upgraded traffic signal sites, the settings for minimum green, red / yellow and pedestrian times shall be calculated using the DPTI phase time setting template.

3.23 The saturation flows for existing traffic signal sites shall be consistent with SCATS® MF values. For unmodified approaches of existing intersections the saturation flows shall remain unchanged, in project scenario models, from the base case models.

3.24 For new traffic signal sites the input saturation flows used shall reflect those typical of existing sites in the same environment.

3.25 When developing models, the Contractor will calibrate the lane utilisation in base case models. For design options, the Contractor will consider the effect of lane utilisation and be able report and justify the traffic flow lane distribution.

3.26 Where an intersection design is a modification of an existing intersection or a new intersection, the phase sequence should 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.

Traffic Network Analysis

3.27 Traffic modelling techniques shall be used to demonstrate that the traffic signals will be capable of being effectively coordinated with adjacent traffic signal controlled sites. Intersections included in the modelling provisions of the Contract Documents are required to be included in the modelling assessment of the base case models and project scenarios.

3.28 The traffic signal offsets data for the approved design scenario is to be included in the TSOPR.

3.29 Those intersections currently linked via SCATS® to the intersections affected by the project shall be included in the traffic network models.

3.30 New or modified intersections created as part of the project scenario shall be included in the network models.

3.31 The network analysis is to determine any adverse impacts of the project on traffic signal operation particularly the effects on the design of upstream queues. Where such impacts are evident, the design shall (as appropriate):

a) develop and assess alternative concepts and select a preferred concept for capacity improvements at the intersections and the interchange ramps; and

b) identify locations at which temporary capacity improvements may be required to cater for traffic diversions resulting from proposed full or partial road closures during construction.

Modelling Software Applications

SIDRA Intersection Analysis

3.32 SIDRA analysis shall be undertaken for all signal controlled intersections. The SIDRA analysis is to consider only the performance of individual intersections and not as a network assessment application. The SIDRA analysis shall confirm that the proposed traffic signal design and operation will satisfy the performance criteria.

3.33 The SIDRA modelling shall conform to the DPTI Traffic Modelling Guidelines – SIDRA 7.

3.34 In addition to the intersection requirements above the SIDRA analysis shall:

a) use the Site Level of Service Method as per the SIDRA "standard left" template;

b) calibrate saturation flows in the base model to reflect those experienced in existing traffic conditions. (SCATS® MF data which represents measured saturation flows in passenger car equivalent values are included in the SCATS® Summaries);

c) for new intersections, use default values from SIDRA modified to reflect intersection geometry, traffic composition, road environment, and grade; the basic adjusted saturation values produced by SIDRA shall be consistent with measured saturation flow values experienced at adjacent SCATS® sites;

d) where intersections are closely spaced, the "Full length lane" "Lane Length" parameter shall be equal to the measured storage space between intersections in order to accurately reflect upstream blocking effects;

e) incorporate pedestrian and cycle movements in the phasing at all sites, on all approaches, with phase times that reflect existing demands. Use the existing pedestrian demands in scenarios unless a significant change is predicted to future demands;

f) use the "User Given Phase times" in SIDRA to calibrate the base case models;

g) use the "user given cycle time" based on SCATS® SUMMARIES for optimising the green splits for future scenarios;

h) include in models downstream merges, the lane's length measured from the intersection to the start of the merge taper, before making manual adjustments to lane distributions;

i) adjust the heavy vehicle PCU/veh configuration factor, queue space and vehicle length parameters based on current heavy vehicle composition;

j) models of projected scenarios will assume the same PCU and queue values as existing traffic composition unless this is predicted to change; and

k) use the %age lane utilisation feature in SIDRA to calibrate the traffic flow lane distribution.

Network Modelling

3.35 The network modelling shall be undertaken by a modelling application used by DPTI, which currently includes: AIMSUN, LINSIG and TRANSYT.

3.36 Deterministic, modelling software, e.g. LINSIG or TRANSYT, shall be used for Optimising traffic signals.

3.37 TRANSYT may be used to analyse the network performance of traffic signal controlled intersections and the at grade elements of interchanges to produce optimised offsets, and phase sequences. The TRANSYT model shall be developed in accordance with the DPTI "Traffic Modelling Guidelines - TRANSYT 15".

