A12 Chelmsford to A120 widening scheme

TR010060

7.2 Transport Assessment

Appendix E: Junction Modelling Technical Notes – Overarching Vissim Modelling Methodology

APFP Regulation 5(2)(q)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 7

August 2022

Infrastructure Planning

Planning Act 2008

A12 Chelmsford to A120 widening scheme

Development Consent Order 202[]

7.2 TRANSPORT ASSESSMENT

APPENDIX E: JUNCTION MODELLING TECHNICAL NOTES – OVERARCHING VISSIM MODELLING METHODOLOGY

Regulation Reference	Regulation 5(2)(q)
Planning Inspectorate Scheme Reference	TR010060
Application Document Reference	TR010060/APP/7.2
Author	A12 Project Team, National Highways

Version	**Date**	**Status of Version**
Rev 1	August 2022	DCO Application

CONTENTS

E.1. Junction Modelling Technical Notes – Overarching Vissim Modelling Methodology

E.1.1 Introduction

Overview

As part of the A12 Chelmsford to A120 widening project, Vissim microsimulation models have been created to assess the operational performance of junctions. Junctions have been assessed under a variety of scenarios, such as:

- Current operation (2019);
- Future operation with construction (2025);
- Future operation without scheme (opening year 2027/ design year 2042); and
- Future operation with scheme (opening year 2027/ design year 2042).

This technical note provides details of the modelling approach adopted in the set-up of all the Vissim modelling undertaken for this project. It also includes details of how results have been output from the models and processed, as well as a note on the internal checking process carried out.

The models for this project have been developed using PTV Vissim 2020-08.

E.1.2 Model Development

Simulation Parameters and Model Units

Traffic regulation is set as left-side traffic.

AM and PM peak hours have been modelled for all scenarios, in a few instances, an IP period has also been modelled. The peak hours modelled match those in the strategic Saturn model, and are as follows:

- AM peak – 07:30 to 08:30
- IP average hour 10:00 – 16:00
- PM peak – 17:00 to 18:00

The model simulation period is set to one hour 15 minutes in total. This consists of a one hour peak period as shown above and a 15-minute 'warm-up' period used to populate the network with traffic prior to the evaluation periods. It was decided that a 'cool-down' period would not be required for this study. The demand used in the 15-minute warm-up period is a quarter of the peak hour demand.

Analysis of traffic data showed that the level of demand in the 15 minutes prior to the peak period was 97% in the AM and 99% in the PM. Based on this analysis, it was considered a robust approach to simply use the peak hour level of demand in the warm-up period

Simulation resolution is set to five time steps per simulation second.

Model units used: speed mph & m/s, distance km / m, acceleration m/s^2.

Static routing assignment has been used in all Vissim models.

Network Development

The network structure for the 2019 base models has been developed using the default Bing maps which can be accessed directly through Vissim. The new proposed model networks have been created by importing and scaling a background image showing the design being presented at DCO. The design layouts included details required to develop the network, such as road width, number of lanes, lane allocations, junction geometries and position of signal heads.

Vehicle Compositions

Three vehicle types have been defined as part of the modelling, they are Car, Heavy Goods Vehicles (HGVs) and buses.

Construction vehicles have been input into the model using Car and HGV vehicle types, but labelled as separate vehicle compositions, ie “Car Construction”.

Vissim default settings for vehicle characteristics have been used. This includes maximum/minimum acceleration and standard weight and power distributions. The construction vehicle compositions have the same characteristics as the default car and HGV vehicle types.

Driving Behaviour

Driving behaviours, which are applied to the links in the model, affect how vehicles use the network and interact with other vehicles. The following driving behaviours were included and used the models:

1: Urban (motorized) - this driving behaviour type is as per the default Vissim set with the exception that the parameter ‘behaviour at red/amber signal’ has been changed from its default of ‘go (same as green)’ to ‘stop (same as red)’.

Four additional Driving Behaviours were added to the default Vissim template for this project:

104: Motorway – This driving behaviour is similar to the PTV default **3: Freeway (free lane selection)** but with the following changes:

- *Following: Number of interaction objects* is set to 4 (as opposed to 2)
- *Car Following Model: CC2 Following Variation* is set to 2.5m (as opposed to 4m)
- *Lane Change: Advanced merging* and *Cooperative lane change* are selected

105: Motorway Merge – This driving behaviour is similar to **104: Motorway** but with the following changes:

- *Car Following Model: CC0 Standstill Distance* is set to 2m (as opposed to 1.5m)
- *Car Following Model: CC1 Headway Time* is set to 0.5s (as opposde to 0.9s)
- *Car Following Model: CC2 Following Variation* is set to 4m (as opposed to 2.5m)
- *Lane Change: Accepted Deceleration* is set to -1.5 m/s^2 (as opposed to -0.5m/s^2)
- *Lane Change: Safety distance reduction factor* is set to 0.35 (as opposed to 0.6)
- *Lane Change: Maximum deceleration for cooperative* braking is set to -9m/s^2 (as opposed to -3m/s^2)

106: Motorway Diverge – This driving behaviour is similar to **104: Motorway** but with the following changes:

- *Car Following Model: CC0 Standstill Distance* is set to 2m (as opposed to 1.5m)
- *Car Following Model: CC6 Speed dependency of Oscillation* is set to 10 (as opposed to 11.44)
- *Lane Change: -1m/s^2 per distance* is set to 100m (as opposed to 200m)
- *Lane Change: Accepted Deceleration* is set to -1 m/s^2 (as opposed to -0.5m/s^2)
- *Lane Change: Cooperative lane change* is not selected

201: Urban Merge – This driving behaviour was added to enable quicker and more efficient lane changing behaviour. This driving behaviour is being used in locations where there is a lane drop exiting a junction and traffic is required to merge. The parameters for this behaviour type were taken

from the example provided by PTV: *"Examples Training\Merging & Weaving\Inside Merge"*. This parameter is similar to **1: Urban (motorized)** but with the following changes:

- *Lane Change: Safety distance reduction factor* is set to 0.3 (as opposed to 0.6)
- *Lane Change: Cooperative lane change* is selected
- *Lateral: Observe adjacent lane(s)* is selected

Speed Distributions

Desired speeds are coded into Vissim models to reflect the expected speed of vehicles along any particular link. A set of desired speed distributions have been created based on *Department for Transport (DfT) data - Table SPE0111: Free flow vehicle speeds by road type and vehicle type in Great Britain*.

The speed distribution profiles within the models are based on 2019 data with the exception of the "40mph urban" speed distribution which is based on the latest data from 2006.

Additionally, speed distributions have been input for various turning radii and approaches to stoplines and giveway junctions.

Reduced speed areas (RSAs) have been used in the models where vehicle speeds are likely to be lower than the desired speed ie, vehicles travelling round a bend, on the approach to stop lines and other points of potential conflict.

At the approach to roundabouts, desired speed decision points have also been added, to replicate drivers reducing their speeds while going around roundabouts.

Priority Rules

Priority rules have been used throughout the models where it's been necessary to replicate give-way junctions and yellow boxes. Where a base model has been developed, priority rule parameters have been adjusted as part of the calibration process, these have then remained the same for future year scenarios. In scenarios where no corresponding base model has been created, Vissim guidance on gap time and headway parameters has been used. For the dumbbell roundabouts within the models, in general a gap time of 1.8 – 2.6 seconds has been used for cars, and 3.6 seconds for HGVs.

Priority rules have been carefully adjusted to avoid conflict between vehicles.

Signal Controllers

As part of the proposed scheme, several of the new junctions are signalised or partially signalised.

Traffic signals within the models have been modelled as fixed-time controllers which mean they follow a set timed cycle. Given the flexibility that was required during the design stages of the project and the assessment iterations between the Highway design team and the junction modelling team, it was deemed that fixed signal timings would be more efficient in terms of providing a quicker approach to configuring and assessing the effectiveness of signals as part of a junction scheme. Design ideas for assessment in Vissim changed frequently during the first twelve months of the project, consisting of minor and major changes as the traffic demand was developed in SATURN, and fixed time control allowed for a more seamless approach to assessing the high-level effectiveness of signals as part of the A12 scheme.

It is envisaged that when the A12 scheme is constructed, it is highly likely that Microprocessor Optimised Vehicle Actuation (MOVA) control would be used at the A12 junctions which will have signal control. This method of control allows signal timings to be adjusted every single cycle time based upon actual traffic demand and changing traffic flows patterns, leading to improved efficiency and capacity.

Given the modelling milestones that were identified in the project programme, timescales/budgets did not allow for MOVA datasets to be developed and assessed for the A12 junctions. Therefore, fixed-time signals are considered a robust approach given the demands from the project.

Traffic Demand

A strategic traffic model has been developed for the appraisal of the proposed scheme using industry standard SATURN software, further details can be found in the ComMA. The outputs from that traffic model have been used as inputs into the Vissim modelling.

Actual flow in vehicles was extracted from the core scenario models by cordoning the strategic Saturn model to match the Vissim-modelled area. O-D matrices representing Total and HGV traffic flows were processed and input into the Vissim models using vehicle inputs and vehicle routing. Traffic flows have been included for all movements at the junctions.

Public Transport

Bus routes and bus stops have been included in the Vissim models. Data showing timings of bus services was extracted from public transport provider timetables for the modelled periods.