3.38 LINSIG has similar functionalities to TRANSYT. Main Road WA "Operational Modelling Guidelines" Section 3, and Transport for New South Wales, Roads and Marine Services "Traffic Modelling Guidelines" provide some useful information on processing LINSIG models.

3.39 AIMSUN shall be used for assessing traffic impacts of freeways, transit facilities, level crossings, queue relocation features, and may be used to analyse complex intersections. Freeway impacts include weaving, merging and diverging behaviour.

3.40 AIMSUN models for network analysis shall be developed in accordance with the DPTI MATSAM Guidelines.

3.41 AIMSUN models shall be used in conjunction with other, deterministic, modelling software capable of optimising traffic signal phasing and offsets, e.g. LINSIG or TRANSYT.

3.42 In consideration of the predicted queuing effects, the model analysis using any of the network modelling software applications shall be consistent with the "SIDRA Intersection" analysis.

General Requirements for Traffic Modelling

3.43 Where RD-GM-D4 "Traffic Analysis and Modelling Requirements" has been included in the Contract, the provisions of that Part shall apply in respect of the Road Geometry assessment. Traffic analysis and modelling requirements of RD-GM-D4 "Traffic Analysis and Modelling Requirements" shall apply to modelling requirements for this Part, except that additional modelling scenarios may be required to model traffic signal options.

3.44 The Contractor shall be responsible for transport and traffic models developed for the purpose of assessing the traffic signals design including any systems or road geometry considerations.

3.45 Software applications to be used for traffic modelling require approval. Software applications shall be listed in the traffic model scoping document which will be included in the Design Basis Report (15% completion).

3.46 To ensure that the modelling is fit for purpose, the Contractor shall submit a "Traffic Model Scoping Document" which will include all aspects of the modelling requirements for approval before commencing modelling. Submission of the "Traffic Model Scoping Document" shall constitute a **Hold Point.**

3.47 The traffic model scoping document shall outline the modelling applications proposed to be used, and their intended purpose in determining the optimal design of the traffic signals, e.g. use of TRANSYT to provide signal offsets.

3.48 The Contractor shall, in all cases, provide a calibrated and validated base case model using existing traffic volumes. Base Case models shall reflect current circumstances. The output from the base case model shall be included in the Preliminary Design Report (30% completion). Provision of a Report on the Base Case Models, fully calibrated and validated shall constitute a **Hold Point**.

3.49 Proposed options shall be derived from the calibrated and validated base case models using Future year traffic volumes.

3.50 The scenarios to be tested will be fully documented in the traffic model scoping document to clarify the detailed modelling requirements.

3.51 Where intersections are specified to be included in the scope of models these intersections will be listed in the Contract Documents.

3.52 Where new intersections are developed as part of the project design, the Contractor is responsible for ensuring these are included in the models.

3.53 The Contractor is responsible for the comprehensive nature of the network models, including modelling uncontrolled intersections, to ensure that the effect of the project on the traffic signal controlled network can be adequately demonstrated.

3.54 The Contractor shall consider the effects on the models of intersections that operate on common and different cycle lengths owing to the SCATS® signal configuration. The implications of different cycle lengths shall be included in the traffic model scoping document.

3.55 In models, traffic signal controlled intersections shall use the TS number series to identify intersections. (TS numbers for new sites are provided by DPTI, Manager TMC.)

3.56 As part of the calibration, for consistency and to avoid confusion in model interpretation, the traffic signal site TS numbers, traffic signal group numbers, traffic signal phase labels and detector numbers shall be labelled in models to conform to DPTI conventions used in drawing S-6841, Sheets 1 and 2. Models should however use the same labels as the existing personalities for existing intersections in base case models.

3.57 Where object IDs in a model are numbered automatically, and cannot be changed to the DPTI conventions, the descriptive field of the object shall be completed to match the DPTI standards for labelling these features.