No on site data was collected to inform how long buses stopped at stops, so an assumption was made that buses stop at every stop for 20 seconds dwell time. It is assumed that bus routes and frequencies remain the same for future year scenarios.

Calibration and Validation of Base Models

2019 base year Vissim models have been created for two junction models: Maldon Road / The Street junction in Hatfield Peverel and A12 junction 25. Observed traffic flow data and journey time data have been used to calibrate and validate the models to meet TAG criteria. The Technical Note appendices for each of these junction models detail the development of their base year models.

Model Checks

An internal check of all models has been carried out using TfL's VMAP (Vissim Model Audit Process) guide. An example of VMAP 2a – Skeleton Model, VMAP 2b – Calibration and VMAP 3 – Validation is given in Annex A.

E.1.3 Model Outputs and Presentation of Results

Simulation Runs and Warnings

All models have been run for ten simulation runs, with an increment of ten between each random seed. Results from each simulation run have been checked.

All warnings and errors produced by Vissim have been recorded. Issues, such as a significant number of vehicles leaving the network have tried to be resolved; any remaining significant issues will be reported on.

For simulations where not all vehicles were loaded into the model, the number of vehicles remaining will be reported.

Presentation of Results

Results presented include a Level of Service (LOS) category for each arm as well as for the junction as a whole. The level service is based on average vehicle delay and can be used as a guide for how well the junction operates. Table 3-1 shows the bands used in the LOS calculation:

Table 3-1 LOS Categories

LOS	Signalised junction Delay (s/veh)	Priority controlled junction Delay (s/veh)	Description of traffic operation
A	≤10 sec	≤10 sec	Highly stable, free-flow condition with little or no congestion.
B	10–20 sec	10–15 sec	Stable, free-flow condition with little congestion.
C	20–35 sec	15–25 sec	Stable flow condition, with moderate congestion.
D	35–55 sec	25–35 sec	Less stable Approaching unstable condition with increasing congestion.
E	55–80 sec	35–50 sec	Unstable flow condition, volume at or slightly over capacity, considerable delays.
F	>80 sec	>50 sec	Forced flow condition, volumes exceed capacity; long delays with stop-and-go traffic.

Queue results have been collected from the models in five minute intervals. Results presented for each model show the average queue length for the peak hour model, as well as the average of the maximum queue length output every five minutes. These results should fairly represent the average queue which can be expected by a vehicle approaching the junction, and also the likely maximum queue.

E.1.4 Annex A

VMAP 2a – Skeleton Model

Question	Pass / Fail	Sub Questions
V201 Technical Note		**Is the following Included**
		Scope and Purpose of the Model
		Extent of the Modelling area
		Variation and justification of changed default parameters
		Sources of data used
		Traffic assignment method used (Dynamic requires strong justification)
		Any other modelling assumptions that will impact on model development
V202 Simulation Parameters		**Is the following correct**
		Traffic regulation (left side)
		Simulation resolution (4+)
V203 Model Units		**Is the following correct**
		Distance (M and KM)
		Speed (mph recommended)
		Acceleration (m/s)
V204 Background		**Is the following correct**
		Resolution
		Up to date
		Not skewed
		Scaled correctly
V205 Functions (acceleration parameters)		**Is the following correct (should use DTO measured parameters)**
		Justification for any changes to the maximum and desired acceleration / deceleration profiles
V206 Desired Speed Distributions		**Is the following correct**
		Different speed limits in the model area
		Different vehicle types: Ped / Light Vehs / Buses / HGVs / Cyclists
		A range of reduced speeds for turning radii
		A range of reduced speeds for sat flow calibration

Question	Pass / Fail	Sub Questions
V207 Vehicle Data		**Is the following correct**
		Vehicle Model - correct 3D models
		Vehicle Type: Category / Model / Accerlation Profiles / Colours
		Vehicles Classes
V208 Driving Behaviour		**Is the following correct**
		Look Ahead Distance
		Observed Vehicles
		Look Back Distance
		Standstill Distance (1m - 1.2m)
		Additive and multiplic parts of safety distance - 2 & 3
		Lane Change
		Lateral Driving Behaviour (should be default unless overtaking on the same lane is allowed
		Signal Control
V209 Link Types		**Is the following correct**
		Are the default link types there
		Do they match the correct driving behaviour
V210 Route Assignment choice		**Is the following correct**
		Is it static or dynamic. Dynamic requires justification
V211 Network Structure		**Is the following correct**
		Number of link lanes
		Link Lengths
		Lane Utilisation
		Bus Lanes and Lane Closures
		Pedestrian and Cycle links
		Flares
		Connector movements
		Lane to Lane structure
		Connector Lengths

Question	Pass / Fail	Sub Questions
		Connector closures
V212 Other Modelling Issues		**Are there any other Issues**
Overall Pass Fail:		

VMAP 2b – Calibration

Question	Pass / Fail	Sub Questions
V221: Technical Note received		**Is the following Included**
		Purpose of the model
		Modelled time periods
		List of TFL Nodes
		Clear notes of on site obs
		Datasheet with measured Sat Flow
		Derivation of Signal Timings (FT or SCOOT)
		List of all changes made to Skeleton model with justifications
		Sources of data
		List of assumptions with justifications
		List of parameter changes with justifications
V222: Traffic Data		**Is the following correct**
		Simulation start time
		Simulation period (warm-up, modelled peak, cool-down)
		Traffic compositions
		Vehicle Types and associated speed distributions
		Vehicle Inputs look reasonable
		Vehicle Input 15 minute profiles
		Routing decisions and distributions
		Has SATURN been validated against survey data
		Are Cyclists Included
		Does SATURN routing look sensible

Question	Pass / Fail	Sub Questions
		Routing decision sufficiently upstream of junction
		At least one routing decision per vehicle input
		Routing decision specified by vehicle type
		Correct Link connector sequence for routes
V223: Public Transport		**Is the following correct**
		Bus routes
		Bus lanes (including operational hours)
		Bus frequencies
		Bus route offsets
		Bus dwell time distributions
		Bus stops and stands
		Interference with traffic
V224: Signal Data		**Is the following correct**
		Controllers Configurations
		2 sec Red Amber period is modelled correctly
		Cycle Times
		Pulse Points
		Stage Durations
		Interstage Design
		Phase Intergreens
		Phase Delays
		Demand Dependent stages and stage frequencies
		Offsets
		Bus Priority
		Signal head positions (should be on link 2m + from start / end)
		Has VAP been used
V225: Priority Rules & Conflict areas		**Is the following correct**
		Position of red yield markers
		Priority between different streams of traffic

Question	Pass / Fail	Sub Questions
		Operation of priority rules & conflict areas
		Headways (Time and Distance)
		Conflict area parameters
		Yellow Boxes
V226: Reduced Speed Areas		**Is the following correct**
		Lower speeds used for turning movements where appropriate
		Localised changes in speeds due to network geometry
		Localised changes in speeds due to driver psychology
		Calibrate saturation flows at junction stoplines
V227: Link Connector Structure / Network Operation		**Is the following correct**
		Network Changes from the approved VMAP 2a model
		Lane utilisation
		Flare utilisation
		Merging and diverging
		Exit blocking
		Bottlenecks in the network
		Queuing
		Lane change behaviour
		Overtaking
V228: Other Modelling Issues		**Are there any other Issues**
Overall Pass Fail:		

VMAP 3 – Validation

Question	Pass / Fail	Sub Questions
V301: Validation Report		**Is the following Included**
		Is there a validation report
		Details on when traffic surveys were done and by whom
		Demand dependency calculations

Question	Pass / Fail	Sub Questions
		Evidence of validation
		Flare usage observed on site
		Flashing amber usage at pelicans
		Queue lengths
		Bottlenecks
		Detail on parking / loading
		Detail on give ways
		Detail on exit blocking observed
V302 Model adjustments		**Is the following correct**
		V202 Simulation parameters
		V203 Model Units
		V204 Background
		V205 Functions
		V206 Desired Speed Distributions
		V207 Vehicle Data
		V208 Driving Behaviour
		V209 Link Types
		V210 Route Assignment choice
		V211 Network Structure
		V222: Traffic Data
		V223: Public Transport
		V224: Signal Data
		V225: Priority Rules & Conflict areas
		V226: Reduced Speed Areas
		V227: Link Connector Structure / Network Operation
V303: Saturation Flows / Degree of Saturation		**Is the following correct**
		Have Saturation flows been measured
		Have DOS been measured
		Are they all within 10%

Question	Pass / Fail	Sub Questions
V304 Vehicle Capacity and traffic flow comparison		**Is the following correct**
		Is there evidence of model vs street flow comparison
		Are entry flows within 5%
		Has GEH been used
		Are GEH values less than 5 on all links
		Are GEH values less than 3 on major links
V305 Queue Length Analysis		**Is the following correct**
		Have queues been used as a validation criteria
		Do queues look appropriate
V306 Journey Time Comparison		**Is the following correct**
		Have a Min of 10 runs been used
		Have 300 to 600m "blocks" been used
		Is accuracy within the blocks within 15%
		Is overall accuracy within 15%
V307 Error Logs		**Is the following correct**
		Are the errors acceptable
V308 Other		Are there any other issues?
Overall Pass Fail:		