3.58 The traffic signals analysis shall include:

a) the base case model, fully calibrated and validated to reflect the existing traffic conditions, which is constructed from existing intersection geometry and operational parameters;

b) the model scenarios, which shall be created using the calibrated and validated base case;

c) an assessment of the impacts on intersection and network performance of proposed major temporary traffic arrangements, where these are to be adopted during the construction phase of a project;

d) analysis for all traffic signal arrangements, for major temporary traffic arrangements during construction; and

e) for existing sites, comparison of the current intersection performance with proposed scenarios.

3.59 The SCATS® Summaries and SCATS® Group System Links reports provided by DPTI shall be used to calibrate and validate base case models.

Heavy Vehicles and Buses

3.60 The design shall clearly show how the effect of heavy vehicles and buses on design flows and signal timings are taken into account. In particular, the design shall allow for the yellow and all red clearances for long vehicles required by the NTC Guidelines, Section 2.5 “Signalised Intersections”.

3.61 In deterministic models (SIDRA, TRANSYT and LINSIG) the passenger car equivalent values used to represent heavy vehicles and buses shall be calculated based on the existing vehicle composition.

3.62 The PCU values to use are based on the following equivalents:

Table RD-EL-D2 3-3 Standard Vehicle PCU and Length Values

Austroads Vehicle Type	Austroads Class	PCU Value	Average Vehicle Length (m)
Short < 5.5 m	1	1.0	5
Medium (short + trailer or Ridged) 5.5 m – 14.5 m	2-5	2.0	12
Long (articulated) 11.5 m – 19 m	6-9	3.0	19
Medium Combination 17.5 m - 36.5 m	10-11	4.0	26
Tram		3.5	20

Notes:

a) Refer to Austroads GTRD, Part 4, Table 5.1.

b) For vehicle “queue space”, add 2 m gap to the average vehicle length.

Modelling Information Supplied by DPTI

3.63 Information may be supplied to the Contractor including:

a) nominating the model application software to be used;

b) traffic volumes for base case and future year projections;

c) traffic flow characteristics, e.g. saturation flows;

d) traffic control operational data including signal phasing and timing (in the form of SCATS® Summaries and SCATS® Group Systems Links reports);

e) lists of intersections to be included in the models; and

f) existing model structures including native data files.

3.64 Where current traffic volumes and projected traffic design volumes are supplied as part of a specific contract, these are required to be used in models by the Contractor.

3.65 Although information may be provided in support of a Contract which is used in traffic models to determine the traffic signals design, the Contractor is responsible for ensuring that this information is complete, appropriate for use, fit for purpose, and up to date; and for the collection of any additional data required to support the development of the model.

3.66 Where DPTI has developed a model, it may be provided as part of a Contract to assist the Contractor in developing a model or models. Where a model is supplied as part of the Contract, it remains the Contractor's responsibility to update, augment, calibrate and validate the models.

3.67 Provision by the Principal of a previous traffic model does not remove the Contractor from the responsibility of updating, augmenting, calibrating and validating models.

4 Traffic Signal Design Report

4.1 A Traffic Signal Design Report shall be prepared, which details the following:

a) system description;

b) reference to all applicable standards and specifications;

c) details of design outputs from the Traffic Signals Operational Performance Report;

d) details of interfaces to existing or third party systems;

e) operational description, including phasing philosophy;

f) location of all equipment;

g) explanations for non-standard equipment locations;

h) controller input / output allocations;

i) signal group allocations;

j) detector input allocations;

k) power system, volt drop and fault loop impedance calculations;

l) details of all proposed construction materials;

m) construction designs for all equipment;

n) traffic signal hardware documentation;

o) specification for supply and installation of traffic signals;

p) design, procurement, installation, integration and commissioning program;

q) drawings showing the swept paths are capable of achieving the proposed design operation; and

r) all data collected in the course of developing the traffic signal design and related traffic models.

Drawings and Schedules

4.2 The design shall be documented in the following drawings and schedules:

a) traffic signal layout drawings;

b) turning path drawings to demonstrate clearances achieved;

c) signal conduit and pits layout drawings;

d) site wiring diagrams;

e) cable connection schedules, including the identification of spare cores shall be in accordance with master specification RD-EL-D3 "Conduit Design for Road Lighting, Traffic Signals and ITS";

f) hardware schedules;

g) traffic signal phasing plan; and

h) equipment drawings.

4.3 DPTI standard drawings for traffic signals and associated equipment shall be incorporated into the Issued for Construction (IFC) documents.

General Traffic Signal Design Requirements

4.4 The traffic signal design shall comply with the following:

a) the design shall facilitate compliance with, and be capable of delivering the requirements of the Master Specification RD-EL-C2 “Installation of Traffic Signals”;

b) the design phase arrangement and phase sequences shall be compatible with SCATS® operating requirements;

c) all right turn movements shall be fully controlled and separate right turn lanes provided;

d) the operational performance requirements documented in the TSOPR are achieved;

e) cater for all turn movements of the maximum size specified design vehicle;

f) the design of the turn movements is checked to ensure that adequate provision has been made to cater for all possible traffic signal phase arrangements and sequences;

g) use the traffic signal site TS numbers for drawings (new TS numbers are allocated by the Manager TMC) and included in the Preliminary Design Documentation (30% completion);

h) traffic signal group numbers, traffic signal phase labels, detector numbers and Post numbers shall be labelled on drawings to conform to DPTI conventions used in drawing S-6841 sheets 1 and 2;

i) the design of pedestrian activated crossings is in accordance with DPTI standard drawings:

   i) GD 704 “PAC Standard - No Median”;

   ii) GD 705 “PAC Standard Median up to 3m (solid or painted)”; and

   iii) GD 706 “PAC Standard Dual Carriage Way Raised Median more than 3m”.

j) the pedestrian push button orientation is shown in S-4074 Kerb Ramps for Signalised Locations shall apply;

k) pedestrian displays are incorporated in the phasing at all sites except where there is no demand demonstrated by the design process, or at “T” intersections following the standard arrangement;

l) provision of vehicle and pedestrian detection is included at all signalised intersections;

m) a vehicle stop line detector is required for every discrete traffic lane at an intersection, including left turn lanes which are not controlled by a signal group. The loops in left turn lanes, not controlled, will be used for counting vehicles and must be functional;

n) provide queue detectors at intersections and level crossings where blocking back is anticipated from upstream intersections or level crossings;

o) the design is documented in accordance with the Design Presentation – Construction Drawings DP011 - Traffic Signals;

p) where an intersection is large (i.e. requiring 14 signal groups or more, and / or more than 22 detectors), the design shall assume the provision of a single controller capable of controlling 32 signal groups and 48 detectors (VC6 personality), and document this in the traffic signal design report; and

q) drawings are to document separate ducting for connecting conductive loop detection, and low voltage / extra low voltage cabling to the traffic signal lanterns and auxiliary equipment, e.g. push buttons.

Turn Movements

4.5 All turning paths shall cater for the type and size of the design vehicle and check vehicle. Design vehicle turning paths shall be applied in designing the most effective phasing for the intersections and the physical intersection arrangement to maximise the traffic throughput. The design vehicle requirements is as described in RD-GM-D1 “Road Design” or as provided for in the Contract Documents.

4.6 Swept paths for right turns, including double lanes, shall ensure a minimum clearance of 2 m to opposing right turn swept paths (i.e. left side of vehicle to left side of vehicle). For new designs, assume right turns from opposing directions will be operated simultaneously.

4.7 Right turn lanes and left turn lanes shall be designed with turn bays. Turn bays are to be provided with sufficient length to accommodate predicted queues and deceleration to the back of queue from the adjacent lane. Turn bays are considered to be of sufficient length when the storage length will accommodate 95%ile demand. Through lane and short lane queue interaction is not permitted.

4.8 The deceleration length of a turn bay is to be provided in addition to the storage length.

4.9 Filter right turning movements are not permitted for new signal installations or where the intersection geometry is modified. This is to be reflected in the modelling of intersections and their design.

4.10 The design vehicles adopted for double right and left turns shall provide for simultaneous movements of the design vehicle and an 8.8 m service vehicle, with the service vehicle using the right hand lane of the approach.

4.11 Where 3 simultaneous turns are provided for left and right turns, the design vehicles shall comprise the specified design vehicle for the left hand lane, a ridged 14.5 m (equivalent to a bus) in the centre lane, and an 8.8 m Service vehicle in the right hand lane of the approach.

4.12 The design of left turns at unsignalised intersections and high entry angle left turn slip lanes may allow the design vehicle to encroach on the second lane of a multi-lane carriageway, where it can be demonstrated that:

a) the manoeuvre is a legal movement for the design vehicle; and

b) current access conditions are maintained.

4.13 Notwithstanding the requirements of the design vehicle and check vehicle, the design should provide accommodation for existing road use, access and routing, e.g. use of local roads by19 m articulated buses.

Design Vehicle

4.14 The design vehicle, unless otherwise specified in master specification or in the Contract Documents:

a) for Urban Arterial Roads, shall comprise a 19 m Single unit Articulated Truck, and the check vehicle shall comprise a B-Double (26 m) combination; and

b) for National Highways and Major Rural Roads, shall comprise a B-Double (26 m) and the check vehicle shall comprise a performance based B-Triple level 3A (36.5 m).

4.15 The B-Triple as a design vehicle shall be in accordance with the National Transport Council standards. B-Triple PBS L3A specification that is deemed to satisfy level 3 Performance based specification requirements with an overall maximum length of 36.5 m.

4.16 The Contractor shall provide drawings and transport modelling to demonstrate the road design can accommodate the design vehicle and check vehicle. Design and check vehicle templates shall be applied in accordance with GTRD Part 4 “Intersections and crossings - General” for standard vehicles design and checking design, unless specified otherwise.

4.17 The road design shall accommodate the design vehicle within marked lanes. Swept paths shall include a 0.5 m clearance to kerbs, pavement edge lines; and centre of pavement lines on two-way roads. The minimum turning radii used in the determination of a design vehicle or checking design vehicle shall be not less than the recommended turning radii in Austroads GTRD Part 4 “Intersections and crossings - General” for those specific types of vehicles.

4.18 The design of all roads shall allow for the design vehicle, including accommodation of vehicle swept paths, for all through lanes, turning lanes, deceleration lanes and intersections.

4.19 The design shall make allowance for over-dimensional / over-mass vehicles as per DPTI Over-Dimensional Route Network as detailed in the DPTI Heavy Vehicle Access Framework.

5 Traffic Management during Construction

5.1 Traffic modelling is required to be prepared by the Contractor to analyse the impacts of Major temporary traffic arrangements and restrictions during the various construction stages.

5.2 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.

5.3 The impacts on the performance of traffic signal controlled intersections and network of proposed major temporary traffic arrangements shall be assessed.

5.4 A construction stage traffic model used to assess proposed traffic signal requirements for Major temporary traffic arrangements shall be submitted for approval by the Principal. Major temporary Traffic arrangement proposals should be approved prior to the completion of Final Design Documentation (100% completion) and Issued for Acceptance certificates.

5.5 All traffic signals analysis for Major temporary traffic arrangements shall be fully documented in reviews of the TSOPR.

6 Traffic Signal Hardware

6.1 All traffic signals and associated equipment included in the Final design and IFA shall comply with the requirements of Master Specification RD-EL-C2 “Installation of Traffic Signals”.

Approved Products

6.2 Where the Contractor has assumed specific propriety products shall be used these shall be listed in the Traffic Signal Design Report.

6.3 Traffic Signal equipment products shall be of a type approved by DPTI or submitted for approval. (Note: The supply of a list of traffic signal products constitutes a **Hold Point** in the Issued For Construction (IFC) Contract.)

Traffic Signal Hardware Documentation Requirements

6.4 Where the Traffic Signal hardware requirements are known they shall be documented in the Traffic Signal Design Report, including:

a) traffic signal site number;

b) Telstra PSTN and port service numbers;

c) 3G/4G mobile number;

d) fibre optic and switch details (applicable for connecting directly to the DPTI ITS network); and

e) confirmation of site specific parameters.

Traffic Signal Operating Voltage

6.5 Traffic Signal Design shall incorporate extra low voltage (ELV) traffic signal controllers, and associated equipment.

Traffic Signal Lanterns

6.6 At new traffic signal sites, all traffic signal lanterns shall be the 42 Volt Extra Low Voltage (ELV) Light Emitting Diode (LED) type, compliant with AS 2144.

6.7 Where additional lanterns are to be provided at an existing traffic signal site, they shall be of the LED type of same Voltage (LV or ELV) as the existing lanterns, and compliant with AS2144.

6.8 200 mm or 300 mm aspects and shall be provided in accordance with DPTI Operational Instruction 14.2 “Traffic Signal Faces”.

Location of Signal Equipment and Signal Face Layouts and Display Sequences

6.9 The arrangement of traffic signal faces shall be in accordance with DPTI: Operational Instruction 14.2 “Traffic Signal Faces”.

Traffic Signal Controller

6.10 All new traffic signal controllers shall conform to Transport for New South Wales Road and Marine Services, NSW specification No.TSI-SP-069 and be approved by DPTI.

6.11 The location of the traffic signal controller shall be determined and documented as part of the design using the following criteria:

a) minimisation of obstruction to pedestrians;

b) minimisation of visual obstruction to drivers;

c) minimisation of the risk of accidental damage by traffic;

d) provision of safe and easy access for maintenance personnel and associated vehicles;

e) permit maintenance staff to have a clear view of the whole of the intersection from the controller as far as is practicable;

f) orientation so that the cabinet door(s) open away from the centre of the intersection; and

g) close location to the power supply and telecommunications service.

CCTV Cameras

6.12 CCTV shall be designed for new traffic signal controlled intersections, and its location is to be approved by the Principal. (The Manager TMC will be consulted.) The locations for CCTV shall be determined and included in the Preliminary Design Documents (30% completion).

6.13 CCTV shall be provided at level crossings located within the scope of the project. Where CCTV is provided at level crossings, the equipment shall be integrated with traffic signal control equipment, unless the installation is to be provided in a separate cabinet.

6.14 CCTV equipment shall also be specified as part of the ITS component of the design of a project.

6.15 CCTV shall also be included to provide coverage at approaches to level crossings where queue relocation management strategies are required to prevent queuing over the level crossing. The video surveillance system for level crossing queue relocation shall be incorporated in the traffic signal controller hardware.

6.16 Where CCTV equipment is required to be installed at intersections, the roadside equipment shall be housed in an extension housing attached to the top of the traffic signal controller cabinet and is therefore required to be documented in the Traffic Signal Design Report.

6.17 CCTV equipment products shall be of a type approved by DPTI. The Contractor shall submit alternative equipment for the approval of the Principal (Manager TMC). (Approval of CCTV products constitutes a **Hold Point** in the IFC Contract.)

Programming Of Traffic Signal Controller(s)

6.18 The Programmable Controller Personality Module (PCPM) contains the personality for the controller.

6.19 Eight (8) weeks’ notice is required by DPTI Traffic Management Centre for programming the controller after formal approval of the traffic signal arrangement drawings. The Contractor needs to be aware of this time constraint in processing the Design Documents, including all reports, TSOPR and drawings.

6.20 The Traffic Signals Design Report shall be approval by the Principal. The Traffic Signals Design Report and traffic signals drawings shall be submitted in the Detailed Design Documentation Stage (70% completion) to enable approval of the traffic signals as traffic control devices. Programming the

controller(s) cannot proceed without approved drawings. Provision of the Traffic Signal Design Report shall constitute a **Hold Point**.

Uninterrupted Power Supply

6.21 Uninterrupted Power Supply (UPS) shall be designed for new traffic signal controlled intersections, and is to be approved by the Principal. (The Manager TMC will be consulted.) The design for UPS shall be included in the Preliminary Design Documents (30% completion).

6.22 UPS equipment products shall be type approved by DPTI.

Provision of Telecommunications for SCATS®

6.23 All traffic signal controllers shall be connected to SCATS® via a DPTI approved method which shall involve a connection directly to the DPTI fibre optic cable network, or a combination of 3G/4G and ADSL service.

6.24 Traffic signals require a fibre optic connection to the DPTI network for both the traffic signals communications and the CCTV link to the TMC. An alternative communications path will generally only be considered if this is considered impractical for logistical reasons.

6.25 The form of the connection is subject to approval by DPTI. The communications path and associated cable and connection products shall be documented. The supply of this product information constitutes a **Hold Point** in the IFC contract.

Bluetooth Capture Stations

6.26 The Contractor shall provide for the installation, testing and commissioning of Bluetooth Capture Stations within all new traffic signal controller cabinets.

6.27 The design and equipment, including the antenna, for the traffic signal controller installation shall be as specified in RD-ITS-D1 “Design of Intelligent Transport Systems” and RD-EL-C2 “Installation of Traffic Signals”.

Vehicle Detection

6.28 The Contractor shall document the location of all loop detectors.

6.29 Loops shall be as detailed on DPTI Drawing No. S-4500 sheets 1 and 2. Other loops shall be arranged appropriate to their function.

6.30 Vehicle stop line type detectors suitable for SCATS® operations shall be provided for all lanes irrespective of the control function. Loops on non-controlled lanes, e.g. left turn lanes, shall be provided and connected to traffic controllers.

6.31 Advanced detectors shall be considered on approaches with speed limits 80 km/h and over. The location of the detector relative to the stop line approach is to be calculated on the basis of the design speeds and shall consider the approach gradient. Advanced loops shall be located in accordance with the DPTI design template (ADVDET.xls).

6.32 Alternative technologies to loop detection may be considered providing they are compatible with SCATS® operation.

6.33 Where queue detectors are required, they shall be fully documented in the Detailed Design Report (70% completion). Their position within the lane shall be in accordance with RD-EL-C2 “Installation of Traffic Signals”.

Pedestrian and Bicycle Detection and Control

6.34 Push buttons provided for this purpose shall be a product type approved by DPTI.

6.35 All pedestrian movements shall be demand actuated by audio tactile pedestrian push buttons.

6.36 Pedestrian push buttons shall:

a) be orientated so that the face of the push button is in line with or parallel to the crosswalk marking, and be clearly documented on the drawings (typical orientation is as shown on standards drawing S-4074 Kerb Ramps for Signalised Locations);

b) incorporate arrow legends (in the audio tactile display) on all pedestrian push buttons;

c) incorporate legends and buttons correctly oriented to guide visually impaired pedestrians in the same direction indicated by cross walk markings;

d) be provided on median traffic islands; and

e) only have one audio tactile pedestrian push button located on a post. (More than one audio tactile signal can cause confusion to pedestrians.)

6.37 Microwave pedestrian sensors are to be provided where pedestrian displays are controlling marked foot crossings 15 m and longer to facilitate pedestrian extensions of times.

6.38 Microwave sensors may also be required to record demands from pedestrians waiting on the footpath. The site locations to be provided with this form of detection will be included in the Contract Documents. Where sites are included all the pedestrian crosswalks associated with the site are to be equipped.

6.39 Cycle push buttons shall be provided on side road approaches and at locations where extended minimum green clearance is required, e.g. for roads >30 m wide. Cycle Push button faces are to be parallel to the kerb and positioned adjacent to the road carriageway within reach of a cyclist stopped at the stop line.

6.40 Where a cycle lane is created between marked vehicle lanes, in-ground stop line loop detection shall be provided.

6.41 Where a “stand-up” cycle area is created between the cycle stop line and a stop line for general traffic, in-ground loop detection shall be provided.

6.42 Cycle signal groups requiring additional signal faces / aspects may be required to control cyclists at locations with potentially long clearance times, i.e. all red periods. The Contractor shall consider the special needs of cyclists in relation to long clearance times, including alternative options to reduce the consequential delays to both cyclists and general motor vehicles.

Level Crossings

6.43 Interlocking between level crossings and adjacent traffic signal installations shall be provided with a hard-wired connection.

6.44 Four standard inputs are to be provided via the hard wire connection and these shall be documented in the Traffic Signal Design Report.

6.45 Level crossings are considered adjacent to traffic signals where the traffic signals could be interpreted to conflict with the level crossing wigwag signs or where the level crossing is expected to create queues across the intersection, or vice versa. There shall be a cable link provided in duct between the level crossing controller and the traffic controller, which will enable the traffic signal controller to be forced to a "safe" state before the level crossing closes to permit the passage of a train.

6.46 Queue relocation signals may be required which are controlled independently from the adjacent intersections separate controller. The Q relocation signal controller will also be required to be connected to the level crossing in a similar fashion.

6.47 The provision of equipment for level crossings and the method of control is subject to approval of DPTI (Manager TMC) and the respective rail authority.

Traffic Signal Posts

6.48 The location of traffic signal posts shall take into account site constraints such as services and roadside furniture. The post location(s) shall ensure that the signals can be sited where they can be clearly seen by approaching drivers. (Refer to DPTI: Operational Instruction 14.2 “Traffic Signal Faces”.) Notwithstanding the above, care shall be taken not to locate posts in locations where

lanterns, including backing boards and visors, are likely to be struck by vehicles following a conventional turning path, or where long vehicles may mount the kerb while negotiating a turn.

6.49 The Contractor is responsible for ensuring the post locations are achievable without compromising the driver's visibility of all the signal aspects, or safe clearances. Primary lanterns are to be located in line with, or downstream of, the stop line.

6.50 Traffic signal posts shall not be located within painted medians / islands, i.e. where there are no kerbed islands or there is an area physically raised from the road, which is designed only to discourage overrunning by large vehicles.

6.51 Wherever possible, combination posts comprising road lighting and / or mast arms shall be used to minimise the number of signal posts. Where a site is specified to be ELV operation and low voltage (LV) road lighting is used, appropriate electrical segregation shall be maintained between the two systems.

6.52 Where combination posts are to be incorporated into the traffic signal design consideration shall be given to source of the energy supply for the street lighting. Provision of this type of post is not to compromise the design of either the street lighting or the traffic signals.

6.53 The provision of road lighting is not to compromise the safe location and distribution of traffic signal posts. Traffic signal posts are to be located for optimal design. Where the signal post location is also a suitable location for a road lighting post then combining of the functions on a common post shall be considered.

Pavement Markings

6.54 The provisions of the DPTI: Pavement Marking Manual shall apply to traffic signals.

Signs

6.55 Regulatory signs associated with traffic signals included in the Contract are to comply with the following requirements.

6.56 Non-illuminated regulatory signs should not be used in place of illuminated signs on traffic signal posts.

6.57 Where regulatory signs (e.g. No Left Turn / No Right Turn) are to be provided for part time regulation, a symbolic internally illuminated sign shall be provided at a stop line post and a secondary (or tertiary) post.

6.58 Sign equipment shall be approved by DPTI.

6.59 Signs shall be equipped with fault monitoring, and report faults back to the signal controller and TMC.

7 Hold Points

7.1 The following is a summary of Hold Points referenced in this Part:

Document Ref.	Hold Point	Response Time
2.23	Provision of the Traffic Signals Operational Performance Report	15 working days
3.46	Provision of the Traffic Model Scoping Document	10 working days
3.48	Provision of a Report on the Base Case Models, fully calibrated and validated	10 working days
6.3	Provision of a list of traffic signal products.	
6.17	Approval of CCTV products.	
6.20	Provision of the Traffic Signal Design Report	15 working days
6.25	Provision of product information for communications path and associated cable and connection products.	
???	Provision of each major temporary traffic arrangement Model assessment.	10 working days
???	Approval of equipment to be used for traffic signals.	10 working days

Notes:

a) The Contractor is responsible for ensuring that the traffic signals, which are Traffic Control Devices (TCDs), are properly approved by DPTI (Manager TMC) prior to applying for controller programming. Provision of Approved drawings, TSOPR and Traffic Signals Design Report.

b) The Contractor shall be responsible for ensuring that provision is made in construction documents for the supply of a cable connection chart. The cable connection chart is to be approved by the Principal.

8 Periods of Notice

8.1 The following periods of notice are required:

a) 15 working days' (three weeks) notice is required for the approval of traffic control devices which include traffic signals. (Traffic Control Devices (TCDs) require approval pursuant to the Road Traffic Act 1961 (SA).)

b) 8 weeks' notice is required prior to switching on new traffic signals, or changing the personality(s) in existing traffic signals.

8.2 Note the above two periods of notice are consecutive not concurrent, i.e. eleven weeks overall.